BEFORE THE UNITED STATES DEPARTMENT OF ENERGY

Federal Power Act Section 202(c) Emergency Order: Midcontinent Independent System Operator and Northern Indiana Public Service Company LLC	)))))	Order No. 202-26-19
Federal Power Act Section 202(c) Emergency Order: Midcontinent Independent System Operator and CenterPoint Energy Indiana South	))))	Order No. 202-26-20

Exhibit to
Motion to Intervene and Request for Rehearing and Stay of
Public Interest Organizations

Exhibit 138
MISO Fall 2025 Operations Report

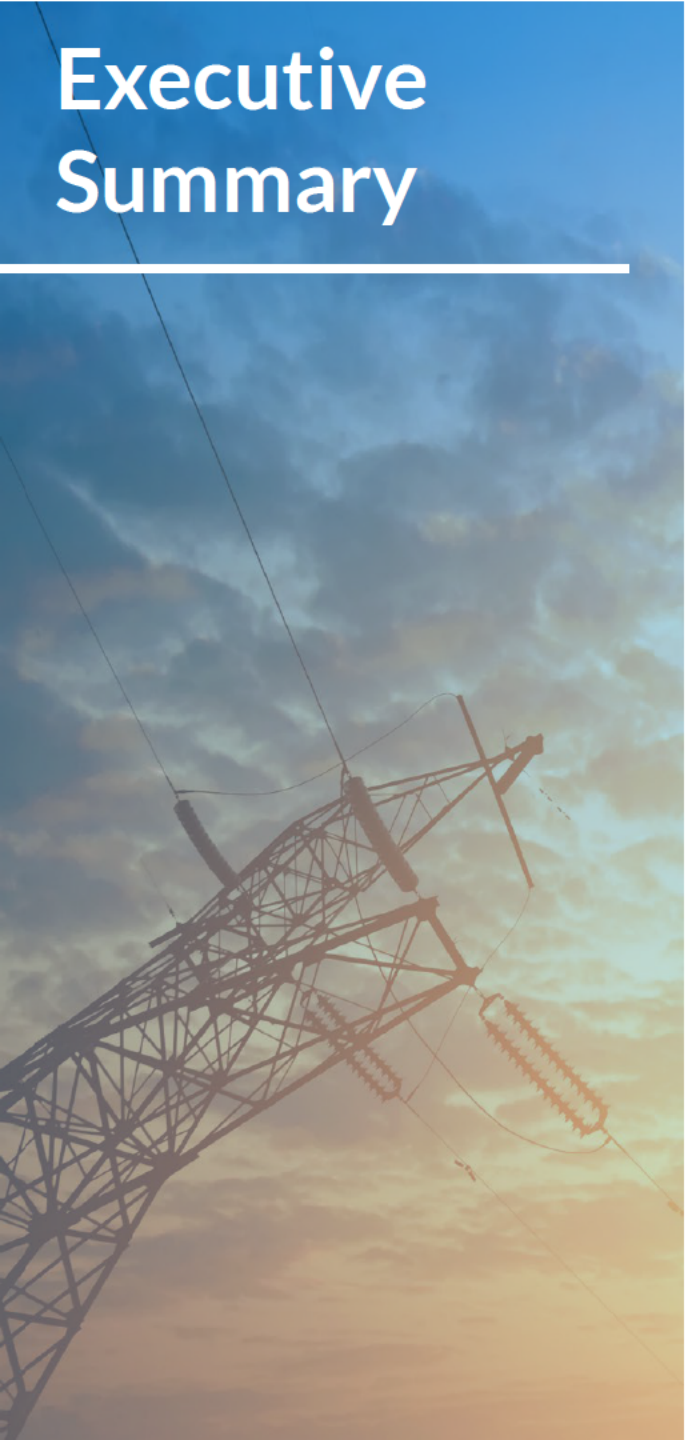


Operations Report

Markets Committee of the Board of Directors

December 9, 2025

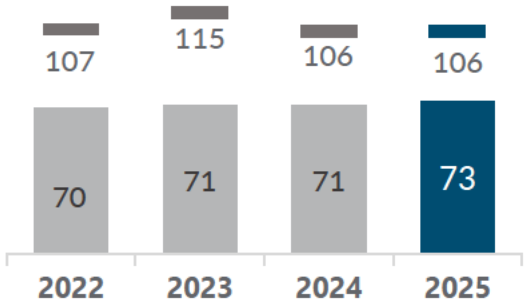
Executive Summary



- MISO's market and operations performed as expected during a mild fall.
- MISO is continually working to review and improve its Operational Risk Model, which will be used this winter to position operations in advance of challenging conditions, helping enable efficient reliability.
- Winter preparedness activities include training and drills for MISO and its members to practice for various conditions.

Reliability, markets and operational functions performed as expected this fall

AVERAGE AND PEAK LOAD (GW)



SYSTEMWIDE PEAK

106 GW

September 16

Fall Forecasted Peak: 110 GW

SOLAR PEAK

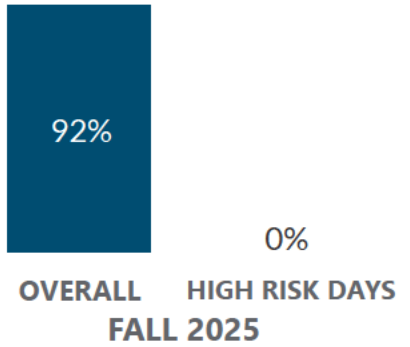
14.5 GW

September 7

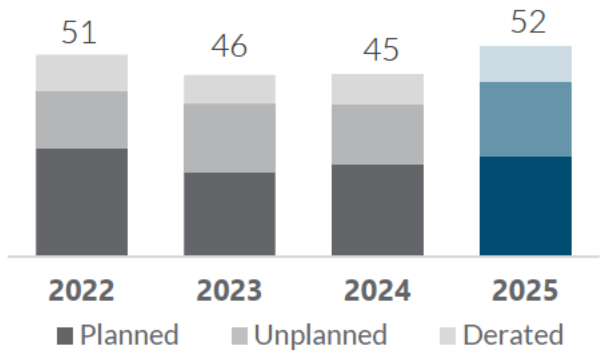
ACTUAL HIGH-RISK DAYS

6

RISK PREDICTION ACCURACY



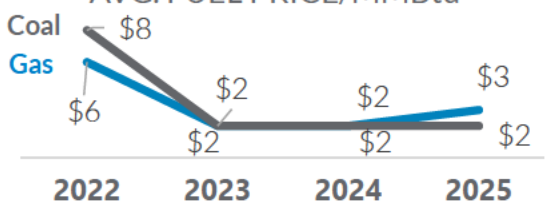
AVERAGE DAILY GENERATION OUTAGES (GW)



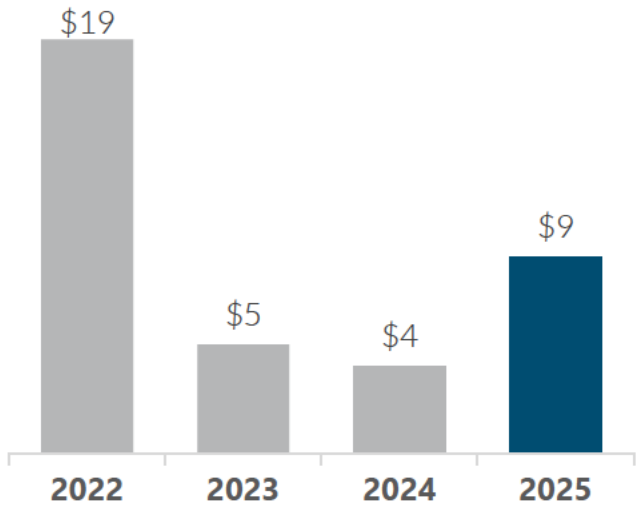
REAL-TIME LMP



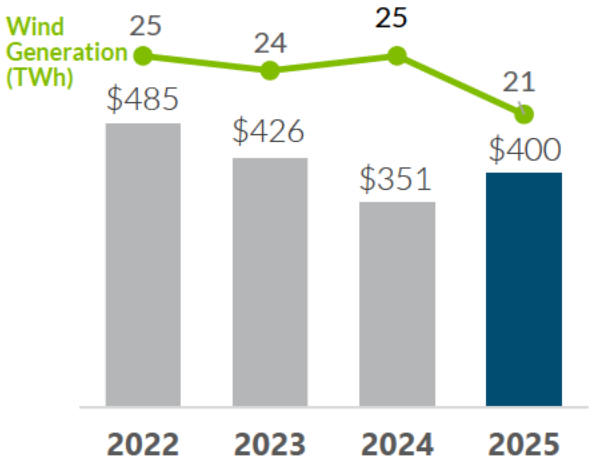
AVG. FUEL PRICE/MMBtu



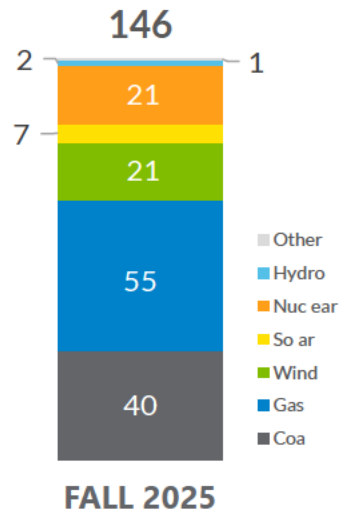
REAL-TIME UPLIFT* PAYMENTS ($M)



REAL-TIME CONGESTION ($M)**



ENERGY FUEL MIX (TWh)



Data shown for fall (September-November) as of 11/23/2025. Some November data not yet available.
Uplift is also known as revenue sufficiency guarantee (RSG); uplift values may change due to resettlement
Real-time congestion cost includes external constraints

MISO's Operational Risk Platform aids in unit commitment management through dynamic reserve products, and will continue to be impactful with planned maturity

OPERATIONAL RISK PLATFORM

MISO's dynamic Short-Term Reserves are set using a machine learning model that is focused on daily sufficiency with plans for maturity and expansion

TODAY

- ✓ Securing more reserves on the system on High-Risk days based on peak hour
- ✓ Informing operational situational awareness and decision making

FUTURE

- Management of additional reserve products
- Reserve requirements based on hourly predictions
- More robust inputs
- Automation

UNIT COMMITMENT EFFICIENCY IMPROVEMENTS

- **Unit Commitment:** Additional investment in Look-Ahead Commitment enhancements and process improvements
- **Reserve Planning:** Dynamic requirements through our Operational Risk Platform
- **Congestion Management:** Continue to improve congestion forecasting and work with stakeholders to address forced outage rates

STI Performance

Metric	YTD Performance
MARKET EFFICIENCY	
Unit Commitment Efficiency	●
Market Funding Efficiency	■
RELIABLITY	
Reliability Control	▼

▼ *Below Threshold* ■ *Threshold* ● *Target* ▲ *Excellent*

STI: Short-Term Incentive

Monthly Operational Metrics

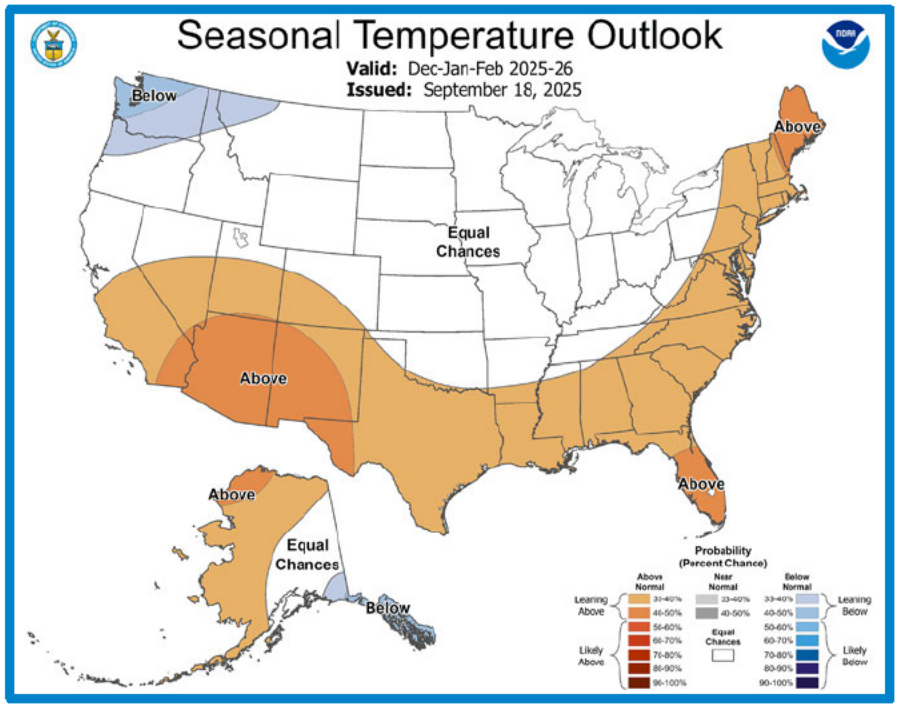
Metric	Oct 2025	Sept 2025	Aug 2025	July 2025	Metric	Oct 2025	Sept 2025	Aug 2025	July 2025
OPERATIONAL EXCELLENCE									
Control Performance – BAAL	●	●	●	●	Control Performance – CPS1 and CPS1 12-month rolling	●	●	●	●
Price Deviation	●	▼	●	▼	Real-Time Obligation fulfilled by Day-Ahead Supply at the Peak Hour	●	●	●	●
Monthly Average Gross Virtual Profitability	●	●	●	●	Day-Ahead Wind Generation Forecast Error	●	●	●	●
FTR Funding	●	●	●	●	Day-Ahead Solar Generation Forecast Error	●	●	●	●
RSG per MWh to Energy Price	■	●	●	●	Tie Line Error	●	●	●	●
Day-Ahead Mid-Term Load Forecast	●	●	●	●	ARS Deployment	●	●	●	●
Short-Term Load Forecast	●	●	●	●					
CUSTOMER SERVICE									
System Impact Study Performance	●	●	●	●	Settlement Disputes	●	●	●	●

● *Expected* ■ *Concern/Monitor* ▼ *Review*

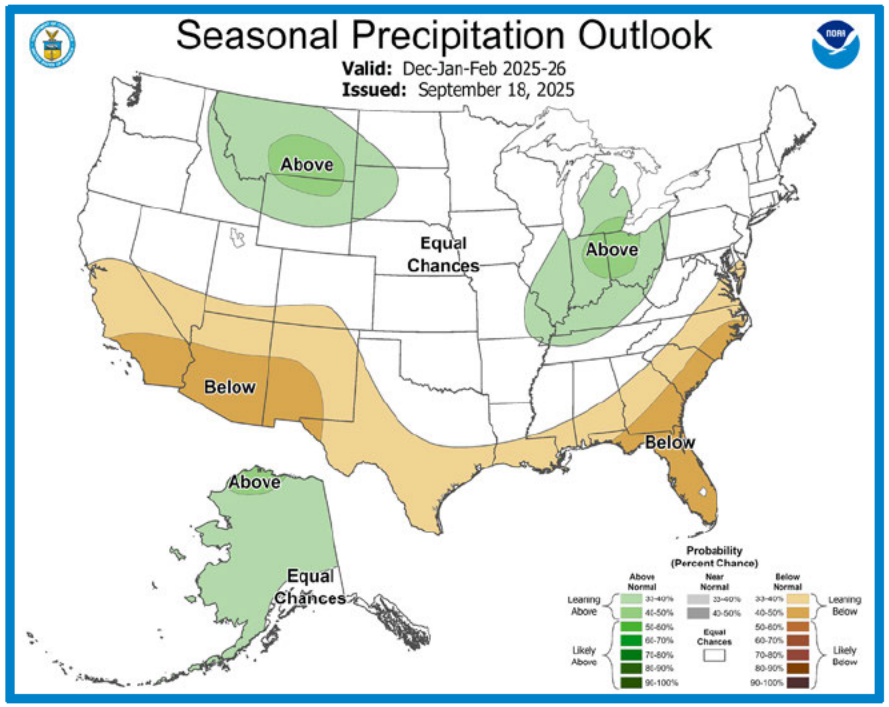
CLICK HERE to see MISO's monthly Operations Reports

MISO and its members evaluate anticipated risks for the winter and prepare for expected challenges, including drills for all steps of the emergency procedures

WINTER 2025-26 WEATHER PROJECTIONS



More variability in temperature is expected in the North and Central regions, while the South is anticipated to be above average



Above-normal precipitation is forecast for the Great Lakes region and drier along the Gulf Coast

WINTER PREPARATIONS

- Winter readiness workshops
- FERC/NERC winter recommendations
- Year-round operator training on normal and abnormal conditions
- Emergency procedure drills with member company operators
- Continuous improvement of processes and procedures

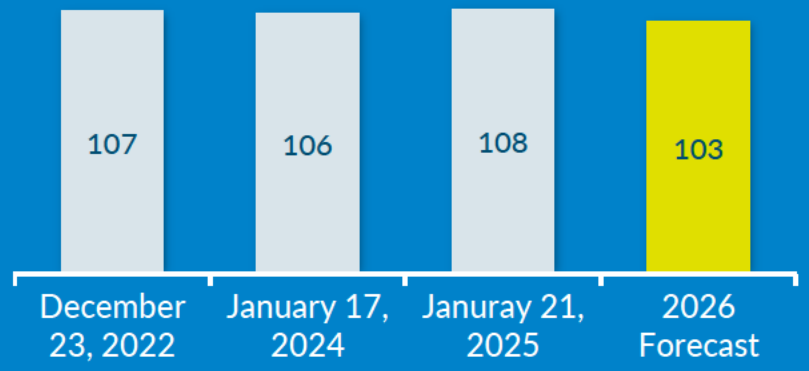
Seasonal outlook maps source: National Oceanic and Atmospheric Administration

The MISO Seasonal Resource Adequacy Construct cleared sufficient resources to cover demand this winter

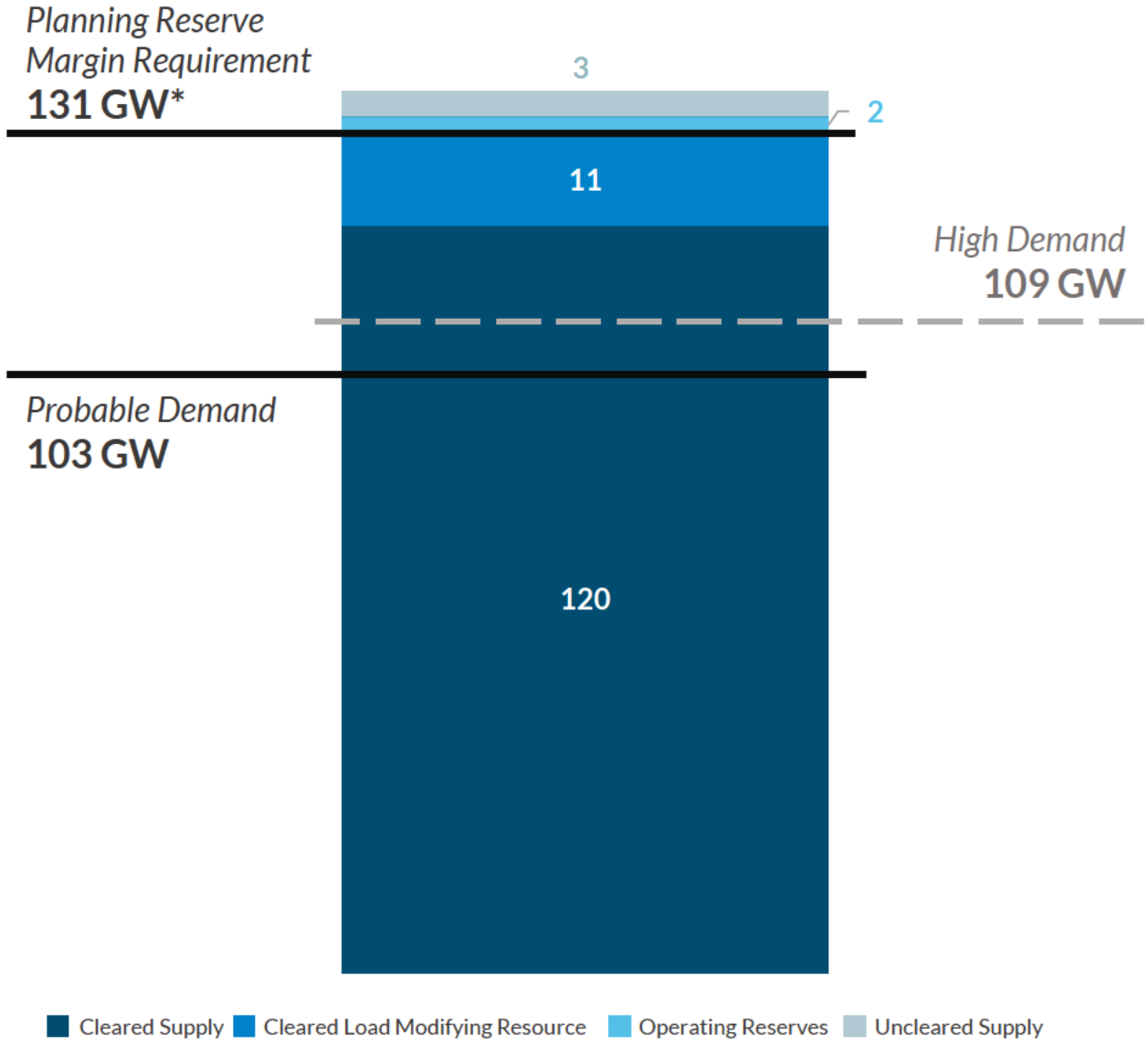
WINTER PRA CLEARING PRICES

All Zones
$33.20/MW-day

WINTER PEAK (GW)



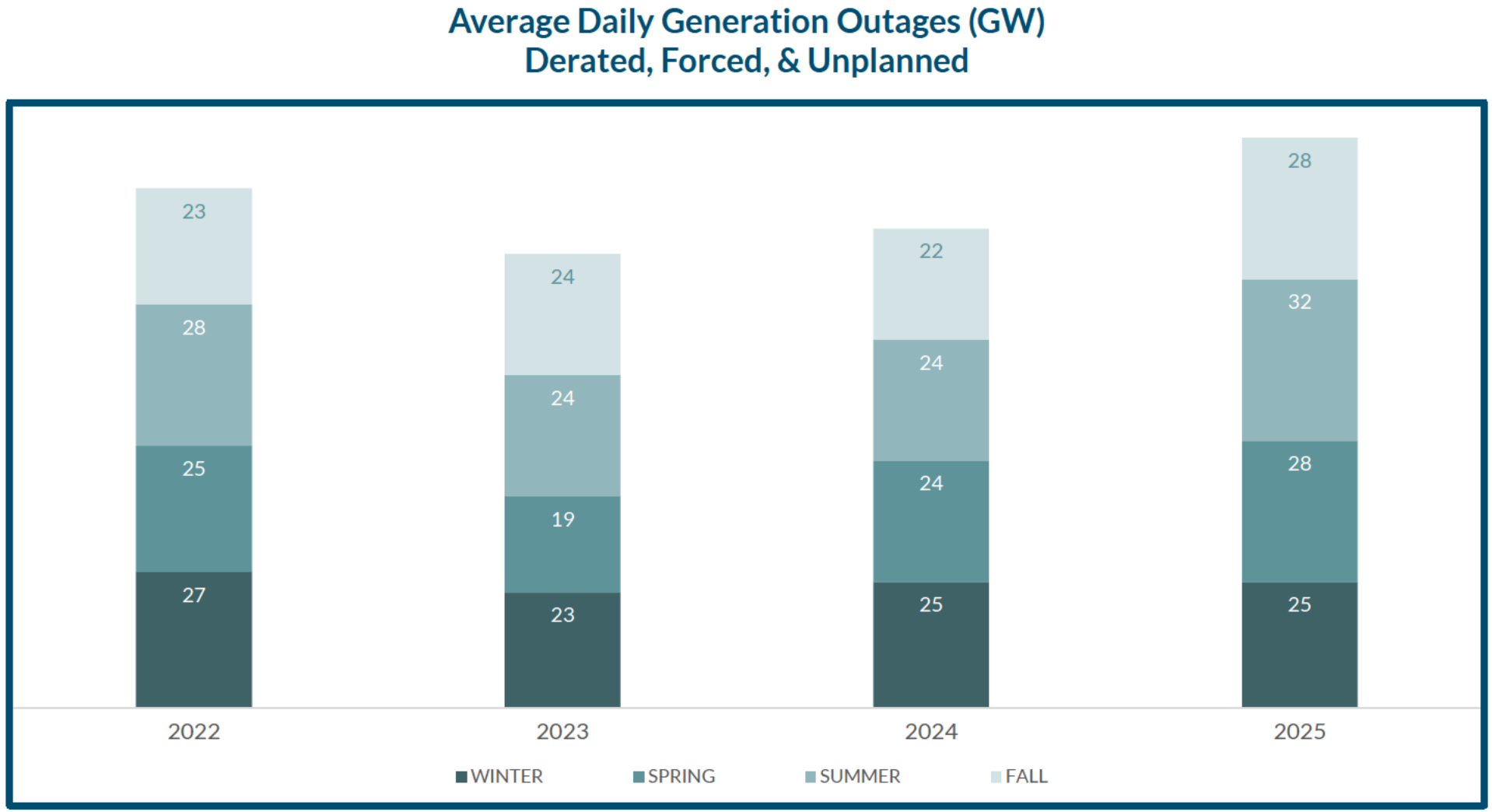
PRA – Planning Resource Auction



Appendix



Increased generation outage rates continued into the fall season



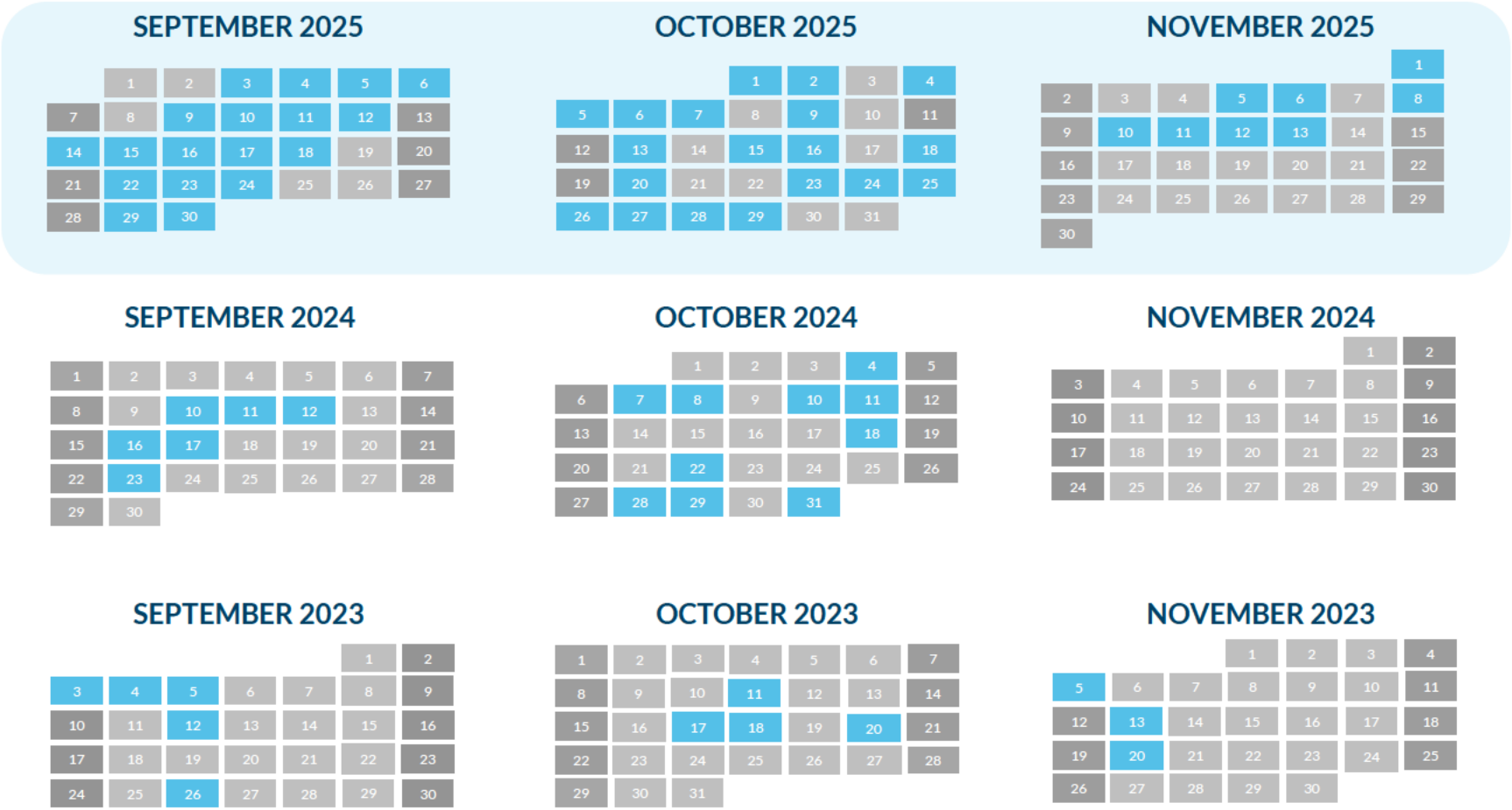
Four metrics fell outside of the expected range this fall

Metric	Status	Comments
Price Percentage Deviation	September Review	Periods of congestion and real-time ancillary service product scarcity pricing throughout the month resulted in price divergence between the Day-Ahead and Real-Time Markets.
RSG Per Megawatt Hour to Energy Price	October Monitor	84% of the total $4.4M of Real-Time RSG MWP for October was paid in the first 19 days of month to resources primarily committed by RAC to manage active transmission constraints caused by increased load demand and decreased resource capacity from the Day-Ahead clearing.

CLICK HERE to see MISO's monthly Operations Reports, which include the charts previously shared in the Appendix of this report

No reliability actions were needed this fall

FALL OPERATING CONDITIONS



Data as of 11/24/2025

Awareness and Weather *Alerts and Warnings* *Reliability Actions and Events*

Details of the Fall Operating Conditions

September

- **09/03 – Footprint:** System Status Level 1
- **09/04 – South Region:** Capacity Advisory* (Texas)
- **09/05 – South Region:** Capacity Advisory* (Texas)
- **09/06 – South Region:** Capacity Advisory* (Texas)
- **09/09 – South Region:** Capacity Advisory* (Texas)
- **09/10 – South Region:** Capacity Advisory* (Texas)
- **09/11 – South Region:** Capacity Advisory* (Texas)
- **09/12 – South Region:** Capacity Advisory* (Texas)
- **09/15 – Footprint:** Geomagnetic Disturbance Warning
- **9/15-9/17 – Footprint:** Conservative Operations
- **9/15-9/17 – Footprint:** Hot Weather Alert
- **9/15-9/18 – Footprint:** Capacity Advisory
- **09/17 – South Region:** Capacity Advisory* (Texas)
- **09/22 – Footprint:** Capacity Advisory
- **09/23 – South Region:** Capacity Advisory* (Texas and Louisiana)
- **09/24 – South Region:** Capacity Advisory* (Texas and Louisiana)
- **9/29-9/30 – Footprint:** Conservative Operations

October

- **10/01 – Footprint:** Geomagnetic Disturbance Warning
- **10/02 – Footprint:** Geomagnetic Disturbance Alert
- **10/04 – South Region:** Capacity Advisory* (Texas)
- **10/05 – South Region:** Capacity Advisory* (Texas)
- **10/06 – Central:** Conservative Operations
- **10/06 – South Region:** Capacity Advisory* (Texas)
- **10/6-10/7 – Central:** Capacity Advisory
- **10/07 – South Region:** Capacity Advisory* (Texas)
- **10/09 – Footprint:** Conservative Operations
- **10/09 – South Region:** Capacity Advisory* (Louisiana)
- **10/13 – Footprint:** System Status Level 1
- **10/15 – South Region:** Capacity Advisory* (Texas)
- **10/16 – South Region:** Capacity Advisory* (Texas)
- **10/18 – South Region:** Capacity Advisory* (Texas)
- **10/20 – AMRN:** System Status Level 1
- **10/23-10/29 – South Region:** Transmission Advisory
- **10/29 – Footprint:** System Status Level 1

November

- **11/01 – South Region:** Capacity Advisory* (Texas)
- **11/5-11/6 – Footprint:** Geomagnetic Disturbance Warning
- **11/6 – Footprint:** Geomagnetic Disturbance Alert
- **11/8 – South Region:** Capacity Advisory* (Texas)
- **11/10 – South Region:** Capacity Advisory* (Texas)
- **11/11 – South Region:** Capacity Advisory* (Texas)
- **11/11 – Footprint:** Geomagnetic Disturbance Warning
- **11/11-11/12 – Footprint:** Geomagnetic Disturbance Alert
- **11/12-11/13 – Footprint:** Geomagnetic Disturbance Warning

**MISO issued Capacity Advisories for South region load pockets to provide proactive notice of elevated reliability risk.*
Data as of 11/24/2025

BEFORE THE UNITED STATES DEPARTMENT OF ENERGY

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Exhibit to
Motion to Intervene and Request for Rehearing and Stay of
Public Interest Organizations

Exhibit 139
Report of the National Energy Policy Development Group

National Energy Policy



Report of the National Energy Policy Development Group

May 2001

Reliable, Affordable, and Environmentally Sound Energy for America's Future

Report of the

National Energy Policy Development Group

"America must have an energy policy that plans for the future, but meets the needs of today. I believe we can develop our natural resources and protect our environment."

— President George W. Bush

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THE VICE PRESIDENT

WASHINGTON

May 16, 2001

The Honorable George W. Bush
President of the United States
The White House
Washington, D.C. 20500

Dear Mr. President:

On behalf of the National Energy Policy Development Group, I submit for your consideration our National Energy Policy report. As you directed us at the outset of your Administration, we have developed a national energy policy designed to help bring together business, government, local communities and citizens to promote dependable, affordable and environmentally sound energy for the future.

The report reflects the requirements and philosophy you set out for our work. It envisions a comprehensive long-term strategy that uses leading edge technology to produce an integrated energy, environmental and economic policy. To achieve a 21st century quality of life -- enhanced by reliable energy and a clean environment -- we must modernize conservation, modernize our infrastructure, increase our energy supplies, including renewables, accelerate the protection and improvement of our environment, and increase our energy security.

We submit these recommendations with optimism. The tasks ahead are great but achievable. To meet our energy challenge, we must put to good use the resources around us and the talents within us. It summons the best of America and offers a healthier environment, a stronger economy and a brighter future for the American people.

Sincerely,

Dick Cheney

Enclosure

PRINTED ON RECYCLED PAPER

Members of the
National Energy Policy Development Group

DICK CHENEY
The Vice President

COLIN L. POWELL
The Secretary of State

PAUL O'NEILL
The Secretary of the Treasury

GALE NORTON
The Secretary of the Interior

ANN M. VENEMAN
The Secretary of Agriculture

DONALD L. EVANS
The Secretary of Commerce

NORMAN Y. MINETA
The Secretary of Transportation

SPENCER ABRAHAM
The Secretary of Energy

JOE M. ALLBAUGH
The Director of the Federal Emergency Management Agency

CHRISTINE TODD WHITMAN
The Administrator of the Environmental Protection Agency

JOSHUA B. BOLTEN
The Assistant to the President and Deputy Chief of Staff for Policy

MITCHELL E. DANIELS
The Director of the Office of Management and Budget

LAWRENCE B. LINDSEY
The Assistant to the President for Economic Policy

RUBEN BARRALES
Deputy Assistant to the President and Director of Intergovernmental Affairs

Executive Director: Andrew D. Lundquist

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7 America's Energy Infrastructure
A Comprehensive Delivery System

8 Strengthening Global Alliances
Enhancing National Energy Security and International Relationships

Appendix One
Summary of Report Recommendations

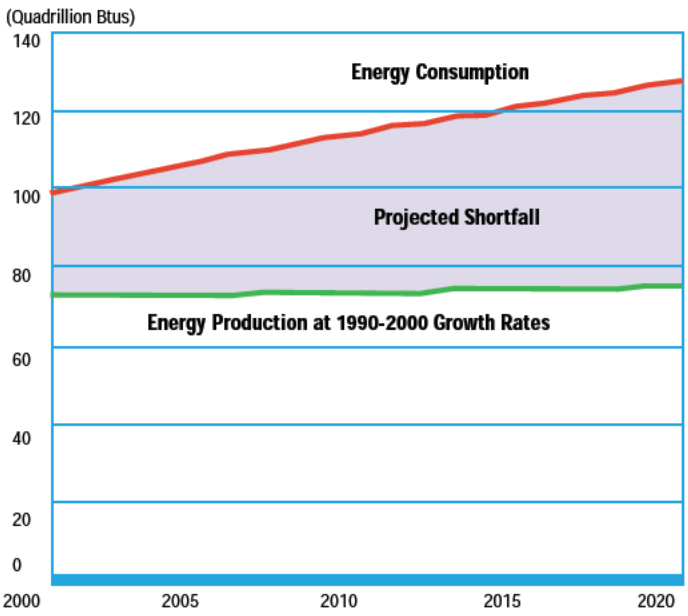
Appendix Two
Glossary

Overview

Reliable, Affordable, and Environmentally Sound Energy for America's Future

In his second week in office, President George W. Bush established the National Energy Policy Development Group, directing it to "develop a national energy policy designed to help the private sector, and, as necessary and appropriate, State and local governments, promote dependable, affordable, and environmentally sound production and distribution of energy for the future." This Overview sets forth the National Energy Policy Development (NEPD) Group's findings and key recommendations for a National Energy Policy.

Figure 1
Growth in U.S. Energy Consumption Is Outpacing Production



Over the next 20 years, growth in U.S. energy consumption will increasingly outpace U.S. energy production, if production only grows at the rate of the last 10 years.

Sources: Sandia National Laboratories and U.S. Department of Energy, Energy Information Administration.

America in the year 2001 faces the most serious energy shortage since the oil embargoes of the 1970s. The effects are already being felt nationwide. Many families face energy bills two to three times higher than they were a year ago. Millions of Americans find themselves dealing with rolling blackouts or brownouts; some employers must lay off workers or curtail production to absorb the rising cost of energy. Drivers across America are paying higher and higher gasoline prices.

Californians have felt these problems most acutely. California actually began the 1990s with a surplus of electricity generating capacity. Yet despite an economic boom, a rapidly growing population, and a corresponding increase in energy needs, California did not add a single new major electric power plant during the 1990s. The result is a demand for electricity that greatly succeeds the amount available.

A fundamental imbalance between supply and demand defines our nation's energy crisis. As the chart illustrates, if energy production increases at the same rate as during the last decade our projected energy needs will far outstrip expected levels of production.

This imbalance, if allowed to continue, will inevitably undermine our economy, our standard of living, and our national security. But it is not beyond our power to correct. America leads the world in scientific achievement, technical skill, and entrepreneurial drive. Within our country are abundant natural resources, unrivaled technology, and unlimited human creativity. With forward-looking leadership and sensible policies, we can meet our fu-



America's expanding economy, growing population, and rising standard of living will be sustained by our unmatched technological know-how.

ture energy demands and promote energy conservation, and do so in environmentally responsible ways that set a standard for the world.

The Challenge

America's energy challenge begins with our expanding economy, growing population, and rising standard of living. Our prosperity and way of life are sustained by energy use. America has the technological know-how and environmentally sound 21st century technologies needed to meet the principal energy challenges we face: promoting energy conservation, repairing and modernizing our energy infrastructure, and increasing our energy supplies in ways that protect and improve the environment. Meeting each of these challenges is critical to expanding our economy, meeting the needs of a growing population, and raising the American standard of living.

We are already working to meet the first challenge: using energy more wisely. Dramatic technological advances in energy efficiency have enabled us to make great strides in conservation, from the operation of farms and factories to the construction of buildings and automobiles. New technology allows us to go about our lives and work with less cost, less effort, and less burden on the natural environment. While such advances cannot alone solve America's energy problems, they can and will continue to play an important role in our energy future.

The second challenge is to repair and expand our energy infrastructure. Our current, outdated network of electric generators, transmission lines, pipelines, and refineries that convert raw materials into usable fuel has been allowed to deteriorate. Oil pipelines and refining capacity are in need of repair and expansion. Not a single major oil refinery has been built in the United States in nearly a generation, causing the kind of bottlenecks that lead to sudden spikes in the price of gasoline. Natural gas distribution, likewise, is hindered by an aging and inadequate network of pipelines. To match supply and demand will require some 38,000 miles of new gas pipelines, along with 255,000 miles of distribution lines. Similarly, an antiquated and inadequate transmission grid prevents us from routing electricity over long distances and thereby avoiding regional blackouts, such as California's.

"America must have an energy policy that plans for the future, but meets the needs of today. I believe we can develop our natural resources and protect our environment."

— President
George W. Bush

Increasing energy supplies while protecting the environment is the third challenge. Even with successful conservation efforts, America will need more energy.

Renewable and alternative fuels offer hope for America's energy future. But they supply only a small fraction of present energy needs. The day they fulfill the bulk of our needs is still years away. Until that day comes, we must continue meeting the nation's energy requirements by the means available to us.

Estimates indicate that over the next 20 years, U.S. oil consumption will increase by 33 percent, natural gas consumption by well over 50 percent, and demand for electricity will rise by 45 percent. If America's energy production grows at the same rate as it did in the 1990s we will face an ever-increasing gap.

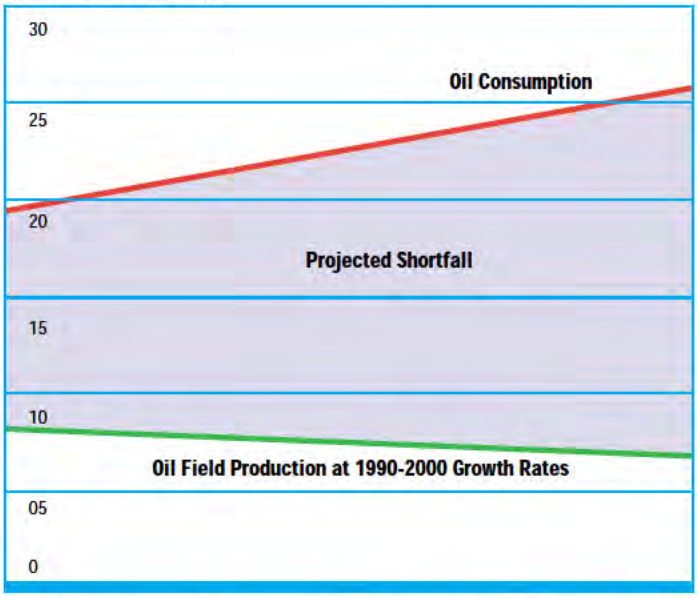
Increases on this scale will require preparation and action today. Yet America has not been bringing on line the necessary supplies and infrastructure.

Extraordinary advances in technology have transformed energy exploration and production. Yet we produce 39 percent less oil today than we did in 1970, leaving us ever more reliant on foreign suppliers. On our present course, America 20 years from now will import nearly two of every three barrels of oil – a condition of increased dependency on foreign powers that do not always have America's interests at heart. Our increasing demand for natural gas – one of the cleanest forms of energy – far exceeds the current rate of production. We should reconsider any regulatory restrictions that do not take technological advances into account.

Figure 2

U.S. Oil Consumption Will Continue to Exceed Production

(Millions of Barrels per Day)



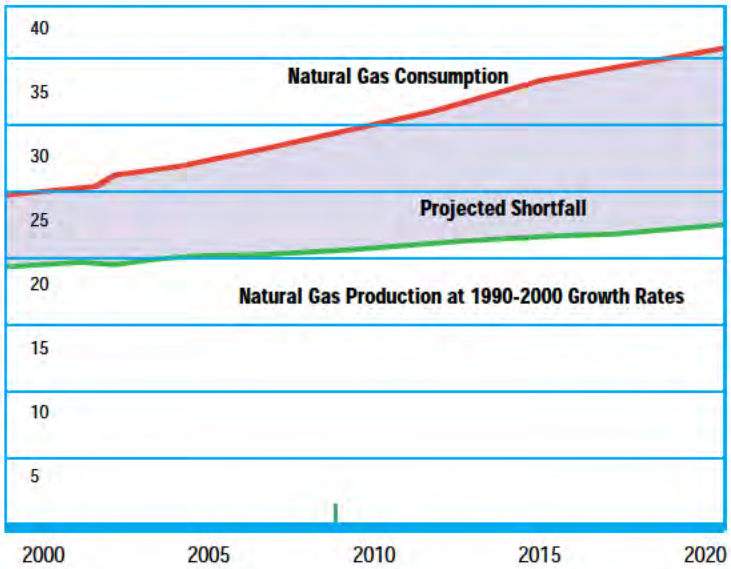
Over the next 20 years, U.S. oil consumption will grow by over 6 million barrels per day. If U.S. oil production follows the same historical pattern of the last 10 years, it will decline by 1.5 million barrels per day. To meet U.S. oil demand, oil and product imports would have to grow by a combined 7.5 million barrels per day. In 2020, U.S. oil production would supply less than 30 percent of U.S. oil needs.

Sources: Sandia National Laboratories and U.S. Department of Energy, Energy Information Administration.

Figure 3

U.S. Natural Gas Consumption Is Outpacing Production

(Trillion Cubic Feet)



Over the next 20 years, U.S. natural gas consumption will grow by over 50 percent. At the same time, U.S. natural gas production will grow by only 14 percent, if it grows at the rate of the last 10 years.

Sources: Sandia National Laboratories and U.S. Department of Energy, Energy Information Administration.

erview chart

We have a similar opportunity to increase our supplies of electricity. To meet projected demand over the next two decades, America must have in place between 1,300 and 1,900 new electric plants. Much of this new generation will be fueled by natural gas. However, existing and new technologies offer us the opportunity to expand nuclear generation as well. Nuclear power today accounts for 20 percent of our country's electricity. This power source, which causes no greenhouse gas emissions, can play an expanding part in our energy future.

The recommendations of this report address the energy challenges facing America. Taken together, they offer the thorough and responsible energy plan our nation has long needed.

Components of the National Energy Policy

The National Energy Policy we propose follows three basic principles:

- The Policy is a long-term, comprehensive strategy. Our energy crisis has been years in the making, and will take years to put fully behind us.
- The Policy will advance new, environmentally friendly technologies to increase energy supplies and encourage cleaner, more efficient energy use.
- The Policy seeks to raise the living standards of the American people, recognizing that to do so our country must fully integrate its energy, environmental, and economic policies.

Applying these principles, we urge action to meet five specific national goals. America must modernize conservation, modernize our energy infrastructure, increase energy supplies, accelerate the protection and improvement of the environment, and increase our nation's energy security.

Modernize Conservation

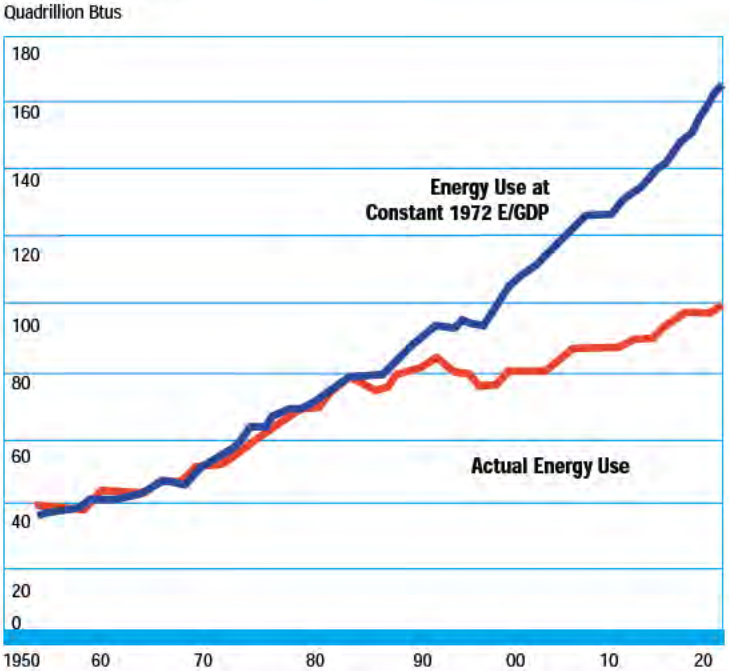
Americans share the goal of energy conservation. The best way of meeting this goal is to increase energy efficiency by applying new technology – raising productivity, reducing waste, and trimming costs. In addition, it holds out great hope for improving the quality of the environment. American families, communities, and businesses all depend upon reliable and affordable energy services for their well being and safety. From transportation to communication, from air conditioning to lighting, energy is critical to nearly everything we do in life and work. Public policy can and should encourage energy conservation.

Over the past three decades, America has made impressive gains in energy efficiency. Today's automobiles, for example, use about 60 percent of the gasoline they

"Here we aim to continue a path of uninterrupted progress in many fields... New technologies are proving that we can save energy without sacrificing our standard of living. And we're going to encourage it in every way possible."

— Vice President
Richard B. Cheney

Figure 4
U.S. Economy is More Energy Efficient (Energy Intensity)
Primary Energy Use



Improvements in energy efficiency since the 1970s have had a major impact in meeting national energy needs relative to new supply. If the intensity of U.S. energy use had remained constant since 1972, consumption would have been about 70 quadrillion Btus (74 percent) higher in 1999 than it actually was.

Source: U.S. Department of Energy, Energy Information Administration.

did in 1972, while new refrigerators require just one-third the electricity they did 30 years ago. As a result, since 1973, the U.S. economy has grown by 126 percent, while energy use has increased by only 30 percent. In the 1990s alone, manufacturing output expanded by 41 percent, while industrial electricity consumption grew by only 11 percent. We must build on this progress and strengthen America's commitment to energy efficiency and conservation.

The National Energy Policy builds on our nation's successful track record and will promote further improvements in the productive and efficient use of energy. This report includes recommendations to:

- Direct federal agencies to take appropriate actions to responsibly conserve energy use at their facilities, especially during periods of peak demand in regions where electricity shortages are possible, and to report to the President on actions taken.
- Increase funding for renewable energy and energy efficiency research and development programs that are performance-based and cost-shared.
- Create an income tax credit for the purchase of hybrid and fuel cell vehicles to promote fuel-efficient vehicles.
- Extend the Department of Energy's "Energy Star" efficiency program to include schools, retail buildings, health care facilities, and homes and extend the "Energy Star" labeling program to additional products and appliances.
- Fund the federal government's Intelligent Transportation Systems program, the fuel cell powered transit bus program, and the Clean Buses program.
- Provide a tax incentive and streamline permitting to accelerate the development of clean Combined Heat and Power technology.
- Direct the Secretary of Transportation to review and provide recommendations on establishing Corporate Average Fuel Economy (CAFE) standards with due consideration to the National Academy of Sciences study of CAFE standards to be released in July, 2001.

Modernize Our Energy Infrastructure

The energy we use passes through a vast nationwide network of generating facilities, transmission lines, pipelines, and refineries that converts raw resources into usable fuel and power. That system is deteriorating, and is now strained to capacity.

One reason for this is government regulation, often excessive and redundant. Regulation is needed in such a complex field, but it has become overly burdensome. Regulatory hurdles, delays in issuing permits, and economic uncertainty are limiting investment in new facilities, making our energy markets more vulnerable to transmission bottlenecks, price spikes and supply disruptions. America needs more environmentally-sound energy projects to connect supply sources to growing markets and to deliver energy to homes and business.

To reduce the incidence of electricity blackouts, we must greatly enhance our ability to transmit electric power between geographic regions, that is, sending power to where it is needed from where it is produced. Most of America's transmission lines, substations, and transformers were built when utilities were tightly regulated and provided service only within their assigned regions. The system is simply unequipped for large-scale swapping of power in the highly competitive market of the 21st century.

The National Energy Policy will modernize and expand our energy infrastructure in order to ensure that energy supplies can be safely, reliably, and affordably transported to homes and businesses. This report includes recommendations to:

- Direct agencies to improve pipeline safety and expedite pipeline permitting.
- Issue an Executive Order directing federal agencies to expedite permits and coordinate federal, state, and local actions necessary for energy-related project approvals on a national basis

"For the electricity we need, we must be ambitious. Transmission grids stand in need of repair, upgrading, and expansion. . . . If we put these connections in place, we'll go a long way toward avoiding future blackouts."

— Vice President
Richard B. Cheney

in an environmentally sound manner, and establish an interagency task force chaired by the Council on Environmental Quality. The task force will ensure that federal agencies set up appropriate mechanisms to coordinate federal, state and local permitting activity in particular regions where increased activity is expected.

- Grant authority to obtain rights-of-way for electricity transmission lines with the goal of creating a reliable national transmission grid. Similar authority already exists for natural gas pipelines and highways.
- Enact comprehensive electricity legislation that promotes competition, encourages new generation, protects consumers, enhances reliability, and promotes renewable energy.
- Implement administrative and regulatory changes to improve the reliability of the interstate transmission system and enact legislation to provide for enforcement of electricity reliability standards.
- Expand the Energy Department's research and development on transmission reliability and superconductivity.

Increase Energy Supplies

A primary goal of the National Energy Policy is to add supply from diverse sources. This means domestic oil, gas, and coal. It also means hydropower and nuclear power. And it means making greater use of non-hydro renewable sources now available.

One aspect of the present crisis is an increased dependence, not only on foreign oil, but on a narrow range of energy options. For example, about 90 percent of all new electricity plants currently under construction will be fueled by natural gas. While natural gas has many advantages, an over-reliance on any one fuel source leaves consumers vulnerable to price spikes and supply disruptions. There are several other fuel sources available that can help meet our needs.

Currently, the U.S. has enough coal to last for another 250 years. Yet very few coal-powered electric plants are now under construction. Research into clean coal technologies may increase the attractiveness of coal as a source for new generation plants.

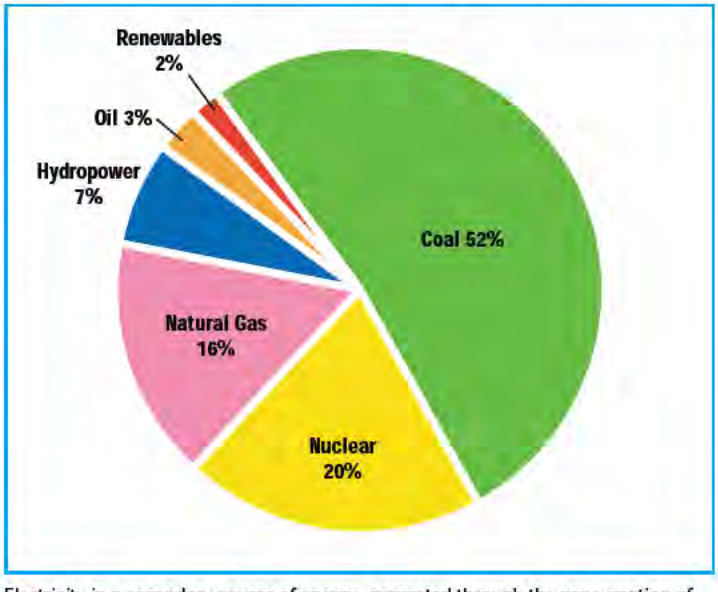
Nuclear power plants serve millions of American homes and businesses, have a dependable record for safety and efficiency, and discharge no greenhouse gases into the atmosphere. As noted earlier, these facilities currently generate 20 percent of all electricity in America, and more than 40 percent of electricity generated in 10 states in the Northeast, South, and Midwest. Other nations, such as Japan and France, generate a much higher percentage of their electricity from nuclear power. Yet the number of nuclear plants in America is actually projected to decline in coming years, as old plants close and none are built to replace them.

Enormous advances in technology have made oil and natural gas exploration and production both more efficient and more environmentally sound. Better technology means fewer rigs, more accurate drilling, greater resource recovery and envi-

"As a country, we have demanded more and more energy. But we have not brought on line the supplies needed to meet that demand.... We can explore for energy, we can produce energy and use it, and we can do so with a decent regard for the natural environment."

—Vice President
Richard B. Cheney

Figure 5
Fuel Sources for Electricity Generation in 2000



Electricity is a secondary source of energy, generated through the consumption of primary sources. Coal and nuclear energy account for nearly 75 percent of U.S. electricity generation.

Source: U.S. Department of Energy, Energy Information Administration

ronmentally friendly exploration. Drilling pads are 80 percent smaller than a generation ago. High-tech drilling allows us to access supplies five to six miles away from a single compact drilling site, leaving sensitive wetlands and wildlife habitats undisturbed. Yet the current regulatory structure fails to take sufficient account of these extraordinary advances, excessively restricting the environmentally safe production of energy from many known sources.

Our policy will increase and diversify our nation's sources of traditional and alternative fuels in order to furnish families and businesses with reliable and affordable energy, to enhance national security, and to improve the environment. This report includes recommendations to:

- Issue an Executive Order directing all federal agencies to include in any regulatory action that could significantly and adversely affect energy supplies a detailed statement on the energy impact of the proposed action.
- Open a small fraction of the Arctic National Wildlife Refuge to environmentally regulated exploration and production using leading-edge technology. Examine the potential for the regulated increase in oil and natural gas development on other federal lands.
- Earmark $1.2 billion of bid bonuses from the environmentally responsible leasing of ANWR to fund research into alternative and renewable energy resources – including wind, solar, biomass, and geothermal.
- Enact legislation to expand existing alternative fuels tax incentives to include landfills that capture methane gas emissions for electricity generation and to electricity produced from wind and biomass. Extend the number of eligible biomass sources to include forest-related sources, agricultural sources, and certain urban sources.
- Provide $2 billion over 10 years to fund clean coal technology research and a new credit for electricity produced from biomass co-fired with coal.
- Direct federal agencies to streamline the hydropower relicensing process with proper regard given to environmental factors.
- Provide for the safe expansion of nuclear energy by establishing a national repository for nuclear waste, and by streamlining the licensing of nuclear power plants.

Accelerate Protection and Improvement of the Environment

America's commitment to environmental protection runs deep. We are all aware of past excesses in our use of the natural world and its resources. No one wishes to see them repeated. In the 21st century, the ethic of good stewardship is well established in American life and law.

We do not accept the false choice between environmental protection and energy production. An integrated approach to policy can yield a cleaner environment, a stronger economy, and a sufficient supply of energy for our future. The primary reason for that has been steady advances in the technology of locating, producing, and using energy. Since 1970, emissions of key air emissions are down 31 percent. Cars today emit 85 percent less carbon monoxide than 30 years ago. Lead emissions are down 90 percent. Lead levels in ambient air today are 98 percent lower than they were in 1970. America is using more, and polluting less.

One of the factors harming the environment today is the very lack of a comprehensive, long-term national energy policy. States confronting blackouts must take desperate measures, often at the expense of environmental standards, requesting waivers of environmental rules, and delaying the implementation of anti-pollution efforts. Shortfalls in electricity generating capacity and short-sighted policies have blocked construction of new, cleaner plants, leaving no choice but to rely on older, inefficient plants to meet demand. The increased use of emergency power sources, such as diesel generators, results in greater air pollution.

New anti-pollution technologies hold great promise for the environment. The same can be said of 21st century power generators that must soon replace older models; signifi-

"We will insist on protecting and enhancing the environment, showing consideration for the air and natural lands and watersheds of our country."

— Vice President
Richard B. Cheney

cant new resources for land conservation efforts; and continued research into renewable energy sources. All have a place in the National Energy Policy.

The National Energy Policy will build upon our nation's successful track record and will promote further improvements in the productive and efficient use of energy. This report includes recommendations to:

- Enact "multi-pollutant" legislation to establish a flexible, market-based program to significantly reduce and cap emissions of sulfur dioxide, nitrogen oxides, and mercury from electric power generators.
- Increase exports of environmentally friendly, market-ready U.S. technologies that generate a clean environment and increase energy efficiency.
- Establish a new "Royalties Conservation Fund" and earmark royalties from new, clean oil and gas exploration in ANWR to fund land conservation efforts.
- Implement new guidelines to reduce truck idling emissions at truck stops.

Increase Energy Security.

The National Energy Policy seeks to lessen the impact on Americans of energy price volatility and supply uncertainty. Such uncertainty increases as we reduce America's dependence on foreign sources of energy. At the same time, however, we recognize that a significant percentage of our resources will come from overseas. Energy security must be a priority of U.S. trade and foreign policy.

We must look beyond our borders and restore America's credibility with overseas suppliers. In addition, we must build strong relationships with energy-producing nations in our own hemisphere, improving the outlook for trade, investment, and reliable supplies.

Energy security also requires preparing our nation for supply emergencies, and assisting low-income Americans who are most vulnerable in times of supply disruption, price spikes, and extreme weather.

To ensure energy security for our nation and its families, our report includes these recommendations:

- Dedicate new funds to the Low Income Home Energy Assistance Program by funneling a portion of oil and gas royalty payments to LIHEAP when oil and natural gas prices exceed a certain amount.
- Double funding for the Department of Energy's Weatherization Assistance Program, increasing funding by $1.4 billion over 10 years.
- Direct the Federal Emergency Management Administration to prepare for potential energy-related emergencies.
- Support a North American Energy Framework to expand and accelerate cross-border energy investment, oil and gas pipelines, and electricity grid connections by streamlining and expediting permitting procedures with Mexico and Canada. Direct federal agencies to expedite necessary permits for a gas pipeline route from Alaska to the lower 48 states.

Looking Toward the Future

The President's goal of reliable, affordable, and environmentally sound energy supplies will not be reached overnight. It will call forth innovations in science, research, and engineering. It will require time and the best efforts of leaders in both political parties. It will require also that we deal with the facts as they are, meeting serious problems in a serious way. The complacency of the past decade must now give way to swift but well-considered action.

Present trends are not encouraging, but they are not immutable. They are among today's most urgent challenges, and well within our power to overcome. Our country has met many great tests. Some have imposed extreme hardship and sacrifice. Others have demanded only resolve, ingenuity, and clarity of purpose. Such is the case with energy today.

We submit these recommendations with optimism. We believe that the tasks ahead, while great, are achievable. The energy crisis is a call to put to good use the resources around us, and the talents within us. It summons the best of America, and offers the best of rewards – in new jobs, a healthier environment, a stronger economy, and a brighter future for our people.

"The goals of this strategy are clear: to ensure a steady supply of affordable energy for America's homes and businesses and industries."

— President
George W. Bush

Taking Stock

Energy Challenges Facing the United States

America's current energy challenges can be met with rapidly improving technology, dedicated leadership, and a comprehensive approach to our energy needs. Our challenge is clear—we must use technology to reduce demand for energy, repair and maintain our energy infrastructure, and increase energy supply. Today, the United States remains the world's undisputed technological leader; but recent events have demonstrated that we have yet to integrate 21st-century technology into an energy plan that is focused on wise energy use, production, efficiency, and conservation.

Prices today for gasoline, heating oil, and natural gas are dramatically higher than they were only a year ago. In California, homeowners, farmers, and businesses face soaring electricity prices, rolling blackouts, increasing financial turmoil, and an uncertain energy future. Our nation's dependence on foreign sources of oil is at an all-time high and is expected to grow. Current high energy prices and supply shortages are hurting U.S. consumers and businesses, as well as their prospects for continued economic growth.

Our national energy policy must be comprehensive in scope. It must protect our environment. It must also increase our supply of domestic oil, natural gas, coal, nuclear, and renewable energy sources. Our failure over the past several years to modernize our energy infrastructure—the network of transmission lines, gas pipelines, and oil refineries that transports our energy to consumers and converts raw materials into usable fuels—is a result of the lack of careful planning and lack of a comprehensive national energy plan. The United States faces serious energy challenges: electricity shortages and disruptions in California and elsewhere in the West, dramatic increases in gasoline prices due to record-low inventories, a strained supply system, and continued dependence on foreign suppliers. These challenges have developed from years of neglect and can only be addressed with the implementation of sound policy. There are no easy, short-term solutions.

Our increased dependence on foreign oil profoundly illustrates our nation's failure to establish an effective energy policy. Between 1991 and 2000, Americans used 17 percent more energy than in the previous decade, while during that same period, domestic energy production rose by only 2.3 percent. While U.S. production of coal, natural gas, nuclear energy, and renewable energy has increased somewhat in recent years, these increases have been largely offset by declines in domestic oil production. As a result, America has met almost all of its increased energy demand over the past ten years with increased imports.

U.S. energy consumption is projected to increase by about 32 percent by 2020. Unless a comprehensive national energy policy is adopted, Americans will continue to feel the effects of an inadequate electrical transmission grid, a pipeline system stretched to capacity, insufficient domestic energy supply, and a regional imbalance in supply sources. It is important that we meet these challenges with a comprehensive energy plan that takes a long-term approach to meeting our energy needs.



The U.S. economy depends on reliable and affordable energy. In the coming months, we face several serious long-term energy challenges: electricity shortages and disruptions in California and the West, dramatic increases in gasoline prices due to record-low inventories, a strained supply system, and continued dependence on foreign suppliers.

Philadelphia Convention & Visitors Bureau



California's Energy Challenge

Recent and looming electricity blackouts in California demonstrate the problem of neglecting energy supply. They also foretell the consequences of failing to implement a long-term energy plan for our nation as a whole. Though weather conditions and design flaws in California's electricity restructuring plan contributed, the California electricity crisis is at heart a supply crisis.

Since 1995, California's peak summer demand for electricity has risen by at least 5,500 megawatts (MW), while in-state generation has failed to keep pace. California's generation shortfall did not stem from a lack of interest in building capacity. Since 1997, power producers filed applications to build an additional 14,000 MW of new capacity in California.

In addition to a lack of new generation, a crucial transmission bottleneck in the middle of the state—called Path 15—prevents power in the south from being shipped to the north during emergencies.

This year, reduced hydropower availability due to low rainfall, higher than expected unplanned plant outages, and the financial problems of California's utilities exacerbated this growing supply–demand imbalance. As a result, California's supply problem turned into a crisis, resulting in soaring electricity bills for homes and businesses and rolling blackouts.

In part due to the interconnected nature of the western electricity grid, California's critical electricity shortages have helped to drive up electricity costs in the West.

Unfortunately, there are no short-term solutions to long-term neglect. It can take new power plants and transmission facilities years to site, permit, and construct. Despite expedited federal permitting, California's emergency efforts to increase new generation by 5,000 MW by July appear to be falling short. Less than 2,000 MW of new generation is expected to be in place by summer. Even with aggressive conservation measures, peak demand this summer is projected to outstrip supply by several thousand megawatts. The California grid operator expects more than 30 days of blackouts.

California officials have warned that the crisis may last several years. Though California's efforts to increase generation may not suffice to prevent blackouts this summer, if continued and strengthened, they promise to limit the duration of the crisis.

Recommendations:

★ The National Energy Policy Development (NEPD) Group recommends that the President issue an Executive Order to direct all federal agencies to include in any regulatory action that could significantly and adversely affect energy supplies, distribution, or use, a detailed statement on (1) the energy impact of the proposed action, (2) any adverse energy effects that cannot be avoided should the proposal be implemented, and (3) alternatives to the proposed action. The agencies would be directed to include this statement in all submissions to the Office of Management and Budget of proposed regulations covered by Executive Order 12866, as well as in all notices of proposed regulations published in the Federal Register.

★ The NEPD Group recommends that the President direct the executive agencies to work closely with Congress to implement the legislative components of a national energy policy.

Conservation and Energy Efficiency

Conservation and energy efficiency are crucial components of a national energy plan. Energy efficiency is the ability to use less energy to produce the same amount of useful work or services. Conservation is closely related and is simply using less energy. Improved energy efficiency and conservation reduces energy consumption and energy costs, while maintaining equivalent service in our homes, offices, factories, and automobiles. Greater energy

efficiency helps the United States reduce energy imports, the likelihood of energy shortages, emissions, and the volatility of energy prices.

Over the last three decades, the United States has significantly improved its energy efficiency by developing and expanding the use of energy efficient technologies. Although our economy has grown by 126 percent since 1973, our energy use has increased by only 30 percent. Had energy use kept pace with economic growth, the nation would have consumed 171 quadrillion British thermal units (Btus) last year instead of 99 quadrillion Btus.

About a third to a half of these savings resulted from shifts in the economy, such as the growth of the service sector. The other half to two-thirds resulted from greater energy efficiency. Technological improvements in energy efficiency allow consumers to enjoy more energy services without commensurate increases in energy demand. The rate at which these efficiency improvements are made varies over time, depending on the extent to which factors—such as energy policies, research and development, prices, and market regulations—encourage the development of new, efficient products and consumer investment in these products. An increased rate of improvement in energy efficiency can have a large impact on energy supply and infrastructure needs, reducing the need for new power plants and other energy resources, along with reduced stress on the energy supply infrastructure.

Load management is the ability to adjust energy loads to reflect immediate supply conditions. In the very short term, direct appeals for conservation can ease strained energy supply markets for a time. Over the longer run, the ability to adjust demand on an as-needed basis can be an important source of energy reserves, resulting in lower energy bills for participating customers.

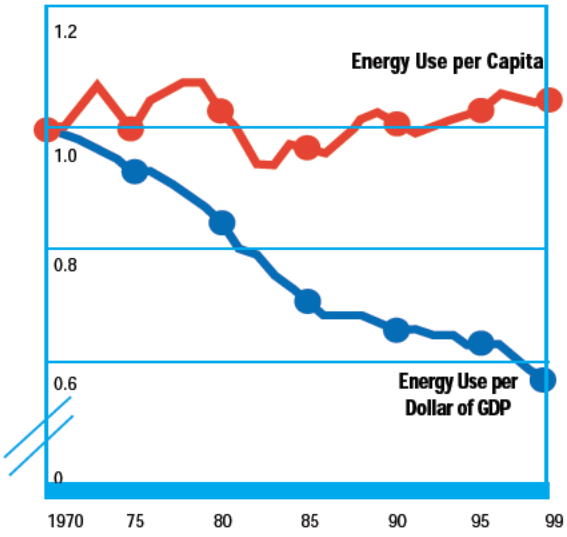
The impact that improvements in energy efficiency can have on energy supply markets grows over time. Electricity demand is projected to rise by 1.8 percent a year over the next 20 years, requiring the addition of some 393,000 MW of generation capacity. At the same time, energy efficiency is projected to continue to improve between 2000 and 2020. A decrease in demand from 1.8 percent to 1.5 percent would reduce the need for new generating capacity next year by about 2,000 MW. Extending that reduction over the next 20 years would reduce the need for new generation by 60,000 to 66,000 MW.

While this projection shows that conservation can help ensure the United States has adequate energy supplies for the future, it also shows that conservation alone is not the answer. Even with more conservation, the U.S. will need more energy supplies. Today, new technologies offer new opportunities to enhance our energy efficiency. As these technologies gain market acceptance, they will help ensure a reliable and affordable energy and electric power supply for the nation.

Energy Intensity

The energy intensity of the U.S. economy is measured by the amount of energy used to produce a dollar's worth of gross domestic product (GDP). It now takes only about 56 percent of the energy required in 1970 to produce a

Figure 1-1
U.S. Energy Use per Capita and per Dollar of GDP: 1970–1999
(Index: 1970 = 1)



The energy intensity of the U.S. economy is measured by the amount of energy used to produce a dollar's worth of gross domestic product (GDP). By that yardstick, U.S. energy intensity declined significantly between 1970 and 1985, and has continued to decline, albeit at a slower rate.

Source: U.S. Department of Energy, Energy Information Administration.

Measures of Electrical Power

A watt is a measure of the amount of energy that can be produced during a specific period of time.

1 kilowatt (KW)= 1,000 watts
1 megawatt (MW)=1million watts
1 gigawatt (GW)=1 billion watts
1 terawatt (TW)=1 trillion watts

U.S. Energy Efficiency Is Improving

- New home refrigerators now use about one-third less energy than they did in 1972.
- New commercial fluorescent lighting systems use less than half the energy they did during the 1980s.
- Federal buildings now use about 20 percent less energy per square foot since 1985.
- Industrial energy use per unit of output declined by 25 percent from 1980 to 1999.
- The chemical industry's energy use per unit of output has declined by roughly 40 percent in the past 25 years.
- The U.S. government has reduced its energy use in buildings by over 20 percent since 1985.
- The amount of energy required to generate 1 kilowatt-hour of electricity has declined by 10 percent since 1980.

What Causes Transmission Constraints?

When additional electricity flow from one area exceeds a circuit's capacity to carry that flow to another area, the overloaded circuit becomes congested and blocks a steady flow of power. To prevent transmission bottlenecks, system operators curtail transactions between areas or increase generation on the side of the constraint where the electricity is flowing and reduce generation on the opposite side. Transmission constraints result in price differences between regions that exceed differences due to line losses, because electricity can no longer flow freely to the affected area.

dollar of GDP today (Figure 1-1). This reduction is attributable to improved energy efficiency, as well as to structural changes in the economy, particularly the relative decline of energy-intensive industries.

The decline in the nation's energy intensity accelerated between 1999 and 2000, a period when nonenergy-intensive industries experienced rapid growth. Energy intensity is projected to continue to decline through 2020 at an average rate of 1.6 percent a year. This is a slower rate of decline than experienced in the 1970s and early 1980s, which was characterized by high energy prices and a shift to less energy-intensive industries, but is a more rapid rate of decline than experienced on average during the latter part of the 1980s and the 1990s.

Challenges Confronting Electricity Supply

Our nation's electricity supply has failed to keep pace with growing demand. This imbalance is projected to persist into the future. The adverse consequences have manifested themselves most severely in the West, where supply shortages have led to high prices and even blackouts. In other regions, inadequate supply threatens the reliability and affordability of electric power.

Large amounts of new generating capacity are slated for installation around the country from 2001 to 2004. However, there is a geographic mismatch between where we will generate energy and where it is needed. For example, little capacity is being added where it is most needed, such as in California and eastern New York.



A pressing long-term electricity challenge is to build enough new generation and transmission capacity to meet projected growth in demand.

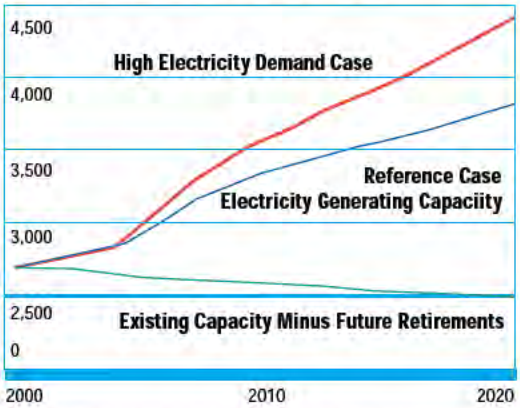
Electricity supply conditions in the Southeast are expected to be tight in the summer of 2001, much as they have been the previous two years. The Northeast may also face supply shortages. If the temperatures of the summer of 2000 had been normal rather than unseasonably cool, New York and New England would most likely have experienced electricity supply shortfalls and price spikes. Critical supply problems could arise if the weather in the summer of 2001 is unusually warm or if plant outages rise above average levels.

Our nation's most pressing long-term electricity challenge is to build enough new generation and transmission capacity to meet projected growth in demand. Across the country, we are seeing the same signs that California faced in the mid-1990s: significant economic regulatory uncertainty, which can result in inadequate supply. This level of uncertainty can vary across the country, depending on state and local regulations. Of the approximately 43,000 MW of new generating capacity that power companies planned in 1994 for construction from 1995 to 1999, only about 18,000 MW were actually built. Although plans have been announced to build more capacity than the country will need over the next five to seven years, this new construction assumes market and regulatory conditions that are not yet assured. Over the next twenty years, the United States will need 1,300 to 1,900 new power plants, which is the equivalent of 60 to 90 new power plants a year (Figure 1-2).

But even with adequate generating capacity, we do not have the infrastructure to ensure reliable supply of electricity. Investment in new transmission capacity has failed to keep pace with growth in demand and with changes in the industry's structure. Since 1989, electricity sales to consumers have increased by 2.1 percent annually, yet transmission capacity has increased by only 0.8 percent annually. As electricity markets become more regional, transmission constraints are impeding the movement of electricity both within and between regions.

The price spikes in the Midwest in the summer of 1998 were in part caused by trans-

Figure 1-2
The U.S. Needs More Power Plants



The nation is going to require significant new generation capacity in the next two decades. Depending on demand, the United States will need to build between 1,300 and 1,900 new power plants—or about one new power plant a week.

Source: U.S. Department of Energy, Energy Information Administration.

mission constraints, which limited the region's ability to import electricity from other regions at a time of high demand. Transmission bottlenecks contributed to the blackouts in California over the past year, and have been a persistent cause of price spikes in New York City during peak demand. Constraints on New England's ability to import low-cost power from Canada could raise electricity prices during periods of high demand.

Electricity is a secondary source of energy, generated through the consumption of primary sources (Figure 1-3). The largest source of U.S. electricity generation is coal, followed by nuclear energy, natural gas, hydropower, oil, and non-hydropower renewable energy.

Coal

Coal is America's most abundant fuel source. The United States has a 250-year supply of coal. Over 1 billion tons of coal were produced in 25 states in 2000. About 99.7 percent of U.S. coal production is consumed domestically, with electricity generation accounting for about 90 percent of coal consumption.

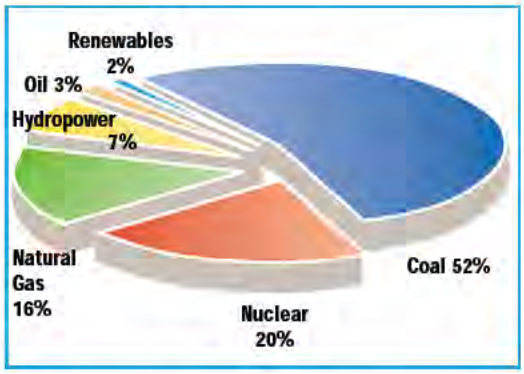
After peaking in 1982, coal prices have generally declined. This trend is projected to continue through 2020, reflecting an expanding shift into lower-cost western coal production and substantial increases in productivity. While coal is expected to remain the dominant fuel in meeting increasing U.S. electricity demand through 2020, energy policy goals must be carefully integrated with environmental policy goals. The Clean Air Act Amendments of 1990 and related state regulations require electricity generators to reduce emissions of sulfur dioxide and nitrogen oxide.

Nuclear Energy

Nuclear energy is the second-largest source (20 percent) of U.S. electricity generation. Nuclear power is used exclusively to generate electricity. Nuclear power has none of the emissions associated with coal and gas power plants, including nitrogen oxides, sulfur dioxide, mercury and carbon dioxide. Costs of electricity generation by nuclear plants compare favorably with the costs of generation by other sources.

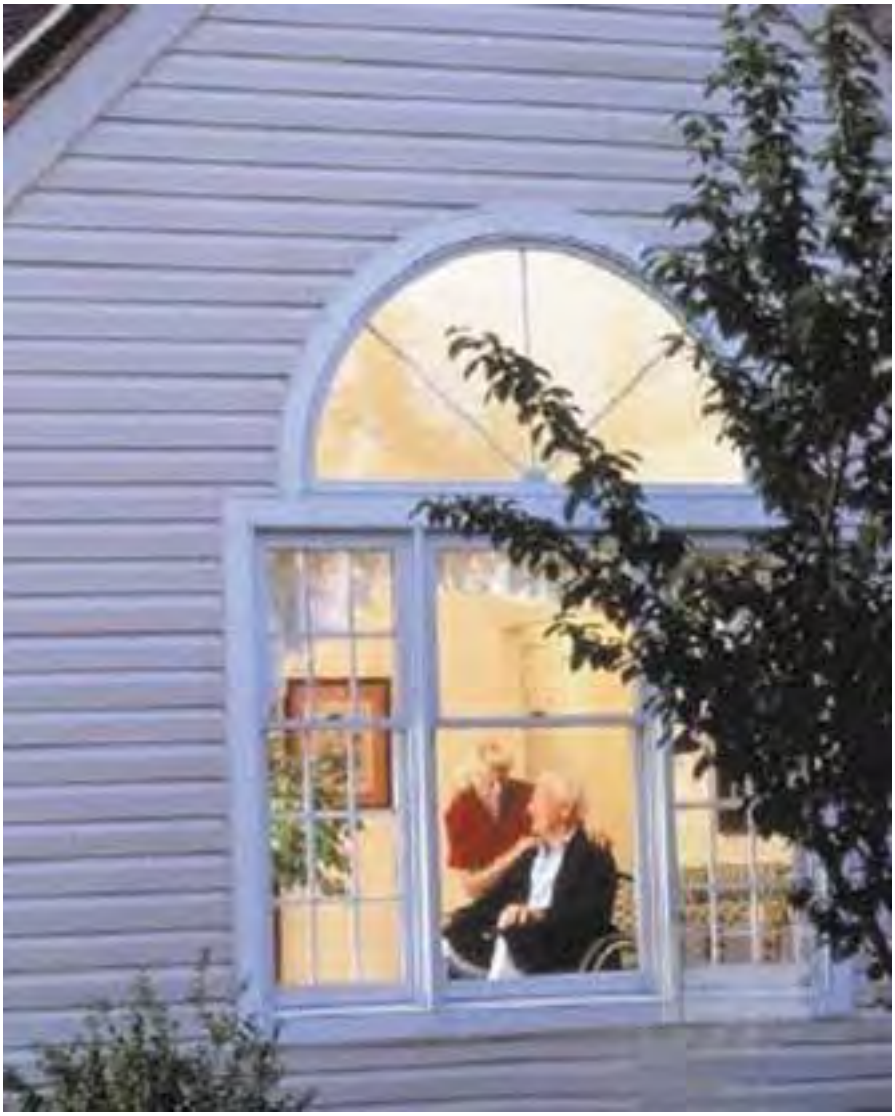
While the number of nuclear plants has declined due to retirements, nuclear electricity generation has steadily increased in recent years. Several factors have created a more favorable environment for nuclear energy: safe, standardized plant designs; an improved licensing process; effective safety oversight by the Nuclear Regulatory Commission (NRC); the advent of new technologies; and uncertain, volatile natural gas prices. This more favorable environment has resulted in increased re-licensing of nuclear plants and the consolidation of several plants in the hands of fewer, more experienced operators.

Figure 1-3
Fuel Sources for Electricity Generation in 2000



Electricity is a secondary source of energy, generated through the consumption of primary sources. Coal and nuclear energy account for over 70 percent of U.S. electricity generation.

Source: U.S. Department of Energy, Energy Information Administration.



Many Americans received high heating bills this winter as a result of sharp increases in natural gas prices.

The nuclear industry is closely regulated by the NRC, which provides oversight of the operation and maintenance of these plants. This oversight includes a comprehensive inspection program that focuses on the most significant potential risks of plant operations, and features full-time resident inspectors at each plant, as well as regional inspectors with specialized expertise. In addition to rigorous inspection criteria, the installation of new design features, improvements in operating experience, nuclear safety research, and operator training have all contributed to the nuclear industry's strong safety record.

An important challenge to the use of nuclear energy is the issue of safe and timely long-term storage of spent nuclear fuel and high- and low-level radioactive waste. Currently, no plans exist to construct any new nuclear plants. However, due to more favorable conditions, the decline in nuclear energy generation has not been as rapid as was predicted only a few years ago, as evidenced by increased re-licensing.

Natural Gas

Natural gas is the third-largest source of U.S. electricity generation, accounting for 16 percent of generation in 2000. Under existing policy, natural gas generating capacity is expected to constitute about 90 percent of the projected increase in electricity generation between 1999 and 2020. Electricity generated by natural gas is expected to grow to 33 percent in 2020—a growth driven by electricity restructuring and the economics of natural gas power plants. Lower capital costs, shorter construction lead times, higher efficiencies, and lower emissions give gas an advantage over coal and other fuels for new generation in most regions of the country.

However, natural gas is not just an electricity source. It is used in many different ways, including as vehicle fuel, as industrial fuel, and in our homes. In addition, natural gas is used as a feedstock during the manufacturing process of such products as chemicals, rubber, apparel, furniture, paper, clay, glass, and other petroleum and coal products. Overall, natural gas accounts for 24 percent of total U.S. energy consumed and for all purposes 27 percent of domestic energy produced.

Eighty-five percent of total U.S. natural gas consumption is produced domestically. The import share of consumption rose from 5 percent in 1987 to 15 percent in 2000, and net imports have comprised more than 50 percent of the growth in gas demand since 1990. Canada, with very large gas supplies and easy pipeline access to the lower 48 states, accounts for nearly all U.S. natural gas imports. Unlike oil, almost all natural gas is produced and sold within the same region. Therefore, prices are determined by regional, rather than global, markets.

In 2000, natural gas prices moved

sharply higher after fifteen years of generally flat prices. Futures prices surged by 320 percent in 2000 to an all-time high of $9.98 per million Btus in late December 2000—nearly five times higher than the $2.05 per million Btu average from 1991 to 1999. While prices have declined since the beginning of 2001, they remain much higher than recent levels.

Between 2000 and 2020, U.S. natural gas demand is projected by the Energy Information Administration to increse by more than 50 percent, from 22.8 to 34.7 trillion cubic feet. Others, such as Cambridge Energy Research Associates, expect gas consumption to increase by about 37 percent over that period. Growth is projected in all sectors—industrial, commercial, residential, transportation, and electric generation. More than half of the increase in overall gas consumption will result from rising demand for electricity generation.

Although high natural gas prices have negative effects on consumers, businesses, industries, and the economy as a whole, they also promote more rapid development and adoption of new energy efficient technologies, investment in distribution systems, and greater investment in exploration and development. Although these market responses do not occur rapidly enough to prevent near-term price spikes, over time, they help to hold down prices.

As a result of the sharp increase in natural gas prices, many consumers received historically high utility bills this winter. The price spike has had a particularly severe impact on low-income consumers who use natural gas for heating. In recent months, 5 million consumers have applied for federal and state assistance to pay their heating bills—an increase of 1 million consumers over last year.

The projected rise in domestic natural gas production—from 19.3 trillion cubic feet in 2000 to 29.0 trillion cubic feet in 2020—may not be high enough to meet projected demand. In the near term, incremental production of natural gas is expected to come primarily from unconventional sources in the Rocky Mountain, Gulf Coast, and mid-continent regions; the North Slope of Alaska; and the offshore Gulf of Mexico. Onshore federal lands currently contribute about 10 percent of U.S. production, and federal offshore production contributes about 26 percent.

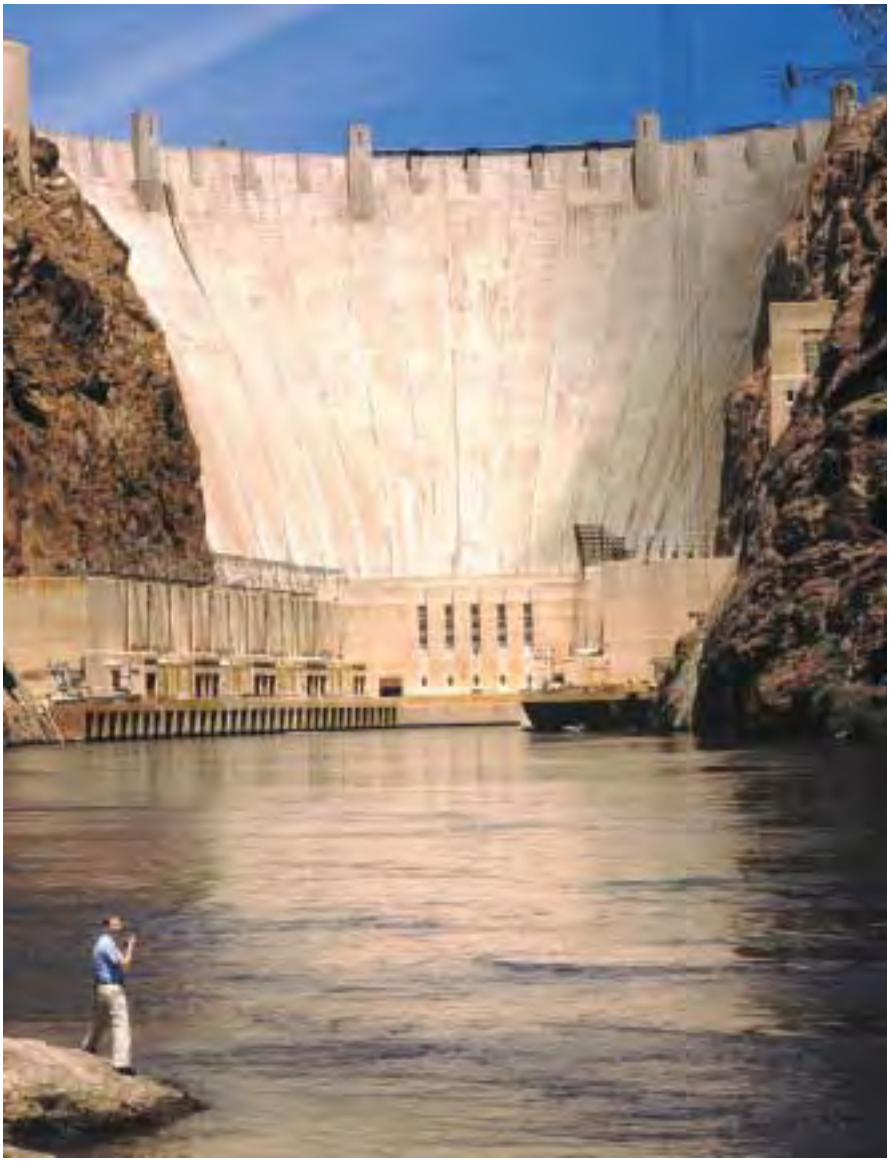
The most significant long-term challenge relating to natural gas is whether adequate supplies can be provided to meet sharply increased projected demand at reasonable prices. If supplies are not adequate, the high natural gas prices experienced over the past year could become a continuing problem, with consequent impacts on electricity prices, home heating bills, and the cost of industrial production. These concerns will redouble if policy decisions sharply reduce electricity generation by any other source, since it is doubtful that natural gas electricity generation could expand to the extent necessary to compensate for that loss of generation.

To meet this long-term challenge, the United States not only needs to boost production, but also must ensure that the natural gas pipeline network is expanded to the extent necessary. For example, although natural gas electricity generation in New England is projected to increase by 16,000 MW through 2000, bottlenecks may block the transmission of necessary supplies. Unless pipeline constraints are eliminated, they will contribute to supply shortages and high prices, and will impede growth in electricity generation.

Hydropower

Hydropower is the fourth-largest source of U.S. electricity generation, accounting for about 7 percent of total generation in 2000. In some regions of the country, such as the Northwest and New York, hydropower makes a much bigger contribution to electricity generation. Although the United States is second only to Canada in hydropower generation, hydropower generation has remained relatively flat in the United States for years.

Hydropower has significant environmental benefits. It is a form of low-cost electricity generation that produces no emissions, and it will continue to be an important source of U.S. energy for the future. Given the potential impacts on fish and wildlife, however, it is important to ef-



Hydropower is the fourth-largest source of U.S. electricity generation. The most significant challenge confronting this source of energy is regulatory uncertainty regarding the federal licensing process.

ficiently and effectively integrate national interests in both natural resource preservation and environmental protection with energy needs.

There are two categories of hydropower projects in the United States: (1) those operated by federal electric utilities, such as the federal power marketing administrations (Bonneville, Western, Southwestern, and Southeastern); and (2) the approximately 2,600 non-federal hydropower dams licensed or exempted by the Federal Energy Regulatory Commission (FERC). The federal utilities have large hydropower systems operated by the Bureau of Reclamation and Army Corps of Engineers, and play an important role meeting electricity demand, especially in the Northwest and the West. Hydropower projects operate with multiple purposes, such as electricity generation, flood control, navigation, and irrigation.

Although most potential for hydropower has already been developed, there is some undeveloped hydropower capacity in the United States. Much of this capacity could be expanded without constructing a new dam.

The most significant challenge confronting hydropower is regulatory uncertainty regarding the federal licensing process. The process is long and burdensome, and decision-making authority is spread across a range of federal and state agencies charged with promoting different public policy goals. Reforms can improve the hydropower licensing process, ensuring better public participation, ensuring that effective fish and wildlife conditions are adopted, and providing interagency resolution before conflicting mandatory license conditions are presented. The licensing process needs both administrative and legislative reforms. In addition, FERC should be encouraged to adopt appropriate deadlines for its own actions during the process.

Oil

Oil accounts for approximately 3 percent of electricity generation. Oil is used as a primary source to fire electricity generation plants in some regions. Specifically, oil is an important source of electricity in Hawaii, Florida, and some northeastern states. Oil can also be used an additional source of fuel for electricity generation in plants that can use either natural gas or oil. However, electricity generation from oil is projected to decline to about one-half of one percent of total electricity generation by 2020.

Renewable Energy: A Growing Resource

Renewable energy technologies tap natural flows of energy—such as water, wind, solar, geological, and biomass sources—to produce electricity, fuels, and heat. Non-hydropower renewable electricity generation is projected to grow at a faster rate

than all other generation sources, except natural gas. These sources of energy are continuously renewable, can be very clean, are domestically produced, and can generate income for farmers, landowners, and others. Although its production costs generally remain higher than other sources, renewable energy has not experienced the price volatility of other energy resources.

Non-hydropower renewable energy sources currently account for only about 4 percent of total energy consumption and 2 percent of total electricity generation. The sources of non-hydropower renewable electricity generation are biomass (the direct combustion of plant matter and organic residues, such as municipal solid waste use); geothermal (use of naturally occurring steam and hot water); wind; and solar. Biomass and geothermal account for most renewable electricity generation.

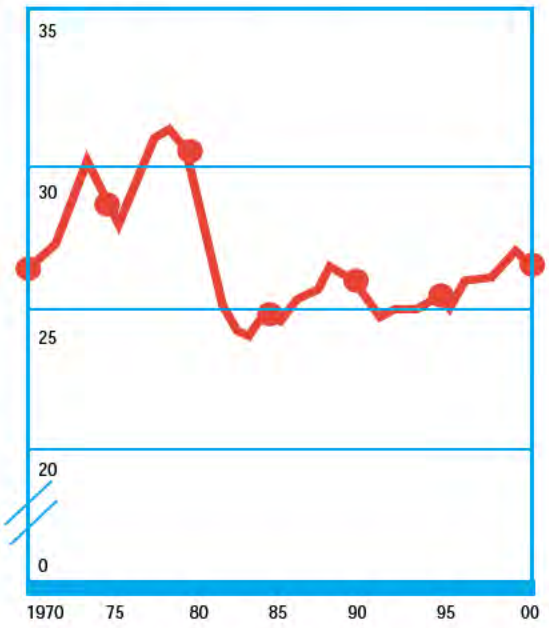
The most important long-term challenge facing renewable energy remains economic. Renewable energy costs are often greater than those of other energy sources. However, these costs have declined sharply in recent years, due to improved technology. If this trend continues, renewable energy growth will accelerate. By 2020, non-hydropower renewable energy is expected to account for 2.8 percent of total electricity generation.

Transportation Energy Needs

Oil is the nation's largest source of primary energy, serving almost 40 percent of U.S. energy needs. In 2000, the United States consumed an average of 19.5 million barrels of oil every day. Transportation fuels account for about two-thirds of our oil consumption, and the industrial sector for 25 percent. Residential and commercial uses, such as heating oil and propane—important fuels in the Northeast and Midwest—account for most of the rest.

The share of oil in U.S. energy supply has declined since the early 1970s, the result of growth in other fuels, particularly coal and nuclear. Per capita oil consumption, which reached a peak in 1978, has fallen by 20 percent from that level (Figure 1-4).

Figure 1-4
U.S. Per Capita Oil Consumption: 1970–2000



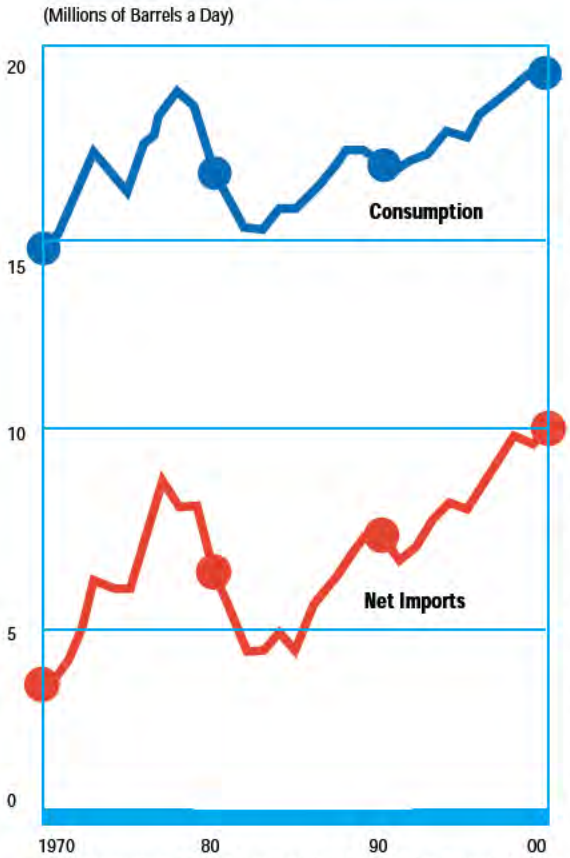
Per capita oil consumption reached a peak in 1978 of 31 barrels. it has fallen by 20 percent since then to 26 barrels per capita.

Source: U.S. Department of Energy, Energy Information Administration

Renewable energy technologies tap natural flows of energy to produce electricity, fuels, and heat.
U.S. Department of Energy, National Renewable Energy Laboratory



Figure 1-5
Dependence on Foreign Sources of Oil



U.S. dependence on oil imports is a serious long-term challenge. The economic security of our nation and our trading partners will remain closely tied to global oil market developments.

Source: U.S. Department of Energy, Energy Information Administration.

In 2020, oil is projected to account for roughly the same share of U.S. energy consumption as it does today.

The United States has been a net importer of energy since the 1950s, and U.S. dependence on imports has grown sharply since 1985 (Figure 1-5). Today, oil accounts for 89 percent of net U.S. energy imports. Net oil imports account for most of the rise in energy imports since the mid-1980s, and have grown from about 4.3 million barrels per day (bpd) in 1985 to 10 million bpd in 2000.

World oil prices have been marked by notable price volatility over the past several years. For example, the average initial purchase price of crude oil rose from $8.03 a barrel in December 1998 to $30.30 a barrel in November 2000. Spot prices rose even higher. This dramatic price swing was the product of several events. A series of production cuts by the Organization of Petroleum Exporting Countries (OPEC) in 1998 and 1999 sharply curtailed global oil supplies. At the same time, rebounding demand for oil in Asia following roughly two years of economic weakness, and rapid economic growth in the United States boosted oil consumption and squeezed supplies even further. By September 2000, oil prices peaked as markets faced limited supply of crude and petroleum products



U.S. Department of Transportation

Domestic oil supply cannot be increased unless several access and infrastructure challenges are addressed. For example, U.S. refining and pipeline capacity has not kept pace with increasing demand for petroleum products.

ahead of the winter season, when demand is typically higher. In December 2000, oil prices fell after the market absorbed the impact of a series of OPEC production increases.

This recent price volatility illustrates the effect of intermittent market power exerted by cartel behavior in a global petroleum market. Moreover, prices are set in a market where supply is geographically concentrated. Almost two-thirds of world proven reserves are in the Middle East. Elsewhere, Central and South America account for 9 percent; Africa, 7 percent; North America, 5 percent; Eastern Europe and the former Soviet Union, 5 percent; the rest of Asia, 4 percent; and Western Europe, 2 percent. OPEC's huge oil reserves and production capacity and its periodic efforts to influence prices add to volatility in the market.

Oil prices are expected to remain high through 2002, affecting the cost of transportation, heating, electricity generation, and industrial production. High oil prices mean high prices for petroleum products, such as gasoline, diesel fuel, heating oil, propane, and jet fuel. The summer 2001 base case average gasoline price from the Department of Energy *Short-Term Energy Outlook* is $1.49 per gallon. However, prices have risen more rapidly than anticipated since the report's release, and a much higher summer average in the range of $1.50 to $1.65 per gallon is likely. Some areas have already experienced gasoline prices above $2.00 per gallon. Gasoline inventories going into the driving season are projected to be lower than last year, which could set the stage for regional supply problems that once again create significant price volatility in gasoline markets.



Because the United States is a mature oil-producing region, production costs are often higher than in foreign countries.

Price Volatility in Gasoline Markets

During the early summer of 2000, low inventories set the stage for a gasoline price run-up in the Midwest. Several pipeline and refinery problems sent marketers scrambling for limited supplies of both reformulated gasoline (RFG) and conventional gasoline, driving prices up rapidly. In Chicago, the spot price for blend stock for RFG, excluding ethanol, doubled in about six weeks, from 83 cents per gallon on April 25 to $1.65 on June 7. Spot prices then fell back over the next five weeks to 84 cents on July 12 as extra supply began arriving. Retail regular-grade RFG prices in the Midwest rose from $1.47 on April 24 to just over $2.00 per gallon on June 19, before falling back to $1.43 by July 24, showing the typical tendency of

retail prices to lag spot price changes.

Refiners face additional challenges as a result of various state and local clean fuel requirements for distinct gasoline blends ("boutique fuels"). These different requirements sometimes make it difficult, if not impossible, to draw on gasoline supplies from nearby areas or states to meet local needs when the normal supply is disrupted.

In 2000, very low inventories of gasoline and other refined products on the U.S. East and Gulf coasts increased the market's susceptibility to external shocks, such as operating problems in refineries or pipelines, or short-term surges in demand. Last winter, heating oil prices were at near-record levels. During 2000, the federal government reduced the vulnerability of the Northeast to heating oil shortages, such as those experienced in January 2000, by creating a 2-million-barrel heating oil reserve in New Jersey and Connecticut.

Because the United States is a mature oil-producing region, production costs are often higher than in foreign countries, particularly OPEC countries. In addition, access to promising domestic oil reserves is limited. U.S. oil production in the lower 48 states reached its peak in 1970 at 9.4 million bpd. A surge in Alaskan North Slope oil production beginning in the late 1970s helped postpone the decline in overall U.S. production, but Alaska's production peaked in 1988 at 2 million bpd, and fell to 1 million bpd by 2000. By then, U.S. total oil output had fallen to 5.8 million bpd, 39 percent below its peak.

By 2020, U.S. oil production is projected to decline from 5.8 to 5.1 million bpd under current policy. However, oil consumption is expected to rise to 25.8 million bpd by 2020, primarily due to growth in consumption of transportation fuels. Given existing law, production from offshore sources, particularly the Gulf of Mexico, is predicted to play an increasingly important role in the future, accounting for a projected high of 40 percent of domestic oil production by 2010, up from 27 percent today. Technological advances can mitigate the decline in U.S. oil production by enhancing recovery from domestic oil reserves and lowering production costs.

Our projected growing dependence on oil imports is a serious long-term challenge. U.S. economic security and that of our trading partners will remain closely tied to global oil market developments. Without a change in current policy, the share of U.S. oil demand met by net imports is projected to increase from 52 percent in 2000 to 64 percent in 2020. By 2020, the oil for nearly two of every three gallons of our gasoline and heating oil could come from foreign countries. The sources of this imported oil have changed considerably over the last thirty years, with more of our imports coming from the Western Hemisphere. Despite progress in diversifying our oil suppliers over the past two decades, the U.S. and global economies remain vulnerable to a major disruption of oil supplies.

The Strategic Petroleum Reserve (SPR), the federal government's major tool for responding to oil supply disruptions, has not kept pace with the growth in imports. The number of days of net oil import protection provided by the Reserve declined from 83 days of imports in 1992 to 54 days of imports today. Net domestic oil imports have increased significantly since 1992, while the SPR's oil inventory actually decreased.

Domestic oil supply cannot be increased unless several access and infrastructure challenges are addressed. U.S. refining and pipeline capacity has not kept pace with increasing demand for petroleum products. Unless changes take place, the net effect will likely be increased imports, regionally tight markets, and circumstances in which prices for gasoline, heating oil, and other products rise independently of oil prices.

Greater price volatility for gasoline, diesel fuel, heating oil, propane, and jet fuel is likely to become a larger problem over time, unless additional refining capacity and expanded distribution infrastructure can be developed at the same time cleaner products are required. Increasing domestic oil production and reducing demand, particularly for transportation fuels, will re-

quire adoption of a comprehensive national energy policy.

Alternative Transportation Fuels

Development of alternative fuels such as ethanol and other biofuels (liquid fuels derived from organic matter, such as crops), natural gas, and electricity, can help diversify the transportation sector that is so reliant on oil.

Ethanol, a biofuel based on starch crops such as corn, is already making a significant contribution to U.S. energy security, displacing more oil than any other alternative fuel. Other biofuels, such as biodiesel, which can be made from soybean, canola oils, animal fats, and vegetable oils, are making an increasingly important contribution

The success of the federal alternative fuels program has been limited, however. The program focuses on mandating that certain fleet operators purchase alternative fueled vehicles. The hope was that this vehicle purchase mandate would lead to expanded use of alternative fuels. That expectation has not been realized, since most fleet operators purchase dual-fueled vehicles that operate on petroleum motor fuels. Reforms to the federal alternative fuels program could promote alternative fuels use, such as expanding the development of an alternative fuels infrastructure.

Summary of Recommendations

Taking Stock: Energy Challenges Facing the United States

★ The NEPD Group recommends that the President issue an Executive Order to direct all federal agencies to include in any regulatory action that could significantly and adversely affect energy supplies, distribution, or use, a detailed statement on: (1) the energy impact of the proposed action, (2) any adverse energy effects that cannot be avoided should the proposal be implemented, and (3) alternatives to the proposed action. The agencies would be directed to include this statement in all submissions to the Office of Management and Budget of proposed regulations covered by Executive Order 12866, as well as in all notices of proposed regulations published in the Federal Register.

★ The NEPD Group recommends that the President direct the executive agencies to work closely with Congress to implement the legislative components of a national energy policy.

★ The NEPD Group recommends to the President that the NEPD Group continue to work and meet on the implementation of the National Energy Policy, and to explore other ways to advance dependable, affordable, and environmentally responsible production and distribution of energy.

Note: All recommendations in this report are subject to execution in accordance with applicable law. Legislation would be sought where needed. Also, any recommendations that involve foreign countries would be executed in accordance with the customs of international relations, including appropriate diplomatic consultation.

Regional U.S. Energy Challenges

Midwest

Energy consumption in the Midwest is dominated by the industrial sector, the sector with the fastest-growing consumption rate through 2020. The transportation sector has the second-fastest consumption growth rate through 2020. States are affected by higher prices for natural gas, propane, and gasoline, and they expect gasoline price spikes this summer. Electricity supplies in some parts of the region may be tight during peak summer demand. High energy prices will drive up farm operating costs, particularly for fertilizer, irrigation, grain drying, and fuel for tractors.

Illinois consumers are reeling from high heating and cooling costs. Landlords are forced to pass on these costs in the form of higher rents. Farmers face low commodity prices, high fuel costs, and dramatically higher fertilizer costs. A key refinery is closing in part because of the cost of meeting cleaner-burning gasoline requirements.

Minnesota's residential electricity use has increased due to population growth and a healthy economy.

Iowa imports over 90 percent of its energy. Farmers are paying twice the 1999 price of fertilizer because of higher prices for natural gas, which is a major component in the fertilizer production.



West

Energy consumption in the West is dominated by the transportation sector, which is followed closely by the industrial sector. The region's drought emergency is exacerbating an already challenging energy picture. California is likely to experience more severe electricity blackouts this summer. The Pacific Northwest faces a major shortage of hydropower generation due to low water levels. Electricity prices will remain high in the West until more supply is added. Gasoline could be in short supply this summer in California and other states.

California's energy consumption has grown by about 7 percent a year, while production has remained flat. The point has been reached where demand is occasionally exceeding supply, which has caused rolling blackouts. The situation is likely to worsen this summer when demand will peak.

Oregon's lowest snow pack in history will result in the most severe short-term electricity problem in decades. The state will face high spot market prices and reports the highest gasoline prices in the country.

Washington businesses are closing down or cutting back on production. Electricity costs of $400 per unit compared to $35 a year ago contributed to the closure of a major paper plant employing 800 employees.

Colorado small business are suffering as well. A 169 percent jump in natural gas prices in one year may force small businesses to close.

Idaho utilities are offering to pay their irrigation customers to not farm portions of their fields to reduce electricity demand and make that saved power available for other local customers. The low snow pack has reduced water in river systems needed for hydropower generation.

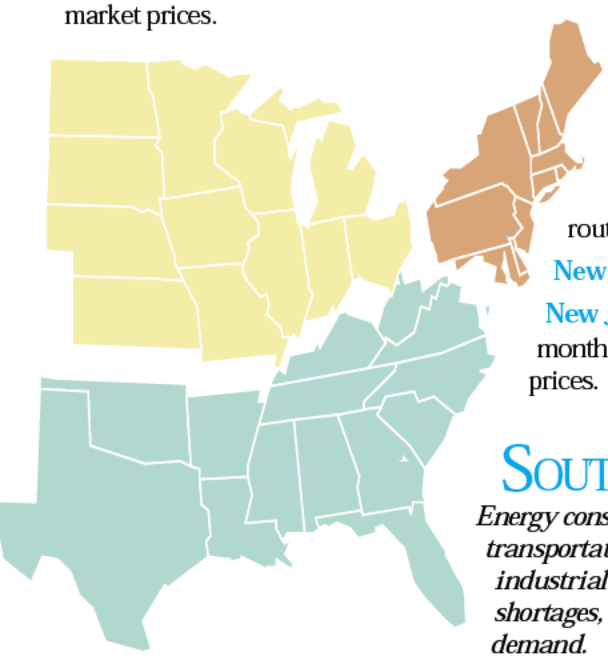
Hawaii's geographic isolation contributes to its many energy issues, such as importing 100 percent of its energy, its disproportionately high consumption of jet fuel and heavy reliance on tourism, and its dependence on imported oil for over 90 percent of its primary energy, the majority from sources in the Asia-Pacific region. Electricity is produced mainly from oil, including residuals and distillates from refineries and coal. Because the Islands' electric grids are not interconnected, electric utilities must operate with high reserve margins.

Nevada is covered in large part by federal lands that require federal approval for permitting new transmission and generation facilities. The permitting process can be protracted and cumbersome, despite efforts by federal agencies to streamline and coordinate. The desert climate requires both heating and cooling, the cost of which can be burdensome. While the desert climate is also conducive to geothermal, wind, and solar technologies, additional work is needed to make these technologies economically competitive.

Northeast

Energy consumption in the Northeast is dominated by the transportation sector. Forecasts developed by the Energy Information Administration indicate that the transportation sector will also remain the dominant sector with the fastest-growing consumption rate through 2020. Northeast states' energy challenges include reducing vehicle pollution and interstate transport of power plant emissions. Heavy dependence on heating oil results in disproportionate impacts during cycles of high prices. Energy supplies in the region are limited by electric transmission and gas pipeline bottlenecks.

New York is rushing to complete 11 small natural gas turbines to avoid blackouts in New York City this summer, where customers pay market prices.



Delaware needs upgraded transmission lines to handle increasing loads. Traditional distributed generation using diesel generators may address these shortfalls, but could raise environmental problems.

Connecticut expects no power shortages this summer, but brownouts are possible if there is a prolonged spike in energy use while power plants are shut down for routine maintenance.

New Hampshire must conserve power on hot days to avoid summer blackouts.

New Jersey regulators have had to allow utilities to raise natural gas rates by 2 percent a month through July 2001 to make up for money lost during the winter due to high fuel prices.

South

Energy consumption in the South is dominated by the industrial sector, followed by the transportation sector. The transportation sector, however, is expected to grow faster than the industrial sector through 2020. While no state in the region anticipates summer power shortages, electricity supplies in parts of the region may be tight during peak summer demand.

Arkansas' costs of natural gas and propane have doubled and then tripled, contributing to employee layoffs.

Oklahoma's second-largest industry is the oil and gas industry. The volatility of oil and gas markets can severely affect Oklahomans and the state's economy.

Striking Home

The Impacts of High Energy Prices on Families, Communities, and Businesses

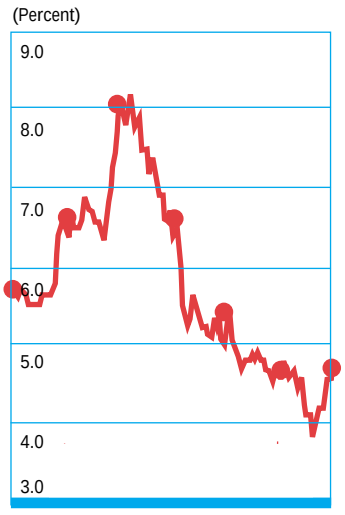
American families, communities, and businesses all depend on reliable and affordable energy for their health, safety, and livelihood. Energy is a critical component of nearly everything that affects our daily lives, from transportation to communication, from food production to medical services, and from air conditioning to heating. Americans expect these services to enhance our lives, and are keenly aware that each additional, unanticipated energy expense is a decrease in funds available for other needs.

Recommendation:

★ The NEPD Group recommends that the President direct the Secretary of Energy to explore potential opportunities to develop educational programs related to energy development and use. This should include possible legislation to create public education awareness programs about energy. Such programs should be long-term in nature, should be funded and managed by the respective energy industries, and should include information on energy's compatibility with a clean environment.

Figure 2-1

Income Spent on Energy



Until recently, the share of disposable household income spent on energy steadily declined, falling to a low of 3.8 percent at the end of 1998. Higher prices for oil and other energy products and record cold temperatures in late 2000 bumped this share up to 4.8 percent in the fourth quarter.

Note: Plotted quarterly through the fourth quarter of 2000.

Source: U.S. Department of Commerce, Bureau of Economic Analysis.

Impacts of High Energy Prices on the Daily Lives of Americans

Many American families and businesses have already felt the strain of rising prices and unreliable energy supplies. Every time energy prices rise, American families have fewer dollars available to meet their needs. Low-income households, energy-intensive industries, and farmers generally find it difficult to make rapid adjustments to energy price increases.

Rising oil prices act like a tax by foreign oil exporters on Americans. Changing energy prices impose economic costs, such as forcing plants to change schedules, replace machinery, or even shut down. These costs can eventually impact economic growth. So far, increased capital investment by domestic energy producers has offset only a small part of the dampening effects of higher energy costs on consumer spending.

Families

Energy bills for the 74 million middle-class American households consist primarily of home and transportation related expenses. Heating and cooling expenses represent about 40 percent of household energy costs. Other energy expenses include costs for lighting, hot water, appliances, and transportation.

For almost twenty years, the share of household income that Americans spent on their energy needs steadily declined. However, between 1998 and the end of last year, family spending on energy rose by more than 26 percent, from 3.8 to 4.8 percent of after-tax income (Figure 2-1).

Last winter, heating bills for many families tripled. Roughly 50 percent of American families heat their homes with natural gas. Because the last two months of 2000 were particularly cold in some parts of the country, heating bills increased significantly relative to the previous winter. Last winter, average natural gas heating costs in the Midwest increased by 73 percent, from $540 to $933. New Englanders' heating bills rose by 27 percent, from $760 to $967.





Higher energy prices have forced some energy-intensive manufacturing industries to halt or scale back production and lay off workers.

Many working households can usually accommodate such increases in energy by cutting back on other needs. However, low-income households often have more difficult choices to make. Energy costs for an average low-income household could total 14 percent of family income during the winter of 2000–01, up from about 11 percent for the previous winter. In contrast, energy costs typically represent only about 4 percent of a middle-class family's household budget.

The Low Income Home Energy Assistance Program (LIHEAP) is a federal block grant program that helps low-income consumers pay their energy bills. Last winter, 1.2 million more American families applied for LIHEAP assistance to pay their heating bills, bringing the total close to 5 million American families—up by 26 percent over last year's 3.9 million applicants. As many as 3.6 million families in eighteen states and the District of Columbia risk being unable to pay their bills and having their energy cut off because of the effects of rapidly increasing energy costs.

Recommendations:

★ The NEPD Group recommends that the President take steps to mitigate impacts of high energy costs on low-income consumers. These steps would include:

- Strengthening the Low Income Home Energy Assistance Pro gram by making $1.7 billion available annually. This is an increase of $300 million over the regular FY 2001 appropriation.
- Directing the Secretaries of Interior and Health and Human Services to propose legislation to bolster LIHEAP funding by using a portion of oil and gas royalty payments.
- Redirecting royalties above a set trigger price to LIHEAP, whenever crude oil and natural gas prices exceed that trigger price, as determined by the responsible agencies.

★ The NEPD Group recommends that the President increase funding for the Weatherization Assistance Program by $1.2 billion over ten years. This will roughly double the spending during that period on weatherization. Consistent with that commitment, the FY 2002 Budget includes a $120 million increase over 2001. The Department of Energy will have the option of using a portion of those funds to test improved implementation approaches for the weatherization program.

★ The NEPD Group recommends that the President support legislation to allow funds dedicated for the Weatherization and State Energy Programs to be transferred to LIHEAP if the Department of Energy deems it appropriate.

The low-income elderly are particularly vulnerable to disruptions in energy supply. If they keep their homes at a reasonable temperature, the high cost of electricity may make it difficult for them to pay their higher electricity bills. This could further result in an elimination of service. Another summer of very hot weather and high energy bills could cause serious health problems for some Americans, particularly those sensitive to high temperatures.

The Department of Energy's Weatherization Assistance Program has reduced the heating and cooling costs of low-income households by weatherizing more than 5 million homes since its inception in 1976. The President has requested $1.2 billion in additional funding for this program over ten years, roughly double the current level of spending. Consistent with that commitment, the 2002 budget will include a $120 million increase over 2001.

The Department of Energy's Weatherization Assistance Program

The energy burden on low-income households, as a proportion of income, is four times greater than for other American households. The Weatherization Program provides grant funding for a network of all states and some 970 local weatherization agencies to provide insulation, duct system improvements, furnace upgrades, and other cost-effective, energy-saving improvements based on the energy needs of each home weatherized. Currently, each dollar spent on home weatherization generates $2.10 worth of energy savings over the life of the home; with additional economic, environmental, health, and safety benefits associated with the installations and resulting home improvements. Typical savings in heating bills, for a natural gas heated home, grew from about 18 percent in 1989 to 33 percent today.

Businesses

For businesses, higher energy prices and disruptions in energy supply may increase inflation and reduce profits, production, investment, and employment. The im-

pact of higher energy prices takes two forms: the higher costs of paying for the energy to run the business, and the higher costs when raw fuel sources are used in manufacturing.

In some energy-intensive industries, rising energy prices have had a significant effect on product prices and operations. For instance, while nonenergy producer prices at the intermediate stage of processing have risen by only 3.6 percent since December 1998, prices of industrial materials and plastic resins, which use petroleum inputs, are up 14 and 23 percent, respectively. DuPont, the leading U.S. producer of plastics, chemicals, and fibers derived from oil and natural gas, faced an increase of $1.3 billion in raw material costs last year, the largest increase in the industry in a decade. The company expects further disruptions this year due to high energy costs.

The Federal Reserve has reported that businesses have experienced higher energy costs for a number of months, but have been unable to pass these increases on to customers due to intense foreign and domestic competition and slowing demand. On March 7, 2001, the Federal Reserve reported that businesses across the country experienced higher fuel and other energy costs in February 2001, but most businesses were unwilling or unable to pass these costs on to consumers.

This absorption of much of the higher costs of energy has deteriorated the profit margins of many businesses. About one-quarter of the increase in total unit costs of nonfinancial, nonenergy corporations in the final quarter of last year reflected a rise in energy costs. A more moderate pace of consumer spending, due in part to higher energy prices (natural gas in particular) also contributed to the margin squeeze. The reduction in businesses' purchasing power has also constrained outlays for plants and equipment and most likely intensified the slowdown in business investment that occurred in the last half of 2000.

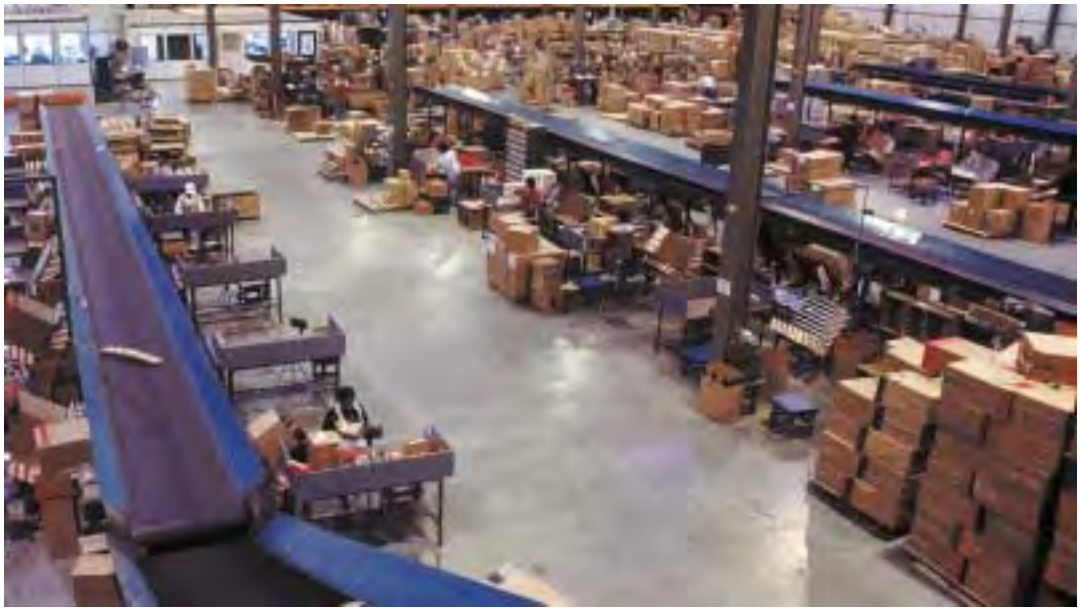
Energy-intensive manufacturing industries are very sensitive to changes in energy prices, and adjust their production accordingly. Some companies have been forced to halt or scale back production and lay off workers. Others have deemed it more profitable to sell their energy than to produce their products. In the Pacific Northwest, Georgia-Pacific's paper mill closed down and laid off 800 workers until diesel generators could be installed. In recent months, the company's average power costs soared from $1.2 million to $10 million.

For other industries, such as computer-driven service industries, energy is not an important component of the total cost. However, many such businesses require a high-quality, reliable source of power. Even a brief loss of power can impose significant costs on high-technology firms.

Energy supply disruptions also impose costs on firms when products or prod-



Disruptions in the supply of energy impose hardships on businesses when products or product inputs are damaged or destroyed, or when production runs are interrupted.



Many companies have been unable to pass higher energy costs on to their customers, which has sharply reduced their profit margins.



Farmers have been hit especially hard by higher fuel and oil prices, which accounted for over a third of the rise in the cost of running their farms.

uct inputs are damaged or destroyed, or when production runs are interrupted. For example, a survey of small businesses conducted by the National Federation of Independent Business in February, 2001, found that more than half of the firms surveyed that had experienced blackouts this year in California were forced to reduce or shut down business operations altogether during the blackouts. About one-third lost sales, almost 21 percent said materials were damaged or destroyed, and nearly 40 percent had to absorb wage costs for work that was not completed.

For businesses that seek to mitigate energy price volatility, an important factor is access to derivatives markets. Both exchange-traded futures and over-the-counter derivative contracts allow firms to substantially reduce their exposure to changes in energy prices. A wide variety of highly liquid futures contracts on energy products such as oil, natural gas, and electricity allow energy users and market participants to reduce or add financial exposure to energy prices. More sophisticated and customizable products are available in the over-the-counter derivative markets. As these markets become increasingly liquid and efficient, more firms will take advantage of these products, reducing the economy's sensitivity to shifts in energy prices. However, most small businesses currently lack the resources or sophistication to take advantage of these products, and will therefore remain vulnerable to rising energy costs. The U.S. government should continue to support the development of efficient derivatives markets.

Figure 2-2

Farmers Are Being Squeezed by Energy Prices

(Index: 1990–92 = 100)



Costs for fuel, fertilizer, and electricity have boosted total prices paid by farmers, while prices farmers receive for their products have remained weak.

Note: Prices paid are for goods, services, interest, taxes, and wages; prices received are for all farm products.

Source: U.S. Department of Agriculture.

Agriculture

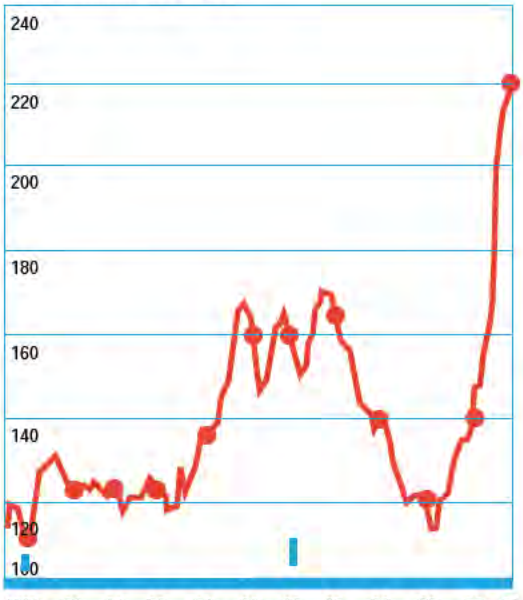
Farmers need ample, affordable energy to run their machinery and equipment. Today, farm production costs are rising sharply, while farm income remains low. Increasing oil prices and interest rates, along with higher prices for other production inputs (including hired labor), boosted farmers' production expenses by 4 percent, or $7.6 billion, in 2000. The rise in farm production expenses has occurred at a time of continued weakness in the prices farmers receive for their products (Figure 2-2).

Higher fuel and oil prices accounted for over one-third of the increase in farm

Figure 2-3

Farm Costs Are Increasing

(Index: December 1979 = 100)



Rising energy prices had a significant effect on product prices in some industries that are heavily dependent on energy inputs. The most dramatic example is the 90 percent increase in the price of nitrogenous fertilizer since December 1998.

Source: U.S. Department of Labor.

production costs. Retail diesel prices this past winter were $1.60 a gallon, compared to about $1.40 a year ago and only $1.00 two years ago. Propane prices were over $1.60 a gallon this winter, compared to $1.10 a year ago. And, natural gas prices hit $10.00 per million Btus in January, after averaging about $2.50 for most of 1998–99. Although natural gas prices have declined, they remain much higher than earlier levels.

Natural gas is an important component of farm production costs. For example, it is used to dry grain, heat farm buildings, and run food-processing equipment. Heating costs for poultry producers soared last winter, sharply reducing earnings.

Natural gas also is a major component in the production of fertilizers, pesticides, and other farm chemicals. It accounts for 70 to 90 percent of the cost of producing anhydrous ammonia, a key source of nitrogen fertilizer. Surging natural gas prices have boosted the price of nitrogenous fertilizer by 90 percent since 1998 (Figure 2-3). During last December and January, several nitrogen production plants shut down, and capacity utilization fell to 50 percent. Anhydrous ammonia recently sold for $330 a ton in the Midwest, compared to $210 a ton for all of 2000 and $160 to $170 a ton at the start of 2000.

Depending on the region of the country and type of farming enterprises, energy-related expenses range from 10 to 30 percent of operating costs for producing major crops. Farm operating costs are highest where fertilizer use is heaviest and natural gas is used for irrigation pumps, such as wheat, cotton, and corn farms in the West and southwestern plains states. Costs are high for greenhouse and nursery crops that use natural gas for heating. Perishable crops also face problems, as energy costs in processing are markedly higher.

Most of California's 9.5 million irrigated acres use electricity to pump water. In addition to higher bills, California farmers will likly face rolling blackouts this summer, which may disrupt farming and processing operations. Low stream flows in the West this year may lead to more pumping of ground water, which will add to irrigation costs in the West. As a result, the costs of California's agricultural products may rise significantly.

In 2001, farmers' total cash production expenses are forecast to increase by an additional $1.5 billion to a record $179.5 billion.

Farm production costs are rising sharply, while farmers' incomes remain low. Depending on the region of the country and type of farming enterprises, energy-related expenses range from 10 to 30 percent of operating costs for producing major crops



Even though total planted acreage is expected to fall this year, higher natural gas prices will raise expenses for nitrogen fertilizer. At the same time, net cash farm income is projected to decline from $56.4 billion in 2000 to under $51 billion in 2001, as production expenses continue to rise.

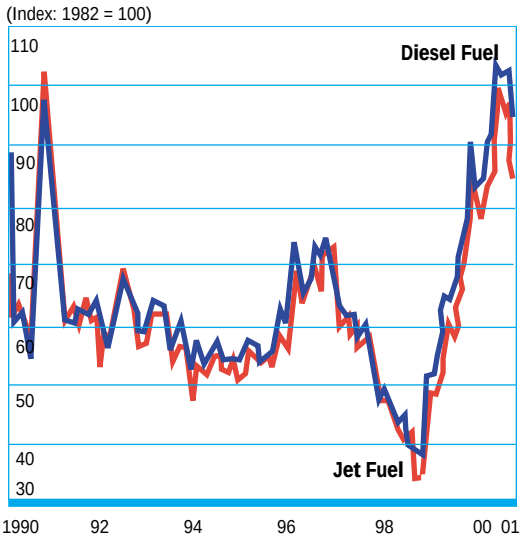
Taken together, fertilizer, fuel, and electricity costs for farmers are forecast to reach $24 billion for 2001, up by about 28 percent from $18.7 billion in 1999. This increase is about 9 percent of U.S. net cash farm income, and that share could be much higher for many individual commodities.

Transportation

The transportation sector accounts for nearly 30 percent of total U.S. energy consumption. The major transportation fuel sources are petroleum-based gasoline and diesel, jet, and marine-mode bunker fuels. Natural gas pipelines are used for product distribution, and electricity is the primary source of power for rail transit and liquid pipeline transmission and distribution.

During 2000, oil prices surged to a nine-year high, and gasoline prices skyrocketed. On average, fuel prices rose by 30 to 40 cents a gallon from 1999 prices, resulting in sharp increases for most modes of transportation, with nearly a 60 percent increase in railroad diesel fuel prices.

Figure 2-4
Transportation Costs Are on the Rise



The recent 140 percent rise in producer prices for intermediate diesel and airline fuels has affected the price of passenger and freight transport.

Note: Plotted through February 2001.
Source: U.S. Department of Labor.



A recent study by a San Francisco Bay business group concluded that blackouts could cost California as much as $16 billion annually, and $5 billion in the Bay area alone.

Price spikes have hit the travel and trucking industries particularly hard and have led to the closure of some operations. Trucking bankruptcies are currently at an all-time high. Over 3,500 motor carrier operations failed in 2000, a dramatic increase over the previous record high of 2,700 motor carrier failures in 1997. Producer prices for intermediate diesel fuel and aviation fuel each rose by about 140 percent from a low in December 1998, affecting passenger and freight transport in the highway, airline, rail, and other transportation sectors (Figure 2-4).

For most transport operations, energy-related expenses were 7 to 14 percent of total operating costs in 1998–99. This share was expected to jump to 10 to 25 percent in 2000. Excluding private auto travel, U.S. passenger and freight operations in 1999 generated about $600 billion in annual revenue and paid approximately $60 billion for fuel and power. If the volume stayed the same in 2000, the various increases in fuel costs for each mode of transportation would yield a fuel bill of

about $80 billion—an increase of one-third over the prior year's bill.

Economic Impacts of California's Energy Crunch

In California, 43 percent of small businesses surveyed in February, 2001, said the power problem had dimmed their views about California as an attractive place for doing business. When asked whether they agreed with the statement, "The electricity problem has forced me to take concrete steps exploring the possibility of moving my business out of California," 18.3 percent of small business respondents said they either agreed or strongly agreed with the statement. More than 31 percent said they will probably or definitely cut back on planned business investment, and almost 20 percent are exploring a move to another state. Half of these small businesses concluded that blackouts would reduce their earnings.

The Silicon Valley Manufacturing Group recently estimated that its nearly 200 members lost over $100 million dollars because of one day of rolling blackouts in June 2000. Countless more millions of dollars have been lost by interruptible commercial power users. Fontana-based California Steel Industries estimates it lost $2.4 million in a single day after its interruptible power was cut off twice for a total of about 12 hours. A recent study by a San Francisco Bay business group concluded that blackouts could cost California as much as $16 billion annually, and $5 billion in the Bay area alone.

The example of California's utilities illustrates the potentially severe negative effects on companies whose business is highly sensitive to energy prices. In this instance, rising energy costs coupled with an inability to pass those costs along to customers has created a sharp increase in short-term liabilities. Pacific Gas & Electric has been forced to file for bankruptcy as a result, and Southern California Edison, while avoiding bankruptcy for the time being, has seen its access to credit markets disappear and the value of its financial assets plummet. Resulting concerns about solvency have led to a withdrawal of bank-lending facilities and supplier credit.

The situation in California is of particular concern because of the major role the state plays in the regional and national economies. California's economy is equivalent to about 13 percent of U.S. gross domestic product (GDP), and it has accounted for an even larger share of U.S. GDP growth in recent years. Some businesses and consumers have been affected by production losses, lost wages, and higher energy bills resulting from rolling blackouts and higher natural gas prices.

The power supply crunch in California and the West could affect the region's economy, as energy supply uncertainty could reduce investment in the region. California's troubles could also spill over to the national economy:

- California accounted for 11 percent of U.S. manufacturing output in 1998. Sectors in other regions that rely on those products, or that supply inputs to California manufacturers, may share any pain caused by the energy squeeze.
- Disruptions to California's economy could have negative impacts on our international trade. California accounts for over 16 percent of total U.S. commodity exports; nearly 25 percent of industrial equipment and computers, electronics, and instruments exports; and over 15 percent of farm commodity and food product exports.
- The credit problems of the California utilities have boosted commercial paper rates for all lower-rated borrowers, and liquidity in the commercial paper market has fallen. This will push some firms to seek other sources of financing, which can be more costly than commercial paper.

American consumers and businesses are best served when markets function freely. Free markets allow prices to reflect changes in demand and supply, and avoid subsidies, price caps, and other constraints.

Improvements in Energy Efficiency Can Help

Improved energy efficiency strengthens energy security. The 42 percent decline in the intensity of U.S. energy use since the energy crisis in 1973 reflects a combination of technological advances, conservation ef-



The Silicon Valley Manufacturing Group recently estimated that its nearly 200 members lost over $100 million dollars because of only one day of rolling blackouts in California.

Figure 2-5
Conservation Through Higher Efficiency
Energy Consumption per Dollar of Real GDP



Energy intensity is the amount of energy used to produce a dollar's worth of gross domestic product (GDP). As a result of the 42 percent decline in energy intensity since the first energy crisis in 1973, the U.S. economy is far better prepared to day than it was in the 1970s to ad just to energy price or supply shocks.

Note: Real GDP in 1996 chained dollars.
Source: U.S. Department of Energy, Energy Information Administration.

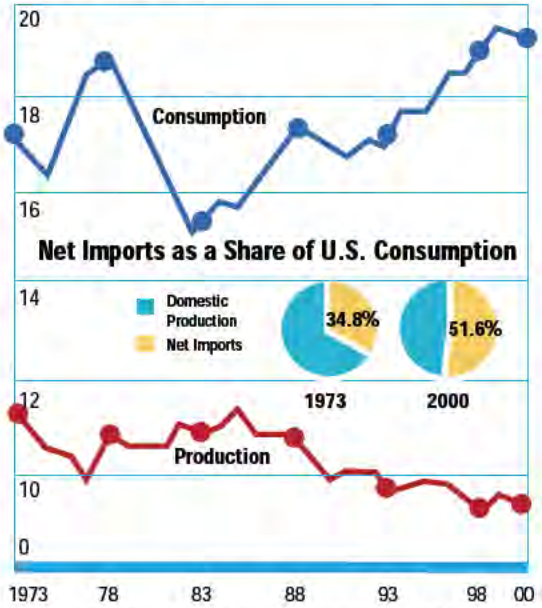
forts, regulatory action, market response, and a shift toward a service economy (Figure 2-5). Our improvements in energy efficiency have prevented our current energy problems from becoming worse.

The macroeconomic effects of a substantial rise in energy prices take two forms. First, to the extent that energy resources are imported, more U.S. dollars must be sent abroad to finance energy consumption, thus reducing funds available for investing in our own country. Second, higher prices cause dislocations among certain sectors of the economy, which could ultimately feed through to lower GDP growth and higher inflation.

Reliance on Foreign Energy

Between 1973 and 2000, U.S. dependence on foreign oil rose from about 35 percent to more than 52 percent of U.S. consumption (Figure 2-6). During the same period, the import share of natural gas consumption climbed from less than 5 percent to more than 15 percent and continues to rise.

Figure 2-6
Dependence on Oil Imports Is Rising
(Millions of Barrels per Day)



Over the past few decades, U.S. consumption of oil and petroleum products has increasingly outpaced domestic production. Today the United States imports over half of the oil it consumes—up from about 35 percent in the early 1970s.

Note: Petroleum includes both crude oil and petroleum products.
Source: U.S. Department of Energy, Energy Information Administration.

Figure 2-7
Oil Prices Have Risen Sharply
Monthly Spot Price of West Texas Intermediate Crude Oil
(Dollars per Barrel)



Despite the sharp rise in crude oil prices since late 1998, real prices still remain lower than at any time from 1974 to 1985.

Note: Real prices in 2000 dollars. Prices deflated using the Consumer-Price Index–Urban (CPI–U) Research Series for all items linked to CPI–U–X1 prior to December 1977.
Sources: Wall Street Journal; U.S. Department of Labor, Bureau of Labor Statistics.

Imports of energy products make up nearly 11 percent of all U.S. imports. By contrast, U.S. energy exports are relatively small. The energy trade deficit relative to our GDP represents the share of U.S. income that must be exported to purchase foreign fuel to meet domestic energy needs. The U.S. energy trade deficit in 2000 was about $120 billion, most of which was spent on oil imports.

As a share of GDP, the energy trade deficit had fallen to as low as 0.4 percent at the beginning of 1999, when prices for imported crude oil were less than $10 a barrel. However, by the end of 2000, these prices had tripled to more than $30 a barrel (Figure 2-7). As a result of both the oil price spike and growing U.S. demand, the energy deficit deteriorated significantly to 1.3 percent of GDP by the fourth quarter of last year—the largest deficit relative to GDP since the mid-1980s (Figure 2-8). The rise in oil prices alone has added about 0.7 percent of GDP to the U.S. trade deficit, compared to 0.9 percent in the euro currency area, and 0.8 percent in Japan.



Financial markets react to energy costs and the effect those energy costs have on both individual firms and sectors of the market.

Figure 2-8

The U.S.Energy Trade Deficit Has Worsened

(Percent)



The energy trade deficit relative to GDP represents the share of domestic income that must be exported to sup port domestic energy needs. For the past several years, the United States has been a net importer of energy prod ucts. As a consequence, our energy trade balance has been in deficit. By the fourth quarter of 2000, the energy deficit had deteriorated significantly to 1.3 percent of GDP—the largest since the mid-1980s.

Note: Plotted quarterly through the fourth quarter of 2000.-
Source: U.S. Department of Commerce, Bureau of Economic Analysis.-

Net U.S. oil imports are 4 billion barrels a year, which means that each $1 increase in the price of imported crude oil boosts U.S. expenditures by about $4 billion. Given these guidelines, the $20 per barrel increase from early 1999 to late 2000 translates into an export of roughly $80 billion a year (0.9 percent of GDP) when measured from the low price prevailing at the end of 1998.

Impacts of Energy Prices on Financial Markets

An analysis of the financial impacts of higher energy prices can be divided into two parts: the effects on individual firms whose securities comprise the financial markets, and the macroeconomic impact on inflation and interest rates. Rising energy costs and greater volatility in energy prices can have a negative effect on both individual firms and the broader financial environment, generally producing lower asset prices and higher interest rates. The financial market impact to date of rising energy prices has been limited to firms with high sensitivity to energy costs and to those with significant exposure to the California crisis. The second broad effect of rising energy costs is an increase both in measured inflation

and in expectations for future inflation. Both factors have considerable impact on interest rates and, therefore, on the borrowing costs for businesses and consumers throughout the economy.

Inflation Expectations and Interest Rates

Measurable inflation, for both producers and consumers, is a primary concern of the Federal Reserve in conducting monetary policy. Energy costs represent roughly 16 percent of the producer price index for finished goods and 8 percent of the consumer price index. This means that sharply rising energy costs can have a substantial impact on the Federal Reserve's decision-making process. Additional impacts will come from the market's anticipating Federal Reserve actions and pushing short-term interest rates higher than they otherwise would have been. Higher short-term interest rates raise the nominal cost of borrowing for firms and individuals and can slow economic growth.

Rising energy prices can also raise the inflation expectations of lenders, which can result in higher interest rates for borrowing at longer maturities. Rising long-term interest rates can reduce long-term investment, limiting future economic growth and productivity gains. Such an outcome would carry negative consequences for growth-sensitive financial sectors, such as equity and high-yield debt markets.

More broadly, declining credit fundamentals for certain business sectors could raise borrowing costs for firms not directly affected by higher energy prices. For example, commercial paper rates for all lower-rated borrowers have been affected by the credit problems of the California utilities, and liquidity in the market has fallen. As a result, firms may need to seek other sources of financing, such as bank loans (if obtainable) or asset-backed loans, that can be more costly than traditional commercial paper issuance.

Global Financial Markets

The upward pressure on interest rates that may result from higher U.S. energy costs also affects markets beyond our borders. U.S. monetary policy and related movements in short-term interest rates can have a significant impact on other countries. While the effect varies from region to region, many emerging market economies, particularly in Latin America, are vulnerable to upward moves in U.S. interest rates.

Higher nominal interest rates in the developed countries tend to reduce the amount of capital flowing to emerging markets. To the extent that this reduces investment, economic activity may be further reduced. In addition, borrowing in dollars is a significant source of funding for sovereign and private-sector entities worldwide, particularly in the emerging markets. Rising U.S. interest rates will increase the interest expenses for these borrowers, diverting funds from more productive uses and reducing overall credit quality.

The global market for energy is highly fragmented and region-specific, with the exception of oil. Nevertheless, certain nations and regions are net importers of energy and are highly sensitive to changing prices. Japan, a major importer of oil and natural gas, is particularly vulnerable. Europe is a net importer of energy, with certain exceptions, while emerging market nations vary widely in their dependence on foreign energy sources.

At the macroeconomic level, rising energy prices will increase the current account deficit of energy-importing nations. Since current account deficits must be financed, these nations will most likely need to pay higher interest rates to attract the necessary capital. As noted, this will tend to reduce domestic investment and lower long-term growth. In some countries, such as the United States or Japan, changes in interest rates and growth expectations can have substantial global impact.

Central banks and monetary authorities vary in the degree to which they focus on inflation in setting monetary policy, making some countries more or less likely than others to raise interest rates in an environment of rising energy prices.

Although Japan maintains a current account surplus due to manufacturing exports, its role as an international creditor could diminish. This may have additional impacts on the global financial markets, since Japanese financial institutions are generally suppliers of global credit.

The impact of rising energy costs on the dollar is likely to be mixed. While slower U.S. growth generally reduces demand for dollars, rising oil prices are likely to increase demand, since oil contracts are usually denominated in dollars.

Summary of Recommendations

★ The NEPD Group recommends that the President direct the Secretary of Energy to explore potential opportunities to develop educational programs related to energy development and use. This should include possible legislation to create public education awareness programs about energy. Such programs should be long-term in nature, should be funded and managed by the respective energy industries, and should include information on energy's compatibility with a clean environment.

★ The NEPD Group recommends that the President take steps to mitigate impacts of high energy costs on low-income consumers. These steps would include:

- Strengthening the Low Income Home Energy Assistance Program by making $1.7 billion available annually. This is an increase of $300 million over the regular FY 2001 appropriation.
- Directing the Secretaries of Interior and Health and Human Services to propose legislation to bolster LIHEAP funding by using a portion of oil and gas royalty payments.
- Redirecting royalties above a set trigger price to LIHEAP, whenever crude oil and natural gas prices exceed that trigger price, as determined by the responsible agencies.

★ The NEPD Group recommends that the President increase funding for the Weatherization Assistance Program by $1.2 billion over ten years. This will roughly double the spending during that period on weatherization. Consistent with that commitment, the FY 2002 Budget includes a $120 million increase over 2001. The Department of Energy will have the option of using a portion of those funds to test improved implementation approaches for the weatherization program.

★ The NEPD Group recommends that the President support legislation to allow funds dedicated for the Weatherization and State Energy Programs to be transferred to LIHEAP if the Department of Energy deems it appropriate.

★ The NEPD Group recommends the President recognize unique regional energy concerns by working with the National Governors Association and regional governor associations to determine how to better serve the needs of diverse areas of the country.

★ The NEPD Group recommends the President direct FEMA to prepare for potential energy emergencies.

- -FEMA should work with states' Offices of Emergency Management as they expand existing emergency operations plans to identify potential problems and address consequences of the power shortages. FEMA should use its current Regional Incident Reporting System to identify any situations that might demand immediate attention.
- Using the structure of the already existing Federal Response Plan, FEMA should conduct Regional Interagency Steering Committee (RISC) meetings for states affected by the energy shortfalls. The RISC is a FEMA-led interagency committee comprised of agencies and departments that support the Federal Response Plan. Either an upcoming, scheduled RISC meeting or a special-focus RISC meeting can be held to identify the short-term energy outlook, as well as any expected consequences, in each of the states during the peak summer season.

Protecting America's Environment

Sustaining the Nation's Health and Environment

Over the last three decades, American ingenuity has led to a reduction in adverse environmental and public health impacts from energy development and use. Americans demand a reliable energy supply and a clean environment, and we can achieve both. Spurred by strong environmental concerns, competitive forces, and environmental regulations, businesses have developed innovative technologies and pollution-prevention techniques to protect the environment. However, more can be done.

As our energy needs continue to grow and our production and distribution system is strained to capacity, it is clear that the lack of a comprehensive energy policy has environmental costs. For example, to prevent blackouts, California officials must tolerate a large short-term increase in smog-forming nitrogen oxides emissions. In Los Angeles, older, dirtier power plants have had to run longer than expected. California is also rushing to use mid-sized "peaker power plants" and diesel-fired emergency backup generators to keep the lights on.

The short-term cost in increased pollutant emissions of these emergency measures has been stark. Preliminary figures from California's South Coast Air Quality Management District indicate emissions have doubled in the first three months of the year compared with last year. In addition to nitrogen oxides emissions, diesel-fired backup generators also emit toxic soot. But with many days of blackouts predicted in California this summer, these generators will most likely run for much longer than expected, and could greatly increase emissions.

In the longer term, penalties and technological improvements should offset the impact of these increased emissions. However, California's experience demonstrates the environmental costs of not building an adequate supply of clean energy.

Government's Role

The federal government has a unique role in facilitating energy development while simultaneously protecting the environment and conserving our country's natural resource legacy. Energy development initiatives will be successful only if they adequately address their impacts on natural resource values.

Federal, state, tribal, and local governments have the responsibility of protecting unique natural resources and environmental values. In fact, some environmental protections we enjoy today are often taken for granted. For example, lead levels in ambient air today are 98 percent lower than they were in 1970, largely because government regulations required that lead be removed from gasoline. The reduced number of children with IQs below 70 is attributed to reducing lead in our environment.

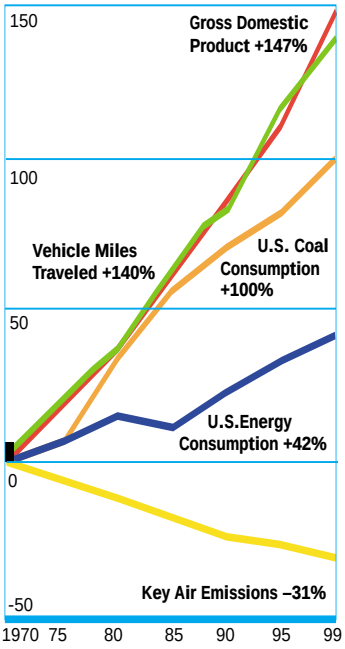
As U.S. energy needs grow, additional innovations will be necessary to continue improving environmental conditions and to meet new environmental challenges. As we improve the energy production and distribution system, all levels of government must ensure that regulatory systems protecting public health and the environment are rigorous and efficient, and encourage innovation and improvement.



Roughly 30 percent of our nation's electricity supply is now generated by nuclear, hydropower, and renewable sources, all of which have few air emissions.

Figure 3-1
Cleaner Air: Energy Consumption Has Risen While Emissions Have Declined

(Percent Change Since 1970)



Despite a marked increase in U.S. energy consumption, a combination of environmental regulations and technologies has decreased aggregate emissions of key air emissions: SO_2, NOx, mercury, CO, and volatile organic compounds.

Sources: U.S. Department of Energy, Energy Information Administration, and U.S. Environmental Protection Agency.

Air Quality

Regulatory Programs

Advances in technology and environmental regulations have decreased aggregate emissions of key air pollutants over the last three decades, despite a marked increase in energy consumption (Figure 3-1). Roughly 30 percent of our nation's electricity supply is now generated by nuclear, hydropower, and renewable sources, all of which have few air emissions.

Nonetheless, fossil fuel-fired power plants, other industrial sources, and vehicles remain significant sources of air pollution (Figure 3-2). These emissions can be associated with significant health problems, including respiratory and cardiopulmonary disease, cancer, and birth defects. In addition, they can be harmful to forests, water bodies, and fish, and can decrease visibility in scenic areas.

Environmental Protection Agency's (EPA) Acid Rain Program, enacted as part of the 1990 Clean Air Act Amendments, is the only program directed primarily at reducing air emissions from electric utilities.

Using flexible market-based incentives instead of technology-forcing standards, the program has reduced sulfur dioxide (SO_2) emissions from utilities faster than required by law for a fraction of the initial cost estimates. By 2010, EPA expects the program will reduce annual SO_2 emissions by 10 million tons from 1980 levels, thus avoiding significant health problems and the costs associated with those levels.

Federal and state regulatory programs also limit air pollution directly by restricting emissions from cars and trucks, and indirectly by setting criteria for the fuel for these vehicles. An individual car meeting 2004 federal requirements will emit 95 percent less carbon monoxide (CO), 94 percent fewer nitrogen oxides (NOx), and 98 percent fewer hydrocarbons than an average car did before laws limiting such vehicle pollution. Although individual cars and trucks are far cleaner today than they were in 1970, total emissions from the fleet of highway vehicles have remained relatively constant, because Americans drive twice as many miles today (2.5 trillion miles a year) as they did in 1970 (1.1 trillion miles a year).

Despite these and other achievements, further air quality improvements can be sought, as well as ways to address new problems identified by recent scientific findings. EPA has recently adopted new, more stringent standards to further reduce ozone and particulate matter. To meet public health and environmental challenges, power plants, industrial sources, and vehicles will need to produce fewer potentially harmful emissions.

Recommendation:

★ The NEPD Group recommends that the President direct the Administrator of the Environmental Protection Agency (EPA) to propose multi-pollutant legislation. The NEPD Group recommends that the President direct the EPA Administrator to work with Congress to propose legislation that would establish a flexible, market-based program to significantly reduce and cap emissions of sulfur dioxide, nitrogen oxides, and mercury from electric power generators. Such a program (with appropriate measures to address local concerns) would provide significant public health benefits even as we increase electricity supplies.

- Establish mandatory reduction targets for emissions of three main pollutants: sulfur dioxide, nitrogen oxides, and mercury.
- Phase in reductions over a reasonable period of time, similar to the successful acid rain reduction program established by the 1990 amendments to the Clean Air Act.
- Provide regulatory certainty to allow utilities to make modifications to their plants without fear of new litigation.
- Provide market-based incentives, such as emissions-trading credits to help achieve the required reductions.

Cleaner, More Efficient Technologies

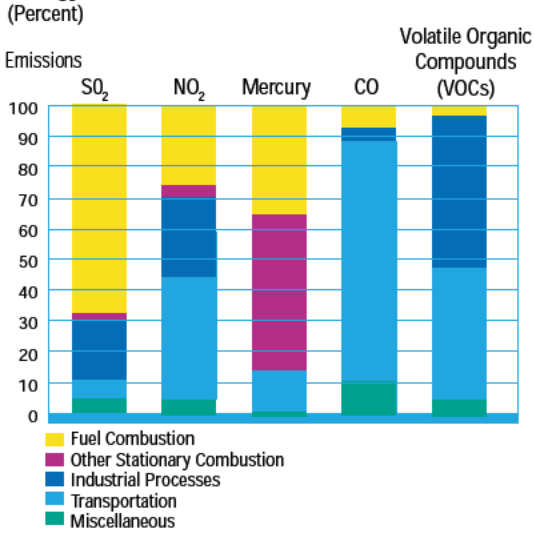
Emission control technologies and emission prevention not only decrease pollution but can also contribute to economic prosperity. Innovative emission control and prevention technology and increasingly efficient energy systems have developed at a brisk pace, increasing our ability to provide cleaner, cheaper energy. Besides reducing pollution, environmental technologies account for about $21.3 billion in U.S. exports, and support approximately 136,000 U.S. jobs.

The need to reduce emissions from cars and trucks has contributed to technological innovations that have transformed the domestic and global automotive industries. U.S. vehicle emission standards were the primary driving force for the original development of innovative technologies, many of which have become standard design features of today's high-tech vehicles: sophisticated three-way catalysts, on-board computers, oxygen sensors, and fuel-injection systems for cars and advanced fuel systems for trucks. Technologies such as these have allowed today's vehicles to be much cleaner, more efficient, higher performing, more reliable, and more durable than their counterparts of the 1960s and 1970s. Manufacturers are now working on developing state-of-the-art pollution control technology to further reduce emissions from motor vehicles. For optimal performance, this technology requires low-sulfur fuel that, consistent with applicable law, will be required in 2004 for gasoline and 2006 for diesel fuel. Some vehicles use alternative fuels (*e.g.,* natural gas, propane, ethanol, and electricity); others operate with a hybrid gasoline and electrical motor; and others are using fuel cells.

Cleaner Electricity

The source of energy used for power generation significantly affects the amount of air emissions. Clean energy can be generated from nuclear plants, hydropower facilities, wind farms, and solar energy systems with negligible (if any) air emissions. These sources today make up about 30 percent of our electricity supply. Solar and wind energy systems will continue to improve with advances in short-term weather and climate forecasting. Improved forecasting can also maximize hydropower efficiency.

Figure 3-2
Sources of Pollutants from Energy Generation and Use
(Percent)



Technology significantly reduces pollution from coal-fired power plants, which generate more electricity in the United States than any other source. For example, scrubbers can remove 95 percent of the SO_2 emissions from a coal-fired power plant. With the innovative, market-based SO_2 reduction requirements of the Clean Air Act Amendments of 1990, the estimated cost of using a scrubber on a coal-fired power plant to remove one ton of SO_2 has dropped approximately 40 percent in four years, from $474/ton in a 1993 estimate to $282/ton in a 1997 estimate, and continues to decline. Other existing control technologies for coal-fired plants can reduce NOx emissions by more than 90 percent.

A recently permitted state-of-the-art coal-fired unit, for example, at a Kansas City Power & Light facility, has 88 percent lower NOx, 99 percent lower particulate matter, and 92 percent lower SO_2 emissions than would an uncontrolled facility.

Recent research by the Department of Energy (DOE), EPA, and private companies suggests that existing technologies can also significantly reduce mercury emissions.

Technologies for Reducing SO_2 Emissions

Many power plants use flue-gas desulfurization, or scrubbers, to reduce SO_2 emissions from burning coal. The most common wet scrubber, the limestone forced-oxidation (LSFO) process, removes SO_2 from the flue gas by sorption and through chemical reactions with the limestone. LSFO technologies can remove up to 98 percent of SO_2 and significant amounts of mercury. The most common dry scrubber, the lime spray-drying process, is used for plants that burn lower-sulfur coals. A lime slurry mixes with the hot flue gas in a spray dryer and reacts with SO_2. By recapturing sorbent at the bottom of the spray dryer removed in a particulate control device, dry scrubbers can remove up to 96 percent of SO_2.

Clean Coal Technologies

New clean coal technologies are showing that air pollution can be reduced, and energy efficiency increased, by using America's abundant supply of coal.

Most conventional air emission control technologies installed on coal-fired electric-generating boilers have been designed to remove a specific pollutant from the stack flue gas. Because these technologies may not be the most cost effective means of reducing multiple pollutants, several companies are developing a single-control technology to reduce multiple air pollutants to levels equivalent to those achieved by conventional controls.

For example, a First Energy plant in New Hampshire recently pilot-tested state-of-the-art technology that has cut NOx emissions by 76 percent, SO_2 by 44 percent, total particulate matter by 99.94 percent, and mercury by 81 percent. The process uses electrically charged particles instead of catalysts to oxidize the air pollutants into products that are easily removed and can be converted to gypsum, fertilizer, and concentrated acids. American Electric Power is installing a wet scrubber system that it expects will remove up to 75 percent NOx and 90 percent mercury. It injects a phosphorus mixture into the hot flue gas, causing the release of ozone. The ozone then oxidizes the mercury into ionic mercury and the NOx into N_2, both of which are water-soluble and easily removed.

Using flexible market-based incentives, EPA's Acid Rain Program has reduced sulfur dioxide (SO_2) emissions from utilities faster than required by law for a fraction of the initial cost estimates.



Technologies for Improved Efficiencies

Two-thirds of the energy used in a conventional coal-fired power plant is wasted in the production of electricity. These losses can be minimized through a number of innovations, including installing high efficiency steam turbines, reducing steam leaks, and using software to optimize combustion efficiency. New coal-burning power plants can achieve efficiencies of over 40 percent using existing technology, and companies are developing even more efficient technologies. Wasted energy can also be recycled for use in industrial processes or for heating buildings.

A family of technologies known as combined heat and power (CHP) can achieve efficiencies of 80 percent or more. In addition to environmental benefits, CHP projects offer efficiency and cost savings in a variety of settings, including industrial boilers, energy systems, and small, building-scale applications. At industrial facilities alone, there is potential for an additional 124,000 megawatts (MW) of efficient power from gas-fired CHP, which could result in annual emission reductions of 614,000 tons of NOx emissions and 44 million metric tons of carbon equivalent. CHP is also one of a group of clean, highly reliable distributed energy technologies that reduce the amount of electricity lost in transmission while eliminating the need to construct expensive power lines to transmit power from large central power plants.

The U.S. Department of Energy, through its Clean Coal Technology Program, is working with utilities and scientists to develop even cleaner, more efficient electricity-generating systems using coal. One of the most promising new approaches to using coal for clean production of electricity is integrated gasification combined-cycle (IGCC) technology. IGCC power plants convert coal to a gaseous fuel, from which most

Clean Coal Technologies Up Close

The Wabash River Coal Gasification Project in Terre Haute, Indiana, is one of the cleanest, most efficient coal-burning facilities in the country. Partly funded by the Department of Energy (DOE) as part of its Clean Coal Technology Program, the 262-MW coal gasification facility is owned and operated by PSI Energy and Global Energy, Inc. Instead of being directly burned, the coal is gasified and then combusted in a combined-cycle gas turbine. This allows the coal to burn more efficiently—which means it gets more energy than a traditional plant out of the same amount of coal. The Wabash River Facility is over 20 percent more efficient than a typical coal-fired power plant.

The gasification process also allows many of the impurities in the coal to be removed before it is combusted to generate electricity. At the Wabash River project, over 99 percent of the sulfur is removed from the coal and marketed to industrial users of sulfur. Slag is also removed and is marketed to the construction industry. The plant's design allows it to burn other fuels, such as petroleum coke.

DOE is currently working with Global Energy and other industry partners to see if the plant could also be used to co-produce chemical feedstocks and transportation fuels. Additionally, DOE and its partners are studying lessons learned from the project to design a less expensive, more efficient coal gasification facility that would be ready for commercial deployment by 2005.

of the impurities are removed prior to combustion, and then use the gaseous fuel in a combustion turbine to produce electricity. Waste heat from the turbine is used to generate steam and drive a steam turbine, to produce more electricity.

Coal gasification plants offer the flexibility to burn other fuels, such as petroleum coke, and to make other products in addition to electricity, such as chemical feedstocks and transportation fuels. Hydrogen, which is produced directly in the coal gasifier, can be used in fuel cell-equipped vehicles. Methane, hydrogen, and other gasified coal products can be recombined into more traditional fuels, such as methanol, gasoline, or diesel fuel. Because these fuels would contain essentially no sulfur, they would easily meet EPA's sulfur standards for transportation fuels, and they would be usable in fuel cell-equipped vehicles designed for these fuels.

Two plants demonstrating coal gasification technology have already been built in the United States and have achieved over 98 percent SO_2 reduction, 90 percent NOx reduction, particulate emissions below detectable levels, and approximately 38 percent efficiency. EPA believes that lessons learned will enable the next plant of this design to achieve 42 percent efficiency, and the research goal is to achieve 60 percent efficiency for plants introduced after 2015.

A modern gas-fired power plant has virtually no SO_2 or mercury emissions and emits 97 percent less NOx and 50 percent less carbon dioxide (CO_2) than a traditional coal-fired plant. Natural gas as a source of electricity generation is on the rise, in part because it can help generators meet increasingly stringent clean air requirements.

Conservation and Environmental Protection

Conserving energy minimizes adverse environmental effects. Government partnerships with businesses and consumers are improving the energy efficiency of homes, office buildings, transportation sources, and industrial sites throughout the country. EPA's voluntary conservation and energy efficiency programs include Energy Star products labeling; Energy Star Residential programs for both new homes and home improvement; Energy Star Buildings, principally for commercial buildings; and new Energy Star for Industry, which focuses on manufacturers. In 2000, business participation in EPA's voluntary energy efficiency

programs reduced NOx emissions by more than 160,000 tons.

Through EPA's and the Department of Transportation's Commuter Choice Leadership Initiative, private-public employers are offering employees a variety of commuting options, which encourage commuting patterns that save fuel and energy while reducing emissions. For example, a 10 percent reduction in the rate of growth in vehicle miles traveled can result in annual savings of 38 million barrels of gasoline (82 million barrels of oil) by 2005, and can remove 45,000 metric tons of NOx, 37,000 metric tons of hydrocarbons, and 4.8 million metric tons of carbon-equivalent emissions.

Energy efficiency and conservation in the home are also important factors. Examples include EPA's home improvement program, which involves efficient appliances, duct work to prevent air conditioners from leaking, efficient windows, programmable thermostats, and efficient residential lighting.

Federal and state regulators are working with businesses and communities to mitigate adverse environmental impacts by requiring developers and operators to choose more environmentally friendly sites, infrastructure routes, and operational criteria; fostering the use of technologies that both protect the environment and still meet energy production goals; and requiring reclamation and mitigation of any environmental damage.



Water Quality

Oil, gas, and coal extraction processes can degrade water quality through their discharges. Energy generation and use can also degrade water quality by directly discharging pollutants into water bodies; changing the temperature, timing, and flow characteristics of water bodies; and emitting pollutants into the air that are ultimately deposited in water. Leaking storage tanks and pipelines release petroleum and fuel additives that can contaminate surface water and ground water, including drinking-water supplies.

Federal and state regulators are working with businesses and communities to mitigate these adverse impacts by requiring developers and operators to choose more environmentally friendly sites, infrastructure routes, and operational criteria; fostering the use of technologies that both protect the environment and meet energy production goals; and requiring reclamation and mitigation of any environmental damage. For example, as a result of an analysis under the National Environmental Policy Act of the impacts of a new power plant in California, the company building the plant agreed to change the design to use a dry cooling method. This change reduced ground-water consumption by 95 percent and eliminated both cooling tower "blowdown" water and particulate emissions, while still achieving the desired energy production. Adverse impacts to aquatic life from cooling-water intakes, thermal discharges, and hydropower intakes can be minimized with proper design and environmental controls. A cooperative government, industry, and community-based approach during project siting and design will help ensure full consideration of the effects upon fish and aquatic resources.

Programs to reduce air pollution also help clean up water bodies. For example, reducing electric utilities' air emissions of NOx and SO_2 and vehicles' NOx emissions reduces eutrophication and acid deposition in estuaries, both of which can harm fish populations and threaten commercial and recreational yields. For example, roughly 25 percent of nitrogen (which contributes to

eutrophication) entering Chesapeake Bay is from air emissions. And by significantly reducing SO_2 air emissions, the Acid Rain Program has helped reduce the acidification of water bodies.

Airborne mercury emitted by coal-fired power plants has been deposited into thousands of water bodies, and humans can be exposed to toxic methyl mercury when they eat fish from these waters. The Bush Administration will propose legislation adding mercury to the list of pollutant emissions from power plants that will be subject to mandatory limits.

Fish, Wildlife, and Their Habitat

Ecosystems provide food, shelter, and critical breeding and spawning grounds for fish and wildlife, and support commercial and recreational fishing, tourism, and other activities that contribute billions of dollars to the U.S. economy every year. Oil and gas exploration and production, hydropower dams, power plants, pipelines, and other energy-related projects can potentially affect fish, wildlife, and habitat. However, technological advances, a strong commitment to environmental protection, and the use of appropriate regulatory tools can enable proper energy development to go forward in an environmentally sensitive manner. It is important to recognize and to continue the progress in this area.

When energy development is proposed, the federal government has the dual responsibilities of facilitating such energy development *and* conserving our natural resource legacy.

Recommendation:

★ The NEPD Group recommends that the President direct the Secretary of the Interior to work with Congress to create the "Royalties Conservation Fund."

- This fund will earmark potentially billions of dollars in royalties from new oil and gas prodution in ANWR to fund land conservation efforts.
- This fund will also be used to eliminate the maintenance and improvements backlog on federal lands.



Technological advances and a strong commitment to environmental protection are enabling the healthy coexistence of our nation's diverse ecosystems with the development of energy resources.

Special efforts are often necessary to ensure that proposed energy projects do not diminish the vitality of these unique resources. Working together, the public, businesses, and federal, state, tribal, and local governments can ensure that environmental impacts are carefully evaluated when considering energy exploration and production activities. For example, such precautions have been important for the exploration and production that is already allowed today in 42 National Wildlife Refuges.

Hydropower Generation

Hydropower, although a clean energy source, does present environmental challenges. Unless properly designed and operated, hydropower dams can injure or kill fish, such as salmon, by blocking their passage to upstream spawning pools. Innovations in fish ladders, screens, and hatcheries are helping to mitigate these adverse impacts. Ongoing dam relicensing efforts are resulting in community involvement and the industry's application of the latest technologies to ensure the maintenance of downstream flows and the upstream passage of fish. These efforts also have been successful in identifying and removing older, nonfunctioning dams and other impediments to fish movements.



Ecosystems provide food, shelter, and critical breeding and spawning grounds for fish and wildlife, and support commercial and recreational fishing, tourism, enhance our quality of life,and other activities that contribute billions of dollars to the U.S. economy every year.



Some natural resource areas are to be protected from any exploration. In other areas, energy development can proceed using the most advanced designs and technologies to ensure that proposed energy projects do not diminish the vitality and diversity of these unique resources.

An example of such successful collaboration involves the Wanapum Dam on the Columbia River. In coordination with the National Marine Fisheries Service, the Grant County Public Utility District No. 2 installed spillway deflectors that effectively reduced concentrations of total dissolved gas that can harm fish and other aquatic life. Furthermore, through the unique collaboration on this project, the cost for the spillway deflectors was a fraction of that for deflectors installed at other hydropower projects.

Coal, Oil, and Gas Exploration and Production

Certain exploration and production activities can pose environmental impacts to wildlife habitat, unless conducted in a way that protects the environment. In sensitive areas, these effects can often be avoided or minimized by timing exploration and operation activities in light of migration, nesting, and other critical time periods for wildlife. In addition, new technologies designed to lessen these and other impacts can be used, such as double-walled pipes to reduce the risk of oil spills.

Surface impacts from coal mining and oil exploration can temporarily damage habitats during the operation phases until reclamation is complete. To mitigate impacts during mining, for example, stormwater runoff and discharge into undisturbed environments are controlled. After mining is complete, reclamation efforts required by the Surface Mining Control and Reclamation Act restore viable habitats through careful reconstruction of physical and botanical resources. For instance, in the Powder River Basin, as part of reclamation, coal companies strategically place large boulders and other rock material to create wildlife cover and denning habitat. Restoration of wildlife habitat on these reclaimed areas has been quite successful.

In Alaska's Arctic—home to such animals as polar bears, musk oxen, caribou, wolves, and arctic fox—the bitterly cold winters have proven to be beneficial for environmentally responsible energy development. For example, when the North Slope is frozen and snow-covered, seismic trains can travel across it to gather geophysical information. Furthermore, companies have adopted innovative techniques to reduce the possible impacts of exploration and development. In Alaska's National Petroleum Reserve, the "footprint" from most exploratory wells on federal lands is short-lived and has minimal impact due to the use of ice roads and ice pads that melt with the spring thaw. Advances in extended-reach drilling technologies have also served to minimize environmental effects during energy production activities.

A lengthy 1999 Department of Energy study examined the environmental benefits of new exploration and production technologies and concluded that "improvements over the past 40 years have dramatically reduced industry's footprint on the fragile tundra, have minimized waste produced, and have protected the land for resident and migrating wildlife." The same study concluded that "it is important to tell this remarkable story of environmental progress in E&P [exploration and production] technology. Greater awareness of the industry's achievements in environmental protection will provide the context for effective policy, and for informed decision-making by both the private and public sectors."

Waste Management

Vigilant management and careful disposal of waste from energy extraction and production can prevent the contamination of our air, land, and water. Federal and state authorities are working to ensure that energy projects maintain sound programs to safely handle wastes from mining, drilling, generation and transmission.

Nuclear power plants present waste management challenges unique among energy-generating technologies. They generate spent fuel, as well as other radioactive waste, which must be isolated from ecosystems and human contact for long periods of time. Currently, spent fuel is stored at reactor sites in a number of states, although capacity is limited. Newer technologies have been developed to reduce the volume and

increase the manageability of spent fuel, but such spent fuel will still require safe handling and long-term isolation.

While the federal government has the responsibility to address such high-level wastes, states have the responsibility to address low-level wastes from nuclear plants, such as clothing and equipment. Disposal options for this type of radioactive waste are limited, because siting these facilities has been controversial. In fact, there are only three disposal facilities active in the United States.

Accidental Releases

Since the passage of the Oil Pollution Act in 1990, which, among other things, required double-hulled vessels and improved industry readiness, oil spilled in coastal zone waters has decreased from almost 8 million gallons in 1990 to just over 1 million gallons in 1999. Most energy production facilities implement comprehensive risk-management plans, which reduce the potential for accidents and help local officials prepare for accidents that may arise.

In contrast, inland oil spills do not appear to be decreasing at the same rate as coastal spills. The federal government receives many more inland oil spill notifications (9,000 notifications a year in the early 1990s versus 10,000 to 12,000 a year in the late 1990s), and many very large inland oil spills occur each year (over 100,000 gallons). The continued problem with inland oil spills may be due to aging pipelines, storage tanks, and other infrastructure components.

Since the advent of commercial nuclear power generation, there have been no radiation-related injuries or deaths associated with the operation of a commercial nuclear power plant in the United States. The most significant incident from a nuclear plant in the United States, at Three Mile Island in 1979, prompted improved safety regulation of nuclear plants. New nuclear reactor designs promise even higher safety levels than the reactors currently operating in this country.

Radiation exposure from nuclear facilities is extremely rare. In fact, roughly 82 percent of human exposure to radiation comes from natural sources: radon gas; the human body, which contains radioactive elements; outer space; and rocks and soil. Radon accounts for about 55 percent of our exposure to natural sources of radiation; radioactive elements in our own bodies account for 11 percent; rocks and soil account for 11 percent; and outer space, including the sun, accounts for 8 percent. The remaining 18 percent of average human radiation exposure comes from man-made sources, primarily medical and dental X-rays and consumer products.

The safety of U.S. nuclear energy plants has improved sharply in recent years. A safe nuclear energy plant is one that runs well, experiences few unplanned outages, and has a well-disciplined work force that follows procedures and avoids accidents. The safety of a U.S. nuclear energy plant is typically gauged by monitoring indicators of its performance in these areas: unplanned automatic reactor shutdowns, the annual percentage of possible power generated, and the industrial safety accident rate for plant workers.

In 2000, for the fourth year in a row, the number of unscheduled reactor shutdowns was zero. The industry generated 91.1 percent of its potential maximum output, breaking its 1999 record of 88.7 percent, far better than the typical 80 percent number of ten years ago.

Today, U.S. nuclear plants are more efficient and safer than ever. In the increasingly deregulated marketplace, competition has forced improvements in plant operations that have benefited safety performance as much as economic performance.

Climate Change

Energy-related activities are the primary sources of U.S. man-made greenhouse gas emissions, representing about 85 percent of the U.S. man-made total carbon-equivalent emissions in 1998.

Scientists continue to learn more about global climate change, its causes, potential impacts, and possible solutions.

The United States recognizes the seriousness of this global issue as scientists attempt to learn more about climate change. The United States is making progress in reducing emissions of greenhouse gases. Recent data show that the rate of growth in U.S. greenhouse gas emissions has begun to decline, even as the U.S. economy has been growing at an unprecedented rate. For example, historically U.S. CO_2 emissions have grown at roughly half the rate of GDP. In recent years, however, very robust growth in the nation's GDP has been accompanied by a slowdown in the growth of greenhouse gas emissions. In both 1998 and 1999, U.S. GDP grew by more than 4 percent a year, while CO_2 emissions grew by less than 1.5 percent a year. In addition, the carbon intensity of the U.S. economy—the amount of CO_2 emitted per unit of GDP—declined by 15 percent during the 1990s.

The United States has reduced greenhouse gas emissions by promoting energy efficiency and the broader use of renewable energy through a wide range of public-private partnership programs. These programs save energy, cut energy bills, enhance economic growth, and reduce emissions of conventional air pollutants as well as greenhouse gases.

The U.S. government, businesses, and nongovernmental organizations are sequestering carbon, at home and abroad. For example, working with the U.S. Fish and Wildlife Service Research, Illinova Generating Company has voluntarily committed to reforesting 100,000 acres of bottomland hardwood forests on National Wildlife Refuges in the Lower Mississippi River Valley. It is projected that this project will sequester approximately 13.5 million tons of carbon, improve fish and wildlife populations by restoring the natural forest wetland habitats, and enhance the Gulf of Mexico's near-shore aquatic environment by restoring natural forested wetland filters to the Mississippi River floodplain.

Industry and the federal government are researching various new technologies that will reduce greenhouse gas emissions or sequester those emissions, in geologic formations, oceans, and elsewhere.



Forests can absorb carbon dioxide, which accounts for the largest share of greenhouse gas emissions. Working with the U.S. Fish and Wildlife Service Research, Illinova Generating Company has voluntarily committed to reforesting 100,000 acres of bottomland hardwood forests on National Wildlife Refuges in the Lower Mississippi River Valley.

Regulatory Structure

The United States has adopted many regulatory protections to limit the environmental damage and public health consequences of the exploration, extraction, production, and use of energy. Most environmental controls are implemented through state or federal permitting or review systems, which often require time for agency review and public participation. Facilities may need several different permits or reviews from different agencies, and they may also need to meet local licensing or zoning laws. Businesses have an interest in moving expeditiously to respond to consumers' needs. The public also has an interest in participating in the system to ensure that appropriate health and environmental precautions will be taken.

Regulatory requirements are not static. New scientific information and new control technologies result in new regulations and modifications to existing regulations over time. However, some level of certainty in the regulatory environment is important for all parties. Businesses can plan more effectively in such an environment, and regulators can focus on ensuring that the desired outcomes are in fact achieved consistently. For example, studies have shown that if electricity generators knew today what their emission requirements for several emissions would be for a defined time period, they would most likely control emissions more cost effectively and sooner than if their emission requirements were decided upon one gas at a time.

Traditional permit and regulatory programs may not always be the most effective and efficient way to protect the environment. Increasingly, regulatory programs are considering approaches that include market-based incentives. These types of incentives offer advantages over traditional forms of regulation because they set high performance standards and then allow market forces to determine the most effective way to meet them. While not appropriate for every situation, market-based incentives can control pollution at a lower cost to society than traditional regulation, stimulate technological improvements, and be structured to achieve larger reductions in pollution than would result from traditional regulations.

A good example of a U.S. market-based program is the Acid Rain Program, which has reduced SO_2 air emissions from utilities at a fraction of the initial cost estimates. Other emerging market-based environmental protection mechanisms include effluent trading, wetland mitigation banks, tradable development rights, easement purchases, off-site mitigation, and leasing or purchasing of water rights. These programs can reduce mitigation or pollution control costs, increase business flexibility, and provide transparency and environmental protection for the public.



The environmental review process can also be made more open, understandable, predictable, and coordinated among federal agencies and with state and local agencies. It can be improved by providing greater information to clarify expectations for energy developers, facilitating concurrent reviews by federal agencies by standardizing certain information needs, sharing information received by project applicants, and seeking opportunities to integrate required environmental processes and reviews.

Recommendation:

★ The NEPD Group recommends that the President issue an Executive Order to rationalize permitting for energy production in an environmentally sound manner by directing federal agencies to expedite permits and other federal actions necessary for energy-related project approvals on a national basis. This order would establish an interagency task force chaired by the Council on Environmental Quality to ensure that federal agencies responsible for permitting energy-related facilities are coordinating their efforts. The task force will ensure that federal agencies set up appropriate mechanisms to coordinate federal, state, tribal, and local permitting activity in particular regions where increased activity is expected.

Summary of Recommendations

Protecting America's Environment: Sustaining the Nation's Health and Environment

★ The NEPD Group recommends that the President direct the Administrator of the Environmental Protection Agency (EPA) to propose multi-pollutant legislation. The NEPD Group recommends that the President direct the EPA Administrator to work with Congress to propose legislation that would establish a flexible, market-based program to significantly reduce and cap emissions of sulfur dioxide, nitrogen oxides, and mercury from electric power generators. Such a program (with appropriate measures to address local concerns) would provide significant public health benefits even as we increase electricity supplies.

- Establish mandatory reduction targets for emissions of three main pollutants: sulfur dioxide, nitrogen oxides, and mercury.
- Phase in reductions over a reasonable period of time, similar to the successful acid rain reduction program established by the 1990 amendments to the Clean Air Act.
- Provide regulatory certainty to allow utilities to make modifications to their plants without fear of new litigation.
- Provide market-based incentives, such as emissions trading credits to help achieve the required reductions.

★ The NEPD Group recommends the President direct the Secretary of the Interior to work with Congress to create the "Royalties Conservation Fund."

- This fund will earmark potentially billions of dollars in royalties from new oil and gas production in ANWR to fund land conservation efforts.
- This fund will also be used to eliminate the maintenance and improvements backlog on federal lands.

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Using Energy Wisely

Increasing Energy Conservation and Efficiency

The Department of Energy has installed two low-sulfur light bulbs as a test at its Forrestal Building headquarters in Washington, D.C. The two golf ball-sized bulbs, like those on the opposite page, are at each end of a 240-foot, 10-inch-wide reflective plastic "light pipe."
U.S. Departmentof Energy



U S Departmentof Energy

Energy efficiency is the ability to use less energy to produce the same amount of lighting, heating, transportation, and other energy services. For a family or business, conserving energy means lower energy bills. For the country as a whole, greater energy efficiency helps us make the most of U.S. energy resources, reduces energy shortages, lowers our reliance on energy imports, mitigates the impact of high energy prices, and reduces pollution. Improvements in efficiency can be particularly effective in reducing energy demand when energy is most expensive.

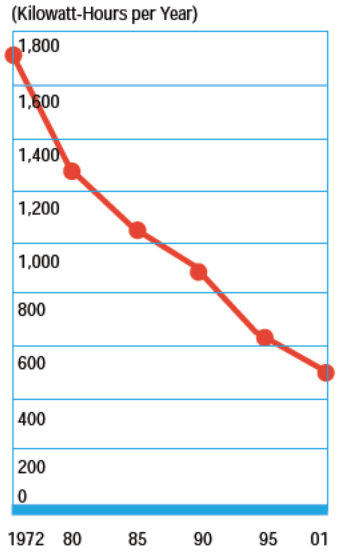
Conservation and energy efficiency are important elements of a sound energy policy. Improved energy efficiency is the result of many decisions, including those of individual consumers; manufacturers of cars and appliances; home builders; and state, federal, and local government officials. The federal government can promote energy efficiency and conservation by including the dissemination of timely and accurate information regarding the energy use of consumers' purchases, setting standards for more energy efficient products, and encouraging industry to develop more efficient products. The federal government can also promote energy efficiency and conservation through programs like the Energy Star program, and search for more innovative technologies that improve efficiency and conservation through research and development.

Since 1973, the U.S. economy has grown nearly five times faster than energy use (126 percent versus 26 percent). Had Americans continued to use energy as intensively as in 1970, the U.S. would have consumed about 177 quadrillion Btus of energy last year, compared to about 99 quadrillion Btus actually consumed.

British Thermal Unit (Btu)
A British thermal unit is the amount of heat required to raise the temperature of one pound of water one degree Fahrenheit at sea level. Put another way, it is approximately the same amount of energy contained in a wooden match head.



Figure 4-1
New Refrigerator-Freezers are Using Less Energy
Consumption per Unit for New Shipments



Over the last thirty years, the energy efficiency of refrigerator-freezer appliances has increased by approximately 70 percent.

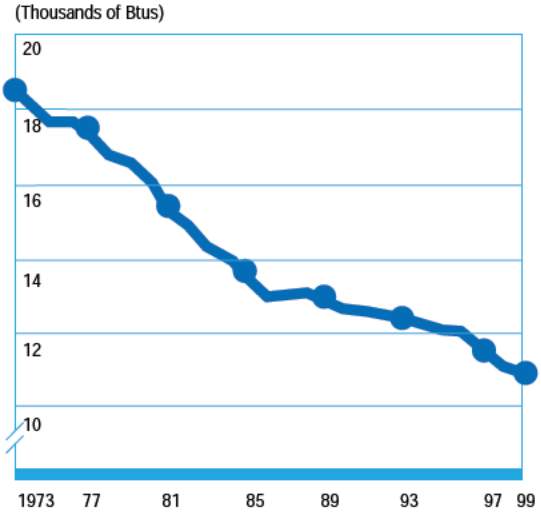
Sources: AHAM 2000 Major Home Industry Fact Book and BTS appliance standard.

Improving Efficiency through Innovative Technologies

One measure of energy efficiency is energy intensity—the amount of energy it takes to produce a dollar of gross domestic product (GDP). While about half of the long-term decline in energy intensity can be attributed to changes in the economy, especially the shift from manufacturing to services, the other half reflects improved energy efficiency. Gains in energy efficiency over the last three decades were built on a combination of technological improvements, better management practices, and learning to put these technologies and practices to their best use in automobiles, homes, offices, factories, and farms. In many areas the results have been quite impressive. New home refrigerators use about one-third of the electricity they used in 1972 (Figure 4-1). Compact fluorescent lights use about 25 percent of the electricity of the incandescent bulbs they replace. Automobiles use roughly 60 percent of the gasoline they did in 1972 per mile driven. These individual technological improvements have resulted in significant reductions in energy use (Figure 4-2).

Several new and innovative technologies offer expanded opportunities to improve our energy efficiency. For example, advanced sensors and controls enable more efficient operation of buildings and factories, and allow equipment and lights to be turned off or dimmed when not in use. Hybrid vehicles use power electronics and battery storage to get more out of every gallon of gasoline consumed, and provide the ability to double vehicle mileage. Cogeneration of electricity and heat and combined heat and power allow for the productive use of much of the waste heat from electricity production, which accounts for about two-thirds of the energy used to produce electricity.

Figure 4-2
The U.S. Economy Has Become More Energy Efficient



The amount of energy used by the United States in relation to its economic output has steadily declined since the early 1970s.

Source: U.S. Department of Energy, Energy Information Administration.

District Energy St. Paul—A Combined Heat and Power Plant

District Energy St. Paul, Inc., is a combined heat and power plant that can operate on natural gas, oil, or clean-burning coal that is mixed with wood chips. These wood wastes come from downed trees, trimmings, and branches. District Energy has been able to keep its rates stable because it is able to rely on a diverse fuel supply. District Energy serves about 75 percent of all building space in the city. Nearly 150 large buildings and 3,200 residential units use the system. It is the largest system of its kind in the nation.

Recommendation:

★ The NEPD Group recommends that the President direct the Secretary of Energy to conduct a review of current funding and historic performance of energy efficiency research and development programs in light of the recommendations of this report. Based on this review, the Secretary of Energy is then directed to propose appropriate funding of those research and development programs that are performance-based and are modeled as public-private partnerships.

Consumer Choices

The two most important factors in consumers' decisions about purchasing an energy efficient product are price and the life of the product. When energy prices are high, consumers tend to weigh energy efficiency more heavily. Unless consumers are informed about the price of energy, they may not have the incentive to select the most energy efficient product.

Consumers do not receive timely signals about rising electricity costs in order to make adjustments to their energy use and efficiency. When consumers' peak costs are averaged with off-peak costs, the higher cost of peak electricity supplies is masked. As a result, consumers may not recognize the benefits of investing in technologies that best target peak consumption.

Some energy efficiency improvements are easiest and most cost effective to undertake when first building new factories, cars, equipment, appliances, and buildings. Some energy-using equipment, like computers, are used for only a few years before being replaced. Other equipment is used from five to twenty years, such as home appliances, home electronics, and lighting systems. Some capital stock, such as buildings and boilers, can last a half a century or more.

The average car now lasts fourteen years, and newer cars have even more longevity. Vehicle efficiency improvements require significant technological changes. Development of new-car production models requires at least three to four years, which limits the rate at which new technologies can enter the market. Making fundamental changes, such as switching to the use of a fuel cell, would take even longer. Once those new vehicles are in the showroom, it then takes several more years before they constitute any sizable percentage of total vehicles.

In a typical U.S. home, appliances are responsible for about 20 percent of the energy bills. Refrigerators, freezers, clothes washers, dryers, dishwashers, and ranges and ovens are the primary energy-using appliances in most households. Taking steps to save energy while using these appliances, and replacing old inefficient appliances with modern ones can save money.



Some efficiency improvements are easiest and most cost-effective to undertake when first building new factories, cars, equipment, appliances and buildings.

The federal government established a mandatory program in the 1970s requiring that certain types of new appliances bear a label to help consumers compare the energy efficiency of various products. Under this program, all refrigerators, freezers, clothes washers, and dishwashers are sold with yellow Energy Guide labels to indicate their energy efficiency. These labels provide an estimated annual operating cost of the appliance, and also indicate the cost of operating the models with the highest annual operating cost and the lowest annual operating cost. By comparing a model's annual operating cost with the operating cost of the most efficient model, you can compare their efficiencies. This labeling program ensures that consumers have the information they need to make the right decisions when they purchase major home appliances. However, Energy Guide labels are not currently required for some products, such as kitchen ranges, microwave ovens, clothes dryers, on–demand water heaters, portable space heaters, and lights.

The federal government not only ensures consumers have information on the energy efficiency of major home appliances. It also promotes the most energy efficient products through the Energy Star program, a joint program run by the Department of Energy and the Environmental Protection



In April 2001, the Sustainable Buildings Industry Council showcased a net-zero-energy home featuring passive solar design strategies, an integrated photovoltaic system, domestic solar hot water, high-efficiency lights and appliances, and a host of sustainable, market-ready components and systems.
Sustainable Buildings Industry Council



A 48-story skyscraper at the corner of Broadway and 42nd Street in New York City has a photovoltaic skin that uses thin-film PV panels to replace traditional glass cladding material. The PV curtain wall extends from the 35th to the 48th floors on the south and east walls of the tower, making it a highly visible part of the New York City skyline.
U.S. Department of Energy, National Renewable Energy Laboratory

Agency. Energy Star is only awarded to appliances that significantly exceed minimum energy efficiency standards. The Energy Star program does not extend to all products. Energy efficiency would be further promoted if the Energy Star program were expanded to a broader range of products.

Recommendation:

★ The NEPD Group recommends that the President direct the Secretary of Energy to promote greater energy efficiency.

- Expand the Energy Star program beyond office buildings to include schools, retail buildings, health care facilities, and homes.
- Extend the Energy Star labeling program to additional products, appliances, and services.
- Strengthen Department of Energy public education programs relating to energy efficiency.

Energy efficiency can also be improved by the establishment of minimum energy efficiency standards. Congress enacted legislation in 1987 and 1988 to establish minimum energy efficiency standards for many major appliances. These standards apply to manufacturers, not consumers. Appliance manufacturers must produce products that meet the minimum level of energy efficiency. These rules do not affect the marketing of products manufactured before the standards went into effect, and any products made beforehand can be sold. The new standards will stimulate energy savings that benefit the consumer, and reduce fossil fuel consumption, thus reducing air emissions.

These laws established minimum energy efficiency standards for many appliances, including refrigerators, refrigerator-freezers, freezers, room air conditioners, fluorescent lamp ballasts, and incandescent reflector lamps, clothes dryers, clothes washers, dishwashers, kitchen ranges, and ovens, pool heaters, and water heaters. The Energy Policy Act of 1992 added standards for fluorescent and incandescent reflector lamps, plumbing products, electric motors, and commercial water heaters, and heating, ventilation, and air conditioning systems. Under current law, the Department of Energy can raise the minimum energy efficiency standards for these appliances if certain criteria are met, such as cost, technological feasibility, and the impact on competition among appliance manufacturers. In addition, the Department can set energy efficiency standards for appliances not covered by these laws.

Recommendation:

★ The NEPD Group recommends that the President direct the Secretary of Energy to take steps to improve the energy efficiency of appliances.

- Support appliance standards program for covered products, setting higher standards where technologically feasible and economically justified.
- Expand the scope of the appliance standard program, setting standards for additional appliances where technologically feasible and economically justified.

Energy Efficiency

Government Agencies

As the largest energy consumer in the nation, the U.S. government's cost- and energy-saving opportunity is enormous. In 1999, the government consumed nearly 1.1 percent of all U.S. energy and spent nearly $8 billion for its vehicles, operations, and its nearly 500,000 buildings.

The federal government has reduced its energy use in buildings by about 30 percent from 1990 levels, largely by installing energy efficient technologies (Figure 4-3). It has reduced its energy use for vehicles and equipment by 35 percent. Some of these improvements are attributable to the Department of Energy, whose Federal Energy Management Program helps government agencies reduce their energy and water use, manage their utility costs, and promote renewable energy.

Recommendations:

★ The NEPD Group recommends that the President direct heads of executive departments and agencies to take appropriate actions to conserve energy use at their facilities to the maximum extent consistent with the effective discharge of public responsibilities. Agencies located in regions where electricity shortages are possible should conserve especially during periods of peak demand.

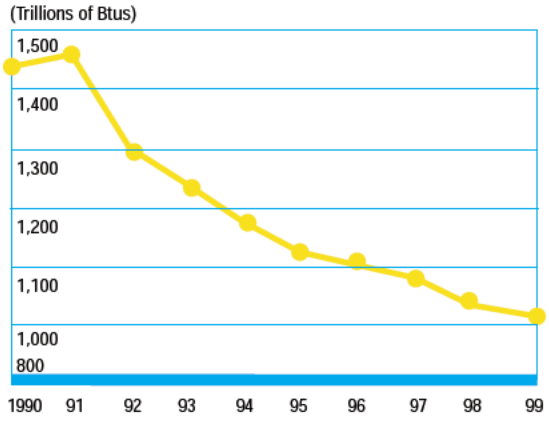
- Agencies should report to the President, through the Secretary of Energy, within 30 days of the conservation actions taken.

State and local governments have unique opportunities for energy savings in schools, transportation, state buildings, and building codes. For example, the Texas School Energy Management Program could save school districts as much as $100 million in energy costs every year by helping school districts evaluate their energy needs and resources. Similarly, Wisconsin's Energy Initiative is working with utilities to make basic changes to public buildings. By installing new lighting fixtures and taking other steps, Wisconsin estimates that it will save $60 million in state spending on energy over ten years.

Residential and Commercial Buildings

There are significant opportunities to improve the energy efficiency of buildings and homes through technologies and better practices. For existing homes, immediate options for improving efficiency include reducing air infiltration with caulking and weather stripping, installing modern thermostats, sealing ductwork, and adding insulation. These steps can reduce the 40 percent share of residential energy bills that

Figure 4-3
The U.S. Government is Reducing Its Energy Consumption



During the 1990s, energy use in federal buildings decreased by about 30 percent.

Source: U.S. Department of Energy, Energy Information Administration.



Pulte Homes

Building America—Pulte Homes

Pulte Homes Southwest Division has used technical assistance from the Department of Energy's Building America program to create what one residential expert calls "the best production house in the world," which won the 2001 National Association of Home Builders' Energy Value Award. In Tucson, Phoenix, and Las Vegas, Pulte Homes has worked with the Department of Energy to redesign the energy features of its basic models.

Using advanced insulation techniques, highly efficient equipment and windows, and right-sized heating and cooling systems, the homes look the same, but perform so well they use half the energy for heating and cooling at virtually no increase in construction costs.

The whole building/systems engineering approach used in the Building America program allows builders to add more insulation and more efficient windows while reducing the size of the heating and cooling equipment. The trade-off means no added cost to the builder, better value for the buyer, reduced electric load for the utility, and improved affordability.

go toward heating and cooling. Additional savings are possible when efficient appliances are purchased or major home renovations are undertaken. Installing a new, more efficient gas furnace can save up to 20 percent annually on natural gas. New buildings offer the greatest energy efficiency opportunities and can be designed to be both more comfortable and more efficient, cutting heating and cooling costs by close to 50 percent.

In commercial buildings, typically the quickest, most cost effective way to increase energy efficiency is to replace the lighting systems. Sensors help to avoid 24-hour operation of lights and equipment that are only used for a portion of the day. As with homes, advances in windows, heating and air conditioning systems, overall building designs, and equipment and appliances present significant energy saving opportunities.

Many families and businesses can face obstacles to realizing energy cost reductions.

Insufficient Information

Monthly energy bills generally report only total electricity or natural gas used, leaving families and businesses unsure about which energy services are most responsible for their energy use, and which investments could best help them reduce their costs. In addition, consumers may be unsure about the credibility of the energy-saving claims of individual manufacturers, salesmen, and designers. This incomplete information causes imperfections in the marketplace that hinder purchases of efficient technologies that would actually save families and businesses money.

Lack of Availability

Frequently, the most energy efficient products cost more and are not widely available, especially in smaller communities. Builders who would like to construct more efficient homes and businesses face the same problem at the wholesale level. For example, to keep costs down, builders are less likely to install top-of-the-line,

highly efficient products. The less expensive and generally less efficient products are heavily stocked and deeply discounted due to volume ordering. The decisions made about the energy efficiency of buildings and homes are not usually made by the consumer who will ultimately pay the energy bills. The incentive is for the builders to choose the material that poses the least cost to the builder, which is not necessarily the most energy efficient choice.

Lack of Automation

People often walk out of their offices and homes with the lights on and the air conditioner running. Turning off unused appliances, electronics, and lights is not always easy. Lack of automation (e.g., daylight sensors) means that conservation mostly depends on people turning off switches. Some appliances and electronics, such as stereos, video tape players, and televisions, continue to use electricity even after they are turned off.

Higher Initial Costs

Efficient products often cost more than less efficient versions, especially when they are first introduced to the market. Unless consumers can verify the resulting savings, they may be reluctant to pay the additional costs. Businesses that adopt labeling programs that spell out energy savings may be more successful in selling a more efficient, yet initially more expensive product. Higher initial costs can be particularly difficult for the purchaser or builder of a new home or office building.

Industry and Agriculture

Six industries consume three-quarters of all industrial energy: lumber and paper; chemicals; petroleum refining; primary metals; food processing; and stone, clay, and glass. Improved energy efficiency in these energy-intensive industries yields even larger improvements in overall productivity, product quality, safety, and pollution prevention. Manufacturing companies generally obtain their largest savings from improved efficiency of motors (motors account for 54 percent of electricity use in manufacturing) and from improved steam and hot-water systems. Many companies can reduce energy needs further by cogenerating their electricity and heat for steam.



High energy prices during the 1970s and early 1980s caused many farmers to find ways to reduce their energy costs, such as by switching from gasoline-powered to more fuel efficient diesel-powered engines and by adopting conservation tillage practices.

Energy use for U.S. agriculture grew during the 1960s and 1970s, peaking in 1978. High energy prices during the 1970s and early 1980s caused many farmers to find ways to reduce their energy costs, such as by switching from gasoline-powered to more fuel-efficient diesel-powered engines, adopting conservation tillage practices, shifting to larger multiprocessor machines, and using energy saving methods for drying and irrigating crops. These measures helped farmers reduce their energy use by 41 percent from 1978 to 1998, while agricultural output grew by about 40 percent over the same period.

Farmers can reap additional energy savings as they replace old machinery with more energy efficient equipment. Furthermore, farmers can adopt more advanced practices, such as precision farming, that optimize the use of machines, chemicals, and fertilizers to achieve energy savings. New seed varieties can also reduce energy-intensive chemical requirements.

Despite the opportunity for increased energy efficiency, the industrial and agricultural sectors face several obstacles. Because many manufacturing and farming operations are highly specialized, they need specific information on energy-saving opportunities to effectively respond to energy price signals and supply problems.

Cogeneration

In 1998, Malden Mills Industries, a textile manufacturer employing 2,300 workers in Lawrence, Massachusetts, installed a state-of-the-art combined heat and power (CHP) facility. The system uses two 4.3 MW industrial gas turbines, retrofitted with ceramic combustion liners, that were developed as part of the Department of Energy's Advanced Turbine Systems program, and that enable higher operating temperatures and lower emissions. The CHP system saves Malden Mills more than $1 million annually. The liners have accumulated more than 9,500 hours of successful operation and have cut emissions of nitrogen oxides and carbon monoxide to less than 15 parts per million.



In order for manufacturing or agriculture to switch to more efficient energy products and practices, significant costs are incurred due to production delays, waste and spoilage, and labor costs. As a result, manufacturers and farmers tend to use readily available and reliable equipment when upgrading, instead of untested, newer products and approaches.

Because of their large needs for both heat and electricity, businesses find combined heat and power (CHP) systems particularly attractive. However, replacing old, inefficient boilers with highly efficient CHP systems may add a number of new regulatory requirements (such as air permits), but does not offer the same tax depreciation incentives the tax code grants to power plants.

Recommendations:

★ The NEPD Group recommends that the President direct the Secretary of the Treasury to work with the Congress on legislation to encourage increased energy efficiency through combined heat and power (CHP) projects by shortening the depreciation life for CHP projects or providing an investment tax credit.

★ The NEPD Group recommends that the President direct the Administrator of the Environmental Protection Agency (EPA) to work with local and state governments to promote the use of well-designed CHP and other clean power generation at brownfield sites, consistent with the local communities' interests. EPA will also work to clarify liability issues if they are raised at a particular site.

★ The NEPD Group recommends that the President direct the EPA Administrator to promote CHP through flexibility in environmental permitting.

Conservation can be improved by car pooling, telecommuting, increasing public transit choices, and pricing highway use during periods of peak demand.

Transportation

Transportation plays a key role in a growing U.S. economy, comprising 16 percent of GDP in 1998, 10.5 percent of total employment, and 27 percent of total U.S. energy consumption. Trucks and automobiles account for over three-fourths of the sector's petroleum use, with the remainder attributable to rail, ship, air, and pipeline systems. Mass transit ridership has increased by 21 percent since 1996. Automobiles today use roughly 60 percent of the gasoline they did in 1972 per mile driven, due in part to new technology, such as better engine and design controls, improved transmission, weight reduction, and improved aerodynamics. Despite the adoption of more efficient transportation technologies, average fuel economy for passenger vehicles has remained relatively flat for ten years and is, in fact, at a twenty-year low, in large part due to the growth and popularity of low-fuel-economy pickup trucks, vans, and sport utility vehicles (Figure 4-4).

Recommendation:

★ The NEPD Group recommends that the President direct the Secretary of Transportation to:

- Review and provide recommendations on establishing Corporate Average Fuel Economy (CAFE) standards with due consideration of the National Academy of Sciences study to be released in July 2001. Responsibly crafted CAFE standards should increase efficiency without negatively impacting the U.S. automotive industry. The determination of future fuel economy standards must therefore be addressed analytically and based on sound science.
- Consider passenger safety, economic concerns, and disparate impact on the U.S. versus foreign fleet of automobiles.
- Look at other market-based approaches to increasing the national average fuel economy of new motor vehicles.

Opportunities for reducing oil demand in the transportation sector include increasing conservation, vehicle efficiency, and alternative fuels. Conservation can be improved by car pooling, telecommuting, and increasing transit choices. For example, an increase in the average fuel economy of the on-road vehicle fleet by three miles per gallon would save one million barrels of oil a day, or about half of the global shortfall between supply and demand that triggered the oil price increases since 1998. In addition, fuel conservation can be further improved by technologies to reduce congestion.

A recent analysis indicates that the fuel economy of a typical automobile could be enhanced by 60 percent by increasing engine and transmission efficiency and reducing vehicle mass by about 15 percent. Several promising efficiency technologies are being presented to the U.S. market. For example, some automobile manufacturers have already introduced hybrid vehicles, and others have announced that they will introduce hybrid vehicles within the next several years. Advanced lightweight materials offer up to 6 percent improvement in mileage for each 10 percent reduction in body weight. Although promising, it may be many years before hybrids become a substantial part of the automotive fleet.

Recommendations:

★ The NEPD Group recommends that the President direct the Secretary of Transportation to review and promote congestion mitigation technologies and strategies and to work with the Congress on legislation to implement these strategies.

★ The NEPD Group recommends that the President direct the Secretary of the Treasury to work with Congress on legislation to increase energy efficiency with a tax credit for fuel-efficient vehicles. The NEPD Group recommends that a temporary, efficiency-based income tax credit be available for purchase of new hybrid or fuel cell vehicles between 2002 and 2007.

Higher Initial Production Costs

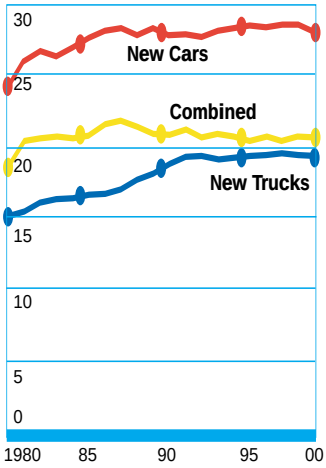
Because of the large economies of scale in automobile manufacturing, new technologies with limited early production runs often enter the market at higher initial costs. In this highly competitive international market, higher initial production costs can be a significant impediment to the introduction of new technologies. Unless U.S. automakers can remain competitive with their overseas counterparts, it is unlikely they will invest in new, more efficient technologies. Vehicle efficiency technologies, such as advanced engines, fuel cells, and cutting-edge electronic drive-train technologies, will become widely available only when component costs are reduced or demand is increased.

Hybrid Vehicles

The engine of a conventional gasoline vehicle is typically sized for the small amount of time the driver spends accelerating to enter the freeway, to pass another car, or to climb a hill. Most of the time it operates at less than 20 percent efficiency. An attractive alternative is to use a hybrid system that allows the engine to operate at peak efficiency, and get a boost from a battery when entering the freeway or climbing a hill. Not only does this system allow improved performance from a smaller engine, but the energy usually lost in stopping the car can be recovered and stored in the battery.

What does this mean to the average American? Significantly improved fuel economy and reduced emissions.

Figure 4-4
Fuel Efficiency of Light Vehicles Has Remained Flat
(Miles per Gallon)



Despite the adoption of more efficient transportation technologies, U.S. average fuel economy has been flat for 10 years. In large part, this is due to the growth of low-fuel-economy pickup trucks, vans, and sport utility vehicles.

Source: U.S. Department of Energy, Energy Information Administration.

Summary of Recommendations

Using Energy Wisely: Increasing Energy Conservation and Efficiency

★ The NEPD Group recommends that the President direct the Office of Science and Technology Policy and the President's Council of Advisors on Science and Technology to review and make recommendations on using the nation's energy resources more efficiently.

★ The NEPD Group recommends that the President direct the Secretary of Energy to conduct a review of current funding and historic performance of energy efficiency research and development programs in light of the recommendations of this report. Based on this review, the Secretary of Energy is then directed to propose appropriate funding of those research and development programs that are performance-based and are modeled as public-private partnerships.

★ The NEPD Group recommends that the President direct the Secretary of Energy to promote greater energy efficiency.

- Expand the Energy Star program beyond office buildings to include schools, retail buildings, health care facilities, and homes.
- Extend the Energy Star labeling program to additional products, appliances, and services.
- Strengthen Department of Energy public education programs relating to energy efficiency.

★ The NEPD Group recommends that the President direct the Secretary of Energy to improve the energy efficiency of appliances.

- Support the appliance standards program for covered products, setting higher standards where technologically feasible and economically justified.
- Expand the scope of the appliance standards program, setting standards for additional appliances where technologically feasible and economically justified.

★ The NEPD Group recommends that the President direct heads of executive departments and agencies to take appropriate actions to conserve energy use at their facilities to the maximum extent consistent with the effective discharge of public responsibilities. Agencies located in regions where electricity shortages are possible should conserve especially during periods of peak demand. Agencies should report to the President, through the Secretary of Energy, within 30 days on the conservation actions taken.

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- Review and provide recommendations on establishing Corporate Average Fuel Economy (CAFE) standards with due consideration of the National Academy of Sciences study to be released in July 2001. Responsibly

crafted CAFE standards should increase efficiency without negatively impacting the U.S. automotive industry. The determination of future fuel economy standards must therefore be addressed analytically and based on sound science.
- Consider passenger safety, economic concerns, and disparate impact on the U.S. versus foreign fleet of automobiles.
- Look at other market-based approaches to increasing the national average fuel economy of new motor vehicles.

★ The new NEPD Group recommends that the President direct the Secretary of Transportation to review and promote congestion mitigation technologies and strategies and work with Congress on legislation to implement these strategies.

★ The NEPD Group recommends that the President direct the Secretary of the Treasury to work with Congress on legislation to increase energy efficiency with a tax credit for fuel-efficient vehicles. The NEPD Group recommends that a temporary, efficiency-based income tax credit be available for purchase of new hybrid fuel cell vehicles between 2002 and 2007.

★ The NEPD Group recommends that the President direct all agencies to use technological advances to better protect our environment.
- The Administration remains committed to investing in Intelligent Transportation Systems (ITS) and encourages the private sector to invest in ITS applications. This Department of Transportation (DOT) program funds the development of improved transportation infrastructure that will reduce congestion, such as traveler information/navigation systems, freeway management, and electronic toll collection. ITS applications reduce fuel associated with travel.
- The Administration remains committed to the DOT's fuel-cell-powered transit bus program, authored by the Transportation Equity Act for the 21st Century (TEA-21). This program demonstrates the viability of fuel-cell power plants for transit bus applications.
- The Administration remains committed to the Clean Buses program. TEA-21 establishes a new clean fuel formula grant program, which provides an opportunity to accelerate the introduction of advanced bus propulsion technologies into the mainstream of the nation's transit fleet.

★ The NEPD Group recommends that the President direct the EPA and DOT to develop ways to reduce demand for petroleum transportation fuels by working with the trucking industry to establish a program to reduce emissions and fuel consumption from long-haul trucks at truck stops by implementing alternatives to idling, such as electrification and auxiliary power units at truck stops along interstate highways. EPA and DOT will develop partnership agreements with trucking fleets, truck stops, and manufacturers of idle-reducing technologies (*e.g.*, portable auxiliary packs, electrification) to install and use low-emission-idling technologies.

★ The NEPD Group recommends that the President direct the Secretary of Energy to establish a national priority for improving energy efficiency. The priority would be to improve the energy intensity of the U.S. economy as measured by the amount of energy required for each dollar of economic productivity. This increased efficiency should be pursued through the combined efforts of industry, consumers, and federal, state, and local governments.

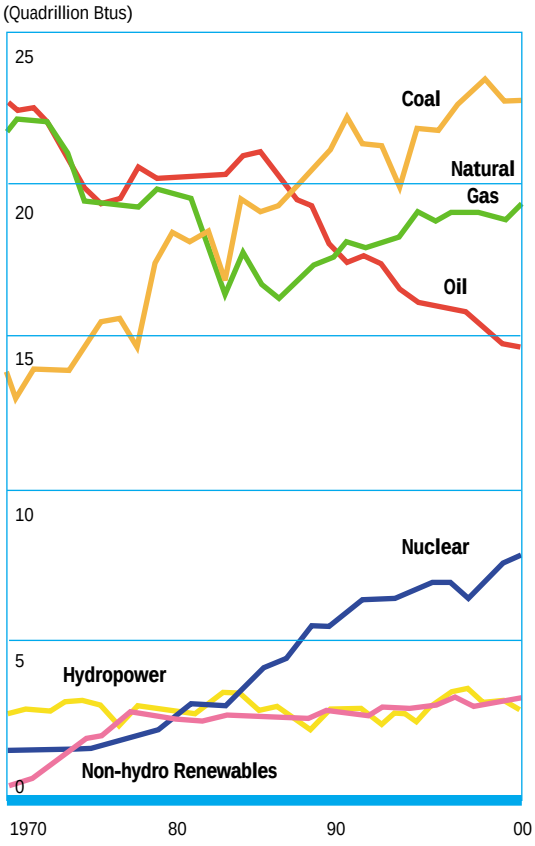
★ The NEPD Group recommends that the President direct the EPA Administrator to develop and implement a strategy to increase public awareness of the sizable savings that energy efficiency offers to homeowners across the country. Typical homeowners can save about 30 percent (about $400) a year on their home energy bill by using Energy Star-labeled products.

Energy for a New Century

Increasing Domestic Energy Supplies

America's energy strength lies in the abundance and diversity of its energy resources, and in its technological leadership in developing and efficiently using these resources. Our nation has rich deposits of coal, oil, and natural gas. The United States is the third-largest oil-producing nation in the world, despite a thirty-year decline in domestic production. While our economy runs primarily on fossil fuels, we also have long experience with hydropower and nuclear energy. We are pursuing the ability to further capture the energy of sunlight, the heat of the earth, and the power of wind.

Figure 5-1
U.S. Energy Production: 1970–2000



Production of coal, the nation's most abundant fuel source, exceeded 1 billion tons in 2000. Electricity generation accounted for about 90 percent of U.S. coal consumption last year.

Source: U.S. Department of Energy, Energy Information Administration.

Economic factors will help determine the future development of our nation's energy sources. These factors will be shaped not only by conservation, energy demand, and the cost of energy development, but also by the regulations that federal, state, and local governments put in place to balance energy needs with legitimate competing aims, including the protection of the environment. A number of factors will make it difficult to increase domestic energy production in response to the growing demand for energy: economic and technological factors associated with depletion of the fossil fuel resource base in the U.S.; regulatory uncertainty; limitations on access to federal lands with high potential for new discoveries; infrastructure constraints, such as electricity transmission and gas pipeline bottlenecks; and conflicts with legitimate land use, environmental, and other public policy goals.

The United States has significant domestic energy resources, and remains a major energy producer. Between 1986 and 2000, production of coal, natural gas, nuclear energy, and renewable energy increased. However, these increases have been largely offset by declines in oil production (Figure 5-1).

U.S. Department of the Interior, Minerals Management Service



Even with improved energy efficiency, the United States will need more energy supply. U.S. energy demand is projected to rise to 127 quadrillion Btus by 2020, even with significantly improved energy efficiency. However, domestic production is expected to rise to only 86 quadrillion Btus by 2020. The shortfall between projected energy supply and demand in 2020 is nearly 50 percent. That shortfall can be made up in only three ways: import more energy; improve energy efficiency even more than expected; and increase domestic energy supply.

The challenge for our nation is to use technology to maintain and enhance the diversity of our supplies, thus providing a reliable and affordable source of energy for Americans. These goals can and must be accomplished while maintaining our commitment to environmental protection.

Oil and Natural Gas

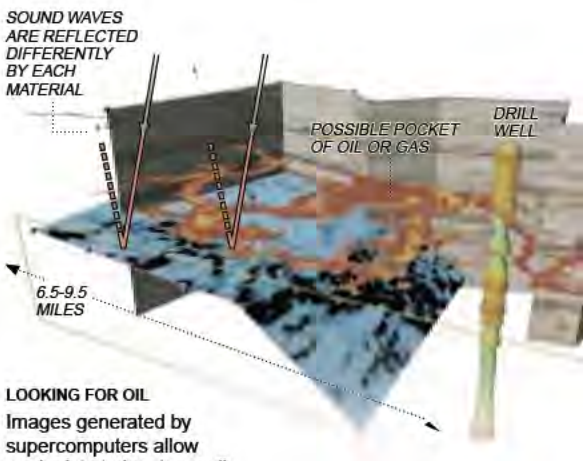
Oil and natural gas are the dominant fuels in the U.S. economy, providing 62 percent of the nation's energy and almost 100 percent of its transportation fuels. By 2020, the Energy Information Administration expects the United States will need about 50 percent more natural gas and one-third more oil to meet demand.

U.S. oil production is expected to decline over the next two decades. Over the same period, demand for natural gas will most likely continue to outpace domestic production. As a result, the United States will rely increasingly on imports of both natural gas and oil from Canada, and imports of oil and liquefied natural gas from producers across the globe.

21st Century Technology

Remaining U.S. oil reserves are becoming increasingly costly to produce because much of the lower-cost oil has already been largely recovered. The remaining resources have higher exploration and production costs and greater technical challenges, because they are located in geologically complex reservoirs, (*e.g.*, deep water

Figure 5-2



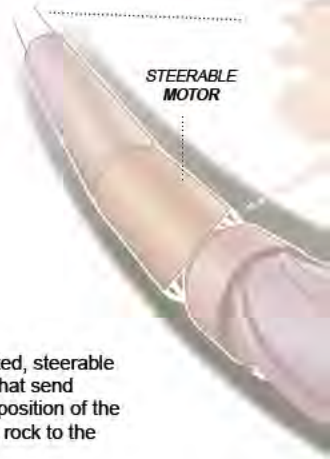
LOOKING FOR OIL
Images generated by supercomputers allow geologists to locate small pockets of oil or gas.



DRILLING TECHNOLOGY
Old drills were limited to a single vertical well, but newer wells can drill horizontally or spread in different directions to tap small pockets of oil.



TRANSPORTING THE OIL
A 14-inch pipeline connects the Alpine field to the Trans-Alaska Pipeline about 60 miles west of the Arctic National Wildlife Refuge, a site proposed for new drilling.



TRANSPORTING THE OIL
Today's drills are sophisticated, steerable machines with instruments that send information about the exact position of the drill bit and properties of the rock to the drilling team.

Sources Phillips Petroleum Company, Chevron Corporation, BP Amoco, Magic Earth, Arctic Connections

DRILL BIT MADE OF STEEL AND/OR TUNGSTEN

Using the Latest Drilling Technology to Reduce Environmental Damage

Oil drilling sites like those in the Alpine field on Alaska's North Slope are using cutting-edge technology in hopes of reducing environmental damage.

Recent advances are lessening the industry's impact on the fragile Arctic ecosystem.



BP Amoco

ALPINE FIELD, ALASKA

A PIPELINE ELEVATED 5 FT. ALLOWS THE CROSSING OF CARIBOU

PIPELINE TO THE TRANS-ALASKA PIPELINE

NEW DIRECTIONAL AND MULTILATERALDRILLING

DISPOSING OF OIL FIELD WASTES

EXTENDS HORIZONTALLY, TURNING IN DIFERRENT DIRECTIONS TO AVOID DIFFICULT MATERIALS

MULTILATERAL DRILLING ALLOWS ONE WELL TO REACH DIFFERENT OIL POCKETS

DIAMOND CUTTING PARTS

MUD/ROCK PUMPING, CRUSHING AND INJECTION

DRILL

MUD LAYER

OIL LAYER

Sea level

-50'

-100'

Pipeline

Permafrost

DRILLSITE SIZE

5 ACRES

24 ACRES

11 ACRES

13 ACRES

1970

1980

1985

1999

2 MILES

3 MILES

5 MILES

8 MILES

SUBSURFACE DRILLABLE AREA

GETTING THERE

To minimize the project's impact on the environment, temporary ice roads are used in the winter, leaving few traces after they thaw.

DISPOSING OF WASTES

Mud and debris from drilling used to be placed in big reserve pits. Today, rock cuttings are crushed, mixed with the mud, and sent deep into the earth where they originated. This minimizes the size of well pads.

CROSSING A RIVER

Although traditional pipelines are built above ground, the pipeline to the Trans-Alaska Pipeline plunges beneath the Colville River, preserving the surface and the river bed environment.

OCCUPYING LESS OF THE TUNDRA

The new drilling technology allows for smaller surface production pads and larger areas explored in the earth.

Source: New York Times News Service

21st Century Technology: The Key to Environmental Protection and New Energy Production

Producing oil and gas from geologically challenging areas while protecting the environment is important to Americans and to the future of our nation's energy security. New technology and management techniques allow for sophisticated energy production as well as enhanced environmental protection. A technology evolution has occurred in the way oil and natural gas are found. The computer, three dimensional seismic technology, and other technologies have transformed the process from one based on "feel," to one highly dependent on the most advanced and sophisticated technology available. These technologies reduce cost and protect the environment.

Today's oil and gas exploration technology, for example, is boosting the success rate of pinpointing new resources. The results: fewer dry holes, reduced waste volumes, and a cleaner environment. Smaller, lighter drilling rigs coupled with advances in directional and extended-reach drilling significantly increase protection of the environment.

- Advanced, more energy efficient drilling and production methods:
  - — reduce emissions;
  - — practically eliminate spills from offshore platforms; and
  - — enhance worker safety, lower risk of blowouts, and provide better protection of groundwater resources.
- With each improvement in operational performance and efficiency, more oil and gas resources can be recovered with fewer wells drilled, resulting in smaller volumes of:
  - — cuttings;
  - — drilling muds and fluids; and
  - — produced waters.
- Modular drilling rigs, "slimhole" drilling, directional drilling, and other advances enable:
  - — production of oil and gas with increased protection to wetlands and other sensitive environments;
  - — reduced greenhouse gas emissions;
    and worker safety through the use of innovative best management practices.

Other examples of advanced technology include:

- 3-D seismic technology that enables geologists to use computers to determine the location of oil and gas before drilling begins, dramatically improving the exploration success rate;
- deep-water drilling technology that enables exploration and production of oil and gas at depths over two miles beneath the ocean's surface;
- high-powered lasers that may one day be used for drilling for oil and gas; and
- highly sophisticated directional drilling that enables wells to be drilled long horizontal distances from the drilling site.

:

and harsh environments).

While the resource base that supplies today's natural gas is vast, U.S. conventional production is projected to peak as early as 2015. Increasingly, the nation will have to rely on natural gas from unconventional resources, such as tight sands, deep formations, deep water, and gas hydrates. Also, many resources are in environmentally sensitive areas that require use of less intrusive technologies.

New technologies are being developed to reduce both the environmental effects and the economic costs of exploration for oil and gas. These exciting new technologies, like horizontal drilling and three-dimensional seismic technology allow for much greater precision and significantly less impact on the environment (Figure 5-2).

Small independent businesses account for 50 and 65 percent, respectively, of domestic petroleum and natural gas production in the lower 48 states. However, even when new technology is available, independent producers can lack the investment capital needed to apply the technology and be unable to cope with the increased economic and technical risks associated with harder-to-recover resources.

For example, most new gas wells drilled in the United States will require hydraulic fracturing. This is a common procedure used by producers to complete gas wells by stimulating the well's ability to flow increased volumes of gas from the reservoir rock into the wellbore. During a fracture procedure, fluid and a propping agent (usually sand) are pumped into the reservoir rock, widening natural fractures to provide paths for the gas to migrate to the wellbore. In certain formations, it has been demonstrated that the gas flow rate may be increased as much as twenty-fold by hydraulic fracturing. Each year nearly 25,000 oil and gas wells are hydraulically fractured.

The use of hydraulic fracturing in natural gas production from coal seams is one of the fastest-growing sources of gas production. This source will most likely face added controls, and costs to ensure that disposal (by re-injection or discharge) of production waters is done in an environmentally sensitive manner.

For each of these issues, opportunities exist to better coordinate, improve performance, and meet America's energy, public health, safety and environmental goals.

Recommendation:

★ The NEPD Group recommends that the President direct the Secretaries of Energy and the Interior to promote enhanced oil and gas recovery from existing wells through new technology.

Anywhere from 30 to 70 percent of oil, and 10 to 20 percent of natural gas, is not recovered in field development. It is estimated that enhanced oil recovery projects, including development of new recovery techniques, could add about 60 billion barrels of oil nationwide through increased use of existing fields (Figure 5-3).

Figure 5-3
Major U.S. Oil and Gas Fields



The United States is the most mature oil-producing region in the world, and much of our easy-to-find resource base has been delpeted. Advanced exploration and production technologies of the past two decades have played a key role in recovering additional oil and natural gas from existing fields.

Source: U.S. Department of Energy, Energy Information Administration.

Public Lands Leasing

The federal government owns about 31 percent of the nation's land, so it can have a major role in increasing energy production in appropriate places. A large portion of U.S. energy resources are contained in these federal lands and offshore areas. Public lands provide nearly 30 percent of

Small independent businesses account for 50 and 65 percent, respectively, of domestic petroleum and natural gas production in the lower 48 states.

annual national energy production, and are estimated to contain a substantial majority of the nation's undiscovered domestic energy resources.

Portions of federal onshore and offshore lands are off-limits to oil and gas exploration and development. Access is restricted for a variety of reasons, including administrative land withdrawals for competing land uses, such as national defense or water projects; and stipulations affecting surface occupancy, use, and timing for environmental compatibility.

Recommendations:

★ The NEPD Group recommends that the President direct the Secretary of the Interior to examine land status and lease stipulation impediments to federal oil and gas leasing, and review and modify those where opportunities exist (consistent with the law, good environmental practice, and balanced use of other resources).

- Expedite the ongoing Energy Policy and Conservation Act study of impediments to federal oil and gas exploration and development.
- Review public lands withdrawals and lease stipulations, with full public consultation, especially with the people in the region, to consider modifications where appropriate.

★ The NEPD Group recommends that the President direct the Secretary of the Interior to consider economic incentives for environmentally sound offshore oil and gas development where warranted by specific circumstances: explore opportunities for royalty reductions, consistent with ensuring a fair return to the public where warranted for enhanced oil and gas recovery; for reduction of risk associated with production in frontier areas or deep gas formations; and for development of small fields that would otherwise be uneconomic.

Offshore

Congress has designated about 610 million acres off limits to leasing on the Outer Continental Shelf (OCS), which contains large amounts of recoverable oil and gas resources. These Congressional moratoria have been expanded by Presidential action through 2012, effectively confining the federal OCS leasing program to the central and western Gulf of Mexico, a small portion of the eastern Gulf, existing leases off California's shore, and areas off of Alaska.

Concerns over the potential impacts of oil spills have been a major factor behind imposition of the OCS moratoria. For areas that are available for possible development, it is projected that with advanced technology, we could recover 59 billion barrels of oil and 300 trillion cubic feet of natural gas. This type of exploration and production from the OCS has an impressive environmental record. For example, since 1985, OCS operators have produced over 6.3 billion barrels of oil, and have spilled only 0.001 percent of production. Naturally occurring oil seeps add about 150 times as much oil to the oceans. Additionally, about 62 percent of OCS energy production is natural gas, which poses little risk of pollution.

For those areas that are available for potential coastal zone and OCS exploration and production activity, businesses must comply with a variety of federal and state statutes, regulations, and executive orders. Aspects of these, under the Coastal Zone Management Act and the Outer Continental Shelf Lands Act and their regulations, attempt to provide for responsible development while considering important environmental resources. However, effectiveness is sometimes lost through a lack of clearly defined requirements and information needs from federal and state entities, as well as uncertain deadlines during the process. These delays and uncertainties can hinder proper energy exploration and production projects.

The Deep Water Royalty Relief Act of 1995, granting variable royalty reductions for new leases in deep water, contributed to a significant increase in deep-water leasing in the central and western Gulf over the last five years. The opportunities created in deep water help spur the development of new

technologies and infrastructure for this frontier area. However, substantial economic risks remain to investment in deep water and continued incentives could help draw investment in other countries. Similar incentives could spur development in other technological frontiers, such as deep gas, or make possible continued production from both offshore and onshore fields near the end of their economic life.

Recommendation:

★ The NEPD Group recommends that the President direct the Secretaries of Commerce and Interior to re-examine the current federal legal and policy regime (statutes, regulations, and Executive Orders) to determine if changes are needed regarding energy-related activities and the siting of energy facilities in the coastal zone and on the Outer Continental Shelf (OCS).

Arctic Outer Continental Shelf

It is estimated there are significant undiscovered resources in the two planning areas of the Arctic OCS. Geologists estimate that there are approximately 22.5 billion barrels of oil and 92 trillion cubic feet of natural gas in the Arctic OCS. The Beaufort Sea Planning Area encompasses approximately 65 million acres. Active leases within the Beaufort Sea Planning Area represent only 0.4 percent of the total acreage, and only 5 percent of the leased acreage is being actively pursued for development and production. The Chukchi Sea Planning Area encompasses approximately 63.7 million acres, none of which is currently leased.

Lease offerings totaling 58 million acres over the past twenty years have resulted in 34 exploratory wells. Two oil discoveries are now moving toward production, but economic factors have delayed several others. These discoveries have estimated recoverable reserves of more than 260 million barrels of oil. This is another area where periodic, well-scheduled lease sales can help contribute to national energy production.



The high-technology oil industry requires an educated, technologically sophisticated work force. Many workers left the industry in the mid-1980s because of job insecurity caused by price volatility. The lack of an experienced work force today may limit the amount and increase the cost of future exploration and production activity.

U.S. Department of Energy

Recommendation:

★ The NEPD Group recommends that the President direct the Secretary of the Interior continue OCS oil and gas leasing and approval of exploration and development plans on predictable schedules.

Onshore

North Slope Oil and Gas

The Alaska North Slope is a promising area for discovery of additional reserves to increase our domestic production of oil and natural gas. Currently, state lands on Alaska's North Slope provide about 17 percent of U.S. oil production. Oil and gas development in the Arctic, however, needs to be done in an environmentally responsible manner, using new technology and relying upon on the best available scientific information. Such technology is making it possible to explore and develop oil and gas with significantly less impact on the environment. Areas with potential for oil and gas development are the National Petroleum Reserve–Alaska (NPR–A), the Arctic Outer Continental Shelf, and the Arctic National Wildlife Refuge (ANWR).

National Petroleum Reserve–Alaska

The National Petroleum Reserve–Alaska lies between the Brooks Range and the Arctic Ocean. The U.S. Geological Survey (USGS) estimates a high potential for oil and gas resources in the NPR–A, with a mean estimate of 2.1 billion barrels of oil and 8.5 trillion cubic feet of gas. A leasing program was designed and initiated in 1999 for the northeast sector of NPR–A, resulting in the award of 133 leases covering 900,000 acres. Eight exploratory wells have been completed in the past two years, and additional exploratory wells are expected this coming winter.

Recommendation:

★ The NEPD Group recommends that the President direct the Secretary of the Interior to consider additional environmentally responsible oil and gas development, based on sound science and the best available technology, through further lease sales in the National Petroleum Reserve-Alaska. Such consideration should include areas not currently leased within the Northeast corner of the Reserve.

Arctic National Wildlife Refuge

The Alaska National Interest Lands Conservation Act expanded ANWR from 9 million acres to 19 million acres, and designated 8 million acres as wilderness. Congress specifically left open the question of management of a 1.5-million-acre Arctic Coastal Plain area of ANWR because of the likelihood that it contains significant oil and gas resources. Section 1002 of the Act directed the Department of the Interior to conduct geological and biological studies of the Arctic Coastal Plain, "the 1002 Area," and to provide to Congress the results of those studies with recommendations on future management of the area. Section 1003 of the Act prohibits leasing of the 1002 Area until authorized by an act of Congress.

In 1987, after more than five years of biological baseline studies, surface geological studies, and two seasons of seismic exploration surveys, the Department of the Interior recommended to Congress that the 1002 Area be leased for oil and gas exploration and production in an environmentally sensitive manner. In 1995, both the Senate and the House passed legislation containing a provision to authorize leasing in the 1002 Area, but the legislation was vetoed.

In May 1998, the USGS issued revised estimates of oil and gas resources in the 1002 Area. The 1998 USGS assessment shows an overall increase in estimated oil resources when compared to all previous government estimates. The estimate reaffirms the 1002 Area's potential as the single most promising prospect in the United States. The total quantity of recoverable oil within the entire assessment area is estimated to be between 5.7 and 16 billion barrels (95 percent and 5 percent probability range) with a mean value of 10.4 billion barrels. The mean estimate of 10.4 billion barrels is just below the amount produced to date from North America's largest field, Prudhoe Bay, since production began 23 years ago. Peak production from ANWR could to be between 1 and 1.3 million barrels a day and account for more than 20 percent of all U.S. oil production. ANWR production could equal 46 years of current oil imports from Iraq.

Technological improvements over the past 40 years have dramatically reduced industry's footprint on the tundra, minimized waste produced, and protected the land for resident and migratory wildlife. These advances include the use of ice roads and drilling pads, low-impact exploration approaches such as winter-only exploration activities, and extended reach and through-tubing rotary drilling. These technologies have significantly reduced the size of production-related facilities on the North Slope. Estimates indicate that no more than 2,000 acres will be disturbed if the 1002 Area of ANWR is developed. For purposes of comparison, ANWR is about the size of the state of South Carolina, whereas the developed area is estimated to be less than one-fifth the size of Washington D.C.'s Dulles International Airport.

Recommendation:

★ The NEPD Group recommends that the President direct the Secretary of the Interior to work with Congress to authorize exploration and, if resources are discovered, development of the 1002 Area of ANWR. Congress should require the use of the best available technology and should require that activities will result in no significant adverse impact to the surrounding environment.

Other Onshore Restrictions

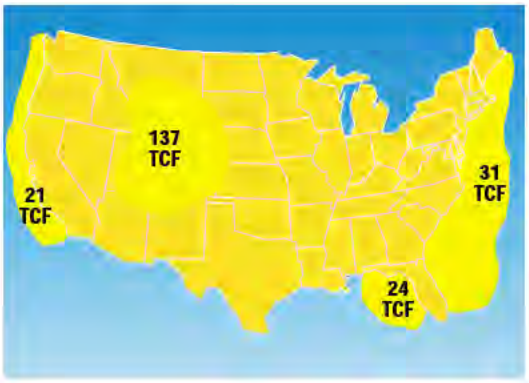
There is a significant potential for oil and gas resources on federal land in the lower 48 states as well. According to the most recent estimates from the USGS and the Minerals Management Service, oil resources underlying federal lands in the lower 48 states are estimated to be 4.1 billion barrels, and natural gas reserves are estimated to be 167 trillion cubic feet (Figure 5-4). Much of these potential resources have been placed off-limits or are subject to significant restrictions. For example, about 40 percent of the natural gas resources on federal land in the Rocky Mountain region have been placed off-limits.

The Department of the Interior initiated a study to examine the energy potential and restrictions on development on federal lands in the lower 48 states. In many cases, limits on oil and gas development are appropriate. However, improved technology has helped to reduce the impact of oil and gas development on the environment.

Exploration and Production

To meet increased natural gas demand in the coming decades, total wells drilled annually will need to double the 1999 level by 2020. Very few new onshore rigs have been built since the mid-1980s, because the oil field supply and service sectors have been hit especially hard by price volatility. Major additions to the offshore rig fleet will also be needed just to develop existing leases. The lack of an experienced work force may limit the speed and increase the cost of exploration and production activity.

Figure 5-4
Restricted Natural Gas Resource Areas in the U.S. Lower 48



Much of the nation's oil and gas resource base resides on federal lands or in federal waters. A large portion of this is not open to exploration and development. For example, an estimated 40 percent or 137 trillion cubic feet of potential natural gas resource in the Rockies is either closed to exploration (29 tcf) or is open to development under restrictive provisions (108 tcf).

Source: U.S. Department of Energy, Energy Information Administration.

Electricity

Electricity is an essential part of modern life. When supply fails to keep pace with demand, costs to consumers and businesses rise and reliability falls. The California experience demonstrates the crippling effect that electricity shortages and blackouts can have on a state or region. This summer, the possibility exists for more intense electricity shortfalls in the West, with additional problems possible in New York City and on Long Island.

Electricity demand is projected to grow sharply over the next twenty years. Based on current estimates, the United States will need about 393,000 MW of new generating capacity by 2020 to meet the growing demand. If the U.S. electricity demand continues to grow at the high rate it has recently, we will need even more generating capacity. To meet that future demand, the United States will have to build between 1,300 to 1,900 new power plants; that averages out to be more than 60 to 90 plants a year, or more than one a week.

Over the next few years, if the demand for electricity continues to grow as predicted, and if we fail to implement a

comprehensive energy plan that recognizes the need to increase capacity, we can expect our electricity shortage problems to grow. The result will be higher costs and lower reliability.

Electricity Restructuring

One of the most important energy issues facing the Administration and Congress is electricity restructuring. The electricity industry is going through a period of dramatic change. To provide ample electricity supplies at reasonable prices, states are opening their retail markets to competition. This is the most recent step in a long transition from reliance on regulation to reliance on competitive forces.

Changes in Wholesale Electricity Market

This transition from regulation to competition began in 1978 with enactment of the Public Utility Regulatory Policies Act, which promoted independent electricity generation. Open-access transmission policies adopted by the Federal Energy Regulatory Commission (FERC) in the late 1980s further promoted competition in wholesale power markets. Congress largely ratified these policies with enactment of the Energy Policy Act of 1992, which further promoted non-utility generation. FERC took another large step to promote competition with its open-access rule in 1996, which provided greater access to the transmission grid, the highway for interstate commerce in electricity.

Electricity demand is projected to rise sharply over the next twenty years. If we fail to build the 1,300–1,900 new power plants needed to increase generation and transmission capacity, current electricity shortages will become more frequent and more widespread.
U.S. Department of Energy



Changes in the Retail Electricity Market

Increased competition in wholesale power markets encourages states to open retail electricity markets. Under current law, FERC has jurisdiction over the wholesale power market, while states have jurisdiction over retail markets. Beginning in 1996, states began opening their retail markets to competition in order to lower electricity prices. Twenty-five states have opted to open their retail electricity markets to competition.

Most new electricity generation is being built not by regulated utilities, but by independent power producers. These companies assume the financial risk of investment in new generation, and their success rides on their ability to generate electricity at a low cost.

These dramatic changes affecting the industry led to important structural changes. Independent power producers, which were once infant industries, now dwarf many utilities. Utility mergers, which were once rare, are now commonplace. U.S. utilities have been purchased by foreign companies, and U.S. utilities have in turn purchased utilities abroad. While utilities had service areas that were limited to a single state or region, independent power producers are international companies that can build power plants across the globe. Many utilities that were once vertically integrated divested themselves of generation, either voluntarily or because of state law.

Pending Congressional Action

Since 1995, Congress has been grappling with electricity competition legislation. Initial efforts sought to require states to open their retail markets by a date certain. Subsequent efforts focused on promoting competition in electricity markets and complementing state retail competition plans. Under this

approach, federal legislation focused on core federal issues, including:

- regulation of interstate commerce;
- assuring open access to the interstate and international transmission system;
- enhancing reliability of the grid;
- lowering barriers to entry;
- reforming outdated federal electricity laws, such as the Public Utility Holding Company Act and Public Utility Regulatory Policies Act of 1978;
- reforming the role of federal electric utilities in competitive markets;
- protecting consumers; and
- clarifying federal and state regulatory jurisdictions.

Recommendations:

★ The NEPD Group recommends that the President direct the Secretary of Energy to propose comprehensive electricity legislation that promotes competition, protects consumers, enhances reliability, improves efficiency, promotes renewable energy, repeals the Public Utility Holding Company Act, and reforms the Public Utility Regulatory Policies Act.

★ The NEPD Group recommends the President encourage FERC to use its existing statutory authority to promote competition and encourage investment in transmission facilities.

California Electricity Crisis

The California electricity crisis is not a test of the merits of competition in electricity markets. Instead, it demonstrates that a poorly designed state retail competition plan can have disastrous results if electricity supply does not keep pace with increased demand. At heart, the California electricity crisis is a supply crisis. California allowed demand to outstrip supply, and did little to lower barriers to entry through reform of an inflexible siting process. The risk that the California experience will repeat itself is low, since other states have not modeled their retail competition plans on California's plan.

The California crisis also shows that state electricity markets do not stay neatly confined within legal and jurisdictional bounds. Due to regional interconnection, disastrous mistakes made by the State of California have dire effects on the entire West. California's failure to reform flawed regulatory rules affecting the market drove up wholesale prices. Actions such as forcing utilities to purchase all their power through volatile spot markets, imposing a single-price auction system, and barring bilateral contracts all contributed to the problems that California now faces.

Lessons Learned from Successful Deregulation

As stated previously, 25 states have decided to open their retail electricity markets. A comparison of the different approaches taken by California and other states demonstrates that competition will benefit consumers if implemented effectively. A better gauge of the potential for retail competition to lower prices can be found in Pennsylvania, where electricity prices have fallen significantly as a result of competition. There is also reason to believe that the plan in Texas will have similar success.

A major difference between the California experience and the approaches taken by Pennsylvania and Texas is that the latter states ensured they had adequate electricity supplies. Pennsylvania and Texas took steps to ensure that procedures for adding new power plants were efficient. Unlike California, which imports 25 percent of its electricity, Pennsylvania is a net exporter of power, and Texas imports almost no power from other states. For these reasons, Pennsylvania and Texas have ample electricity supply to meet demand, while California is confronting a serious supply shortage.

In addition, California required its utilities to divest themselves of much of their generation, unlike Pennsylvania and Texas. This action forced California utilities to rely much more heavily on buying power, at ever-increasing prices, instead of generating power themselves.

Another major difference is that Pennsylvania and Texas did not require their utilities to purchase electricity through volatile spot markets. This requirement, combined with frozen retail rates imposed by the State, forced California utilities to purchase power at much higher costs than could be passed along to the consumer. As a result, the California regulatory plan resulted in unreliable service, destroyed the financial health of the State's utilities, and drove one utility into bankruptcy.

The federal government does not site power plants; that is a responsibility of the states. For that reason, delays relating to the construction of new power plants are usually the result of state action. A number of federal agencies, such as the Environmental Protection Agency, the Department of Commerce, and the Department of the Interior, do issue air and other permits for generation facilities. Some of the concerns about permitting or review delays in other states can be similarly addressed by expediting processes. These agencies, pursuant to President Bush's Executive Order, have expedited permit-processing applications for energy production in California.

Some of the concerns about permitting or review delays in other states can be similarly addressed by expediting processes.For example, in 1999–2000, the time for issuing air permits (including the time for public participation) for turbines was reduced to three to four months (compared to the twelve months allowed by the regulations) for the majority of permit applications.

Fuels for Electricity Generation

Electricity is not a primary source of energy. It is generated by the use of primary energy sources (Figure 5-5). Coal, nuclear energy, natural gas and hydropower account for about 95 percent of total electricity generation, with oil and renewable energy contributing the remainder. Despite this healthy diversity of energy sources, each type of electricity resource is faced with constraints to maintaining or expanding its contribution to electricity production.

Coal

Coal is used almost exclusively to generate electricity. Coal power plants account for over 50 percent of all U.S. electricity generation, and over 80 percent of generation in twelve states in the Midwest, Southeast, and West. Coal electricity generation costs are low, and coal prices have proved remarkably stable. In 1999, the United States produced 1.1 billion tons of coal. Production of coal from federal and tribal lands, which has increased substantially in the past decade, accounted for 38 percent of this total.

Although coal is the nation's most abundant fossil energy source, production and market issues can affect the adequacy of supply. Production issues include the protection of public health, safety, property, and the environment, and the effectiveness of federal and state agencies implementing various laws governing coal mining. These issues have resulted in some coal resources becoming uneconomical to produce. Statutory, regulatory, and administrative difficulties also may limit or prevent the production of some coal resources. However, technological advances in cleaner coal technology have allowed for significant progress toward reducing these barriers. There are also opportunities to protect the environment while lowering costs through further improvements in technology.

Over the past decade, greater efficiencies, lower capital costs, fewer emissions and quicker start-up times have made power plants fueled by natural gas a more attractive choice for new coal generation. Recently, however, rising natural gas prices have renewed interest in building coal power plants.

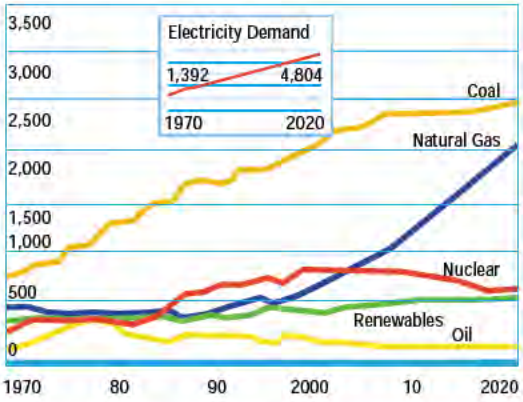
Uncertainty about future environmental controls is of particular concern for companies that operate existing coal power plants. Regulations under development include a variety of measures requiring reductions in emissions of nitrogen oxide, sulfur dioxide, and mercury. In addition, rules related to discharges to streams and cooling-water intake structures, possible regulation of large-volume wastes as hazardous wastes,

uncertainty over rules requiring air permits for certain modifications to power plants, and uncertainty over global and domestic efforts to reduce carbon dioxide emissions also play a role. This regulatory uncertainty discourages power producers from building coal power plants and is one reason the Unites States is relying so heavily on natural gas power generation to meet growing electricity demand.

Much of the current uncertainty has resulted because regulators do not weigh the cumulative impacts of their proposals. Compliance decisions by businesses concerning each new regulation must often be made without the benefit of clear information regarding additional requirements that may be imposed. More effective and economical compliance strategies are possible if companies know the full range of requirements with which they must comply.

If rising U.S. electricity demand is to be met, then coal must play a significant role. Under current policies, in the next two decades, nuclear electricity generation and hydropower are projected to decline. Natural gas electricity generation is projected to increase from about 16 to 36 percent of total generation, which would require the tripling of natural gas used for electricity generation. Significantly, this projected increase in natural gas generation assumes that coal electricity generation will continue to account for about 50 percent of U.S. electricity generation. If policies are adopted that sharply lower coal electricity generation, then the likely result is an even greater dependence on natural gas generation. This creates concern about the adequacy of natural gas supplies and policies.

Figure 5-5
Electricity Generation by Fuel: Current Trends
(Billions of Kilowatt-Hours)



Source: U.S. Department of Energy, Energy Information Administration

Clean Coal Technology

Technology has been and will continue to be a key to achieving our energy, economic, and environmental goals. In recent years, technological advancements through efforts of both the public and private sectors have led to substantial reductions in the cost of controlling sulfur dioxide and nitrogen oxide emissions, while the effectiveness of control systems increased significantly. The Department of Energy, through its Clean Coal Technology Program, has worked to provide effective control technologies. These nitrogen oxide and sulfur dioxide control technologies have moved into the utility marketplace and now provide a means to achieve cost effective regulatory compliance.

For example, most power plants that can use low nitrogen oxide burners have now installed them, and about 25 percent of all coal power plants have either ordered or installed selective catalytic reduction technology, which reduces nitrogen oxide emissions.

Technologies like fluidized-bed combustion and integrated gasification combined cycle have been developed that further reduce emissions. Fluidized-bed combustion is a low-emitting nitrogen oxide combustion technology that allows the use of fuels, such as coal pile washer waste, that were not formerly usable. Integrated gasification combined cycle is a relatively new technology that uses refinery waste as fuel.

Future coal electricity generation will need to meet new challenges to reduce emissions even further, especially mercury emissions. The Department of Energy is supporting efforts to develop more cost effective control technology. Indeed, the goal

Clean Coal Technology

Clean Coal Technology describes a category of technologies that allow for the use of coal to generate electricity while meeting environmental regulations at low cost.

- In the short term, the goal of the program is to meet existing and emerging environmental regulations, which will dramatically reduce compliance costs for controlled mercury, NOx, SO_2, and fine particulate at new and existing coal power plants.
- In the mid-term, the goal of the program is to develop low-cost, super-clean coal power plants, with efficiencies 50 percent higher than today's average. The higher efficiencies will reduce emissions at minimal costs.
- In the long term, the goal of the program is to develop low-cost, zero-emission power plants with efficiencies close to double that of today's fleet.

of these research, development, and demonstration programs is to develop and demonstrate coal power systems with near zero environmental emissions, while maintaining low production costs.

Recommendations:

★ The NEPD Group recognizes the importance of looking to technology to help us meet the goals of increasing electricity generation while protecting our environment. To that end, the NEPD Group recommends that the President direct the Department of Energy to continue to develop advanced clean coal technology by:

- Investing $2 billion over 10 years to fund research in clean coal technologies.
- Supporting a permanent extension of the existing R&D tax credit.
- Directing agencies to explore regulatory approaches that will encourage advancements in environmental technology.

★ The NEPD Group recommends that the President direct federal agencies to provide greater regulatory certainty relating to coal electricity generation through clear policies that are easily applied to business decisions.

Nuclear Energy

Nuclear energy accounts for 20 percent of all U.S. electricity generation, and more than 40 percent of the electricity generation in ten states in the Northeast, the South, and the Midwest. Despite the closure of several less efficient plants during the 1990s, the 103 U.S. nuclear energy plants currently operating produce more electricity today than at any time in history.

There are a number of reasons why nuclear energy expansion halted in the 1980s. Regulatory changes implemented after the Three Mile Island incident in 1979 lengthened the licensing period to an average of fourteen years, resulting in large cost overruns. Increased public concern about the safety of nuclear energy after the accident often resulted in active opposition to proposed plants. As a result, the last completed nuclear energy plant in the United States was ordered in 1973.

Since the 1980s, the performance of nuclear energy plant operations has substantially improved. While U.S. nuclear energy plants once generated electricity only around 70 percent of the time, the average plant today is generating electricity close to 90 percent. This improved performance has lowered the cost of nuclear generation, which is now competitive with other sources of electricity (Figure 5-6).

There is potential for even greater generation from existing nuclear energy plants. Experts estimate that 2,000 MW could be added from existing nuclear power plants by increasing operating performance to 92 percent. In addition, about 12,000 MW of additional nuclear electricity generation could be derived from uprating U.S. nuclear power plants, a process that uses new technologies and methods to increase rated power levels without decreasing safety. However, modifications to uprate plants can be expensive and require extensive licensing review and approval by the Nuclear Regulatory Commission (NRC). Another way to increase nuclear generation from existing plants is through license renewal. Many nuclear utilities are planning to extend the operating license of existing nuclear plants by twenty years, and the licenses of as many as 90 percent of the currently operating nuclear plants may be renewed.

The nuclear energy industry is closely regulated by the NRC, which provides rigorous oversight of the operation and maintenance of these plants. This oversight includes a comprehensive inspection program that focuses on the most significant potential risks of plant operations and features full-time resident inspectors at each plant, as well as regional inspectors with specialized expertise. The NRC has made great strides to provide greater regulatory certainty while maintaining high safety standards.

The installation of new design features, improvements in operating experience, nuclear safety research, and operator training have all contributed to the strong safety record of the nuclear energy industry. Since the Three Mile Island incident in 1979, the nuclear industry's safety record has significantly improved. This safety record has been achieved through a defense-in-depth philosophy accomplished by way of engineering design, quality construction, safe operation, and emergency planning. This philosophy provides for diverse and redundant systems to prevent accidents from occurring, as well as multiple safety barriers to mitigate the effects of accidents in the highly unlikely event they do occur.

Over the last several years, utilities have begun purchasing nuclear plants from other operators as the industry undergoes consolidation. Several nuclear utilities have merged, creating management teams with extensive expertise in running and maintaining nuclear plants. These mergers are impeded by tax rules relating to the transfer of decommissioning funds.

Utilities are also considering nuclear energy as an option for new generation. The NRC has certified three standardized nuclear power plant designs, and Congress enacted legislation in 1992 to reform the nuclear licensing process. Under this process, a utility can apply for a combined construction and operating license for one of these standardized designs in a streamlined process. This reformed licensing process provides for site permits—a way to resolve siting issues early in the process. Building new generators on existing sites avoids many complex issues associated with building plants on new sites. Many U.S. nuclear plant sites were designed to host four to six reactors, and most operate only two or three; many sites across the country could host additional plants.

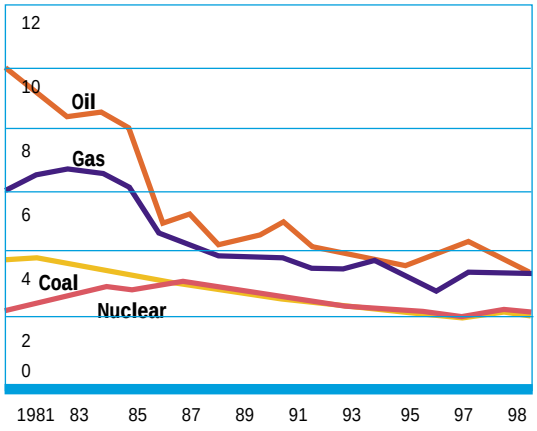
Advanced reactor technology promises to improve nuclear safety. One example of an advanced reactor design is the gas-cooled, pebble-bed reactor, which has inherent safety features. The industry has an interest in this and other advanced reactor designs.

The federal government must also provide for the safe disposal of nuclear waste. At present, nuclear waste continues to be stored at local plant sites. The Department of Energy is over a decade behind schedule for accepting nuclear waste from utilities, but has made progress toward characterization of the Yucca Mountain, Nevada site. Construction of an exploratory studies facility has been completed, a viability assessment was published, and recently scientists placed their extensive research about Yucca Mountain on the record for public scrutiny. However, key regulatory standards to protect public health and the environment at the repository have not been issued.

The Administration will continue to study the science to determine whether to proceed with the consideration of this site as the location for the repository. If the Administration decides to proceed, the Department of Energy must file a license application with the NRC. No waste will be sent to any location until the NRC determines it to be safe.

Other countries have developed different approaches for nuclear waste disposal. For example, the French, British and Japanese rely on reprocessing, an in-

Figure 5-6
Nuclear Generation is Competitively Priced
(1998 Cents per Kilowatt-Hour)



Note: Fuel costs are included.
Source: Utility Data Institute via the Nuclear Energy Institute.



Calvert Cliffs is the first U.S. nuclear plant to receive a renewed license from the Nuclear Regulatory Commission. The renewal will allow the plant to continue producing environmentally sound electricity for an additional twenty years.
CONSTELLATION ENERGY GROUP

dustrial approach that separates nuclear waste into usable fuel and highly concentrated waste. While this approach does not obviate the need for geologic disposal of nuclear waste, it could significantly optimize the use of a geologic repository. There is growing interest in new technology known as accelerator transmutation, which could be used in combination with reprocessing to reduce the quantity and toxicity of nuclear waste.

Recommendations:

★ The NEPD Group recommends that the President support the expansion of nuclear energy in the United States as a major component of our national energy policy. Following are specific components of the recommendation:

- Encourage the Nuclear Regulatory Commission (NRC) to ensure that safety and environmental protection are high priorities as they prepare to evaluate and expedite applications for licensing new advanced-technology nuclear reactors.
- Encourage the NRC to facilitate efforts by utilities to expand nuclear energy generation in the United States by uprating existing nuclear plants safely.
- Encourage the NRC to relicense existing nuclear plants that meet or exceed safety standards.
- Direct the Secretary of Energy and the Administrator of the Environmental Protection Agency to assess the potential of nuclear energy to improve air quality.
- Increase resources as necessary for nuclear safety enforcement in light of the potential increase in generation.
- Use the best science to provide a deep geologic repository for nuclear waste.
- Support legislation clarifying that qualified funds set aside by plant owners for eventual decommissioning will not be taxed as part of the transaction.
- Support legislation to extend the Price–Anderson Act.

★ The NEPD Group recommends that, in the context of developing advanced nuclear fuel cycles and next generation technologies for nuclear energy, the United States should reexamine its policies to allow for research, development and deployment of fuel conditioning methods (such as pyroprocessing) that reduce waste streams and enhance proliferation resistance. In doing so, the United States will continue to discourage the accumulation of separated plutonium, worldwide.

★ The United States should also consider technologies, in collaboration with international partners with highly developed fuel cycles and a record of close cooperation, to develop reprocessing and fuel treatment technologies that are cleaner, more efficient, less waste-intensive, and more proliferation-resistant.

Hydropower

Although hydropower generation accounts for only about 7 percent of overall U.S. electricity generation, the following states depend heavily on this source of energy: Idaho, Washington, Oregon, Maine, South Dakota, California, Montana, and New York.

Hydropower generation has remained relatively flat for years. The most significant constraint on expansion of U.S. hydropower generation is physical; most of the best locations for hydropower generation have already been developed. Potential does remain for some increases in hydropower generation, and capacity can be optimized by adding additional turbines and increasing efficiency at existing facilities.

Also, the amount of hydropower generation depends upon the quantity of available water. A drought can have a devastating effect on a region that depends on hydropower. In fact, this year's water availability has been a contributing factor in California's electricity supply shortages. The amount of hydropower generation depends upon the quantity of available water. A drought can have a devastating effect on a region that depends on hydropower. In fact, this year's water availability has been a contributing factor in California's electricity supply shortages.

The Federal Energy Regulatory Commission is required to incorporate mandatory conditions proposed by different state and federal resource agencies into hydropower licenses. Decision-making authority in the licensing process is diffused among a host of federal and state agencies, all of which are pursuing different statutory missions. The hydropower licensing process is prolonged, costly, and poses regulatory uncertainty. The challenge is to efficiently and effectively balance national interests in natural resource and environmental preservation with energy needs.

Recommendation:

★ The NEPD Group recognizes there is a need to reduce the time and cost of the hydropower licensing process. The NEPD Group recommends that the President encourage the Federal Energy Regulatory Commission (FERC) and direct federal resource agencies to make the licensing process more clear and efficient, while preserving environmental goals. In addition, the NEPD Group recognizes the importance of optimizing the efficiency and reliability of existing hydropower facilities, and will encourage the Administration to adopt efforts toward that end.

- Support administrative and legislative reform of the hydropower licensing process.
- Direct federal resource agencies to reach interagency agreement on conflicting mandatory license conditions before they submit their conditions to FERC for inclusion in a license.
- Encourage FERC to adopt appropriate deadlines for its own actions during the licensing process.

Natural Gas

Currently, natural gas provides about 16 percent of U.S. electricity generation. Seven states obtain over one-third of their generation from natural gas (Rhode Island, new York, Delaware, Louisiana, Texas, California, and Alaska). Perhaps more importantly, natural gas-fired electricity is projected to constitute about 90 percent of capacity additions between 1999 and 2020. The amount of natural gas used in electricity generation is projected to triple by 2020.

Ensuring the long-term availability of adequate, reasonably priced natural gas supplies is a challenge. Low gas prices in 1998 and 1999 caused the industry to scale back gas exploration and production activity. Since 2000, the North American natural gas market has remained tight due to strong demand and diminished supplies. Last year, natural gas prices quadrupled, which resulted in substantially higher prices for electricity generated with natural gas.

While the largest barriers to expanded natural gas electricity generation relate to production and pipeline constraints, there are several other barriers. Environmental regulations affect the use of gas for electricity generation. Although natural gas electric plants produce fewer emissions than coal-fired power plants, they still emit nitrogen oxides, carbon dioxide and small amounts of toxic air emissions.

Oil

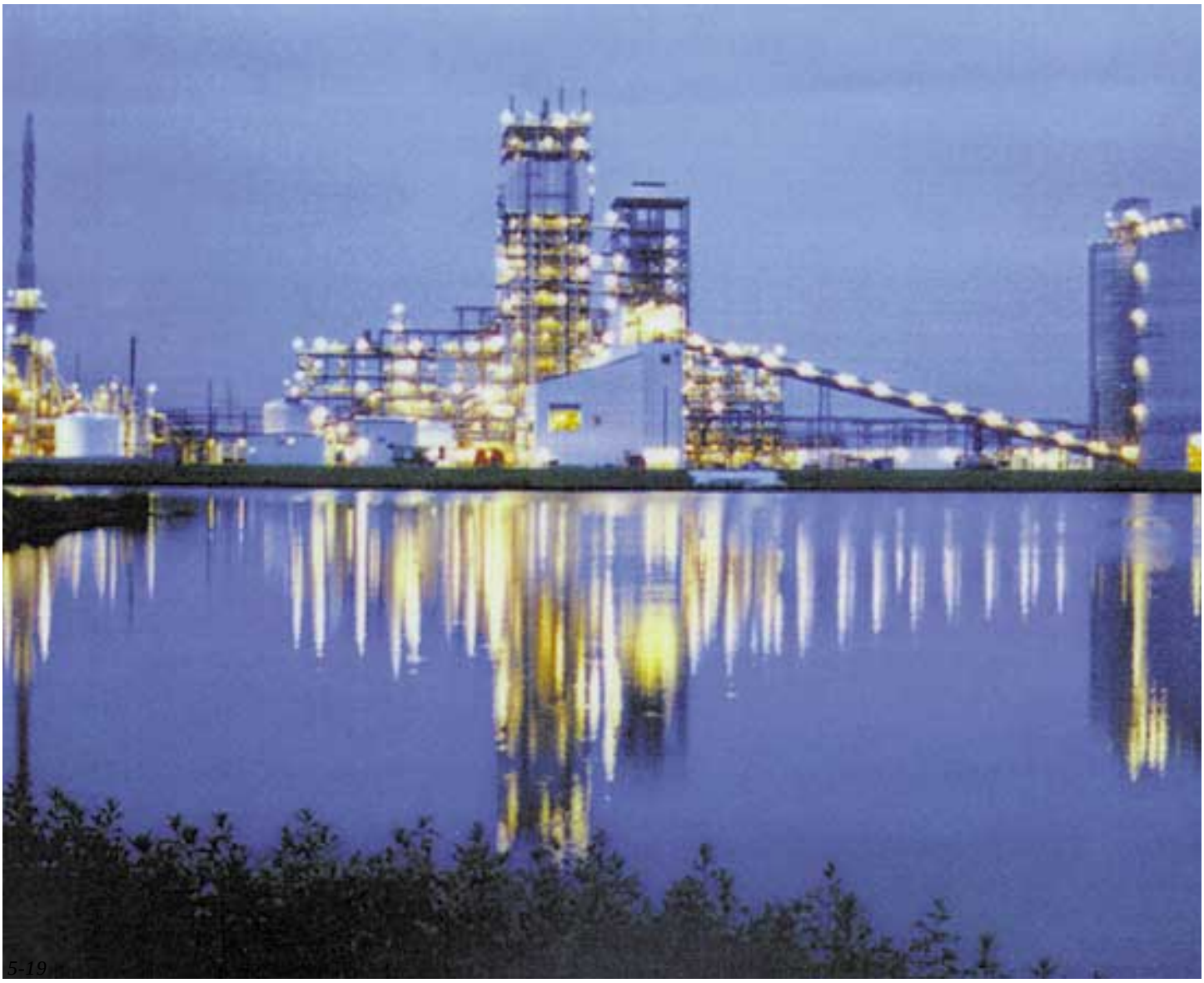
While oil fuels only about 3 percent of total U.S. electricity generation, it is the dominant source of electricity generation in Hawaii, and provides over 20 percent of the generation in Massachusetts, Connecticut, Delaware, Maine, and Florida. Over the next twenty years, market conditions are expected to reduce today's level of oil electricity generation by about 80 percent.

Renewable Energy

Hydropower is, to date, the most successful form of renewable energy. However, some forms of renewable energy generation—wind, geothermal, and biomass—have the potential to make more significant contributions in coming years, and the cost of most forms of renewable energy has declined sharply in recent years. The most important barrier to increased renewable energy production remains economic; nonhydropower renewable energy generation costs are greater than other traditional energy sources. The following chapter discusses renewable and alternative energy in greater detail.

High-tech power plants, like this combined cycle plant, are signaling a new age in electric power generation. The capability to co-produce electricity and a slate of fuels and chemicals makes the technology economically attractive to a broad range of industrial applications.

Tampa Electric Company



Summary of Recommendations
Energy for a New Century: Increasing Domestic Energy Supplies

★ The NEPD Group recommends that the President direct the Secretaries of Energy and the Interior to promote enhanced oil and gas recovery from existing wells through new technology.

★ The NEPD Group recommends that the President direct the Secretary of Energy to improve oil and gas exploration technology through continued partnership with public and private entities.

★ The NEPD Group recommends that the President direct the Secretary of the Interior to examine land status and lease stipulation impediments to federal oil and gas leasing, and review and modify those where opportunities exist (consistent with the law, good environmental practice, and balanced use of other resources).

- Expedite the ongoing Energy Policy and Conservation Act study of impediments to federal oil and gas exploration and development.
- Review public lands withdrawals and lease stipulations, with full public consultation, especially with the people in the region, to consider modifications where appropriate.

★ The NEPD Group recommends that the President direct the Secretary of the Interior to consider economic incentives for environmentally sound offshore oil and gas development where warranted by specific circumstances: explore opportunities for royalty reductions, consistent with ensuring a fair return to the public where warranted for enhanced oil and gas recovery; for reduction of risk associated with production in frontier areas or deep gas formations; and for development of small fields that would otherwise be uneconomic.

★ The NEPD Group recommends that the President direct the Secretaries of Commerce and Interior to re-examine the current federal legal and policy regime (statutes, regulations, and Executive Orders) to determine if changes are needed regarding energy-related activities and the siting of energy facilities in the coastal zone and on the Outer Continental Shelf (OCS).

★ The NEPD Group recommends that the President direct the Secretary of the Interior continue OCS oil and gas leasing and approval of exploration and development plans on predictable schedules.

★ The NEPD Group recommends that the President direct the Secretary of the Interior to consider additional environmentally responsible oil and gas development, based on sound science and the best available technology, through further lease sales in the National Petroleum Reserve-Alaska. Such consideration should include areas not currently leased within the Northeast corner of the Reserve.

★ The NEPD Group recommends that the President direct the Secretary of the Interior work with Congress to authorize exploration and, if resources are discovered, development of the 1002 Area of ANWR. Congress should require the use of the best available technology and should require that activities will result in no significant adverse impact to the surrounding environment.

★ The NEPD Group recommends that the President direct the Secretary of the Interior to work with Congress and the State of Alaska to put in place the most expeditious process for renewal of the Trans-Alaska Pipeline System rights-of-way to ensure that Alaskan oil continues to flow uninterrupted to the West Coast of the United States.

★ The NEPD Group recommends that the President direct the Secretary of Energy to propose comprehensive electricity legislation that promotes competition, protects consumers, enhances reliability, promotes renewable energy, improves efficiency repeals the Public Utility Holding Company Act, and reforms the Public Utility Regulatory Policies Act.

★ The NEPD Group recommends that the President encourage FERC to use its existing statutory authority to promote competition and encourage investment in transmission facilities.

★ The NEPD Group recognizes the importance of looking to technology to help us meet the goals of increasing electricity generation while protecting our environment. To that end, the NEPD Group recommends that the President direct the Department of Energy to continue to develop advanced clean coal technology by:

- Investing $2 billion over 10 years to fund research in clean coal technologies.
- Supporting a permanent extension of the existing research and development tax credit.
- Directing federal agencies to explore regulatory approaches that will encourage advancements in environmental technology.

★ The NEPD Group recommends that the President direct federal agencies to provide greater regulatory certainty relating to coal electricity generation through clear policies that are easily applied to business decisions.

★ The NEPD Group recommends that the President support the expansion of nuclear energy in the United States as a major component of our national energy policy. Following are specific components of the recommendation:

- Encourage the Nuclear Regulatory Commission (NRC) to ensure that safety and environmental protection are high priorities as they prepare to evaluate and expedite applications for licensing new advanced-technology nuclear reactors.
- Encourage the NRC to facilitate efforts by utilities to expand nuclear energy generation in the United States by uprating existing nuclear plants safely.
- Encourage the NRC to relicense existing nuclear plants that meet or exceed safety standards.
- Direct the Secretary of Energy and the Administrator of the Environmental Protection Agency to assess the potential of nuclear energy to improve air quality.
- Increase resources as necessary for nuclear safety enforcement in light of the potential increase in generation.
- Use the best science to provide a deep geologic repository for nuclear waste.
- Support legislation clarifying that qualified funds set aside by plant owners for eventual decommissioning will not be taxed as part of the transaction.
- Support legislation to extend the Price–Anderson Act.

★ The NEPD Group recommends that, in the context of developing advanced nuclear fuel cycles and next generation technologies for nuclear energy, the United States should reexamine its policies to allow for research, development and deployment of fuel conditioning methods (such as pyroprocessing) that reduce waste streams and enhance proliferation resistance. In doing so, the United States will continue to discourage the accumulation of separated plutonium, worldwide.

★ The United States should also consider technologies (in collaboration with international partners with highly developed fuel cycles and a record of close cooperation) to develop reprocessing and fuel treatment technologies that are cleaner, more efficient, less waste-intensive, and more proliferation-resistant.

★ The NEPD Group recognizes there is a need to reduce the time and cost of the hydropower licensing process. The NEPD Group recommends that the President encourage the Federal Energy Regulatory Commission (FERC) and direct federal resource agencies to make the licensing process more clear and efficient, while preserving environmental goals. In addition, the NEPD Group recognizes the importance of optimizing the efficiency and reliability of existing hydropower facilities and will encourage the Administration to adopt efforts toward that end.

- Support administrative and legislative reform of the hydropower licensing process.
- Direct federal resource agencies to reach interagency agreement on conflicting mandatory license conditions before they submit their conditions to FERC for inclusion in a license.
- Encourage FERC to adopt appropriate deadlines for its own actions during the licensing process.

Nature's Power

Increasing America's Use of Renewable and Alternative Energy

A sound national energy policy should encourage a clean and diverse portfolio of domestic energy supplies. Such diversity helps to ensure that future generations of Americans will have access to the energy they need.

Renewable energy can help provide for our future needs by harnessing abundant, naturally occurring sources of energy, such as the sun, the wind, geothermal heat, and biomass. Effectively harnessing these renewable resources requires careful planning and advanced technology. Through improved technology, we can ensure that America will lead the world in the development of clean, natural, renewable and alternative energy supplies.

Renewable and alternative energy supplies not only help diversify our energy portfolio; they do so with few adverse environmental impacts. While the current contribution of renewable and alternative energy resources to America's total electricity supply is relatively small—only 9 percent—the renewable and alternative energy sectors are among the fastest growing in the United States. Non-hydropower only account for 2 percent of our electricity needs. However, electricity generation from non-hydropower renewable energy grew by nearly 30 percent in the 1990s. Continued growth of renewable energy will continue to be important in delivering larger supplies of clean, domestic power for America's growing economy.

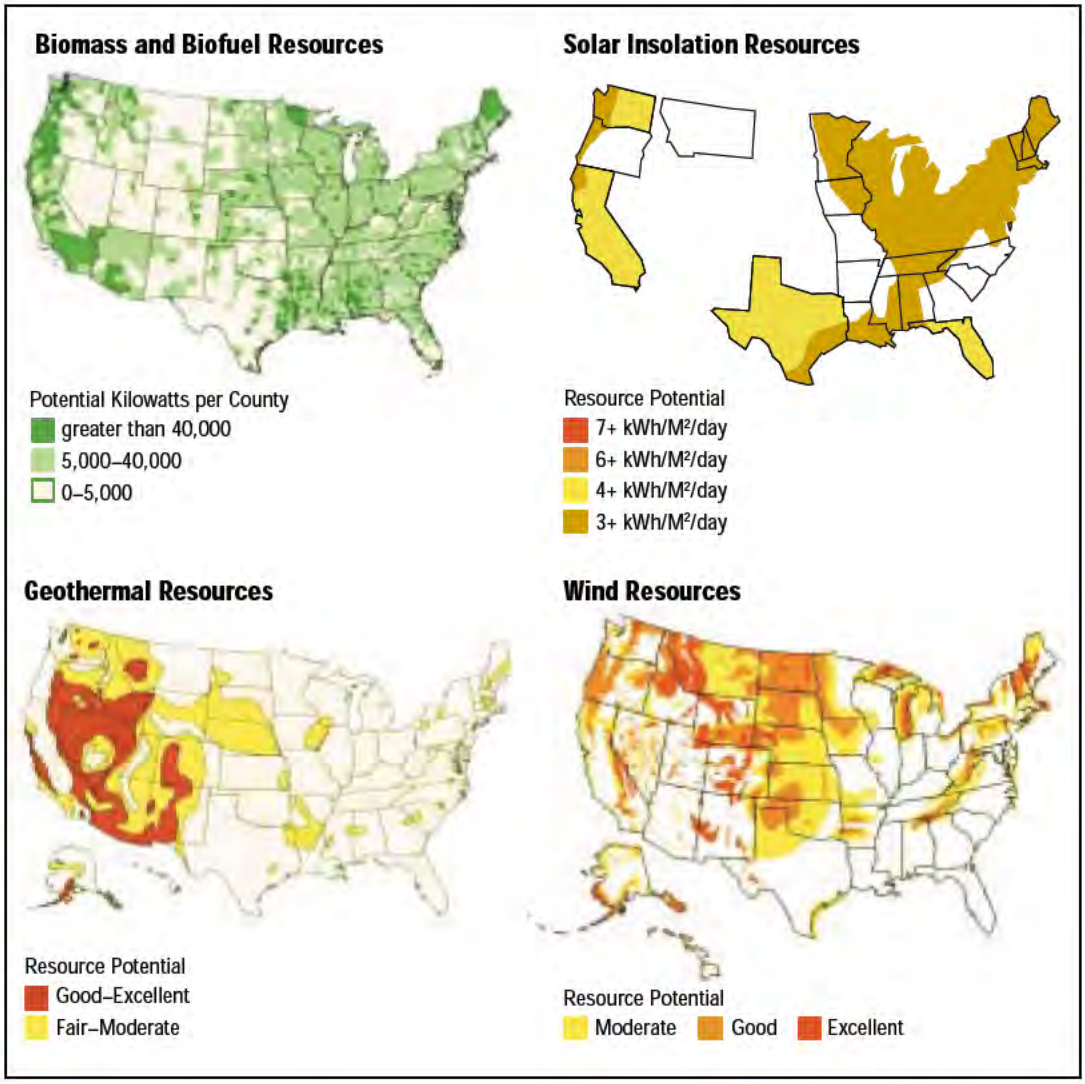
Renewable energy resources tap naturally occurring flows of energy to produce electricity, fuel, heat, or a combination of these energy types. One type of renewable energy, hydropower, has long provided a significant contribution to the U.S. energy supply and today is competitive with other forms of conventional electricity. However, there is limited growth potential for hydropower. Non-hydropower renewable energy is generated from four sources: biomass, geothermal, wind, and solar (Figure 6-1). The United States has significant potential for renewable resource development. These nondepletable sources of energy are domestically abundant and often have less impact on the environment than conventional sources. They can provide a reliable source of energy at a stable price, and they can also generate income for farmers, landowners, and others who harness them.



Renewable hydropower has long provided a significant contribution to the U.S. energy supply. Today, hydropower is competitive with other forms of conventionally generated electricity.



Figure 6-1
U.S. Resource Potential for Renewable Energy



Almost every state has the potential for wind energy and for biomass and biofuel production. The Southwest has the greatest potential for solar energy, and geothermal energy resources are most abundant in the West.

Source: U.S. Department of Energy, National Renewable Energy Laboratory.

Recommendation:

★ The NEPD Group recommends that the President direct the Secretaries of the Interior and Energy to re-evaluate access limitations to federal lands in order to increase renewable-energy production, such as biomass, wind, geothermal, and solar.

Alternative energy includes: alternative fuels that are transportation fuels other than gasoline and diesel, even when the type of energy, such as natural gas, is traditional; the use of traditional energy sources, such as natural gas, in untraditional ways, such as for distributed energy at the point of use through microturbines or fuel cells; and future energy sources, such as hydrogen and fusion.

Both renewable and alternative energy resources can be produced centrally or on a distributed basis near their point of use. Providing electricity, light, heat, or mechanical energy at the point of use diminishes the

need for some transmission lines and pipe lines, reducing associated energy delivery losses and increasing energy efficiency. Dis tributed energy resources may be renew able resources, such as biomass cogenera tion in the lumber and paper industry or rooftop solar photovoltaic systems on homes, or they may be alternative uses of traditional energy, such as natural gas microturbines.

Recommendations:

★ The NEPD Group supports the increase of $39.2 million in the FY 2002 budget amendment for the Department of Energy's Energy Supply account that would provide increased support for research and development of renewable energy resources.

★ The NEPD Group recommends that the President direct the Secretary of Energy to conduct a review of current funding and historic perfor mance of renewable energy and alternative energy research and development programs in light of the recommendations of this report. Based on this review, the Secretary of Energy is then directed to propose appropriate funding of those research and development programs that are performance-based and are modeled as public-private partnerships.

Microturbines

Microturbines are small combustion turbines approximately the size of a refrigerator with outputs of 25 to 500 kilowatts. Microturbines can be used to power a home or small business. This technology has evolved largely from automotive and truck turbochargers, auxiliary power units for airplanes, and small jet engines.

Compared to other technologies for small-scale power generation, microturbines offer a number of significant advantages, including a small number of moving parts; compact size; lightweight, optimal effi ciency; lower emissions and electricity costs; and opportunities to use waste fuels. For these reasons, microturbines could easily capture a significant share of the distributed generation market.

Renewable Energy Technologies

Biomass

Biomass is organic matter that can be used to provide heat, make fuel, and gener ate electricity. Wood, the largest source of biomass, has been used to provide heat for thousands of years. Many other types of biomass are also used as an energy source, such as plants, residue from agriculture or forestry, and the organic component of mu nicipal and industrial wastes. Landfill gas is also considered a biomass source. Biomass resources can be replenished through culti- vation of what are known as energy crops, such as fast-growing trees and grasses.

Unlike other renewable energy sources, biomass can be converted directly into liquid fuels, called biofuels, to meet our transportation needs. The two most com mon biofuels are ethanol and biodiesel. Ethanol is made by fermenting any biomass that is rich in carbohydrates, such as corn. It is mostly used as a fuel additive to reduce a vehicle's emissions. Biodiesel is made us ing vegetable oils, animal fats, algae, or even recycled cooking greases. It can be used as a diesel additive to reduce emissions or in its pure form to fuel a vehicle. Beyond en ergy benefits, development of biomass ben efits rural economies that produce crops used for biomass, particularly ethanol and biomass electricity generation.



Biomass, like corn, that is rich in carbohydrates can be converted directly into biofuels to meet our transportation needs. The biofuel ethanol is mostly used as a fuel additive to reduce vehicles' smog-causing emissions. In June 1992, the Greater Peoria Mass Transit District began operating fourteen ethanol-powered buses along regular city routes.
U.S. Department of Energy

Biomass is also used to generate electricity. This is accomplished through the direct combustion of wood, municipal solid waste, and other organic materials; co-firing with coal in high efficiency boilers; or combustion of biomass that has been chemically converted into fuel oil. In the lumber and paper industries, wood scraps are sometimes directly fed into boilers to produce steam for their manufacturing processes or to heat their buildings. For that reason, renewable energy offers a particular advantage to the lumber and paper industry, and many analysts project the industry may soon become a net seller of electricity. Co-firing coal power plants with biomass has environmental benefits, since co firing can significantly reduce emissions. Biomass accounts for 76 percent of renewable electricity generation and 1.6 percent of total U.S. electricity supply.

Even gas for generating electricity can be produced from biomass. Gasification systems use high temperatures to convert biomass into a gas that is used to fuel a turbine. The decay of biomass in landfills also produces methane, a gas that can be captured and burned in a boiler to produce steam for electricity generation or for industrial processes. Using methane emissions increases electricity supplies, reduces pollution from landfills and reduces greenhouse gas emissions. The technologies to collect and use landfill methane to generate electricity are already in the market. However, they have not been successfully integrated at present due to the perceived higher risk of new technologies.

The Geysers in northern California is the world's largest producer of renewable geothermal power. The dry-steam field has successfully produced power since the early 1960s, when Pacific Gas & Electric installed the first 11-megawatt plant. Today, nearly 2,000 megawatts are on line – enough energy to supply the electricity needs of San Francisco and Oakland.
Pacific Gas & Electric



Recommendation:

★ The NEPD Group recommends that the President direct the Secretary of the Treasury, to work with Congress on legislation to expand the section 29 tax credit to make it available for new landfill methane projects. The credit could be tiered, depending on whether a landfill is already required by federal law to collect and flare its methane emissions due to local air pollution concerns.

Geothermal

Geothermal energy is the use of steam and hot water generated by heat from the Earth to perform work. Some geothermal power plants use steam or hot water from a natural underground reservoir to power a generator. Others use hot water to provide direct heat for residential and other buildings, and for other applications.

The most readily accessible resources for geothermal power generation in the United States are located in the West, Alaska, and Hawaii. A wide array of high technology geological, geochemical, and geophysical techniques are used to locate geothermal resources. In large measure, the technology for developing these resources has been adapted from the oil industry. Improvements in drill bits, drilling techniques, advanced instruments, and other technological advances have made energy production from geothermal resources increasingly efficient.

Geothermal accounts for 17 percent of renewable electricity generation and 0.3 percent of total U.S. electricity supply. However, the net installed capacity of U.S. geothermal power plants has increased significantly, from 500 MW in 1973 to 2,800 MW today.

Hot water near the surface of the Earth can also be used directly for heat. These direct-use applications include heat

ing buildings, growing plants in green houses, drying crops, heating water at fish farms, and several industrial processes, such as pasteurizing milk.

In addition, individual homeowners, farmers, and businesses can tap into geo thermal energy through geothermal heat pumps to heat and cool buildings. A geo thermal heat pump system consists of a heat pump, an air delivery system, a heat exchanger, and a system of pipes buried in the shallow ground near the building. In the winter, a heat pump removes heat from the heat exchanger and pumps that heat into the indoor air delivery system. In the sum mer, the process is reversed, and the heat pump moves heat from the indoor air into the heat exchanger. The heat removed from the indoor air during the summer can also be used to provide a free source of hot water. Geothermal heat pumps can be used almost anywhere in the United States, and can sig nificantly increase system efficiencies.

Recommendation:

★ The NEPD Group recommends that the President direct the Secretary of the Interior to determine ways to reduce the delays in geothermal lease process ing as part of the permitting review process.

Wind Energy

Wind energy has been used since at least 200 B.C. for grinding grain and pump ing water. By 1900, windmills were used on farms and ranches in the United States to pump water and, eventually, to produce electricity. Windmills developed into mod ern-day wind turbines.

Wind turbines are used for several ap plications. Wind power uses the naturally occurring energy of the wind for practical purposes like generating electricity, charg ing batteries, or pumping water. Large, modern wind turbines operate together in wind farms to produce electricity for utili ties. Small turbines are used by homeowners, farmers, and remote villages to help meet localized energy needs.

Wind turbines capture energy by using propeller-like blades that are mounted on a rotor. These blades are placed on top of high towers, in order to take advantage of the stronger winds at 100 feet or more above the ground. The wind causes the pro pellers to turn, which then turn the attached shaft to generate electricity. Wind can be used as a stand-alone source of energy or in conjunction with other renewable energy systems. Wind and natural gas hybrid sys tems are a promising approach that offers clean power to consumers.

Wind energy accounts for 6 percent of renewable electricity generation and 0.1 percent of total electricity supply. However, advances by research labs, universities, utilities, and wind energy developers have helped cut wind energy's costs by more than 80 percent during the last twenty years. The industry is poised for growth. In some parts of the country, electricity from wind power can be produced at prices that are comparable to other conventional en ergy technologies. The United States has many areas with abundant wind energy po tential, namely in the West, the Great Plains and New England.



In 1996, the National Association of Home Builders constructed advanced townhouses featuring standing-seam roofs and other energy efficient materials and systems. The townhouse on the right differs from the others in that it has an integrated photovoltaic standing-seam roof that also produces electricity.
Tim Ellison, Energy Conversion Devices

Solar

Sunlight, or solar energy, can be used to generate electricity; heat water; and heat, cool, and light buildings. Photovoltaic (so lar cell) systems use semiconductor materi als similar to those used in computer chips to capture the energy in sunlight and to convert it directly into electricity. Photovol taic cells have been used in everything from

the solar cells in calculators to the space station Freedom.

Another technology for harnessing the sun's energy is a concentrating solar power system, which uses the sun's heat to gener ate electricity. The sunlight is collected and focused with mirrors to create a high inten sity heat source that in turn can be used to generate electricity through a steam turbine or a heat engine.

Solar hot water systems use the sun to heat water for domestic or industrial use. Many large commercial buildings also use solar collectors for heat. A solar ventilation system can be used in cold climates to pre heat air as it enters a building. The heat from a solar collector can even be used to provide energy for cooling a building.

Some architects are using careful de sign and new optical materials to use sun light to reduce the need for traditional light ing and to cut down on heating and cooling costs. For example, materials that absorb and store the sun's heat can be built into the sunlit floors and walls. The floors and walls will store heat during the day and slowly re lease heat at night.

While solar energy technologies have undergone technological and cost improve ments and are well established in high value markets like remote power, satellites, communications, and navigational aids, continued research is needed to reduce costs and improve performance. Solar en ergy accounts for 1 percent of renewable electricity generation and 0.02 percent of total U.S. electricity supply.

Alternative Energy

Alternative Transportation Fuels

Alternative fuels are any transporta tion fuels made from a nontraditional source, including ethanol, biodiesel, and other biofuels. These can be made from biomass resources, including liquid fuels (e.g., ethanol, methanol, biodiesel) and gas eous fuels (e.g., hydrogen and methane). Biofuels are primarily used to fuel vehicles, but can also fuel engines or fuel cells for electricity generation. Alternative fuels also

Recommendations:

★ The NEPD Group recommends that the President direct the Administrator of the Environmental Protection Agency to develop a new renewable energy partnership program to help companies more easily buy renewable energy, as well as receive recognition for the environmental benefits of their purchase, and help consumers by promoting consumer choice programs that increase their knowledge about the environmental benefits of purchasing renewable energy.

★ The NEPD Group recommends that the President direct the Secretary of the Treasury to work with Congress on legislation to extend and expand tax credits for electricity produced using renewable technology, such as wind and biomass. The President's budget request extends the present 1.7 cents per kilowatt hour tax credit for electricity produced from wind and biomass; expands eligible biomass sources to include forest-related sources, agricultural sources, and certain urban sources; and allows a credit for electricity produced from biomass co-fired with coal.

★ The NEPD Group recommends that the President direct the Secretary of the Treasury to work with Congress on legislation to provide a new 15 percent tax credit for residential solar energy property, up to a maximum credit of $2,000.

★ The NEPD Group recommends that the President direct the Secretaries of the Interior and Energy to work with Congress on legislation to use an estimated $1.2 billion of bid bonuses from the environmentally responsible leasing of ANWR for funding research into alternative and renewable energy resources, including wind, solar, geothermal, and biomass.

Alternative Fuel Vehicles

Alternative fuel vehicles (AFVs) can run on methanol, ethanol, compressed natural gas, liquefied natural gas, propane, hydrogen, electricity, biodiesel, and natural gas. Today, more than 450,000 alternative vehicles are operating in the United States. Some of the barriers to using AFVs include:

Cost—For example, a Ford Crown Victoria that runs on compressed natural gas costs about $4,000 more than its gasoline counterpart.

Refueling Infrastructure—Refueling infrastructure is limited, which can make refueling inconvenient and travel options difficult.

Travel Distance—Ability to travel a long distance on a single volume of fuel. Al ternative fuels have an energy content lower than that of gasoline, which means that AFVs cannot travel as far as traditional vehicles on a single tank of fuel.

In the short term, natural gas and propane offer the greatest potential for market growth, especially in niche markets where lower fuel costs make them attractive, such as transit buses, school buses, shuttles, and other heavy-duty vehicles. Ethanol vehicles offer tremendous potential if ethanol production can be expanded. Electric vehicles could reach large numbers in the future if technology breakthroughs help bring costs down and increase driving distance. Fuel cell vehicles operating on com pressed hydrogen offer long-term potential. Compressed natural gas offers a distribu tion stepping-stone to a hydrogen-refueling infrastructure.

include traditional energy sources, such as natural gas and liquid propane that are tra ditionally not used as a transportation fuel.

Currently, there are approximately 450,000 alternative fuel vehicles in the United States, and more than 1.5 million flexible-fuel vehicles that can use gasoline or a mixture of ethanol and gasoline. Etha nol is made by converting the carbohydrate portion of biomass into sugar, which is then converted into ethanol through a fermenta tion process. Ethanol is the most widely used biofuel, and its production has in creased sharply since 1980, rising from 200 million gallons a year to 1.9 billion gallons. Today, many states are considering phasing out the use of MTBE (methyl tertiary butyl ether), an oxygenate additive for gasoline. If they do so, that will likely spur greater re liance on ethanol.

Each year, approximately 65 percent of the oil consumed in the United States is used for transportation. As a result, vehicle emissions have become the leading source of U.S. air pollution. However, recent ad vances in fuels and vehicle design are help ing increase fuel efficiency and reduce toxic substances discharged into the air.

Changes in the composition of trans portation fuels, such as gasoline and diesel fuels, are one way to improve vehicle per formance while reducing emissions and lowering oil consumption. Reformulated gasoline contains fuel additives such as ethanol to increase oxygen content, which reduces harmful emissions such as carbon monoxide. Low-sulfur gasoline reduces sul fur oxide emissions. New diesel fuels, some of which have lower sulfur contents or are produced from clean-burning natural gas, can help vehicles with diesel engines achieve lower emissions.

In addition to advanced transportation fuels, alternative fuels are being developed, such as biodiesel, electricity, ethanol, hydro gen, methanol, natural gas, and propane. These alternative fuels not only reduce de pendence on petroleum transportation fu els. They reduce or entirely eliminate harm ful emissions as well. With the exception of natural gas and propane, these fuels also have the potential of being generated from renewable resources, such as ethanol from corn. The federal government has promoted development of alternative fuels for many years and this program has helped to reduce U.S. reliance on oil-based fuels.

The evolution toward more efficient,

environmentally friendly transportation fu els has been mirrored by improvements in vehicle design, components, and materials. Alternative fuel vehicles, which can either switch between two fuels or run on a mix ture of two fuels such as gasoline and etha nol, are now available. Recent developments in both alternative fuel vehicles and petro leum-based vehicles, such as advances in engines, drive trains, and emission-control technologies, may double or triple the effi ciency of current vehicles. Some of these new technologies include hybrid electric ve hicles, which combine an engine with an electric motor, and fuel cells, which produce electricity by converting a fuel, generally hy drogen and oxygen, into water.

A number of issues drive the research and marketability of advanced alternative fuel vehicles and petroleum-based vehicles in the United States. The goal of reducing U.S. dependence on imported oil, combined with the link between vehicle emissions and air pollution, have prompted the develop ment of emissions and fuel economy stan dards for car manufacturers. In addition, federal, state, and local governments have enacted regulations, laws, and incentives de signed to reduce the number of vehicle miles traveled and to encourage businesses and individuals to purchase alternative fuel vehicles.

The success of the federal alternative fuels program has been limited, however. The current program focuses on mandating certain fleet operators to purchase alterna tive fueled vehicles. The hope was that this vehicle purchase mandate would lead to ex panded use of alternative fuels. That expec tation has not been realized, since most fleet operators purchase dual-fueled vehicles that operate on petroleum motor fuels. The Clean Air Act required the use of oxygen ates, such as MTBE (methyl tertiary butyl ether) and ethanol in fuel. These oxygenates account for 92 percent of alternative fuel use. Reforms to the federal alternative fuels program could promote alternative fuels use instead of mandating purchase of vehicles that ultimately run on petroleum fuels.

Recommendation:

★ The NEPD Group recommends that the President direct the Secretary of Treasury to work with Congress to continue the ethanol excise tax exemption.

Distributed Energy

Untapped opportunities for reducing energy demand loads could be realized by better integrating electricity supply systems and customers. Improved integration can produce a variety of benefits for tight en ergy markets, including reducing peak de mand loads, bypassing congested areas of transmission by placing new generating ca pacity closer to the consumer, and thus achieving greater overall system efficien cies.

Current electricity load management efforts are typically limited to cutting off in terruptible or nonfirm customers, appeals to the public to conserve, and brownouts. Some utilities are incorporating current generation metering, sensor, and control technologies to take the next step: selective reduction of individual energy-using appli ances. In some areas, residents can reduce their monthly bills by allowing the utility to electronically turn off selected appliances, such as water heaters, on a rotating basis. If this option is well managed, consumers are unaware of the temporary loss service, and critical systems continue to run unimpeded. Advanced integrated supply-and-demand load management controls also allow for widespread “demand auctions,” in which consumers can decide which energy ser vices to forego on which days.

Distributed energy resources describe a variety of smaller electricity-generating options well suited for placement in homes, offices, and factories, or near these facili ties. Distributed energy systems have the distinct advantage of being brought on line faster than new central power plants. While natural gas microturbines and solar roof panels are the most familiar types of distrib uted energy, other distributed energy re sources include: combined heat and power, stationary fuel cells, generation of

bioenergy from landfill methane recovery, and small wind systems. Photovoltaic solar distributed energy is a particularly valuable energy generation source during times of peak use of power.

Efficiency gains from distributed en ergy come from three sources. First, trans mission and distribution line losses (about 5 percent) are reduced because the energy is generally used near the source. Second, the co-location with consumption makes it more feasible to use waste heat, displacing otherwise needed natural gas or electricity for heating purposes. And, third, the co-lo cation with consumption allows for the in tegration of on-site energy efficiency and generating capabilities. For example, in the residential market, distributed energy appli cations can make possible the concept of the "net zero energy home," in which the overall level of energy produced at the home equals or exceeds the amount of en ergy used in the home.

Despite these advantages, a number of impediments and competing policy ob jectives discourage the wider application of integrated electricity supply and demand solutions, many of which reflect the relative newness and lack of familiarity with these technologies.

For example, the lack of standards governing interconnection of distributed energy to the grid impedes development. The lack of standards prevents a uniformly effective means of getting excess distrib uted energy to the grid.

In addition, current air quality regula tions do not take into account the additional energy savings from many distributed en ergy technologies. Likewise, distributed en ergy systems purchased by consumers may receive different tax rates than those pur chased by traditional electricity producers.

Although distributed energy can alle viate distribution constraints, these systems often cannot be sited and permitted in a timely manner. For instance, land-use zon ing codes may not allow generating equip ment in association with residential or com mercial land uses, and building code offi cials may not know enough about solar roof systems to provide timely building permits.

As with energy efficiency equipment, load management integrating systems, both controls and distributed energy, have higher first costs associated with lower future en ergy bills.

Another barrier to development of dis tributed energy is the need for net metering, which enables consumers to install a small electricity project at their homes and sell the excess to the local utility, offsetting their purchases from the utility at other times. Net metering can lower the cost to consumers of distributed energy projects. Some consumers are reluctant to install dis tributed renewable energy resources be cause many regions do not have the regula tory framework under which consumers can sell energy back to the grid under a net metering system.

Future Energy Sources

As we look to the long-term future of alternative energy technologies, there is sig nificant promise in these technologies to meet an ever-growing portion of our nation's energy needs.

Hydrogen

In the long run, alternative energy technologies such as hydrogen show great promise. Hydrogen is the most common ele ment in the universe and can be made from water. Converting hydrogen into energy is compatible with existing energy technolo gies, such as fuel cells, engines, and com bustion turbines. The energy for extracting hydrogen could come from existing, tradi tional fuels, or it could be derived from re newable energy sources, such as solar, nuclear, and fossil, to achieve the cleanest possible energy cycle. Hydrogen can be converted into useful energy forms effi ciently and without detrimental environ mental effects. Unlike other energy sources, its production by-product is water.

In the future, hydrogen may be able to be used in furnaces and as a transportation fuel for automobiles, buses, trains, ships and airplanes. Hydrogen could also be con verted directly into electricity by fuel cells. Combustion of hydrogen with oxygen re sults in pure steam, which has many appli-



There is a significant promise in renewable technologies to meet an ever-growing portion of our nation's energy needs. Wind power has significant growth potential. The principal challenges to achieving this level of renewable energy generation are cost and market acceptance of renewable power technologies.
U.S. Department of Energy, National Renewable Energy Laboratory

cations in industrial processes and space heating. Moreover, hydrogen is an important industrial gas and raw material in numerous industries, such as computer, metallurgical, chemical, pharmaceutical, fertilizer and food industries.

An energy infrastructure that relies on hydrogen could enable much greater use of distributed energy systems. These systems are small, modular electricity generators that can be placed right where they are needed for heating, cooling, and powering offices, factories, and residences. Hydrogen fuel cells are a promising type of distributed energy system that can provide the exacting reliability needed for the high-tech industry.

Fuel cells can produce electricity and heat from hydrogen, natural gas, and petroleum fuels, and fuel gases derived from coal and biomass. What makes fuel cells unique is that they can use fuels without combustion, simply by chemical reactions, making them extremely clean and efficient.

Fuel cells were developed by the National Aeronautics and Space Administration to generate electricity, heat, and water in space vehicles. The first-generation fuel cells for stationary power applications entered the commercial market in 1995. This type of fuel cell is used to generate very high-quality electricity and heat with negligible emissions in commercial and industrial settings. It is most likely to be used in cases where users are willing to pay a premium for cleaner, more reliable power than is available from the commercial grid.

The second generation of stationary fuel cells is currently in the demonstration phase, including a combined fuel cell–turbine hybrid. These fuel cells are expected to be more efficient and cost less when used in similar distributed energy systems. Smaller fuel cells for residential units are also being developed, and some are in the demonstration phase.

Despite technical progress, high costs remain the main deterrent to widespread fuel cell use. Significant cost reductions must be achieved before fuel cells will be competitive with internal combustion engines, and the size and weight of fuel cell systems must be reduced even more to accommodate vehicle packaging requirements.

The primary challenge to using more hydrogen in our energy systems is the cost of producing, storing, and transporting it. A serious challenge confronting a move toward distributed energy is the transition away from centralized energy systems of supply and production. These challenges are not expected to be resolved overnight, but progress made in the last few years has already far surpassed the expectations of just a decade ago.

A significant amount of promising research and development has already been completed. The automobile industry is aggressively exploring the fuel cell as the future of the industry. Moreover, a new first generation class of distributed energy technologies are already hitting the market.

Fusion

Fusion—the energy source of the sun—has the long-range potential to serve as an abundant and clean source of energy. The basic fuels, deuterium (a heavy form of hydrogen) and lithium, are abundantly available to all nations for thousands of years. There are no emissions from fusion, and the radioactive wastes from fusion are short lived, only requiring burial and oversight for about 100 years. In addition, there is no risk of a melt-down accident because only a small amount of fuel is present in the system at any time. Finally, there is little risk of nuclear proliferation because special nuclear materials, such as uranium and plutonium, are not required for fusion energy. Fusion systems could power an energy supply chain based on hydrogen and fuel cells, as well as provide electricity directly.

Although still in its early stages of development, fusion research has made some advances. In the early 1970s, fusion research achieved the milestone of producing 1/10 of one watt of fusion power, for 1/100 of a second. Today the energy produced from fusion is 10 billion times greater, and has been demonstrated in the laboratory at powers over 10 million watts in the range of a second.

Internationally, an effort is underway in Europe, Japan, and Russia to develop plans for constructing a large-scale fusion science and engineering test facility. This test facility may someday be capable of steady operation with fusion power in the range of hundreds of megawatts.

Both hydrogen and fusion must make significant progress before they can be come viable sources of energy. However, the technological advances experienced over the last decade and the advances yet to come will hopefully transform the en ergy sources of the distant future.

Recommendation:

★ The NEPD Group recommends that the President direct the Secretary of Energy to develop next-generation technology—including hydrogen and fusion.

- Develop an education campaign that communicates the benefits of alternative forms of energy, including hydrogen and fusion.
- Focus research and development efforts on integrating current pro grams regarding hydrogen, fuel cells, and distributed energy.

Current Markets for Renewable and Alternative Energy

Advances in Technology

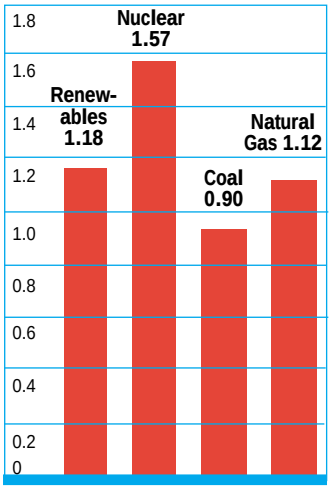
Non-hydropower renewable energy accounts for about 4 percent of current U.S. energy production, divided evenly be tween electricity generation and transpor tation fuels such as ethanol. Between 1990 and 1999, renewable energy generation grew by 29 percent, and renewable energy is projected to continue to grow (Figure 6-1). Renewable fuel consumption, includ ing ethanol for gasoline blending, is pro jected to grow at an average rate of 1.1 per cent a year through 2020. In 2020, 55 per cent of renewables are projected to be used for electricity generation and the rest for dispersed heating, industrial uses, and fuel blending.

The success of renewables is, in part, the result of over twenty years of research, development, and demonstration conducted by the public and private sectors. This work has dramatically improved these technolo gies and has reduced their costs by as much as 90 percent. For example:

- The Department of Energy (DOE), the National Renewable Energy Laboratory (NREL), and Alstom Energy Systems jointly created Advanced Direct-Contact Condens ers, which improve the efficiency and gener ating capacity of electric power plants by providing the best surface area for condens ing spent steam. This technological ad vance, tested in geothermal applications in California, can improve the efficiency of electricity production by 5 percent and capacity by 17 percent.
- United Solar Systems in Michigan pioneered the first commercial use of solar photovoltics as a building material. The triple-junction, thin-film technology is now sold as flexible solar panels, solar shingles for building roofs, and a peel-and-stick-on variety for standing seam metal roofs. United Solar is now building a larger manu facturing plant in Michigan that is five times the size of its existing manufacturing facil ity. DOE collaborates with United Solar on research and development helping over come hurdles in manufacturing. As a result, United Solar is able to provide unique solar electric products using a unique roll-to-roll manufacturing process.
- In partnership with DOE, NREL, Battelle Lab, Burlington Electric and others, Future Energy Resources Corporation of Norcross, Georgia, was able to build, test, and operate the world's first biomass gasifi cation system. The McNeil Plant, located in Burlington, Vermont, gasifies rather than combusts wood chips to power a gas boiler. The technology has shown itself to be com mercially viable, and is being considered worldwide by industries as a way of upgrad ing existing inefficient and aging boilers.

Improved renewable and alternative energy technologies are becoming increas ingly attractive to a number of energy com panies seeking to build new business oppor tunities for the future (Figure 6-3). Follow ing are a few examples:

Figure 6-1
Increases in U.S. Energy Production: 1990–1999



During the last decade, renewable energy sources contributed substantially to the growth in U.S. energy production, outpacing all fuel sources except for nuclear energy.

Source: U.S. Department of Energy, Energy Information Administration.

Table 6-2

Electricity Generated by Renewable Energy Sources: 1999

	Solar	Wind	Geothermal	Biomass	Hydropower
Current net summer capacity (MW)	350	2,600	2,870	6,170	79,130
Annual generation (millions of kWh)	940	4,460	13,070	36,570	312,000
Expected growth in generation (%)	PV: 19.3 Thermal: 21	5.3	3.3	3.0	-0.1
Cost (cents/kWh)	20	4–6	5–8	6–20	2–6

Renewable energy has become a significant source of electric power in the United States.

Note: Capacity, generation, and growth data do not include off-grid electricity, thermal, or other nonelectricity energy production, municipal solid waste, or methane from landfills.

Sources: U.S. Department of Energy, Energy Information Administration and Office of Power Technologies.

• FPL Group announced in January 2001 the construction of two major wind farms: a 300 MW facility on the Washington–Oregon border, and a 25.5 MW facility in Wisconsin. The company now has more than 1,000 MW of wind generating capacity in operation or under construction in seven states.

• CalEnergy Company has made renewable and alternative energy generation a central focus of its power portfolio. The company operates 1,300 MW of geothermal, natural gas, hydropower, and other power facilities in the U.S. and abroad, with another 750 MW currently under construction.

• General Motors, Ford, DaimlerChrysler, Texaco, BP/Amoco, and Shell are collectively spending between $500 million and $1 billion dollars a year on fuel cells, hydrogen storage, and infrastructure development for passenger vehicles. Ongoing bus demonstrations in the United States and Europe are expected to commercialize fuel cell power hydrogen buses in the next five years.

Because alternative and renewable energy resources can be used in so many different ways throughout the economy to produce so many combinations of energy types, their total use is often difficult to measure precisely. As of 1996, California alone had over 10 MW of installed distributed energy, a large increase in generating capacity during a period of otherwise limited growth in generation (Figure 6-3). In 1999, several types of renewable energy were used to produce electricity (Table 6-2).

On the transportation side, there are approximately 450,000 alternative fuel vehicles in the United States. Additionally, there are more than 1.5 million flexible-fuel vehicles that can use gasoline or a high mixture of ethanol and gasoline. These include the Ford Taurus, the DaimlerChrysler Caravan, and the General Motors S10 pickup. Ethanol is the most widely used biofuel, and its production is currently 1.9 billion gallons a year, representing a nearly ten-fold growth from about 200 million gallons a year in 1980.

Recommendation:

★ The NEPD Group recommends that the President direct the Secretary of the Treasury to work with Congress to develop legislation to provide for a temporary income tax credit available for the purchase of new hybrid or fuel-cell vehicles.

Hybrid Electric Vehicles

Hybrid electric vehicles (HEVs) combine the internal combustion engine of a conventional engine with the battery and electric motor of an electric vehicle, resulting in twice the fuel economy of conventional vehicles. This combination offers the extended range and rapid refueling that consumers expect from a conventional vehicle, with a significant portion of the energy and environmental benefits of an electric vehicle. The practical benefits of HEVs include improved fuel economy and lower emissions compared to conventional vehicles. The car's flexibility will mean convenient use for individuals as well as businesses.

Removing Barriers to Renewable and Alternative Energy Growth

Perhaps the greatest barrier to growth of renewable energy is cost. Currently, the cost of renewable energy generation fre

quently exceeds the costs of conventional electricity generation. In recent years, though, the costs of renewable energy have declined substantially. For example, the cost of wind energy has declined by more than 80 percent over the past twenty years and is increasingly competitive with con ventional electricity generation sources. Wind, biomass, and geothermal are all in creasingly competitive with conventional electricity generation.

The ability of these technologies to meet specific market needs is another fac tor in how quickly their market share will grow. These technologies and energy sources provide multiple benefits to the en ergy producer and the consumer. For ex ample, many of these technologies are modular and can be constructed rapidly, adding an immediate source of new power in areas that otherwise might face a short fall. Distributed renewable energy re sources can enhance the reliability and quality of power.

Cogeneration uses of waste products and heat can increase profits by reducing purchased electricity costs, as well as costs for process steam and heating or cooling. Several sectors, including lumber and paper, steel, and chemical manufacturing, are ex ploring the increased use of cogeneration. With the technological development of biom ass gasification, the lumber and paper indus try could become a seller of electricity.

Recommendation:

★ The NEPD Group recommends that the President direct the Adminis trator of the Environmental Protec tion Agency to issue guidance to encourage the development of well designed combined heat and power (CHP) units that are both highly efficient and have low emissions. The goal of this guidance would be to shorten the time needed to obtain each permit, provide certainty to industry by ensuring consistent implementation across the country, and encourage the use of these cleaner, more efficient technologies.

Renewable technologies can help pro vide insurance against price volatility. In ad dition, many renewable technologies can help industry achieve compliance with the Clean Air Act and other environmental regu lations. In some cases, renewables can be more readily located in urban areas whose air quality does not meet regulatory require ments.

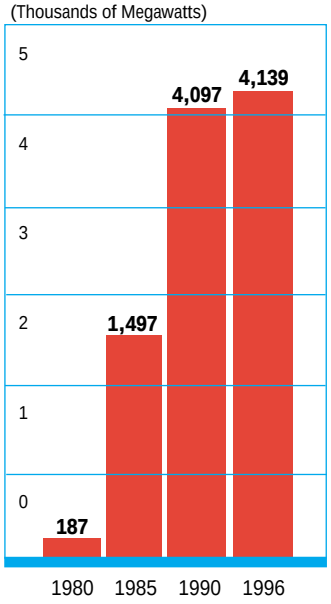
With the growth rate for non-hydro power renewable electricity generation more than doubling the expected growth in overall electricity capacity, these energy sources will play a more significant role in electricity markets in the next two decades. However, the extent to which these domes tic resources are successfully tapped will depend in large part on continued techno logical development.

For renewable and alternative energy to play a greater role in meeting our energy de mands, these sources of generation must be able to integrate into our existing distribution system. The tools that form the necessary in terface between distributed energy systems and the grid need to be less expensive, faster, more reliable, and more compact.

Promising technologies exist that will improve the transmission, storage, and reli ability of renewable energy. An example of recent technological success that will allow for increased access to all forms of energy, including renewable energy, is the high-tem perature superconducting underground power transmission cables that the Depart ment of Energy is developing in partnership with industry. These cables will allow a 300 percent increase in capacity without exca vation to lay new transmission lines. This summer, Detroit Edison is demonstrating this commercially viable high-temperature superconducting cable system in an applica tion that serves 14,000 customers.

Renewable and alternative energy technologies, such as wind energy and com bined heat and power could be significantly expanded, given today's technologies. They could be further expanded with added in vestment in technology. For example, wind energy could be developed that could be adapted to sites with lower wind speeds than is feasible today. Combined heat and

Figure 6-3
Growth in California's Renewable Energy Capacity



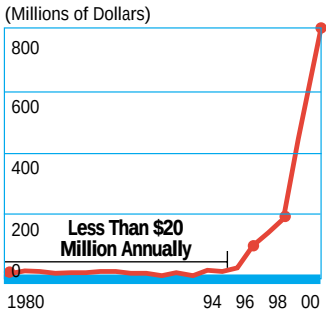
Source: U.S. Department of Energy, Energy Information Administration.



While solar energy technologies have undergone technological and cost improvements, and are well established in high value markets like remote power, satellites, communications, and navigational aids continued research is needed to reduce costs and improve performance.

U.S. Department of Energy

Figure 6-4
Investors Are Betting on Distributed Energy



In the last few years, surging venture capital investments showed strong support for distributed energy technologies.

Note: Data for 2000 are projected investments.
Source: Nth Power via the Economist, August 5, 2000.

power in buildings offers great potential for increased system efficiencies and lower costs. New developments in microturbine and fuel cell technologies are also highly promising. Performance improvements of other technologies, such as photovoltaic systems, would facilitate much wider use. In addition to technological performance, attention to several key market and regula tory constraints would accelerate the devel opment and use of renewable and alterna tive energy in the marketplace.

Because many renewable and alterna tive energy technologies do not fit into tra ditional regulatory categories, they are of ten subjected to competing regulatory re quirements or to requirements that were never designed to address them. For ex ample, much of the current Clean Air Act does not specifically address the use of new, more efficient renewable energy tech nologies. Consequently, the Act does not provide significant incentives for the devel opment of such technologies.

The lack of interconnection standards or guidelines for electricity supply and loads impedes the use of distributed energy tech nologies. As a result, developers of small re newable energy projects must negotiate in terconnection agreements on a site-by-site basis with local distribution companies that are often opposed to distributed energy projects because of the increased competi tion. Although a few states have established interconnection standards, there is no na tional standard to facilitate development of distributed energy (Figure 6-4).

New combined heat and power facili ties may face air permitting hurdles when they replace marginally dirty boilers. The Clean Air Act does not recognize the pollu tion prevention benefits of the increased ef ficiency of combined heat and power units. At the same time, these combined heat and power investments are taxed at the industry's tax rate, not at the rate they would receive if they were considered part of the utility sector for tax purposes.

In addition, modifications to permitting and siting requirements may be necessary to fa cilitate the incorporation of these technolo gies into buildings.

The infrastructure needed for increas ing the use of renewable and alternative en ergy varies considerably. In particular, the alternative fuels infrastructure lags far be hind the existing infrastructure for conven tional fuels. The lack of infrastructure for al ternative fuels is a major obstacle to con sumer acceptance of alternative fuels and the purchase of alternative fuel vehicles. It is also one of the main reasons why most al ternative fuel vehicles actually operate on petroleum fuels, such as gasoline and diesel. In addition, a considerable enlargement of ethanol production and distribution capac ity would be required to expand beyond their current base in the Midwest in order to increase use of ethanol-blended fuels.

The use of natural gas or electricity for vehicles requires enhancements to these distribution systems, such as compression stations for natural gas. While many alterna tive fuels can be shipped by pipeline, they may require separation within the pipeline to avoid mixing different energy products. Geographically dispersed renewable energy plants often face significant transmission barriers, including unfavorable grid sched ule policies and increased embedded costs.

Uncertainty regarding the tax treat ment of these technologies and energy sources can discourage long-term invest ment. Though existing tax credits provide an incentive for investing in some types of renewable energy, the limited scope of the credit and its frequent expiration discour ages investment.

Summary of Recommendations

Nature's Power: Increasing America's Use of Renewable and Alternative Energy

★ The NEPD Group recommends that the President direct the Secretaries of the Interior and Energy to re-evaluate access limitations to federal lands in order to increase renewable energy production, such as biomass, wind, geothermal, and solar.

★ The NEPD Group supports the increase of $39.2 million in the FY 2002 budget amendment for the Department of Energy's Energy Supply account that would provide increased support for research and development of renewable energy re sources.

★ The NEPD Group recommends that the President direct the Secretary of Energy to conduct a review of current funding and historic performance of renewable energy and alternative energy research and development programs in light of the recommen dations of this report. Based on this review, the Secretary of Energy is then directed to propose appropriate funding of those research and development programs that are performance-based and are modeled as public-private partnerships.

★ The NEPD Group recommends that the President direct the Secretary of the Treasury to work with Congress on legislation to expand the section 29 tax credit to make it available for new landfill methane projects. The credit could be tiered, depending on whether a landfill is already required by federal law to collect and flare its methane emissions due to local air pollution concerns.

★ The NEPD Group recommends that the President direct the Secretary of the Interior to determine ways to reduce the delays in geothermal lease processing as part of the permitting review process.

★ The NEPD Group recommends that the President direct the Administrator of the Environmental Protection Agency to develop a new renewable energy partnership program to help companies more easily buy renewable energy, as well as receive recognition for the environmental benefits of their purchase, and help consumers by promoting consumer choice programs that increase their knowledge about the environmental benefits of purchasing renewable energy.

★ The NEPD Group recommends that the President direct the Secretary of the Treasury to work with Congress on legislation to extend and expand tax credits for electricity produced using wind and biomass. The President's budget request extends the present 1.7 cents per kilowatt hour tax credit for electricity produced from wind and biomass; expands eligible biomass sources to include forest-related sources, agricultural sources, and certain urban sources; and allows a credit for electricity produced from biomass co-fired with coal.

★ The NEPD Group recommends that the President direct the Secretary of the Treasury to work with Congress on legislation to provide a new 15 percent tax credit for residential solar energy property, up to a maximum credit of $2,000.

★ The NEPD Group recommends that the President direct the Secretaries of the Interior and Energy to work with Congress on legislation to use an estimated $1.2 billion of bid bonuses from the environmentally responsible leasing of ANWR for funding research into alternative and renewable energy resources, including wind, solar, geothermal, and biomass.

★ The NEPD Group recommends that the President direct the Secretary of the Treasury to work with Congress to continue the ethanol excise tax exemption.

★ The NEPD Group recommends that the President direct the Secretary of Energy to develop next-generation technology—including hydrogen and fusion.
• Develop an education campaign that communicates the benefits of alternative forms of energy, including hydrogen and fusion.
• Focus research and development efforts on integrating current programs regarding hydrogen, fuel cells, and distributed energy.
• Support legislation reauthorizing the Hydrogen Energy Act.

★ The NEPD Group recommends that the President direct the Secretary of the Treasury to work with Congress to develop legislation to provide for a temporary income tax credit available for the purchase of new hybrid or fuel-cell vehicles be tween 2002 and 2007.

★ The NEPD Group recommends that the President direct the Administrator of the Environmental Protection Agency to issue guidance to encourage the development of well-designed combined heat and power (CHP) units that are both highly efficient and have low emissions. The goal of this guidance would be to shorten the time needed to obtain each permit, provide certainty to industry by ensuring consistent implementa tion across the country, and encourage the use of these cleaner, more efficient tech nologies.

America's Energy Infrastructure

A Comprehensive Delivery System

One of the greatest energy challenges facing America is the need to use 21st- century technology to improve America's aging energy infrastructure. Americans need a comprehensive, long-term solution to deliver energy to industry and consumers in a reliable and safe manner.

Our energy infrastructure is comprised of many components, such as the physical network of pipes for oil and natural gas, electricity transmission lines and other means for transporting energy to consumers. This infrastructure also includes facilities that turn raw natural resources into useful energy products. The rail network, truck lines, and marine transportation are also key components of America's energy infrastructure.

The energy industry has undergone major changes in the last two decades, and more are expected. These changes affect how our energy infrastructure operates. For example, while the electricity industry was once vertically integrated, it is increasingly separated into three isolated segments: generation, transmission, and distribution.

Our energy infrastructure has failed to keep pace with the changing requirements of our energy system. Domestic refining capacity has not matched increases in demand, requiring the United States to import refined products. Natural gas pipelines have not expanded sufficiently to meet demand. The electricity transmission system is constrained by insufficient capacity. Rail capacity was significantly increased during the 1970s when rail facilities were improved to move more coal. Since then, however, few additions to the coal transportation rail network have been built.

The United States needs to modernize its energy infrastructure. One sign of a lack of an energy policy in recent years has been the failure to maintain the infrastructure needed to move energy where it is needed most.

Electricity

The electricity infrastructure includes a nationwide power grid of long-distance transmission lines that move electricity from region to region, as well as the local distribution lines that carry electricity to homes and businesses. Electricity originates at power plants, which are primarily fueled by coal, nuclear, natural gas, water and, to a lesser extent, oil. Coal, natural gas and oil powered plants require a dependable transportation infrastructure to deliver the fuels necessary for the production of electricity. A transportation network for waste disposal is also necessary for power plants that create by products.

Restructuring

The electricity industry has undergone considerable changes in the last two decades. These changes affect how our electricity infrastructure operates. Major industry restructuring has separated once vertically integrated electric utilities that supplied generation, transmission, and distribution services into distinct entities. To facilitate competition at the wholesale level, in 1996, the Federal Energy Regulatory Commission (FERC) required transmission-owning utilities to "unbundle" their transmission and power marketing functions, and provide nondiscriminatory, open access to their transmission systems by other utilities

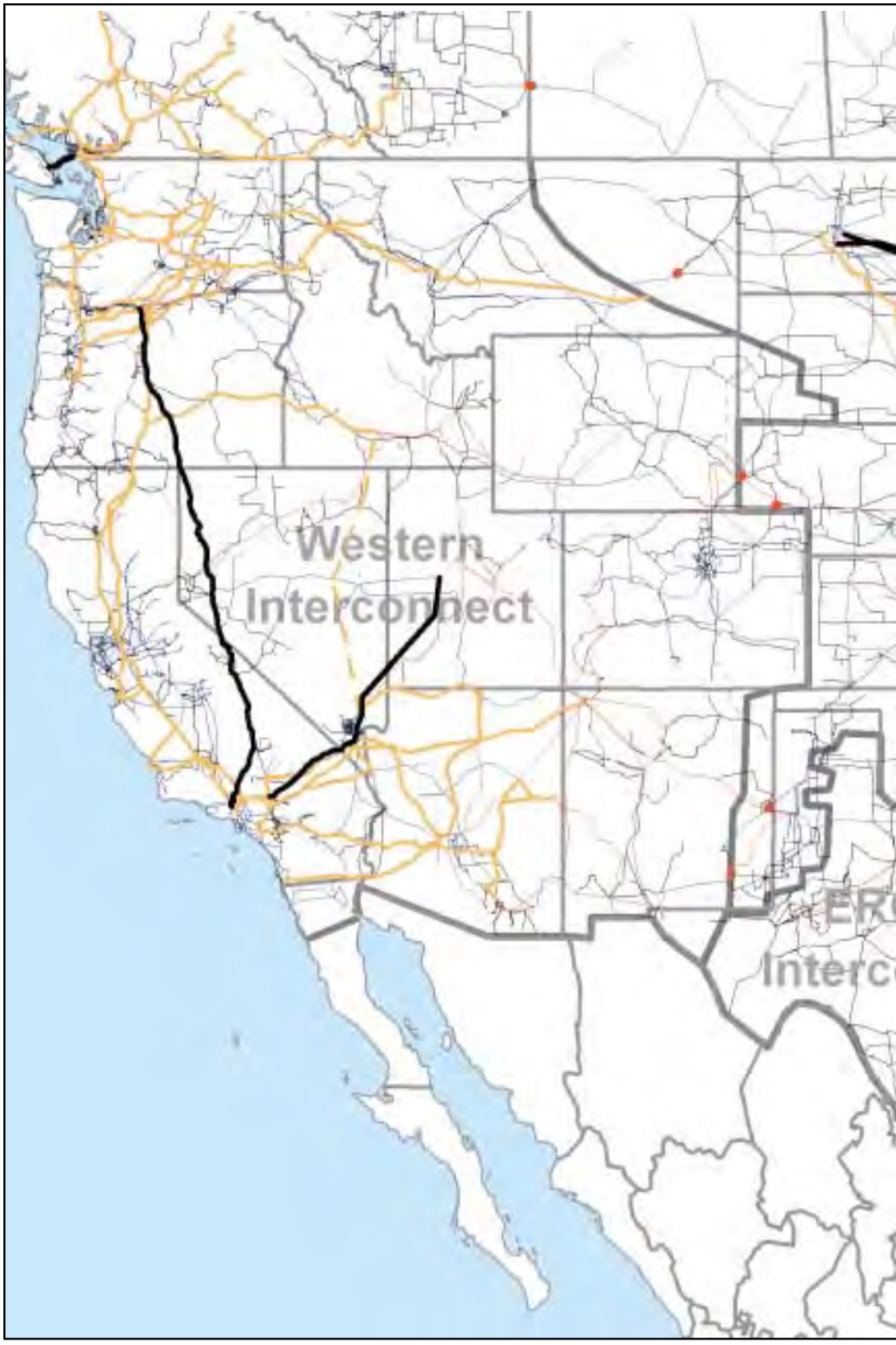
U.S. DEPARTMENT OF ENERGY



FIGURE 7-1
North American Transmission Lines

About 204,000 miles of long-distance transmission lines move power from region to region. The four integrated transmission grids serving North America are the Western Interconnection, Eastern Interconnection, Electric Reliability Council of Texas, and Province of Quebec.

Source: PA Consulting Group




Eastern
Interconnect
COT
onnect
Legend
Below 230kv
230kv - 344kv
345kv - 499kv
500kv - 734kv
735kv - 999kv
AC-DC-AC Tie
DC Line
Dashed lines indicate proposed transmission lines.
Prepared using RDI PowerMap data. Information on this map is believed to be accurate but is not guaranteed.

and independent power producers. At the retail level, some states have required utilities to divest their generation assets as part of restructuring. These utilities currently supply only transmission and distribution services for customers who purchase electricity (i.e., generation services) from other firms. In addition, power marketers—who often do not own generation, transmission, or distribution facilities—buy and sell power on wholesale markets and market electricity directly to customers.

Electricity competition has led to significant changes in the operation of the bulk power grid, which are the power plants and high-voltage transmission facilities that make up the wholesale power market. More electricity is being shipped longer distances over a transmission system that was initially designed only to provide limited power and reserve sharing among neighboring utilities. Electric utilities that were once solely responsible for ensuring that adequate generation was available to meet demand now purchase a substantial amount of the power they need from the wholesale market, relying on independent power producers to build and operate plants.

Electricity Generation

There are roughly 5,000 power plants in the United States, and they have a total generating capacity of nearly 800,000 megawatts. Over the past few years, there has been an explosion of "merchant" power plants proposed by independent power producers seeking to sell into wholesale markets. In spite of this interest, a number of regions of the country are experiencing capacity shortages as a result of wholesale market design problems and barriers to siting and building new power plants.

Over the next ten years, demand for electric power is expected to increase by about 25 percent, and more than 200,000 megawatts of new capacity will be required. However, under current plans electric transmission capacity will increase by only 4 percent. This shortage could lead to serious transmission congestion and reliability problems.

Transmission Grid

The United States does not have a national transmission grid. Instead, there are four integrated transmission grids serving North America: the Western Interconnection, Eastern Interconnection, Electric Reliability of Council of Texas, and the Province of Quebec (Figure 7-1). These regional grids themselves are international, encompassing the United States, Canada, and part of Mexico.

Transactions between the four integrated transmission grids are very limited because they are interconnected at only a few locations through interties, so for all practical purposes they can be viewed as separate transmission grids. The four integrated transmission grids break down into a series of smaller regions, largely defined by transmission constraints. Altogether, 204,000 miles of transmission lines in North America move power from the point of generation to where electricity is needed. There are 157,810 miles of transmission lines in the United States. Transmission grid expansions are expected to be slow over the next ten years, with additions totaling only 7,000 miles.

The transmission system is the highway system for interstate commerce in electricity. Transmission allows the sale of electricity between regions. In a particular region, transmission can be a substitute for generation, allowing that region to import power that otherwise would have to be generated within that region. In some cases, transmission expansion may be more cost effective than generation additions, allowing a region better access to lower-cost generation.

Transmission constraints limit these power flows, and result in consumers paying higher prices for electricity. The electricity price spikes in the Midwest in the summer of 1998 were caused in part by transmission constraints limiting the ability of the region to import electricity from other regions of the country that had available electricity. During the summer of 2000, transmission constraints limited the ability to sell low-cost power from the Midwest to the South during a period of peak demand,

resulting in higher prices for consumers. Transmission capacity limits could result in price pressures and reliability problems this summer in California, Long Island, the Great Lakes, the Southeast, and New En gland (Figure 7-2).

Regional shortages of generating ca pacity and transmission constraints com bine to reduce the overall reliability of elec tric supply in the country and are reducing the quality of power delivered to end users. Power quality is becoming an increasingly important issue as our digital economy con tinues to grow.

One factor limiting reliability is the lack of enforceable reliability standards. Since 1968, the reliability of the U.S. trans mission grid has depended entirely on vol untary compliance with reliability stan dards. There is a broad recognition that vol untary adherence with reliability standards is no longer a viable approach in an increas ingly competitive electricity market. There is a need to provide for enforcement of mandatory reliability standards. Broad sup port has emerged for development of these standards by a self-regulating organization overseen by FERC.

Recommendations:

★ The NEPD Group recommends that the President direct the Secretary of Energy to work with FERC to improve the reliability of the interstate trans mission system and to develop legisla tion providing for enforcement by a self-regulatory organization subject to FERC oversight.

★ The NEPD Group recommends that the President direct the Secretary of Energy to expand the Department's research and development on trans mission reliability and superconduc tivity.

Transmission constraints were also a primary factor in blackouts in northern California, which imports power from both the Northwest and southern California. When resources are not available in the Northwest, electricity supply must come from southern California's Path 15 transmis sion route. Path 15 does not have sufficient capacity to provide all of the power needed in northern California.

Figure 7-2

Current Electric Power Bottlenecks



Transmission capacity limits could result in price pressures and reliability problems this summer in California, Long Island, the Great Lakes, the Southeast, and New England. The arrows in this figure de-pict the locations and directions of current transmission congestion.

Source: North American Electric Reliability Council.

Recommendation:

★ The NEPD Group recommends that the President direct the Secretary of Energy to authorize the Western Area Power Administration to explore relieving the "Path 15" bottleneck through transmission expansion financed by nonfederal contributions.

Transmission constraints have been a persistent cause of price spikes in New York City in recent years. The New York Indepen dent System Operator (the grid operator in that state) estimates that the city will be short about 400 MW below their desired re serve margin of power during the summer peak. To fill this gap, the New York Power Authority is trying to install additional gen eration capacity in the city. Market-oriented approaches could also be used to create ad ditional capacity and alleviate some of the potential problems.

If transmission constraints are not re moved, the result can be higher prices and

lower reliability. There are various reasons why transmission constraints exist. One is the lack of sufficient investment in trans mission. Transmission investment has lagged dramatically over the past decade (Figure 7-3). There is a need to ensure that transmission rates create incentives for ad equate investment in the transmission sys tem, especially as restructuring leads to the creation of transmission companies whose only business is operation of transmission facilities. FERC recognizes this need and has expressed a willingness to consider in novative transmission pricing proposals.

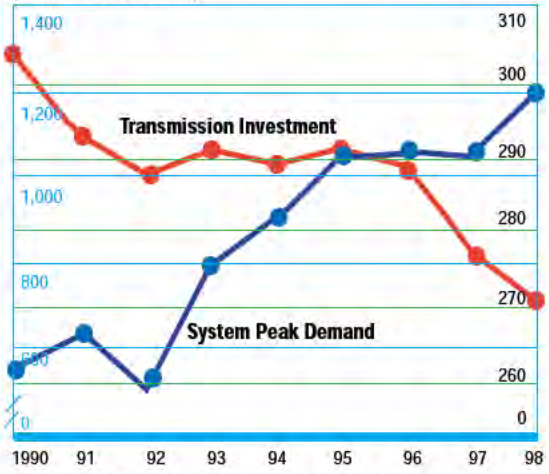
Another cause of transmission con straints is the siting process. Under current law, siting of transmission facilities is a re sponsibility of state governments, not the federal government, even though the trans mission system is not only interstate but also international, extending into both Canada and Mexico. This stands in stark contrast to siting of other interstate facili ties, such as natural gas pipelines, oil pipe lines, railroads, and interstate highways.

Federal law governing the responsibil ity for siting transmission facilities was written in 1935, nearly 80 years ago. At the time, transmission facilities were not inter-

Figure 7-3

U.S. Investment in New Electric Power Transmission

(Millions of 1990 Dollars)



Growth in peak demand for electricity has far outstripped investment in transmission capacity. As a result, transmission constraints could aggravate already limited supplies of power and could result in high prices in some areas of the country.

Source: PA Consulting Group, based on data from the UDI data base.

state, and there was virtually no interstate commerce in electricity. Congress did not anticipate the development of an interstate and international transmission system.

State decisions on where to locate transmission lines often do not recognize the importance of proposed transmission fa cilities to the interstate grid. For example, a recent decision by regulators in Connecticut to block a proposed transmission line to Long Island did not recognize the need for electricity on Long Island. Some state siting laws require that the benefits of a proposed transmission facility accrue to the indi vidual state, resulting in the rejection of transmission proposals that benefit an en tire region, rather than a single state.

Much has changed since 1935. The transmission system is the highway for in terstate commerce in electricity. Transmis sion constraints are resulting in higher prices for consumers and lower reliability. The siting process must be changed to re flect the interstate nature of the transmis sion system.

Recommendations:

★ The NEPD Group recommends that the President direct the appropriate federal agencies to take actions to re move constraints on the interstate transmission grid and allow our nation's electricity supply to meet the growing needs of our economy.

- Direct the Secretary of Energy, by December 31, 2001, to examine the benefits of establishing a national grid, identify transmission bottle necks, and identify measures to re move transmission bottlenecks.
- Direct the Secretary of Energy to work with FERC to relieve trans mission constraints by encouraging the use of incentive rate-making proposals.
- Direct the federal utilities to deter mine whether transmission expan sions are necessary to remove con straints. The Administration should review the Bonneville Power Administration's (BPA's) capital and



financing requirements in the context of its membership in a regional RTO, and if additional Treasury financing appears warranted or necessary in the future, the Administration should seek an increase in BPA's borrowing authority at that time.

- Direct the Secretary of Energy, in consultation with appropriate federal agencies and state and local government officials, to develop legislation to grant authority to obtain rights-of-way for electricity transmission lines, with the goal of creating a reliable national transmission grid. Similar authority already exists for natural gas pipelines in recognition of their role in interstate commerce.

Another cause of transmission constraints is limited access to federal lands. The federal government is the largest land owner in the United States and owns most of the land in some western states. Limited access to federal lands can block needed transmission expansion. A case in point is a transmission line being built from West Virginia to Virginia. Five years ago, the Department of Energy identified that line as critical to the reliability of the transmission system on the East Coast. Five years later, the line is still not complete. Improved access to federal land can help remove transmission constraints.

Rights-of-Way on Federal Lands

The Bureau of Land Management (BLM) estimates that 90 percent of the oil and natural gas pipeline and electric transmission rights-of-way in the western United States cross federal lands. These lands are principally lands managed by either the BLM or the U.S. Forest Service. Rights-of-way are authorized through an approval process that allows the public to comment on proposals to locate infrastructure items, like utility poles, on these rights-of way. As part of this process, proposals are examined for resource and other use conflicts, and a national interest test is applied prior to approval.

The BLM administers 85,000 rights-of-way, including 23,000 for oil and gas pipelines and 12,000 for electric transmission lines. It processes over 1,200 pipeline and electric system right-of-way applications a year, with an increase in applications of

The electric power infrastructure includes a nationwide "power grid" of long-distance transmission lines that move electricity from the point of generation to where the electricity is needed. Over the next ten years, U.S. demand for electric power is expected to increase by 25 percent, while transmission capacity is expected to increase by only 4 percent.



Virtually all natural gas in the United States is moved via pipeline. The current domestic natural gas transmission capacity of approximately 23 trillion cubic feet (tcf) will be insufficient to meet the projected 50 percent increase in U.S. consumption projected for 2020.

over 10 percent a year in recent years. The demand for additional energy and electric ity is expected to increase the need for rights-of-way across federal lands.

Other federal entities also deal with rights-of-way, each approaching the issue from a unique perspective. The National Park Service is authorized to grant leases and permits, but discourages rights-of-way corridors unless there are no practical alter natives. The U.S. Fish and Wildlife Service manages National Wildlife Refuge lands for wildlife and habitat values, and allows corri dors where they were pre-existing or are de termined to be compatible with the pur poses for which a refuge was established. The Bureau of Reclamation is authorized to grant rights-of-way over lands acquired or withdrawn for reclamation purposes, if compatible with authorized project pur poses. The Bureau of Indian Affairs and tribal governments are authorized to grant rights-of-way across both tribal and indi vidually owned Indian lands.

Pipelines

After being pumped from the ground in domestic oil fields, oil travels through gathering lines to pipelines, which bring it to refineries, where it is transformed into petroleum products like gasoline, diesel fuel, or heating oil. These products then travel through pipelines and tanker trucks to distribution outlets for purchase by con sumers. Natural gas must similarly travel from gas fields through gathering lines to processing facilities, and then into pipelines and local distribution lines to its final desti nation. These pipeline systems involve a complex infrastructure of their own, includ ing pump stations or compressor stations, and control systems that open and close valves and switch product flow through pipes, often with the use of computer tech nology.

Oil Pipelines

The two million miles of oil pipelines in the United States are the principal mode for transporting oil and petroleum products such as gasoline. They account for about 66 percent of domestic product movements (Figure 7-4). Increases in the demand for oil and changes in where it is supplied will lead to the need for more pipeline capacity.

Pipelines are less flexible than other forms of oil transport, because they are fixed assets that cannot be easily adjusted to changes in supply and demand. Once built, they are an efficient way to move pe troleum and petroleum products. A modest sized pipeline carries the equivalent of 750 tanker truckloads a day—the equivalent of a truckload leaving every two minutes, 24 hours a day, 7 days a week. Replacing the same pipeline with a railroad train of tank cars, carrying 2,000 barrels each, would re quire a 75-car train to arrive and be un loaded every day. Pipelines are relatively in expensive to operate and are generally quiet and safe. Ensuring pipeline safety requires careful management, as multiple products move through a single pipeline system at the same time.

Insufficient domestic pipeline capacity has caused peak-load problems in moving oil and petroleum products such as gasoline from one region of the country to another. For example, many energy analysts fore casted the possibility of a shortage last win ter in the upper Midwest of liquefied petro leum gas used for heating and for drying crops. Others were concerned about pos sible shortages of heating oil in New En gland.

Energy supply shortages can create operational difficulties for the pipelines themselves. The complex interrelationship

of our energy infrastructure is evident, since pipelines have been shut down for varying time periods due to regional elec tricity shortages.

For example, fuel supplies to Las Ve gas and Phoenix became dangerously low when blackouts in California shut down the main pipeline serving those areas. The Cali fornia Public Utilities Commission (CPUC) has granted a waiver of penalties to oil pipelines that have interruptible contracts for electricity to help ensure the uninter rupted flow of motor fuel supplies to Cali fornia. The California Energy Commission asked the CPUC to grant the waiver in or der to minimize the threat to public health due to disruptions of fossil fuel supplies. While the waiver of penalties does not guar antee that disruptions of power to petro leum product pipelines will not occur, it di minishes the threat by allowing disruptions to occur only when they are coordinated with the entire petroleum product delivery system, from refiner to pipeline to termi nals. Both Phoenix and Las Vegas would benefit from this decision because refiner ies and pipelines from California supply the two cities.

Much of the existing oil pipeline infra structure is old, requiring regular safety and environmental reviews to ensure its reliabil ity. The potential risk of pipeline accidents to human health and safety is of grave con cern. In June 1999, a petroleum product pipeline ruptured and caught fire in Bellingham, Washington. In addition to tragic loss of life, the pipeline's 18-month shutdown caused an economic hardship to the Seattle–Tacoma Airport and other local businesses that relied on the pipeline for aviation and diesel fuels. To avoid similar crises, the Department of Transportation, which has responsibility for pipeline safety, has adopted regulations and other risk man agement approaches to ensure safety in pipeline design, construction, testing, operation, maintenance, and emergency response.

Recommendation:

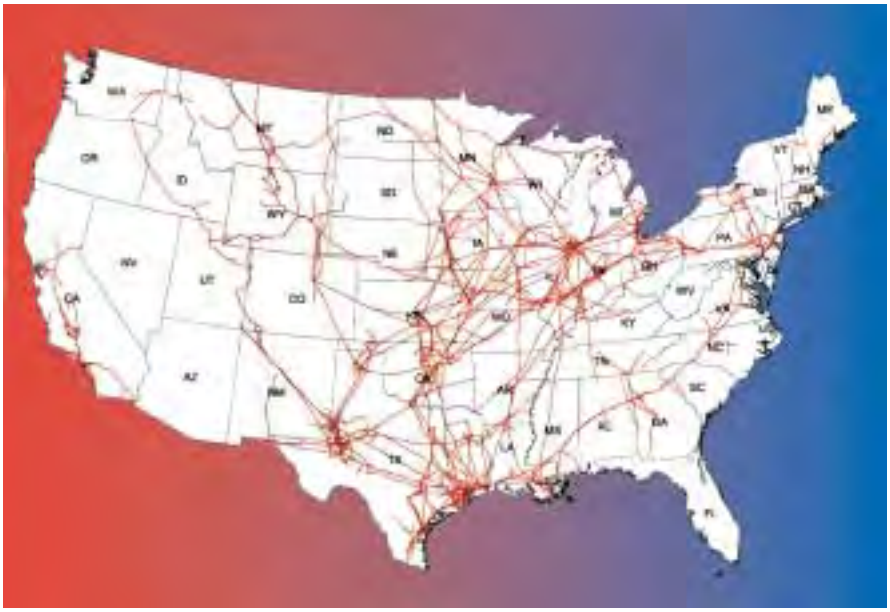
★ The NEPD Group recommends that the President direct the Secretary of the Interior to work with Congress and the State of Alaska to put in place the most expeditious process for renewal of the Trans-Alaskan Pipeline System rights-of-way to ensure that Alaskan oil continues to flow uninterrupted to the West Coast of the United States.

The Trans-Alaska Pipeline System is the single most important crude oil pipeline in the United States, and is perhaps the most regulated oil pipeline in the world. The pipeline system has carried nearly one-fifth of all domestically produced oil for the last two decades. Since beginning operations in 1977, it has transported more than 13 billion barrels of oil from Alaska's North Slope across 800 miles to the Port of Valdez. Since the pipeline began operation, only 0.00014 percent of the total amount of oil trans ported through it has been spilled.

The pipeline's federal grant and state lease for right-of-way expires in 2004 and will require renewal. That process will in-

Figure 7-4

U.S. Oil Pipelines



The two million miles of oil pipelines in the United States are the principal mode for transporting crude oil and refined products. They account for about 66 percent of domestic product movements.

Source: U.S. Department of Transportation, Office of Pipeline Safety.



Several federal agencies are authorized to grant rights-of-way for oil and gas pipeline and electric transmission systems on federal lands, and each approaches the issue from a unique perspective. Authorizing agencies include the Bureau of Land Management, the U.S. Forest Service the National Park Service, the U.S. Fish and Wildlife Service, the Bureau of Reclamation, and the Bureau of Indian Affairs.

volve a thorough review of compliance with federal laws and regulations, including those related to safety and environmental impacts. Because nearly 50 percent of the right-of-way is owned by the State of Alaska, they must also renew the applicable state permits. To commence the formal portion of the federal renewal process, regulations require a renewal application to be filed with the Alaska Office of the BLM of the Department of the Interior. To the extent possible, a single, joint federal/state approach should be considered.

Natural Gas Pipelines

Virtually all natural gas in the United States is moved via pipeline (Figure 7-5). The current domestic natural gas transmission capacity of approximately 23 trillion cubic feet (tcf) will be insufficient to meet the projected 50 percent increase in U.S. consumption projected for 2020.

Some parts of the country, such as California and New England, already face capacity shortages. Several pipeline operators have applied for permits to increase their delivery of natural gas to California, but right-of-way issues and local permitting delays have constrained the ability to transport natural gas to California, contributing to high prices. In addition, the natural gas pipeline connections from Canada are near capacity, so any greater U.S. reliance on Canadian natural gas will require increased pipeline capacity.

One of the largest known reserves of natural gas in the United States has been found in the Arctic, associated with the development of oil at Alaska's Prudhoe Bay. These known gas reserves, over 35 tcf, would make a significant long-term contribution to the nation's energy supplies if delivered to the lower 48 states. It is estimated there may be an additional 100 tcf on the North Slope of Alaska. Recently, as the energy supply situation has changed, interest has renewed in tapping into Alaska's natural gas supplies. Over the past year, the Alaska North Slope gas producers have been reviewing whether projected market conditions will make transportation of this natural gas economically feasible. The North Slope gas producers are scheduled to complete that review by the end of 2001.

Recommendation:

★ The NEPD Group recommends that the President direct the Secretaries of Energy and State, coordinating with the Secretary of the Interior and the Federal Energy Regulatory Commission, to work closely with Canada, the State of Alaska, and all other interested parties to expedite the construction of a pipeline to deliver natural gas to the lower 48 states. This should include proposing to Congress any changes or waivers of law pursuant to the Alaska Natural Gas Transportation Act of 1976 that may be required.

America needs the energy that Alaska's North Slope natural gas can provide. The Administration seeks to expedite the construction of a pipeline to deliver this natural gas to the lower 48 states.

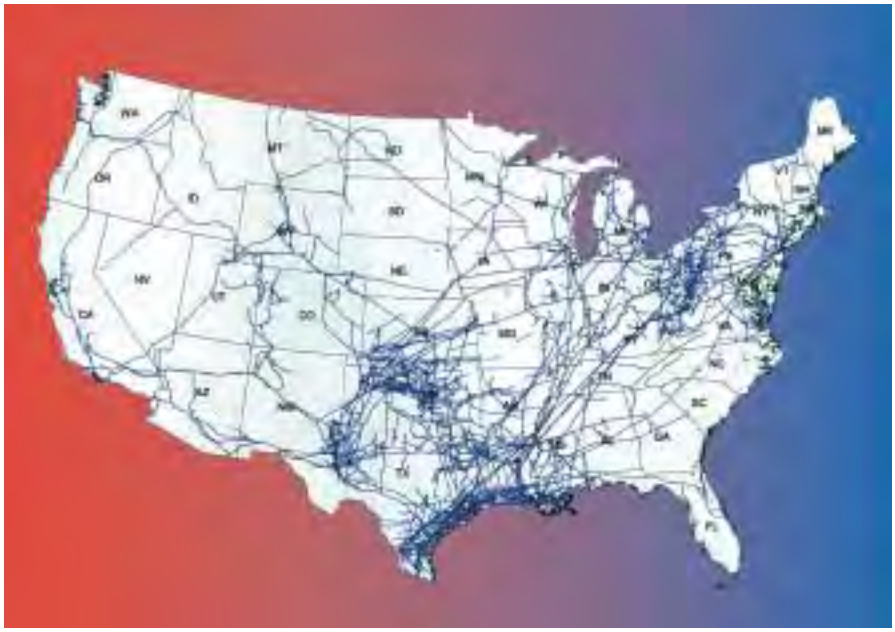
In addition to shortfalls in capacity, sources of natural gas have shifted from the Southwest to the deep water of the Gulf of Mexico, the Rocky Mountains, western Canada, and the Canadian Atlantic. At the same time, demand has shifted from the in dustrial Midwest to the growing population centers in the South and the West. An addi tional 263,000 miles of distribution pipe lines and 38,000 miles of new transmission pipelines will be necessary to meet in creased consumption and the new geo graphic realities of supply and demand.

Several factors complicate efforts to meet the need for increased pipeline capac ity, including encroachment on existing rights-of-way and heightened community resistance to pipeline construction. Cur rently it takes an average of four years to obtain approvals to construct a new natural gas pipeline. In some cases it can take much longer.

The projected growth in energy de mand has called into question whether regulatory actions and permitting processes can keep pace with the necessary construc tion of new facilities for storage and deliv ery. Consistent federal, state, and local gov ernment policies, and faster, more predict able regulatory decisions on permitting for oil and natural gas pipelines are needed to enable timely and cost-effective infrastruc ture development. The permitting process has a positive role in protecting the environ ment, public health, and safety by allowing all interested parties an opportunity to par ticipate effectively and fully in the delibera tions prior to the permit issuance.

Recent pipeline ruptures involving a natural gas pipeline near Carlsbad, New Mexico, and an underground natural gas storage facility near Hutchinson, Kansas, highlight the need to develop technologies and policies that protect people, environ ment, and the safety of the nation's energy infrastructure. The federal government has an important role in ensuring and improv ing the safety of these gas pipelines. New technologies need to be developed to im prove monitoring and assessment of system integrity, improve data quality for system planning, extend the serviceability and life of the national natural gas transmission and dis tribution network, provide safer transport of energy products, and lessen the impacts of the energy infrastructure on the environ ment.

Figure 7-5
U.S. Natural Gas Transmission Pipelines



Virtually all natural gas in the United States is moved via pipeline. The forecast of a doubling in the number of new natural gas wells drilled annually and an 80 percent increase in the number of active drilling rigs will require new pipelines.

Source: U.S. Department of Transportation, Office of Pipeline Safety.

Recommendations:

★ The NEPD Group recommends that the President support legislation to im prove the safety of natural gas pipelines, protect the environment, strengthen emergency preparedness and inspec tions and bolster enforcement.

★ The NEPD Group recommends that the President direct agencies to con tinue their interagency efforts to im prove pipeline safety and expedite pipe line permitting in an environmentally sound manner and encourage the Fed eral Energy Regulatory Commission to consider improvements in the regulatory process governing approval of interstate natural gas pipeline projects.



U.S. demand for refined petroleum products currently exceeds its domestic capacity to produce them. The refinery industry is now running at nearly 100 percent of capacity during the peak gasoline consumption season.

Oil Refineries

U.S. demand for refined petroleum products, such as gasoline and heating oil, currently exceeds our domestic capacity to produce them. The refinery industry is now running at nearly 100 percent of capacity during the peak gasoline consumption sea son and is producing record levels of needed products at other times. The excess demand has recently been met by increased imports.

The U.S. refining industry has experi enced a decade of low profitability and rates of return on investment. This has dis couraged investment in new refineries. In fact, almost 50 U.S. refineries closed over the last ten years, and no major refineries have been built in the last twenty-five years.

During the last ten years, overall refin ing capacity grew by about 1 to 2 percent a year as a result of expansion in the capacity of existing, larger refineries. Although there was a significant, sustained improvement in margins during 2000, those gains arose out of a very tight supply situation and high, vola tile prices. Industry consolidation has been a key response to this poor profitability.

The U.S. refining industry is also fac ing major infrastructure problems. While the industry expanded steadily through the 1970s, it went through a period of consoli dation after the oil shocks of 1973 and 1978. Ongoing industry consolidation, in an effort to improve profitability, inevitably leads to the sale or closure of redundant facilities by the new combined ownership. This has been particularly true of terminal facilities, which can lead to reductions in inventory and system flexibility. While excess capac ity may have deterred some new capacity investments in the past, more recently, other factors, such as regulations, have de terred investments.

Refiners are subject to significant en vironmental regulation and face several new clean air requirements over the next de cade. Refiners will face many clean fuel pro duction standards, which require the pro duction of many different kinds of gasoline and diesel fuel for different parts of the country. New Environmental Protection Agency rules will require refiners to pro duce gasoline and diesel fuel with signifi cantly lower sulfur content. New clean air requirements will benefit the environment, but will also require substantial capital in vestments and additional government per mits. The proliferation of distinct regional and state gasoline and diesel product stan dards, the significant permitting needed, and the downtime to make the needed physical and operational changes will chal lenge refiners and governments to effec tively coordinate in order to reduce the like lihood of supply shortfalls and price spikes.

Recommendation:

★ The NEPD Group recommends that the President direct the Administrator of the EPA to study opportunities to maintain or improve the environmen tal benefits of state and local "bou tique" clean fuel programs while ex ploring ways to increase the flexibility of the fuels distribution infrastructure, improve fungibility, and provide added gasoline market liquidity. In conclud ing this study, the Administrator shall consult with the Departments of En ergy and Agriculture, and other agen cies as needed.

Since 1990, refiners have met growing demand by increasing the use of existing equipment and increasing the efficiency and capacity of existing plants. Even with these efforts, however, refining capacity has be gun to lag behind peak summer demand. Price volatility and the cyclical nature of oil markets inhibit investment in supply infra structure. While investors can withstand market fluctuations for some commodities, large investments in oil exploration and de velopment—such as for drilling required to maintain a steady supply and the pipelines needed to bring supply to market—are of ten curtailed during times of low oil prices. The outcome of this lack of steady invest ment is less supply, higher prices, and the abandonment of marginal oil resources that may never be recovered.

Recommendations:-

★ The NEPD Group recommends that- the President direct the Administrator- of the Environmental Protection- Agency and the Secretary of Energy to- take steps to ensure America has ad - equate refining capacity to meet the- needs of consumers.-

- Provide more regulatory certainty to refinery owners and streamline the permitting process where pos sible to ensure that regulatory over lap is limited.
- Adopt comprehensive regulations (covering more than one pollutant and requirement) and consider the rules' cumulative impacts and benefits.

★ The NEPD Group recommends that the President to direct the Administra tor of the Environmental Protection Agency, in consultation with the Secre tary of Energy and other relevant agencies, to review New Source Re view regulations, including administra tive interpretation and implementa tion, and report to the President within 90 days on the impact of the regula tions on investment in new utility and refinery generation capacity, energy ef ficiency, and environmental protec tion.

- The NEPD Group recommends that the President direct the Attorney General to review existing enforce ment actions regarding New Source Review to ensure that the enforce ment actions are consistent with the Clean Air Act and its regula tions.

Energy Transportation Infrastructure

The infrastructure used to transport energy products includes ocean tankers; in land barges; specialized trucks for oil and refined products, such as gasoline and heat ing oil; railroad tank cars and coal cars; and the waterways, highways, and railroads upon which they travel. There is also a sub stantial inventory of river and oceanside port facilities that are used for moving en ergy materials.

Marine Transportation

Marine transportation of oil and re fined products accounts for nearly one-third of domestic shipments. Approximately 3.3 billion barrels of oil and petroleum products and 229 million short tons of coal move through the nation's ports and waterways every year.

There are three kinds of ship trans ports of domestic energy products. Tankers



Double-hulled tank barges provide distribution of petroleum products.

Nicole Leigh Reinauer and RTC 135

primarily carry Alaskan oil to the West Coast. Product tankers transport refined products from the Gulf of Mexico to the At lantic Coast, from the Gulf to the West Coast, and between ports within the West Coast. Tank barges provide coastwise distri bution of refined product imports, distribu tion from pipeline terminals, and inland dis tribution. In addition, 477 foreign tankers and 64 U.S. flag tankers deliver oil and pe troleum products to the United States. They deliver approximately 2.1 million barrels a day, for a total of 770 million barrels a year.

Ships are also used to import liquefied natural gas (LNG). With increasing demand for natural gas for electricity generation, there is a potential for substantial growth in the demand for LNG imports. From 1998 to 1999, the number of LNG carrier arrivals in Boston increased by 350 percent. In addi-- tion, mothballed terminals at Elba Island,- Georgia, and Cove Point, Maryland, may- reinitiate LNG imports by 2002.-

Winter storms, extended darkness, and ice formation disrupt barge and tanker movements. The U.S. Coast Guard's fleet of ice breakers has become an important component of the energy infrastructure for the New England, Mid-Atlantic, and Great Lakes regions.
U.S. Coast Guard



Unlike pipelines, water transportation requires the positioning of vessels to where cargoes are located. For example, it can take three weeks to move a tanker from the Gulf of Mexico to the West Coast. Conse quently, tanker markets do not respond quickly to temporary surges in demand, which typically result in price spikes.

Safety

In accordance with the Oil Pollution Act of 1990, a timeline has been established to replace all single-hulled vessels with double-hulled vessels. Many have already been replaced. Modern navigation and port services also help to prevent maritime oil spills. Spill-response technologies and coor dinated response plans are key to minimiz ing damage to property and the environ ment. Oil spill technology has improved dur ing the last decade and will continue to do so. Risk assessments, preparedness drills, and cleanup strategies are all necessary safeguards for transporting energy goods. As maritime transportation grows, port and waterway infrastructure, as well as the availability of accurate and timely naviga tion information, will continue to be impor tant for the safe, efficient delivery of energy.

New England's Dependence on Marine Transportation

New England has no refineries, and its small oil pipeline system is not connected to the interstate pipeline system. As a result, New England must rely on tanker and barge shipments of petroleum products from the south as well as direct imports from over seas. There is some question as to whether this distribution system is sufficient to meet the future needs of the region and, if not, what steps need to be taken to ensure fu ture economical, reliable energy supplies.

In recent years, lower national inven tories, market forces, and other factors have combined to create much lower inventories for petroleum products such as heating oil in the Northeast. A supply system with less capacity in reserve is more vulnerable to variations in product delivery, and is less ca pable of absorbing the disruptions in barge and tanker movements that inevitably come

with winter storms, extended darkness, and ice formation. A rapid change to colder weather affects both supply and demand: households need more fuel at the same time that harbors and rivers experience severe ice conditions.

For the New England and Mid-Atlantic seaboards, U.S. Coast Guard icebreakers have become an important component of the infrastructure necessary to provide energy to the region.

The Department of Energy established the Northeast Heating Oil Reserve to ensure heating oil supplies in the region. This emergency buffer can support a shortage for approximately ten days, which is the time required for ships to carry heating oil from the Gulf of Mexico to New York Harbor.

Even with the Reserve in place, marine transportation remains the only source of heating oil for the New England's winter months.

Recommendation:

★ The NEPD Group supports the President's budget proposal to provide $8 million to maintain the two-million-barrel Northeast Heating Oil Reserve. Operated by the private sector, the Reserve helps ensure adequate supplies of heating oil in the event that colder than normal winters occur in the Northeast United States.

Rail Transportation

Coal, which provides about 52 percent of America's electricity, is the most important single commodity carried by rail. Over the past ten years, the rail share of coal transportation has increased, primarily as a result of increases in low-sulfur western coal, which moves long distances over rail. In 1999, domestic railroads carried 68 percent of the nation's coal, and in 2000, they transported an average of 14.4 million tons of coal a week.

Transportation costs account for 30 to 50 percent of the final delivered price of coal to utilities. About 74 percent of U.S. low-sulfur coal reserves are located in Montana and Wyoming. Demand for clean coal from Wyoming's Powder River Basin is expected to increase because of its environmental benefits. However, rail capacity problems in the Powder River Basin have created a bottleneck in the coal transportation system.

With little excess capacity in the rail lines supporting the Powder River Basin, expected increases in demand could result in capacity shortfalls and delays in providing coal to power plants that are relying increasingly on "just-in-time" shipments to reduce inventory costs. Additionally, delays in other parts of the rail network, such as at key rail facilities, can undermine the efficiency and reliability of the system. There is a need to eliminate bottlenecks in the coal transportation system.

Infrastructure Security

The energy infrastructure is vulnerable to physical and cyber disruption that could threaten its integrity and safety. Disruptions could come from natural events, like geomagnetic storms and earthquakes, or could come from accidents, equipment failures, or deliberate sabotage. In addition, the nation's transportation and power infrastructures have grown increasingly complex and interdependent. Consequently, any disruption can have extensive consequences.

Transportation facilities have weathered relatively short interruptions in power as a result of natural disasters and accidents, with varying degrees of impact. In a few instances, they have experienced intermittent, lengthy outages that have affected not only primary systems, but integrated services as well, such as voice, data, Internet, and wireless networks that may be used to transmit control information. The growing reliance on computer technologies, automated monitoring and control systems, and electronic commerce makes the system more efficient and vibrant, but also requires a greater level of diligence and use of safeguards.

Accurate weather and climate forecasting can prevent millions of dollars in

damage to U.S. energy infrastructure. For example, the interaction of geomagnetic storms with the Earth's magnetic field can cause additional current to enter transmis sion lines, which at times has caused re gional grid collapse and has destroyed power plant electrical transformers. Given sufficient warning, the industry can initiate protective countermeasures, such as when several northeastern power plants shed 20 percent of their load during a July 2000 geo magnetic storm.

Improvements in forecasting can fur ther assist in the management of energy re sources and materials, can prevent power outages in many cases, and can accelerate restoration of power after outages that do occur. Also, data from extreme weather events can be used to design and build infra structure, such as transmission lines, pipe lines, and hydropower dams.

Summary of Recommendations

America's Energy Infrastructure: A Comprehensive Delivery System

★ The NEPD Group recommends that the President direct the Secretary of Energy to work with the Federal Energy Regulatory Commission (FERC) to improve the reliability of the interstate transmission system and to develop legislation provid ing for enforcement by a self-regulatory organization subject to FERC oversight.

★ The NEPD Group recommends that the President direct the Secretary of Energy to expand the Department's research and development on transmission re liability and superconductivity.

★ The NEPD Group recommends that the President direct the Secretary of Energy to authorize the Western Area Power Administration to explore relieving the "Path 15" bottleneck through transmission expansion financed by nonfederal contributions.

★ The NEPD Group recommends that the President direct the appropriate federal agencies to take actions to remove constraints on the interstate transmission grid and allow our nation's electricity supply to meet the growing needs of our economy.

- Direct the Secretary of Energy, by December 31, 2001, to examine the benefits of establishing a national grid, identify transmission bottlenecks, and identify mea sures to remove transmission bottlenecks.
- Direct the Secretary of Energy to work with FERC to relieve transmission con straints by encouraging the use of incentive rate-making proposals.
- Direct the federal utilities to determine whether transmission expansions are necessary to remove constraints. The Administration should review the Bonneville Power Administration's (BPA's) capital and financing requirements in the context of its membership in a regional RTO, and if additional Treasury fi nancing appears warranted or necessary in the future, the Administration should seek an increase in BPA's borrowing authority at that time.
- Direct the Secretary of Energy, in consultation with appropriate federal agencies and state and local government officials, to develop legislation to grant author ity to obtain rights-of-way for electricity transmission lines, with the goal of cre ating a reliable national transmission grid. Similar authority already exists for natural gas pipelines in recognition of their role in interstate commerce.

★ The NEPD Group recommends that the President direct the Secretary of the Interior to work with Congress and the State of Alaska to put in place the most expeditious process for renewal of the Trans-Alaskan Pipeline System rights-of-way to ensure that Alaskan oil continues to flow uninterrupted to the West Coast of the United States.

★ The NEPD Group recommends that the President direct the Secretaries of Energy and State, coordinating with the Secretary of the Interior and the Federal Energy Regulatory Commission, to work closely with Canada, the State of Alaska, and all other interested parties to expedite the construction of a pipeline to deliver natural gas to the lower 48 states. This should include proposing to Congress any changes or waivers of law pursuant to the Alaska Natural Gas Transportation Act of 1976 that may be required.

★ The NEPD Group recommends that the President support legislation to improve the safety of natural gas pipelines, protect the environment, strengthen emergency preparedness and inspections and bolster enforcement.

★ The NEPD Group recommends that the President direct agencies to continue their interagency efforts to improve pipeline safety and expedite pipeline permitting in an environmentally sound manner and encourage FERC to consider improvements in the regulatory process governing approval of interstate natural gas pipeline projects.

★ The NEPD Group recommends that the President direct the Administrator of the EPA to study opportunities to maintain or improve the environmental benefits of state and local "boutique" clean fuel programs while exploring ways to increase the flexibility of the fuels distribution infrastructure, improve fungibility, and provide added gasoline market liquidity. In concluding this study, the Administrator shall consult with the Departments of Energy and Agriculture, and other agencies as needed.

★ The NEPD Group recommends that the President direct the Administrator of the Environmental Protection Agency and the Secretary of Energy to take steps to ensure America has adequate refining capacity to meet the needs of consumers.

- Provide more regulatory certainty to refinery owners and streamline the permitting process where possible to ensure that regulatory overlap is limited.
- Adopt comprehensive regulations (covering more than one pollutant and requirement) and consider the rules' cumulative impacts and benefits.

★ The NEPD Group recommends that the President direct the Administrator of the Environmental Protection Agency, in consultation with the Secretary of Energy and other relevant agencies, to review New Source Review regulations, including administrative interpretation and implementation, and report to the President within 90 days on the impact of the regulations on investment in new utility and refinery generation capacity, energy efficiency, and environmental protection.

★ The NEPD Group recommends that the President direct the Attorney General to review existing enforcement actions regarding New Source Review to ensure that the enforcement actions are consistent with the Clean Air Act and its regulations.

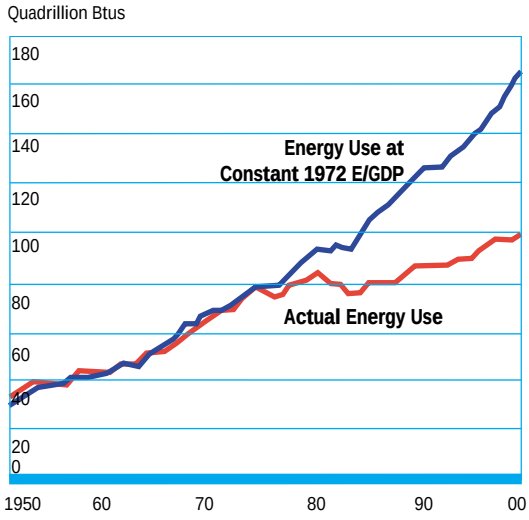
★ The NEPD Group supports the President's budget proposal to provide $8 million to maintain the two-million-barrel Northeast Heating Oil Reserve. Operated by the private sector, the Reserve helps ensure adequate supplies of heating oil in the event that colder than normal winters occur in the Northeast United States.

Strengthening Global Alliances

Enhancing National Energy Security and International Relationships

U.S. national energy security depends on sufficient energy supplies to support U.S. and global economic growth. Energy policies that have emphasized reliance on market forces have led to major energy security gains over the past two decades. Major improvements in exploration and production technology, as well as the trend toward opening new areas around the globe for exploration and development, have yielded significant dividends:

Figure 8-1
The U.S. Economy is More Energy Efficient (Energy Intensity)
Primary Energy Use



Improvements in energy efficiency since the 1970s have had a major impact in meeting national energy needs relative to new supply. If the intensity of U.S. energy use had remained constant since 1972, consumption would have been about 70 quadrillion Btus (74 percent) higher in 1999 than it actually was.

Source: U.S. Department of Energy, Energy Information Administration.

- The U.S. and world economies have diversified their sources of oil supplies, largely through increased production in the Western Hemisphere, the North Sea, and Africa.
- The world's fuel mix is also more diverse, primarily because of greater reliance on natural gas and nuclear power.
- The rate of growth in U.S. oil demand has slowed significantly since the first oil shocks of the 1970s because of more energy-efficient industries, structural changes in the economy, and greater efficiencies in vehicles, appliances, and buildings.

Since 1970, as the economy has shifted toward greater use of more efficient technologies, U.S. energy intensity (the amount of energy it takes to produce a dollar of GDP) has declined by 30 percent (Figure 8-1). However, energy use per person in the United States is expected to rise as is overall demand for energy.

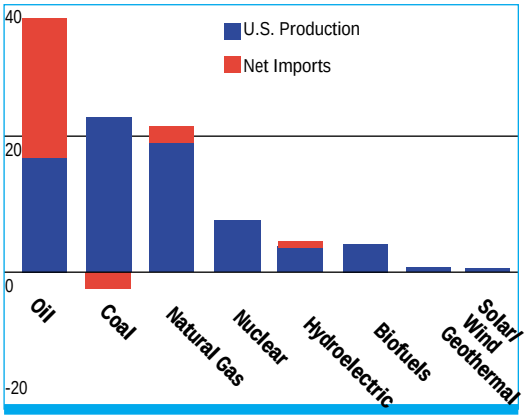
Measures to enhance U.S. energy security by meeting this increased demand must begin at home. The first step toward a sound international energy policy is to use our own capability to produce, process, and transport the energy resources we need in an efficient and environmentally sustainable manner. Market solutions to limit the growth in our oil imports would reduce oil consumption for our economy and increase our economic flexibility in responding to any domestic or international disruption of oil or other energy supplies. The United States produces 72 of the 99 quadrillion British thermal snits (Btus) of



Figure 8-2

Sources of U.S. Fuel Consumption in 1999

(Quadrillion Btus)



The United States produced 72 of the 98 quadrillion Btus of energy that it consumed in 1999. We are self-sufficient in vir tually all our energy resources, except oil, of which we import 52 percent of our net requirements, and natural gas, of which we import 15–16 percent net, primarily from Canada.

Source: U.S. Department of Energy, Energy Information Administration.

energy that it consumes (Figure 8-2). We are self-sufficient in virtually all our energy resources except oil, of which we import 52 percent of our net requirements, and natu ral gas, of which we import 15 to 16 percent of our net requirements, primarily from Canada.

We should not, however, look at en ergy security in isolation from the rest of the world. In a global energy marketplace, U.S. energy and economic security are di rectly linked not only to our domestic and international energy supplies, but to those of our trading partners as well. A significant disruption in world oil supplies could ad versely affect our economy and our ability to promote key foreign and economic policy objectives, regardless of the level of U.S. dependence on oil imports.

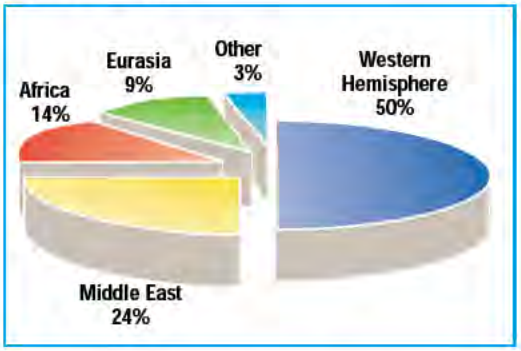
Our energy security also depends on an efficient domestic and international in frastructure to support all segments of the energy supply chain. We can strengthen our own energy security and the shared pros perity of the global economy by working cooperatively with key countries and insti tutions to expand the sources and types of global energy supplies. We can also ad vance these goals by increasing the effi ciency of energy consumption, enhancing the transparency and efficient operation of energy markets, and strengthening our ca pacity to respond to disruptions of oil sup plies. Energy is fundamental to economic growth, and we believe that economic growth and environmental protection can be mutually achieved.

We need to strengthen our trade alli ances, to deepen our dialogue with major oil producers, and to work for greater oil pro duction in the Western Hemisphere, Africa, the Caspian, and other regions with abun dant oil resources. Greater cooperation with our allies in addressing the growth in oil de mand in the transportation sector is particu larly important, given the growing demand for oil and other energy resources. Signifi cant economic and environmental benefits can be realized from increased energy effi ciency and from the use of clean energy technologies. We need to ensure that our partners in the International Energy Agency (IEA) continue to meet their obligations for emergency supply reserves. Finally, we must continue to work with the IEA, the Asia-Pacific Economic Cooperation (APEC) forum, and others to encourage other large importers to consider measures to augment their oil reserves

Oil Imports and Global Reserves

The U.S. influence on overall world markets is substantial in terms of produc tion and consumption. The United States is the world's second largest natural gas pro ducer and its third largest oil producer. The United States consumes over 25 percent of the oil produced worldwide, slightly more than half of which it imports. Nevertheless, because the price of our domestic and im ported oil is determined by a world market, our energy security interests transcend the source of our physical energy supplies (Fig ure 8-3). Given the large and projected growing volume of U.S. oil imports, our en ergy and economic security will increase if we take the steps necessary to realize America's potential as a major world oil and natural gas producer.

Figure 8-3
Regional Sources of U.S. Oil Imports in 2000



Slightly over half of the oil the United States imports every day comes from the Western Hemisphere. Canada, Venezuela, and Mexico account for the bulk (41%) of these imports.

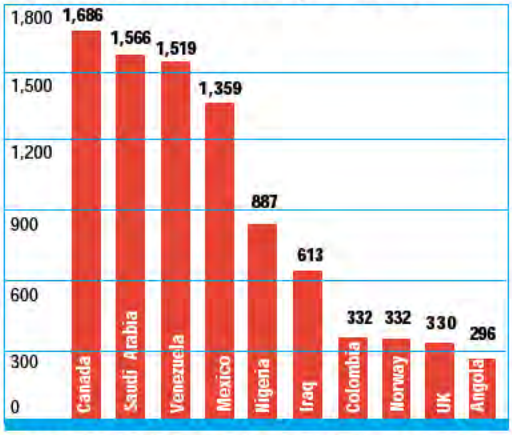
Source: US. Department of Energy, Energy Information Administration.

Recommendation:

★ The NEPD Group recommends that the President make energy security a priority of our trade and foreign policy.

In 2000, nearly 55 percent of U.S. gross oil imports came from four countries: 15 percent from Canada, 14 percent each from Saudi Arabia and Venezuela, and 12 percent from Mexico (Figure 8-4). The security of U.S. energy supply is enhanced by several factors characterizing our diplomatic and economic relationships with our four top suppliers. These factors range from geographic proximity and free trade agreements to integrated pipeline networks, reciprocal energy-sector investments, shared security commitments, and, in all cases, long-term reliable supply relationships (Figure 8-5).

Figure 8-4
Top 10 Suppliers of U.S. Oil Imports in 2000



In 2000, nearly 55 percent of gross U.S. oil imports came from four leading suppliers: Canada (15%), Saudi Arabia (14%), Venezuela (14%), and Mexico (12%).

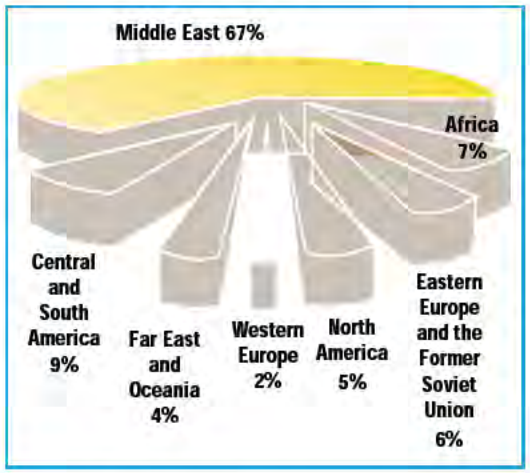
Source: U.S. Department of Energy, Energy Information Administration.

Saudi Arabia and the Middle East Oil Supplies

By 2020, Gulf oil producers are projected to supply between 54 and 67 percent of the world's oil. Thus, the global economy will almost certainly continue to depend on the supply of oil from Organization of Petroleum Exporting Countries (OPEC) members, particularly in the Gulf. This region will remain vital to U.S. interests. Saudi Arabia, the world's largest oil exporter, has been a linchpin of supply reliability to world oil markets.

Saudi Arabia has pursued a policy of investing in spare oil production capacity, diversifying export routes to both of its coasts, and providing effective assurances that it will use its capacity to mitigate the

Figure 8-5
Proven World Oil Reserves in January 2000



The world's proven crude oil reserves remain relatively concentrated. The Middle East holds 664 billion barrels, or roughly two-thirds of the world's conventional oil reserves, followed by the Western Hemisphere (14%) and Africa (7%).

Source: U.S. Department of Energy, Energy Information Administration.

Saudi Arabia has pursued a policy of investing in spare oil production capacity, diversifying export routes to both of its coasts, and providing effective assurances that it will use its capacity to mitigate the impact of oil supply disruptions in any region.
ARAMCO



impact of oil supply disruptions in any region (Figure 8-6). Algeria, Kuwait, Oman, Qatar, Saudi Arabia, the United Arab Emirates (UAE), Yemen, and other states in the region with which we maintain diplomatic relations have all, to some extent, opened their energy sectors to international investment. This development provides an important opportunity to further encourage foreign investment in these important energy-producing countries, thereby broadening our shared commercial and strategic interests. By any estimation, Middle East oil producers will remain central to world oil security. The Gulf will be a primary focus of U.S. international energy policy, but our engagement will be global, spotlighting existing and emerging regions that will have a major impact on the global energy balance.

Figure 8-6
Saudi Arabia Export Pipelines



Saudi Arabia, the world's largest oil supplier, maintains major oil export ports and storage capacity on both the Gulf and the Red Sea.

ARAMCO

Recommendation:
★ The NEPD Group recommends that the President support initiatives by Saudi Arabia, Kuwait, Algeria, Qatar, the UAE, and other suppliers to open up areas of their energy sectors to foreign investment.

Improving Market Transparency

The United States must work with oil producers to improve the transparency, timeliness, and accuracy of the data that guide global oil markets. A lack of timely and accurate data relating to both oil production and inventory levels has contributed to the price volatility witnessed in 2000. Discussions among the major oil producers and consumer countries should be designed to improve the transparency, accuracy, and timeliness of data that guide the market. In turn, enhanced data quality and increased data transparency will improve market efficiency. Refocusing that dialogue beyond short-term market developments to long-term issues of world economic growth, improving data quality, and addressing energy infrastructure is needed to maintain a smooth flow of energy from the wellhead to the consumer.

Recommendation:
★ The NEPD Group recommends that the President direct the Secretaries of State, Energy and Commerce work to improve dialogue among energy producing and consuming nations.

Promoting International Trade and Investment

Longstanding U.S. policy supports a liberalized global energy sector that is open to international trade and investment. The United States benefits from international investments at home that have increased our

energy sector's capacity and its infrastruc ture. Both producers and consumers will benefit from ensuring that the global energy infrastructure is sufficient and flexible to meet growing global demand.

American energy firms remain world leaders, and their investments in energy producing countries enhance efficiencies and market linkages while increasing envi ronmental protections. Expanded trade and investment between oil importing and ex porting nations can increase shared inter ests while enhancing global energy and eco nomic security. Promoting such investment will be a core element of our engagement with major foreign oil producers.

Recommendations:

★ The NEPD Group recommends that the President direct the Secretaries of State, Commerce and Energy to con tinue supporting American energy firms competing in markets abroad and use our membership in multilat eral organizations, such as the Asia-Pacific Economic Cooperation (APEC) forum, the Organization for Economic Cooperation and Develop ment (OECD), the World Trade Orga nization (WTO) Energy Services Ne gotiations, the Free Trade Area of the Americas (FTAA), and our bilateral relationships to implement a system of clear, open, and transparent rules and procedures governing foreign in vestment; to level the playing field for U.S. companies overseas; and to re duce barriers to trade and investment.

★ The NEPD Group recommends that the President direct the Secretaries of Commerce and Energy, and the U.S. Trade Representative, to support a sectoral trade initiative to expand in vestment and trade in energy-related goods and services that will enhance exploration, production, and refining, as well as the development of new technologies.

Reviewing and Reforming Sanctions

Economic sanctions include U.S. uni lateral sanctions as well as multilateral sanctions, such as United Nations (UN) Se curity Council Resolutions. Sanctions can advance important national and global se curity objectives and can be an important foreign policy tool, especially against na tions that support terrorism or seek to ac quire weapons of mass destruction. Never theless, sanctions should be periodically re viewed to ensure their continued effective ness and to minimize their costs on U.S. citizens and interests.

Recommendation:

★ The NEPD Group recommends that the President direct the Secretaries of State, Treasury, and Commerce to ini tiate a comprehensive review of sanc tions. Energy security should be one of the factors considered in such a re view.

Diversity of Supply

Concentration of world oil production in any one region of the world is a potential contributor to market instability, benefiting neither oil producers nor consumers. Peri odic efforts by OPEC to maintain oil prices above levels dictated by market forces have increased price volatility and prices paid by consumers, and have worked against the shared interests of both producers and con sumers in greater oil market stability. This remains a policy challenge, which we will meet over the longer term through a com prehensive energy policy that addresses both supply and demand, as well as through increased engagement with all our major suppliers. Greater diversity of world oil pro duction remains important.

Encouraging greater diversity of oil production and, as appropriate, transporta tion, within and among geographic regions has obvious benefits to all market partici pants. Technological advances will enable the United States to accelerate the diversifi cation of oil supplies, notably through deep-



The United States is helping developing countries use energy efficient technologies. Photovoltaic-powered pumps are being used in many wells throughout rural India for collecting potable water.

U.S. Department of Energy, National Renewable Energy Laboratory

water offshore exploration and production in the Atlantic Basin, stretching from off shore Canada to the Caribbean, Brazil, and West Africa. The Caspian Sea can also be a rapidly growing new area of supply.

The ongoing development of so-called "heavy oil" reserves in the Western Hemi sphere is an important factor that promises to significantly enhance global oil reserves and production diversity. Recent Canadian and Venezuelan success in making heavy oil deposits commercially viable suggests that they will contribute substantially to the di versity of global energy supply, and to our own energy supply mix over the medium to long term. Leading non-OPEC oil exporters, such as Mexico and Norway, remain critical to the diversity of global energy supply.

Growing levels of conventional and heavy oil production and exports from the Western Hemisphere, the Caspian, and Af rica are important factors that can lessen the impact of a supply disruption on the U.S. and world economies. Overall U.S. policies in each of these high-priority re gions will focus on improving the invest ment climate and facilitating the flow of needed investment and technology.

Bilateral energy working groups, such as the U.S.-Kazakhstan Oil, Gas and Com mercial Energy Working Group and the U.S.-Russian Oil and Gas Working Group, can improve the trade climate in high-prior ity countries. In addition to seeking new sources of oil, the United States is helping developing countries use energy efficient technologies to mitigate the environmental impacts of energy use, and to improve ac cess to energy resources.

WTO members are beginning to exam ine global trade in energy services. The United States has called on WTO members to open markets eligible for private partici pation in the entire range of energy ser vices, from exploration to the final cus tomer. The energy service proposal would attempt to ensure nondiscriminatory access to foreign providers of energy services. Equally important, the U.S. proposal sug gests that WTO members consider how to best create a pro-competitive regulatory en-

Figure 8-7

Canada–U.S. Natural Gas Pipelines: 2001



Canada–U.S. Oil Pipelines: 2001



An integrated network of oil and gas pipelines demonstrates the seamless nature of North American energy trade.

Sources: Lakehead Pipe Line Company, Inc., and Canadian Association of Petroleum Producers.

Figure 8-8

Maritimes and Northeast Pipeline: 2000



New England's geography made it the "last stop" for natural gas pipelines stretching thousands of miles across the continent from the South and the West. Consequently, the region became the most oil-dependent area in the country, particularly for home heating and electricity. With the January 1, 2000, inauguration of Atlantic Canada's Maritimes and Northeast Pipeline, New England is now at the beginning of the line for natural gas flowing across the border from Canada at Calais, Maine. Overall, the region's fuel mix is becoming increasingly diversified, with natural gas demand slated to increase by 2.4 percent a year through 2020.

Source: Maritimes and NorthEast Pipeline.

vironment for energy services, so that opaque or discriminatory regulatory prac tices do not undermine commitments to open their domestic markets to foreign ser vice providers. Such objectives can also be pursued in the FTAA and APEC.

Toward a North American Energy Framework

Increased U.S., Canadian, and Mexi can energy production and cooperation would enhance energy security and, through our economic links in the North America Free Trade Agreement (NAFTA) economy, fundamentally advance each country's economic security. As state and federal governments consider energy re forms, there will be a need to ensure com patible regulatory frameworks with our neighbors while recognizing differences in jurisdictions.

Canada

Canada's deregulated energy sector has become America's largest overall en ergy trading partner, and our leading for eign supplier of natural gas, oil, and elec tricity. Canada's sustainable development based energy strategies contribute to the health of the NAFTA economy and of our shared environment.

Canada provided 14 percent of U.S. natural gas supply last year. An integrated network of pipelines demonstrates the seamless nature of North American energy trade (Figure 8-7). Estimated natural gas deposits in Alaska and Northwest Canada exceed 70 trillion cubic feet, representing over three years of total U.S. consumption at present levels.

To advance shared economic and en vironmental objectives, the private sector is poised to develop the continent's northern gas reserves, with pipeline linkages be tween both countries. To the east, recent development of Canada's Atlantic offshore energy reserves has made significant strides, with major offshore natural gas and oil production now available. Canada's At lantic energy development is now providing previously untapped sources of clean-burn ing natural gas not only to Nova Scotia and New Brunswick but also to heating oil-de pendent New England (Figure 8-8).



Offshore oil platform near Campeche, Mexico. Mexico's large crude oil reserves—approximately 25 percent larger than our own proven reserves—makes it a likely source of increased oil production over the next decade.

U.S. EMBASSY, MEXICO CITY

Our large cross-border electricity trade flows in each direction. Our electric ity imports from Canada are derived largely from hydropower produced in eastern Canada, Canadian and American hydro power projects in the Pacific Northwest op erating pursuant to the Columbia River Treaty, and a nuclear power plant in New Brunswick. All of these sources provide im portant trade and clean air benefits, while allowing both countries to benefit from load sharing and integration. The reliability of the North American electricity grid can be enhanced yet further through closer coordi nation and compatible regulatory and juris dictional approaches.

Canada's oil trade, responding to mar ket signals, increased 4 percent worldwide and 10 percent with the United States last year. Estimates of Canada's recoverable heavy oil sands reserves are substantial, and new technologies are being deployed to de velop their potential. Production from these promising areas now approaches 600,000 barrels a day. Their continued development can be a pillar of sustained North American energy and economic security.

Mexico

Our energy relationship with Mexico reflects the increasingly interrelated charac ter of NAFTA economies and our contigu ous border. U.S. natural gas reserves, pipe-

Figure 8-9

Mexican Oil and Gas Resources: 2001



Mexico's large oil reserves—approximately 25 percent larger than U.S. proven reserves—make it a likely source of increased oil production over the next decade.

Source: U.S. Central Intelligence Agency.

lines, and industries are closer to the grow ing border area than some of Mexico's re serves. The United States is a net exporter of refined petroleum products and natural gas to Mexico, primarily through pipeline connections to northern Mexico. Mexico is a leading and reliable source of imported oil, and its large reserve base, approxi mately 25 percent larger than our own proven reserves, makes Mexico a likely source of increased oil production over the next decade (Figure 8- 9).

Mexico began exporting 50 megawatts of electricity from Baja to California in Janu ary 2001. However, the transmission infra structure on both sides of the border is in sufficient for greater flows of energy in ei ther direction without expansion. In the United States, our process for "Presidential Permitting" of cross-border infrastructure linkages needs to be updated and stream lined.

Mexico will make its own sovereign decisions on the breadth, pace, and extent to which it will expand and reform its electric ity and oil and gas capacities. Where the country has opened its energy sector to pri vate investment, such as in natural gas trans mission, distribution, and storage, invest ments have been made to our mutual ben efit. To the extent Mexico seeks to attract additional foreign investment consistent with its Constitution, which reserves explo ration and production rights to the Mexican government, the United States should ac tively encourage the U.S. private sector to consider market-based investments.

Recommendations:

★ The NEPD Group recommends that the President direct the Secretaries of State, Commerce, and Energy to en gage in a dialogue through the North American Energy Working Group to develop closer energy integration among Canada, Mexico, and the United States and identify areas of co operation, fully consistent with the countries' respective sovereignties.

★ The NEPD Group recommends that the President direct the Secretaries of Energy and State, in consultation with the Federal Energy Regulatory Com mission, to review their respective oil, natural gas, and electricity cross boundary "Presidential Permitting" authorities, and to propose reforms as necessary in order to make their own regulatory regimes more compatible for cross-border trade.

A carrier transports liquefied natural gas (LNG) from Trinidad and Tobago—our largest LNG supplier—to Boston harbor. LNG currently represents 16 percent of New England's natural gas supply.
Cabot LNG



★ The NEPD Group recommends that the President direct the Secretaries of Energy and State, coordinating with the Secretary of the Interior and the Federal Energy Regulatory Commis sion, to work closely with Canada, the State of Alaska, and all other inter ested parties to expedite the construc tion of a pipeline to deliver natural gas to the lower 48 states. This should include proposing to Congress any changes or waivers of law pursuant to the Alaska Natural Gas Transporta tion Act of 1976 that may be required.

South America: Latin America and the Caribbean

Latin America and the Caribbean are growing not only as major producing re gions, but also as major consumers of oil and natural gas. Trinidad and Tobago's pro gressive investment code has made it the hemisphere's largest exporter of LNG and the largest supplier of LNG to the United States in 2000. Unprecedented development of Central and South America's vast natural gas reserves—222.7 trillion cubic feet as of January 2000, illustrated by transcontinen tal pipelines linking Bolivia, Brazil, Argen tina, Chile, Paraguay, and Uruguay—in crease regional self-reliance, affirm eco nomic integration, aid the environment, and stem the growth in oil demand. Colombia has also become an important supplier of oil to the United States.

The United States, with Venezuela, is a co-coordinator of the Hemispheric En ergy Initiative process. In March 2001, a Summit of the Americas Hemispheric En ergy Ministerial meeting was hosted by the Government of Mexico. At the meeting, the region's energy ministers pledged to sup port integration and sustainable develop ment in the hemisphere, recognizing the need to foster stable and transparent regu latory frameworks. In April 2001, the thirty four democratically elected leaders of the Western Hemisphere met in Quebec City for the Third Summit of the Americas. They called for a renewed effort to strengthen the hemisphere's energy cooperation and integration.



U.S. Secretary of Energy Spencer Abraham listens to his colleagues at the Summit of the Ameri-cas Hemispheric Energy Ministerial meeting in Mexico City on March 9, 2001.

U.S. Embassy, Mexico City

Venezuela is the world's fifth largest oil exporter, and the third largest oil sup plier to the United States. Its energy indus try is increasingly integrated into the U.S. marketplace. Venezuela's downstream in vestments in the United States make it a leading refiner and gasoline marketer here. Growing U.S. and international investments in Venezuela's energy sector, particularly in its resource-rich heavy oil sector, are en hancing the country's ability to meet its de velopment goals and to keep pace with a growing world energy marketplace. Venezu ela is also moving to liberalize its natural gas sector, which will increase opportuni ties for foreign investment to expand Ven ezuelan natural gas production. These posi tive steps along with conclusion of a Bilat eral Investment Treaty, which is now being negotiated, would provide investors from both the United States and Venezuela incen tives for increased investment.

Brazil has long been a pioneer in the development of deep-water offshore oil and gas resources. Its world-class oil industry is now moving to become a partner with U.S. and international investors to more fully de velop its prolific offshore oil reserves. This welcome development will enhance hemi spheric energy production from well-estab lished sedimentary basins.

Recommendations:

★ The NEPD Group recommends that the President direct the Secretaries of State and Commerce to conclude ne gotiations with Venezuela on a Bilat eral Investment Treaty, and propose formal energy consultations with Bra zil, to improve the energy investment climate for the growing level of energy investment flows between the United States and each of these countries.

★ The NEPD Group recommends that the President direct the Secretaries of Energy, Commerce, and State to work through the Summit of the Americas Hemispheric Energy Initiative to de velop effective and stable regulatory frameworks and foster reliable supply sources of all fuels within the region.

Africa

Sub-Saharan Africa holds 7 percent of world oil reserves and comprises 11 percent of world oil production. Along with Latin America, West Africa is expected to be one of fastest-growing sources of oil and gas for the American market. African oil tends to be of high quality and low in sulfur, making it suitable for stringent refined product re quirements, and giving it a growing market share for refining centers on the East Coast of the United States.

In 2000, OPEC member Nigeria ex ported an average of 900,000 barrels of oil per day to the United States, out of its total production of 2.1 million barrels of oil per day. Nigeria, in partnership with the private sector, has set ambitious production goals as high as 5 million barrels of oil per day over the coming decade.

Angola's growing offshore oil indus try, with participation by U.S. and interna tional oil firms, is also a major source of growth. In 2000, Angola exported 300,000 barrels of oil per day out of its 750,000 bar rels of oil per day of total production to the United States, and is thought to have the potential to double its exports over the next ten years. Other significant exporters to the United States included Gabon and the Congo-Brazzaville.

The World Bank has supported Chad's efforts to begin ambitious oil development. This year an international consortium that includes U.S. firms began investing $3.5 bil lion in this pipeline from Chad to Cameroon, the largest infrastructure project in Africa to day. When complete, the pipeline will allow Chad to export up to 250,000 barrels of oil per day.

The U.S. Agency for International De velopment (USAID) has provided technical assistance in support of a West Africa Power Pool and associated pipeline project involving a number of U.S. oil companies, and is providing assistance for the creation of a regional regulatory framework that will enable Ghana and Nigeria to become major exporters of natural gas and electricity.

The West Africa Gas Pipeline is a 161 mile (1,000-kilometer), $400 million on shore/offshore natural gas pipeline connect ing Nigeria with Benin, Togo, and Ghana. The pipeline is being built by a consortium of companies, and includes financing by the U.S. Export-Import Bank.

Recommendations:

★ The NEPD Group recommends that the President direct the Secretaries of State, Energy, and Commerce to rein vigorate the U.S.-Africa Trade and Economic Cooperation Forum and the U.S.-African Energy Ministerial pro cess; deepen bilateral and multilateral engagement to promote a more recep tive environment for U.S. oil and gas trade, investment, and operations; and promote geographic diversification of energy supplies, addressing such is sues as transparency, sanctity of con tracts, and security.

★ The NEPD Group recommends that the President direct the Secretaries of State, Energy, and Commerce to re cast the Joint Economic Partnership Committee with Nigeria to improve the climate for U.S. oil and gas trade, investment, and operations and to ad vance our shared energy interests.

★ The NEPD Group recommends that the President direct the Secretaries of

State, Energy, and Commerce to support more transparent, accountable, and responsible use of oil resources in African producer countries to enhance the stability and security of trade and investment environments.

The Caspian

Proven oil reserves in Azerbaijan and Kazakhstan are about 20 billion barrels, a little more than the North Sea and slightly less than the United States. Exploration, however, is continuing, and proven reserves are expected to increase significantly.

For example, initial results of the exploration well at Kazakhstan's Kashagan field indicate the find is one of the most important in thirty years, and is comparable to Prudhoe Bay in size. Current exports from the region are only about 800,000 barrels of oil per day, in part due to limited export route options. However, potential exports could increase by 1.8 million barrels of oil per day by 2005, as the United States works closely with private companies and countries in the region to develop commercially viable export routes, such as the Baku-Tbilisi-Ceyhan (BTC) and Caspian Pipeline Consortium oil pipelines (Figure 8-10). Moreover, there is considerable optimism that exports could grow even more substantially in subsequent years because of positive prospects for new oil and gas finds as additional geologic structures undergo exploration, and the development of new export routes.

Foreign investors and technology are critical to rapid development of new commercially viable export routes. Such development will ensure that rising Caspian oil production is effectively integrated into world oil trade. U.S.-supported East–West pipeline routes will add substantial new oil transportation capacity to allow continued expansion of production and exports. Overland routes via pipeline, such as the planned BTC oil pipeline, will also help mitigate maritime risks in the crowded Bosporus Straits. To help countries prepare for increased oil production within the region, the United States is working with Black Sea and Caspian Sea border states to ensure that they develop adequate oil spill response capabilities.

Figure 8-10

Caspian Energy Export Pipelines: 2001



Several oil and natural gas pipeline projects are proposed for the Caspian area.

Source: U.S. Central Intelligence Agency.

Recommendations:

★ The NEPD Group recommends that the President direct the Secretaries of State, Commerce, and Energy to support the BTC oil pipeline as it demonstrates its commercial viability.

★ The NEPD Group recommends that the President direct the Secretaries of Commerce, State, and Energy to continue working with relevant companies and countries to establish the commercial conditions that will allow oil companies operating in Kazakhstan the option of exporting their oil via the BTC pipeline.

★ The NEPD Group recommends that the President direct the Secretaries of State, Commerce, and Energy to support the efforts of private investors and regional governments to develop the Shah Deniz gas pipeline as a way to help Turkey and Georgia diversify their natural gas supplies and help Azerbaijan export its gas via a pipeline that will continue diversification of secure energy supply routes.

★ The NEPD Group recommends that the President direct appropriate federal agencies to complete the current cycle of oil spill response readiness workshops and to consider further appropriate steps to ensure the implementation of the workshops' recommendations.

★ The NEPD Group recommends that the President direct the Secretary of State to encourage Greece and Turkey to link their gas pipeline systems to allow European consumers to diversify their gas supplies by purchasing Caspian gas.

★ The NEPD Group recommends that the President direct the Secretaries of Commerce, Energy, and State to deepen their commercial dialogue with Kazakhstan, Azerbaijan, and other Caspian states to provide a strong, transparent, and stable business climate for energy and related infrastructure projects.

Russia

Russia has about 5 percent of the world's proven oil reserves. In 2000, Russia produced an average of 6.7 million barrels of oil and natural gas liquids per day, making it both the world's third largest producer and second largest exporter at 4.2 million barrels of oil per day. Russia's oil production in 2000 represented an increase of 7 percent over 1999, the first increase since the dissolution of the Soviet Union. A similar rate of increase is projected for 2001. New fields are being developed, including those with U.S. and other foreign investors.

Nevertheless, substantial infrastructure investment is still needed, as well as legislation and a stable and reliable regime of contracting to finalize the Production Sharing Agreement (PSA) mechanism for private-sector participation and actions to improve the general investment climate. Russian oil firms are increasingly active on a global scale, with upstream and downstream investments in the Caspian, the United States, Africa, South Asia, and Europe, enhancing Russia's ability to develop its own and international oil reserves.

Russia holds 33 percent of the world's natural gas reserves, exporting a full 35 percent of its production to Europe and Central Asia in 1999. Russian natural gas exports can increase regional fuel diversification and advance environmental goals. With production declines now evident in existing fields, development of new reserves that require substantial new investments will be necessary.

Recommendations:

★ The NEPD Group recommends that the President direct the Secretaries of State, Commerce, and Energy to deepen the focus of the discussions with Russia on energy and the investment climate.

★ The NEPD Group recommends that the President direct the Secretaries of Commerce, State, and Energy to assist U.S. companies in their dialogue on the investment and trade climate with

Russian officials, to encourage reform of the PSA law and other regulations and related tax provisions, as well as general improvements in the overall investment climate. This will help ex pand private investment opportunities in Russia and will increase the inter national role of Russian firms.

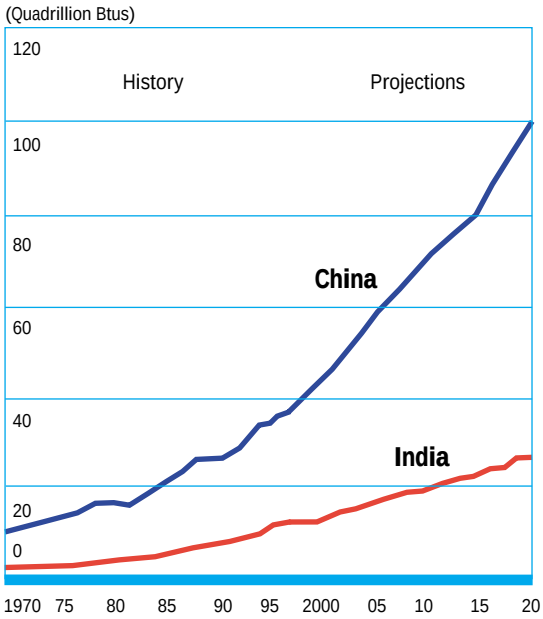
Asia

Asia holds less than 5 percent of world proven oil reserves, but accounts for more than 10 percent of oil production and about 30 percent of world oil consumption. The developing countries of the Pacific Rim are expected to increase their total petro leum imports by almost 43 percent between 1997 and 2020. The developing countries of Asia are expected to remain heavily depen dent on Middle East imports.

China is a critical player in global en ergy security issues, since its net oil im ports are expected to rise from approxi mately 1 million barrels of oil per day at present to possibly 5 to 8 million barrels of oil per day by 2020, with a predominant (over 70 percent) dependence on Middle East imports. China moved in the mid-1990s from being a net oil exporter to a net oil im porter.

About 7 percent of the world's proven natural gas reserves are located in Asia. Asian gas production represents about 11 percent of the world total, and consumption is less than 3 percent of world natural gas demand. Other natural gas producers, such as Malaysia, Myanmar, and Australia, are net gas exporters. Currently Japan, South Korea, and Taiwan are the major gas im porters in Asia. China, in addition to accel erating domestic exploration and develop ment of natural gas resources, is planning to import gas via pipeline from Central Asia. India, likewise, is considering several po tential LNG import projects (Figure 8-11).

Figure 8-11
Energy Consumption in China and India: 1970–2020



China and India account for the bulk of projected growth in oil demand in non-OECD countries.

Source: U.S. Department of Energy, Energy Information Administration.

Recommendations:

★ The NEPD Group recommends that the President direct the Secretaries of State, Commerce, and Energy to con tinue to work in the APEC Energy Working Group to examine oil market data transparency issues and the vari ety of ways petroleum stocks can be used as an option to address oil mar ket disruptions.

★ The NEPD Group recommends that the President direct the Secretaries of State and Energy to work with India's Ministry of Petroleum and Natural Gas to help India maximize its domestic oil and gas production.

Diversification of Fuel Mix

The growing demand for more fuel efficient technologies offers U.S. businesses significant trade and investment opportuni ties overseas, while addressing rising world oil demand. The United States supports a practical, market-based approach that en

courages the adoption of efficient technolo gies, including those relating to natural gas, nuclear energy, and renewable energy. This approach takes into account existing na tional and international programs and has the potential to energize both public action and private involvement. Introduction of these technologies abroad also supports U.S. national interests by reducing competi tion for the oil resources on which the glo bal economy continues to rely. Overall, the U.S. government's goal is to adopt policies that support innovative finance and market mechanisms that will provide U.S. busi nesses and consumers greater incentives to make more cost effective, energy efficient investment and consumption decisions.

Increased use of renewable energy technologies would improve U.S. energy se curity, yield global environmental benefits, improve social and economic stability in the developing world, and provide significant trade and investment opportunities to U.S. businesses. Promotion of clean energy tech nology exports can mitigate international dependence on oil supplies from volatile re gions, help lower energy costs for U.S. con sumers, bring U.S. firms greater access to large foreign markets, and enhance U.S. in tegration with global sources of innovation. In consultation with U.S. industry, the U.S. government is participating in efforts of the IEA, the G-8, the OECD, the United Nations, and multilateral development banks to for mulate effective strategies for accelerated market penetration of renewable energy technologies. Significant market penetra tion will depend on further reducing the costs of deploying these technologies.

The Clean Energy Technology Exports Working Group, a Federal interagency task force comprised of USAID and the Depart ments of Commerce and Energy, is creating a strategic plan that will provide a roadmap for future exports of U.S. clean energy tech nologies. Through its international trade programs, the Department of Commerce will showcase market-ready U.S. technolo gies that generate a cleaner environment and increase energy efficiency.

Recommendation:

★ The NEPD Group recommends that the President direct the Secretaries of Commerce, State, and Energy to pro mote market-based solutions to envi ronmental concerns; support exports of U.S. clean energy technologies and encourage their overseas develop ment; engage bilaterally and multilat erally to promote best practices; ex plore collaborative international basic research and development in energy alternatives and energy efficient tech nologies; and explore innovative pro grams to support the global adoption of these technologies.

Climate Change

The President is committed to ad dressing the issue of global climate change in a manner that protects our environment and economy. Toward this end, the Admin istration is undertaking a Cabinet-level re view of domestic and international policies for addressing this issue.

The United States invited other nations to re-examine global climate change issues, including technologies and market-based systems. Increasing our understanding of the most recent science and further research into the science of climate change will be es sential to developing the optimal strategy.

There is increasing awareness of glo bal competition for fossil fuels and their po tential threats to the global environment. The United States can diminish both risks by becoming more energy efficient at home, by working with other nations, and by en couraging developing countries to use the cleanest and most energy-efficient technolo gies. Through educational programs, the United States can encourage developing countries to use advanced U.S. energy tech nologies, energy management practices, and market-based policies. The United States is uniquely positioned to help emerging na tions build energy and institutional capacity and to finance energy-related activities and services. Doing so could prove to be a cost effective investment, for both the United States and emerging economies.

Recommendation:

★ The NEPD Group recommends that the President direct federal agencies to support continued research into global climate change; continue efforts to identify environmentally and cost-effective ways to use market mechanisms and incentives; continue development of new technologies; and cooperate with allies, including through international processes, to develop technologies, market-based incentives, and other innovative approaches to address the issue of global climate change.

Oil Consumption

Although U.S. energy security can be reinforced by domestic efforts to enhance supply and use energy more efficiently, growth in international oil demand will exert increasing pressure on global oil availability. Worldwide oil consumption is projected to grow by 2.1 percent a year over the next two decades. However, oil demand is projected to grow three times as fast in non-OECD countries as in OECD countries, which will increase worldwide competition for global oil supplies and put increased pressure on our shared environment. Accordingly, non-OECD countries' share of oil demand is expected to rise from 41 percent to 52 percent (Figure 8-12). China and India will be major contributors to this growth in demand and will rely heavily on imports to meet their needs. This growth will increase the stake that many developing countries have in ensuring access to significant energy resources, as well as their incentive to pursue energy efficiency.

Transportation has been responsible for nearly all the growth in OECD oil consumption over the last twenty years, and is projected to be the leading source of future growth in oil consumption through 2020. Transportation-related fuel consumption in the developing world is expected to more than double by 2020, growing at an annual average rate of 4 percent. Therefore, both OECD and developing countries will need to increase their focus on efficiencies in the transportation sector. The momentum to create market mechanisms supporting alternative-fuel vehicles will increase. Best practices that seek to reduce the cost of these technologies and to promote market penetration should be pursued. Without additional efforts to reduce this growth in consumption, the transportation sector's fuel needs will force an increasing dependence on oil in the developed and developing worlds.

Recommendations:

★ The NEPD Group recommends that the President seek to increase international cooperation on finding alternatives to oil, especially for the transportation sector.

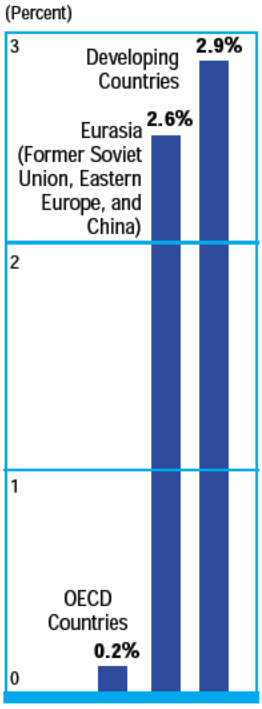
★ The NEPD Group recommends that the President direct the Secretary of State to reinvigorate its dialogue with the European Union on energy issues, and resume the consultative process this year in Washington.

★ The NEPD Group recommends that the President promote a coordinated approach to energy security by calling for an annual meeting of G-8 Energy Ministers or their equivalents.

Emergency Preparedness for Oil Supply Disruption

U.S. and world exposure to oil supply disruptions increases as the size of strategic and commercial stocks relative to demand declines. This vulnerability is a result of rising global demand, tight supplies, and inadequate efforts to establish or expand oil stockpiles. Such a situation magnifies the importance of U.S. coordination with other members of the IEA, comprised of most OECD member governments. Each IEA member that is a net oil importer is required to hold stocks equal to 90 days or more of its net imports. The IEA maintains agreed mechanisms for coordinating the use of these stocks in responding to a physical supply disruption. Collectively, the net oil-importing members of the IEA currently hold

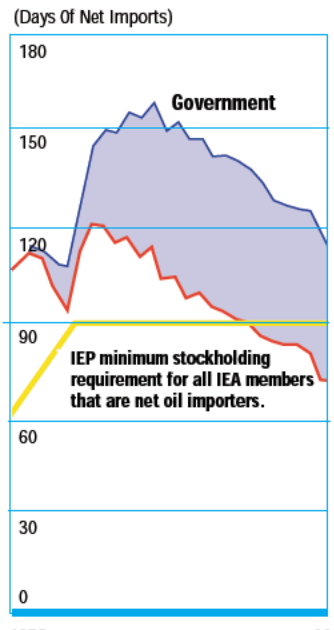
Figure 8-12
Projected Oil Consumption Rates in Three Economic Regions: 1999–2020



Over the next two decades, oil consumption in developing countries and Eurasia will grow three times faster than in the rest of the world.

Source: U.S. Department of Energy, Energy Information Administration.

Figure 8-13
Stocks of IEA Net Importers: 1975–2000



The International Energy Agency, of which the United States is a member, closely tracks the amount of strategic and commercial petroleum stocks maintained by its member states. The International Energy Program (IEP) Agreement "binds Participating Countries to make specific measures to meet any oil supply emergency and, over the long term, to reduce dependence on oil."

Source: International Energy Agency.

approximately 113 days worth of strategic and commercial stocks. U.S. stocks, which include both government and commercial stocks, are slightly above the IEA average. While this is more than required, it is far be low the peak coverage of 157 days reached in 1986. Moreover, several member states have fallen below the 90-day threshold (Fig ure 8-13).

The United States meets part of its IEA obligation through government-owned stocks held in the U.S. Strategic Petroleum Reserve (SPR). The SPR currently holds 541 million barrels of oil, which is enough to cover the loss of all U.S. imports for 54 days or a partial disruption for much longer. Close to 33 million barrels of oil will be de posited in the SPR by the fourth quarter of 2002, returning oil that had been "ex changed" out of the reserve last year. SPR oil can be withdrawn at a maximum rate of over 4 million barrels of oil per day initially and could reach the market within fifteen days of a Presidential directive. Because of increased net oil imports, the days of oil im port coverage provided by the SPR have de clined considerably over the past decade. In 1990, the SPR contained enough oil to com pensate for the loss of 82 days worth of U.S. imports—substantially more than today's 54-day supply. As domestic production and import patterns evolve, the Administration will work to inform Congress about chang ing coverage levels provided by the SPR. It should be noted that the United States also counts on the SPR as a national defense fuel reserve.

The oil market's day-to-day operation and its ability to respond to supply prob lems depend heavily on the availability of information on supply, demand, and price. The oil market volatility of the past two years has emphasized the need for more comprehensive and timely oil market infor mation.

Recommendations:

★ The NEPD Group recommends that the President reaffirm that the SPR is designed for addressing an imminent or actual disruption in oil supplies, and not for managing prices.

★ The NEPD Group recommend that the President direct the Secretary of Energy to work within the Interna tional Energy Agency (IEA) to ensure that member states fulfill their stock holding.

★ The NEPD Group recommends that the President direct the Secretary of Energy to encourage major oil-con suming countries that are not IEA members to consider strategic stocks as an option for addressing potential supply disruptions. In this regard, we should work closely with Asian econo mies, especially through APEC.

★ The NEPD Group recommends that the President direct the Secretary of Energy offer to lease excess SPR stor age facilities to countries (both IEA and non-IEA members) that might not otherwise build storage facilities or hold sufficient strategic stocks, consis tent with statutory authorities.

★ The NEPD Group recommends that the President, at such time that ex changed SPR barrels are returned to the SPR, should determine whether offshore Gulf of Mexico royalty oil de posits to the SPR should be resumed, thereby increasing the size of our re serve.

★ The NEPD Group recommends that the President direct the Secretary of Energy to work closely with Congress to ensure that our SPR protection is maintained.

★ The NEPD Group recommends that the President direct the Secretary of Energy to work with producer and consumer country allies and the IEA to craft a more comprehensive and timely world oil data reporting system.

Summary of Recommendations

Strengthening Global Alliances: Enhancing National Energy Security and International Relationships

★ The NEPD Group recommends that the President make energy security a priority of our trade and foreign policy.

★ The NEPD Group recommends the President support initiatives by Saudi Arabia, Ku wait, Algeria, Qatar, the UAE, and other suppliers to open up areas of their energy sec tors to foreign investment.

★ The NEPD Group recommends that the President direct the Secretaries of State, En ergy and Commerce work to improve dialogue among energy producing and consuming nations.

★ The NEPD Group recommends that the President direct the Secretaries of State, Commerce, and Energy to continue supporting American energy firms competing in markets abroad and use our membership in multilateral organizations, such as the Asia-Pacific Economic Cooperation (APEC) forum, the Organization for Economic Coopera tion and Development (OECD), the World Trade Organization (WTO) Energy Services Negotiations, the Free Trade Area of the Americas (FTAA), and our bilateral relation ships to implement a system of clear, open, and transparent rules and procedures gov erning foreign investment; to level the playing field for U.S. companies overseas; and to reduce barriers to trade and investment.

★ The NEPD Group recommends that the President direct the Secretaries of Commerce and Energy, and the U.S. Trade Representative, to support a sectoral trade initiative to expand investment and trade in energy-related goods and services that will enhance ex ploration, production, and refining, as well as the development of new technologies.

★ The NEPD Group recommends that the President direct the Secretaries of State, Treasury, and Commerce to initiate a comprehensive review of sanctions. Energy secu rity should be one of the factors considered in such a review.

★ The NEPD Group recommends that the President direct the Secretaries of State, Commerce, and Energy to engage in a dialogue through the North American Energy Working Group to develop closer energy integration among Canada, Mexico, and the United States and identify areas of cooperation, fully consistent with the countries' re spective sovereignties.

★ The NEPD Group recommends that the President direct the Secretaries of Energy and State, in consultation with the Federal Energy Regulatory Commission, to review their respective oil, natural gas, and electricity cross-boundary "Presidential Permitting" authorities, and to propose reforms as necessary in order to make their own regulatory regimes more compatible for cross-border trade.

★ The NEPD Group recommends that the President direct the Secretaries of Energy and State, coordinating with the Secretary of the Interior and the Federal Energy Regulatory Commission, to work closely with Canada, the State of Alaska, and all other interested parties to expedite the construction of a pipeline to deliver natural gas to the lower 48 states. This should include proposing to Congress any changes or waivers of law pursuant to the Alaska Natural Gas Transportation Act of 1976 that may be required.

★ The NEPD Group recommends that the President direct the Secretaries of State and Commerce to conclude negotiations with Venezuela on a Bilateral Investment Treaty, and propose formal energy consultations with Brazil, to improve the energy invest ment climate for the growing level of energy investment flows between the United States and each of these countries.

★ The NEPD Group recommends that the President direct the Secretaries of Energy, Commerce, and State to work through the Summit of the Americas Hemispheric En ergy Initiative to develop effective and stable regulatory frameworks and foster reli able supply sources of all fuels within the region.

★ The NEPD Group recommends that the President direct the Secretaries of State, Energy, and Commerce to reinvigorate the U.S.-Africa Trade and Economic Coopera tion Forum and the U.S.-African Energy Ministerial process; deepen bilateral and mul tilateral engagement to promote a more receptive environment for U.S. oil and gas trade, investment, and operations; and promote geographic diversification of energy supplies, addressing such issues as transparency, sanctity of contracts, and security.

★ The NEPD Group recommends that the President direct the Secretaries of State, Commerce, and Energy to support more transparent, accountable, and responsible use of oil resources in African producer countries to enhance the stability and security of trade and investment environments.

★ The NEPD Group recommends that the President direct the Secretaries of State, Commerce, and Energy to support the BTC oil pipeline as it demonstrates its commer cial viability.

★ The NEPD Group recommends that the President direct the Secretaries of Com merce, State, and Energy to continue working with relevant companies and countries to establish the commercial conditions that will allow oil companies operating in Kazakhstan the option of exporting their oil via the BTC pipeline.

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★ The NEPD Group recommends that the President direct the Secretaries of Com merce, Energy, and State to deepen their commercial dialogue with Kazakhstan, Azerbaijan, and other Caspian states to provide a strong, transparent, and stable business climate for energy and related infrastructure projects.

★ The NEPD Group recommends that the President direct the Secretaries of State, Commerce, and Energy to deepen the focus of the discussions with Russia on energy and the investment climate.

★ The NEPD Group recommends that the President direct the Secretaries of Com merce, State, and Energy to assist U.S. companies in their dialogue on the investment and trade climate with Russian officials, to encourage reform of the PSA law and other regulations and related tax provisions, as well as general improvements in the overall investment climate. This will help expand private investment opportunities in Russia and will increase the international role of Russian firms.

★ The NEPD Group recommends that the President direct the Secretaries of State, Commerce, and Energy to continue to work in the APEC Energy Working Group to ex amine oil market data transparency issues and the variety of ways petroleum stocks can be used as an option to address oil market disruptions.

★ The NEPD Group recommends that the President direct the Secretaries of State and Energy to work with India's Ministry of Petroleum and Natural Gas to help India maxi mize its domestic oil and gas production.

★ The NEPD Group recommends that the President direct the Secretaries of Com merce, State, and Energy to promote market-based solutions to environmental con cerns; support exports of U.S. clean energy technologies and encourage their overseas development; engage bilaterally and multilaterally to promote best practices; explore collaborative international basic research and development in energy alternatives and energy-efficient technologies; and explore innovative programs to support the global adoption of these technologies.

★ The NEPD Group recommends that the President direct federal agencies to support continued research into global climate change; continue efforts to identify environ mentally and cost-effective ways to use market mechanisms and incentives; continue development of new technologies; and cooperate with allies, including through inter national processes, to develop technologies, market-based incentives, and other inno vative approaches to address the issue of global climate change.

★ The NEPD Group recommends that the President seek to increase international co operation on finding alternatives to oil, especially for the transportation sector.

★ The NEPD Group recommends that the President direct the Secretary of State to re invigorate its dialogue with the European Union on energy issues, and resume the con sultative process this year in Washington.

★ The NEPD Group recommends that the President promote a coordinated approach to energy security by calling for an annual meeting of G-8 Energy Ministers or their equivalents.

★ The NEPD Group recommends that the President reaffirm that the SPR is designed for addressing an imminent or actual disruption in oil supplies, and not for managing prices.

★ The NEPD Group recommend that the President direct the Secretary of Energy to work within the International Energy Agency (IEA) to ensure that member states ful fill their stockholding.

★ The NEPD Group recommends that the President direct the Secretary of Energy to encourage major oil-consuming countries that are not IEA members to consider strate gic stocks as an option for addressing potential supply disruptions. In this regard, we should work closely with Asian economies, especially through APEC.

★ The NEPD Group recommends that the President direct the Secretary of Energy of fer to lease excess SPR storage facilities to countries (both IEA and non-IEA mem bers) that might not otherwise build storage facilities or hold sufficient strategic stocks, consistent with statutory authorities.

★ The NEPD Group recommends that the President, at such time that exchanged SPR barrels are returned to the SPR, should determine whether offshore Gulf of Mexico royalty oil deposits to the SPR should be resumed, thereby increasing the size of our reserve.

★ The NEPD Group recommends that the President direct the Secretary of Energy to work closely with Congress to ensure that our SPR protection is maintained.

★ The NEPD Group recommends that the President direct the Secretary of Energy to work with producer and consumer country allies and the IEA to craft a more compre hensive and timely world oil data reporting system.

CHAPTER ONE
Taking Stock: Energy Challenges Facing the United States

★ The NEPD Group recommends that the President issue an Executive Order to direct all federal agencies to include in any regulatory action that could significantly and adversely affect energy supplies, distribution, or use, a detailed statement on: (1) the energy impact of the proposed action, (2) any adverse energy effects that cannot be avoided should the proposal be implemented, and (3) alternatives to the proposed action. The agencies would be directed to include this statement in all submissions to the Office of Management and Budget of proposed regulations covered by Executive Order 12866, as well as in all notices of proposed regulations published in the Federal Register.

★ The NEPD Group recommends that the President direct the executive agencies to work closely with Congress to implement the legislative components of a national energy policy.

★ The NEPD Group recommends to the President that the NEPD Group continue to work and meet on the implementation of the National Energy Policy and explore other ways to advance dependable, affordable, and environmentally responsible production and distribution of energy.

Note: All recommendations in this report are subject to execution in accordance with applicable law. Legislation would be sought where needed. Also, any recommendations that involve foreign countries would be executed in accordance with the customs of international relations, including appropriate diplomatic consultation.

CHAPTER TWO
Striking Home The Impacts of High Energy Prices on Families, Communities, and Businesses

★ The NEPD Group recommends that the President direct the Secretary of Energy to ex plore potential opportunities to develop educational programs related to energy develop ment and use. This should include possible legislation to create public education aware ness programs about energy. Such programs should be long-term in nature, should be funded and managed by the respective energy industries, and should include information on energy's compatibility with a clean environment.

★ The NEPD Group recommends that the President take steps to mitigate impacts of high energy costs on low-income consumers. These steps would include:

- Strengthening the Low Income Home Energy Assistance Program by making $1.7 bil lion available annually. This is an increase of $300 million over the regular FY 2001 ap propriation.
- Directing the Secretaries of Interior and Health and Human Services to propose legis lation to bolster LIHEAP funding by using a portion of oil and gas royalty payments.
- Redirecting royalties above a set trigger price to LIHEAP, whenever crude oil and natural gas prices exceed that trigger price, as determined by the responsible agencies.

★ The NEPD Group recommends that the President increase funding for the Weatheriza tion Assistance Program by $1.2 billion over ten years. This will roughly double the spend ing during that period on weatherization. Consistent with that commitment, the FY 2002 Budget includes a $120 million increase over 2001. The Department of Energy will have the option of using a portion of those funds to test improved implementation approaches for the weatherization program.

★ The NEPD Group recommends that the President support legislation to allow funds dedicated for the Weatherization and State Energy Programs to be transferred to LIHEAP if the Department of Energy deems it appropriate.

★ The NEPD Group recommends the President recognize unique regional energy con cerns by working with the National Governors Association and regional governor associa tions to determine how to better serve the needs of diverse areas of the country.

★ The NEPD Group recommends the President direct FEMA to prepare for potential en ergy emergencies.

- FEMA should work with states' Offices of Emergency Management as they expand existing emergency operations plans to identify potential problems and address conse quences of the power shortages. FEMA should use its current Regional Incident Re porting System to identify any situations that might demand immediate attention.
- Using the structure of the already existing Federal Response Plan, FEMA should con duct Regional Interagency Steering Committee (RISC) meetings for states affected by the energy shortfalls. The RISC is a FEMA-led interagency committee comprised of agencies and departments that support the Federal Response Plan. Either an upcom ing, scheduled RISC meeting or a special-focus RISC meeting can be held to identify the short-term energy outlook, as well as any expected consequences, in each of the states during the peak summer season.

CHAPTER THREE

Protecting America's Environment: Sustaining the Nation's Health and Environment

★ The NEPD Group recommends that the President direct the Administrator of the Environmental Protection Agency (EPA) to propose multi-pollutant legislation. The NEPD Group recommends that the President direct the EPA Administrator to work with Congress to propose legislation that would establish a flexible, market-based program to significantly reduce and cap emissions of sulfur dioxide, nitrogen oxides, and mercury from electric power generators. Such a program (with appropriate measures to address local concerns) would provide significant public health benefits even as we increase electricity supplies.

- Establish mandatory reduction targets for emissions of three main pollutants: sulfur dioxide, nitrogen oxides, and mercury.
- Phase in reductions over a reasonable period of time, similar to the successful acid rain reduction program established by the 1990 amendments to the Clean Air Act.
- Provide regulatory certainty to allow utilities to make modifications to their plants without fear of new litigation.
- Provide market-based incentives, such as emissions trading credits to help achieve the required reductions.

★ The NEPD Group recommends the President direct the Secretary of the Interior to work with Congress to create the "Royalties Conservation Fund."

- This fund will earmark potentially billions of dollars in royalties from new oil and gas production in ANWR to fund land conservation efforts.
- This fund will also be used to eliminate the maintenance and improvements backlog on federal lands.

★ The NEPD Group recommends the President issue an Executive Order to rational ize permitting for energy production in an environmentally sound manner by directing federal agencies to expedite permits and other federal actions necessary for energy related project approvals on a national basis. This order would establish an inter agency task force chaired by the Council on Environmental Quality to ensure that federal agencies responsible for permitting energy-related facilities are coordinating their efforts. The task force will ensure that federal agencies set up appropriate mechanisms to coordinate federal, state, tribal, and local permitting activity in particu lar regions where increased activity is expected.

CHAPTER FOUR
Using Energy Wisely: Increasing Energy Conservation and Efficiency

★ The NEPD Group recommends that the President direct the Office of Science and Technology Policy and the President's Council of Advisors on Science and Technology to review and make recommendations on using the nation's energy resources more effi ciently.

★ The NEPD Group recommends that the President direct the Secretary of Energy to conduct a review of current funding and historic performance of energy efficiency re search and development programs in light of the recommendations of this report. Based on this review, the Secretary of Energy is then directed to propose appropriate funding of those research and development programs that are performance-based and are modeled as public-private partnerships.

★ The NEPD Group recommends that the President direct the Secretary of Energy to promote greater energy efficiency.

- Expand the Energy Star program beyond office buildings to include schools, re tail buildings, health care facilities, and homes.
- Extend the Energy Star labeling program to additional products, appliances, and services.
- Strengthen Department of Energy public education programs relating to energy efficiency.

★ The NEPD Group recommends that the President direct the Secretary of Energy to improve the energy efficiency of appliances.

- Support the appliance standards program for covered products, setting higher standards where technologically feasible and economically justified.
- Expand the scope of the appliance standards program, setting standards for ad ditional appliances where technologically feasible and economically justified.

★ The NEPD Group recommends that the President direct heads of executive depart ments and agencies to take appropriate actions to conserve energy use at their facilities to the maximum extent consistent with the effective discharge of public responsibili ties. Agencies located in regions where electricity shortages are possible should con serve especially during periods of peak demand. Agencies should report to the Presi dent, through the Secretary of Energy, within 30 days on the conservation actions taken.

★ The NEPD Group recommends that the President direct the Secretary of the Trea sury to work with Congress to encourage increased energy efficiency through combined heat and power (CHP) projects by shortening the depreciation life for CHP projects or providing investment tax credits.

★ The NEPD Group recommends that the President direct the Administrator of the En vironmental Protection Agency (EPA) to work with local and state governments to pro mote the use of well-designed CHP and other clean power generation at brownfields sites, consistent with the local communities' interests. EPA will also work to clarify li ability issues if they are raised at a particular site.

CHAPTER FOUR

★ The NEPD Group recommends that the President direct the EPA Administrator to promote CHP through flexibility in environmental permitting.

★ The NEPD Group recommends that the President direct the Secretary of Transporta tion to:

- Review and provide recommendations on establishing Corporate Average Fuel Economy (CAFE) standards with due consideration of the National Academy of Sciences study to be released in July 2001. Responsibly crafted CAFE standards should increase efficiency without negatively impacting the U.S. automotive indus try. The determination of future fuel economy standards must therefore be ad dressed analytically and based on sound science.
- Consider passenger safety, economic concerns, and disparate impact on the U.S. versus foreign fleet of automobiles.
- Look at other market-based approaches to increasing the national average fuel economy of new motor vehicles.

★ The new NEPD Group recommends that the President direct the Secretary of Trans portation to review and promote congestion mitigation technologies and strategies and work with Congress on legislation to implement these strategies.

★ The NEPD Group recommends that the President direct the Secretary of the Trea sury to work with Congress on legislation to increase energy efficiency with a tax credit for fuel-efficient vehicles. The NEPD Group recommends that a temporary, efficiency based income tax credit be available for purchase of new hybrid fuel cell vehicles be tween 2002 and 2007.

★ The NEPD Group recommends that the President direct all agencies to use techno logical advances to better protect our environment.

- The Administration remains committed to investing in Intelligent Transportation Systems (ITS) and encourages the private sector to invest in ITS applications. This Department of Transportation (DOT) program funds the development of improved transportation infrastructure that will reduce congestion, such as trav eler information/navigation systems, freeway management, and electronic toll collection. ITS applications reduce fuel associated with travel.
- The Administration remains committed to the DOT's fuel-cell-powered transit bus program, authored by the Transportation Equity Act for the 21st Century (TEA-21). This program demonstrates the viability of fuel-cell power plants for transit bus applications.
- The Administration remains committed to the Clean Buses program. TEA-21 es tablishes a new clean fuel formula grant program, which provides an opportu nity to accelerate the introduction of advanced bus propulsion technologies into the mainstream of the nation's transit fleet.

★ The NEPD Group recommends that the President direct the EPA and DOT to develop ways to reduce demand for petroleum transportation fuels by working with the trucking industry to establish a program to reduce emissions and fuel consumption from long-haul trucks at truck stops by implementing alternatives to idling, such as electrification and auxiliary power units at truck stops along interstate highways. EPA and DOT will develop partnership agreements with trucking fleets, truck stops, and manufacturers of idle-reducing technologies (*e.g.*, portable auxiliary packs, electrification) to install and use low emission-idling technologies.

★ The NEPD Group recommends that the President direct the Secretary of Energy to establish a national priority for improving energy efficiency. The priority would be to improve the energy intensity of the U.S. economy as measured by the amount of energy required for each dollar of economic productivity. This increased efficiency should be pursued through the combined efforts of industry, consumers, and federal, state, and local governments.

★ The NEPD Group recommends that the President direct the EPA Administrator to develop and implement a strategy to increase public awareness of the sizable savings that energy efficiency offers to homeowners across the country. Typical homeowners can save about 30 percent (about $400) a year on their home energy bill by using Energy Star labeled products.

Chapter Five Energy for a New Century: Increasing Domestic Energy Supplies

★ The NEPD Group recommends that the President direct the Secretaries of Energy and the Interior to promote enhanced oil and gas recovery from existing wells through new technology.

★ The NEPD Group recommends that the President direct the Secretary of Energy to improve oil and gas exploration technology through continued partnership with public and private entities.

★ The NEPD Group recommends that the President direct the Secretary of the Interior to examine land status and lease stipulation impediments to federal oil and gas leasing, and review and modify those where opportunities exist (consistent with the law, good environmental practice, and balanced use of other resources).

- Expedite the ongoing Energy Policy and Conservation Act study of impediments to federal oil and gas exploration and development.
- Review public lands withdrawals and lease stipulations, with full public consultation, especially with the people in the region, to consider modifications where appropriate.

★ The NEPD Group recommends that the President direct the Secretary of the Interior to consider economic incentives for environmentally sound offshore oil and gas development where warranted by specific circumstances: explore opportunities for royalty reductions, consistent with ensuring a fair return to the public where warranted for enhanced oil and gas recovery; for reduction of risk associated with production in frontier areas or deep gas formations; and for development of small fields that would otherwise be uneconomic.

★ The NEPD Group recommends that the President direct the Secretaries of Commerce and Interior to re-examine the current federal legal and policy regime (statutes, regulations, and Executive Orders) to determine if changes are needed regarding energy-related activities and the siting of energy facilities in the coastal zone and on the Outer Continental Shelf (OCS).

★ The NEPD Group recommends that the President direct the Secretary of the Interior continue OCS oil and gas leasing and approval of exploration and development plans on predictable schedules.

★ The NEPD Group recommends that the President direct the Secretary of the Interior to consider additional environmentally responsible oil and gas development, based on sound science and the best available technology, through further lease sales in the National Petroleum Reserve-Alaska. Such consideration should include areas not currently leased within the Northeast corner of the Reserve.

★ The NEPD Group recommends that the President direct the Secretary of the Interior work with Congress to authorize exploration and, if resources are discovered, development of the 1002 Area of ANWR. Congress should require the use of the best available technology and should require that activities will result in no significant adverse impact to the surrounding environment.

★ The NEPD Group recommends that the President direct the Secretary of the Interior to work with Congress and the State of Alaska to put in place the most expeditious process for renewal of the Trans-Alaska Pipeline System rights-of-way to ensure that Alaskan oil continues to flow uninterrupted to the West Coast of the United States.

★ The NEPD Group recommends that the President direct the Secretary of Energy to propose comprehensive electricity legislation that promotes competition, protects consumers, enhances reliability, promotes renewable energy, improves efficiency repeals the Public Utility Holding Company Act, and reforms the Public Utility Regulatory Policies Act.

★ The NEPD Group recommends that the President encourage FERC to use its existing statutory authority to promote competition and encourage investment in transmission facilities.

★ The NEPD Group recognizes the importance of looking to technology to help us meet the goals of increasing electricity generation while protecting our environment. To that end, the NEPD Group recommends that the President direct the Department of Energy to continue to develop advanced clean coal technology by:

- Investing $2 billion over 10 years to fund research in clean coal technologies.
- Supporting a permanent extension of the existing research and development tax credit.
- Directing federal agencies to explore regulatory approaches that will encourage advancements in environmental technology.

★ The NEPD Group recommends that the President direct federal agencies to provide greater regulatory certainty relating to coal electricity generation through clear policies that are easily applied to business decisions.

★ The NEPD Group recommends that the President support the expansion of nuclear energy in the United States as a major component of our national energy policy. Following are specific components of the recommendation:

- Encourage the Nuclear Regulatory Commission (NRC) to ensure that safety and environmental protection are high priorities as they prepare to evaluate and expedite applications for licensing new advanced-technology nuclear reactors.
- Encourage the NRC to facilitate efforts by utilities to expand nuclear energy generation in the United States by uprating existing nuclear plants safely.
- Encourage the NRC to relicense existing nuclear plants that meet or exceed safety standards.
- Direct the Secretary of Energy and the Administrator of the Environmental Protection Agency to assess the potential of nuclear energy to improve air quality.
- Increase resources as necessary for nuclear safety enforcement in light of the potential increase in generation.
- Use the best science to provide a deep geologic repository for nuclear waste.
- Support legislation clarifying that qualified funds set aside by plant owners for eventual decommissioning will not be taxed as part of the transaction.
- Support legislation to extend the Price–Anderson Act.

★ The NEPD Group recommends that, in the context of developing advanced nuclear fuel cycles and next generation technologies for nuclear energy, the United States should reexamine its policies to allow for research, development and deployment of fuel conditioning methods (such as pyroprocessing) that reduce waste streams and enhance proliferation resistance. In doing so, the United States will continue to discourage the accumulation of separated plutonium, worldwide.

★ The United States should also consider technologies (in collaboration with international partners with highly developed fuel cycles and a record of close cooperation) to develop reprocessing and fuel treatment technologies that are cleaner, more efficient, less waste intensive, and more proliferation-resistant.

CHAPTER FIVE

★ The NEPD Group recognizes there is a need to reduce the time and cost of the hydro power licensing process. The NEPD Group recommends that the President encourage the Federal Energy Regulatory Commission (FERC) and direct federal resource agencies to make the licensing process more clear and efficient, while preserving environmental goals. In addi tion, the NEPD Group recognizes the importance of optimizing the efficiency and reliability of existing hydropower facilities and will encourage the Administration to adopt efforts to ward that end.

- Support administrative and legislative reform of the hydropower licensing process.
- Direct federal resource agencies to reach interagency agreement on conflicting manda tory license conditions before they submit their conditions to FERC for inclusion in a license.
- Encourage FERC to adopt appropriate deadlines for its own actions during the licensing process.

CHAPTER SIX
Nature's Power: Increasing America's Use of Renewable and Alternative Energy

★ The NEPD Group recommends that the President direct the Secretaries of the Interior and Energy to re-evaluate access limitations to federal lands in order to increase renewable energy production, such as biomass, wind, geothermal, and solar.

★ The NEPD Group supports the increase of $39.2 million in the FY 2002 budget amendment for the Department of Energy's Energy Supply account that would provide increased support for research and development of renewable energy re sources.

★ The NEPD Group recommends that the President direct the Secretary of Energy to conduct a review of current funding and historic performance of renewable energy and alternative energy research and development programs in light of the recommen dations of this report. Based on this review, the Secretary of Energy is then directed to propose appropriate funding of those research and development programs that are performance-based and are modeled as public-private partnerships.

★ The NEPD Group recommends that the President direct the Secretary of the Treasury to work with Congress on legislation to expand the section 29 tax credit to make it available for new landfill methane projects. The credit could be tiered, de pending on whether a landfill is already required by federal law to collect and flare its methane emissions due to local air pollution concerns.

★ The NEPD Group recommends that the President direct the Secretary of the Interior to determine ways to reduce the delays in geothermal lease processing as part of the permitting review process.

★ The NEPD Group recommends that the President direct the Administrator of the Environmental Protection Agency to develop a new renewable energy partnership program to help companies more easily buy renewable energy, as well as receive recognition for the environmental benefits of their purchase, and help consumers by promoting consumer choice programs that increase their knowledge about the environmental benefits of purchasing renewable energy.

★ The NEPD Group recommends that the President direct the Secretary of the Treasury to work with Congress on legislation to extend and expand tax credits for electricity produced using wind and biomass. The President's budget request extends the present 1.7 cents per kilowatt hour tax credit for electricity produced from wind and biomass; expands eligible biomass sources to include forest-related sources, agricultural sources, and certain urban sources; and allows a credit for electricity produced from biomass co-fired with coal.

★ The NEPD Group recommends that the President direct the Secretary of the Treasury to work with Congress on legislation to provide a new 15 percent tax credit for residential solar energy property, up to a maximum credit of $2,000.

★ The NEPD Group recommends that the President direct the Secretaries of the Interior and Energy to work with Congress on legislation to use an estimated $1.2 billion of bid bonuses from the environmentally responsible leasing of ANWR for funding research into alternative and renewable energy resources, including wind, solar, geothermal, and biomass.

★ The NEPD Group recommends that the President direct the Secretary of the Treasury to work with Congress to continue the ethanol excise tax exemption.

CHAPTER SIX

★ The NEPD Group recommends that the President direct the Secretary of Energy to develop next-generation technology—including hydrogen and fusion.

- Develop an education campaign that communicates the benefits of alternative forms of energy, including hydrogen and fusion.
- Focus research and development efforts on integrating current programs regarding hydrogen, fuel cells, and distributed energy.
- Support legislation reauthorizing the Hydrogen Energy Act.

★ The NEPD Group recommends that the President direct the Secretary of the Treasury to work with Congress to develop legislation to provide for a temporary income tax credit available for the purchase of new hybrid or fuel-cell vehicles between 2002 and 2007.

★ The NEPD Group recommends that the President direct the Administrator of the Environmental Protection Agency to issue guidance to encourage the development of well-designed combined heat and power (CHP) units that are both highly efficient and have low emissions. The goal of this guidance would be to shorten the time needed to obtain each permit, provide certainty to industry by ensuring consistent implementation across the country, and encourage the use of these cleaner, more efficient technologies.

CHAPTER SEVEN
America's Energy Infrastructure: A Comprehensive Delivery System

★ The NEPD Group recommends that the President direct the Secretary of Energy to work with the Federal Energy Regulatory Commission (FERC) to improve the reliabil ity of the interstate transmission system and to develop legislation providing for en forcement by a self-regulatory organization subject to FERC oversight.

★ The NEPD Group recommends that the President direct the Secretary of Energy to expand the Department's research and development on transmission reliability and superconductivity.

★ The NEPD Group recommends that the President direct the Secretary of Energy to au thorize the Western Area Power Administration to explore relieving the "Path 15" bottle neck through transmission expansion financed by nonfederal contributions.

★ The NEPD Group recommends that the President direct the appropriate federal agencies to take actions to remove constraints on the interstate transmission grid and allow our nation's electricity supply to meet the growing needs of our economy.

- Direct the Secretary of Energy, by December 31, 2001, to examine the benefits of establishing a national grid, identify transmission bottlenecks, and identify mea sures to remove transmission bottlenecks.
- Direct the Secretary of Energy to work with FERC to relieve transmission con straints by encouraging the use of incentive rate-making proposals.
- Direct the federal utilities to determine whether transmission expansions are nec essary to remove constraints. The Administration should review the Bonneville Power Administration's (BPA's) capital and financing requirements in the context of its membership in a regional RTO, and if additional Treasury financing appears war ranted or necessary in the future, the Administration should seek an increase in BPA's borrowing authority at that time.
- Direct the Secretary of Energy, in consultation with appropriate federal agencies and state and local government officials, to develop legislation to grant authority to obtain rights-of-way for electricity transmission lines, with the goal of creating a re liable national transmission grid. Similar authority already exists for natural gas pipelines in recognition of their role in interstate commerce.

★ The NEPD Group recommends that the President direct the Secretary of the Inte rior to work with Congress and the State of Alaska to put in place the most expedi tious process for renewal of the Trans-Alaskan Pipeline System lease to ensure that Alaskan oil continues to flow uninterrupted to the West Coast of the United States.

★ The NEPD Group recommends that the President direct the Secretaries of Energy and State, coordinating with the Secretary of the Interior and the Federal Energy Regulatory Commission, to work closely with Canada, the State of Alaska, and all other interested parties to expedite the construction of a pipeline to deliver natural gas to the lower 48 states. This should include proposing to Congress any changes or waivers of law pursuant to the Alaska Natural Gas Transportation Act of 1976 that may be required.

★ The NEPD Group recommends that the President support legislation to improve the safety of natural gas pipelines, protect the environment, strengthen emergency preparedness and inspections and bolster enforcement.

CHAPTER SEVEN

★ The NEPD Group recommends that the President direct agencies to continue their interagency efforts to improve pipeline safety and expedite pipeline permitting in an environmentally sound manner and encourage FERC to consider improvements in the regulatory process governing approval of interstate natural gas pipeline projects.

★ The NEPD Group recommends that the President direct the Administrator of the EPA to study opportunities to maintain or improve the environmental benefits of state and local "boutique" clean fuel programs while exploring ways to increase the flexibility of the fuels distribution infrastructure, improve fungibility, and provide added gasoline market liquidity. In concluding this study, the Administrator shall con sult with the Departments of Energy and Agriculture, and other agencies as needed.

★ The NEPD Group recommends that the President direct the Administrator of the Environmental Protection Agency and the Secretary of Energy to take steps to ensure America has adequate refining capacity to meet the needs of consumers.

- Provide more regulatory certainty to refinery owners and streamline the permitting process where possible to ensure that regulatory overlap is limited.
- Adopt comprehensive regulations (covering more than one pollutant and require ment) and consider the rules' cumulative impacts and benefits.

★ The NEPD Group recommends that the President direct the Administrator of the Environmental Protection Agency, in consultation with the Secretary of Energy and other relevant agencies, to review New Source Review regulations, including adminis trative interpretation and implementation, and report to the President within 90 days on the impact of the regulations on investment in new utility and refinery generation capacity, energy efficiency, and environmental protection.

★ The NEPD Group recommends that the President direct the Attorney General to review existing enforcement actions regarding New Source Review to ensure that the enforcement actions are consistent with the Clean Air Act and its regulations.

★ The NEPD Group supports the President's budget proposal to provide $8 million to maintain the two-million-barrel Northeast Heating Oil Reserve. Operated by the pri vate sector, the Reserve helps ensure adequate supplies of heating oil in the event that colder than normal winters occur in the Northeast United States.

CHAPTER 8
Strengthening Global Alliances: Enhancing National Energy Security and International Relationships

★ The NEPD Group recommends that the President make energy security a priority of our trade and foreign policy.

★ The NEPD Group recommends the President support initiatives by Saudi Arabia, Ku wait, Algeria, Qatar, the UAE, and other suppliers to open up areas of their energy sec tors to foreign investment.

★ The NEPD Group recommends that the President direct the Secretaries of State, En ergy and Commerce work to improve dialogue among energy producing and consuming nations.

★ The NEPD Group recommends that the President direct the Secretaries of State, Commerce, and Energy to continue supporting American energy firms competing in markets abroad and use our membership in multilateral organizations, such as the Asia-Pacific Economic Cooperation (APEC) forum, the Organization for Economic Coopera tion and Development (OECD), the World Trade Organization (WTO) Energy Services Negotiations, the Free Trade Area of the Americas (FTAA), and our bilateral relation ships to implement a system of clear, open, and transparent rules and procedures gov erning foreign investment; to level the playing field for U.S. companies overseas; and to reduce barriers to trade and investment.

★ The NEPD Group recommends that the President direct the Secretaries of Commerce and Energy, and the U.S. Trade Representative, to support a sectoral trade initiative to expand investment and trade in energy-related goods and services that will enhance ex ploration, production, and refining, as well as the development of new technologies.

★ The NEPD Group recommends that the President direct the Secretaries of State, Treasury, and Commerce to initiate a comprehensive review of sanctions. Energy securi ty should be one of the factors considered in such a review.

★ The NEPD Group recommends that the President direct the Secretaries of State, Commerce, and Energy to engage in a dialogue through the North American Energy Working Group to develop closer energy integration among Canada, Mexico, and the United States and identify areas of cooperation, fully consistent with the countries' re spective sovereignties.

★ The NEPD Group recommends that the President direct the Secretaries of Energy and State, in consultation with the Federal Energy Regulatory Commission, to review their respective oil, natural gas, and electricity cross-boundary "Presidential Permitting" authorities, and to propose reforms as necessary in order to make their own regulatory regimes more compatible for cross-border trade.

★ The NEPD Group recommends that the President direct the Secretaries of Energy and State, coordinating with the Secretary of the Interior and the Federal Energy Regulatory Commission, to work closely with Canada, the State of Alaska, and all other interested parties to expedite the construction of a pipeline to deliver natural gas to the lower 48 states. This should include proposing to Congress any changes or waivers of law pursuant to the Alaska Natural Gas Transportation Act of 1976 that

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may be required.

★ The NEPD Group recommends that the President direct the Secretaries of State and Commerce to conclude negotiations with Venezuela on a Bilateral Investment Treaty, and propose formal energy consultations with Brazil, to improve the energy investment climate for the growing level of energy investment flows between the United States and each of these countries.

★ The NEPD Group recommends that the President direct the Secretaries of Energy, Commerce, and State to work through the Summit of the Americas Hemispheric Ener gy Initiative to develop effective and stable regulatory frameworks and foster reliable supply sources of all fuels within the region.

★ The NEPD Group recommends that the President direct the Secretaries of State, En ergy, and Commerce to reinvigorate the U.S.-Africa Trade and Economic Cooperation Forum and the U.S.-African Energy Ministerial process; deepen bilateral and multilater al engagement to promote a more receptive environment for U.S. oil and gas trade, in vestment, and operations; and promote geographic diversification of energy supplies, addressing such issues as transparency, sanctity of contracts, and security.

★ The NEPD Group recommends that the President direct the Secretaries of State, Commerce, and Energy to support more transparent, accountable, and responsible use of oil resources in African producer countries to enhance the stability and security of trade and investment environments.

★ The NEPD Group recommends that the President direct the Secretaries of State, Commerce, and Energy to support the BTC oil pipeline as it demonstrates its commer cial viability.

★ The NEPD Group recommends that the President direct the Secretaries of Com merce, State, and Energy to continue working with relevant companies and countries to establish the commercial conditions that will allow oil companies operating in Kaza khstan the option of exporting their oil via the BTC pipeline.

★ The NEPD Group recommends that the President direct the Secretaries of State, Commerce, and Energy to support the efforts of private investors and regional govern ments to develop the Shah Deniz gas pipeline as a way to help Turkey and Georgia di versify their natural gas supplies and help Azerbaijan export its gas via a pipeline that will continue diversification of secure energy supply routes.

★ The NEPD Group recommends that the President direct appropriate federal agen cies to complete the current cycle of oil spill response readiness workshops and to consider further appropriate steps to ensure the implementation of the workshops' rec ommendations.

★ The NEPD Group recommends that the President direct the Secretary of State to en courage Greece and Turkey to link their gas pipeline systems to allow European con sumers to diversify their gas supplies by purchasing Caspian gas.

★ The NEPD Group recommends that the President direct the Secretaries of Commerce, Energy, and State to deepen their commercial dialogue with Kazakhstan, Azerbaijan, and other Caspian states to provide a strong, transparent, and stable business climate for energy and related infrastructure projects.

★ The NEPD Group recommends that the President direct the Secretaries of State, Commerce, and Energy to deepen the focus of the discussions with Russia on energy and the investment climate.

★ The NEPD Group recommends that the President direct the Secretaries of Commerce, State, and Energy to assist U.S. companies in their dialogue on the investment and trade climate with Russian officials, to encourage reform of the PSA law and other regulations and related tax provisions, as well as general improvements in the overall investment climate. This will help expand private investment opportunities in Russia and will increase the international role of Russian firms.

★ The NEPD Group recommends that the President direct the Secretaries of State, Commerce, and Energy to continue to work in the APEC Energy Working Group to examine oil market data transparency issues and the variety of ways petroleum stocks can be used as an option to address oil market disruptions.

★ The NEPD Group recommends that the President direct the Secretaries of State and Energy to work with India's Ministry of Petroleum and Natural Gas to help India maximize its domestic oil and gas production.

★ The NEPD Group recommends that the President direct the Secretaries of Commerce, State, and Energy to promote market-based solutions to environmental concerns; support exports of U.S. clean energy technologies and encourage their overseas development; engage bilaterally and multilaterally to promote best practices; explore collaborative international basic research and development in energy alternatives and energy-efficient technologies; and explore innovative programs to support the global adoption of these technologies.

★ The NEPD Group recommends that the President direct federal agencies to support continued research into global climate change; continue efforts to identify environmentally and cost-effective ways to use market mechanisms and incentives; continue development of new technologies; and cooperate with allies, including through international processes, to develop technologies, market-based incentives, and other innovative approaches to address the issue of global climate change.

★ The NEPD Group recommends that the President seek to increase international cooperation on finding alternatives to oil, especially for the transportation sector.

★ The NEPD Group recommends that the President direct the Secretary of State to reinvigorate its dialogue with the European Union on energy issues, and resume the consultative process this year in Washington.

★ The NEPD Group recommends that the President promote a coordinated approach to energy security by calling for an annual meeting of G-8 Energy Ministers or their equivalents.

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★ The NEPD Group recommends that the President reaffirm that the SPR is designed for addressing an imminent or actual disruption in oil supplies, and not for managing prices.

★ The NEPD Group recommend that the President direct the Secretary of Energy to work within the International Energy Agency (IEA) to ensure that member states ful fill their stockholding.

★ The NEPD Group recommends that the President direct the Secretary of Energy to encourage major oil-consuming countries that are not IEA members to consider stra tegic stocks as an option for addressing potential supply disruptions. In this regard, we should work closely with Asian economies, especially through APEC.

★ The NEPD Group recommends that the President direct the Secretary of Energy of fer to lease excess SPR storage facilities to countries (both IEA and non-IEA mem bers) that might not otherwise build storage facilities or hold sufficient strategic stocks, consistent with statutory authorities.

★ The NEPD Group recommends that the President, at such time that exchanged SPR barrels are returned to the SPR, should determine whether offshore Gulf of Mexi co royalty oil deposits to the SPR should be resumed, thereby increasing the size of our reserve.

★ The NEPD Group recommends that the President direct the Secretary of Energy to work closely with Congress to ensure that our SPR protection is maintained.

★ The NEPD Group recommends that the President direct the Secretary of Energy to work with producer and consumer country allies and the IEA to craft a more compre hensive and timely world oil data reporting system.

Glossary

Barrel (Oil): A unit of volume equal to 42 U.S. gallons.

Barrels per Day (Operable Refinery Capacity): The maximum number of barrels of in put that can be processed during a 24-hour period after making allowances for the following limitations: the capability of downstream facilities to absorb the output of crude oil process ing facilities of a given refinery (no reduction is made when a planned distribution of inter mediate streams through other than downstream facilities is part of a refinery's normal op eration); the types and grades of inputs to be processed; the types and grades of products to be manufactured; the environmental constraints associated with refinery operations; the re duction of capacity for scheduled downtime, such as routine inspection, mechanical prob lems, maintenance, repairs, and turnaround; and the reduction of capacity for unscheduled downtime, such as mechanical problems, repairs, and slowdowns.

Biomass: Organic nonfossil material of biological origin constituting a renewable energy source.

British Thermal Unit (Btu): The quantity of heat needed to raise the temperature of 1 pound of water by 1°F at or near 39.2°F.

Coal: A readily combustible black or brownish-black rock whose composition, including in herent moisture, consists of more than 50 percent by weight and more than 70 percent by volume of carbonaceous material. It is formed from plant remains that have been com pacted, hardened, chemically altered, and metamorphosed by heat and pressure over geo logic time.

Cogeneration: The production of electricity and another form of useful energy (such as heat or steam) used for industrial, commercial, heating, or cooling purposes.

Commercial Building: A building with more than 50 percent of its floor space used for commercial activities. Commercial buildings include stores, offices, schools, churches, gym nasiums, libraries, museums, hospitals, clinics, warehouses, and jails. Government buildings are also included, except buildings on military bases or reservations.

Commercial Sector: Business establishments that are not engaged in transportation or in manufacturing or other types of industrial activity (agriculture, mining, or construction). Commercial establishments include hotels, motels, restaurants, wholesale businesses, retail stores, laundries, and other service enterprises; religious and nonprofit organizations; health, social, and educational institutions; and federal, state, and local governments. Streetlights, pumps, bridges, and public services are also included if the establishment oper ating them is considered commercial.

Conversion Factor: A number that translates units of one system into corresponding val ues of another system. Conversion factors can be used to translate physical units of mea sure for various fuels into Btu equivalents.

Crude Oil: A mixture of hydrocarbons that exists in liquid phase in natural underground reservoirs and remains liquid at atmospheric pressure after passing through surface separat ing facilities. Crude oil may also include:

- Small amounts of hydrocarbons that exist in the gaseous phase in natural under ground reservoirs but are liquid at atmospheric pressure after being recovered from oil well (casing head) gas in lease separators and that subsequently are commingled with the crude stream without being separately measured.
- Small amounts of nonhydrocarbons produced with the oil, such as sulfur and other compounds

Crude Oil Stocks: Stocks of crude oil and lease condensate held at refineries, in pipelines, at pipeline terminals, and on leases.

District Heat: Steam or hot water from an outside source used as an energy source in a building. The steam or hot water is produced in a central plant and is piped into the build ing. District heat may be purchased from a utility or provided by a physical plant in a sepa rate building that is part of the same facility (for example, a hospital complex or university).

Electric Power Plant: A station containing prime movers, electric generators, and auxil iary equipment for converting mechanical, chemical, and/or fission energy into electric en ergy.

Electricity Generation: The process of producing electric energy or transforming other forms of energy into electric energy. Also, the amount of electric energy produced or ex pressed in watt-hours (Wh).

End-Use Sectors: The residential, commercial, industrial, and transportation sectors of the economy.

Energy: The capacity for doing work as measured by the capability of doing work (poten tial energy), or the conversion of this capability to motion (kinetic energy). Energy has sev eral forms, some of which are easily convertible and can be changed to another form useful for work. Most of the world's convertible energy comes from fossil fuels that are burned to produce heat that is then used as a transfer medium to mechanical or other means in order to accomplish tasks. Electrical energy is usually measured in kilowatt-hours, while heat en ergy is usually measured in British thermal units.

Energy Consumption: The use of energy as a source of heat or power or as an input in the manufacturing process.

Energy Source: A substance, such as oil, natural gas, or coal, that supplies heat or power. Electricity and renewable forms of energy, such as wood, waste, geothermal, wind, and so lar, are considered to be energy sources.

Exports: Shipments of goods from the 50 states and the District of Columbia to foreign countries and to Puerto Rico, the Virgin Islands, and other U.S. possessions and territories.

Federal Energy Regulatory Commission (FERC): The federal agency with jurisdiction over interstate electricity sales, wholesale electric rates, hydroelectric licensing, natural gas pricing, oil pipeline rates, and gas pipeline certification. FERC is an independent regulatory agency within the Department of Energy and is the successor to the Federal Power Com mission.

Fossil Fuel: Any naturally occurring organic fuel formed in the Earth's crust, such as oil, coal, and natural gas.

Fuel Ethanol: An anhydrous, denatured aliphatic alcohol intended for motor gasoline blending.

Gas-Turbine Electric Power Plant: A plant in which the prime mover is a gas turbine. A gas turbine typically consists of an axial-flow air compressor and one or more combustion chambers where liquid or gaseous fuel is burned. The hot gases expand to drive the genera tor and then are used to run the compressor.

Geothermal Energy: Energy from the internal heat of the Earth, which may be residual heat, friction heat, or a result of radioactive decay. The heat is found in rocks and fluids at various depths and can be extracted by drilling or pumping.

Gross Domestic Product (GDP): The total value of goods and services produced by la bor and property located in the United States.

Hydrocarbon: An organic chemical compound of hydrogen and carbon in the gaseous, liq uid, or solid phase. The molecular structure of hydrocarbon compounds varies from the simplest (methane, a constituent of natural gas) to the very heavy and very complex.

Hydropower: The production of electricity from the kinetic energy of falling water.

Hydropower Plant: A plant in which the turbine generators are driven by falling water.

Independent Power Producer: Wholesale electricity producers (other than qualifying fa cilities under the Public Utilities Regulatory Policies Act of 1978) that are unaffiliated with franchised utilities in the area in which the independent power producers are selling power and that lack significant marketing power. Unlike traditional electric utilities, independent power producers do not possess transmission facilities that are essential to their customers and do not sell power in any retail service territory where they have a franchise.

Industrial Sector: Manufacturing industries, which make up the largest part of the sector, along with mining, construction, agriculture, fisheries, and forestry. Establishments in this sector range from steel mills, to small farms, to companies assembling electronic compo nents.

Jet Fuel: A refined petroleum product used in jet aircraft engines. It includes kerosene type jet fuel and naphtha-type jet fuel.

Methane: Hydrocarbon gas, which is the major component of natural gas.

Methanol: A light, volatile alcohol eligible for motor gasoline blending.

Methyl Tertiary Butyl Ether (MTBE): An ether, intended for motor gasoline blending.

Natural Gas: A gaseous mixture of hydrocarbon compounds, primarily methane, delivered via pipeline for consumption. It is used as a fuel for electricity generation, a variety of uses in buildings, and as raw material input and fuel for industrial processes. *Note*: This product, also referred to as *dry natural gas* or *consumer-grade natural gas*, is the product that re mains after *wet natural gas* has been processed at lease facilities and/or natural gas pro cessing plants. This processing removes nonhydrocarbon gases (e.g., water vapor, carbon dioxide, helium, hydrogen sulfide, and nitrogen) that would otherwise make the gas unmar ketable and natural gas liquids.

Natural Gas, Dry: The marketable portion of natural gas production, which is obtained by subtracting extraction losses, including natural gas liquids removed at natural gas process ing plants, from total production.

Natural Gas, Wet: A mixture of hydrocarbon compounds and small quantities of various nonhydrocarbons existing in the gaseous phase or in solution with crude oil in porous rock formations at reservoir conditions. The principal hydrocarbons normally contained in the mixture are methane, ethane, propane, butane, and pentanes. Typical nonhydrocarbon gases that may be present in reservoir natural gas are water vapor, carbon dioxide, helium, hydrogen sulfide, and nitrogen. Under reservoir conditions, natural gas and the liquefiable portions occur either in a single gaseous phase in the reservoir or in solution with oil and are not distinguishable at the time as separate substances.

Nitrogen Oxides (NOx): Compounds of nitrogen and oxygen produced by the burning of fossil fuels.

North American Electric Reliability Council (NERC): A council formed in 1968 by the electric utility industry to promote the reliability and adequacy of bulk power supply in the electric utility systems of North America. The NERC consists of ten regional reliability councils and encompasses essentially all the power systems of the contiguous United States and Canada.

Nuclear Electric Power: Electricity generated by an electric power plant whose turbines are driven by steam generated in a reactor by heat from the fissioning of nuclear fuel.

Organization for Economic Cooperation and Development (OECD): Current mem bers are Australia, Austria, Belgium, Canada, Czech Republic, Denmark and its territories (Faroe Islands and Greenland), Finland, France, Germany, Greece, Greenland, Hungary, Iceland, Ireland, Italy, Japan, Luxembourg, Mexico, the Netherlands, New Zealand, Norway, Poland, Portugal, South Korea, Spain, Sweden, Switzerland, Turkey, United Kingdom, and United States and its territories (Guam, Puerto Rico, and Virgin Islands).

Organization of Petroleum Exporting Countries (OPEC): Countries that have orga nized for the purpose of negotiating with oil companies on matters of oil production, prices, and future concession rights. Current members are Algeria, Indonesia, Iran, Iraq, Kuwait, Libya, Nigeria, Qatar, Saudi Arabia, United Arab Emirates, and Venezuela.

Photovoltaic Energy: Direct-current electricity generated from sunlight through solid state semiconductor devices that have no moving parts.

Pipeline, Natural Gas: A continuous pipe conduit, complete with such equipment as valves, compressor stations, communications systems, and meters, for transporting natural gas and/or supplemental gaseous fuels from one point to another, usually from a point in or beyond the producing field or processing plant to another pipeline or to points of use. Also refers to a company operating such facilities.

Pipeline, Oil: Oil and product pipelines (including interstate, intrastate, and intracompany pipelines) used to transport oil and petroleum products, respectively, within the 50 states and the District of Columbia.

Proved Reserves, Oil: The estimated quantities of all liquids defined as crude oil that geo logical and engineering data demonstrate with reasonable certainty to be recoverable in fu ture years from known reservoirs under existing economic and operating conditions.

Proved Reserves, Natural Gas: The estimated quantities of natural gas that analysis of geological and engineering data demonstrates with reasonable certainty to be recoverable in future years from known reservoirs under existing economic and operating conditions.

Refinery (Oil): An installation that manufactures finished fuels from oil, unfinished oils, natural gas liquids, other hydrocarbons, and alcohol.

Renewable Energy: Energy obtained from sources that are essentially inexhaustible (un like, for example, fossil fuels, of which there is a finite supply). Renewable sources of en ergy include conventional hydroelectric power, wood, waste, geothermal, wind, photovol taic, and solar thermal energy.

Spot Price: The price for a one-time open market transaction for immediate delivery of the specific quantity of product at a specific location where the commodity is purchased “on the spot” at current market rates.

Strategic Petroleum Reserve (SPR): Petroleum stocks maintained by the federal gov ernment for use during periods of major supply interruption.

Stocks: Supplies of fuel or other energy source(s) stored for future use. Stocks are re ported as of the end of the reporting period.

Sulfur Dioxide (SO_2): A toxic, colorless gas soluble in water, alcohol, and ether. Used as a chemical intermediate in paper pulping and ore refining, and as a solvent.

Transportation Sector: Private and public vehicles that move people and commodities. Included are automobiles, trucks, buses, motorcycles, railroads, and railways (including streetcars), aircraft, ships, barges, and natural gas pipelines.

Wellhead Price: The price of oil or natural gas at the mouth of the well.

Wind Energy: The kinetic energy of wind converted into mechanical energy by wind tur bines (i.e., blades rotating from a hub) that drive generators to produce electricity.

Wood Energy: Wood and wood products used as fuel, including round wood (cord wood), limb wood, wood chips, bark, sawdust, forest residues, charcoal, pulp waste, and spent pulping liquor.


SEAL OF THE PRESIDENT OF THE UNITED STATES

BEFORE THE UNITED STATES DEPARTMENT OF ENERGY

Federal Power Act Section 202(c) Emergency Order: Midcontinent Independent System Operator and Northern Indiana Public Service Company LLC	)))))	Order No. 202-26-19
Federal Power Act Section 202(c) Emergency Order: Midcontinent Independent System Operator and CenterPoint Energy Indiana South	))))	Order No. 202-26-20

Exhibit to
Motion to Intervene and Request for Rehearing and Stay of
Public Interest Organizations

Exhibit 140
MISO ERAS December Release

MISO announces second cycle of ERAS projects

6,100 MW of proposed capacity supports reliability, economic growth and regional energy needs

For Immediate Release

December 1, 2025

Media Contact

McKenzie Barbknecht

CARMEL, Ind. — MISO announced today the second cycle of projects to be evaluated under its Expedited Resource Addition Study (ERAS) process, reinforcing its commitment to accelerating the addition of critical generation resources across the region.

The second cycle includes 15 projects totaling approximately 6,100 MW of proposed new capacity. These projects span a range of fuel sources — including solar, wind, natural gas, and battery storage and are located across MISO's North, Central and South regions. The in-service dates range from December 1, 2027 to August 6, 2028.

"Cycle 2 builds on the momentum of Cycle 1 and reflects the continued demand for timely, reliable interconnection solutions," said Aubrey Johnson, MISO's Vice President, System Planning. "These projects are essential to meeting near-term reliability needs and ensuring new resource additions are online to meet load growth."

To date, 51 projects representing nearly 30,000 MW of proposed new capacity have been accepted or are pending validation into ERAS. Cycle 1 had 10 projects, representing approximately 5,300 MW of capacity. Three Cycle 1 projects already have executed generator interconnection agreements and the other seven will be completed in December. MISO evaluates each ERAS project for eligibility and completeness, and after FERC's recent approval MISO will study up to 15 projects per quarter. There is a program cap of 68 projects before ERAS sunsets on August 31, 2027.

"ERAS is one of several tools we're using to meet the evolving needs of our members and the communities they serve," added Johnson. "MISO remains focused on reducing timelines in our generator interconnection queue through the recently approved queue cap and through improved software automation."

###

MEDIA CONTACT:
McKenzie Barbknecht

About MISO

Midcontinent Independent System Operator (MISO) is an independent, not-for-profit organization that delivers safe, cost-effective electric power across 15 U.S. states and the Canadian province of Manitoba. 42 million people depend on MISO to generate and transmit the right amount of electricity every minute of every day. MISO is committed to reliable, nondiscriminatory operation of the bulk power transmission system and collaborating with all stakeholders to create cost-effective and innovative solutions for our changing industry. MISO operates one of the world's largest energy markets with more than $22 billion in annual gross market energy transactions.

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Exhibit 142
Energy Reliability and Resilience

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Energy Reliability and Resilience



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Energy reliability is the ability of a power system to consistently deliver power to homes, buildings, and devices—even in the face of instability, uncontrolled

events, cascading failures, or unanticipated loss of system components. Energy resilience is the ability of the grid, buildings, and communities to withstand and rapidly recover from power outages and continue operating with electricity, heating, cooling, ventilation, and other energy-dependent services. Energy resilience increases energy reliability and renewable energy sources can help support a resilient, reliable energy system.

Resilient, reliable energy is critical to the well-being of every American. It keeps life-saving hospital equipment and communications systems operating, buildings at safe temperatures with good ventilation, and American workers to go about their business without interruption. Energy infrastructure—facilities or equipment used to generate, deliver, process, or produce energy—that can withstand and quickly recover from disruptions is resilient and reliable infrastructure.

A resilient and reliable power system reduces the likelihood of long-duration outages over large service areas, limits the scope and impact of outages when they do occur, and rapidly restores power after an outage.

What Makes Energy Resilient?

Power outages can be caused by extreme weather, breaches in cybersecurity, high energy demand that overloads the electric grid, failure of aging equipment, and physical interference with equipment. Grid disturbances are changes in electrical voltage and frequency on the grid that can lead to power outages.

A resilient electric grid distribution system uses local resources, such as solar panels and battery storage in homes and buildings, to quickly reconfigure power flows and recover electricity services during a disturbance. The approach to modernize the grid and

increase resilience focuses on integrating distributed energy resources, advanced controls, grid architecture, and emerging grid technologies at a regional scale.

Strong resilience measures in building energy codes can also ensure that new construction and major renovation projects minimize energy use, maximize comfort, and enhance potentially life-saving resilience benefits. Building owners and operators, communities, and local and state governments can strategically plan to increase resilience using these resources.

What Makes Energy Reliable?

When we diversify our energy mix by adding more types of energy to the grid, we increase our energy reliability. The rise of renewable power, which comes from unlimited energy resources, like wind, sunlight, water, and the Earth's natural heat, has the potential to vastly improve the reliability of the American energy system. Currently, renewable energy generates about 21% of all U.S. electricity, and that percentage is rising quickly.

A reliable electric grid distribution system can continue to deliver electricity to homes and buildings regardless of any disruptions or disturbances. The approach to modernizing the grid to increase resilience and reliability focuses on integrating distributed energy resources, advanced controls, grid architecture, and emerging grid technologies at a regional scale. DOE efforts, like the Energy Storage Grand Challenge Roadmap, will increase resilience.

DOE's Grid Modernization Initiative works with public and private partners to develop concepts, tools, and technologies needed to measure, analyze, predict, protect, and control the grid of the future.

Improving Reliability Through Energy Storage

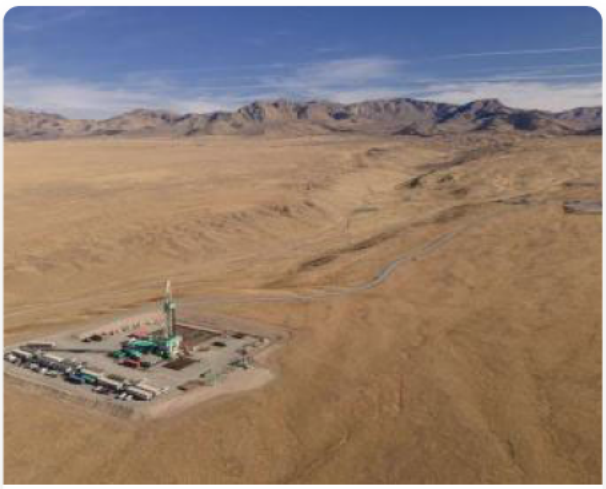
Energy storage technologies can improve energy reliability by making surplus energy available whenever it is needed, such as during a power outage.

Pumped storage hydropower is responsible for most U.S. commercial energy storage capacity and has been used for more than 100 years. Wind energy and solar energy can be captured and stored for later use with batteries, and researchers are investigating geothermal energy storage.

Energy storage is also essential to efficient transportation. EERE invests in research and development of hydrogen storage and batteries to ensure on- and off-road vehicles can reliably move people and goods from one place to another.

The U.S. Department of Energy's Energy Storage Grand Challenge is a comprehensive program to accelerate the development, commercialization, and use of next-generation energy storage technologies. As part of this program, the Long Duration Storage Shot™ aims to, within the decade, reduce the cost of grid-scale energy storage by 90% for systems that can provide energy for at least 10 hours in duration.

Energy Reliability and Resilience News



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Exhibit to
Motion to Intervene and Request for Rehearing and Stay of
Public Interest Organizations

Exhibit 143
NERC 2025–2026 Winter Reliability Assessment

NERC
NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION

2025–2026 Winter Reliability Assessment

November 2025



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Preface

Electricity is a key component of the fabric of modern society, and the Electric Reliability Organization (ERO) Enterprise serves to strengthen that fabric. The vision for the ERO Enterprise, which is comprised of NERC and the six Regional Entities, is a highly reliable, resilient, and secure North American bulk power system (BPS). Our mission is to assure the effective and efficient reduction of risks to the reliability and security of the grid.

Reliability | Resilience | Security

Because nearly 400 million citizens in North America are counting on us

The North American BPS is made up of six Regional Entities as shown in the map and corresponding table below. The multicolored area denotes overlap as some load-serving entities participate in one Regional Entity while associated Transmission Owners/Operators participate in another.



MRO	Midwest Reliability Organization
NPCC	Northeast Power Coordinating Council
RF	ReliabilityFirst
SERC	SERC Reliability Corporation
Texas RE	Texas Reliability Entity
WECC	Western Electricity Coordinating Council

About this Assessment

NERC's *2025–2026 Winter Reliability Assessment* (WRA) identifies, assesses, and reports on areas of concern regarding the reliability of the North American BPS for the upcoming winter season. In addition, the WRA presents peak electricity demand and supply changes and highlights any unique regional challenges or expected conditions that might affect the reliability of the BPS.

The reliability assessment process is a coordinated evaluation between the Reliability Assessment Subcommittee, the Regional Entities, and NERC staff with demand and resource projections obtained from the assessment areas.

This report reflects an independent assessment by the ERO Enterprise (i.e., NERC and the six Regional Entities) and is intended to inform industry leaders, planners, operators, and regulatory bodies so that they are better prepared to ensure BPS reliability. This report also provides an opportunity for industry to discuss plans and preparations to ensure reliability for the upcoming winter period.

Key Findings

This WRA covers the upcoming three-month (December–February) winter period, providing an evaluation of the generation resource and transmission system adequacy necessary to meet projected winter peak demands and operating reserves. This assessment identifies potential reliability issues of interest and regional risks. The following findings are the ERO Enterprise's independent evaluation of electricity generation and transmission capacity as well as the potential operational concerns that may need to be addressed for the upcoming winter.

Two trends affecting resource adequacy across the BPS for the upcoming winter are rising electricity demand forecasts and a continued shift in the resource mix characterized by the retirement of thermal generators and growth in battery resources. After years of flat or low (~1%) peak demand growth, the aggregate peak demand for all NERC assessment areas has risen by 20 GW (2.5%) since the previous winter. Nearly all assessment areas are reporting year-on-year demand growth; some are forecasting increases near 10%. Total BPS resources have also increased since last winter, but by a smaller amount of 9.4 GW. This number includes the net change in generating capacity as well as additional demand response. These demand and resource changes are described in **Escalating Winter Demand** and **Resource Trends** sections.

The following findings are derived from NERC and the ERO Enterprise's independent evaluation of electricity generation and transmission capacity as well as potential operating concerns that should receive attention for Winter 2025–2026:

1. **All areas are assessed as having adequate resources for normal winter peak-load conditions (i.e., the area's 50-50 peak forecast). However, more extreme winter conditions extending over a wide area could result in electricity supply shortfalls.** Prolonged, wide-area cold snaps can drive sharp increases in electricity demand and threaten reliable BPS generation and the availability of fuel supplies for natural-gas-fired generation. Four severe arctic storms have descended to cover much of North America since 2021, causing regional demand for electricity and heating fuel to soar and exposing generation and fuel infrastructure in temperate areas to freezing conditions.[1] The following areas face risks of electricity supply shortfalls during periods of more extreme conditions this winter (see **Figure 1**):

    - **NPCC-Maritimes**: The peak demand forecast has fallen slightly (-1.6%) in the NPCC-Maritimes assessment area, contributing to higher reserves compared to the 2024–2025 winter. Maritimes is projected to have an Anticipated Reserve Margin (ARM) of 16.9%, which is 270 MW below the area's Reference Margin Level of 20% . New Brunswick has long-term energy contracts that can be used to mitigate resource adequacy challenges through the purchase of energy on a day-ahead basis. NPCC's all-hours probabilistic assessment for the NPCC Region included the simulation of both a base case (i.e., normal 50/50 demand) and highest peak load scenario (having an approximate 7% chance of occurring), for both an expected and a low-likelihood, reduced-resource condition. The preliminary results of this assessment indicate that operators in Maritimes are likely to require emergency operating mitigations and/or energy emergency alerts (EEA) during above-normal demand or low-resource output conditions.
    - **NPCC-New England**: A lower peak demand forecast and additional resources from demand response and firm imports offset recent generator retirements, resulting in little change to the NPCC-New England ARM for this winter. New England continues to closely monitor regional energy adequacy, particularly during extended cold snaps where constrained natural gas pipelines contribute to rapid depletion of stored fuel supplies. ISO-NE's deterministic winter scenario analysis shows limited exposure to energy shortfalls this winter. In New England, winter energy concerns are highest in scenarios when stored fuels are rapidly depleted; during these periods, timely replenishment is critical to minimizing the potential for energy shortfalls.
    - **SERC-East**: The winter peak demand forecast has increased by 700 MW (1.6%) since last winter, while winter firm capacity has declined, resulting in lower reserves. SERC-East has changed from a summer-peaking area to potentially peaking during both summer and winter. This is due to the continued addition of solar photovoltaic (PV) generation that shaves off summer peak demand and a trend toward electrification of heating that drives up winter peak demand. All-hours probabilistic analysis from SERC found some load-loss hours (<0.1 hrs) and small amounts of expected unserved energy, with the highest risk occurring during above-normal peak demand and early morning hours when solar output is absent.
    - **SERC-Central:** Additional demand response and flat load growth since last winter is offsetting declining resource capacity (down 1,120 MW), resulting in little change to the ARM at 30.5%. There are adequate resources for normal winter peak demand; however, higher levels of demand that can occur during extreme cold temperatures can result in insufficient reserves that operators would need to manage with non-firm imports and potential energy emergencies.
    - **Texas RE-ERCOT:** Strong load growth from new data centers and other large industrial end users is driving higher winter electricity demand forecasts and contributing to continued risk of supply shortfalls. For the upcoming winter season, Texas RE-ERCOT is expected to continue facing reserve shortage risks during the peak load hour and high-

[1] See detailed reports on the January 2024 and January 2025 Arctic Storms, Winter Storm Elliott, and Winter Storm Uri.

net-load hours, particularly under extreme load conditions that accompany freezing temperatures. Elevated forced outage of thermal resources and reduced output from intermittent resources during these conditions exacerbates the risk of supply shortfalls. In winter, peak demands typically occur before sunrise and after sunset coinciding with the unavailability of solar generation making the system dependent on wind generation and dispatchable resources. Data centers are altering the daily load shape due to their round-the-clock operating pattern, lengthening peak demand periods. Additional battery storage and demand-response resources since last winter help mitigate shortfall risks. However, with the continued flattening of the load curve, maintaining sufficient battery state of charge will become increasingly challenging for extended periods of high loads, such as a severe multi-day storm like Winter Storm Uri.

- **WECC-Basin**: There is sufficient capacity in the area for expected peak conditions; however, Balancing Authorities (BA) are likely to require external assistance during extreme winter weather that causes thermal plant outages, adverse wind turbine conditions, and natural gas fuel supply issues for area internal resources. External assistance may not be available during region-wide extreme winter conditions. With an expected winter peak demand of 11.1 GW, under an extreme combination of generator derates and outages, the region could be short 1.6 GW before imports. Forecasted net internal demand has increased 1% since last year, with little change in winter capacity. Note that the WECC-Basin assessment area includes Utah, southern Idaho, and a portion of western Wyoming. In prior WRA reports, this part of the BPS was included as part of the WECC-NW assessment area. The *2025–2026 WRA* includes a new assessment area map for the Western Interconnection. The new assessment area boundaries provide reliability risk information in more geographic detail for the United States and Mexico.
- **WECC-NW**: Like WECC-Basin, there is sufficient capacity in the area for expected peak conditions; however, BAs are likely to require external assistance during extreme winter weather that causes thermal plant outages and adverse wind turbine conditions for area internal resources. External assistance may not be available during region-wide extreme winter conditions. Winter peak demand for the area is forecast to be 2.9 GW higher (9.3%) compared to last year. Over 3 GW of new resources have been in development for the assessment area this year, primarily battery storage, solar PV, and wind resources. Delays that threaten timely completion of these resource additions will make the area more reliant on imports to meet peak demand.

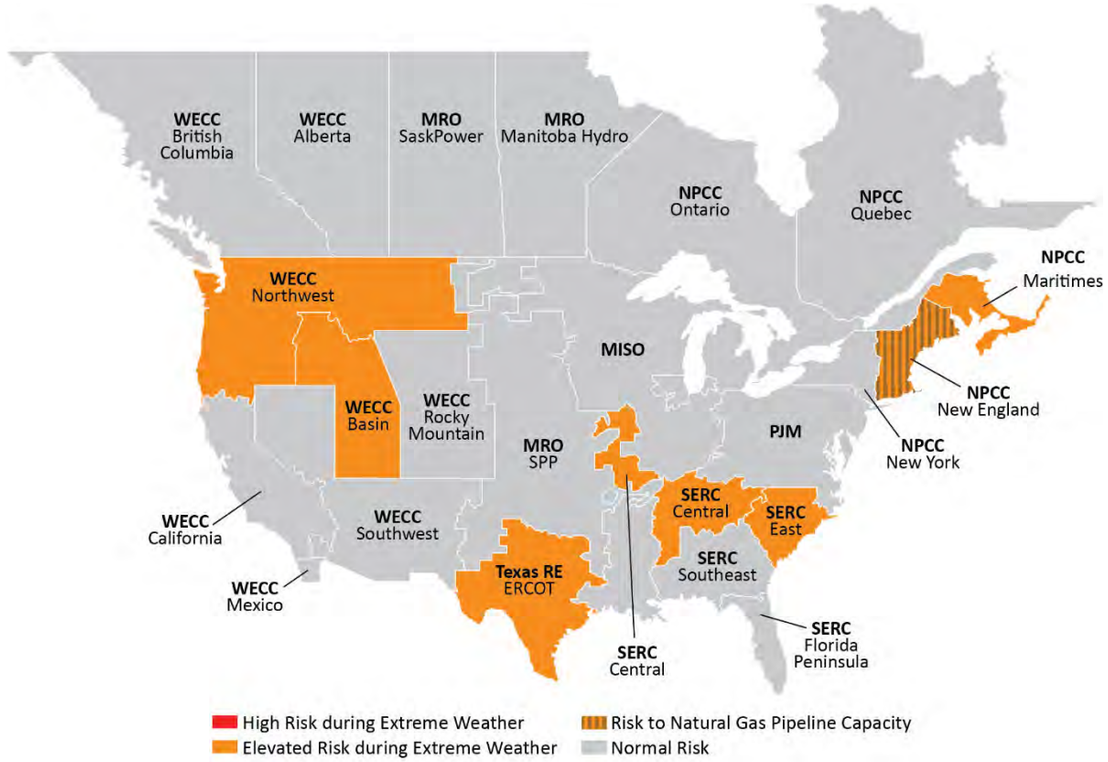


Figure 1: Winter Reliability Risk Area Summary

2. **The performance of natural gas production and supply infrastructure during peak winter conditions will again have a significant effect on BPS reliability.** Natural gas is an essential fuel for electricity generation in winter. Winter fuel supplies for thermal generators must be readily available during the periods of high electricity and natural gas demand that accompany extreme cold weather. Yet these periods are the most challenging for natural-gas-fired Generator Operators to obtain sufficient fuel and delivery. Natural gas production often falls off in extreme winter temperatures as supply infrastructure is affected by freezing issues, and Generator Operators that fail to secure firm fuel delivery are frequently unable to access fully subscribed pipelines. Evidence from the past two winters indicates notable improvement in the delivery of natural gas to BPS generators since winter storms Elliott and Uri with overall less natural gas production decline during cold weather and fewer natural gas infrastructure

force majeures.[2] Still, natural gas infrastructure freeze protection mitigations are voluntary for the natural gas industry in most of North America, resulting in uneven application of protections and continued supply risks during extreme conditions. Furthermore, timing misalignments between the natural gas and electric markets continue to challenge generator fuel procurement in advance of severe winter conditions that occur over winter holiday weekends. As winter approaches, NERC encourages all entities across the gas-electric value chain—from production to the burner tip—to take all necessary preparations for extreme cold and keep natural gas flowing and the lights on.

3. **Cold weather Reliability Standards first introduced in 2023 have been improved prior to the upcoming winter and address recommendations from winter storms Elliott and Uri.** In September 2025, the Federal Energy Regulatory Commission (FERC) approved EOP-012-3 with an effective date of October 1, 2025, concluding the development of Reliability Standards for generator cold weather preparedness.[3] The EOP-012 Reliability Standard contains requirements for generator freeze protection measures, cold weather preparedness plans, and operator training. Among the improvements in the new version are enhanced and expanded requirements to ensure that Generator Owners (GO) are implementing corrective actions to address known issues affecting their ability to operate in cold weather in a timely manner. NERC collects data on the winterization of generating units, which, in conjunction with NERC's monitoring of BPS performance and analysis of cold weather events, helps determine the effectiveness of Reliability Standards. NERC submitted to FERC its first annual *Cold Weather Data and Analysis* informational filing in October 2025.[4] Based on the data reported this year, 96% of the total net winter capacity reported extreme cold weather temperatures (ECWT) at or below 32 degrees Fahrenheit, triggering winter preparedness measures under the Cold Weather Preparedness Standard, and 99% of total net winter capacity in the continental US reporting the ability to operate at the calculated ECWT. As the first such report, this *Cold Weather Data and Analysis* filing provides a benchmark for future analysis.

Recommendations

To reduce the risks of energy shortfalls on the BPS this winter, NERC recommends the following:

- Reliability Coordinators (RC), BAs, and Transmission Operators (TOP) in the elevated risk areas identified in the key findings should review seasonal operating plans and the protocols for communicating and resolving potential supply shortfalls in anticipation of potentially high generator outages and extreme demand levels. Operators should review NERC's Resources on Cold Weather Preparations.
- GOs should complete winter readiness plans and checklists prior to December, deploy weatherization packages well in advance of approaching winter storms, and frequently check and maintain cold weather mitigations while conditions persist.
- BAs should be cognizant of the potential for short-term load forecasts to underestimate load in extreme cold weather events and be prepared to take early action to implement protocols and procedures for managing potential reserve deficiencies. Proactive issuance of winter advisories and other steps directed at generator availability contributed to improved reliability during cold weather events of the past two winters.
- RCs and BAs should implement generator fuel surveys to monitor the adequacy of fuel supplies. They should prepare their operating plans to manage potential supply shortfalls and take proactive steps for generator readiness, fuel availability, load curtailment, and sustained operations in extreme conditions.
- Generator Owners/Operators of natural-gas-fired units should maintain awareness of potential extreme cold weather developing over holiday weekends and the implications for fuel planning and procurement that may result given the natural gas purchase close dates that precede long holiday weekends.
- State and provincial regulators can assist grid owners and operators in advance of and during extreme cold weather by maintaining awareness of BA, natural gas pipeline, and gas local distribution company (LDC) operational public announcements and notices, amplifying public appeals for electricity and natural gas conservation, and supporting requested environmental and transportation waivers.

[2] See *January 2025 Arctic Events | A System Performance Review*, April 2025
[3] See NERC's Statement on FERC September Open Meeting for summary and link to FERC's order.
[4] See 2025 Cold Weather Data Collection and Analysis Informational Filing

Risk Highlights

Escalating Winter Demand

Winter electricity demand is rising at the fastest rate in recent years, particularly in areas where data center development is occurring. After several years of low (~1%) growth, total internal demand for the BPS is forecast to increase by 20.2 GW (2.5%) over last winter's forecast. The changes in forecasted net internal demand for each assessment area are shown in Figure 2 below.[5] Assessment areas develop these forecasts based on historical load and weather information as well as future projections. Most assessment areas are projecting an increase in peak demand. SaskPower, PJM, the U.S. Southeast, and parts of the U.S. West have the largest increase in peak demand forecasts.

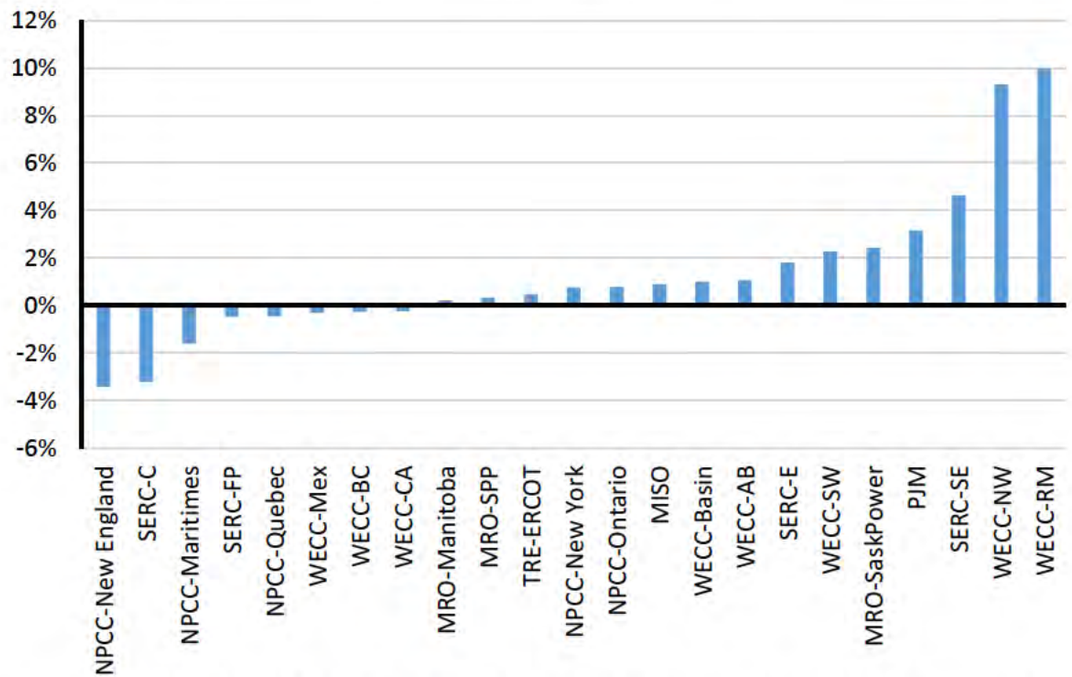


Figure 2: Change in Net Internal Demand—Winter 2025–2026 Forecast Compared to Winter 2024–2025 Forecast

[5] See Data Concepts and Assumptions section for demand definitions.

Resource Trends

BPS resources are growing, but at a slower rate than demand is rising. Battery and solar facilities were the leading resource types added to the BPS since last winter. Solar resources, however, often do not supply output during hours of peak winter demand. Growth in demand response is also contributing to BPS resources for the upcoming winter. Table 1 shows the total change in BPS resources since last winter. For battery, solar, and wind resources, the table includes change in both nameplate (installed) capacity as well as the change in on-peak demand capacity, which is the capacity that resources are expected to provide in their area during the time of peak demand. For assessment-area specific information see Variable Energy Resource Contributions section.

Table 1: BPS Resource Change from Winter 2024–2025 to Winter 2025–2026

Resource	Net Change Nameplate Capacity (MW)	Net Change Peak Demand Capacity (MW)
Total Generator Capacity		1,335
Battery	19,659	11,121
Solar	11,097	1,176
Wind	-562	-14,238
Thermal and Hydro		3,276
Demand Response		8,112
Total Resources		9,447

Total BPS resources for serving winter peak demand, including generating capacity and demand response, have increased since last winter by 9,447 MW. Sizeable additions in battery resources and some new natural gas-fired generators contribute to the increase in resource capacity. However, the increase is offset by lower on-peak capacity values for wind resources, which are the result of revised valuations of wind resource capability at peak demand hours in some areas.[6] As a result, BPS generator capacity for winter peak demand makes up only a small portion of the total BPS increase. Generation accounts for 1,335 MW of the total 9,445 MW increase, while the larger share comes from demand response programs. Area specific information on demand response is provided in the Demand and Resource Tables.

The recent trend in resource additions is contributing to higher risk of electricity supply shortfalls in winter. BA operators are likely to face higher winter demand without a comparable increase in supply resources. Furthermore, the types of resources that are growing the most-- battery resources and

[6] Since last winter, ERCOT and MISO have implemented new methods for determining capacity contributions that result in lower wind and solar resources contributions at peak demand. See ERCOT's Resource Adequacy page and MISO's *Planning Year 2025-2026 Wind and Solar Capacity Credit Report*.

demand response—have unique characteristics that operators will need to account for and could limit the use of these resources in extreme winter conditions. Battery energy is reliable when it can be dispatched and has sufficient charge for the period it is needed, yet little time to recharge can be expected during extreme winter weather. System operators will need good visibility on battery state of charge and should anticipate that some extreme winter events will cause these resources to become depleted when needed. Demand response is limited by contract terms, which typically specify how often and for how long the resource may be used. Other resource types are also challenged in winter (see **Thermal Generator Fuel Adequacy and Security**). As BAs grapple with higher demand in most parts of the BPS, they will do so with resources that are becoming increasingly complex to dispatch especially in winter.

Thermal Generator Fuel Adequacy and Security

The performance of the thermal generator fleet remains critical to winter BPS operations. Winter fuel supplies for thermal generators must be readily available during periods of high demand and extreme cold weather. Generally, fuel adequacy for the thermal generating fleet is bolstered through strategic infrastructure investments and fuel stockpiling that increases the certainty of having fuel on hand that can be converted to electricity when needed. Because of this, winter performance of thermal generators is inextricably linked to extraction, processing, storage, and delivery infrastructure for a variety of fuels. Fuel supply risks have been noted in recent years' WRAs related to coal and natural gas availability and illustrate the interconnected nature of these critical energy infrastructure systems.

BPS stakeholders across North America note multiple fuel-related issues that are being monitored entering the winter season. For example, while coal represents a waning share of the overall resource mix, it continues to play an important role in meeting demand during extreme winter weather events, and oil inventories at dual-fuel gas-oil generators lessen risks related to natural gas deliverability in infrastructure-constrained regions, especially during the winter. Notably, it is infeasible or prohibitively costly to stockpile natural gas locally at power plants, and this exposes the BPS to the risk profile of the constituent systems that comprise the supply and delivery of this just-in-time fuel.

Natural Gas Generator Fuel Supplies

Natural gas generators remain a crucial part of on-peak resources meant to meet winter electricity demand across much of North America. While many Generator Owners and Operators secure backup fuel supplies at critical gas-fired generators, particularly in the northeastern United States and Florida, large contributions to the on-peak winter resource mix by single-fuel natural-gas-fired generators remain across North America (see **Figure 3**).

Natural gas generator performance can be threatened when natural gas supplies are insufficient or when natural gas infrastructure is unable to maintain the flow of fuel to critical generators. Grid operators continue to acknowledge and enhance their winter planning processes to firm up their fuel supplies and guard against natural gas disruptions, but winter storms Uri and Elliott demonstrated that combinations of natural gas flow restrictions and supply insufficiency can occur regardless of whether cold temperatures are common or uncommon in the region and can affect more than one BA area concurrently.

Many BPS areas that regularly experience cold weather events, like New England, have adopted mitigating technologies to lessen the impact of natural gas shortages through generator dual-fuel capability and stored backup fuel. In those areas, prolonged cold weather events present a risk of rapid depletion of stored backup fuel. Robust regional and distributed storage investments and winter planning for timely fuel replenishment are critical to minimizing potential energy shortfalls in the operational time frame in these areas.

Natural gas and electricity infrastructures have the added complexity of interdependence. Electricity is used to power some facilities, such as compressor stations and processing plants that make up natural gas infrastructure. These interdependencies mean that reliability events that originate on one system have the potential to affect the other and worsen the overall event magnitude or duration.

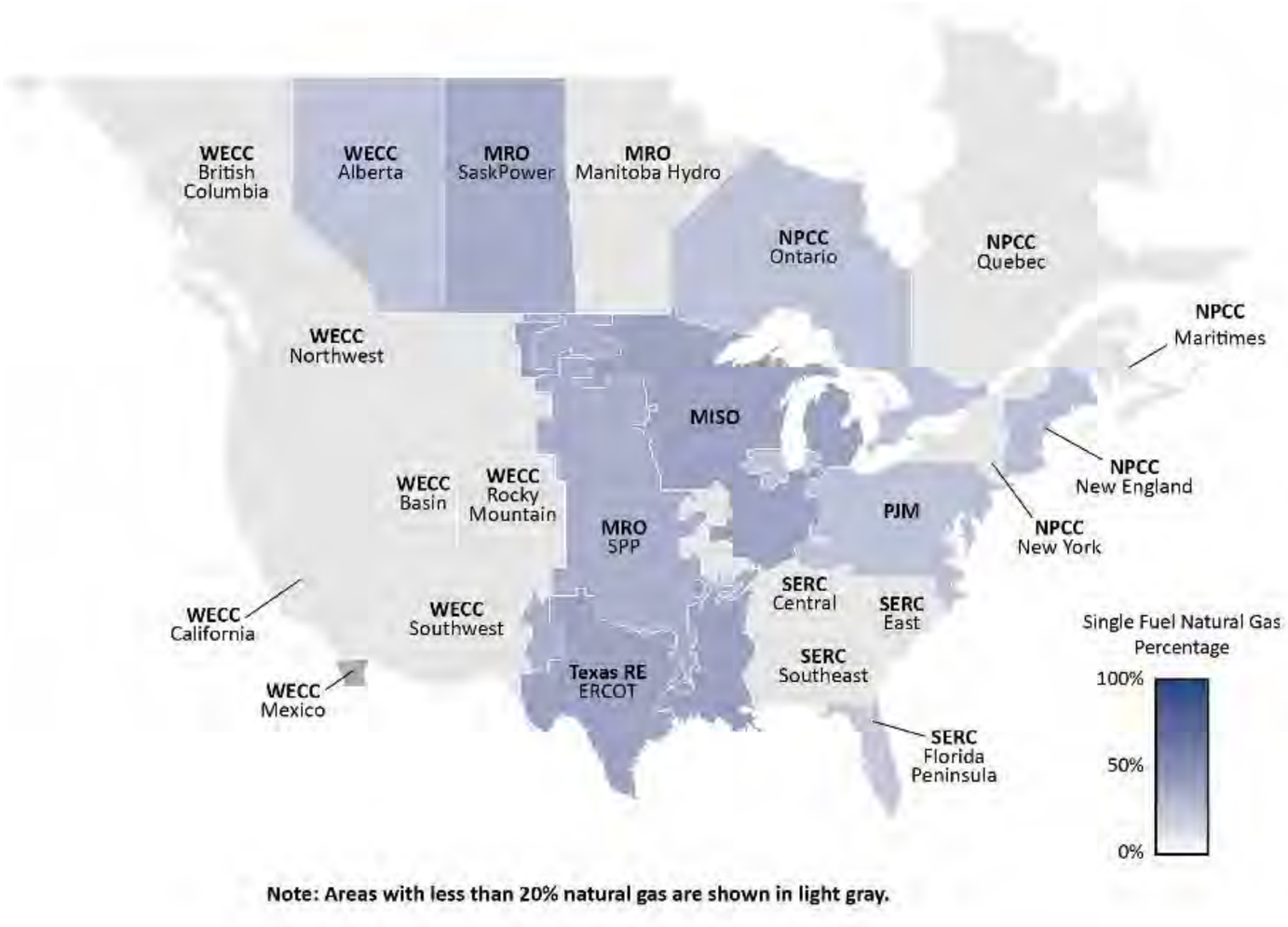
Natural gas infrastructure freeze protection mitigations are voluntary for the natural gas industry in most of North America. Texas is an exception, where the Railroad Commission of Texas adopted rules to require critical natural gas facilities to implement weather-related emergency preparation measures.[7] Lack of consistent standards for natural gas infrastructure protections will result in uneven application of freeze protections and continued supply risks during extreme conditions in many areas.

These considerations have driven higher levels of coordination to ensure sustained reliable operation of the natural gas and electricity systems. While a FERC and ERO staff review of system performance during the January 2025 arctic events[8] details improvements in electric and natural gas coordination since winter storms Uri and Elliott, the review also identifies continuing gaps between the electricity and natural gas industries that remain entering the 2025–2026 Winter season. These include natural gas scheduling challenges during winter holiday weekends, market time frame and process incompatibility, and electric power entities' lack of visibility into operational impact data from natural gas producers and suppliers.

[7] See Railroad Commission of Texas weatherization rule.

[8] FERC, NERC Issue Report on System Performance During the January 2025 Arctic Weather | Federal Energy Regulatory Commission

The U.S. Energy Information Administration (EIA)[9] anticipates a slightly milder winter than last year across much of the United States, especially in the Northeast, leading to a projection that households will consume approximately 2% less natural gas than last winter. Working natural gas storage inventories are about 5% above the previous five-year average in the United States heading into the winter season. The EIA attributes this relative surplus in part to robust production this summer and lower-than-expected natural gas consumption by power generators.



Single-Fuel Natural-Gas-Fired Generation

	Winter Capacity (GW)	Contribution to Total Winter Resource Mix
MISO	63.9	38%
TRE-ERCOT	53.0	38%
WECC-MX	2.2	34%
MRO-SaskPower	2.5	34%
SPP	33.4	32%
NPCC-New England	12.1	24%
PJM	60.9	23%
WECC-AB	13.9	23%
NPCC-Ontario	8.0	23%
SERC-FP	45.6	21%
WECC-CA	35.9	18%
WECC-SW	21.5	17%
WECC-Basin	4.9	16%
WECC-RM	6.2	14%
SERC-C	17.0	13%
SERC-SE	21.5	13%
WECC-NW	8.7	12%
SERC-E	11.3	9%
NPCC-New York	5.0	8%
NPCC-Maritimes	0.5	7%
MRO-Manitoba	0.3	4%
WECC-BC	0.1	1%
NPCC-Quebec	0.0	0%

Figure 3: Single-Fuel Natural-Gas-Fired Generation Capacity Contribution to the 2025–2026 Winter Generation Mix

[9] See the U.S. Energy Information Administration's Winter Fuels Outlook 2025–26

Risk Assessment Discussion

NERC assesses the risk of electricity supply shortfall in each assessment area for the upcoming season by considering Planning Reserve Margins, seasonal risk scenarios, probability-based risk assessments, and other available risk information. NERC provides an independent assessment of the potential for each assessment area to have sufficient operating reserves under normal conditions as well as above-normal demand and low-resource output conditions selected for the assessment. A summary of the assessment approach is provided in Table 2.

Table 2: Seasonal Risk Assessment Summary

Category	Criteria[1]
High Potential for insufficient operating reserves in normal peak conditions	• Planning Reserve Margins do not meet Reference Margin Levels (RML); or • Probabilistic indices exceed benchmarks, e.g., loss of load hours (LOLH) of 2.4 hours over the season; or • Analysis of the risk hour(s) indicates resources will not be sufficient to meet operating reserves under **normal peak-day demand and outage scenarios**[2]
Elevated Potential for insufficient operating reserves in above-normal conditions	• Probabilistic indices are low but not negligible (e.g., LOLH above 0.1 hours over the season); or • Analysis of the risk hour(s) indicates resources will not be sufficient to meet operating reserves under **extreme peak-day demand with normal resource scenarios** (i.e., typical or expected outage and derate scenarios for conditions);[2] or • Analysis of the risk hour(s) indicates resources will not be sufficient to meet operating reserves under **normal peak-day demand with reduced resources** (i.e., extreme outage and derate scenarios)[3]
Normal Sufficient operating reserves expected	• Probabilistic indices are negligible • Analysis of the risk hour(s) indicates resources will be sufficient to meet operating reserves under normal and extreme peak-day demand and outage scenarios[4]

Table Notes:
[1]The table provides general criteria. Other factors may influence a higher or lower risk assessment.
[2]**Normal resource scenarios** include planned and typical forced outages as well as outages and derates that are closely correlated to the extreme peak demand.
[3]**Reduced resource scenarios** include planned and typical forced outages and low-likelihood resource scenarios, such as extreme low-wind scenarios, low-hydro scenarios during drought years, or high thermal outages when such a scenario is warranted.
[4]Even in normal risk assessment areas, extreme demand and extreme outage scenarios that are not closely linked may indicate risk of operating reserve shortfall.

Assessment of Planning Reserve Margins and Operational Risk Analysis

Anticipated Reserve Margins (ARM), which provide the Planning Reserve Margins for normal peak conditions, as well as reserve margins with typical forced outage levels and for the most extreme seasonal risk scenarios are provided in Table 3.

Table 3: Seasonal Risk Scenario On-Peak Reserve Margins

Assessment Area	Anticipated Reserve Margin	Reserve Margin with Typical Outages	Reserve Margin with Higher Demand, Outages, Derates in Extreme Conditions
MISO	49.5%	22.3%	3.7%
MRO-Manitoba	13.7%	11.4%	6.1%
MRO-SaskPower	35.1%	29.0%	16.1%
MRO-SPP	56.5%	29.4%	16.9%
NPCC-Maritimes	16.9%	12.5%	-4.7%
NPCC-New England	58.9%	45.4%	8.7%
NPCC-New York	78.2%	52.4%	16.2%
NPCC-Ontario	28.6%	21.8%	13.2%
NPCC-Québec	15.2%	15.1%	5.0%
PJM	35.6%	24.8%	15.6%
SERC-C	30.5%	22.4%	-0.9%
SERC-E	21.9%	17.5%	3.0%
SERC-FP	41.7%	28.3%	25.6%
SERC-SE	39.7%	24.7%	17.7%
TRE-ERCOT	36.0%	25.2%	-20.0%
WECC-AB	35.2%	32.4%	10.0%
WECC-Basin	29.6%	19.7%	-21.1%
WECC-BC	25.9%	25.8%	15.4%
WECC-CA	82.3%	73.7%	57.9%
WECC-Mex	83.1%	79.4%	52.9%
WECC-NW	30.9%	29.5%	-8.5%
WECC-RM	61.7%	53.2%	10.0%
WECC-SW	104.4%	90.1%	50.1%

Seasonal risk scenarios for each assessment area are presented in the Regional Assessments Dashboards section. The on-peak reserve margin and seasonal risk scenario charts in each dashboard provide potential winter peak demand and resource condition information. The reserve margins on the right side of the dashboard pages provide a comparison to the previous year's assessment. The seasonal risk scenario charts present deterministic scenarios for further analysis of different demand and resource levels with adjustments for normal and extreme conditions. The assessment areas determined the adjustments to capacity and peak demand based on methods or assumptions that are summarized in the seasonal risk scenario charts; more information about these dashboard charts is provided in the Data Concepts and Assumptions section.

The seasonal risk scenario charts can be expressed in terms of reserve margins: In Table 3, each assessment area's ARMs are shown alongside the reserve margins for a typical generation outage scenario (where applicable) and the extreme demand and resource conditions in their seasonal risk scenario.

Areas highlighted in orange in Figure 1 above have been identified as having resource adequacy or energy risks for the winter and are included in the Key Findings section's discussion that follows. The typical outage reserve margin includes anticipated resources minus the capacity that is likely to be in maintenance or forced outage at peak demand. If the typical maintenance or forced-outage margin is the same as the ARM, it is because an assessment area has already factored typical outages into the anticipated resources. The extreme conditions margin includes all components of the scenario and represents the most severe operating conditions of an area's scenario. Note that any reserve margin below zero indicates that the resources fall below demand in the scenario.

In addition to the peak demand and seasonal risk hour scenario charts, the assessment areas provided a resource adequacy risk assessment that was probability-based for the winter season. Results are summarized in Table 5. The risk assessments account for the hour(s) of greatest risk of resource shortfall. For most areas, the hour(s) of risk coincides with the time of forecasted peak demand; however, some areas incur the greatest risk at other times based on the varying demand and resource profiles. Various risk metrics are provided and include loss of load expectation (LOLE), loss of load hours (LOLH), expected unserved energy (EUE), and the probabilities of energy emergency alert (EEA) declarations (see Table 4 for a description of EEA levels).

Table 4: Energy Emergency Alert Levels

EEA Level	Description	Circumstances
EEA 1	All available generation resources in use	• The BA is experiencing conditions in which all available generation resources are committed to meet firm load, firm transactions, and reserve commitments and is concerned about sustaining its required operating reserves. • Non-firm wholesale energy sales (other than those that are recallable to meet reserve requirements) have been curtailed.
EEA 2	Load management procedures in effect	• The BA is no longer able to provide its expected energy requirements and is an energy-deficient BA. • An energy-deficient BA has implemented its operating plan(s) to mitigate emergencies. • An energy-deficient BA is still able to maintain minimum operating reserve requirements.
EEA 3	Firm load interruption is imminent or in progress	• The energy-deficient BA is unable to meet minimum operating reserve requirements.

Energy Emergency Alerts

The combination of above-normal generation outages, low resource output, and peak loads as occurred during the extreme cold weather events of Winter Storm Uri in 2021 and Winter Storm Elliott in 2022 are ongoing winter reliability risks. When supply resources in an area fall below expected demand and operating reserve requirements, BAs may need to employ EEAs to maintain balance between available capacity and energy and real-time demand. A description of each EEA level is provided above.

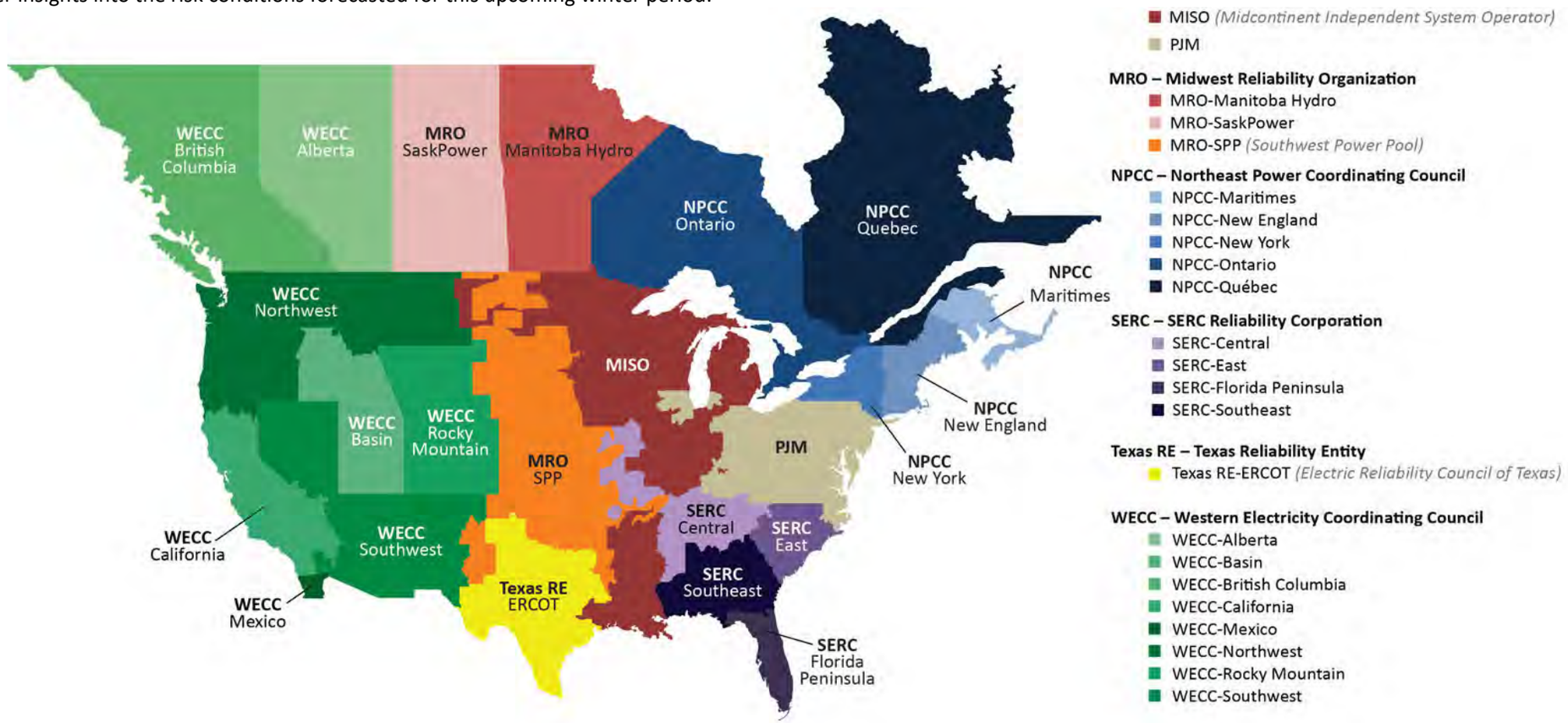
Table 5: Probability-Based Risk Assessment		
Area	**Type of Assessment**	**Results and Insight from Assessment**
MISO	Deterministic	MISO does not provide a probabilistic assessment for the WRA. MISO applies a deterministic look at expected system conditions, looking at generation availability under typical and extreme outages and looking at a typical 50/50 load forecast and an extreme 90/10 load forecast. For the upcoming winter season, under an extreme outage and extreme 90/10 load forecast, this is the riskiest scenario for the MISO footprint. This scenario produces the shortest actual reserve margin for January.
MRO-Manitoba	Probabilistic study for the NERC Probabilistic Assessment (ProbA)	Probabilistic analysis for the 2024 ProbA summarized in NERC's 2024 *Long-Term Reliability Assessment* (LTRA) found no load-loss or unserved energy hours for 2026.
MRO-SaskPower	Probability-based capacity adequacy assessment	SaskPower's probabilistic assessment for the 2025–2026 Winter indicates that risk of shortfalls is lower than the previous winter. LOLH for an elevated risk scenario for the 2025–2026 Winter season is 0.08 hours. The month with the highest LOLH is December (0.05 hours).
MRO-SPP	NERC 2024 ProbA	Probabilistic analysis for the 2024 ProbA summarized in NERC's 2024 LTRA found no load-loss or unserved energy hours for 2026.
NPCC	NPCC conducted an all-hour probabilistic reliability assessment that included detailed neighbor modeling and consisted of a base case and severe case examining low resources, reduced imports, and higher loads. The assessment evaluates the probabilistic indices of LOLE, LOLH, and EUE. The highest peak load scenario has an approximately 7% probability of occurring.	
NPCC-Maritimes	The Maritimes Area low-likelihood resource case assumed: wind derated by 50% for every hour in December through February and a 50% natural gas capacity curtailment for December through February (dual-fuel units assumed reverting to oil) and reduced transfer capabilities.	The preliminary assessment indicates that established operating procedures are not sufficient to maintain a balance between electricity supply and demand. Under highest peak load levels, the Maritimes Area shows a notable likelihood of utilizing its operating procedures such as reducing 30-minute reserves, initiating interruptible loads, and reducing 10-minute reserves to maintain system reliability during the upcoming winter period.
NPCC-New England	The New England Area low-likelihood resource case assumed: 500 MW of additional maintenance outages, ~4,513 MW of gas-fired generation unavailable due to fuel supply constraints, and 50% reduced import capabilities of external ties.	The preliminary results of this assessment indicate that operating procedures were not needed to maintain a balance between electricity supply and demand
NPCC-New York	The New York Area low-likelihood resource case assumed: ~500 MW of extended maintenance in southeastern New York, 600 MW of cable transmission reduction across HVdc facilities, and ~5,000 MW of generation unavailable due to fuel delivery issues.	The preliminary results of this assessment indicate that operating procedures were not needed to maintain a balance between electricity supply and demand. No cumulative LOLE, LOLH or EUE risks were indicated over the December–February winter period, for all the scenarios modeled.
NPCC-Ontario	An energy assessment for the Ontario Assessment Area was conducted for two scenarios: firm resources and firm demand with expected weather, and planned resources with planned demand with expected weather.	No cumulative LOLH or EUE risks were identified over the entire November-to-April winter season for both scenarios modeled.

Table 5: Probability-Based Risk Assessment		
Area	**Type of Assessment**	**Results and Insight from Assessment**
NPCC-Québec	The Québec Area low-likelihood resource case assumed 1,000 MW of generation reductions.	The preliminary results of this assessment indicate that established operating procedures are sufficient to maintain a balance between electricity supply and demand if needed. No cumulative LOLE, LOLH or EUE risks were indicated over the December–February winter period for all the scenarios modeled
PJM	Probabilistic study for the NERC Probabilistic Assessment (ProbA)	Probabilistic study for 2025–2026 Winter is not provided for the WRA. PJM performed probabilistic analysis for 2026-2027 winter as part of the 2024 ProbA summarized in NERC's 2024 LTRA. The results of this study indicate risk of load loss (<0.1 hours) and unserved energy during winter months. For the upcoming winter, load-loss hours are expected to be less than this value because forecasted load is lower and anticipated resource capacity is higher than the case studied for the 2024 ProbA.
SERC	Based on the 2024 NERC Probabilistic Assessment (ProbA) base-case result. SERC's assessment used 38 years of historical load shapes to assess the resource adequacy of years 2026 and 2028, primarily based on data from the 2024 Long Term Reliability Assessment (LTRA).	
SERC-Central		Probabilistic analysis for the 2024 ProbA summarized in NERC's 2024 LTRA found no load-loss or unserved energy hours for 2026.
SERC-East		Probabilistic analysis for the 2024 ProbA summarized in NERC's 2024 LTRA found a small number of load-loss hours (<0.1) and EUE (61 MWh / 1 ppm) for 2026.
SERC-Florida Peninsula		Probabilistic analysis for the 2024 ProbA summarized in NERC's 2024 LTRA found negligible load-loss hours and EUE.
SERC-Southeast		Probabilistic analysis for the 2024 ProbA summarized in NERC's 2024 LTRA found no load-loss or unserved energy hours for 2026.
Texas RE-ERCOT	ERCOT Probabilistic Reserve Risk Model	ERCOT's probabilistic risk assessment indicates a 2% probability of having to declare EEAs during the January forecasted winter peak day (which coincides with the highest reserve shortage risk) and a controlled load shed probability of 1.8%. ERCOT defines low-risk hours as when the probability of an EEA is less than 10%.
WECC	The resource adequacy work performed at WECC used the Multi-Area Variable Resource Integration Convolution (MAVRIC) model for the 2025 LTRA. The MAVRIC model is a convolution-based probabilistic model and is WECC's chosen method for developing probability metrics used for assessing demand and variable resource availability in every hour. In the resource adequacy environment, the reports produced support NERC's seasonal assessments, LTRA, and ProbA.	
WECC-AB		The results of the probabilistic assessment reveal no EUE or LOLH for Winter 2025–2026.
WECC-Basin		The results of the probabilistic assessment reveal no EUE or LOLH for Winter 2025–2026.
WECC-BC		The results of the probabilistic assessment reveal no EUE or LOLH for Winter 2025–2026.

Table 5: Probability-Based Risk Assessment		
Area	**Type of Assessment**	**Results and Insight from Assessment**
WECC-CA		The results of the probabilistic assessment reveal no EUE or LOLH for Winter 2025–2026.
WECC-Mexico		The results of the probabilistic assessment reveal no EUE or LOLH for Winter 2025–2026.
WECC-Rocky Mountain		The results of the probabilistic assessment reveal no EUE or LOLH for Winter 2025–2026.
WECC-NW		The results of the probabilistic assessment reveal no EUE or LOLH for Winter 2025–2026. Results for a case where new resource additions are not completed for the upcoming winter found some EUE and LOLH.
WECC-SW		The results of the probabilistic assessment reveal no EUE or LOLH for Winter 2025–2026.

Regional Assessments Dashboards

The following assessment area dashboards and summaries were developed based on data and narrative information collected by NERC from the six Regional Entities on an assessment area basis. Guidelines and definitions are in the **Data Concepts and Assumptions** table. On-Peak Reserve Margin bar charts show the ARM compared to a reference margin level (RML) that is established for each area to meet resource adequacy criteria. Prospective Reserve Margins can give an indication of additional on-peak capacity but are not used for assessing adequacy. The operational risk analysis shown in the following regional assessments dashboard pages provides a deterministic scenario for understanding how various factors that affect resources and demand can combine to impact overall resource adequacy. For each assessment area, there is a risk-period scenario graphic; the left blue column shows anticipated resources (from the **Demand and Resource Tables**), and the two orange columns at the right show the two demand scenarios of the normal peak net internal demand (from the **Demand and Resource Tables**) and the extreme winter peak demand determined by the assessment area. The middle red or green bars show adjustments that are applied cumulatively to the anticipated resources. Adjustments may include reductions for typical generation outages (maintenance and forced not already accounted for in anticipated resources) and additions that represent the quantified capacity from operational tools (if any) that are available during scarcity conditions but have not been accounted for in the WRA reserve margins. Resources throughout the scenario are compared against expected operating reserve requirements that are based on peak load and normal weather. The cumulative effects from extreme events are also factored in through additional resource derates or low-output scenarios. In addition, results from a probability-based resource adequacy assessment are shown in the Highlights section of each dashboard. Methods vary by assessment area and provide further insights into the risk conditions forecasted for this upcoming winter period.



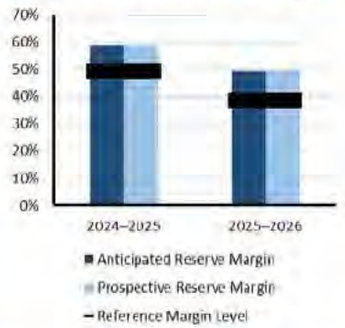


MISO

The Midcontinent Independent System Operator, Inc. (MISO) is an independent, not-for-profit organization responsible for operating the bulk electric power system and administering wholesale electricity markets across 15 U.S. states and the Canadian province of Manitoba. MISO ensures the reliable delivery of electricity to approximately 45 million people by managing regional transmission operations as well as energy and ancillary services markets and advising on long-term resource planning. The MISO footprint includes 39 Local BAs and more than 550 market participants. MISO operates one of the world's largest organized electricity markets, with its members operating a system that consists of over 77,000 miles of transmission lines and approximately 1,888 generating units. The peak electricity demand on the MISO system currently occurs during the summer season. MISO's footprint lies across three regional entities (MRO, RF, and SERC), but MRO is responsible for coordinating data and information submitted for NERC's reliability assessments.

- MISO expects limited risk in the 2025–26 Winter season as MISO was able to procure 6.1% more resources through the annual planning reserve auction than required by its minimum resource adequacy target. A further 3.3 GW of resources were available but not chosen to be committed for the winter season.
- Some risk has been identified for this upcoming winter season. In a high generation outage and high winter load scenario reliability is expected to be maintained by reliance upon operational mitigations that include non-firm energy transfers into the system, energy-only resources not subject to a must-offer requirement that may still offer into the energy markets, load-modifying resources, and internal transfers that exceed the Sub-Regional Import/Export Constraint (SRIC/SREC) between the MISO North/Central and South areas.
- MISO continues to coordinate with neighboring RCs and BAs to improve situational awareness and vet any needs for energy transfers to address extreme system conditions.
- MISO continues to survey and coordinate with its members on winter preparedness and fuel sufficiency.
- MISO has implemented a seasonal resource adequacy construct and seasonal unit accreditation to better affirm adequate supply in all seasons.

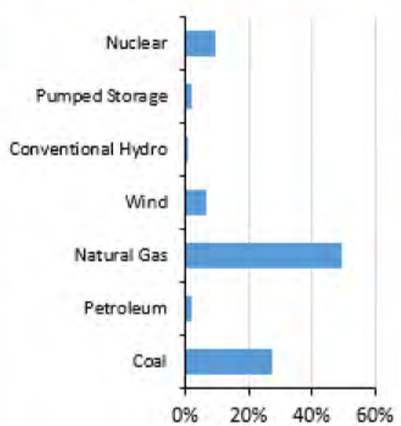
On-Peak Reserve Margin[10]



Risk Scenario Summary

Expected resources meet operating reserve requirements under assessed demand scenarios. Above-normal winter peak load combined with generator outages from freezing or fuel supply issues and low wind output result in the need to employ operating mitigations (i.e., demand response and transfers).

On-Peak Resource Mix



2025–2026 Winter Risk Period Scenario



Scenario Description (See Data Concepts and Assumptions)

Risk Period: Highest risk for unserved energy at peak demand hour

Demand Scenarios: 50/50 net internal demand and additional demand during extreme weather conditions (e.g., Winter Storm Enzo) using member submitted data and historical load data

Typical Maintenance Outages: Rolling three-year winter average of peak-day maintenance and planned outages

Typical Forced Outages: Three-year average of all peak-day outages that were not planned

Resource Derates for Extreme Conditions: Represents derates aligning with the most extreme hour of each of the past 3 years,

Operational Mitigations: Non-firm energy transfers into the system, energy-only resources that do not have a must-offer requirement, or internal transfers that exceed the SRIC/SREC between the MISO North/Central and South regions

[10] The MISO Risk Scenario Assessment for the 2025-26 Winter Season is not directly comparable to that for the 2024-25 Winter Season as methodology improvements have been implemented.



MRO-Manitoba Hydro

Manitoba Hydro is a provincial Crown corporation and one of the largest integrated electricity and natural gas distribution utilities in Canada. Manitoba Hydro is a leader in providing renewable energy and clean-burning natural gas. Manitoba Hydro provides electricity to approximately 608,500 electric customers in Manitoba and natural gas to approximately 293,000 customers in southern Manitoba. Its service area is the province of Manitoba, which is 251,000 square miles. Manitoba Hydro is winter-peaking. Manitoba Hydro is its own Planning Coordinator (PC) and Balancing Authority (BA). Manitoba Hydro is a coordinating member of MISO, which is the RC for Manitoba Hydro.

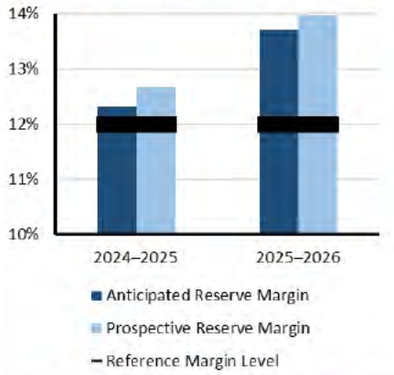
Highlights

- Manitoba Hydro is not anticipating any operational challenges and/or emerging reliability issues in its assessment area for Winter 2025–2026.
- Manitoba Hydro expects to reliably supply its internal demand and export obligations even under continued drought conditions.
- Manitoba Hydro is experiencing well below-average water supply conditions; however, the Manitoba Hydro system is designed and operated such that reliable operations can be maintained under extreme drought.
- The ARM for Winter 2025–26 exceeds the 12% RML.

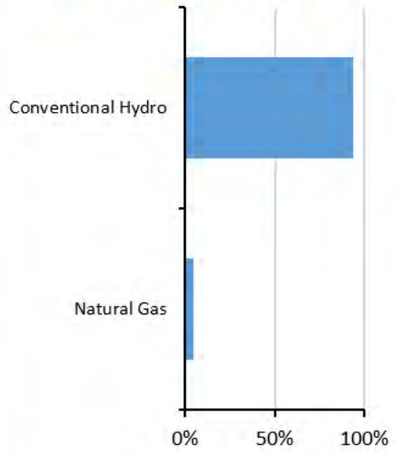
Risk Scenario Summary

Expected resources meet operating reserve requirements under the assessed scenarios.

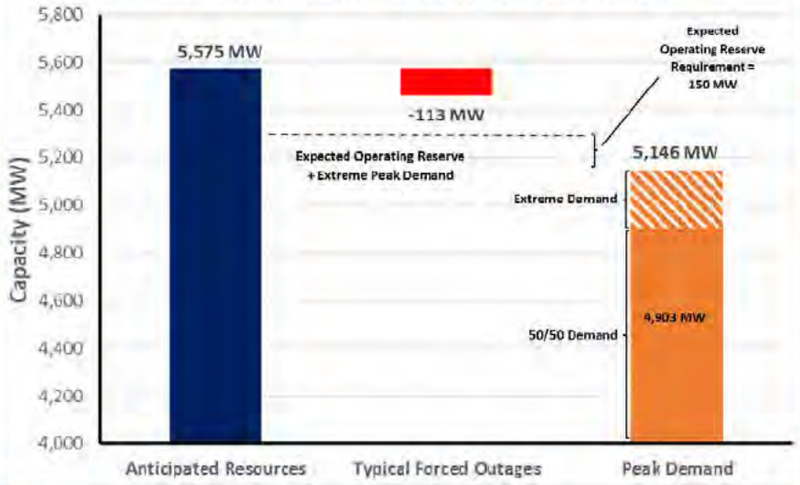
On-Peak Reserve Margin



On-Peak Resource Mix



2025–2026 Winter Risk Period Scenario



Scenario Description (See Data Concepts and Assumptions)

Risk Period: Highest risk for unserved energy at peak demand hour

Demand Scenarios: Net internal demand (50/50) and (90/10) demand forecast using 30 years of weather data

Typical Forced Outages: Accounts for average forced outages



MRO-SaskPower

MRO-SaskPower is an assessment area that covers the Canadian province of Saskatchewan. The province has a geographic area of 651,900 square kilometers (251,700 square miles) and a population of just over 1.1 million people. The Saskatchewan Power Corporation (SaskPower) is the PC and RC for the province of Saskatchewan and is the principal supplier of electricity in the province. SaskPower is a provincial Crown corporation and, under provincial legislation, is responsible for the reliability oversight of the Saskatchewan Bulk Electric System (BES) and its interconnections. Overall, SaskPower operates nearly 14,816 circuit-km of transmission lines, 65 high-voltage switching stations, and 191 distribution substations. Peak electricity demand on the SaskPower system currently occurs during the winter season.

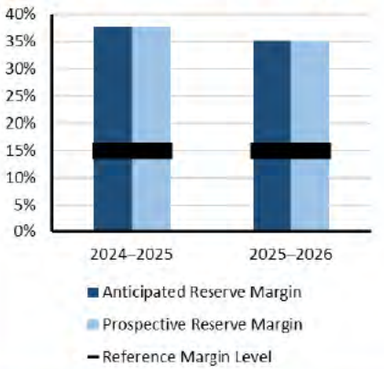
Highlights

- Saskatchewan experiences its peak load during the winter months due to extreme cold weather.
- Based on the planned maintenance, typical forced outages from historical data, and expected renewable generation under the normal and extreme demand conditions, SaskPower does not anticipate any reliability issues during the 2025–2026 Winter.
- During extreme winter conditions, SaskPower would utilize available demand-response programs, short-term power transfers from neighboring utilities, maintenance rescheduling, and/or short-term load interruptions to manage the situation.

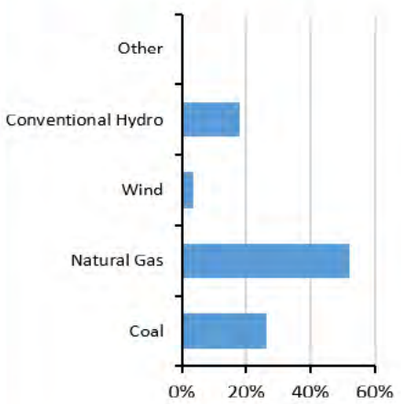
Risk Scenario Summary

Expected resources meet operating reserve requirements under the assessed scenarios.

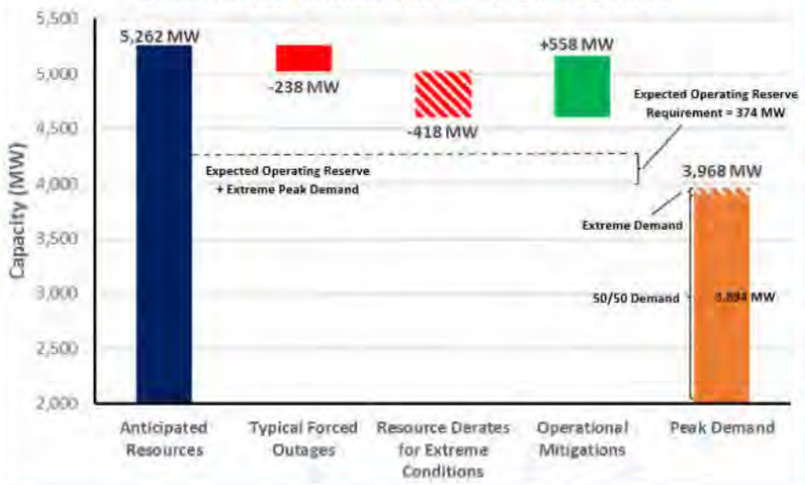
On-Peak Reserve Margin



On-Peak Resource Mix



2025–2026 Winter Risk Period Scenario



Scenario Description (See Data Concepts and Assumptions)

Risk Period: Highest risk for unserved energy at peak demand hour

Demand Scenarios: Based on the historical load variability, SaskPower calculates a probability density function for load to simulate various scenarios that include extreme conditions.

Typical Forced Outages: Estimated using SaskPower forced outage model

Resource Derates for Extreme Conditions: Wind capacity is derated by 96% due to the cut-out of most wind farms below -30°C. Solar generation is expected to be fully unavailable under extreme conditions.

Operational Mitigations: Includes the non-firm import capability (360 MW) and generators in layup status (167 MW) that can be brought online with one to five days' notice; additional demand-side resources are estimated based on other demand response programs and non-firm loads that require 15 minutes to 2 hours of notification



MRO-SPP

SPP's footprint covers 546,000 square miles and encompasses all or parts of Arkansas, Iowa, Kansas, Louisiana, Minnesota, Missouri, Montana, Nebraska, New Mexico, North Dakota, Oklahoma, South Dakota, Texas, and Wyoming. The SPP long-term assessment is reported based on the PC footprint, which touches parts of the MRO Regional Entity and the WECC Regional Entity. The SPP assessment area footprint has approximately 61,000 miles of transmission lines, 756 generating plants, and 4,811 transmission-class substations, and it serves a population of more than 18 million.

Highlights

- SPP anticipates that planning reserves are adequate for the upcoming winter season even as SPP continues to set new winter season load records.
- SPP does not anticipate any emerging reliability issues impacting the area for the 2025–2026 Winter season but realizes that interruptions to fuel supply combined with higher penetration of variable energy resources could create unique operation challenges.
- SPP continues to work at enhancing communications and operator preparedness with neighboring regions to address potential electric deliverability issues associated with extreme weather events.
- To minimize conservative operations, EEAs, and mid-range forecast error uncertainty response in wind forecasts, SPP implemented several new operational mitigation processes and procedures to deal with high-impact real-time areas of reliability concern.
- SPP has proposed numerous resource adequacy initiatives, including addressing EUE standards, fuel assurance, winter planning reserve margins, outage policies, demand response, and accreditation; all were recently approved by FERC.

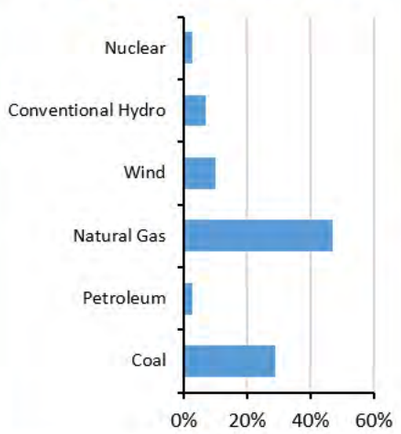
On-Peak Reserve Margin



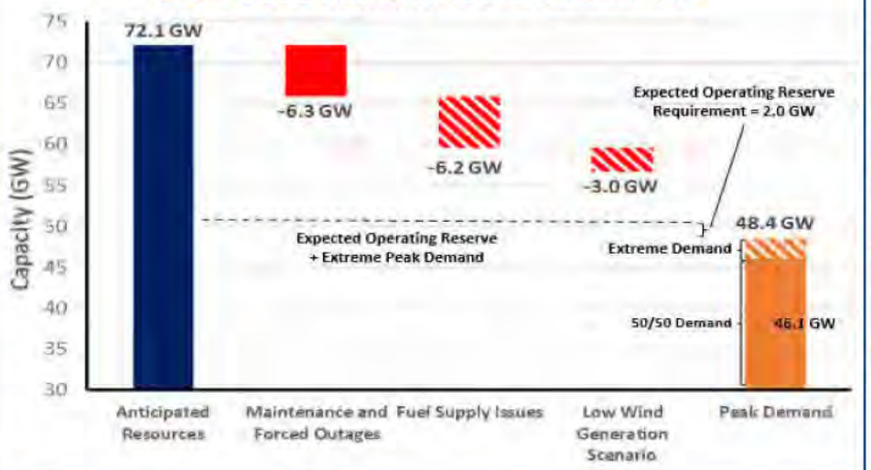
Risk Scenario Summary

Expected resources meet operating reserve requirements under the assessed scenarios.

On-Peak Resource Mix



2025–2026 Winter Risk Period Scenario



Scenario Description (See Data Concepts and Assumptions)

Risk Period: Highest risk for unserved energy at peak demand hour

Demand Scenarios: Net internal demand (50/50) and extreme demand forecast using historical data

Maintenance and Forced Outages: A capacity derate of 6.3 GW for maintenance outages, forced outages, and performance in extreme weather based on historical data

Fuel Supply Issues: BA derate of 6.2 GW based on MW capacity of gas-fired generators experiencing fuel supply issues in winter storm Elliott.

Low Wind Generation Scenario: 3 GW of wind potentially off-line when temperatures fall below their cold weather performance packages



NPCC-Maritimes

NPCC-Maritimes is an assessment area that covers the Canadian Maritime provinces—New Brunswick, Nova Scotia, and Prince Edward Island—and the northernmost portion of the U.S. state of Maine. The area covers approximately 150,000 square kilometers (58,000 square miles) and has a total population of nearly 1.9 million people. The New Brunswick Power Corporation (NB Power) is the balancing authority for New Brunswick, Prince Edward Island, and the northern portion of Maine. Nova Scotia Power Inc. (NSPI) is the balancing authority for Nova Scotia. NB Power's system is electrically interconnected with NPCC-Québec and NPCC-New England, and the electric systems in the provinces of Nova Scotia and Prince Edward Island have ties with New Brunswick but no direct ties with other assessment areas. Peak electricity demand in NPCC-Maritimes occurs during the winter season.

Highlights

- The Maritimes has a diversified mix of capacity resources fueled by oil, coal, hydro, nuclear, natural gas, wind, dual-fuel oil/gas, tie benefits, and biomass with no one type making up more than about 27% of the total capacity in the area.
- The Maritimes has long-term energy contracts in place for its winter supply and can purchase additional energy in the day-ahead and in real time as required.
- As part of the winter planning and preparation process, dual-fueled units will have sufficient supplies of heavy fuel oil stored on site to enable sustained operation in the event of natural gas supply interruptions.

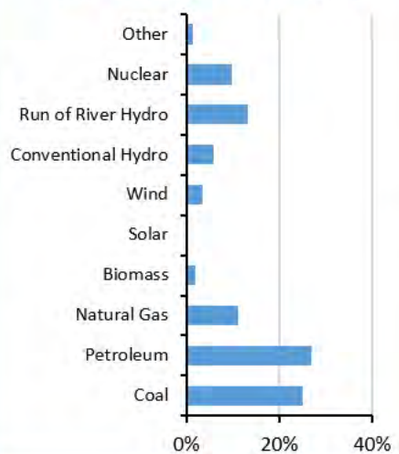
Risk Scenario Summary

Expected resources do not meet operating reserve requirements under normal peak-demand scenarios. Normal winter peak load and outage conditions could result in the need for operating mitigations (i.e., demand response, transfers, appeals) and EEAs. NPCC probabilistic analysis indicates some risk of unserved energy and LOLH under high demand or low resource scenarios.

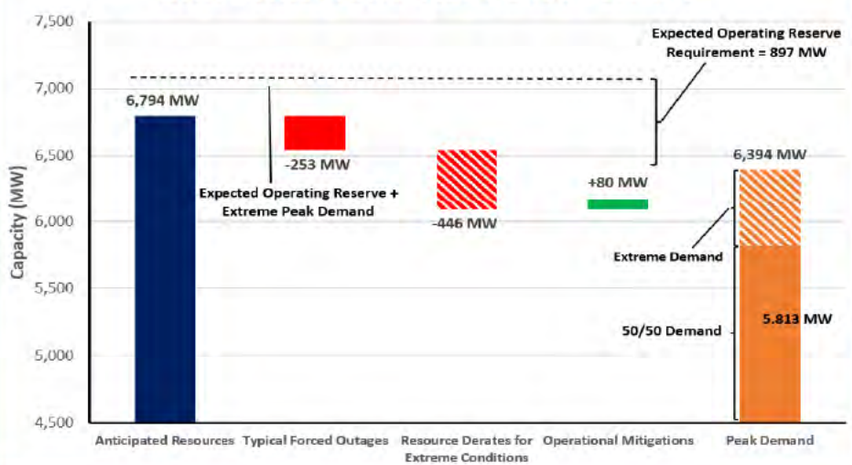
On-Peak Reserve Margin



On-Peak Resource Mix



2025–2026 Winter Risk Period Scenario



Scenario Description (See Data Concepts and Assumptions)

Risk Period: Highest risk for unserved energy at peak demand hour

Demand Scenarios: Scenario peak load with adjustment calculated by adding a 10% margin of error to the peak internal demand forecast taken from the *Long-Term Reliability Assessment* (LTRA) for the 2025–2026 Winter period (aligns with the all-time winter peak, which occurred on February 4, 2024)

Typical Forced Outages: Based on historical operating experience

Resource Derates for Extreme Conditions: Based on ambient temperature thermal derates, wind derated to zero, as well as natural gas capacity derated by 50% due to supply issues

Operational Mitigations: Based on emergency operations and planning procedures in place including fuel switching



NPCC-New England

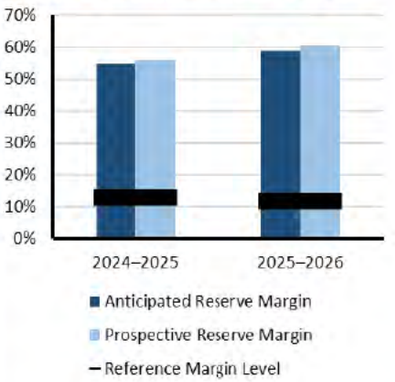
NPCC-New England is an assessment area consisting of the states of Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, and Vermont that is served by ISO New England (ISO-NE) Inc. ISO-NE is a regional transmission organization that is responsible for the reliable day-to-day operation of New England's bulk power generation and transmission system, administration of the area's wholesale electricity markets, and management of the comprehensive planning of the regional BPS.

The New England BPS serves approximately 14.5 million customers over 68,000 square miles.

Highlights

- ISO-NE expects to meet its regional resource adequacy requirements this 2025–2026 Winter operating period without calling upon operating procedures to maintain a balance between electricity supply and demand.
- A standing concern is whether there will be sufficient energy available to satisfy electricity demand during an extended cold spell given the existing resource mix, fuel delivery infrastructure, and expected fuel arrangements without considerable effort to replenish stored fuels (i.e., fuel oil and liquefied natural gas (LNG)).
- ISO-NE expects to have sufficient capacity resources to meet the 2025–2026 50/50 and 90/10 winter peak demand forecast of 19,616 MW and 21,125 MW, respectively, for the weeks beginning January 10, January 17, and January 24.
- ISO-NE has recently developed the Regional Energy Shortfall Threshold (REST) as an effort to quantify the tolerable risk of energy shortfall during extreme events. Within the 0.25% highest-risk scenarios, the REST thresholds are 3.0% normalized EUE over 72-hour periods and 18.0 hours over 21-day periods.
  - ISO-NE does not anticipate exceeding the REST criteria for Winter 2025–2026.

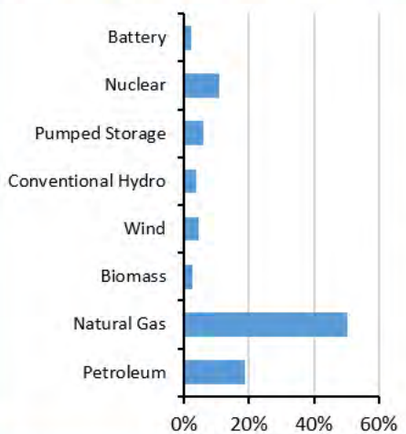
On-Peak Reserve Margin



Risk Scenario Summary

Expected resources meet operating reserve requirements under assessed demand scenarios. Above-normal winter peak load combined with high generator outages could result in the need for operating mitigations (i.e., demand response and transfers). Prolonged extreme cold weather events that result in depletion of stored fuels can lead to resource shortfalls.

On-Peak Resource Mix



2025–2026 Winter Risk Period Scenario



Scenario Description (See Data Concepts and Assumptions)

Risk Period: Highest risk for unserved energy at peak demand hour

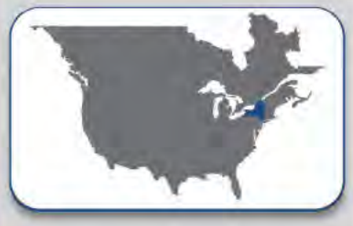
Demand Scenarios: Peak net internal demand (50/50) and (90/10) extreme demand forecast capturing the region's coldest day in the last 30 years using current and future load models

Typical Maintenance Outages: Based on historical weekly averages

Typical Forced Outages: Based on seasonal capacity of each resource as determined by ISO-NE

Resource Derates for Extreme Conditions: Represent a case that is beyond the (90/10) conditions based on historical observation of force outages and additional reductions for generation at risk due to natural gas supply and cold weather-related outages

Operational Mitigations: Based on load and capacity relief assumed available from invocation of ISO-NE operating procedures



NPCC-New York

NPCC-New York is an assessment area consisting of the New York ISO (NYISO) service territory. NYISO is responsible for operating New York's BPS, administering wholesale electricity markets, and conducting system planning. NYISO is the only BA within the state of New York. The BPS in New York encompasses over 11,000 miles of transmission lines and 760 power generation units and serves 20.2 million customers. For this WRA, the established RML is 15%. Wind, grid-connected solar PV, and run-of-river totals were derated for this calculation. However, New York requires load-serving entities to procure capacity for their loads equal to their peak demand plus an Installed Reserve Margin (IRM). The IRM requirement represents a percentage of capacity above peak load forecast and is approved annually by the New York State Reliability Council. The council approved the 2025–2026 IRM at 24.4%.

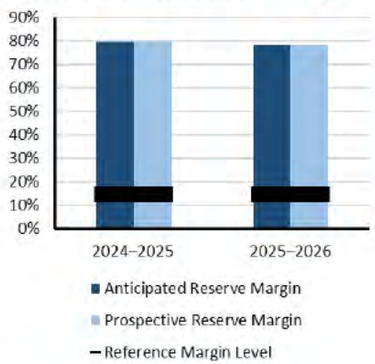
Highlights

- New York is presently a summer-peaking area, and no emerging reliability issues are anticipated during the 2025–26 Winter assessment period.
- Expected resources meet operating reserve requirements under the assessed demand and resource scenarios. A scenario involving an extended cold snap that causes above-normal demand and diminished natural gas supplies would result in low but sufficient reserves.
- The preliminary results of the NPPCC winter probabilistic assessment indicate that operating procedures are not needed to maintain a balance between electricity supply and demand. No cumulative LOLE, LOL,H or EUE risks were indicated over the December–February winter period for all the scenarios modeled.

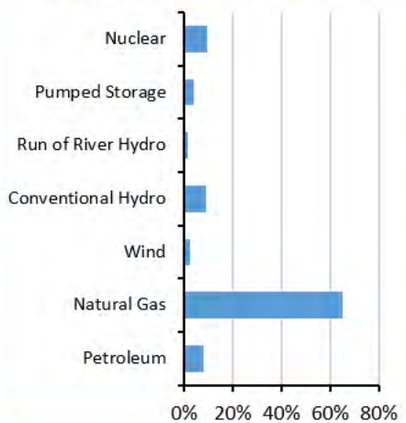
Risk Scenario Summary

Expected resources meet operating reserve requirements under the assessed demand and resource scenarios.

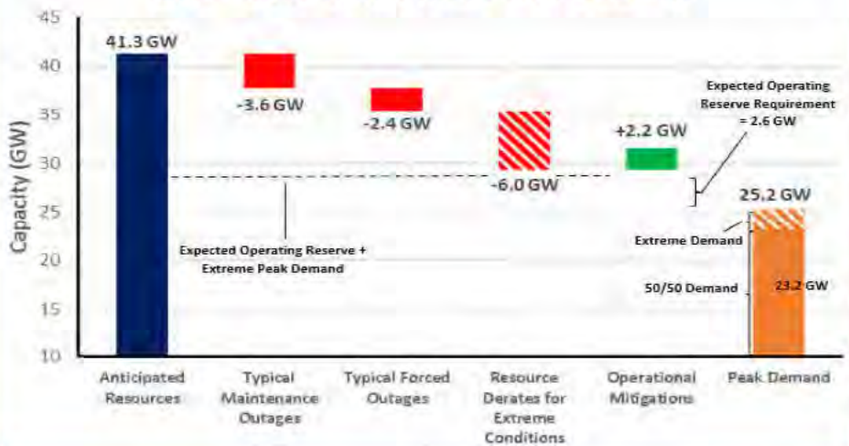
On-Peak Reserve Margin



On-Peak Resource Mix



2025–2026 Winter Risk Period Scenario



Scenario Description (See Data Concepts and Assumptions)

Risk Period: Highest risk for unserved energy at peak demand hour

Demand Scenarios: Net internal demand (50/50) and (90/10) demand forecast

Typical Maintenance Outages: Based on planned scheduled maintenance

Typical Forced Outages: Based on 5–year averages from GADS data.

Resource Derates for Extreme Conditions: Potential natural gas generation at risk if non-firm supply is unavailable in a period of extended cold weather. Based on a 2025 analysis, approximately 6,307 MW of gas generation with non-firm fuel supplies could be unavailable.

Operational Mitigations: Based on NYISO operating procedures



NPCC-Ontario

NPCC-Ontario is an assessment area that covers the Canadian province of Ontario. The province of Ontario covers more than 1 million square kilometers (415,000 square miles) and has a population of almost 16 million people. The Independent Electricity System Operator (IESO) is the balancing authority for the province of Ontario. NPCC-Ontario is electrically interconnected with NPCC-Québec, MRO-Manitoba, MISO, and NPCC-New York. Peak electricity demand in NPCC-Ontario occurs during the summer season.

Highlights

- As Ontario is a summer-peaking province, there is typically a lower risk of reliability issues during the winter than the summer. However, Ontario regularly experiences extreme cold weather in the winter.
- NPCC-Ontario is well prepared for Winter 2025–2026, and IESO expects that the electric system will remain reliable with reserve margins well above required levels.
- Operators and forecasters in Ontario work closely with neighboring jurisdictions to manage extreme weather events.
- Natural-gas-fired generators in Ontario are supplied by pipelines with access to the Enbridge Gas Dawn Hub and its associated storage facilities, which significantly reduces natural gas deliverability and reliability concerns by connecting those systems to several major gas transportation corridors, enabling access to multiple supply basins.

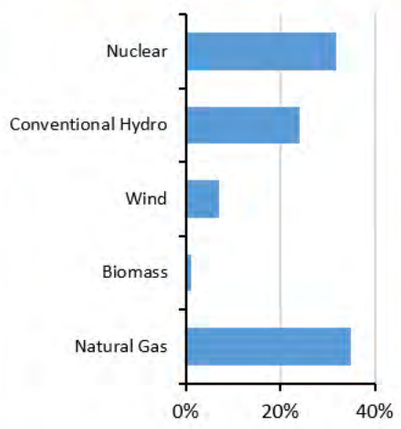
On-Peak Reserve Margin



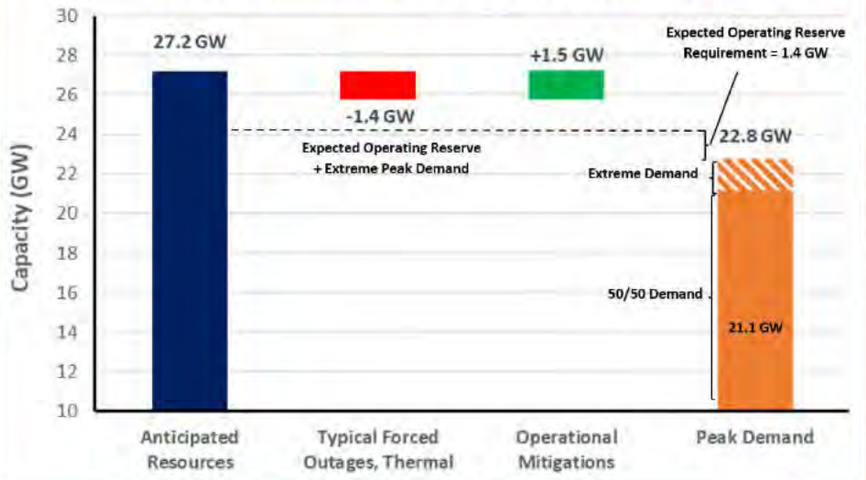
Risk Scenario Summary

Expected resources meet operating reserve requirements under the assessed scenarios.

On-Peak Resource Mix



2025–2026 Winter Risk Period Scenario



Scenario Description (See Data Concepts and Assumptions)

Risk Period: Highest risk for unserved energy at peak demand hour

Demand Scenarios: Net internal demand (50/50 forecast) and highest weather-adjusted daily demand from 31 years of winter demand history

Typical Forced Outages, Thermal: Based on analysis of a rolling five-year history of actual forced outage data.

Operational Mitigations: Imports anticipated from **neighbors** during emergencies



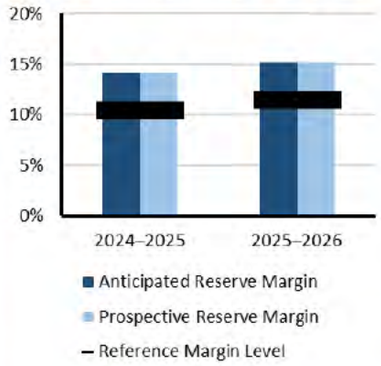
NPCC-Québec

NPCC-Québec is an assessment area that covers the Canadian province of Québec. The province of Québec covers over 1.5 million square kilometers (nearly 600,000 square miles) and has a population of 9 million people. Hydro-Québec is the BA for the province of Québec. The Québec BPS is one of the four electric Interconnections in North America. It is a predominately hydroelectric-generation-based system that is electrically interconnected with NPCC-Ontario, NPCC-New York, NPCC-New England, and NPCC-Maritimes. Peak electricity demand in NPCC-Québec occurs during the winter season.

Highlights

- NPCC-Québec projects adequate capacity margins above its reference reserve requirements and that system resource adequacy will be maintained for the province for the 2025–26 Winter assessment period.
- No hydropower performance issues are expected during extreme cold because of design criteria for cold weather.
- No fuel supply or transportation issues are anticipated for the upcoming winter season.
- While a slight decrease in net firm transfers has occurred since last winter (-89 MW), significant increases in demand-side management programs (+450 MW year-over-year) have been realized over the same period and are expected to compensate for this winter's modest expected load growth.

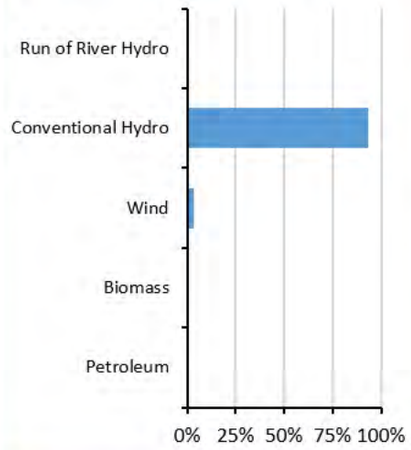
On-Peak Reserve Margin



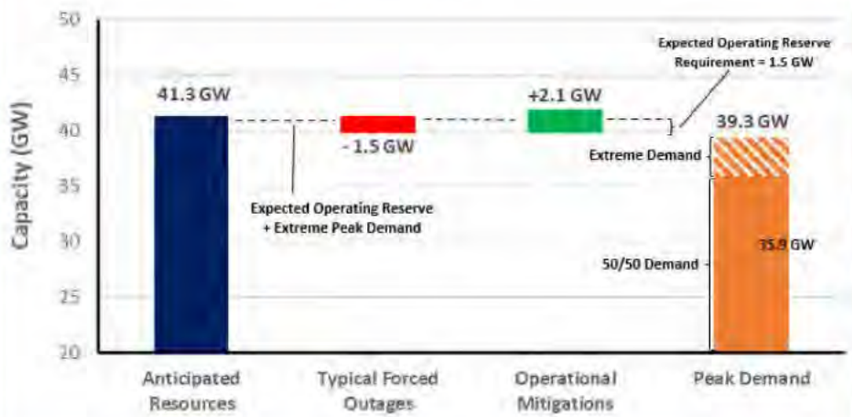
Risk Scenario Summary

Expected resources meet operating reserve requirements under the assessed scenarios.

On-Peak Resource Mix



2025–2026 Winter Risk Period Scenario



Scenario Description (See Data Concepts and Assumptions)

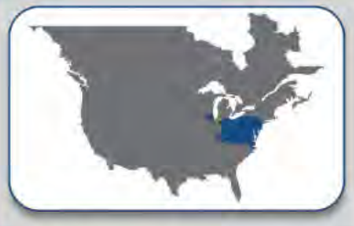
Risk Period: Highest risk for unserved energy at hour ending 8:00 a.m.

Demand Scenarios: Demand forecasts include demand-side resources. The demand side resources are the same for the 50/50 and extreme demand scenarios. The extreme load forecast is determined at two standard deviations higher than the mean, which has a 6.06% probability of occurrence.

Extreme Derates: Maintenance outages and other deratings are already included in existing-certain capacity calculation. Wind capacity is 64% derated

Typical Forced Outages: Unplanned outages are 1,500 MW.

Operational Mitigations: Operational mitigations include imports from neighboring areas and reduction of reserves



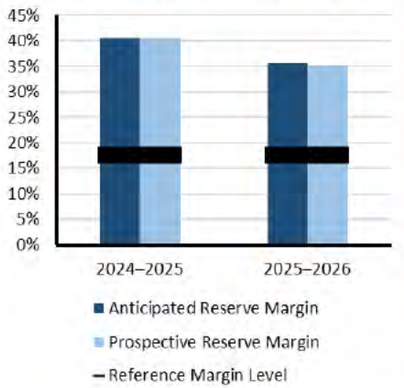
PJM

PJM Interconnection is a regional transmission organization that coordinates the movement of wholesale electricity in all or parts of Delaware, Illinois, Indiana, Kentucky, Maryland, Michigan, New Jersey, North Carolina, Ohio, Pennsylvania, Tennessee, Virginia, West Virginia, and the District of Columbia. PJM's footprint covers approximately 369,054 square miles and with an approximate population of 67 million people. PJM is the area's BA, Transmission and Resource Planner, interchange authority, TOP, transmission service provider, and RC. PJM is electrically interconnected with MISO, NPCC-New York, SERC-Central, and SERC-East. Peak electricity demand in PJM occurs during the summer season.

Highlights

- Due to the low penetration of limited and variable resources in PJM relative to PJM's peak load, the hour with highest loss-of-load risk remains the hour with highest forecasted demand.
- PJM is expecting little capacity adequacy risk during Winter 2025–2026 and expects around 35% installed reserves, which is above the target IRM of 17.7% necessary to meet the 1-day-in-10-years LOLE criterion.
- Last winter, PJM hit a new all-time winter peak, but generator preparations anticipating congestion and tight capacity projections led to sufficient reserves throughout the demand event and PJM's transmission system performed well.
- The decrease in reserves from Winter 2024–2025 is due to load increases and retirement of generation without like (non-solar dispatchable) replacement generation.

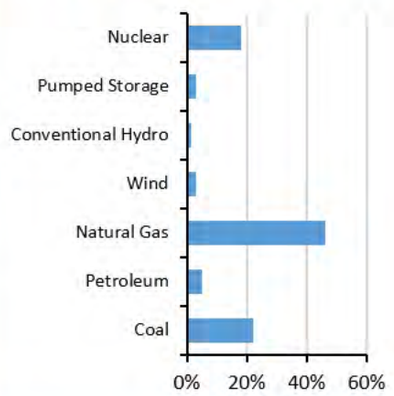
On-Peak Reserve Margin



Risk Scenario Summary

Expected resources meet operating reserve requirements under the assessed scenarios.

On-Peak Resource Mix



2025–2026 Winter Risk Period Scenario



Scenario Description (See Data Concepts and Assumptions)

Risk Period: Highest risk for unserved energy at peak demand hour

Demand Scenarios: Net internal demand (50/50) and (90/10) demand forecast

Typical Forced Outages: Based on historical data and trending

Resource Derates for Extreme Conditions: Reduced thermal capacity contributions due to performance in extreme conditions

Operational Mitigations: accounts for an estimated value based on operational / emergency procedures



SERC-Central

SERC-Central is an assessment area within the SERC Regional Entity. SERC-Central includes all of Tennessee and portions of Georgia, Alabama, Mississippi, Missouri, and Kentucky. Historically a summer-peaking area, SERC-Central is beginning to have higher peak demand forecasts in winter. SERC is one of the six companies across North America that are responsible for the work under FERC-approved delegation agreements with NERC. SERC-Central is specifically responsible for the reliability and security of the electric grid across the Southeastern and Central areas of the United States. This area covers approximately 630,000 square miles and serves a population of more than 91 million. The SERC Regional Entity includes 36 BAs, 28 planning entities, and 6 RCs.

Highlights

- SERC-Central is transitioning from a summer-peaking area to a dual-peaking system.
- For the 2025–2026 Winter, SERC-Central projects a sufficient level of resources to serve the expected load under median weather and typical system operating conditions, based on the 2024 NERC ProbA base-case results.
- Most entities across SERC-Central report that fuel security is strong since it is supported by firm natural gas contracts, storage resources, and reliable pipeline capacity. Coal inventories are projected to remain within operational ranges necessary to meet winter demand.
- Following lessons from Winter Storm Elliott, one SERC-Central entity raised its winter Planning Reserve Margin target to 26% and updated preparedness programs with improved heat trace capabilities.

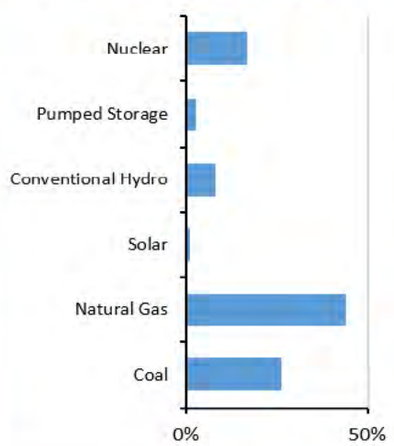
Risk Scenario Summary

Expected resources meet operating reserve requirements under normal peak demand. A severe cold weather event that extends to the south could lead to energy emergencies as operators face sharp increases in generator forced outages and electricity demand. Above-normal winter peak load and outage conditions could result in the need for operating mitigations (i.e., demand response and transfers) and EEAs. Load shedding is unlikely but may be needed under wide-area cold weather events.

On-Peak Reserve Margin



On-Peak Resource Mix



2025–2026 Winter Risk Period Scenario



Scenario Description (See Data Concepts and Assumptions)

Risk Period: Highest risk for unserved energy at peak demand hour

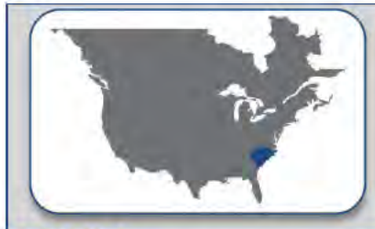
Demand Scenarios: Net internal demand (50/50) and (90/10) demand forecast using 30 years of historical data

Typical Maintenance Outages: Data collected through a survey of members for expected outages during December through February

Typical Forced Outages and Solar Derate: Includes any weighted average forced-outage rates on-peak that are not factored into the anticipated resources calculation . Also, solar resources are derated to account for peak demand occurrence during darkness.

Resource Derates for Extreme Conditions: Entity-provided values for low likelihood extreme conditions

Operational Mitigations: A total of over 1.6 GW based on operational/emergency procedures



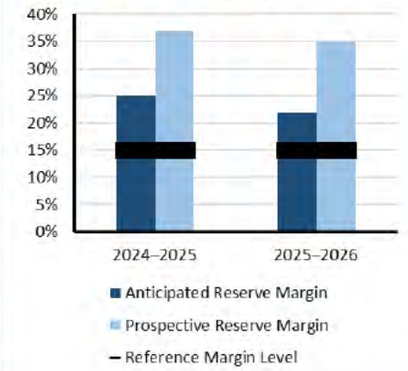
SERC-East

SERC-East is an assessment area within the SERC Regional Entity. SERC-East includes North Carolina and South Carolina. Historically a summer-peaking area, SERC-East is beginning to have higher peak demand forecasts in winter. SERC is one of the six Regional Entities across North America that are responsible for the work under FERC-approved delegation agreements with NERC. SERC is specifically responsible for the reliability and security of the electric grid across the Southeastern and Central United States. The SERC Regional Entity covers approximately 630,000 square miles with a population of more than 91 million. The SERC Regional Entity includes 36 BAs, 28 Planning Authorities (PA), and 6 RCs.

Highlights

- SERC-East is transitioning from a summer-peaking area to potentially peaking during both summer and winter. This shift is attributed to the continued addition of solar PV generation, which reduces summer peak demand, and a trend toward electrification of heating, which drives up winter peak demand.
- For the 2025–2026 Winter, the SERC-East region projects a sufficient level of resources to serve the expected load under median weather and typical system operating conditions, based on the 2024 NERC ProbA base-case results.
- Fuel supplies and transportation remain stable, and entities anticipate maintaining adequate coal and oil inventories with no reported changes to fuel procurement or operator plans for the upcoming winter.
- Probabilistic Base Case Results (Median Weather): EUE is 61.95 MWh and LOLH is 0.06 hours/year. EUE values are likely due to higher winter peaks and/or lower supply of capacity that can meet early winter morning demand.
- Mitigation measures for extreme conditions include voltage reduction (25–50 MW) and load-shedding programs that cover up to 30% of system load.

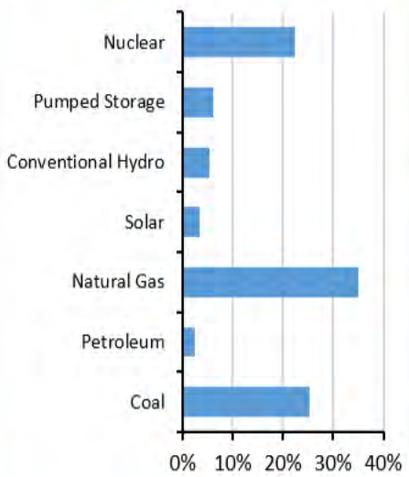
On-Peak Reserve Margin



Risk Scenario Summary

Expected resources meet operating reserve requirements under normal demand scenarios. A severe cold weather event extending to the south could lead to energy emergencies as operators face sharp increases in generator forced outages and electricity demand. Above-normal winter peak load and outage conditions could result in the need for operating mitigations (i.e., demand response and transfers) and EEAs. Load shedding is unlikely but may be needed under wide-area cold weather events.

On-Peak Resource Mix



2025–2026 Winter Risk Period Scenario



Scenario Description (See Data Concepts and Assumptions)

Risk Period: Highest risk for unserved energy at peak demand hour

Demand Scenarios: Net internal demand (50/50) and (90/10) demand forecast

Typical Maintenance Outages: Data collected through a survey of members for outages during December through February

Typical Forced Outages and Solar Derate: Weighted average forced-outage rates on-peak are factored into the anticipated resources calculation. Also, solar resources are derated to account for peak demand occurrence during darkness.

Resource Derates for Extreme Conditions: Maximum historical generation outages (excluding 2022–2025)

Operational Mitigations: A total of 0.2 GW based on operational/emergency procedures



SERC-Florida Peninsula

SERC-Florida Peninsula is a summer-peaking assessment area within SERC. SERC is one of the six Regional Entities across North America that is responsible for the work under FERC-approved delegation agreements with NERC. SERC is specifically responsible for the reliability and security of the electric grid across the Southeastern and Central United States. The SERC Regional Entity area covers approximately 630,000 square miles with a population of more than 91 million. The SERC Regional Entity includes 36 BAs, 28 PAs, and 6 RCs.

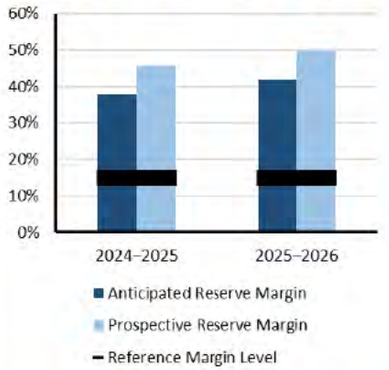
Highlights

- SERC-Florida Peninsula is a summer-peaking assessment area.
- Florida Peninsula entities have not identified any emerging reliability issues for the upcoming 2025–26 Winter season with an ARM projected at 39%, well above the RML, while the 2024 NERC ProbA base-case results project a sufficient level of resources to serve the expected load under median weather and typical system operating conditions (EUE is 1.09 MWh and LOLH is 0.00 hours/year).
- Many entities report strong fuel security, supported by firm natural gas contracts, storage resources, reliable pipeline capacity, and actively managed coal and oil inventories, which are projected to remain within operational ranges to meet winter demand.
- Florida Peninsula entities do not assume non-firm external assistance from neighboring areas during extreme conditions.

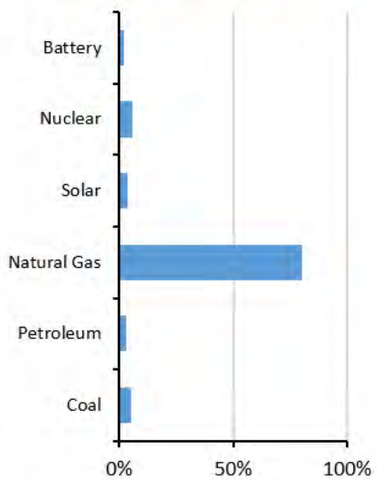
Risk Scenario Summary

Expected resources meet operating reserve requirements under the assessed scenarios.

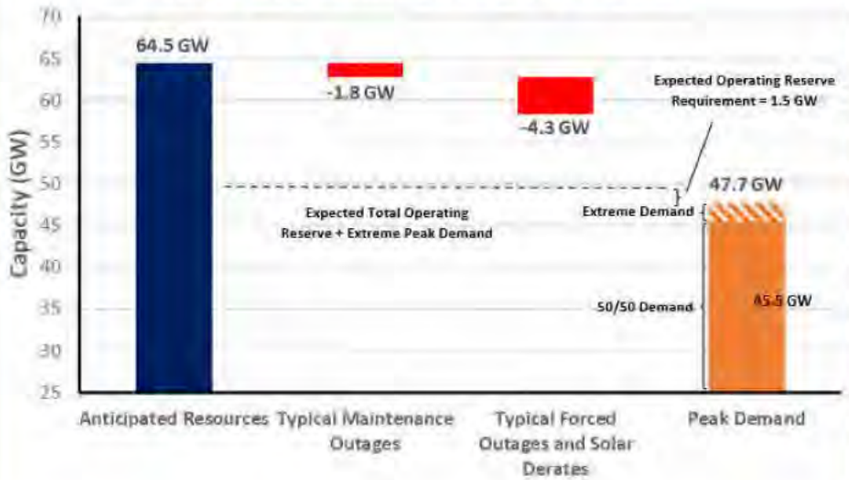
On-Peak Reserve Margin



On-Peak Resource Mix



2025–2026 Winter Risk Period Scenario



Scenario Description (See Data Concepts and Assumptions)

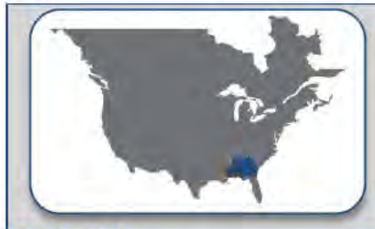
Risk Period: Highest risk for unserved energy at peak demand hour

Demand Scenarios: Net internal demand (50/50) and (90/10) demand forecast using 30 years of historical data

Typical Maintenance Outages: Data collected through a survey of members for outages during December through February

Typical Forced Outages and Solar Derate: Weighted average forced-outage rates on-peak are factored into the anticipated resources calculation. Also, solar resources are derated to account for peak demand occurrence during darkness.

Resource Derates for Extreme Conditions: Entity-provided values for low likelihood extreme conditions



SERC-Southeast

SERC-Southeast is a summer-peaking assessment area within the SERC Regional Entity. SERC-Southeast includes all or portions of Georgia, Alabama, and Mississippi. SERC is one of the six Regional Entities across North America that is responsible for the work under FERC-approved delegation agreements with NERC. SERC is specifically responsible for the reliability and security of the electric grid across the Southeastern and Central United States. The SERC Regional Entity covers approximately 630,000 square miles with a population of more than 91 million. The SERC Regional Entity includes 36 BAs, 28 PAs, and 6 RCs.

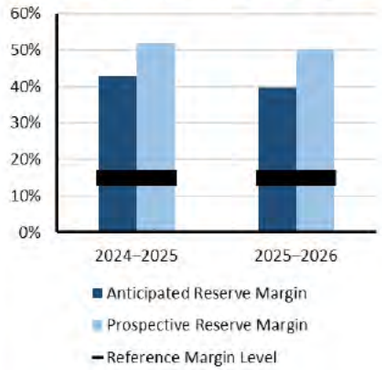
Highlights

- SERC-Southeast is trending towards becoming slightly winter-peaking.
- For the 2025–2026 Winter, SERC-Southeast entities report no emerging reliability concerns and expect to have adequate resources, supported by firm natural gas transportation contracts, diverse fuel portfolios, and sufficient on-site coal inventories to serve the expected load under typical system operating conditions. The 2024 NERC ProbA base-case results in EUE and LOLH are both 0.00.
- While most SERC-Southeast BAs expect to have adequate resources, supported by firm natural gas transportation contracts, diverse fuel portfolios, and sufficient on-site coal inventories, one BA highlights potential risks related to natural gas transportation capacity, citing high pipeline utilization, competition for delivered gas, and ratable flow requirements. Mitigation strategies include securing third-party gas supply, adding dual-fuel capability, and implementing coal inventory management.
- Entities have made refinements such as replacing specific 230 kV circuit breakers and increasing monitoring frequencies for critical plant systems after January 2025 winter events.

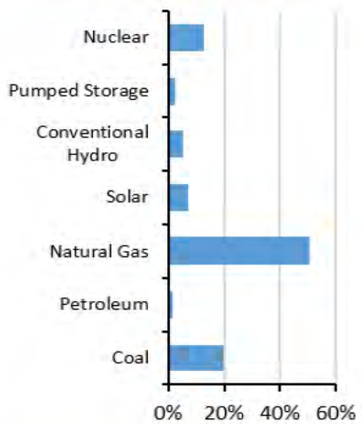
Risk Scenario Summary

Expected resources meet operating reserve requirements under the assessed scenarios.

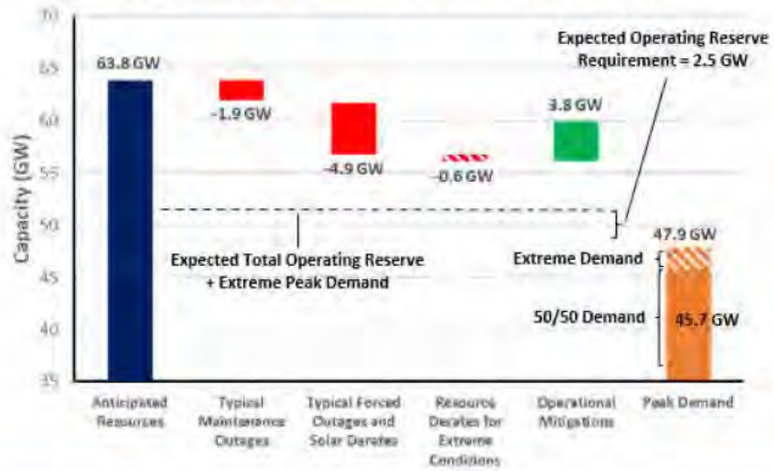
On-Peak Reserve Margin



On-Peak Resource Mix



2025–2026 Winter Risk Period Scenario



Scenario Description (See Data Concepts and Assumptions)

Risk Period: Highest risk for unserved energy at peak demand hour

Demand Scenarios: Net internal demand (50/50) and (90/10) demand forecast using 30 years of historical data

Typical Maintenance Outages: Data collected through a survey of members for outages during December through February

Typical Forced Outages and Solar Derate: Weighted average forced-outage rates on-peak are factored into the anticipated resources calculation. Also, solar resources are derated to account for peak demand occurrence during darkness.

Resource Derates for Extreme Conditions: Maximum historical generation outages

Operational Mitigations: A total of 3.8 GW based on operational/emergency procedures



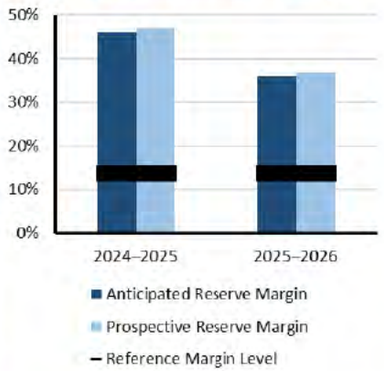
Texas RE-ERCOT

ERCOT is the ISO for the ERCOT Interconnection and is located entirely in the state of Texas; it operates as a single BA. It also performs financial settlement for the competitive wholesale bulk-power market and administers retail switching for nearly 8 million premises in competitive choice areas. ERCOT is governed by a board of directors and subject to oversight by the Public Utility Commission of Texas and the Texas Legislature. ERCOT is summer-peaking and covers approximately 200,000 square miles, connects over 54,100 miles of transmission lines, has over 1,250 generation units, and serves more than 27 million customers. Texas RE is responsible for the Regional Entity functions described in the Energy Policy Act of 2005 for ERCOT. On November 3, 2022, the Public Utility Commission of Texas issued an order directing ERCOT to assume the duties and responsibilities of the reliability monitor for the Texas power grid.

Highlights

- Given expected system conditions, an ARM of 36% and RML of 13.75%, ERCOT expects to have sufficient operating reserves for the peak hour ending 8:00 a.m.
- ERCOT does not expect any significant fuel supply issues for the winter.
- ERCOT has conducted 2,028 generation resource and transmission service provider (TSP) winter weatherization inspections since Winter 2021–2022.
- Winter peak demands typically occur before sunrise and after sunset when solar generation is not available. Significant battery storage mitigates these risks.
- ERCOT's probabilistic risk assessment indicates a 2% probability of having to declare EEAs during the January forecasted winter peak day (which coincides with the highest reserve shortage risk) and a controlled load shed probability of 1.8%. ERCOT defines low-risk hours as when the probability of an EEA is less than 10%.
- Increased load growth in west Texas combined with "no solar" and low wind conditions can cause transmission lines into this area to become heavily loaded. ERCOT has introduced improved dynamic line ratings that allow for greater transfers at colder temperatures and periods of low irradiance.

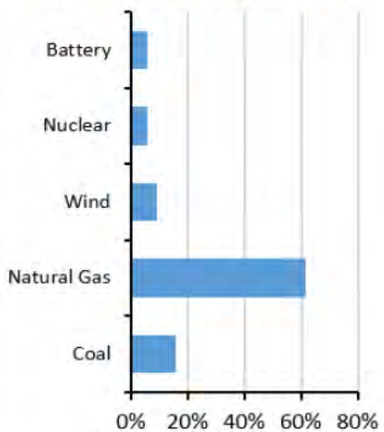
On-Peak Reserve Margin



Risk Scenario Summary

Expected resources meet operating reserve requirements under normal peak-demand scenarios. Above-normal winter peak load and outage conditions could result in the need for operating mitigations (i.e., demand response and transfers) and EEAs. Load shedding is unlikely but may be needed under wide-area cold weather events.

On-Peak Resource Mix



2025–2026 Winter Risk Period Scenario



Scenario Description (See Data Concepts and Assumptions)

Risk Period: Highest risk for unserved energy at peak demand hour

Demand Scenarios: Presumes weather conditions comparable to Winter Storm Uri. The adjustment is calculated as the difference between the 100th percentile and 50th percentile values from ERCOT's Probabilistic Reserve Risk Model (PRRM) simulated load outcome distribution for hour ending 8:00 a.m.

Typical Maintenance Outages: Based on historical winter data and consideration of ERCOT's allowed maximum system daily planned outage capacity

Typical Forced Outages: Based on a probability distribution created using historical ERCOT Outage Scheduler data for the last three Januarys.

Resource Derates for Extreme Conditions: Weather-related thermal and wind outages based on Winter Storm Uri levels, adjusted for reductions due to weatherization standards. Also includes high non-weather-related outages.

Operational Mitigations: Additional potential capacity from switchable generation and imports



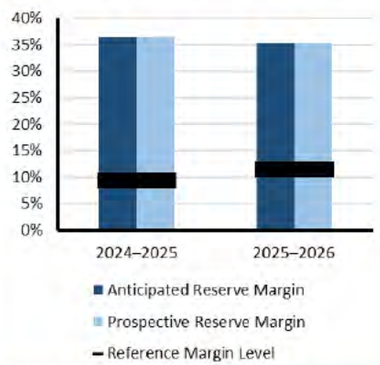
WECC-Alberta

WECC-Alberta is an assessment area that covers the Canadian province of Alberta. The province has a geographic area of 661,848 square kilometers (255,541 square miles) and a population of almost 5 million people. The Alberta Electric System Operator (AESO) is the province's Planning Entity and RC responsible for safe, reliable, and economic operation of the Alberta Interconnected Electric System. AESO is a non-profit corporation that operates a system that includes approximately 26,000 kilometers of transmission lines and connects approximately 426 qualified generating units and nearly 250 market participants through a wholesale market. Alberta's transmission system has three interties with neighboring areas: Saskatchewan (see MRO-SaskPower), British Columbia (see WECC-British Columbia), and Montana (see WECC-Northwest). Peak electricity demand on the AESO system currently occurs during the winter season.

Highlights

- At an extreme winter peak of 12,982 MW, with extreme forced outages at 530 MW and derates for extreme conditions bringing wind energy availability down by 1,800 MW and hydroelectricity by 88 MW, the required reserves are 759 MW and are sufficiently met, even with low availability.
- Demand is expected to increase 1.1% from last winter with the existing-certain installed capacity having increased 23%.
- Solar availability is down because 1,000 MW of PV moved from originally expecting to come on-line in 2024 as Tier 1 resources to Tier 2s mostly anticipated to come on-line in 2025, but with less certainty.

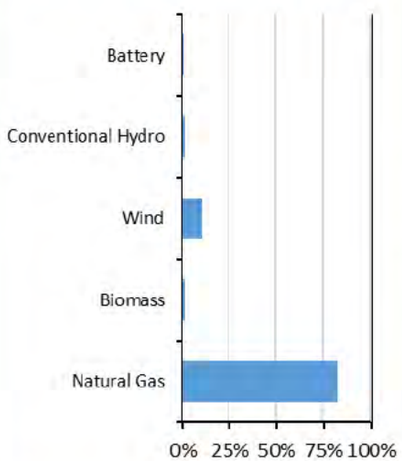
On-Peak Reserve Margin



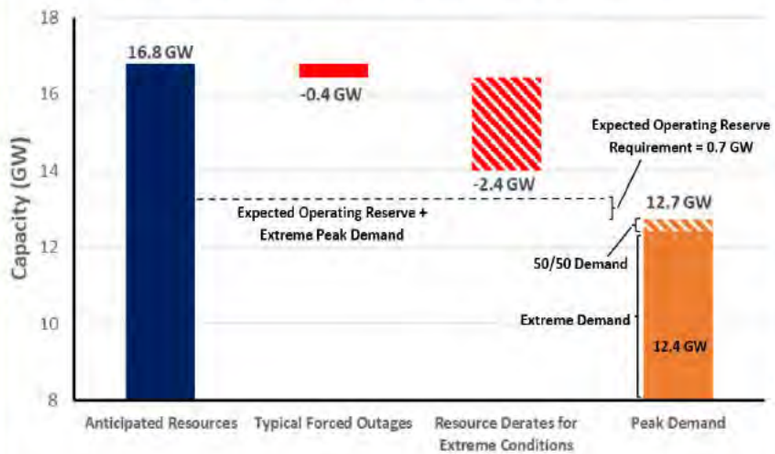
Risk Scenario Summary

Expected resources meet operating reserve requirements under assessed scenarios.

On-Peak Resource Mix



2025–2026 Winter Risk Period Scenario



Scenario Description (See Data Concepts and Assumptions)

Risk Period: Highest risk for unserved energy is on the peak demand hour

Demand Scenarios: Net internal demand is the expected (50th percentile) peak and the 90th percentile of peak demand is the extreme forecast

Typical Forced Outages: Calculated using historical GADS data

Resource Derates for Extreme Conditions: Thermal, wind, and solar are based on the hourly energy availability curves' probability distributions' 10th percentiles for the risk period



WECC-Basin

WECC-Basin is a summer-peaking assessment area in the WECC Regional Entity that includes Utah, southern Idaho, and a portion of western Wyoming, covering Idaho Power and PacifiCorp's eastern BA area. The population of this area is approximately 5.4 million. It has 15,910 miles of transmission. WECC is responsible for coordinating and promoting BES reliability in the Western Interconnection. WECC's 329 members include 40 BAs, representing a wide spectrum of organizations with an interest in the BES. Serving an area of nearly 1.8 million square miles and more than 84.5 million customers, it is geographically the largest and most diverse Regional Entity. *Note: The 2025-26 WRA includes a new assessment area map for the U.S. Western Interconnection. The new assessment area boundaries provide more geographic detail of reliability risk information. WECC-Basin is a new assessment area in 2025 that was part of WECC-NW in the 2024–25 WRA.*

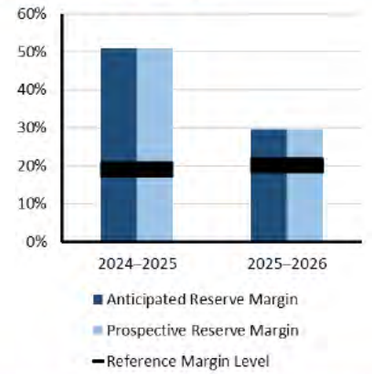
Highlights

- At an extreme winter peak of 11.1 GW under an extreme combination of derates and outages, the region could be short 1.0 GW before imports and is expected to need to rely on transfers.
- Net internal demand is expected to increase 1% since last year, with total internal demand up 1.8% being offset by a doubling of controllable and dispatchable demand response.
- Tier 1 resources have declined and do not appear to be offset by increases in existing-certain generation resource capacity. Nameplate wind has increased by almost 18% and solar by almost 30%. Hydro is also up over 7% in total installed capacity.
- Reliance on imports is expected to be required to maintain resource adequacy during extreme peak demand and extreme derate conditions.

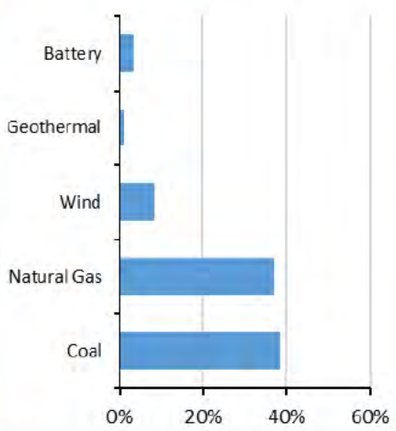
Risk Scenario Summary

Expected resources meet operating reserve requirements under normal peak demand scenarios. Above-normal peak demand combined with high generator outages in extreme conditions results in the need for external assistance to maintain reserves.

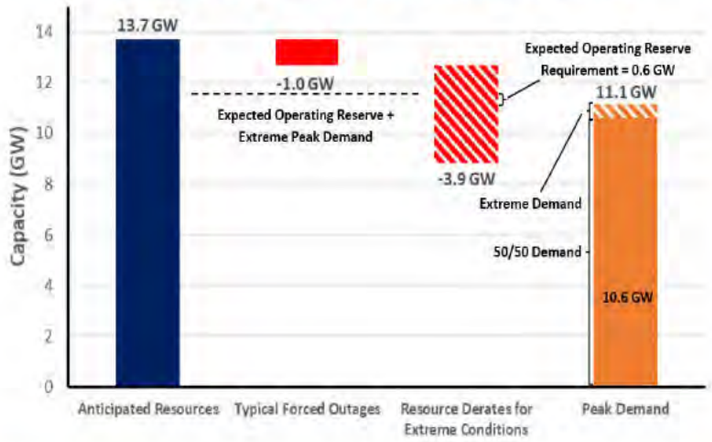
On-Peak Reserve Margin



On-Peak Resource Mix



2025–2026 Winter Risk Period Scenario



Scenario Description (See Data Concepts and Assumptions)

Risk Period: Highest risk for unserved energy is on the peak demand hour

Demand Scenarios: Net internal demand is the expected (50th percentile) peak and the 90th percentile of peak demand is the extreme forecast

Typical Forced Outages: Calculated using historical GADS

Extreme Derates: Thermal, wind, and solar are based on the hourly energy availability curves' probability distributions' 10th percentiles for the risk period



WECC-British Columbia

WECC-British Columbia is an assessment area that covers the Canadian province of British Columbia. The province has a geographic area of 944,735 square kilometers (364,764 square miles) and a population of just over 5 million people. BC Hydro is the Planning Entity and RC for the province of British Columbia and is the principal supplier of electricity for the province. BC Hydro is a provincial Crown corporation and, under provincial legislation, is responsible for the oversight of the British Columbia BES and its interconnections. BC Hydro operates an integrated system supported by 30 hydroelectric plants, approximately 80,000 kilometers of transmission and distribution lines, and 125 contracts with independent power producers. BC Hydro's transmission system has two interties with neighboring areas: the U.S. state of Washington (see WECC-Northwest) and Alberta (see WECC-Alberta). Peak electricity demand on the BC Hydro system currently occurs during winter.

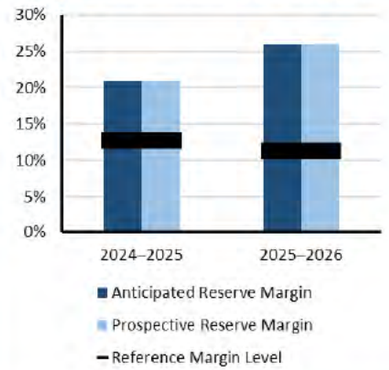
Highlights

- Peak demand is expected to remain about the same as last winter.
- There are about 200 MW more (47%) planned Tier 1 resources for this winter than last.
- Solar nameplate capacity has increased from 2 MW to 17 MW since last winter and hydroelectric nameplate capacity is up more than 5%, or 1,366 MW.

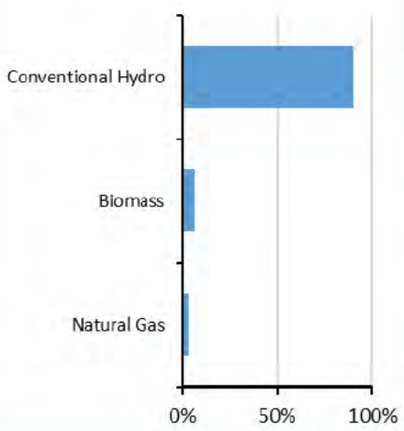
Risk Scenario Summary

Expected resources meet operating reserve requirements under normal and extreme demand scenarios.

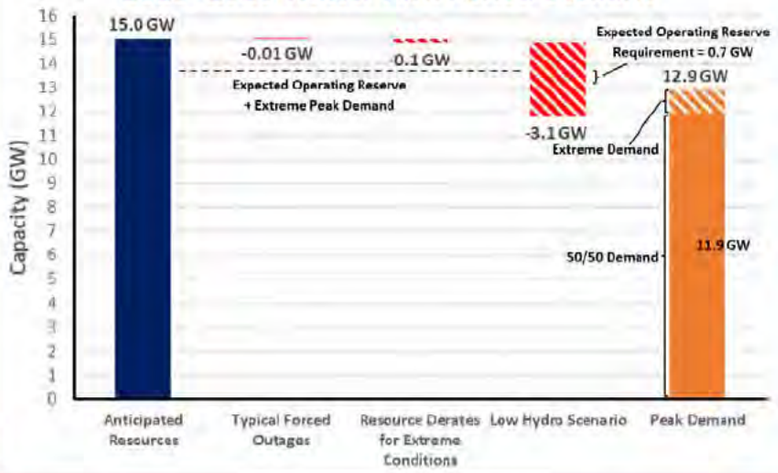
On-Peak Reserve Margin



On-Peak Resource Mix



2025–2026 Winter Risk Period Scenario



Scenario Description (See Data Concepts and Assumptions)

Risk Period: Highest risk for unserved energy is on the peak demand hour

Demand Scenarios: Net internal demand is the expected (50th percentile) peak and the 90th percentile of peak demand is the extreme forecast

Typical Forced Outages: Calculated using historical GADS

Resource Derates for Extreme Conditions: Thermal, wind, and solar are based on the hourly energy availability curves' probability distributions' 10th percentiles for the risk period

Low Hydro Scenario: Estimated derate for lower hydro output



WECC-California

WECC-California is a summer-peaking assessment area in the Western Interconnection that includes most of California and a small section of Nevada. The assessment area has a population of over 42.5 million people. The area includes the California ISO, the Los Angeles Department of Water and Power, the Turlock Irrigation District, and the Balancing Area of Northern California. It has 32,712 miles of transmission. WECC is responsible for coordinating and promoting BES reliability in the Western Interconnection. WECC's 329 members include 40 BAs, representing a wide spectrum of organizations with an interest in the BES. Serving an area of nearly 1.8 million square miles and more than 84.5 million customers, it is geographically the largest and most diverse Regional Entity. *Note: The 2025–26 WRA includes a new assessment area map for the U.S. Western Interconnection. The new assessment area boundaries provide more geographic detail of reliability risk information. WECC-Basin is a new assessment area in 2025 that was part of WECC-NW in the 2024–25 WRA.*

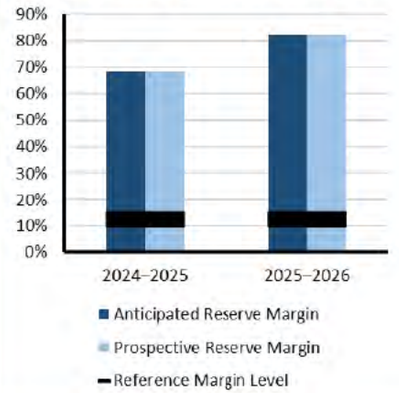
Highlights

- Operating reserve margins are met before imports in all winter resource availability scenarios.
- On-peak demand is expected to remain about the same as last winter. Demand-side management is down about 10%.
- Existing-certain capacity is up almost 5%, while planned Tier 1 resources are up more than 2 GW. The total wind nameplate capacity is up almost 27% and solar almost 13%. Hydro is down 4%.
- No reliance on imports is expected to be required to maintain resource adequacy for Winter 2025–2026.

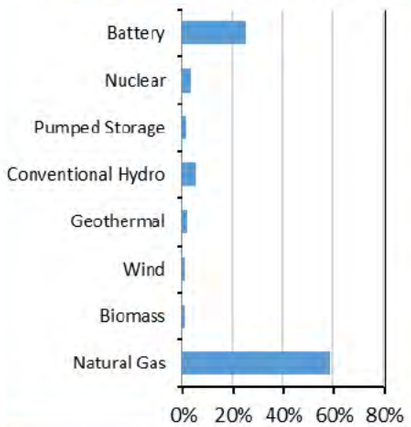
Risk Scenario Summary

Expected resources meet operating reserve requirements under assessed scenarios.

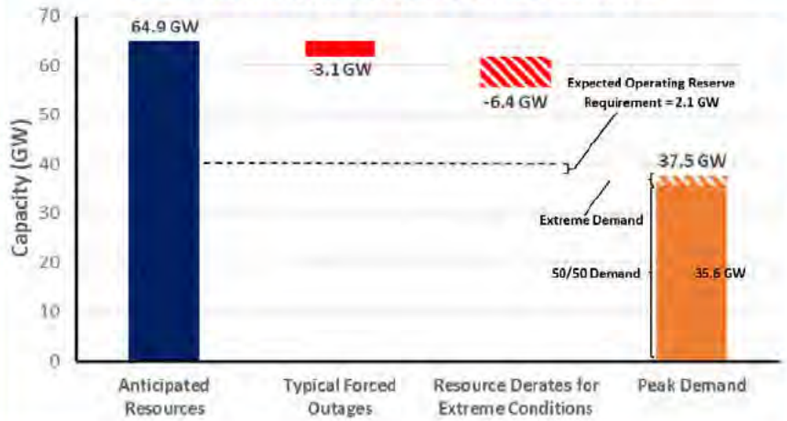
On-Peak Reserve Margin



On-Peak Resource Mix



2025–2026 Winter Risk Period Scenario



Scenario Description (See Data Concepts and Assumptions)

Risk Period: Highest risk for unserved energy is on the peak demand hour

Demand Scenarios: Net internal demand is the expected (50th percentile) peak and the 90th percentile of peak demand is the extreme forecast

Typical Forced Outages: Calculated using historical GADS

Resource Derates for Extreme Conditions: Thermal, wind, and solar are based on the hourly energy availability curves' probability distributions' 10th percentiles for the risk period



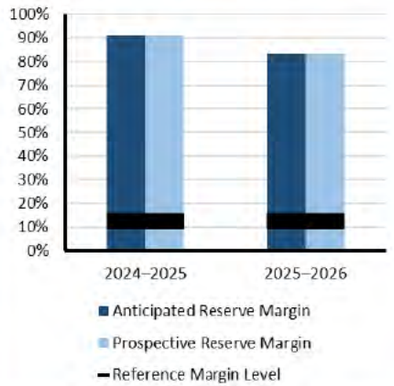
WECC-Mexico

WECC-Mexico is a summer-peaking assessment area in the Western Interconnection that includes the northern portion of the Mexican state of Baja California, which has a population of 3.8 million people and includes CENACE. It has 1,568 miles of transmission. WECC is responsible for coordinating and promoting BES reliability in the Western Interconnection. WECC's 329 members include 40 BAs, representing a wide spectrum of organizations with an interest in the BES. Serving an area of nearly 1.8 million square miles and more than 84.5 million customers, it is geographically the largest and most diverse Regional Entity. *Note: The 2025–26 WRA includes a new assessment area map for the U.S. Western Interconnection. The new assessment area boundaries provide more geographic detail of reliability risk information. WECC-Basin is a new assessment area in 2025 that was part of WECC-NW in the 2024–25 WRA.*

Highlights

- As a summer-peaking region, operating reserve margins are met before imports in all scenarios.
- Planned Tier 1 resources are down 100% to zero as expected resources have either been brought on-line to move into existing or, in the case of some natural gas, have been delayed until 2026 and moved into Tier 2.
- The existing-certain on peak reserve margin is down by 5.2%, and the anticipated and prospective reserve margins are down by 7.8%; however, since Mexico is heavily summer-peaking, the 83% reserve margin still exceeds the RML of 12.5%, which remains unchanged.

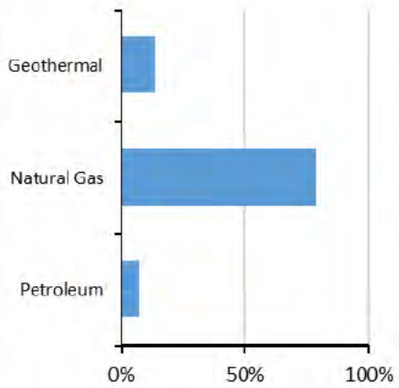
On-Peak Reserve Margin



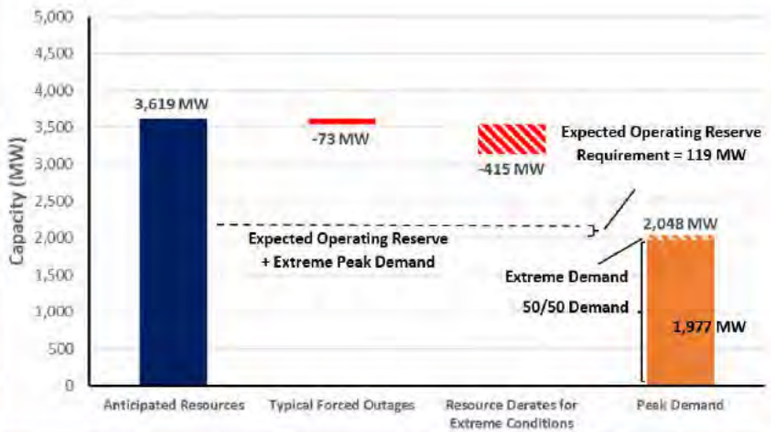
Risk Scenario Summary

Expected resources meet operating reserve requirements under assessed scenarios.

On-Peak Resource Mix



2025–2026 Winter Risk Period Scenario



Scenario Description (See Data Concepts and Assumptions)

Risk Period: Highest risk for unserved energy is on the peak demand hour

Demand Scenarios: Net internal demand is the expected (50th percentile) peak and the 90th percentile of peak demand is the extreme forecast

Typical Forced Outages: Calculated using historical GADS

Resource Derates for Extreme Conditions: Thermal, wind, and solar are based on the hourly energy availability curves' probability distributions' 10th percentiles for the risk period



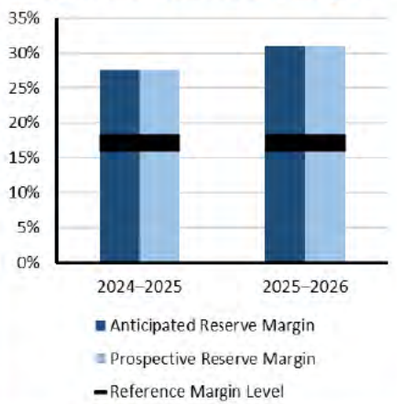
WECC-Northwest

WECC-Northwest is a winter-peaking assessment area in the WECC Regional Entity. The area includes Montana, Oregon, and Washington and parts of northern California and northern Idaho. The population of the area is approximately 13.6 million. It has 32,751 miles of transmission. WECC is responsible for coordinating and promoting BES reliability in the Western Interconnection. WECC's 329 members include 40 BAs, representing a wide spectrum of organizations with an interest in the BES. Serving an area of nearly 1.8 million square miles and more than 84.5 million customers, it is geographically the largest and most diverse Regional Entity. *Note: The 2025–26 WRA includes a new assessment area map for the U.S. Western Interconnection. The new assessment area boundaries provide more geographic detail of reliability risk information. WECC-Basin is a new assessment area in 2025 that was part of WECC-NW in the 2024–25 WRA.*

Highlights

- The Northwest has historically been a mixed season-peaking region.
- Operating reserve margins are expected to be met after imports in all winter scenarios.
- Total and net internal demand are up 9.3% with the primary drivers being data centers, residential electrification, transportation electrification, and semiconductor manufacturing.
- Large coal unit retirements and conventional hydro unit retirements are attributable to the reduction in existing certain capacity of 10.5%; however, planned Tier 1 resources have soared over 580%, from 463 MW to over 3 GW.
- Nameplate wind capacity is up over 3 GW (26%) and solar nameplate capacity is up nearly 2,690 MW (134%), which has also increased the solar availability on the peak hour.
- An increase in firm imports is seen in the model, 6.1 GW, absorbing the reduction in existing certain capacity of 4 GW.

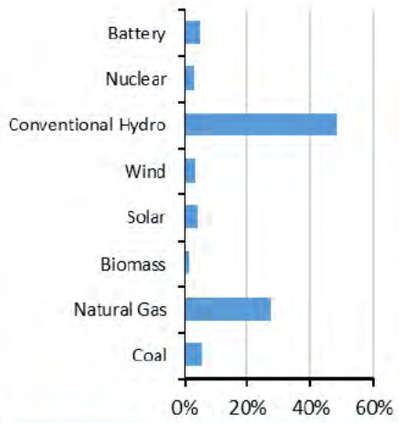
On-Peak Reserve Margin



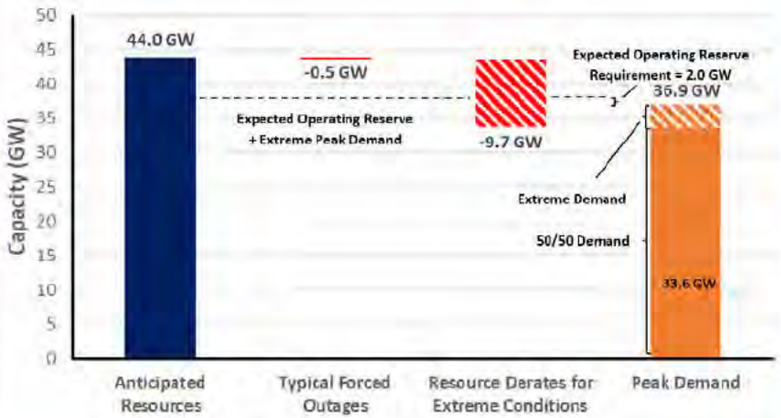
Risk Scenario Summary

Expected resources meet operating reserve requirements under normal peak demand scenarios. Above-normal peak demand combined with high generator outages in extreme conditions results in the need for external assistance to maintain reserves.

On-Peak Resource Mix



2025–2026 Winter Risk Period Scenario



Scenario Description (See Data Concepts and Assumptions)

Risk Period: Highest risk for unserved energy is on the peak demand hour

Demand Scenarios: Net internal demand is the expected (50th percentile) peak and the 90th percentile of peak demand is the extreme forecast

Typical Forced Outages: Calculated using historical GADS

Resource Derates for Extreme Conditions: Thermal, wind, and solar are based on the hourly energy availability curves' probability distributions' 10th percentiles for the risk period. This value includes 6.8 GW of hydro derates.



WECC-Rocky Mountain

WECC-Rocky Mountain is a summer-peaking assessment area in the Western Interconnection that includes Colorado, most of Wyoming, and parts of Nebraska and South Dakota. The population of the area is approximately 6.7 million. It covers the balancing areas of the Public Service Company of Colorado and the Western Area Power Administration's Rocky Mountain Region. It has 18,797 miles of transmission. WECC is responsible for coordinating and promoting BES reliability in the Western Interconnection. WECC's 329 members include 40 BAs, representing a wide spectrum of organizations with an interest in the BES. Serving an area of nearly 1.8 million square miles and more than 84.5 million customers, it is geographically the largest and most diverse Regional Entity. *Note The 2025–26 WRA includes a new assessment area map for the U.S. Western Interconnection. The new assessment area boundaries provide more geographic detail of reliability risk information. WECC-Basin is a new assessment area in 2025 that was part of WECC-NW in the 2024–25 WRA.*

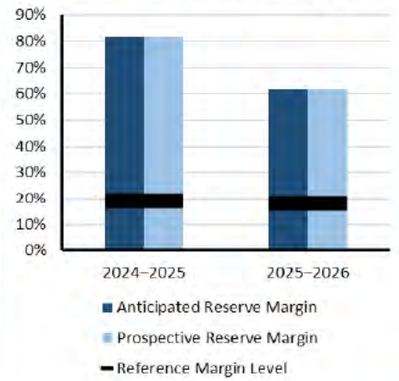
Highlights

- In Rocky Mountain, operating reserve margins are expected to be met before imports in all winter scenarios.
- Total and net internal demand are up almost 1%. The primary drivers are data centers and commercial and industrial customer growth.
- Planned Tier 1 resources are up over 84%, from almost 200 MW to over 365 MW. Solar nameplate capacity is up 27%; however, on-peak solar energy availability is down 100% due to the shift to after sunset. Expected hydro on peak energy availability is also down by around a quarter on the peak hour. Existing-Certain, Anticipated, and Prospective Reserve Margins are all down by over 20% on the peak hour; however, the region still maintains resource adequacy with margins hovering around 60% compared to the RML of 18%.
- No reliance on imports is expected to be required to maintain resource adequacy under combined extreme peak and extreme derated conditions.

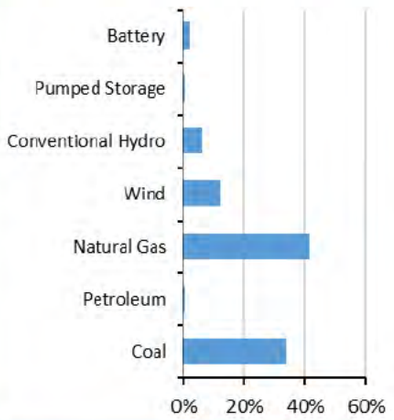
Risk Scenario Summary

Expected resources meet operating reserve requirements under assessed scenarios.

On-Peak Reserve Margin



On-Peak Resource Mix



2025–2026 Winter Risk Period Scenario



Scenario Description (See Data Concepts and Assumptions)

Risk Period: Highest risk for unserved energy is on the peak demand hour

Demand Scenarios: Net internal demand is the expected (50th percentile) peak and the 90th percentile of peak demand is the extreme forecast

Typical Forced Outages: Calculated using historical GADS

Resource Derates for Extreme Conditions: Thermal, wind, and solar are based on the hourly energy availability curves' probability distributions' 10th percentiles for the risk period



WECC-Southwest

WECC-Southwest is a summer-peaking assessment area in the Western Interconnection that includes all of Arizona and New Mexico, most of Nevada, and small parts of California and Texas. The area has a population of approximately 13.6 million. It has 23,084 miles of transmission. WECC is responsible for coordinating and promoting BES reliability in the Western Interconnection. WECC's 329 members include 40 BAs, representing a wide spectrum of organizations with an interest in the BES. Serving an area of nearly 1.8 million square miles and more than 84.5 million customers, it is geographically the largest and most diverse Regional Entity. *Note The 2025–26 WRA includes a new assessment area map for the U.S. Western Interconnection. The new assessment area boundaries provide more geographic detail of reliability risk information. WECC-Basin is a new assessment area in 2025 that was part of WECC-NW in the 2024–25 WRA.*

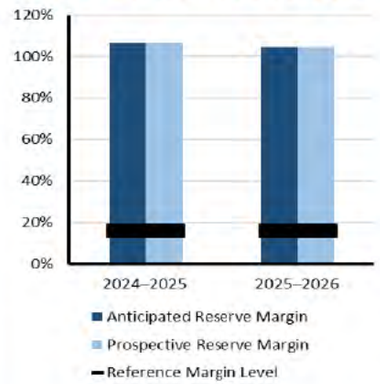
Highlights

- The Southwest is anticipated to be resource adequate under all winter expected and extreme energy availability and demand scenarios before imports.
- Total internal demand is expected to be up 1.5% and net internal demand up 2.3% since last winter. The primary drivers for load growth are data centers and industrial and residential electrification. Controllable and dispatchable demand response is down nearly half, by 163 MW.
- Planned Tier 1 resources are down over 19% as some have moved into existing certain, which is up almost 3%, over 1 GW, and other projects have experienced delays.
- Wind nameplate is up 12%, 470 MW, correlating to on-peak energy availability from wind increasing almost 11%, by 114 MW, while solar nameplate is up 27% or over 2.5 GW.

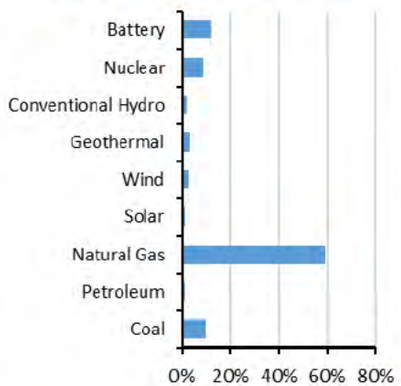
Risk Scenario Summary

Expected resources meet operating reserve requirements under assessed scenarios.

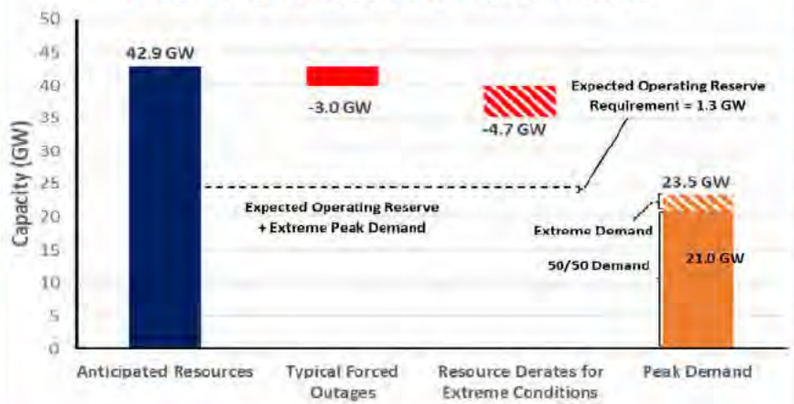
On-Peak Reserve Margin



On-Peak Resource Mix



2025–2026 Winter Risk Period Scenario



Scenario Description (See Data Concepts and Assumptions)

Risk Period: Highest risk for unserved energy is on the peak demand hour

Demand Scenarios: Net internal demand is the expected (50th percentile) peak and the 90th percentile of peak demand is the extreme forecast

Typical Forced Outages: Calculated using historical GADS

Resource Derates for Extreme Conditions: Thermal, wind, and solar are based on the hourly energy availability curves' probability distributions' 10th percentiles for the risk period

Data Concepts and Assumptions

The table below explains data concepts and important assumptions used throughout this assessment.

General Assumptions
• Reliability of the interconnected BPS is comprised of both adequacy and operating reliability:
▪ Adequacy is the ability of the electric system to supply the aggregate electric power and energy requirements of the electricity consumers at all times while taking into account scheduled and reasonably expected unscheduled outages of system components.
▪ Operating reliability is the ability of the electric system to withstand sudden disturbances, such as electric short-circuits or unanticipated loss of system components.
• The reserve margin calculation is an important industry planning metric used to examine future resource adequacy.
• All data in this assessment is based on existing federal, state, and provincial laws and regulations.
• Differences in data collection periods for each assessment area should be considered when comparing demand and capacity data between year-to-year seasonal assessments.
• A positive net transfer capability would indicate a net importing assessment area; a negative value would indicate a net exporter.
Demand Assumptions
• Electricity demand projections, or load forecasts, are provided by each assessment area.
• Load forecasts include peak hourly load[11] or total internal demand for the summer and winter of each year.[12]
• Total internal demand projections are based on normal weather (50/50 distribution)[13] and are provided on a coincident[14] basis for most assessment areas.
• Net internal demand is used in all reserve margin calculations, and it is equal to total internal demand then reduced by the amount of controllable and dispatchable demand response projected to be available during the peak hour.
Resource Assumptions
Resource planning methods vary throughout the North American BPS. NERC uses the categories below to provide a consistent approach for collecting and presenting resource adequacy. Because the electrical output of variable energy resources (VER) (e.g., wind, solar PV) depends on weather conditions, their contribution to reserve margins and other on-peak resource adequacy analysis is less than their nameplate capacity.
Anticipated Resources: • **Existing-Certain Capacity**: Included in this category are commercially operable generating units or portions of generating units that meet at least one of the following requirements when examining the period of peak demand for the summer season: unit must have a firm capability and have a power purchase agreement with firm transmission that must be in effect for the unit; unit must be classified as a designated network resource; and/or, where energy-only markets exist, unit must be a designated market resource eligible to bid into the market. • **Tier 1 Capacity Additions**: This category includes capacity that either is under construction or has received approved planning requirements. • **Net Firm Capacity Transfers (Imports minus Exports)**: This category includes transfers with firm contracts.
Prospective Resources: Includes all anticipated resources plus the following: **Existing-Other Capacity**: Included in this category are commercially operable generating units or portions of generating units that could be available to serve load for the period of peak demand for the season but do not meet the requirements of existing-certain.

[11] https://www.nerc.com/pa/Stand/Glossary%20of%20Terms/Glossary_of_Terms.pdf used in NERC Reliability Standards

[12] The summer season represents June–September and the winter season represents December–February.

[13] Essentially, this means that there is a 50% probability that actual demand will be higher and a 50% probability that actual demand will be lower than the value provided for a given season/year.

[14] Coincident: This is the sum of two or more peak loads that occur in the same hour. Noncoincident: This is the sum of two or more peak loads on individual systems that do not occur in the same time interval; this is meaningful only when considering loads within a limited period of time, such as a day, a week, a month, a heating or cooling season, and usually for not more than one year. SERC calculates total internal demand on a noncoincidental basis.

Reserve Margin Descriptions

Planning Reserve Margin: This is the primary metric used to measure resource adequacy; it is defined as the difference in resources (anticipated or prospective) and net internal demand then divided by net internal demand and shown as a percentage.

Reference Margin Level: The assumptions and naming convention of this metric vary by assessment area. The RML can be determined using both deterministic and probabilistic (based on a 0.1/year loss-of-load study) approaches. In both cases, this metric is used by system planners to quantify the amount of reserve capacity in the system above the forecasted peak demand that is needed to ensure sufficient supply to meet peak loads. Establishing an RML is necessary to account for long-term factors of uncertainty involved in system planning, such as unexpected generator outages and extreme weather impacts that could lead to increase demand beyond what was projected in the 50/50 load forecasted. In many assessment areas, an RML is established by a state, provincial authority, ISO/Regional Transmission Organization (RTO), or other regulatory body. In some cases, the RML is a requirement. RMLs may be different for the summer and winter seasons. If an RML is not provided by an assessment area, NERC applies 15% for predominantly thermal systems and 10% for predominantly hydro systems.

Seasonal Risk Scenario Chart Description

Each assessment area performed an operational risk analysis that was used to produce the seasonal risk scenario charts in the **Regional Assessments Dashboards**. The chart presents deterministic scenarios for further analysis of different resource and demand levels: The left blue column shows anticipated resources, and the two orange columns at the right show the two demand scenarios of the normal peak net internal demand and the extreme summer peak demand—both determined by the assessment area. The middle red or green bars show adjustments that are applied cumulatively to the anticipated resources, such as the following:

- Reductions for typical generation outages (i.e., maintenance and forced outages that are not already accounted for in anticipated resources)
- Reductions that represent additional outage or performance derating by resource type for extreme, low-probability conditions (e.g., drought condition impacts on hydroelectric generation, low-wind scenario affecting wind generation, fuel supply limitations, or extreme temperature conditions that result in reduced thermal generation output)
- Additional capacity resources that represent quantified capacity from operational procedures, if any, that are made available during scarcity conditions

Not all assessment areas have the same categories of adjustments to anticipated resources. Furthermore, each assessment area determined the adjustments to capacity based on methods or assumptions that are summarized below the chart. Methods and assumptions differ by assessment area and may not be comparable.

The chart enables evaluation of resource levels against levels of expected operating reserve requirement and the forecasted demand. Furthermore, the effects from extreme events can also be examined by comparing resource levels after applying extreme scenario derates and/or extreme summer peak demand.

Resource Adequacy

The ARM, which is based on available resource capacity, is a metric used to evaluate resource adequacy by comparing the projected capability of anticipated resources to serve forecast peak demand.[15] Large year-to-year changes in anticipated resources or forecast peak demand (net internal demand) can greatly impact Planning Reserve Margin calculations. NPCC-Maritimes marginally does not meet its RML for the upcoming winter. Other than NPCC-Maritimes, all assessment areas have sufficient ARMs to meet or exceed their RML for the 2025 winter as shown in Figure 4.

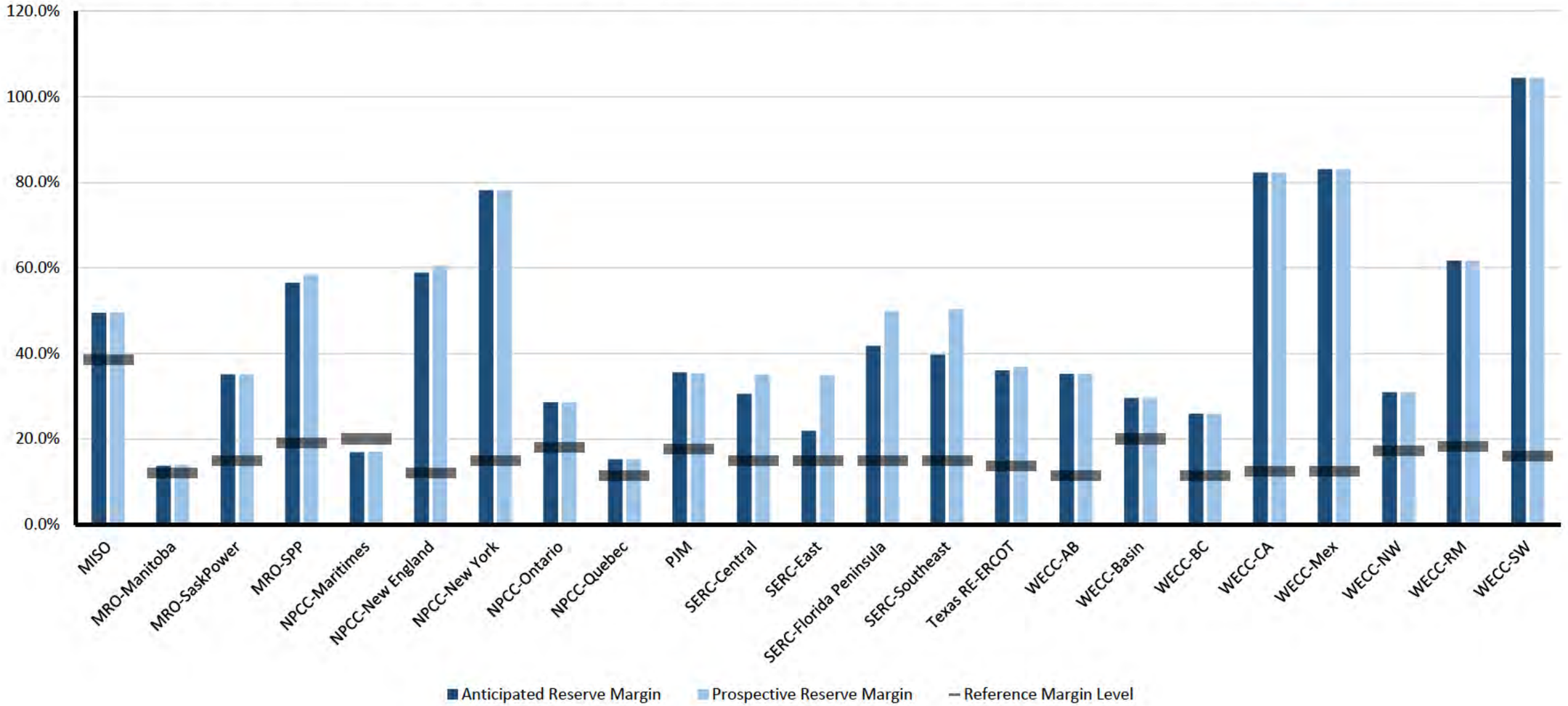


Figure 4: Winter 2025–2026 Anticipated/Prospective Reserve Margins Compared to Reference Margin Level

[15] Generally, anticipated resources include generators and firm capacity transfers that are expected to be available to serve load during electrical peak loads for the season. Prospective resources are those that could be available but do not meet criteria to be counted as anticipated resources. Refer to the Data Concepts and Assumptions section for additional information on Anticipated/Prospective Reserve Margins, anticipated/prospective resources, and RMLs.

Changes from Year-to-Year

Figure 5 provides the relative change in the forecast ARMs from the 2024–2025 Winter to the 2025–2026 Winter. All areas except NPCC-Maritimes remain above their RMLs for 2025–2026 Winter. The Canadian winter-peaking systems, which include MRO-Manitoba, MRO-SaskPower, NPCC-Maritimes, NPCC-Québec, WECC-Alberta, and WECC-British Columbia, may have reserve margins that are near RMLs but are unlikely to experience high outage rates from their winterized generators. Additional details are provided in the Data Concepts and Assumptions section.

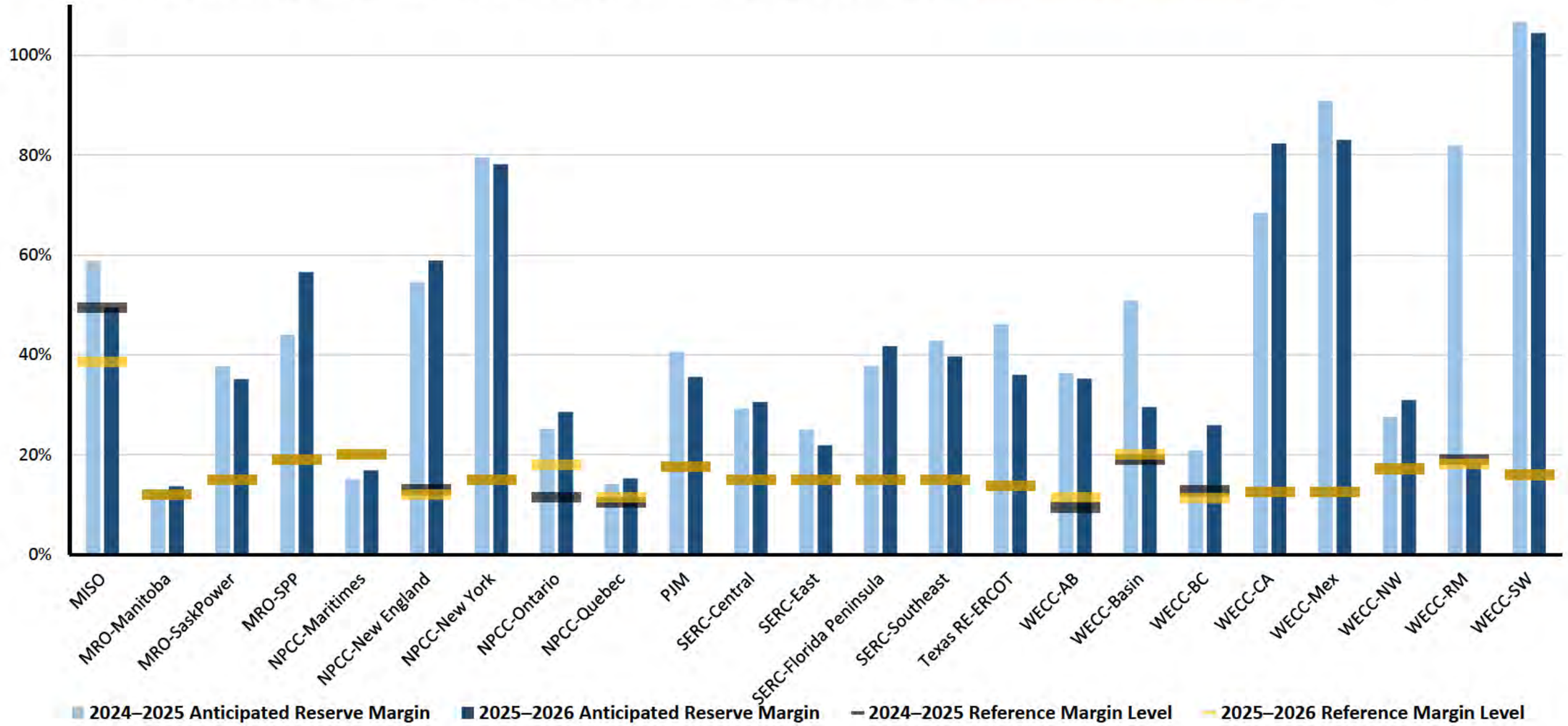


Figure 5: Winter 2024–2025 and Winter 2025–2026 Anticipated Reserve Margins Year-to-Year Change

Demand and Resource Tables

Peak demand and supply capacity data (i.e., resource adequacy data) for each assessment area are as follows in each table.

MISO			
Demand, Resource, and Reserve Margins	**2024–2025 WRA[16]**	**2025–2026 WRA**	**2024–2025 vs. 2025–2026**
Demand Projections	**MW**	**MW**	**Net Change (%)**
Total Internal Demand (50/50)	102,353	105,249	2.8%
Demand Response: Available	6,219	8,250	32.7%
Net Internal Demand	96,134	96,999	0.9%
Resource Projections	**MW**	**MW**	**Net Change (%)**
Existing-Certain Capacity	150,407	142,880	-5.0%
Tier 1 Planned Capacity	122	0	0.0%
Net Firm Capacity Transfers	2,310	2,113	-8.5%
Anticipated Resources	152,717	144,993	-5.1%
Existing-Other Capacity	0	0	0.0%
Prospective Resources	152,839	144,993	-5.1%
Reserve Margins	**Percent (%)**	**Percent (%)**	**Annual Difference**
Anticipated Reserve Margin	58.9%	49.5%	-9.4
Prospective Reserve Margin	59.0%	49.5%	-9.5
Reference Margin Level	49.4%	38.6%	-10.8

MRO-SPP			
Demand, Resource, and Reserve Margins	**2024–2025 WRA**	**2025–2026 WRA**	**2024–2025 vs. 2025–2026**
Demand Projections	**MW**	**MW**	**Net Change (%)**
Total Internal Demand (50/50)	45,788	47,168	3.0%
Demand Response: Available	1,128	1,091	-3.3%
Net Internal Demand	45,926	46,077	0.3%
Resource Projections	**MW**	**MW**	**Net Change (%)**
Existing-Certain Capacity	67,252	71,074	5.7%
Tier 1 Planned Capacity	0	1087	0.0%
Net Firm Capacity Transfers	-1,116	-32	-97.1%
Anticipated Resources	66,136	72,129	9.1%
Existing-Other Capacity	0	0	0.0%
Prospective Resources	66,090	73,029	10.5%
Reserve Margins	**Percent (%)**	**Percent (%)**	**Annual Difference**
Anticipated Reserve Margin	44.0%	56.5%	12.5
Prospective Reserve Margin	43.9%	58.5%	14.6
Reference Margin Level	19.0%	19.0%	0.0

MRO-SaskPower			
Demand, Resource, and Reserve Margins	**2024–2025 WRA**	**2025–2026 WRA**	**2024–2025 vs. 2025–2026**
Demand Projections	**MW**	**MW**	**Net Change (%)**
Total Internal Demand (50/50)	3,852	3,944	2.4%
Demand Response: Available	50	50	0.0%
Net Internal Demand	3,802	3,894	2.4%
Resource Projections	**MW**	**MW**	**Net Change (%)**
Existing-Certain Capacity	4,946	4,972	0.5%
Tier 1 Planned Capacity	0	0	0.0%
Net Firm Capacity Transfers	290	290	0.0%
Anticipated Resources	5,236	5,262	0.5%
Existing-Other Capacity	0	0	0.0%
Prospective Resources	5,236	5,262	0.5%
Reserve Margins	**Percent (%)**	**Percent (%)**	**Annual Difference**
Anticipated Reserve Margin	37.7%	35.1%	-2.6
Prospective Reserve Margin	37.7%	35.1%	-2.6
Reference Margin Level	15.0%	15.0%	0.0

MRO-Manitoba Hydro			
Demand, Resource, and Reserve Margins	**2024–2025 WRA**	**2025–2026 WRA**	**2024–2025 vs. 2025–2026**
Demand Projections	**MW**	**MW**	**Net Change (%)**
Total Internal Demand (50/50)	4,814	4,903	1.8%
Demand Response: Available	0	0	0.0%
Net Internal Demand	4,814	4,903	1.8%
Resource Projections	**MW**	**MW**	**Net Change (%)**
Existing-Certain Capacity	5,924	5,688	-4.0%
Tier 1 Planned Capacity	10	0	-100.0%
Net Firm Capacity Transfers	-527	-113	-78.5%
Anticipated Resources	5,407	5,575	3.1%
Existing-Other Capacity	18	13	-26.8%
Prospective Resources	5,425	5,588	3.0%
Reserve Margins	**Percent (%)**	**Percent (%)**	**Annual Difference**
Anticipated Reserve Margin	12.3%	13.7%	1.4
Prospective Reserve Margin	12.7%	14.0%	1.3
Reference Margin Level	12.0%	12.0%	0.0

[16] MISO-provided updated data post 2024-25 WRA publication.

NPCC-Maritimes			
Demand, Resource, and Reserve Margins	**2024–2025 WRA**	**2025–2026 WRA**	**2024–2025 vs. 2025–2026**
Demand Projections	**MW**	**MW**	**Net Change (%)**
Total Internal Demand (50/50)	6,167	6,061	-1.7%
Demand Response: Available	259	248	-4.4%
Net Internal Demand	5,907	5,813	-1.6%
Resource Projections	**MW**	**MW**	**Net Change (%)**
Existing-Certain Capacity	6,647	6,704	0.9%
Tier 1 Planned Capacity	6	88	0.0%
Net Firm Capacity Transfers	145	1	-99.0%
Anticipated Resources	6,798	6,794	-0.1%
Existing-Other Capacity	0	0	0.0%
Prospective Resources	6,798	6,800	0.0%
Reserve Margins	**Percent (%)**	**Percent (%)**	**Annual Difference**
Anticipated Reserve Margin	15.1%	16.9%	1.8
Prospective Reserve Margin	15.1%	17.0%	1.9
Reference Margin Level	20.0%	20.0%	0.0

NPCC-New England			
Demand, Resource, and Reserve Margins	**2024–2025 WRA**	**2025–2026 WRA**	**2024–2025 vs. 2025–2026**
Demand Projections	**MW**	**MW**	**Net Change (%)**
Total Internal Demand (50/50)	20,651	20,056	-2.9%
Demand Response: Available	343	440	28.2%
Net Internal Demand	20,308	19,616	-3.4%
Resource Projections	**MW**	**MW**	**Net Change (%)**
Existing-Certain Capacity	30,030	29,935	-0.3%
Tier 1 Planned Capacity	194	0	-100.0%
Net Firm Capacity Transfers	1,161	1,235	6.4%
Anticipated Resources	31,385	31,170	-0.7%
Existing-Other Capacity	306	322	5.2%
Prospective Resources	31,691	31,492	-0.6%
Reserve Margins	**Percent (%)**	**Percent (%)**	**Annual Difference**
Anticipated Reserve Margin	54.5%	58.9%	4.4
Prospective Reserve Margin	56.1%	60.5%	4.5
Reference Margin Level	13.0%	12.0%	-1.0

NPCC-New York			
Demand, Resource, and Reserve Margins	**2024–2025 WRA**	**2025–2026 WRA**	**2024–2025 vs. 2025–2026**
Demand Projections	**MW**	**MW**	**Net Change (%)**
Total Internal Demand (50/50)	23,800	24,200	1.7%
Demand Response: Available	802	1,027	28.1%
Net Internal Demand	22,998	23,173	0.8%
Resource Projections	**MW**	**MW**	**Net Change (%)**
Existing-Certain Capacity	40,522	40,080	-1.1%
Tier 1 Planned Capacity	0	0	0.0%
Net Firm Capacity Transfers	759	1,203	58.5%
Anticipated Resources	41,281	41,283	0.0%
Existing-Other Capacity	0	0	0.0%
Prospective Resources	41,281	41,283	0.0%
Reserve Margins	**Percent (%)**	**Percent (%)**	**Annual Difference**
Anticipated Reserve Margin	79.5%	78.2%	-1.3
Prospective Reserve Margin	79.5%	78.2%	-1.3
Reference Margin Level	15.0%	15.0%	0.0

NPCC-Ontario			
Demand, Resource, and Reserve Margins	**2024–2025 WRA**	**2025–2026 WRA**	**2024–2025 vs. 2025–2026**
Demand Projections	**MW**	**MW**	**Net Change (%)**
Total Internal Demand (50/50)	21,898	22,013	0.7%
Demand Response: Available	915	868	-5.2%
Net Internal Demand	20,982	21,146	0.9%
Resource Projections	**MW**	**MW**	**Net Change (%)**
Existing-Certain Capacity	26,652	27,319	2.5%
Tier 1 Planned Capacity	0	294	#DIV/0!
Net Firm Capacity Transfers	-450	-420	-6.7%
Anticipated Resources	26,202	27,193	3.8%
Existing-Other Capacity	0	0	0.0%
Prospective Resources	26,202	27,193	3.8%
Reserve Margins	**Percent (%)**	**Percent (%)**	**Annual Difference**
Anticipated Reserve Margin	25.1%	28.6%	3.5
Prospective Reserve Margin	25.1%	28.6%	3.5
Reference Margin Level	11.5%	18.0%	6.5

NPCC-Québec			
Demand, Resource, and Reserve Margins	**2024–2025 WRA**	**2025–2026 WRA**	**2024–2025 vs. 2025–2026**
Demand Projections	**MW**	**MW**	**Net Change (%)**
Total Internal Demand (50/50)	40,512	40,799	0.8%
Demand Response: Available	4,451	4,902	10.9%
Net Internal Demand	36,061	35,897	-0.4%
Resource Projections	**MW**	**MW**	**Net Change (%)**
Existing-Certain Capacity	41,560	41,698	0.3%
Tier 1 Planned Capacity	73	61	0.0%
Net Firm Capacity Transfers	-479	-390	-18.6%
Anticipated Resources	41,154	41,368	0.5%
Existing-Other Capacity	-479	0	0.0%
Prospective Resources	41,154	41,368	0.5%
Reserve Margins	**Percent (%)**	**Percent (%)**	**Annual Difference**
Anticipated Reserve Margin	14.1%	15.2%	1.1
Prospective Reserve Margin	14.1%	15.2%	1.1
Reference Margin Level	10.5%	11.5%	1.0

PJM			
Demand, Resource, and Reserve Margins	**2024–2025 WRA**	**2025–2026 WRA**	**2024–2025 vs. 2025–2026**
Demand Projections	**MW**	**MW**	**Net Change (%)**
Total Internal Demand (50/50)	136,328	140,827	3.3%
Demand Response: Available	5,616	5,998	6.8%
Net Internal Demand	130,712	134,829	3.1%
Resource Projections	**MW**	**MW**	**Net Change (%)**
Existing-Certain Capacity	179,216	178,335	-0.5%
Tier 1 Planned Capacity	0	0	0.0%
Net Firm Capacity Transfers	4,502	4,448	-1.2%
Anticipated Resources	183,718	182,783	-0.5%
Existing-Other Capacity	0	0	0.0%
Prospective Resources	183,718	182,452	-0.7%
Reserve Margins	**Percent (%)**	**Percent (%)**	**Annual Difference**
Anticipated Reserve Margin	40.6%	35.6%	-5.0
Prospective Reserve Margin	40.6%	35.3%	-5.2
Reference Margin Level	17.7%	17.7%	-12.3

SERC-Central			
Demand, Resource, and Reserve Margins	**2024–2025 WRA**	**2025–2026 WRA**	**2024–2025 vs. 2025–2026**
Demand Projections	**MW**	**MW**	**Net Change (%)**
Total Internal Demand (50/50)	42,895	42,875	0.0%
Demand Response: Available	1,497	2,809	87.6%
Net Internal Demand	41,397	40,067	-3.2%
Resource Projections	**MW**	**MW**	**Net Change (%)**
Existing-Certain Capacity	51,578	50,454	-2.2%
Tier 1 Planned Capacity	0	0	0%
Net Firm Capacity Transfers	1,922	1,847	-3.9%
Anticipated Resources	53,500	52,301	-2.2%
Existing-Other Capacity	1,498	1,810	20.8%
Prospective Resources	54,998	54,111	-1.6%
Reserve Margins	**Percent (%)**	**Percent (%)**	**Annual Difference**
Anticipated Reserve Margin	29.2%	30.5%	1.3
Prospective Reserve Margin	32.9%	35.1%	2.2
Reference Margin Level	15.0%	15.0%	0.0

SERC-East			
Demand, Resource, and Reserve Margins	**2024–2025 WRA**	**2025–2026 WRA**	**2024–2025 vs. 2025–2026**
Demand Projections	**MW**	**MW**	**Net Change (%)**
Total Internal Demand (50/50)	45,005	45,703	1.6%
Demand Response: Available	982	888	-9.6%
Net Internal Demand	44,023	44,815	1.8%
Resource Projections	**MW**	**MW**	**Net Change (%)**
Existing-Certain Capacity	54,379	54,460	0.1%
Tier 1 Planned Capacity	72	11	-84.3%
Net Firm Capacity Transfers	593	150	-74.7%
Anticipated Resources	55,045	54,622	-0.8%
Existing-Other Capacity	5,209	5,832	12.0%
Prospective Resources	60,254	60,453	0.3%
Reserve Margins	**Percent (%)**	**Percent (%)**	**Annual Difference**
Anticipated Reserve Margin	25.0%	21.9%	-3.2
Prospective Reserve Margin	36.9%	34.9%	-2.0
Reference Margin Level	15.0%	15.0%	0.0

SERC-Florida Peninsula			
Demand, Resource, and Reserve Margins	**2024–2025 WRA**	**2025–2026 WRA**	**2024–2025 vs. 2025–2026**
Demand Projections	**MW**	**MW**	**Net Change (%)**
Total Internal Demand (50/50)	48,494	48,628	0.3%
Demand Response: Available	2,780	3,127	12.5%
Net Internal Demand	45,714	45,501	-0.5%
Resource Projections	**MW**	**MW**	**Net Change (%)**
Existing-Certain Capacity	62,579	63,502	1.5%
Tier 1 Planned Capacity	15	692	4510.0%
Net Firm Capacity Transfers	400	300	-25.0%
Anticipated Resources	62,994	64,494	2.4%
Existing-Other Capacity	3,673	3,671	0.0%
Prospective Resources	66,667	68,165	2.2%
Reserve Margins	**Percent (%)**	**Percent (%)**	**Annual Difference**
Anticipated Reserve Margin	37.8%	41.7%	3.9
Prospective Reserve Margin	45.8%	49.8%	4.0
Reference Margin Level	15.0%	15.0%	0.0

SERC-Southeast			
Demand, Resource, and Reserve Margins	**2024–2025 WRA**	**2025–2026 WRA**	**2024–2025 vs. 2025–2026**
Demand Projections	**MW**	**MW**	**Net Change (%)**
Total Internal Demand (50/50)	45,308	47,056	3.9%
Demand Response: Available	1,638	1,365	-16.7%
Net Internal Demand	43,670	45,691	4.6%
Resource Projections	**MW**	**MW**	**Net Change (%)**
Existing-Certain Capacity	62,805	63,339	0.9%
Tier 1 Planned Capacity	765	0	-100.0%
Net Firm Capacity Transfers	-1,192	489	-141.0%
Anticipated Resources	62,378	63,828	2.3%
Existing-Other Capacity	3,920	4,847	23.7%
Prospective Resources	66,298	68,675	3.6%
Reserve Margins	**Percent (%)**	**Percent (%)**	**Annual Difference**
Anticipated Reserve Margin	42.8%	39.7%	-3.1
Prospective Reserve Margin	51.8%	50.3%	-1.5
Reference Margin Level	15.0%	15.0%	0.0

Texas RE-ERCOT			
Demand, Resource, and Reserve Margins	**2024–2025 WRA**	**2025–2026 WRA**	**2024–2025 vs. 2025–2026**
Demand Projections	**MW**	**MW**	**Net Change (%)**
Total Internal Demand (50/50)	73,193	77,387	5.7%
Demand Response: Available	5,447	9,330	71.3%
Net Internal Demand	67,746	68,057	0.5%
Resource Projections	**MW**	**MW**	**Net Change (%)**
Existing-Certain Capacity	98,712	89,977	-8.8%
Tier 1 Planned Capacity	239	1351	464.9%
Net Firm Capacity Transfers	20	1,235	6075.0%
Anticipated Resources	98,971	92,562	-6.5%
Existing-Other Capacity	0	0	0.0%
Prospective Resources	99,691	93,137	-6.6%
Reserve Margins	**Percent (%)**	**Percent (%)**	**Annual Difference**
Anticipated Reserve Margin	46.1%	36.0%	-10.1
Prospective Reserve Margin	47.2%	36.9%	-10.3
Reference Margin Level	13.75%	13.8%	0.0

WECC-AB			
Demand, Resource, and Reserve Margins	**2024–2025 WRA**	**2025–2026 WRA**	**2024–2025 vs. 2025–2026**
Demand Projections	**MW**	**MW**	**Net Change (%)**
Total Internal Demand (50/50)	12,280	12,411	1.1%
Demand Response: Available	0	0	0.0%
Net Internal Demand	12,280	12,411	1.1%
Resource Projections	**MW**	**MW**	**Net Change (%)**
Existing-Certain Capacity	13,535	16,658	23.1%
Tier 1 Planned Capacity	3206	124	-96.1%
Net Firm Capacity Transfers	0	0	0.0%
Anticipated Resources	16,740	16,782	0.3%
Existing-Other Capacity	0	0	0.0%
Prospective Resources	16,740	16,782	0.3%
Reserve Margins	**Percent (%)**	**Percent (%)**	**Annual Difference**
Anticipated Reserve Margin	36.3%	35.2%	-1.1
Prospective Reserve Margin	36.3%	35.2%	-1.1
Reference Margin Level	9.5%	11.5%	2.0

WECC-Basin			
Demand, Resource, and Reserve Margins	**2024–2025 WRA**	**2025–2026 WRA**	**2024–2025 vs. 2025–2026**
Demand Projections	**MW**	**MW**	**Net Change (%)**
Total Internal Demand (50/50)	10,568	10,758	1.8%
Demand Response: Available	85	170	100.0%
Net Internal Demand	10,483	10,588	1.0%
Resource Projections	**MW**	**MW**	**Net Change (%)**
Existing-Certain Capacity	13,213	13,183	-0.2%
Tier 1 Planned Capacity	2,605	533	-79.5%
Net Firm Capacity Transfers	0	0	0%
Anticipated Resources	15,817	13,717	-13.3%
Existing-Other Capacity	0	0	0.0%
Prospective Resources	15,817	13,717	-13.3%
Reserve Margins	**Percent (%)**	**Percent (%)**	**Annual Difference**
Anticipated Reserve Margin	50.9%	29.6%	-21.3
Prospective Reserve Margin	50.9%	29.6%	-21.3
Reference Margin Level	19.0%	20.0%	1.0

WECC-CA			
Demand, Resource, and Reserve Margins	**2024–2025 WRA**	**2025–2026 WRA**	**2024–2025 vs. 2025–2026**
Demand Projections	**MW**	**MW**	**Net Change (%)**
Total Internal Demand (50/50)	36,441	36,281	-0.4%
Demand Response: Available	743	666	-10.4%
Net Internal Demand	35,698	35,615	-0.2%
Resource Projections	**MW**	**MW**	**Net Change (%)**
Existing-Certain Capacity	55,380	57,923	4.6%
Tier 1 Planned Capacity	4,757	6,997	47.1%
Net Firm Capacity Transfers	0	0	0.0%
Anticipated Resources	60,138	64,920	8.0%
Existing-Other Capacity	0	0	0.0%
Prospective Resources	60,138	65,920	8.0%
Reserve Margins	**Percent (%)**	**Percent (%)**	**Annual Difference**
Anticipated Reserve Margin	68.5%	82.3%	13.8
Prospective Reserve Margin	68.5%	82.3%	13.8
Reference Margin Level	12.5%	12.5%	0.0

WECC-BC			
Demand, Resource, and Reserve Margins	**2024–2025 WRA**	**2025–2026 WRA**	**2024–2025 vs. 2025–2026**
Demand Projections	**MW**	**MW**	**Net Change (%)**
Total Internal Demand (50/50)	11,966	11,936	-0.3%
Demand Response: Available	0	0	0.0%
Net Internal Demand	11,966	11,936	-0.3%
Resource Projections	**MW**	**MW**	**Net Change (%)**
Existing-Certain Capacity	13,870	14,389	3.7%
Tier 1 Planned Capacity	433	637	47.0%
Net Firm Capacity Transfers	164	0	-100.0%
Anticipated Resources	14,467	15,026	3.9%
Existing-Other Capacity	0	0	0.0%
Prospective Resources	14,467	15,026	3.9%
Reserve Margins	**Percent (%)**	**Percent (%)**	**Annual Difference**
Anticipated Reserve Margin	20.9%	25.9%	5.0
Prospective Reserve Margin	20.9%	25.9%	5.0
Reference Margin Level	12.8%	11.4%	-1.5

WECC-Mexico			
Demand, Resource, and Reserve Margins	**2024–2025 WRA**	**2025–2026 WRA**	**2024–2025 vs. 2025–2026**
Demand Projections	**MW**	**MW**	**Net Change (%)**
Total Internal Demand (50/50)	1,983	1,977	-0.3%
Demand Response: Available	0	0	0%
Net Internal Demand	1,983	1,977	-0.3%
Resource Projections	**MW**	**MW**	**Net Change (%)**
Existing-Certain Capacity	3,733	3,619	-3.0%
Tier 1 Planned Capacity	52	0	-100.0%
Net Firm Capacity Transfers	0	0	0%!
Anticipated Resources	3,784	3,619	-4.4%
Existing-Other Capacity	0	0	0.0%
Prospective Resources	3,784	3,619	-4.4%
Reserve Margins	**Percent (%)**	**Percent (%)**	**Annual Difference**
Anticipated Reserve Margin	90.8%	83.1%	-7.8
Prospective Reserve Margin	90.8%	83.1%	-7.8
Reference Margin Level	12.5%	12.5%	0

WECC-Northwest			
Demand, Resource, and Reserve Margins	**2024–2025 WRA**	**2025–2026 WRA**	**2024–25 vs. 2025–26**
Demand Projections	**MW**	**MW**	**Net Change (%)**
Total Internal Demand (50/50)	30,748	33,604	9.3%
Demand Response: Available	30	30	0.0%
Net Internal Demand	30,718	33,574	9.3%
Resource Projections	**MW**	**MW**	**Net Change (%)**
Existing-Certain Capacity	38,729	34,671	-10.5%
Tier 1 Planned Capacity	463	3,152	581.5%
Net Firm Capacity Transfers	0	6,136	100%!
Anticipated Resources	39,192	43,959	12.2%
Existing-Other Capacity	0	0	0.0%
Prospective Resources	39,192	43,959	12.2%
Reserve Margins	**Percent (%)**	**Percent (%)**	**Annual Difference**
Anticipated Reserve Margin	27.6%	30.9%	3.3
Prospective Reserve Margin	27.6%	30.9%	3.3
Reference Margin Level	17.2%	17.2%	0.0

WECC-Rocky Mountain			
Demand, Resource, and Reserve Margins	**2024–2025 WRA**	**2025–2026 WRA**	**2024–25 vs. 2025–26**
Demand Projections	**MW**	**MW**	**Net Change (%)**
Total Internal Demand (50/50)	10,481	11,501	9.7%
Demand Response: Available	282	285	1.1%
Net Internal Demand	10,199	11,216	10.0%
Resource Projections	**MW**	**MW**	**Net Change (%)**
Existing-Certain Capacity	18,356	17,768	-3.2%
Tier 1 Planned Capacity	199	366	84.3%
Net Firm Capacity Transfers	0	0	0%
Anticipated Resources	18,555	18,134	-2.3%
Existing-Other Capacity	0	0	0.0%
Prospective Resources	18,555	18,134	-2.3%
Reserve Margins	**Percent (%)**	**Percent (%)**	**Annual Difference**
Anticipated Reserve Margin	81.9%	61.7%	-20.3
Prospective Reserve Margin	81.9%	61.7%	-20.3
Reference Margin Level	19.0%	18.2%	-0.8

WECC-Southwest			
Demand, Resource, and Reserve Margins	**2024–2025 WRA**	**2025–2026 WRA**	**2024–25 vs. 2025–26**
Demand Projections	**MW**	**MW**	**Net Change (%)**
Total Internal Demand (50/50)	20,844	21,147	1.5%
Demand Response: Available	340	177	-47.9%
Net Internal Demand	20,504	20,970	2.3%
Resource Projections	**MW**	**MW**	**Net Change (%)**
Existing-Certain Capacity	38,991	40,135	2.9%
Tier 1 Planned Capacity	3,381	2,733	-19.2%
Net Firm Capacity Transfers	0	0	0.0%
Anticipated Resources	42,372	42,868	1.2%
Existing-Other Capacity	0	0	0.0%
Prospective Resources	42,372	42,868	1.2%
Reserve Margins	**Percent (%)**	**Percent (%)**	**Annual Difference**
Anticipated Reserve Margin	106.6%	104.4%	-2.2
Prospective Reserve Margin	106.6%	104.4%	-2.2
Reference Margin Level	16.0%	16.0%	0.0

Variable Energy Resource Contributions

Because the electrical output of VERs (e.g., wind, solar PV) depends on weather conditions, on-peak capacity contributions are less than nameplate capacity and may vary widely year to year based on the identified risk hour. In many areas, winter demand peaks in the early morning hours or early evening resulting in little or no electrical resource output from solar PV resources and wide variability in wind availability. The following table shows the capacity contribution of existing wind and solar PV resources at the identified risk hour for each assessment area. Resource contributions are also aggregated by Interconnection and across the entire BPS.

BPS Variable Energy Resources On-Peak Capacity Contributions by Assessment Area									
	Wind			Solar			Hydro		
Assessment Area/Interconnection	Nameplate Wind (MW)	Expected Wind (MW)	Expected Share of Nameplate (%)	Nameplate Solar PV (MW)	Expected Solar (MW)	Expected Share of Nameplate (%)	Nameplate Hydro (MW)	Expected Hydro (MW)	Expected Share of Nameplate (%)
MISO	30,247	8,772	29%	13,726	686	5%	9,103	5,354	59%
MRO-Manitoba Hydro	259	52	20%	0	0	0%	6,288	5,676	90%
MRO-SaskPower	816	433	53%	30	0	13%	884	703	80%
MRO-SPP	35,714	7,198	20%	1,197	457	38%	5,602	5,521	99%
NPCC-Maritimes	1,635	241	15%	155	10	6%	1,357	1,283	0%
NPCC-New England	2,675	455	17%	3,620	0	0%	3,742	1,453	39%
NPCC-New York	2,586	737	29%	627	0	0%	6,357	5,283	83%
NPCC-Ontario	4,943	1,971	40%	478	0	0%	8,763	6,824	78%
NPCC-Québec	4,024	1,426	35%	10	0	0%	41,014	39,501	96%
PJM	13,318	5,463	41%	15,732	1	0%	8,134	7,900	97%
SERC-Central	1,324	370	28%	1,576	455	29%	4,991	4,027	81%
SERC-East	0	0	0%	7,068	1,792	25%	3,010	2,951	98%
SERC-Florida Peninsula	0	0	0%	12,058	2,151	18%	0	0	0%
SERC-Southeast	0	0	0%	8,670	4,461	51%	3,258	3,258	100%
Texas RE-ERCOT	40,629	7,833	19%	35,609	660	2%	579	566	98%
WECC-AB	5,712	1,919	34%	2,206	0	0%	1,788	570	32%
WECC-Basin	5,932	1,148	19%	3,853	62	2%	5,334	2,946	55%
WECC-BC	747	85	11%	17	0	0%	35,504	27,119	76%
WECC-CA	9,382	682	7%	28,328	0	0%	31,479	9,143	29%
WECC-Mex	40	4	11%	350	0	0%	0	0	0%
WECC-NW	14,744	1,319	9%	4,695	1,556	33%	65,830	37,005	56%
WECC-RM	5,681	2,265	40%	3,521	0	0%	6,502	2,654	41%
WECC-SW	4,303	1,182	27%	12,139	391	3%	6,234	1,896	30%
EASTERN INTERCONNECTION	93,517	25,692	27%	64,937	10,013	15%	61,489	50,233	82%
QUÉBEC INTERCONNECTION	4,024	1,426	35%	10	0	0%	41,014	39,501	96%
TEXAS INTERCONNECTION	40,629	7,833	19%	35,609	660	0%	579	566	98%
WECC INTERCONNECTION	46,541	8,605	19%	55,108	2,008	4%	152,671	81,333	53%
INTERCONNECTION TOTAL:	**184,711**	**43,556**	**23%**	**155,664**	**12,685**	**8%**	**255,753**	**171,633**	**67%**

Review of Winter 2024–2025 Capacity and Energy Performance

The meteorological winter across the contiguous United States had an average temperature of 34.1 degrees F—1.9 degrees above average—ranking in the warmest third of NOAA's historical record. Total winter precipitation in the US was 5.87 inches, 0.92 of an inch below average, ranking in the driest third of the December–February climate record.[17] Most of Canada experienced temperatures at least 2°C above the baseline average with the Maritime provinces, southern Ontario, and the Canadian west coast recording temperature departures nearer the baseline average while a small region in southern Saskatchewan recorded temperatures just slightly below the baseline average.[18]

In February 2025, FERC and NERC and its Regional Entities launched a joint review of the BPS' performance during the January 2025 arctic events, which comprised Winter Storms Blair, Cora, Demi, and Enzo.[19] The week of January 19–25, 2025 was the third coldest winter week (spanning Sunday through Saturday) across the United States since 2000. Between January 21 and 22, 2025, natural gas demand peaked at 150 Bcf/day, electric demand peaked at 683 GW, and unplanned outages peaked at 71,022 MW. Nevertheless, during the January 2025 arctic events, manual load shed was not required. The January 2025 arctic events had lower observed hourly wind chill temperatures in pockets of the Northeast, the Louisiana Gulf, California, and the Southwest compared to Winter Storms Uri, Elliott, Gerri, and Heather. During the January 2025 arctic events, the most extreme storm relative to typical weather was Winter Storm Enzo—a Gulf and Southern storm. On January 20, 2025, a burst of snow, sleet, and freezing rain developed across Texas and Louisiana late in the day. A mixture of sleet and freezing rain fell from Austin to San Antonio and to the southernmost point of Texas. By the early morning hours of January 21, 2025, for the first time in history, a blizzard warning was issued for southwest Louisiana and the southeastern-most point of Texas. Snow fell in Gulf cities in Texas, southern Mississippi, southern Alabama, and western Florida. On January 21, 2025, Baton Rouge recorded 7.6 inches of snowfall, making it the city's snowiest day since recordkeeping began in 1892, while New Orleans saw its snowiest day on record, with a total of 8.0 inches. Temperatures plunged to single digits in Louisiana. Temperatures in some parts of the state fell to levels not seen in more than 125 years.

The review team engaged with 10 electric entities across the Eastern and Texas Interconnections to gather the information necessary to provide a high-level overview of the BPS' performance during the cold weather events. Based on the data and interviews that the team reviewed, electric generators appear to have performed better during the January 2025 arctic events because of additional generator commitments, improved preparedness, increased situational awareness, and the implementation of lessons learned from previous extreme cold weather events and prior report recommendations. The natural gas system also performed better overall, serving record levels of natural gas demand and experiencing only minor production declines and short-duration force majeure events.

On October 1, 2025, NERC submitted to the Federal Energy Regulatory Commission its first *Cold Weather Data Annual Report*. This report includes a review of forced outage data from GADS for the winter 2024–2025 period indicating performance consistent with historical performance as reported in NERC's annual *State of Reliability* report. This is within the normal range of capacity that occurs across the fleet. During the Winter 2024–2025 period, the highest amount of capacity in a forced outage state for all reasons occurred on January 20, 2025, with 68,519 MW across all regions. The outages occurring over January 20, 2025, were analyzed as part of the joint FERC, NERC, and Regional Entity *2025 System Performance Review*. The joint FERC, NERC, and Regional Entity *2025 System Performance Review* found a reduction in peak coincident unplanned generator outages for the four 2025 winter storms reviewed compared to past winter storms; however, this review also noted that it was not an exact comparison due to prior winter storms having different characteristics.

Eastern Interconnection–Canada and Québec Interconnection

No EEAs were needed during the previous winter season. One entity plans to make a slight increase to the demand-response program based on last winter's operations.

[17] Despite Arctic air outbreaks, U.S. had warm, dry winter on average | National Oceanic and Atmospheric Administration
[18] Climate Trends and Variations Bulletin – Winter 2024/2025 - Canada.ca
[19] https://www.ferc.gov/media/report-january-2025-arctic-events-system-performance-review-ferc-nerc-and-its-regional

Eastern Interconnection–United States

Several entities indicated that generators performed better during the January 2025 arctic events than in previous winter storms. For example, TVA stated that generator performance within its footprint was stable, with minimal natural gas delivery issues. Southeastern RC detailed that no major fuel-related outages occurred. FRCC noted that generator performance was strong during this period. The significant characteristics of Winter Storm Enzo in the Southern and Gulf states were freezing precipitation and snow accumulation, especially in regions where those conditions rarely occur. In FRCC, only the northern portion of Florida experienced severe arctic weather including freezing precipitation and snowfall (record-setting, in some cities) that were abnormal for the region even though certain northern cities have faced cold temperatures in the past. In Florida, entities experienced energy emergencies caused by extended generation outages from hurricanes Milton and Helene, compounded by unusually high loads from cold weather. Entities were able to serve native load and firm delivery obligations, though non-firm sales were curtailed during certain events. ISO-NE, NYISO, and PJM all generally described the January 2025 arctic events as having cold temperatures but overall weather conditions that were similar to a winter without a major storm.

MISO emerged from Winter 2024–2025 without turning to emergency procedures despite the wide-ranging winter storms from January 6 to 9 and again from January 20 to 22. Generators continue to prioritize scheduling planned or maintenance outages to the shoulder seasons of fall and spring to maximize unit availability for the winter season. Also, extreme cold weather outage adders were added to the LOLE model to make sure that winter storm risks are included in planning. In PJM, demand reached a new all-time winter peak on January 22, 2025, of 143,714 MW with sufficient reserves. PJM did call an EEA1 on January 22, 2025, however reserves remained adequate. PJM had less than 3% load forecast error over the peak days of the January cold weather events. Reliability cases were conducted, and units with extended start times were evaluated and started early to ensure units were on-line before extreme cold weather settled in. PJM had a 9.24% forced outage rate on the peak day, a relatively low forced outage rate for the weather experienced. There were also very few gas production problems; however, market issues prevented proper scheduling because of the four-day holiday weekend.

In SERC-Central, entities reported only limited impacts from Winter 2024–2025 coldest weather and made minor adjustments. One entity declared conservative operations ahead of peak conditions but experienced no emergencies. One entity raised its winter Planning Reserve Margin target to 26% following lessons learned from Winter Storm Elliott. Corrective actions were implemented due to isolated equipment issues, including improved heat trace capabilities and adding heat trace equipment to the cold weather critical component list. During the previous winter season, some SERC-Florida Peninsula entities experienced energy emergencies caused by extended generation outages from hurricanes Milton and Helene, compounded by unusually high loads from cold weather. Despite these challenges, entities were able to serve native load and firm delivery obligations, though non-firm sales were curtailed during certain events.

Texas Interconnection–ERCOT

There were no energy emergencies for the Texas RE-ERCOT region last winter and no conditions that prompted changes in operating procedures. Winter Storm Kingston, which occurred in February 2025, was the only storm where ERCOT utilized firm fuel supply service resources (FFSS), a firm-fuel product that provides additional grid reliability and resiliency during extreme cold weather and compensates generation resources that meet a higher resiliency standard. A maximum FFSS deployment of 470 MW occurred on February 19 between the hours 13:10 and 17:02. Two other storms, Enzo and Cora, impacted ERCOT in January 2025, but these storms did not cause any system reliability issues.

Western Interconnection

Between January 11 and 17, 2024, a prolonged Arctic outbreak impacted British Columbia, Alberta, and the U.S. Pacific Northwest, driving record electricity demand and widespread reliability challenges. Four U.S. Northwest BAs and one Canadian BA declared energy emergencies, underscoring two core vulnerabilities: Inadequate capacity during evening peak hours (4 to 8 p.m.) and Insufficient fuel supply (limited hydro availability) across multiple days.

Although temperatures were comparable to the December 2022 cold snap, WECC-Northwest peak demand rose two percentage points to 6% over then, with BC Hydro and AESO both setting new all-time records. The U.S. Northwest relied heavily on imports—averaging 4,745 MW during peaks and 5,241 MW across all hours, mostly from the Southwest and Rockies. California remained a net importer, providing little relief. Market prices in the Northwest reached or neared caps across most hours, indicating persistent scarcity rather than short-term peaks. Overall, the January 2024 event illustrated capacity alone does not ensure resilience. Sustained energy availability with interregional flexibility (both physical and market-based) will be key to maintaining reliability through the 2025–2026 and future winter seasons.

2024–2025 Winter Demand and Generation Summary at Peak Demand											
Assessment Area	**Peak Demand Date**	**Peak Demand Hour**	**Demand[1] (MW)**	**WRA Peak Demand Scenarios[2] (MW)**	**Generation[1] (MWh)**	**Transfers[1] (MW)**	**Wind – Actual[1] (MWh)**	**Wind – Expected[3] (MW)**	**Solar – Actual[1] (MWh)**	**Solar – Expected[3] (MW)**	**Forced Outages Summary[4] (MW)**
MISO	Jan. 21	18:00	108,888*	96,134 100,395	101,655	-977	18,468	16,761	0	519	17,010
MRO-Manitoba Hydro	Jan. 20	08:00	5,132	4,814 5,060	5,292	-277	142	52	N/A	0	146
MRO-SaskPower	Dec. 18	18:00	3,785	3,802 3,897	3,641	-231	664	368	0	3	0
MRO-SPP	Feb. 20	08:00	47,981	45,926 47,054	40,898	-1,424	4,886	4,783	255	36	9,272
NPCC-Maritimes	Jan. 22	07:00	5,810	5,907 6,498	4,266	-1,174	368	261	3	5	*
NPCC-New England	Jan. 21	18:00	19,607	20,308 21,814	17,686	-1,896	285	329	4	23	624
NPCC-New York	Jan. 22	19:00	23,521	22,998 24,023	18,932	-4,589	654	728	0	0	4,835

2024–2025 Winter Demand and Generation Summary at Peak Demand											
Assessment Area	Peak Demand Date	Peak Demand Hour	Demand[1] (MW)	WRA Peak Demand Scenarios[2] (MW)	Generation[1] (MWh)	Transfers[1] (MW)	Wind – Actual[1] (MWh)	Wind – Expected[3] (MW)	Solar – Actual[1] (MWh)	Solar – Expected[3] (MW)	Forced Outages Summary[4] (MW)
NPCC-Ontario	Jan. 22	18:00	21,940	20,951 22,179	24,250	2,990	3,693	1,914	0	0	*
NPCC-Québec	Jan. 22	08:00	37,178	36,061 39,545	39,514	-766	1,463	1,449	0	0	*
PJM	Jan. 22	09:00	144,420	130,712 144,939	152,142	7,731	3,704	3,620	3,076	1	8,663
SERC-C	Jan. 22	08:00	47,815	41,397 47,062	40,898	-6,921	563	176	214	455	1,538
SERC-E	Jan. 23	08:00	47,130	44,023 47,662	41,810	-5,323	0	0	145	2,526	1,830
SERC-FP	Jan. 25	08:00	43,974	45,714 54,239	41,702	-557	0	0	362	1,684	2,824
SERC-SE	Jan. 22	08:00	46,490	43,670 45,116	48,227	1,741	0	0	592	3,861	2,210

2024–2025 Winter Demand and Generation Summary at Peak Demand											
Assessment Area	**Peak Demand Date**	**Peak Demand Hour**	**Demand[1] (MW)**	**WRA Peak Demand Scenarios[2] (MW)**	**Generation[1] (MWh)**	**Transfers[1] (MW)**	**Wind – Actual[1] (MWh)**	**Wind – Expected[3] (MW)**	**Solar – Actual[1] (MWh)**	**Solar – Expected[3] (MW)**	**Forced Outages Summary[4] (MW)**
TRE-ERCOT	Feb. 20	08:00	80,560	73,193[5] 90,405[5]	79,960	-191	9,397	15,697	1,586	15	5,742
WECC-AB	Dec. 18	17:00	12,241	12,280 12,635	12,711	-470	3,175	1,867	4	0	*
WECC-BC	Feb 3	18:00	11,359	11,996 12,749	11,415	44	70	279	0	0	839
WECC-CA/MX	Dec. 12	15:00	35,555	35,359 36,823	31,925	-4,669	4,021	569	11,547	0	1,627
WECC-NW	Feb. 12	08:00	54,278	58,001 62,230	48,437	-920	2,607	7,876	1,494	2,198	3,281
WECC-SW	Feb. 13	16:00	22,969	16,177 17,777	25,087	2,117	2,741	1,065	1,599	182	1,496
Highlighting Notes:			Actual peak demand in the highlighted areas met or exceeded extreme scenario levels				Actual wind output in highlighted areas was significantly below seasonal forecast.		Actual solar output in highlighted areas was significantly below seasonal forecast.		Actual forced outages above or below forecast by factor of two

2024–2025 Winter Demand and Generation Summary at Peak Demand											
Assessment Area	**Peak Demand Date**	**Peak Demand Hour**	**Demand[1] (MW)**	**WRA Peak Demand Scenarios[2] (MW)**	**Generation[1] (MWh)**	**Transfers[1] (MW)**	**Wind – Actual[1] (MWh)**	**Wind – Expected[3] (MW)**	**Solar – Actual[1] (MWh)**	**Solar – Expected[3] (MW)**	**Forced Outages Summary[4] (MW)**
Table Notes: [1] Actual demand, wind, and solar values for the hour of peak demand in U.S. areas were obtained from EIA From 930 data. For areas in Canada, this data was provided to NERC by system operators and utilities. [2] See NERC *2024–2025* WRA demand scenarios for each assessment area. Values are the normal winter peak demand forecast and an extreme peak demand forecast that represents a 90/10, or once-per-decade, peak demand. Some areas use other basis for extreme peak demand. [3] Expected values of wind and solar resources from the *2024–2025 WRA*. [4] Values from NERC Generator Availability Data System for the 2024–2025 winter hour of peak demand in each assessment area. Highlighted areas had actual forced outages that were more than twice the value for typical forced outage rates used in the 2024–2025 winter risk period scenarios in the *2024–2025 WRA*. [5] Texas RE-ERCOT peak demand scenarios are obtained by adding expected demand response (5.4 GW for winter 2024-2025) to the demand scenarios found on p. 29 of the 2024-2025 WRA. *Canadian assessment areas report to the NERC Generator Availability Data System on a voluntary basis, which can contribute to the absence of some values in certain assessment areas.										

BEFORE THE UNITED STATES DEPARTMENT OF ENERGY

Federal Power Act Section 202(c) Emergency Order: Midcontinent Independent System Operator and Northern Indiana Public Service Company LLC	)))))	Order No. 202-26-19
Federal Power Act Section 202(c) Emergency Order: Midcontinent Independent System Operator and CenterPoint Energy Indiana South	))))	Order No. 202-26-20

Exhibit to
Motion to Intervene and Request for Rehearing and Stay of
Public Interest Organizations

Exhibit 145
NERC Email

Subject: Announcement | NERC 2025-2026 Winter Reliability Assessment | Rising Demand, Evolving Resources Continue to Challenge Winter Grid Reliability
Date: Tuesday, November 18, 2025 at 2:02:44 PM Eastern Standard Time
From: NERC Communications Announcements (Do Not Reply) (SM)
To: Rachel Sherrard
Attachments: image007.jpg, image008.png, image009.png, image010.png, image002.png

CAUTION: This is an External email. Please send suspicious emails to abuse@michigan.gov

NERC
NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION

Announcement

Rising Demand, Evolving Resources Continue to Challenge Winter Grid Reliability

Full Announcement | 2025-2026 Winter Reliability Assessment | Infographic | Video

WASHINGTON, D.C.— NERC's *2025–2026 Winter Reliability Assessment* (WRA) finds that much of North America is again at an elevated risk of having insufficient energy supplies to meet demand in extreme operating conditions. Although resources are adequate for normal winter peak demand, any prolonged, wide-area cold snaps will be challenging. This is largely due to rising electricity demand, which has grown by 20 GW since last winter, significantly outpacing winter on-peak capacity. This, coupled with the changing resource mix, is affecting the winter outlook.

Undertaken annually in coordination with the Regional Entities, NERC's WRA examines multiple factors that collectively provide deep and unique insights into reliability risk. These factors include resource adequacy, encompassing reserve margins and scenarios to identify operational risk; fuel assurance; and preparations to mitigate reliability concerns.

For more information or assistance, please contact NERC Communications

www.nerc.com

RELIABILITY | RESILIENCE | SECURITY

BEFORE THE UNITED STATES DEPARTMENT OF ENERGY

Federal Power Act Section 202(c) Emergency Order: Midcontinent Independent System Operator and Northern Indiana Public Service Company LLC	)))))	Order No. 202-26-19
Federal Power Act Section 202(c) Emergency Order: Midcontinent Independent System Operator and CenterPoint Energy Indiana South	))))	Order No. 202-26-20

Exhibit to
Motion to Intervene and Request for Rehearing and Stay of
Public Interest Organizations

Exhibit 147
Schahfer 2024 Groundwater Monitoring Report

2024 Annual Groundwater Monitoring and Corrective Action Report - Waste Disposal Area

NIPSCO LLC R. M. Schahfer Generating Station

Prepared Pursuant to 40 CFR §257.90(e) and Corresponding Regulations under 329 Indiana Administrative Code 10-9-1

Submitted to:

Northern Indiana Public Service Company LLC
R.M. Schahfer Generating Station
Wheatfield, Indiana

Submitted by:

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January 31, 2025

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1.0 INTRODUCTION

On behalf of Northern Indiana Public Service Company LLC (NIPSCO), WSP USA Inc. (WSP) prepared this 2024 Annual Groundwater Monitoring and Corrective Action Report (2024 Annual Report) for the Rollin M. Schahfer Generating Station (RMSGS, Schahfer) coal combustion residuals (CCR) surface impoundment known as the Waste Disposal Area (WDA, the CCR Unit). WSP prepared the 2024 Annual Report in accordance with 40 Code of Federal Regulations (CFR) Parts 257 and 261, “Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals From Electric Utilities; Final Rule” (CCR Rule), as amended, and corresponding regulations under 329 Indiana Administrative Code (IAC) 10-9-1.

In conformance with the applicable requirements of 40 CFR §257.90(e)(1) through (5) and corresponding State of Indiana requirements, the 2024 Annual Report:

- Documents the status of the groundwater monitoring and corrective action program
- Provides figures showing the CCR Unit, monitoring well locations, and groundwater flow direction(s)
- Summarizes key CCR Rule groundwater activities completed during calendar year 2024
- Includes CCR Rule groundwater monitoring data obtained in calendar year 2024
- Describes any problems encountered during the monitoring activities
- Discusses actions taken to resolve the problems, if applicable
- Projects key activities for the upcoming year.

2.0 SUBJECT CCR UNIT

RMSGS is located at 2723 E 1500 N, Wheatfield, Jasper County, Indiana (Latitude 41° 12' 36" and Longitude 87° 01' 48", see Figure 1). As shown in Figure 2, the WDA is an approximately 80-acre impoundment located in the southwest portion of the RMSGS facility.

The CCR Unit is currently in Assessment Monitoring pursuant to 40 CFR §257.95. Routine monitoring activities performed during the reporting period include inspection of wells for integrity and security, measurement of groundwater levels prior to sample collection to assess groundwater flow direction, and collection of groundwater samples for laboratory analysis.

3.0 GROUNDWATER MONITORING AND CORRECTIVE ACTION PROGRAM - OVERVIEW OF CURRENT STATUS

In 2016, NIPSCO/WSP installed a 40 CFR §257.91-compliant groundwater monitoring system (Table 1). Beginning in 2016 and continuing throughout calendar year 2017, WSP collected background groundwater samples and performed Detection Monitoring at the CCR Unit pursuant to the requirements of 40 CFR §257.93-94.

Following Detection Monitoring and the determination of statistically significant increases (SSIs) over background levels of one or more Appendix III constituents, NIPSCO established an Assessment Monitoring program in January 2018 pursuant to the requirements of 40 CFR §257.95 to assess the nature and extent and overall groundwater quality farther downgradient of the WDA.

In 2018, WSP performed the first and second Assessment Monitoring events. Following the first Assessment Monitoring event, including verification sampling, NIPSCO posted a notification to the publicly accessible website of detections of Appendix IV constituents at concentrations above applicable groundwater protection standards (GWPSs) downgradient of the WDA.

In November 2018, WSP prepared an alternative source demonstration (ASD) indicating that the detections of Appendix IV parameters downgradient of the WDA are not due to a release from the WDA.

Subsequent to the ASD, WSP performed the following additional Assessment Monitoring events:

- Third and fourth Assessment Monitoring events in 2019
- Fifth and sixth Assessment Monitoring events in 2020
- Seventh and eighth Assessment Monitoring events in 2021
- Ninth and tenth Assessment Monitoring events in 2022
- Eleventh and twelfth Assessment Monitoring events in 2023
- Thirteenth and fourteenth Assessment Monitoring events in 2024

The thirteenth and fourteenth Assessment Monitoring events were completed in April and September 2024.

For April and September 2024 Assessment Monitoring event, WSP calculated the groundwater elevations from static water level measurements and prepared groundwater elevation contour maps. The static water level measurements and calculated groundwater elevations for the April (water levels measured in March) and September 2024 events are presented in Table 2, and the groundwater elevation contours from those events are presented in Figures 3 and 4, respectively.

For the April and September 2024 Assessment Monitoring events, WSP summarized the sampling activities associated with the events in Table 3. Table 3 includes the sampling dates, number of groundwater samples collected from each background and downgradient well, and the purpose of sampling associated with each event. WSP summarized the analytical results from these events in Table 4.

The WDA began and ended the current annual reporting period in Assessment Monitoring pursuant to 40 CFR §257.95. WSP identified Appendix IV constituents at statistically significant levels (SSLs) in 2024 that included molybdenum and lithium in groundwater samples collected from well GAMW-51B and GAMW-60B, and arsenic in well GAMW-44.

Pursuant to 40 CFR §257.94, in May and November 2024, a qualified Indiana-licensed professional engineer recertified the ASD indicating that the SSLs for molybdenum, lithium, and arsenic were not due to a release from the WDA, therefore, the CCR Unit remained in Assessment Monitoring. Based upon groundwater monitoring results collected pursuant to the CCR Rule to date, no corrective action program requirements as outlined in 40 CFR §257.96-98 have either been triggered or implemented at this CCR Unit.

3.1 Key Actions Completed - 2024

NIPSCO completed the following key actions relative to CCR Rule groundwater monitoring at the WDA during calendar year 2024:

- Preparation of the of 2023 Groundwater Monitoring and Corrective Action Annual Report in January 2024 (2023 Annual Report, WSP 2024a) (40 CFR §257.90(e))
- Evaluation of the results of the twelfth Assessment Monitoring event in February 2024 (40 CFR §257.95)
- Notification that Appendix IV constituents exceeded the GWPS in March 2024 (40 CFR §257.95(g))
- Performance of the thirteenth Assessment Monitoring event in April 2024 (40 CFR §257.95)
- Recertification of the ASD in May 2024 (WSP 2024c) (40 CFR §257.95(g))
- Evaluation of the results of the thirteenth Assessment Monitoring event in August 2024 (40 CFR §257.95)
- Notification that Appendix IV constituents exceeded the GWPS in September 2024 (40 CFR §257.95(g))
- Performance of the fourteenth Assessment Monitoring event in September 2024 (40 CFR §257.95)
- Recertification of the ASD in November 2024 (WSP 2024d) (40 CFR §257.95(g))

3.2 Monitoring System Modifications

In 2024, the WDA remained in Assessment Monitoring. Attached Table 1 provides a summary of the well rationale/purpose and date of installation. Figure 2 shows the well network for the WDA. Table 5 below provides an overview of the modified groundwater monitoring network.

Table 5: Overview of Groundwater Monitoring Network

Background Monitoring Wells	Downgradient Monitoring Wells	Assessment Monitoring Wells
GAMW-03, GAMW-03B, GAMW-68, and GAMW-68B	GAMW-01, GAMW-01B, GAMW-12, GAMW-12B, GAMW-13, GAMW-13B, GAMW-14, and GAMW-14B	GAMW-42, GAMW-42B, GAMW-42C, GAMW-43, GAMW-43B, GAMW-44, GAMW-44B, GAMW-51, GAMW-51B, GAMW-57, GAMW-57B, GAMW-58, GAMW-58B, GAMW-59, GAMW-59B, GAMW-60, GAMW-60B, and GAMW-77

WSP decommissioned, installed, developed, and surveyed the wells in accordance with the CCR Groundwater Monitoring Program Implementation Manual (GMPIM, Golder 2017)

3.3 Groundwater Flow

As noted above, WSP tabulated the March and September 2024 static water measurements and calculated groundwater elevations in Table 2 and prepared the groundwater elevation contour maps for March and September (See Figures 3 and 4) using calculated groundwater elevations. Based on these elevations and contour maps and consistent with the requirements of the CCR Rule, WSP determined the rate and direction of groundwater flow within the uppermost aquifer after each sampling event.

Overall site groundwater flow direction is northeast towards the Kankakee River. In March and September 2024, groundwater flowed toward the northwest in the vicinity of the WDA (Figure 3 and Figure 4). The groundwater elevation, in the vicinity of the WDA, varies between approximately 655 to 665 feet North American Vertical Datum of 1988 (NAVD88) with a depth to groundwater less than 10 feet below ground surface.

WSP calculated the hydraulic gradient in the vicinity of the CCR units at 1.17E-03 feet per foot. Using an assumed porosity value of 30 percent, the average hydraulic conductivity from slug tests for the shallow unconfined aquifer of 93.5 feet per day, and the calculated gradient, WSP calculated the average rate of groundwater flow to be approximately 133 feet per year (Groundwater Monitoring System Design Manual [GMSDM], WSP 2024b).

3.4 Background Monitoring (2016 to 2017)

Per the requirements of 40 CFR §257.94, WSP collected eight independent background groundwater samples from each background and downgradient well between July 2016 and August 2017. WSP used the results of the background monitoring phase to develop appropriate, statistically valid background values for each constituent/monitoring well. WSP submitted the samples to a contract laboratory, in accordance with chain of custody and quality assurance/quality control procedures, for analysis of Appendix III and Appendix IV constituents. In addition, WSP personnel measured field water quality parameters including specific conductance, temperature, dissolved oxygen, turbidity, oxidation-reduction potential, and pH. The background data set was included in the 2017 CCR Annual Groundwater Monitoring and Corrective Action Report, dated January 31, 2018 (2017 Annual Report, Golder 2018a).

WSP performed a periodic update of background datasets, which includes incorporation of additional background data, to improve statistical power and accuracy by providing a more conservative estimate of the true background populations. The CCR Rule Groundwater Monitoring Program Implementation Manual (GMPIM, Golder 2017) allows for the statistical limits to be updated after four to eight new measurements are available (i.e., every two to four years of semi-annual monitoring). WSP incorporated the new data into the background dataset and updated the GWPS in both March 2020 and September 2022.

3.5 Detection Monitoring

WSP performed the first Detection Monitoring event in October 2017, followed by the statistical evaluation and data analysis in January 2018. WSP collected groundwater samples from the CCR Unit background and downgradient monitoring wells for analysis of Appendix III constituents per 40 CFR §257.94 and included the results in the 2017 Annual Report (Golder 2018a). Following receipt and validation of laboratory results, WSP evaluated the results of the first Detection Monitoring sampling event to compare the concentrations of Appendix III constituents to facility background concentrations.

Using Sanitas™ software, WSP pooled the background data to calculate prediction limits and compared the October 2017 results to the calculated prediction limits to identify SSIs. Based on that comparison, WSP established an Assessment Monitoring program in April 2018.

3.6 Assessment Monitoring

WSP performed the first Assessment Monitoring event (i.e., Assessment and Verification sampling) in March and April 2018, followed by a statistical evaluation and data analysis in August 2018. In March 2018, WSP collected groundwater samples from each background and downgradient monitoring well for analysis of Appendix IV constituents per 40 CFR §257.95. In April 2018, WSP collected groundwater samples from the downgradient monitoring well locations for analysis of Appendix III and detected Appendix IV constituents per 40 CFR §257.95.

In August 2018, WSP developed CCR Unit-specific GWPS for comparisons with the Assessment Monitoring results. At the time of the GWPS development, the GWPS was the higher value of either the Maximum Contaminant Level (MCL) or the CCR Unit-specific background concentration for each analyte calculated using a tolerance/prediction limit procedure in accordance with 40 CFR §257.95(h)(2).

Following receipt and validation of laboratory results, WSP evaluated the Appendix IV constituent results relative to CCR Unit-specific GWPSs (Table 6). Results from the downgradient monitoring wells were evaluated by comparing the lower confidence limit (LCL) to the CCR Unit-specific GWPS for each Appendix IV analyte at each well. If the LCL exceeded the GWPS, there is statistical evidence of an SSL. WSP determined that SSLs existed for the WDA in 2018, specifically molybdenum at GAMW-01, GAMW-13B, and GAMW-14B, but identified an alternative natural source for the elevated levels of molybdenum detected in downgradient monitoring wells and prepared an ASD. A qualified Indiana-licensed professional engineer certified the ASD in November 2018 (Appendix A of the 2018 CCR Annual Groundwater Monitoring and Corrective Action Report, dated January 31, 2019 (2018 Annual Report, Golder 2019a)).

Following the initial Assessment Monitoring event, WSP performed thirteen additional Assessment Monitoring events at the WDA by collecting groundwater samples from each background and downgradient monitoring well per 40 CFR §257.95. In addition, WSP performed boundary well sampling in 2018 and 2019. Those sample events and their results are summarized below:

- Second Assessment Monitoring Event – WSP performed the second Assessment Monitoring event in October 2018 by collecting groundwater samples for analysis of Appendix III and Appendix IV constituents and performed the statistical evaluation of the analytical results in February 2019. WSP identified SSLs for arsenic (GAMW-01) and cobalt (GAMW-14). In May 2019, WSP prepared, and a qualified Indiana-licensed professional engineer certified an ASD demonstrating that the arsenic and cobalt concentrations observed in the downgradient monitoring wells were due to natural variation and not a release from the WDA (Appendix A of the 2019 CCR Annual Groundwater Monitoring and Corrective Action Report, dated January 31, 2020 (2019 Annual Report, Golder 2020a))). The results from the first and second Assessment Monitoring events are included in the 2018 Annual Report (Golder 2019a).
- Third Assessment Monitoring Event – WSP performed the third Assessment Monitoring event in April 2019 by collecting groundwater samples for analysis of Appendix III and Appendix IV constituents and performed the statistical evaluation of the analytical results in August 2019. The results confirmed the SSLs for arsenic (GAMW-01) and cobalt (GAMW-14). A qualified-licensed professional engineer recertified the ASD in November 2019 (Appendix B of the 2019 Annual Report, Golder 2020a)).

WSP collected groundwater samples from the following property boundary Assessment Monitoring wells (see Figure 2):

- GAMW-42/42B, GAMW-43/43B, and GAMW-44/44B installed in July 2018 were sampled in March, April, June, July, August, October, and November 2019
- GAMW-42C, GAMW-57/57B, and GAMW-58/58B installed in June 2019 were sampled in July, August, October, and November 2019.

SSLs were not identified in groundwater samples collected from these property boundary wells. The boundary wells have been included in the routine semi-annual sampling since 2020.

- Fourth Assessment Monitoring Event – WSP performed the fourth Assessment Monitoring event in November 2019 by collecting groundwater samples for analysis of Appendix III and detected Appendix IV constituents and performed the statistical evaluation of the analytical results in March 2020. WSP identified an SSL for molybdenum in well GAMW-51B. In June 2020, WSP prepared, and a qualified Indiana-licensed professional engineer certified, an ASD demonstrating that the SSL for molybdenum and observed lithium

levels above the GWPS in GAMW-51B were not due to a release from the WDA (Appendix A of the 2020 CCR Annual Groundwater Monitoring and Corrective Action Report, dated January 31, 2021 (2020 Annual Report, Golder 2021a)). The results from the third and fourth Assessment Monitoring events and the 2019 boundary sampling are included in the 2019 Annual Report (Golder 2020a).

- Fifth Assessment Monitoring Event – WSP performed the fifth Assessment Monitoring event in April/May 2020 by collecting groundwater samples for analysis of Appendix III and Appendix IV constituents and performed the statistical evaluation of the analytical results in September 2020. WSP identified SSLs for molybdenum and lithium in well GAMW-51B. As these results were consistent with the previous Assessment Monitoring event, a qualified Indiana-licensed professional engineer recertified the ASD in December 2020 (Appendix B of the 2020 Annual Report, Golder 2021a).
- Sixth Assessment Monitoring Event – WSP performed the sixth Assessment Monitoring event in October 2020 by collecting groundwater samples for analysis of Appendix III and detected Appendix IV constituents and performed the statistical evaluation of the analytical results in February 2021. WSP identified SSLs for molybdenum and lithium in well GAMW-51B and molybdenum in GAMW-60B. As described in the 2019 Annual Report (Golder 2020a), GAMW-60B was installed downgradient of GAMW-51/51B in 2019 to further assess the nature and extent of groundwater quality further downgradient of the WDA. The October 2020 Assessment Monitoring event was the fourth round of sampling at this location, and therefore, was the first event for which SSLs were calculated. As these results are consistent with the primary lines of evidence presented in the June 2020 ASD, a qualified Indiana-licensed professional engineer recertified the ASD in May 2021 (Appendix A of the 2021 CCR Annual Groundwater Monitoring and Corrective Action Report, dated January 31, 2022 (2021 Annual Report, Golder 2022a)). The results from the fifth and sixth Assessment Monitoring events are included in the 2020 Annual Report (Golder 2021a).
- Seventh Assessment Monitoring Event – WSP performed the seventh Assessment Monitoring event in April 2021 by collecting groundwater samples for analysis of Appendix III and Appendix IV constituents and performed the statistical evaluation of the analytical results in August 2021. WSP identified SSLs for molybdenum and lithium in well GAMW-51B and molybdenum in GAMW-60B. As these results were consistent with the previous Assessment Monitoring event, a qualified Indiana-licensed professional engineer recertified the ASD in November 2021 (Appendix B of the 2021 Annual Report, Golder 2022a).
- Eighth Assessment Monitoring Event – WSP performed the eighth Assessment Monitoring event in September 2021 by collecting groundwater samples for analysis of Appendix III and detected Appendix IV constituents and performed the statistical evaluation of the analytical results in January 2022. The results confirmed the SSLs for molybdenum and lithium in well GAMW-51B and molybdenum in GAMW-60B. A qualified Indiana-licensed professional engineer recertified the ASD in April 2022 (Appendix A of the 2022 CCR Annual Groundwater Monitoring and Corrective Action Report, dated January 31, 2023 (2022 Annual Report, WSP 2023a)). The results from the seventh and eighth Assessment Monitoring events are included in the 2021 Annual Report (Golder 2022a).
- Ninth Assessment Monitoring Event – WSP performed the ninth Assessment Monitoring event in May/June 2022 by collecting groundwater for analysis of Appendix III and Appendix IV constituents and performed the statistical evaluation of the analytical results in September 2022. The results confirmed the SSLs for molybdenum and lithium in well GAMW-51B and molybdenum in GAMW-60B. A qualified Indiana-licensed professional engineer recertified the ASD in December 2022 (Appendix B of the 2022 Annual Report, WSP 2023a).

- Tenth Assessment Monitoring Event – WSP performed the tenth Assessment Monitoring event in October/November 2022 by collecting groundwater samples for analysis of Appendix III and Appendix IV constituents and performed the statistical evaluation of the analytical results in February 2023. The results confirmed the SSLs for molybdenum and lithium in well GAMW-51B and molybdenum in GAMW-60B. A qualified Indiana-licensed professional engineer recertified the ASD in May 2023 (Appendix A of the 2023 CCR Annual Groundwater Monitoring and Corrective Action Report, dated January 31, 2024 (2023 Annual Report, WSP 2024a)). The results from the ninth and tenth Assessment Monitoring events are included in the 2022 Annual Report (WSP 2023a).
- Eleventh Assessment Monitoring Event – WSP performed the eleventh Assessment Monitoring event in April/May 2023 by collecting groundwater samples for analysis of Appendix III and Appendix IV constituents and performed the statistical evaluation of the analytical results in August 2023. The results confirmed the SSLs for molybdenum and lithium in well GAMW-51B and molybdenum in GAMW-60B. The results also indicated a new SSL for arsenic at GAMW-44. WSP prepared, and a qualified Indiana-licensed professional engineer certified, an ASD demonstrating that the SSL for arsenic observed at levels above the GWPS in GAMW-44 were not due to a release from the WDA (Appendix B of the 2023 Annual Report, WSP 2024a). Furthermore, NIPSCO installed an additional monitoring well GAMW-77 downgradient of and closer to the property boundary than GAMW-44 to further evaluate downgradient groundwater quality.
- Twelfth Assessment Monitoring Event – WSP performed the twelfth Assessment Monitoring event in September/October 2023 by collecting groundwater samples for analysis of Appendix III and Appendix IV constituents and performed the statistical evaluation of the analytical results in February 2024. The results confirmed the SSLs for molybdenum and lithium in well GAMW-51B, molybdenum in GAMW-60B, and arsenic in well GAMW-44. The results also indicated a new SSL for lithium in well GAMW-60B. As these results are consistent with the primary lines of evidence presented in the June 2020 ASD, a qualified Indiana-licensed professional engineer recertified the ASD in May 2024 (Appendix A). The results from the ninth and tenth Assessment Monitoring events are included in the 2023 Annual Report (WSP 2024a).
- Thirteenth Assessment Monitoring Event – WSP performed the thirteenth Assessment Monitoring event in April 2024 by collecting groundwater samples for analysis of Appendix III and Appendix IV constituents and performed the statistical evaluation of the analytical results in August 2024. The results confirmed the SSLs for lithium and molybdenum in wells GAMW-51B and GAMW-60B and for arsenic in well GAMW-44. A qualified Indiana-licensed professional engineer recertified the ASD in November 2024 (Appendix B).
- Fourteenth Assessment Monitoring Event – WSP performed the fourteenth Assessment Monitoring event in September 2024 by collecting groundwater samples for analyses of Appendix III and Appendix IV constituents and will perform the statistical evaluation of the analytical results in January 2025.

The analytical laboratory reports for April and September 2024 are provided in Appendix C and Appendix D, respectively. The data usability assessment report for the analytical data is provided in Appendix E. The February and August 2024 statistical evaluation results are provided in Appendix F.

3.7 Statistical Evaluation

In accordance with 40 CFR §257.95, WSP performed the statistical evaluation of the groundwater analytical results following each monitoring event. For this evaluation, WSP utilized the Sanitas™ statistical analysis software package. The methods used during this statistical evaluation are described in the GMPIM (Golder 2017),

were certified by a qualified engineer in October 2017. WSP has summarized the statistical evaluations in the subsections below.

3.7.1 Data Evaluation

After each event, WSP assessed the analytical data for outliers, anomalies, and trends that might be an indication of a sampling or analytical error. Outliers and anomalies are generally defined as inconsistently large or small values that can occur because of sampling, laboratory, transportation, or transcription errors, or even by chance alone. Significant trends may indicate natural geochemical variability, a source of systematic error, influence of an upgradient/off-site source, or an actual occurrence of CCR Unit influence upon groundwater quality. Prior to the calculation of statistical limits, WSP used appropriate statistical methods to remove outliers from the database and manage trends with detrending routines.

To assess the data for outliers, anomalies, and trends, WSP assessed the data using time vs. concentration graphs, and statistical routines included in the Sanitas™ statistical analysis software package.

Outliers and Anomalies

Based on these evaluations, WSP identified outliers in 2024 in addition to those identified in the 2023 Annual Report:

- The April 2023 pH results collected from monitoring wells GAMW-68, GAMW-68B, GAMW-43, and GAMW-43B.

These results were identified as outliers and removed from the dataset for the following reasons:

- Generally, statistical testing, including the Dixon outlier test (see Appendix F), identified the results as outliers
- Trend charts indicate that these results were inconsistent with other concentrations detected in these wells and the high results were not confirmed by the October 2023 data
- A malfunction in field equipment is the suspected cause of the anomalous data.

Trends

WSP evaluated the background data set for trends using Sanitas™ software (Appendix F). WSP will continue to monitor all trends and apply detrending routines, if applicable, before using these data to calculate GWPS. WSP identified the following Appendix IV parameter trends in background monitoring wells:

- Arsenic concentrations detected in groundwater samples collected from GAMW-03B show a decreasing trend. Arsenic has never been detected above the MCL in this well. No detrending routines are required.
- Arsenic concentrations detected in groundwater samples collected from GAMW-68 and GAMW-68B show an increasing trend. Arsenic has never been detected above the MCL in these wells. No detrending routines are required.
- Beryllium concentrations detected in groundwater samples collected from GAMW-03 and GAMW-03B show a decreasing trend. Beryllium has never been detected above the MCL in these wells. No detrending routines are required.

- Cadmium concentrations detected in groundwater samples collected from GAMW-03 and GAMW-03B show a decreasing trend. Cadmium has never been detected above the MCL in these wells. No detrending routines are required.
- Chromium concentrations detected in groundwater samples collected from GAMW-03 show a decreasing trend. Chromium has never been detected above the MCL in this well. No detrending routines are required.
- Lead concentrations detected in groundwater samples collected from GAMW-03 and GAMW-03B show a decreasing trend. Lead has never been detected above the health-based standard in these wells. No detrending routines are required.
- Molybdenum concentrations detected in groundwater samples collected from GAMW-03B show a decreasing trend. Molybdenum has never been detected above the health-based standard in this well. No detrending routines are required.
- Selenium concentrations detected in groundwater samples collected from GAMW-03B show a decreasing trend. Selenium has never been detected above the MCL in this well. No detrending routines are required.
- Thallium concentrations detected in groundwater samples collected from GAMW-03 and GAMW-03B show a decreasing trend. Thallium has never been detected above the MCL in these wells. No detrending routines are required.

3.7.2 Development of Groundwater Protection Standard

Pursuant to CFR §257.95(h), WSP developed GWPS for each of the Appendix IV analytes. The GWPSs are set equal to the MCL or health-based standard or a limit based on background data, whichever is greater, as described in 40 CFR §257.95(h)(2).

The CCR Rule and *Unified Guidance* provide two acceptable approaches for establishing a background-based GWPS; a tolerance interval approach or a prediction interval approach. Either of these approaches can be used in all cases except if all values are non-detect, in which case the background-based GWPS is set equal to the laboratory reporting limit (RL).

If the background dataset is normally or transformed normally distributed, the GMPIM (Golder 2017) states that the tolerance interval approach is used. The background-based GWPS will be based on a 95 percent coverage/95 percent confidence tolerance interval. If the background data are non-normal (even after transformation) than a non-parametric prediction interval approach is used.

As described in Section 3.4, WSP performed a periodic update of background datasets. This update included incorporation of additional background data, to improve statistical power and accuracy by providing a more conservative estimate of the true background populations. The GMPIM (Golder 2017) allows for the statistical limits to be updated after four to eight new measurements are available (i.e., every two to four years of semi-annual monitoring). WSP incorporated the new data into the background dataset and updated the GWPS in both March 2020 and September 2022 (see Table 6). The September 2022 GWPS include the first four data points collected from GAMW-68 and GAMW-68B. A summary of the GWPSs is provided in Table 6. The corresponding tolerance limits and/or prediction limits are provided in Appendix F.

3.7.3 Results of Appendix IV Downgradient Statistical Comparisons

For Assessment Monitoring results, WSP used an interwell statistical evaluation to identify SSLs. An interwell evaluation compares the most recent values from downgradient compliance wells to a background dataset composed of upgradient well data. Because the CCR Unit is in Assessment Monitoring, no statistical evaluations were conducted on Appendix III (Detection Monitoring) constituents.

For Appendix IV constituents, WSP used the confidence interval method to evaluate for potential exceedances or SSLs based on procedures described in the Unified Guidance, and the GMPIM (Golder 2017). Using confidence intervals, SSLs are identified by comparing the calculated confidence interval against the GWPS. A confidence interval statistically defines the upper and lower bounds of a specified population within a stipulated level of confidence. If the lower confidence limit exceeds the GWPS, there is statistical evidence that an SSL has been triggered.

Based on the comparisons discussed above, WSP determined that the results of the statistical analyses completed in February 2024 and August 2024 identified SSLs for lithium in well GAMW-51B and molybdenum in wells GAMW-51B and GAMW-60B. Additionally, trend analysis indicated that there are statistically significant increasing trends for arsenic in well GAMW-44 and lithium in well GAMW-60B and in both cases the lower confidence band is above the GWPS, resulting in SSLs for these locations. The calculated confidence intervals and confidence band for arsenic at GAMW-44 and lithium at GAMW-60B are provided in Appendix F.

3.8 Problems Encountered and Follow-Up Corrective Actions

In the Thirteenth Assessment Monitoring event (April 2024); WSP collected the following groundwater samples with higher than expected turbidity levels:

- GAMW-03; 7.10 nephelometric turbidity units (NTUs)
- GAMW-12B; 5.30 NTUs
- GAMW-42C; 11.60 NTUs
- GAMW-43; 5.11 NTUs
- GAMW-44; 18.80 NTUs
- GAMW-51; 41.80 NTUs.

In the Fourteenth Assessment Monitoring event (September 2024); WSP collected the following groundwater samples with higher than expected turbidity levels:

- GAMW-42B; 9.74 NTUs
- GAMW-42C; 99.79 NTUs

According to the GMPIM (Golder 2017), groundwater samples are to be collected once groundwater has achieved a turbidity level below 5 NTUs. If the 5 NTU objective cannot be achieved due to time constraints in the field, groundwater is then purged for a minimum of two hours and sampled when turbidity appears to stabilize (e.g., no downward or upward trend over three consecutive readings five minutes apart).

WSP's evaluation of the analytical results from these wells suggests that the slightly elevated turbidity levels had no significant effect on the representativeness of groundwater quality.

During future monitoring events, WSP will purge groundwater for a minimum of two hours or five well volumes and then use professional judgement to assess when the purge water is representative of groundwater to be sampled. If an acceptable turbidity level cannot be achieved within a reasonable timeframe (e.g., three hours maximum), WSP will redevelop the affected monitoring well(s) prior to the next sampling event.

4.0 KEY ACTIVITIES PROJECTED FOR 2025

During calendar year 2025, NIPSCO anticipates conducting the following key CCR Rule groundwater monitoring activities for the WDA:

- Prepare and submit the appropriate notifications according to the CCR Rule
- Continue semi-annual Assessment Monitoring groundwater sampling per CCR Rule requirements
- Inspect and maintain the monitoring system including wells, pumps, and equipment.

5.0 REFERENCES

Golder 2017, “CCR Groundwater Monitoring Program Implementation Manual,” Golder Associates Inc., October 2017.

Golder 2018a, “2017 Annual Groundwater Monitoring and Corrective Action Report - Waste Disposal Area, NIPSCO R. M. Schafer Generating Station”, Golder Associates Inc., January 31, 2018.

Golder 2018b, “Waste Disposal Area Alternative Source Demonstration,” Golder Associates Inc., November 19, 2018.

Golder 2019a, “2018 Annual Groundwater Monitoring and Corrective Action Report - Waste Disposal Area, NIPSCO R. M. Schafer Generating Station”, Golder Associates Inc., January 31, 2019.

Golder 2019b, “Alternative Source Demonstration - Waste Disposal Area,” Golder Associates Inc., May 17, 2019.

Golder 2019c, “Recertification of R. M. Schahfer Waste Disposal Area Alternative Source Demonstration,” Golder Associates Inc., November 26, 2019.

Golder 2020a, “2019 Annual Groundwater Monitoring and Corrective Action Report - Waste Disposal Area, NIPSCO R. M. Schafer Generating Station”, Golder Associates Inc., January 31, 2020.

Golder 2020b, “Alternative Source Demonstration – Waste Disposal Area,” Golder Associates Inc., June 9, 2020.

Golder 2020c, “Recertification of R. M. Schahfer Waste Disposal Area Alternative Source Demonstration,” Golder Associates Inc., December 4, 2020.

Golder 2021a, “2020 Annual Groundwater Monitoring and Corrective Action Report – Waste Disposal Area, NIPSCO R. M. Schahfer Generating Station”, Golder Associates Inc., January 31, 2021.

Golder 2021b, “Recertification of R. M. Schahfer Waste Disposal Area Alternative Source Demonstration,” Golder Associates Inc., May 18, 2021.

Golder 2021c, “Recertification of R. M. Schahfer Waste Disposal Area Alternative Source Demonstration,” Golder Associates Inc., November 12, 2021.

Golder 2022a, 2021, “2021 Annual Groundwater Monitoring and Corrective Action Report – Waste Disposal Area, NIPSCO R. M. Schahfer Generating Station”, Golder Associates Inc., January 31, 2022.

Golder 2022b, “Recertification of R. M. Schahfer Waste Disposal Area Alternative Source Demonstration,” Golder Associates Inc., April 15, 2022.

Golder 2022c, “Recertification of R. M. Schahfer Waste Disposal Area Alternative Source Demonstration,” Golder Associates Inc., December 2, 2022.

WSP 2023a, “2022 Annual Groundwater Monitoring and Corrective Action Report – Waste Disposal Area, NIPSCO R. M. Schahfer Generating Station”, WSP USA Inc., January 31, 2023.

WSP 2023b, “Recertification of R. M. Schahfer Waste Disposal Area Alternative Source Demonstration,” WSP USA Inc., May 8, 2023.

WSP 2023c, “Recertification of R. M. Schahfer Waste Disposal Area Alternative Source Demonstration,” WSP USA Inc., November 17, 2023.

WSP 2024a, “2023 Annual Groundwater Monitoring and Corrective Action Report – Waste Disposal Area, NIPSCO R. M. Schahfer Generating Station”, WSP USA Inc., January 31, 2024.

WSP 2024b. “CCR Groundwater Monitoring System Design Manual,” WSP USA Inc., July 2024.

WSP 2024c, “Recertification of R. M. Schahfer Waste Disposal Area Alternative Source Demonstration,” WSP USA Inc., March 25, 2024.

WSP 2024d, “Recertification of R. M. Schahfer Waste Disposal Area Alternative Source Demonstration,” WSP USA Inc., October 15, 2024.

Tables

Table 1: Monitoring Well Network
CCR Unit Schahfer Waste Disposal Area
NIPSCO LLC Rollin M. Schahfer Generating Station
Wheatfield, Indiana

CCR Unit	Well Purpose	Monitoring Well ID	Installation Date	Decommission Date (If Applicable)	Basis For Action
Waste Disposal Area	Background Monitoring Well	GAMW-03	6/27/2015	-	Installed for groundwater quality monitoring(1)
		GAMW-03B	5/24/2016	-	
		GAMW-68	8/27/2020	-	
		GAMW-68B	8/27/2020	-	
	Downgradient Monitoring Well	GAMW-01	6/26/2015	-	Installed for groundwater quality monitoring(1)
		GAMW-12	5/23/2016	-	
		GAMW-13	5/24/2016	-	
		GAMW-13B	5/23/2016	-	
		GAMW-14	5/23/2016	-	
		GAMW-14B	5/23/2016	-	
		GAMW-01B	7/31/2018	-	Installed to characterize the nature and extent of a potential release(2)
		GAMW-12B	7/31/2018	-	
		GAMW-51	7/25/2018	-	
		GAMW-51B	7/25/2018	-	
		GAMW-42	7/24/2018	-	Installed to monitor groundwater quality at the property boundary(3)
		GAMW-42B	7/24/2018	-	
		GAMW-42C	6/8/2019	-	
		GAMW-43	5/16/2018	-	
		GAMW-43B	5/16/2018	-	
		GAMW-44	5/16/2018	-	
		GAMW-44B	5/16/2018	-	
		GAMW-57	6/7/2019	-	
		GAMW-57B	6/7/2019	-	
		GAMW-58	6/6/2019	-	
		GAMW-58B	6/6/2019	-	
		GAMW-59	6/8/2019	-	Installed to characterize the nature and extent of a potential release(2)
		GAMW-59B	6/6/2019	-	
		GAMW-60	6/8/2019	-	
		GAMW-60B	6/4/2019	-	
		GAMW-77	11/10/2023	-	Installed to monitor groundwater quality at the property boundary(3)

1) Per 40 CFR §257.93, WSP collected eight rounds of background data prior to October 17, 2017, excluding wells GAMW-68 and GAMW-68B.
2) Per 40 CFR §257.95(g)(1)(i) Rule requirements, WSP collected additional data to further characterize the nature and extent of potential groundwater impacts.
3) Per 40 CFR §257.95(g)(1)(iii), WSP collected data to monitor groundwater quality in the direction of flow at the property boundary.

Prepared by: MJS 11/20/2024
Checked by: DFSC
Reviewed by: JBG

Table 2: 2024 Groundwater Elevations
CCR Unit Schahfer Waste Disposal Unit
NIPSCO LLC Rollin M. Schahfer Generating Station
Wheatfield, Indiana

Monitoring Well Location	Northing (ft)	Easting (ft)	Top of Casing Elevation (ft-NAVD88)	Measurement Date		Well Diameter (in)	Stickup (ft)	2024-03-13		2024-09-03	
				Screen Interval Top (ft-bgs)	Screen Interval Bottom (ft-bgs)			Depth to Water (ft-btoc)	Groundwater Elevation (ft-NAVD88)	Depth to Water (ft-btoc)	Groundwater Elevation (ft-NAVD88)
Davis Ditch South Culvert	2168387.49	2971366.64	662.83	-	-	-	-	2.95	659.88	3.45	659.38
GAMW01	2169108.22	2968518.99	668.23	5	15	2	3.29	9.24	658.99	9.90	658.33
GAMW01B	2169107.37	2968525.20	667.87	26	36	2	2.67	8.77	659.10	9.42	658.45
GAMW02	2168720.88	2970548.50	669.57	5	15	2	3.49	9.56	660.01	10.23	659.34
GAMW03	2169821.53	2971646.34	668.20	5	15	2	3.06	5.41	662.79	8.65	659.55
GAMW03B	2169813.71	2971647.06	668.16	25	35	2	2.87	5.41	662.75	8.70	659.46
GAMW04	2170947.82	2971503.36	669.24	5	15	2	3.43	6.92	662.32	9.50	659.74
GAMW05	2170870.00	2968721.92	669.75	7	17	2	3.06	10.76	658.99	11.91	657.84
GAMW06	2172320.06	2969128.60	670.81	5	15	2	3.31	11.44	659.37	11.93	658.88
GAMW07	2172327.53	2970256.34	669.94	5	15	2	3.39	10.23	659.71	10.66	659.28
GAMW08	2173335.20	2970799.89	669.76	5	15	2	3.81	10.08	659.68	10.64	659.12
GAMW08B	2173334.70	2970790.59	668.47	26	36	2	2.55	8.83	659.64	9.41	659.06
GAMW09	2172509.36	2971291.29	668.56	5	15	2	3.46	7.98	660.58	9.07	659.49
GAMW09B	2172502.57	2971291.67	668.29	25	35	2	2.94	7.62	660.67	8.73	659.56
GAMW10	2173531.42	2973046.25	667.83	5	15	2	3.84	9.20	658.63	9.79	658.04
GAMW11	2174218.62	2972678.78	667.17	5	15	2	3.57	8.74	658.43	9.24	657.93
GAMW12	2169576.84	2968314.48	667.29	5	15	2	2.94	8.68	658.61	9.30	657.99
GAMW12B	2169580.32	2968309.54	666.81	25	35	2	2.58	8.05	658.76	8.66	658.15
GAMW13	2170059.98	2968285.46	667.24	5	15	2	2.93	8.77	658.47	9.30	657.94
GAMW13B	2170055.88	2968285.69	667.12	25	35	2	2.89	8.65	658.47	9.37	657.75
GAMW14	2170532.49	2968467.96	667.96	5	15	2	3.20	9.10	658.86	9.10	658.86
GAMW14B	2170534.66	2968471.60	667.94	25	35	2	3.32	9.14	658.80	10.17	657.77
GAMW15	2172753.76	2970258.35	668.25	5	15	2	3.24	8.70	659.55	9.16	659.09
GAMW15B	2172749.68	2970258.92	668.05	25	35	2	2.91	8.50	659.55	8.96	659.09
GAMW16BR	2173189.53	2970399.45	664.39	30	40	2	2.93	7.87	656.52	8.28	656.11
GAMW16R	2173189.51	2970396.68	667.17	10	20	2	2.82	7.72	659.45	8.15	659.02
GAMW17	2173164.44	2970944.07	671.93	5	15	2	3.12	12.17	659.76	12.80	659.13
GAMW17B	2173164.84	2970947.44	670.60	25	35	2	1.74	10.83	659.77	12.57	658.03
GAMW18	2171919.78	2971272.41	669.07	5	15	2	3.03	7.87	661.20	9.32	659.75
GAMW18B	2171910.00	2971272.53	668.47	25	35	2	2.53	7.04	661.43	8.50	659.97
GAMW20	2171579.62	2974761.60	667.21	6	16	2	2.60	8.67	658.54	8.60	658.61
GAMW20B	2171579.95	2974757.37	667.40	22.5	32.5	2	2.92	8.73	658.67	8.77	658.63
GAMW24	2171048.72	2974868.68	665.39	6	16	2	3.30	5.84	659.55	6.75	658.64
GAMW24B	2171050.67	2974866.89	665.33	21	31	2	3.20	5.65	659.68	6.55	658.78
GAMW25	2171586.03	2973730.34	668.05	6	16	2	2.79	8.53	659.52	9.01	659.04
GAMW25B	2171588.49	2973730.66	667.95	25	35	2	2.69	8.47	659.48	8.90	659.05
GAMW26	2172243.83	2973744.80	667.71	6	16	2	2.82	8.84	658.87	9.03	658.68
GAMW26B	2172245.87	2973744.66	667.75	23	33	2	2.84	8.86	658.89	9.03	658.72

Table 2: 2024 Groundwater Elevations
CCR Unit Schahfer Waste Disposal Unit
NIPSCO LLC Rollin M. Schahfer Generating Station
Wheatfield, Indiana

Monitoring Well Location	Northing (ft)	Easting (ft)	Top of Casing Elevation (ft-NAVD88)	Measurement Date		Well Diameter (in)	Stickup (ft)	2024-03-13		2024-09-03	
				Screen Interval Top (ft-bgs)	Screen Interval Bottom (ft-bgs)			Depth to Water (ft-btoc)	Groundwater Elevation (ft-NAVD88)	Depth to Water (ft-btoc)	Groundwater Elevation (ft-NAVD88)
GAMW27	2172624.68	2973958.32	665.51	6	16	2	2.83	7.17	658.34	7.41	658.10
GAMW27B	2172624.95	2973960.21	665.44	21	31	2	2.79	7.18	658.26	7.27	658.17
GAMW31	2174043.93	2974076.43	665.40	6	16	2	2.72	7.07	658.33	7.79	657.61
GAMW31B	2174041.68	2974075.83	665.41	20	30	2	2.72	7.03	658.38	7.75	657.66
GAMW32	2174364.59	2974353.14	668.08	8	18	2	2.64	9.63	658.45	10.35	657.73
GAMW32B	2174364.70	2974350.09	668.28	24	34	2	2.75	9.83	658.45	10.52	657.76
GAMW33	2174015.71	2976811.15	665.29	6	16	2	2.66	6.41	658.88	7.65	657.64
GAMW33B	2174015.85	2976814.01	665.29	21	31	2	2.86	6.50	658.79	7.60	657.69
GAMW34	2173123.80	2976637.58	664.82	4	16	2	3.04	5.85	658.97	6.86	657.96
GAMW34B	2173126.75	2976637.84	664.84	19	29	2	3.19	5.75	659.09	6.86	657.98
GAMW35B	2172046.64	2976576.97	664.62	14	24	2	2.84	5.31	659.31	6.39	658.23
GAMW36	2174145.14	2977866.72	665.00	6	16	2	2.76	5.60	659.40	7.60	657.40
GAMW36B	2174142.51	2977866.95	665.07	24.5	34.5	2	2.72	5.61	659.46	7.60	657.47
GAMW37B	2173307.54	2977852.54	665.32	15	25	2	2.64	5.70	659.62	7.33	657.99
GAMW42	2170186.91	2967937.39	665.80	5	15	2	2.68	6.97	658.83	7.97	657.83
GAMW42B	2170182.55	2967943.17	665.66	26	36	2	2.51	6.85	658.81	7.82	657.84
GAMW42C	2170207.09	2967974.69	666.30	40	50	2	3.09	7.53	658.77	8.49	657.81
GAMW43	2170878.63	2967926.92	665.59	5	15	2	2.45	6.80	658.79	8.02	657.57
GAMW43B	2170876.91	2967926.66	665.53	26	36	2	2.41	6.73	658.80	7.51	658.02
GAMW44	2171240.72	2967833.09	666.31	5	15	2	2.20	7.54	658.77	8.84	657.47
GAMW44B	2171239.72	2967834.35	666.25	26	36	2	2.14	7.52	658.73	8.80	657.45
GAMW45	2178836.29	2971287.41	664.50	5	15	2	2.29	8.00	656.50	9.60	654.90
GAMW45B	2178836.27	2971289.23	664.32	28	38	2	2.09	7.80	656.52	9.40	654.92
GAMW46	2178839.03	2973531.39	664.80	5	15	2	2.81	6.95	657.85	8.87	655.93
GAMW46B	2178838.97	2973532.88	664.79	22	32	2	2.81	6.92	657.87	8.84	655.95
GAMW48	2178605.72	2975279.25	663.38	5	15	2	2.57	6.30	657.08	8.15	655.23
GAMW48B	2178606.46	2975283.24	663.33	20	30	2	2.89	6.25	657.08	8.12	655.21
GAMW49	2176111.21	2976600.94	664.64	5	15	2	2.64	5.53	659.11	7.50	657.14
GAMW49B	2176115.76	2976600.61	664.52	23	33	2	2.40	5.53	658.99	7.30	657.22
GAMW50	2174957.14	2977953.35	665.15	5	15	2	2.65	5.98	659.17	7.92	657.23
GAMW50B	2174961.01	2977953.31	664.88	21	31	2	2.62	5.68	659.20	7.65	657.23
GAMW51	2171145.47	2968512.12	668.77	5	15	2	2.62	10.05	658.72	11.06	657.71
GAMW51B	2171147.99	2968515.78	668.79	27	37	2	2.76	9.87	658.92	10.92	657.87
GAMW52	2175030.90	2970079.13	666.79	5	15	2	2.72	8.22	658.57	8.95	657.84
GAMW52B	2175032.00	2970073.23	666.90	27	37	2	2.40	8.29	658.61	9.07	657.83
GAMW53	2174535.34	2971036.47	667.24	5	15	2	2.56	8.60	658.64	9.20	658.04
GAMW53B	2174536.54	2971032.60	667.29	26	36	2	2.67	8.63	658.66	9.17	658.12
GAMW54	2174080.28	2971911.36	666.37	5	15	2	2.50	6.91	659.46	7.87	658.50
GAMW54B	2174081.64	2971906.90	666.47	22	32	2	2.49	7.17	659.30	7.96	658.51

Table 2: 2024 Groundwater Elevations
CCR Unit Schahfer Waste Disposal Unit
NIPSCO LLC Rollin M. Schahfer Generating Station
Wheatfield, Indiana

Monitoring Well Location	Northing (ft)	Easting (ft)	Top of Casing Elevation (ft-NAVD88)	Measurement Date		Well Diameter (in)	Stickup (ft)	2024-03-13		2024-09-03	
				Screen Interval Top (ft-bgs)	Screen Interval Bottom (ft-bgs)			Depth to Water (ft-btoc)	Groundwater Elevation (ft-NAVD88)	Depth to Water (ft-btoc)	Groundwater Elevation (ft-NAVD88)
GAMW55B	2173632.34	2972222.72	667.53	25	35	2	2.35	8.00	659.53	8.98	658.55
GAMW55R	2173631.97	2972230.54	667.73	5	15	2	2.37	8.19	659.54	9.14	658.59
GAMW56	2173343.43	2972428.30	667.91	5	15	2	2.48	8.24	659.67	9.30	658.61
GAMW56B	2173343.23	2972423.77	667.82	25	35	2	2.49	8.16	659.66	9.22	658.60
GAMW57	2171592.09	2967729.66	672.99	5	15	2	2.52	14.22	658.77	15.60	657.39
GAMW57B	2171592.28	2967726.72	672.90	35	45	2	2.44	14.08	658.82	15.49	657.41
GAMW58	2171902.75	2967863.88	667.56	5	15	2	2.52	9.29	658.27	10.30	657.26
GAMW58B	2171900.81	2967867.00	667.61	25	35	2	2.73	9.32	658.29	10.35	657.26
GAMW59	2171317.51	2968668.03	668.51	5	15	2	2.58	9.71	658.80	10.73	657.78
GAMW59B	2171313.72	2968668.36	668.57	30	40	2	2.61	9.76	658.81	10.83	657.74
GAMW60	2171552.61	2968698.92	667.52	5	15	2	2.43	9.00	658.52	9.96	657.56
GAMW60B	2171549.04	2968699.96	667.52	30	40	2	2.46	8.75	658.77	9.72	657.80
GAMW63B	2171969.16	2971860.97	668.76	23	33	2	2.45	7.34	661.42	8.90	659.86
GAMW64B	2171789.81	2972174.66	666.85	21	31	2	2.43	5.52	661.33	7.05	659.80
GAMW65B	2173229.48	2968253.82	668.67	25	35	2	3.22	10.52	658.15	11.13	657.54
GAMW66B	2173363.62	2967853.20	672.99	34	44	2	3.79	15.24	657.75	15.88	657.11
GAMW67B	2174213.30	2967604.35	667.97	30.5	40.5	2	3.32	10.29	657.68	10.98	656.99
GAMW68	2970328.36	2168555.54	665.53	7	17	2	0.42	5.43	660.10	6.34	659.19
GAMW68B	2970325.08	2168557.42	665.72	24.5	34.5	2	0.25	5.61	660.11	6.54	659.18
GAMW72	2173514.76	2973920.43	666.93	5	15	2	2.82	8.22	658.71	8.62	658.31
GAMW72B	2173511.12	2973920.44	666.88	21	31	2	2.68	8.19	658.69	8.60	658.28
GAMW73	2173737.29	2974225.62	664.26	5	15	2	2.62	5.39	658.87	6.06	658.20
GAMW73B	2173740.94	2974228.37	664.31	18	18	2	2.65	5.45	658.86	6.10	658.21
GAMW74	2173737.57	2974539.26	664.44	5	15	2	2.82	5.51	658.93	6.21	658.23
GAMW74B	2173737.58	2974542.01	664.21	18	18	2	2.59	5.27	658.94	6.00	658.21
GAMW77	2171387.05	2967443.04	668.25	9.5	19.5	2	2.27	8.81	659.44	10.73	657.52
GAMW78	2171030.91	2967481.46	674.71	10	20	2	2.38	15.29	659.42	17.13	657.58
GAPIEZ07	2174443.92	2973071.62	668.77	5	15	2	3.62	10.68	658.09	11.04	657.73
MW-10D	2171037.13	2974845.36	663.18	NA	NA	2	0.98	3.44	659.74	4.38	658.80
MW-10S	2171039.40	2974843.76	662.53	NA	NA	2	0.58	2.85	659.68	3.75	658.78

Table 2: 2024 Groundwater Elevations
CCR Unit Schahfer Waste Disposal Unit
NIPSCO LLC Rollin M. Schahfer Generating Station
Wheatfield, Indiana

Monitoring Well Location	Northing (ft)	Easting (ft)	Top of Casing Elevation (ft-NAVD88)	Measurement Date		Well Diameter (in)	Stickup (ft)	2024-03-13		2024-09-03	
				Screen Interval Top (ft-bgs)	Screen Interval Bottom (ft-bgs)			Depth to Water (ft-btoc)	Groundwater Elevation (ft-NAVD88)	Depth to Water (ft-btoc)	Groundwater Elevation (ft-NAVD88)
MW-11D	2175123.58	2976338.85	663.57	NA	NA	2	2.06	4.79	658.78	6.05	657.52
MW-11S	2175119.58	2976338.76	663.25	NA	NA	2	1.79	4.49	658.76	5.72	657.53
MW-12D	2175120.55	2975384.31	663.60	NA	NA	2	2.02	4.75	658.85	5.90	657.70
MW-12S	2175120.73	2975379.24	663.48	NA	NA	2	1.94	4.65	658.83	5.83	657.65
MW-13D	2173960.00	2976837.35	664.80	NA	NA	2	2.77	5.90	658.90	7.08	657.72
MW-13S	2173953.77	2976836.91	664.67	NA	NA	2	2.45	5.77	658.90	6.94	657.73
MW-14D	2174539.41	2977869.89	665.41	NA	NA	2	2.77	6.06	659.35	8.05	657.36
MW-14S	2174539.25	2977863.57	665.24	NA	NA	2	2.67	5.91	659.33	7.86	657.38
MW-1D	2170444.49	2973803.64	668.86	NA	NA	2	2.50	7.23	661.63	9.11	659.75
MW-1S	2170448.20	2973803.98	668.81	NA	NA	2	2.38	7.21	661.60	9.08	659.73
MW-2D	2172923.26	2976537.67	663.73	NA	NA	2	1.56	4.55	659.18	5.62	658.11
MW-2S	2172927.38	2976537.39	664.10	NA	NA	2	2.00	4.95	659.15	6.00	658.10
MW-3D	2174870.27	2976027.63	667.58	NA	NA	2	2.74	9.02	658.56	9.97	657.61
MW-3S	2174870.86	2976031.85	667.58	NA	NA	2	2.76	9.05	658.53	9.91	657.67
MW-4D	2174850.77	2974079.15	666.56	NA	NA	2	2.43	8.44	658.12	8.84	657.72
MW-4S	2174855.51	2974079.60	666.90	NA	NA	2	2.64	8.79	658.11	9.17	657.73
MW-5D	2172943.46	2973945.66	664.37	NA	NA	2	1.62	6.10	658.27	6.34	658.03
MW-5S	2172947.30	2973945.82	664.29	NA	NA	2	1.57	6.00	658.29	6.28	658.01
MW-6D	2176184.07	2979231.73	664.64	NA	NA	2	2.85	7.51	657.13	9.64	655.00
MW-6S	2176187.92	2979232.21	664.61	NA	NA	2	2.60	7.52	657.09	9.64	654.97
MW-7D	2176191.44	2976686.21	664.72	NA	NA	2	2.71	5.99	658.73	7.72	657.00
MW-7S	2176190.47	2976682.35	664.80	NA	NA	2	2.81	5.70	659.10	7.78	657.02
MW-8D	2178623.03	2975045.81	663.52	NA	NA	2	2.18	6.26	657.26	8.11	655.41
MW-8S	2178621.44	2975049.79	663.75	NA	NA	2	2.33	6.48	657.27	8.35	655.40
MW-9D	2178811.96	2972838.00	662.68	NA	NA	2	0.84	5.30	657.38	6.85	655.83
MW-9S	2178809.97	2972839.80	662.42	NA	NA	2	0.59	5.08	657.34	6.60	655.82
SW-10	2170976.65	2975340.69	660.45	-	-	-	-	0.40	660.05	1.18	659.27
SW-4	2174898.62	2973926.86	662.48	-	-	-	-	0.75	661.73	0.75	661.73
Davis Ditch West Gate	2173623.30	2967604.35	668.17	-	-	-	-	10.96	657.21	11.54	656.63

Notes:
Locations surveyed in US State Plane Indiana West Zone North American Datum of 1983 and North American Vertical Datum of 1988 (ft)
CCR = coal combustion residual
ft-bgs = feet below ground surface
ft-btoc = feet below top of casing
ft-NAVD88 = feet relative to NAVD88
in = inch
NA = not available

Prepared by: MJS
Checked by: DFSC
Reviewed by: JBG

Table 3: Summary of Sampling Events
CCR Unit Schahfer Waste Disposal Area
NIPSCO LLC Rollin M. Schahfer Generating Station
Wheatfield, Indiana

Well Purpose	Monitoring Well ID	Sample Event #22	Sample Event #23	Total Number of Samples
Purpose of Sample		Annual Assessment Monitoring	Semi-Annual Assessment Monitoring	
Sample Parameters		Appendix III and Appendix IV	Appendix III and detected Appendix IV	
Background Monitoring Well	GAMW03	4/3/2024	9/12/2024	2
	GAMW03B	4/3/2024	9/12/2024	2
	GAMW68	4/12/2024	9/12/2024	2
	GAMW68B	4/12/2024	9/12/2024	2
Downgradient Monitoring Well	GAMW01	4/2/2024	9/11/2024	2
	GAMW01B	4/2/2024	9/11/2024	2
	GAMW12	4/2/2024	9/17/2024	2
	GAMW12B	4/3/2024	9/24/2024	2
	GAMW13	4/1/2024	9/17/2024	2
	GAMW13B	4/2/2024	9/17/2024	2
	GAMW14	4/1/2024	9/16/2024	2
	GAMW14B	4/1/2024	9/16/2024	2
	GAMW42	4/16/2024	9/25/2024	2
	GAMW42B	4/16/2024	9/25/2024	2
	GAMW42C	4/16/2024	9/26/2024	2
	GAMW43	4/17/2024	9/26/2024	2
	GAMW43B	4/17/2024	9/27/2024	2
	GAMW44	4/16/2024	9/25/2024	2
	GAMW44B	4/16/2024	9/25/2024	2
	GAMW51	4/4/2024	9/13/2024	2
	GAMW51B	4/4/2024	9/13/2024	2
	GAMW57	4/17/2024	9/26/2024	2
	GAMW57B	4/17/2024	9/26/2024	2
	GAMW58	4/19/2024	9/26/2024	2
	GAMW58B	4/19/2024	9/26/2024	2
	GAMW59	4/3/2024	9/13/2024	2
	GAMW59B	4/11/2024	9/13/2024	2
	GAMW60	4/3/2024	9/16/2024	2
	GAMW60B	4/3/2024	9/16/2024	2
	GAMW77	4/16/2024	9/27/2024	2
Total Number of Samples		30	30	60

Notes:

Sample counts do not include QC/QA samples.

(1) Sample events #1-19 were completed prior to 2023. The purpose, sample parameters, and sample dates are included in the 2017, 2018, 2019, 2020, 2021, 2022, and 2023 Annual Reports.

(2) Sample events #20 and 21 correspond to the eleventh and twelfth Assessment Monitoring events, respectively.

Prepared by: AJS 1/7/2025
Checked by: DBSC 1/8/2025
Reviewed by: JRG 1/10/25

Table 4: 2024 Analytical Data
CCR Unit Schahfer Waste Disposal Area
NIPSCO LLC R. M. Schahfer Generating Station
Wheatfield, Indiana

	Location	GAMW01		GAMW01B			GAMW03		GAMW03B		GAMW12			GAMW12B	
	Sample Date	2024-04-02	2024-09-11	2024-04-02		2024-09-11	2024-04-03	2024-09-12	2024-04-03	2024-09-12	2024-04-02	2024-09-17		2024-04-03	2024-09-24
	Sample Type	N	N	FD	N	N	N	N	N	N	N	FD	N	N	N
Chemical	Unit														
CCR Appendix III															
Boron	mg/L	0.86	1.6	0.34	0.34	0.37	0.22	0.17	0.39	0.43	0.053 J	0.069 J	0.072 J	0.36	0.43
Calcium	mg/L	88.1	97.6	110	111	112	85.8	82.1	104	110	75.5	79	83.6	111	103
Chloride	mg/L	4.5	8.7	22.6	22.6	24.5	14.1	4.4	24.6	23.2	4.5	3.2	3.2	23.7	23.6
Fluoride	mg/L	0.3	0.39	0.15	0.15	0.16	0.23	0.13	0.21	0.21	0.22	0.25	0.25	0.11	0.099 J
pH	SU	7.36	6.99		7.18	6.96	7.22	6.81	7.31	7.12	7.03		7.00	7.26	7.62
Sulfate	mg/L	108	123	77.7	75.7	84.7	76.7	48.5	115	129	28.7	9.1	9	107	124 J-
Total Dissolved Solids	mg/L	341	422	451	429	426	319	332	449	475	271	300	302	469	485
CCR Appendix IV															
Antimony	mg/L	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.00042 J	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U
Arsenic	mg/L	0.0033	0.0075	0.00026 J	0.00032 J	0.00032 J	0.004	0.013	0.00042 J	0.00046 J	0.0051	0.014	0.014	0.00034 J	0.00042 J
Barium	mg/L	0.045	0.062	0.17	0.17	0.18	0.087	0.093	0.11	0.11	0.072	0.087	0.086	0.15	0.15
Beryllium	mg/L	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U
Cadmium	mg/L	2E-05 J	0.0002 U	0.0002 U	0.0002 U	0.0002 U	5.7E-05 J	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U
Chromium	mg/L	0.002 U	0.00047 J	0.002 U	0.002 U	0.00051 J	0.00032 J	0.00043 J	0.0004 J	0.00048 J	0.002 U	0.002 U	0.002 U	0.00037 J	0.002 U
Cobalt	mg/L	0.0012	0.0018	0.00026 J	0.00026 J	0.00026 J	0.0053	0.00091 J	0.00051 J	0.00022 J	0.00056 J	0.0012	0.0012	0.00022 J	0.00019 J
Fluoride	mg/L	0.3	0.39	0.15	0.15	0.16	0.23	0.13	0.21	0.21	0.22	0.25	0.25	0.11	0.099 J
Lead	mg/L	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.00013 J	0.001 U	8.8E-05 J	0.001 U	7.3E-05 J	0.001 U	0.001 U	0.001 U	6.5E-05 J
Lithium	mg/L	0.02 U	0.005 J	0.0059 J	0.0095 J	0.0062 J	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.0064 J	0.0041 J	0.02 U	0.0052 J
Mercury	mg/L	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U
Molybdenum	mg/L	0.015	0.017	0.001	0.001	0.00088 J	0.01	0.011	0.006	0.0056	0.011	0.0052	0.0052	0.0016	0.0025
Radium, Total	pCi/L	1.58 U	1.86 U	2.21 U	1.74	2.15 U	1.25 U	2.34 U	1.76	1.8 U	1.86 U	2.19 U	2.38 U	1.6 U	1.69 U
Selenium	mg/L	0.0095	0.0031	0.001 U	0.001 U	0.001 U	0.00039 J	0.001 U	0.001 U	0.001 U	0.00042 J	0.00027 J	0.00028 J	0.001 U	0.001 U
Thallium	mg/L	0.001 U	0.00014 J	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U
Sample Parameters															
Dissolved Oxygen	mg/L	0.08	0.08		-0.42	-0.13	2.01	0.05	-0.35	-0.13	0.84		-0.10	0.20	-0.03
Oxidation-Reduction Potential	millivolts	3.6	-52.7		-85.1	-107.1	98.3	-97.1	-65.8	-121.7	-63.9		-130.1	-103.6	-119.7
pH	SU	7.36	6.99		7.18	6.96	7.22	6.81	7.31	7.12	7.03		7.00	7.26	7.62
Specific Conductance	mS/cm	0.473	0.617		0.606	0.628	0.383	0.488	0.552	0.597	0.502		0.488	0.559	0.624
Temperature	deg c	9.6	18.6		12.3	15.2	8.8	17.6	10.7	14.5	9.4		18.2	11.5	15.1
Turbidity	ntu	4.59	1.85		4.02	1.16	7.10	3.29	3.73	3.94	4.84		3.95	5.30	3.60

Notes:
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Abbreviations:
deg C = degrees Celsius
NTU = Nephelometric Turbidity Units
mg/L = milligrams per liter
mS/cm = milli Siemens per centimeter
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SU = Standard Units
N = normal sample
FD = field duplicate

Table 4: 2024 Analytical Data
CCR Unit Schahfer Waste Disposal Area
NIPSCO LLC R. M. Schahfer Generating Station
Wheatfield, Indiana

	Location	GAMW13		GAMW13B		GAMW14		GAMW14B		GAMW42		GAMW42B		GAMW42C	
	Sample Date	2024-04-01	2024-09-17	2024-04-02	2024-09-17	2024-04-01	2024-09-16	2024-04-01	2024-09-16	2024-04-16	2024-09-25	2024-04-16	2024-09-25	2024-04-16	2024-09-26
	Sample Type	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Chemical	Unit														
CCR Appendix III															
Boron	mg/L	0.15	0.32	0.61	0.69	0.091 J	0.1 U	3.7	4.8	0.025 J	0.041 J	0.032 J	0.037 J	0.56	0.59
Calcium	mg/L	76.1	71.4	78.5	77.6	58.2	49.8	155	149	56.8	57.1	63.5	57.8	56.1	52.1
Chloride	mg/L	12.7	15.1	26.8	27.3	1.1	0.99	125	153	10.9	9.3	12.3	8.5	11.1	8.2
Fluoride	mg/L	0.21	0.28	0.29	0.24	0.21	0.2	0.32	0.28	0.13	0.13	0.13	0.13	0.2	0.18
pH	SU	6.79	6.84	7.60	7.56	6.96	6.82	7.78	7.62	7.67	7.82	7.75	8.02	7.54	7.66
Sulfate	mg/L	30.7	45.7	115	133	34.4	32.7	1240	1520	64.7	42	44.2	34.4	4.9	4
Total Dissolved Solids	mg/L	303	312	373	373	220	203	2220	2550	217	221	243	217	213	212
CCR Appendix IV															
Antimony	mg/L	0.00032 J	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U
Arsenic	mg/L	0.0043	0.0059	0.0014	0.0013	0.011	0.013	0.0008 J	0.00093 J	0.0021	0.0013	0.00027 J	0.00028 J	0.00041 J	0.0011
Barium	mg/L	0.081	0.12	0.081	0.079	0.037	0.025	0.083	0.1	0.022	0.021	0.022	0.02	0.0092	0.0083
Beryllium	mg/L	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	7.5E-05 J	7.9E-05 J	0.0002 U	0.0002 U	0.0002 U	0.0002 U	2.8E-05 J	3.6E-05 J
Cadmium	mg/L	0.00014 J	7.7E-05 J	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U
Chromium	mg/L	0.00089 J	0.002 U	0.002 U	0.002 U	0.00082 J	0.0011 J	0.0019 J	0.0024	0.002 U	0.00092 J	0.002 U	0.0007 J	0.002 U	0.0028
Cobalt	mg/L	0.00082 J	0.00063 J	0.001 U	0.00011 J	0.0079	0.0065	0.00036 J	0.00039 J	0.00014 J	0.0001 J	0.00018 J	0.00011 J	0.00046 J	0.0013
Fluoride	mg/L	0.21	0.28	0.29	0.24	0.21	0.2	0.32	0.28	0.13	0.13	0.13	0.13	0.2	0.18
Lead	mg/L	0.001 U	0.001 U	4.6E-05 J	0.001 U	0.001 U	7.1E-05 J	7.5E-05 J	9.5E-05 J	0.001 U	9.2E-05 J	0.001 U	0.0001 J	0.001 U	0.0018
Lithium	mg/L	0.02 U	0.02 U	0.02 U	0.0053 J	0.02 U	0.02 U	0.011 J	0.004 J	0.02 U	0.02 U	0.02 U	0.02 U	0.029	0.03
Mercury	mg/L	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U
Molybdenum	mg/L	0.0039	0.0082	0.015	0.016	0.0042	0.0073	0.027	0.029	0.0037	0.0028	0.0028	0.0024	0.0026	0.0036
Radium, Total	pCi/L	1.54 U	1.59 U	1.65 U	2.61 U	1.26 U	1.8 U	1.61 U	2.55	2.11 U	1.84 UJ	1.56 U	1.69 UJ	2.02	1.41 UJ
Selenium	mg/L	0.00076 J	0.00057 J	0.001 U	0.001 U	0.001 U	0.00043 J	0.00047 J	0.00054 J	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.00044 J
Thallium	mg/L	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	4.3E-05 J	0.00014 J
Sample Parameters															
Dissolved Oxygen	mg/L	0.41	0.07	0.25	-0.05	-0.40	0.07	-0.33	-0.06	-0.39	0.11	-0.24	-0.05	-0.33	-0.04
Oxidation-Reduction Potential	millivolts	-76.8	-116.6	-128.0	-158.3	-89.6	-92.7	-106.7	-129.1	-107.2	-136.5	-119.7	-163.7	-120.4	-146.2
pH	SU	6.79	6.84	7.60	7.56	6.96	6.82	7.78	7.62	7.67	7.82	7.75	8.02	7.54	7.66
Specific Conductance	mS/cm	0.408	0.527	0.461	0.512	0.227	0.302	2.476	2.817	0.305	0.317	0.336	0.298	0.373	0.351
Temperature	deg c	9.6	18.6	11.9	16.2	9.8	17.4	12.3	14.8	11.7	15.3	12.6	13.3	12.5	12.8
Turbidity	ntu	4.55	0.72	4.12	0.49	0.96	4.21	3.18	1.65	4.31	3.97	4.28	9.74	11.60	99.79

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SU = Standard Units
N = normal sample
FD = field duplicate

Table 4: 2024 Analytical Data
CCR Unit Schahfer Waste Disposal Area
NIPSCO LLC R. M. Schahfer Generating Station
Wheatfield, Indiana

	Location	GAMW43		GAMW43B		GAMW44		GAMW44B			GAMW51		GAMW51B			GAMW57	
	Sample Date	2024-04-17	2024-09-26	2024-04-17	2024-09-27	2024-04-16	2024-09-25	2024-04-16	2024-09-25		2024-04-04	2024-09-13	2024-04-04	2024-09-13		2024-04-17	2024-09-26
	Sample Type	N	N	N	N	N	N	N	FD	N	N	N	N	FD	N	N	N
Chemical	Unit																
CCR Appendix III																	
Boron	mg/L	0.012 J	0.006 J	0.028 J	0.025 J	0.022 J	0.036 J	0.022 J	0.026 J	0.027 J	0.29	0.82	7.7	8.4	8	0.028 J	0.023 J
Calcium	mg/L	21.9	30.3	37.7	36	15.4	21.7	31.7	38.8	39.7	129	175	208	211	196	19.2	23.7
Chloride	mg/L	0.61	0.57	1.6	1.2	2.4	1.5	1.5	22.2	21.9	0.93	5.2	46.4	47.9	47.7	2.2	0.92
Fluoride	mg/L	0.12	0.14	0.18	0.17	0.23	0.075 J	0.11	0.1	0.1	0.14	0.46	1.1	1.2	1.1	0.05 U	0.05 U
pH	SU	7.33	7.38	7.96	8.24	6.18	6.28	7.93		7.93	6.99	6.88	7.99		7.80	6.30	8.07
Sulfate	mg/L	21.8	20	21	18.3	46.2	51.4	12.4	7.8	7.9	99.3	312	1210	1200	1190	48	28.8
Total Dissolved Solids	mg/L	84	94	116	145	140	107	104	146	149	468	752	1910	1890	1780	96	70
CCR Appendix IV																	
Antimony	mg/L	0.00021 J	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U
Arsenic	mg/L	0.0023	0.0033	0.00044 J	0.00045 J	0.03	0.021	0.0002 J	0.00026 J	0.00026 J	0.0017	0.00065 J	0.0044	0.0042	0.0044	0.00028 J	0.00069 J
Barium	mg/L	0.014	0.018	0.011	0.011	0.029	0.019	0.0083	0.011	0.011	0.096	0.1	0.052	0.055	0.055	0.012	0.0038
Beryllium	mg/L	3.4E-05 J	0.0002 U	2.6E-05 J	2.7E-05 J	0.00029	9.6E-05 J	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	2.8E-05 J	0.0002 U
Cadmium	mg/L	2.1E-05 J	2.5E-05 J	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	1.7E-05 J	0.0002 U	0.0002 U	0.0002 U	0.0002 U	4.5E-05 J	0.0002 U
Chromium	mg/L	0.0013 J	0.002 U	0.00064 J	0.00065 J	0.0064	0.0019 J	0.002 U	0.00061 J	0.00055 J	0.00039 J	0.002 U	0.00052 J	0.002 U	0.002 U	0.0009 J	0.002 U
Cobalt	mg/L	0.0011	0.00091 J	9.5E-05 J	8.3E-05 J	0.0012	0.00098 J	7.8E-05 J	6.6E-05 J	6.3E-05 J	0.0017	0.0022	0.00031 J	0.00032 J	0.00033 J	0.0018	0.00014 J
Fluoride	mg/L	0.12	0.14	0.18	0.17	0.23	0.075 J	0.11	0.1	0.1	0.14	0.46	1.1	1.2	1.1	0.05 U	0.05 U
Lead	mg/L	0.00053 J	8.2E-05 J	0.001 U	0.00014 J	0.0017	0.00013 J	0.001 U	0.00026 J	0.00027 J	0.00012 J	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.00047 J
Lithium	mg/L	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.056	0.051	0.055	0.02 U	0.02 U
Mercury	mg/L	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U
Molybdenum	mg/L	0.0018	0.0033	0.0022	0.0023	0.0021	0.0026	0.002	0.0015	0.0015	0.0018	0.016	0.14	0.12	0.13	0.002	0.001
Radium, Total	pCi/L	1.57 U	1.81 UJ	1.24 U	1.71 U	1.9 U	1.6 UJ	1.23 U	1.74 J-	1.49 UJ	2.25 U	1.77 U	2.68 J+	3.32	4.1	1.57 U	1.63 UJ
Selenium	mg/L	0.00039 J	0.00033 J	0.001 U	0.001 U	0.0012	0.001 U	0.001 U	0.001 U	0.001 U	0.0004 J	0.001 U	0.00037 J	0.00036 J	0.00033 J	0.00026 J	0.00041 J
Thallium	mg/L	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U
Sample Parameters																	
Dissolved Oxygen	mg/L	-0.17	0.18	-0.34	0.04	0.51	0.94	0.27		-0.11	-0.18	-0.05	-0.39		-0.12	4.75	4.21
Oxidation-Reduction Potential	millivolts	105.5	18.5	-95.6	-183.5	-51.0	-14.1	-135.3		-167.4	56.7	-107.9	-138.6		-167.8	167.3	75.2
pH	SU	7.33	7.38	7.96	8.24	6.18	6.28	7.93		7.93	6.99	6.88	7.99		7.80	6.30	8.07
Specific Conductance	mS/cm	0.127	0.204	0.184	0.184	0.142	0.179	0.148		0.185	0.519	0.941	2.028		2.021	0.131	0.135
Temperature	deg c	9.9	17.1	11.0	12.9	10.3	15.6	11.9		12.6	10.1	17.2	12.0		14.6	10.2	13.0
Turbidity	ntu	5.11	3.39	0.82	3.09	18.80	2.51	2.00		0.19	41.80	1.01	1.24		0.88	4.14	3.99

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NTU = Nephelometric Turbidity Units
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SU = Standard Units
N = normal sample
FD = field duplicate

Table 4: 2024 Analytical Data
CCR Unit Schahfer Waste Disposal Area
NIPSCO LLC R. M. Schahfer Generating Station
Wheatfield, Indiana

	Location	GAMW57B			GAMW58		GAMW58B		GAMW59		GAMW59B		GAMW60		GAMW60B	
	Sample Date	2024-04-17		2024-09-26	2024-04-19	2024-09-26	2024-04-19	2024-09-26	2024-04-03	2024-09-13	2024-04-11	2024-09-13	2024-04-03	2024-09-16	2024-04-03	2024-09-16
	Sample Type	FD	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Chemical	Unit															
CCR Appendix III																
Boron	mg/L	0.061 J	0.061 J	0.15	0.035 J	0.031 J	0.037 J	0.036 J	4.5	1.4	4.9	4.2	2.8	1.5	3.7	4.2
Calcium	mg/L	46	46.2	52.6	9.2	10.8	37.5	37.9	247	194	124	188	262	337	363	300
Chloride	mg/L	14.3	14.4	15	0.78	0.84	3.7	4.1	105	23.4	59	35.6	39.5	21.5	13.2	21.3
Fluoride	mg/L	0.13	0.13	0.12	0.44	0.6	0.13	0.15	0.8	0.91	0.46	0.55	0.59	0.44	0.54	0.51
pH	SU		7.67	7.57	5.59	5.91	7.80	7.81	7.30	7.14	7.71	7.50	6.99	6.80	7.47	7.49
Sulfate	mg/L	15.6	15.7	19.3	46.3	46.2	23.7	20.7	380	219	843	800	492	673	1050	873
Total Dissolved Solids	mg/L	167	163	182	50	57	122	132	884	686	1570	1480	1040	1320	1590	1420
CCR Appendix IV																
Antimony	mg/L	0.001 U	0.001 U	0.001 U	8.9E-05 J	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.00024 J	0.001 U	0.001 U
Arsenic	mg/L	0.00057 J	0.00054 J	0.00064 J	0.0038	0.0044	0.0007 J	0.00074 J	0.00094 J	0.00099 J	0.0011	0.0008 J	0.00028 J	0.00035 J	0.00024 J	0.00015 J
Barium	mg/L	0.021	0.021	0.024	0.051	0.045	0.015	0.014	0.063	0.049	0.028 J+	0.029	0.036	0.046	0.057	0.053
Beryllium	mg/L	0.0002 U	0.0002 U	0.0002 U	0.0011	0.00086	0.0002 U	0.0002 U	0.0002 U	0.0002 U	2.8E-05 J	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U
Cadmium	mg/L	0.0002 U	0.0002 U	0.0002 U	0.00034	0.0002	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	3.5E-05 J	3.8E-05 J	1.7E-05 J	0.0002 U
Chromium	mg/L	0.00082 J	0.00039 J	0.002 U	0.0014 J	0.002 U	0.00047 J	0.002 U	0.00032 J	0.002 U	0.00088 J	0.002 U	0.00072 J	0.00032 J	0.0005 J	0.00051 J
Cobalt	mg/L	8.7E-05 J	8.2E-05 J	9.1E-05 J	0.015	0.014	9.1E-05 J	9.5E-05 J	0.00084 J	0.00074 J	0.0003 J	0.0003 J	0.00082 J	0.00096 J	0.0004 J	0.00035 J
Fluoride	mg/L	0.13	0.13	0.12	0.44	0.6	0.13	0.15	0.8	0.91	0.46	0.55	0.59	0.44	0.54	0.51
Lead	mg/L	0.001 U	0.001 U	0.001 U	0.00067 J	0.00058 J	6.5E-05 J	5.2E-05 J	0.001 U	0.001 U	3.8E-05 J	0.001 U	9.7E-05 J	0.001 U	0.001 U	0.001 U
Lithium	mg/L	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.0092 J	0.0054 J	0.011 J	0.0047 J	0.012 J	0.0059 J	0.064	0.066
Mercury	mg/L	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U
Molybdenum	mg/L	0.0024	0.0024	0.006	0.0011	0.00084 J	0.0025	0.0041	0.02	0.015	0.072	0.055	0.027	0.011	0.15	0.17
Radium, Total	pCi/L	1.81 U	1.54 U	1.28 UJ	1.32 U	2.22 UJ	1.37 U	1.62 UJ	1.27	1.88	1.85 U	3.05	1.71 U	2.25 U	3.58	1.97 U
Selenium	mg/L	0.001 U	0.001 U	0.001 U	0.0023	0.0034	0.001 U	0.001 U	0.001 U	0.001 U	0.00034 J	0.001 U	0.0012	0.0035	0.001 U	0.001 U
Thallium	mg/L	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U
Sample Parameters																
Dissolved Oxygen	mg/L		0.25	-0.11	1.01	0.16	0.36	-0.15	-0.41	-0.04	0.19	-0.10	0.31	0.05	0.23	-0.11
Oxidation-Reduction Potential	millivolts		-122.3	-138.1	168.9	47.8	-98.9	-147.8	-57.1	-119.4	-128.2	-150.9	82.4	27.4	-102.0	-138.1
pH	SU		7.67	7.57	5.59	5.91	7.80	7.81	7.30	7.14	7.71	7.50	6.99	6.80	7.47	7.49
Specific Conductance	mS/cm		0.239	0.283	0.085	0.098	0.188	0.201	1.041	0.892	1.833	1.661	1.016	1.501	1.47	1.481
Temperature	deg c		11.3	12.4	9.3	14.6	10.6	12.7	12.4	19.6	13.5	16.3	12.6	19.7	12.6	15.6
Turbidity	ntu		2.35	0.01	2.05	2.87	2.97	0.73	3.88	3.75	0.88	0.85	1.90	1.08	2.86	1.29

Notes:
"U" = Indicates the result was not detected above the method detection limit (MDL) for the sample; the quantitation limit (RL) is provided.
"J" = Indicates the result was estimated
"J-" = Indicates the result was estimated, bias low
"J+" = Indicates the result was estimated, bias high
"UJ" = Indicates the result is estimated and non-detect.

Abbreviations:
deg C = degrees Celsius
NTU = Nephelometric Turbidity Units
mg/L = milligrams per liter
mS/cm = milli Siemens per centimeter
pCi/L = picocuries per liter
SU = Standard Units
N = normal sample
FD = field duplicate

Table 4: 2024 Analytical Data
CCR Unit Schahfer Waste Disposal Area
NIPSCO LLC R. M. Schahfer Generating Station
Wheatfield, Indiana

	Location	GAMW68			GAMW68B		GAMW77	
	Sample Date	2024-04-12	2024-09-12		2024-04-12	2024-09-12	2024-04-16	2024-09-27
	Sample Type	N	FD	N	N	N	N	N
Chemical	Unit							
CCR Appendix III								
Boron	mg/L	0.021 J	0.1 U	0.1 U	0.029 J	0.1 U	0.017 J	0.019 J
Calcium	mg/L	61.9	62.8	62.4	38.6	35.2	17.7	17.9
Chloride	mg/L	24.6	24.2	23.9	12.2	12.9	1.4	1.8
Fluoride	mg/L	0.2	0.19	0.19	0.13	0.13	0.13	0.066 J
pH	SU	7.75		7.54	8.05	7.93	6.81	7.53
Sulfate	mg/L	65.5	70.9	64.6	44.8	44.1	24.6	14.1
Total Dissolved Solids	mg/L	293	292	280	225	169	67	86
CCR Appendix IV								
Antimony	mg/L	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U
Arsenic	mg/L	0.0012	0.0011	0.0011	0.00038 J	0.00025 J	0.00024 J	0.0005 J
Barium	mg/L	0.096	0.099	0.099	0.1	0.076	0.036	0.019
Beryllium	mg/L	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0008	0.00054
Cadmium	mg/L	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.00013 J	6.7E-05 J
Chromium	mg/L	0.002 U	0.00063 J	0.00024 J	0.002 U	0.00037 J	0.002 U	0.00071 J
Cobalt	mg/L	0.0004 J	0.00034 J	0.00036 J	8E-05 J	8.1E-05 J	0.0017	0.00066 J
Fluoride	mg/L	0.2	0.19	0.19	0.13	0.13	0.13	0.066 J
Lead	mg/L	0.001 U	0.001 U	0.001 U	0.00019 J	0.00017 J	0.001 U	0.0002 J
Lithium	mg/L	0.02 U	0.02 U	0.0044 J	0.0057 J	0.02 U	0.02 U	0.02 U
Mercury	mg/L	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U
Molybdenum	mg/L	0.0032	0.0035	0.0036	0.002	0.0017	0.00047 J	0.0007 J
Radium, Total	pCi/L	1.78 U	1.74 U	2.08 U	1.81 U	1.71 U	1.66 U	1.7 U
Selenium	mg/L	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.0019	0.0015
Thallium	mg/L	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U
Sample Parameters								
Dissolved Oxygen	mg/L	-0.39		0.07	-0.40	-0.05	3.55	2.88
Oxidation-Reduction Potential	millivolts	-117.9		-106.8	-148.1	-162.1	122.3	45.7
pH	SU	7.75		7.54	8.05	7.93	6.81	7.53
Specific Conductance	mS/cm	0.364		0.407	0.259	0.249	0.107	0.123
Temperature	deg c	9.9		15.8	11.5	14.2	11.4	13.7
Turbidity	ntu	3.89		4.08	4.08	2.33	4.21	3.82

Notes:
"U" = Indicates the result was not detected above the method detection limit (MDL) for the sample; the quantitation limit (RL) is provided.
"J" = Indicates the result was estimated
"J-" = Indicates the result was estimated, bias low
"J+" = Indicates the result was estimated, bias high
"UJ" = Indicates the result is estimated and non-detect.

Prepared by: MJS 11/20/24
Checked by: DFSC
Reviewed by: JBG

Abbreviations:
deg C = degrees Celsius
NTU = Nephelometric Turbidity Units
mg/L = milligrams per liter
mS/cm = milli Siemens per centimeter
pCi/L = picocuries per liter
SU = Standard Units
N = normal sample
FD = field duplicate

Table 6: Groundwater Protection Standards
CCR Unit Schahfer Waste Disposal Area
NIPSCO LLC Rollin M. Schahfer Generating Station
Wheatfield, Indiana

Analyte	MCL (mg/L)	GWPS (mg/L)[2]	GWPS (mg/L)[3]	GWPS (mg/L)[4]
Antimony	0.006	0.006	0.006	0.006
Arsenic	0.01	0.015	0.018	0.019
Barium	2	2	2	2
Beryllium	0.004	0.004	0.004	0.004
Cadmium	0.005	0.005	0.005	0.005
Chromium	0.1	0.1	0.1	0.1
Cobalt[1]	0.006	0.015	0.015	0.015
Fluoride	4	4	4	4
Lead[1]	0.015	0.015	0.015	0.015
Lithium[1]	0.04	0.04	0.04	0.04
Mercury	0.002	0.002	0.002	0.002
Molybdenum[1]	0.1	0.1	0.1	0.1
Radium 226+228	5	5	5	5
Selenium	0.05	0.05	0.05	0.05
Thallium	0.002	0.002	0.002	0.002

Notes:
MCL= Environmental Protection Agency Maximum Contaminant Level
GWPS= Groundwater Protection Standard
mg/L= milligrams per liter
1) As of August 29, 2016, these four constituents have health-based standards that can be used when calculating the GWPS. These health-based standards are not MCLs but are provided in the MCL column.
2) GWPS calculated in August 2018.
3) GWPS calculated in March 2020.
4) GWPS calculated in September 2022.

Prepared by: GRD
Checked by: DFSC
Reviewed by: MAH

Figures



LEGEND

Approximate Property Line

0 0.75 1.5

1 " = 0.75 miles Miles

REFERENCE(S)

SERVICE LAYER CREDITS: SOURCES: ESRI, HERE, GARMIN, USGS, INTERMAP, INCREMENT P, NRCAN, ESRI JAPAN, METI, ESRI CHINA (HONG KONG), ESRI KOREA, ESRI (THAILAND), NGCC, © OPENSTREETMAP CONTRIBUTORS, AND THE GIS USER COMMUNITY

CLIENT

NORTHERN INDIANA PUBLIC SERVICE COMPANY LLC

PROJECT

R.M. SCHAHFER GENERATING STATION
WHEATFIELD, INDIANA

TITLE

SITE LOCATION MAP

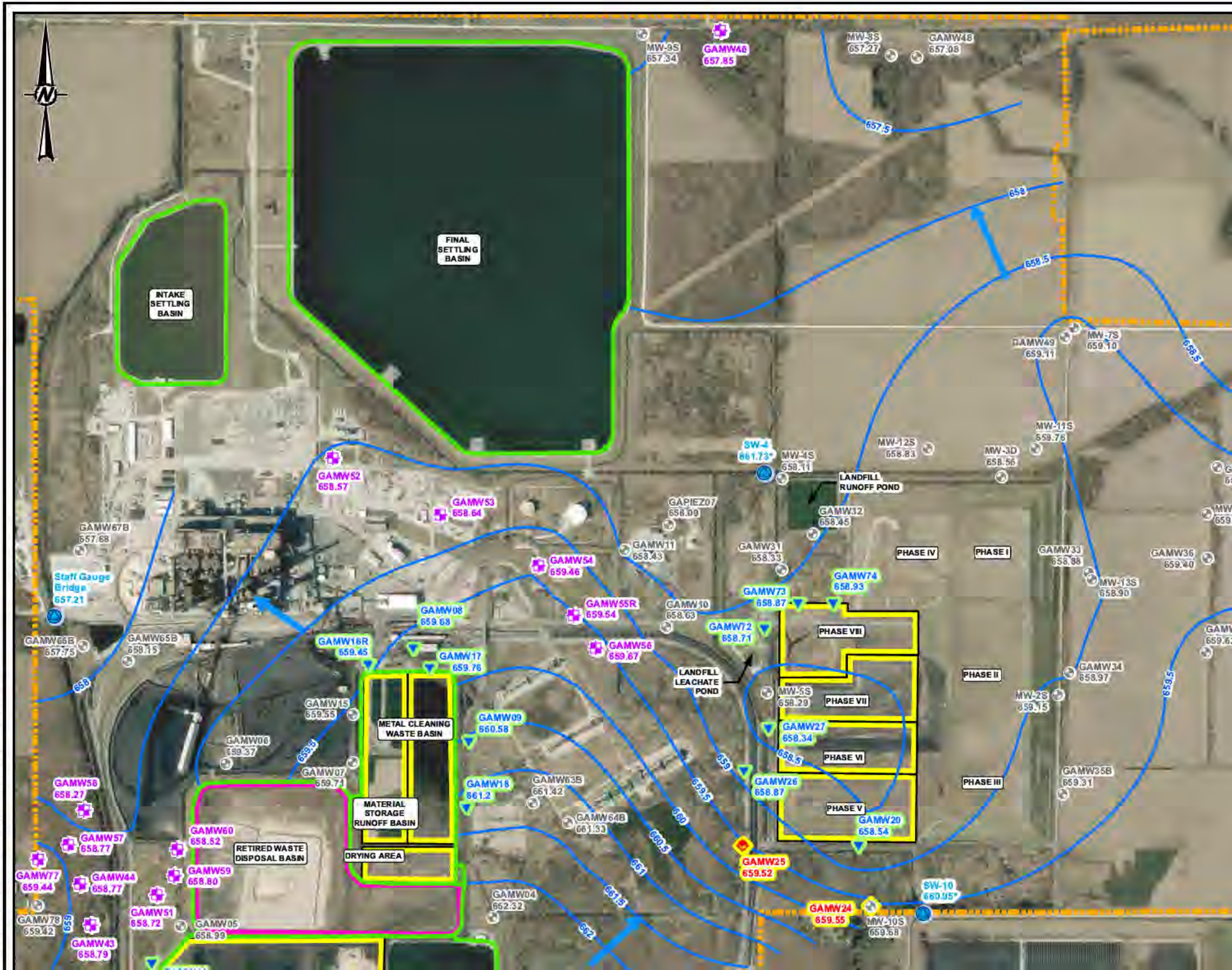
CONSULTANT

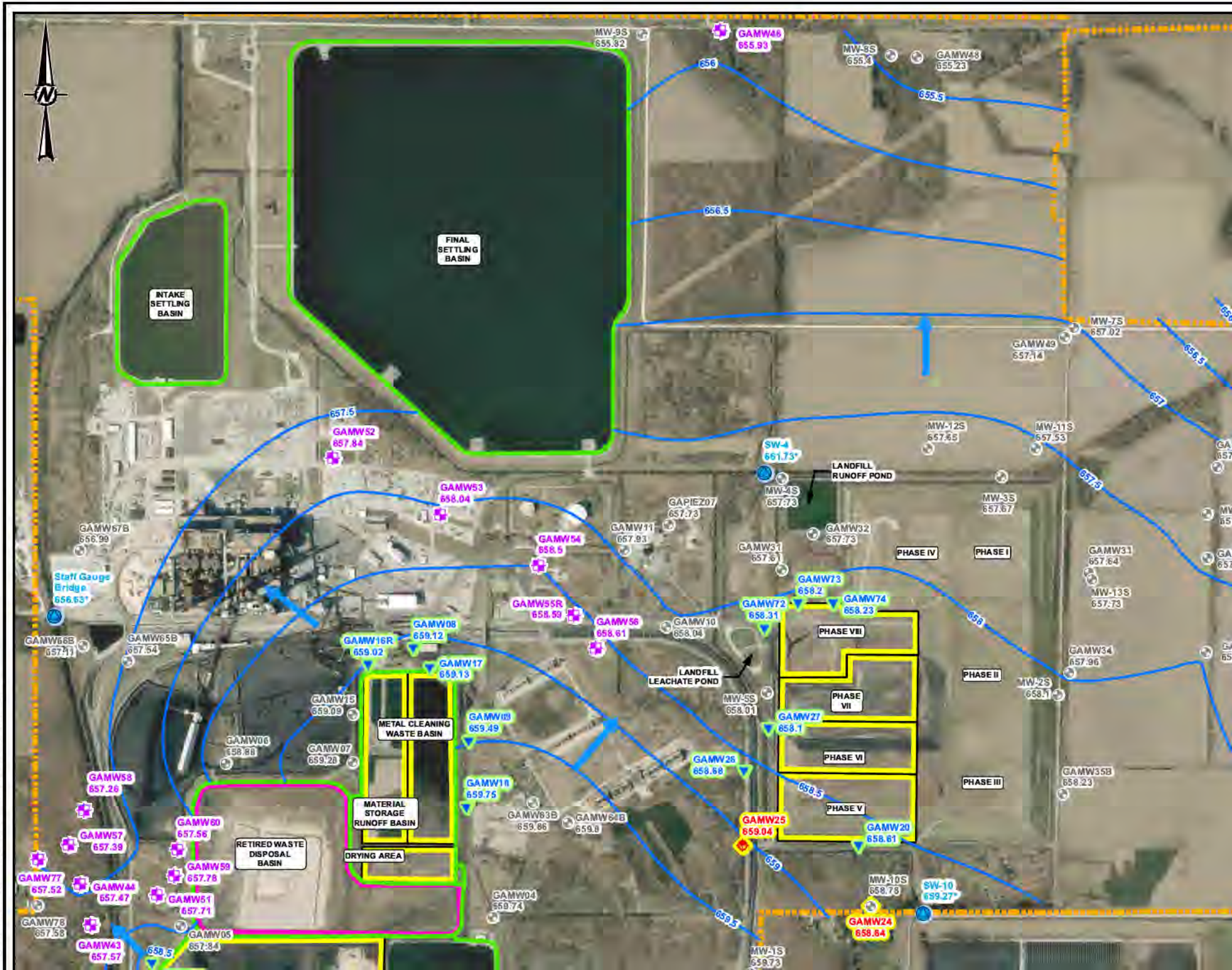
wsp

(YYYY-MM-DD)	1/04/2021
DESIGNED	DFSC
PREPARED	SHL
REVIEWED	DFSC
APPROVED	MAH

PROJECT NO.	CONTROL	REV	FIGURE
31406779	A	0	1


GAMW58/58B
GAMW57/57B
GAMW60/60B
GAMW77
GAMW59/59B
GAMW44/44B
GAMW51/51B
GAMW43/43B
GAMW14/14B
GAMW42C
GAMW42/42B
GAMW13/13B
WASTE
DISPOSAL AREA
GAMW12/12B
GAMW01/01B


FINAL SETTLING BASIN
INTAKE SETTLING BASIN
METAL CLEANING WASTE BASIN
MATERIAL STORAGE RUNOFF BASIN
DRYING AREA
RETIRED WASTE DISPOSAL BASIN
LANDFILL RUNOFF POND
LANDFILL LEACHATE POND
PHASE I
PHASE II
PHASE III
PHASE IV
PHASE V
PHASE VI
PHASE VII
PHASE VIII
MW-9S 657.34
GAMW46 657.85
MW-8S 657.27
GAMW48 657.08
GAMW49 659.11
MW-7S 659.10
MW-11S 659.75
MW-12S 658.83
MW-3D 658.56
SW-4 661.73*
MW-4S 658.11
GAMW52 658.57
GAMW53 658.64
GAPIEZ07 658.09
GAMW32 658.45
GAMW67B 657.68
GAMW11 658.43
GAMW31 658.33
GAMW33 658.88
GAMW36 659.40
MW-13S 658.90
Staff Gauge Bridge 657.21
GAMW54 659.46
GAMW74 658.93
GAMW73 658.87
GAMW55R 659.54
GAMW10 658.63
GAMW08 659.68
GAMW72 658.71
GAMW66B 657.75
GAMW65B 658.15
GAMW16R 659.45
GAMW17 659.76
GAMW56 659.67
GAMW34 658.97
MW-5S 658.29
GAMW15 659.55
GAMW09 660.58
GAMW27 658.34
MW-2S 659.15
GAMW06 659.37
GAMW07 659.71
GAMW35B 659.31
GAMW58 658.27
GAMW18 661.2
GAMW63B 661.42
GAMW26 658.87
GAMW57 658.77
GAMW60 658.52
GAMW64B 661.33
GAMW20 658.54
GAMW77 659.44
GAMW59 658.80
GAMW44 658.77
GAMW25 659.52
GAMW51 658.72
GAMW04 662.32
SW-10 660.95*
GAMW24 659.55
GAMW78 659.42
GAMW05 658.99
MW-10S 659.68
GAMW43 658.79
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FINAL SETTLING BASIN
INTAKE SETTLING BASIN
METAL CLEANING WASTE BASIN
MATERIAL STORAGE RUNOFF BASIN
RETIRED WASTE DISPOSAL BASIN
DRYING AREA
LANDFILL RUNOFF POND
LANDFILL LEACHATE POND
PHASE I
PHASE II
PHASE III
PHASE IV
PHASE V
PHASE VI
PHASE VII
PHASE VIII
MW-9S 655.82
GAMW46 655.93
MW-8S 655.4
GAMW43 655.23
MW-7S 657.02
GAMW49 657.14
MW-12S 657.35
MW-11S 657.53
MW-3S 657.67
MW-4S 657.73
SW-4 661.73*
GAMW52 657.84
GAMW53 658.04
GAMW54 658.5
GAMW55R 658.59
GAMW56 658.61
GAMW57 657.39
GAMW58 657.26
GAMW59 657.78
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GAMW61 659.49
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GAMW67B 656.99
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GAMW77 657.52
GAMW78 657.58
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GAMW10 658.04
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GAMW20 658.61
GAMW24 658.64
GAMW25 659.04
GAMW26 658.68
GAMW27 658.1
GAMW31 657.64
GAMW32 657.73
GAMW34 657.96
GAMW35B 658.23
GAMW43 657.57
GAMW44 657.47
GAMW51 657.71
MW-1S 659.73
MW-2S 658.1
MW-5S 658.01
MW-10S 658.78
MW-13S 657.73
GAPIEZ07 657.73
SW-10 659.27*
Staff Gauge Bridge 656.63*
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BEFORE THE UNITED STATES DEPARTMENT OF ENERGY

Federal Power Act Section 202(c) Emergency Order: Midcontinent Independent System Operator and Northern Indiana Public Service Company LLC	)))))	Order No. 202-26-19
Federal Power Act Section 202(c) Emergency Order: Midcontinent Independent System Operator and CenterPoint Energy Indiana South	))))	Order No. 202-26-20

Exhibit to
Motion to Intervene and Request for Rehearing and Stay of
Public Interest Organizations

Exhibit 148
Culley 2024 Groundwater Monitoring Report

HALEY ALDRICH

www.haleyaldrich.com

ANNUAL GROUNDWATER MONITORING AND CORRECTIVE ACTION REPORT
EAST ASH POND
F.B. CULLEY GENERATING STATION
WARRICK COUNTY, INDIANA

by
Haley & Aldrich, Inc.
Greenville, South Carolina

for
Southern Indiana Gas and Electric Company
Evansville, Indiana

File No. 129420
January 2025

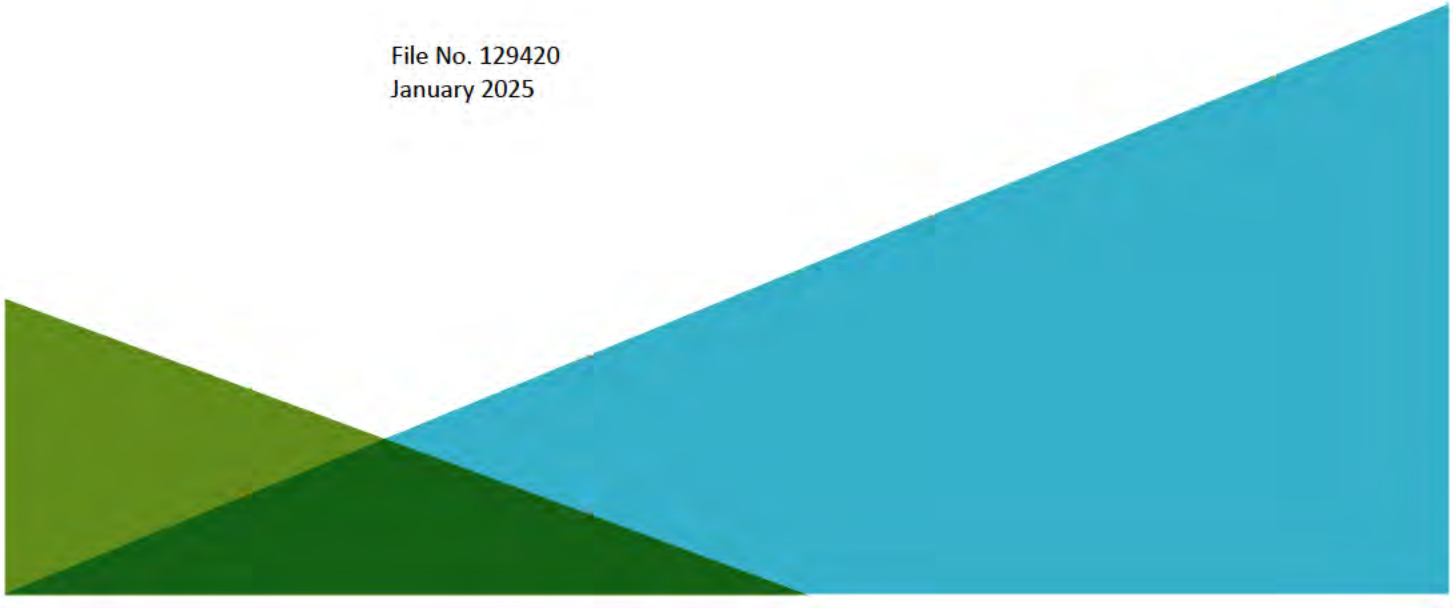


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1. Annual Groundwater Monitoring Report Summary

1.1 CODE OF FEDERAL REGULATIONS TITLE 40 (40 CFR) § 257.90(e)(6) SUMMARY

A section at the beginning of the annual report that provides an overview of the current status of groundwater monitoring and corrective action programs for the [coal combustion residual] CCR unit. At a minimum, the summary must specify all of the following.

1.1.1 40 CFR § 257.90(e)(6)(i) – Status of Monitoring Program at Start of Reporting Period

At the start of the current annual reporting period, whether the CCR unit was operating under the detection monitoring program in § 257.94 or the assessment monitoring program in § 257.95.

At the start of the current annual reporting period (1 January 2024), the East Ash Pond (EAP) at F.B. Culley Generating Station was operating under an assessment monitoring program in compliance with 40 CFR § 257.95.

1.1.2 40 CFR § 257.90(e)(6)(ii) – Status of Monitoring Program at End of Reporting Period

At the end of the current annual reporting period, whether the CCR unit was operating under the detection monitoring program in § 257.94 or the assessment monitoring program in § 257.95.

At the end of the current annual reporting period (31 December 2024), the EAP was operating under an assessment monitoring program in compliance with 40 CFR § 257.95.

1.1.3 40 CFR § 257.90(e)(6)(iii) – Statistically Significant Increases

If it was determined that there was a statistically significant increase over background for one or more constituents listed in appendix III to this part pursuant to § 257.94(e).

1.1.3.1 40 CFR § 257.90(e)(6)(iii)(A)

Identify those constituents listed in appendix III to this part and the names of the monitoring wells associated with such an increase.

The EAP was operating under an assessment monitoring program throughout 2024; therefore, no statistical evaluations were conducted on Appendix III constituents in 2024.

1.1.3.2 40 CFR § 257.90(e)(6)(iii)(B)

Provide the date when the assessment monitoring program was initiated for the CCR unit.

An assessment monitoring program was established on 15 August 2018 for the EAP to meet the requirements of 40 CFR § 257.95. The EAP has remained in assessment monitoring since that time.

1.1.4 40 CFR § 257.90(e)(6)(iv) – Statistically Significant Levels

If it was determined that there was a statistically significant level above the groundwater protection standard for one or more constituents listed in appendix IV to this part pursuant to § 257.95(g) include all of the following.

1.1.4.1 40 CFR § 257.90(e)(6)(iv)(A) – Statistically Significant Level Constituents

Identify those constituents listed in appendix IV to this part and the names of the monitoring wells associated with such an increase.

Statistical analyses of Appendix IV constituents were completed in 2024 following the November 2023 and May 2024 semiannual assessment monitoring events as described in 40 CFR § 257.93(h)(2) and statistically significant levels (SSLs) of molybdenum were identified downgradient of the EAP at monitoring well CCR-AP-5. A summary of statistical analysis is provided in Appendix A.

1.1.4.2 40 CFR § 257.90(e)(6)(iv)(B) – Initiation of the Assessment of Corrective Measures

Provide the date when the assessment of corrective measures was initiated for the CCR unit.

Assessment of corrective measures was initiated on 15 May 2019 for the EAP.

1.1.4.3 40 CFR § 257.90(e)(6)(iv)(C) – Assessment of Corrective Measures Public Meeting

Provide the date when the public meeting was held for the assessment of corrective measures for the CCR unit.

The public was given the opportunity to comment on the assessment of corrective measures prepared for the EAP during a public meeting held on 18 October 2021.

1.1.4.4 40 CFR § 257.90(e)(6)(iv)(D) – Completion of the Assessment of Corrective Measures

Provide the date when the assessment of corrective measures was completed for the CCR unit.

The assessment of corrective measures was completed on 13 September 2019 and placed into the facility's Operating Record, posted to the publicly available website, and the notification was sent to the state agency.

1.1.5 40 CFR § 257.90(e)(6)(v) – Selection of Remedy

Whether a remedy was selected pursuant to § 257.97 during the current annual reporting period, and if so, the date of remedy selection.

The selection of remedy required under 40 CFR § 257.97 was ongoing in 2024 for molybdenum at the EAP. A summary of actions completed associated with selection of remedy are provided in the March 2024 and September 2024 Semi-Annual Remedy Selection Progress Reports.

Information collected through prior field investigations is being used to evaluate and design an alternative remedy, as well as update the groundwater conceptual model for the EAP.

1.1.6 40 CFR § 257.90(e)(6)(vi) – Remedial Activities

Whether remedial activities were initiated or are ongoing pursuant to § 257.98 during the current annual reporting period.

Closure of the EAP by source removal was initiated in November 2023 and is anticipated to be part of the remedy; however, the selection of remedy has not yet been completed due to ongoing work to analyze remedial activities for site suitability. Remedial activities were not initiated in 2024; therefore, no demonstration or certification is applicable for this unit.

1.2 40 CFR § 257.90(a)

Except as provided for in § 257.100 for inactive CCR surface impoundments, all CCR landfills, CCR surface impoundments, and lateral expansions of CCR units are subject to the groundwater monitoring and corrective action requirements under § 257.90 through § 257.98.

The EAP is subject to the groundwater monitoring and corrective action requirements described under 40 CFR § 257.90 through 40 CFR § 257.98 (the Rule). The remainder of this document addresses the specific requirements for the Owner/Operator to prepare an Annual Groundwater Monitoring and Corrective Action Report per 40 CFR § 257.90(e).

1.3 40 CFR § 257.90(e) – SUMMARY

Annual groundwater monitoring and corrective action report. For existing CCR landfills and existing CCR surface impoundments, no later than January 31, 2018, and annually thereafter, the owner or operator must prepare an annual groundwater monitoring and corrective action report. For new CCR landfills, new CCR surface impoundments, and all lateral expansions of CCR units, the owner or operator must prepare the initial annual groundwater monitoring and corrective action report no later than January 31 of the year following the calendar year a groundwater monitoring system has been established for such CCR unit as required by this subpart, and annually thereafter. For the preceding calendar year, the annual report must document the status of the groundwater monitoring and corrective action program for the CCR unit, summarize key actions completed, describe any problems encountered, discuss actions to resolve the problems, and project key activities for the upcoming year. For purposes of this section, the owner or operator has prepared the annual report when the report is placed in the facility's operating record as required by § 257.105(h)(1).

This *2024 Annual Groundwater Monitoring and Corrective Action Report* documents the activities completed in 2024 for the EAP as required by the Rule. Semiannual groundwater sampling and analysis was conducted per the requirements described in 40 CFR § 257.93, and the status of the groundwater monitoring program described in 40 CFR § 257.95 is provided in this report. Field forms for the groundwater sampling events are provided in Appendix B. Laboratory analytical reports are provided in Appendix C.

1.3.1 Status of the Groundwater Monitoring Program

Following completion of the Assessment of Corrective Measures in September 2019, a semiannual groundwater sampling plan was implemented to satisfy requirements of 40 CFR § 257.95(b) and § 257.95(d)(1). During the 2024 reporting period, groundwater samples were collected from the monitoring wells at the EAP from 7 to 13 May 2024 and again from 13 to 15 November 2024. Groundwater monitoring well location and construction details for the existing monitoring well network are summarized in Table 1.

Statistical analysis of Appendix IV constituents collected during the November 2023 sampling event was completed on 25 April 2024, within 90-days following the receipt of laboratory analytical results on 26 January 2024, per the requirements of 40 CFR § 257.93(h)(2). Statistical analysis of Appendix IV constituents collected during the May 2024 sampling event was completed on 17 September 2024, within 90-days following the receipt of laboratory analytical results on 19 June 2024, per the requirements of 40 CFR § 257.93(h)(2). Statistical analysis of Appendix IV constituents collected during the November 2024 sampling event will be completed within the 2025 reporting period and will be included in the 2025 annual report.

Statistical analysis of Appendix IV constituents during the 2024 reporting period determined that SSLs of molybdenum continue to be observed downgradient of the EAP, which is consistent with previous findings. The selection of remedy process required under 40 CFR § 257.97 was still on-going, as discussed in Section 1.1.5, during the 2024 reporting period.

1.3.2 Key Actions Completed

The following key actions were completed in 2024:

- 3 January 2024 – Removed pressure transducers at the EAP after encountering technical difficulties with data collection. Groundwater level data collected over deployment period are presented in Appendix D.
- 30 January 2024 – Prepared *2023 Annual Groundwater Monitoring and Corrective Action Report* (2023 Annual Report) including:
  - Pursuant to 40 CFR § 257.105(h)(1), the 2023 Annual Report was placed in the facility's operating record on 30 January 2024;
  - Pursuant to 40 CFR § 257.106(h)(1), the notification was sent to the relevant State Director and/or Tribal authority within 30 days of the 2023 Annual Report being placed in the facility's operating record [40 CFR § 257.106(d)];
  - Pursuant to 40 CFR § 257.107(h)(1), the 2023 Annual Report was posted to the CCR Website within 30 days of the 2023 Annual Report being placed in the facility's operating record [40 CFR § 257.107(d) and § 257.107(h)(1)];
- 25 April 2024 – Completed statistical analysis of November 2023 assessment monitoring laboratory analytical results received on 26 January 2024.
- 15 March 2024 – Prepared semiannual selection of remedy progress report in accordance with 40 CFR § 257.97(a) to document progress. The semiannual progress report was placed in the operating record as required by 40 CFR § 257.105(h)(12) and posted on the facility's publicly available website as required by 40 CFR § 257.107(h)(9).
- 2 to 4 May 2024 – Completed routine maintenance of monitoring well network including re-development of select wells to address observations of elevated turbidity.

- 6 May 2024 – Static water level measurements were collected in a synoptic gaging at the beginning of the May 2024 sampling event and again immediately prior to collecting each sample to evaluate groundwater flow direction and rate per the requirements of 40 CFR § 257.93(c).
- 23 to 25 May 2023 – Collected groundwater samples from monitoring wells at the EAP for laboratory analysis in accordance with 40 CFR § 257.95.
- 11 June 2024 – Installed pressure transducers in select monitoring wells around the EAP to temporarily monitor groundwater fluctuations related to construction dewatering. Groundwater level data is included in Appendix D.
- 11 September 2024 – Prepared semiannual selection of remedy progress report in accordance with 40 CFR § 257.97(a) to document progress. The semiannual progress report was placed in the operating record as required by 40 CFR § 257.105(h)(12) and posted on the facility's publicly available website as required by 40 CFR § 257.107(h)(9).
- 17 September 2024 – Completed statistical analysis of May 2024 assessment monitoring laboratory analytical results received on 19 June 2024.
- 11 November 2024 – Static water level measurements were collected in a synoptic gaging at the beginning of the November 2024 sampling event and again immediately prior to collecting each sample to evaluate groundwater flow direction and rate per the requirements of 40 CFR § 257.93(c).
- 13 November 2024 – Removed pressure transducers from monitoring wells at the EAP. Groundwater level data collected over deployment period are presented in Appendix D.
- 13 to 15 November 2024 – Collected groundwater samples from monitoring wells at the EAP for laboratory analysis in accordance with 40 CFR § 257.95.

1.3.3 Problems Encountered

Problems encountered during the November 2024 sampling events include:

- Prior to the November 2024 sampling event, monitoring well CCR-AP-5I was damaged during construction activities on site. The monitoring well was inaccessible for the November 2024 synoptic water level gauging.
- Monitoring well CCR-AP-6 was determined to be dry during the November 2024 sampling event and a sample could not be collected.
- Monitoring wells CCR-AP-3, CCR-AP-8 and CCR-AP-8I were temporarily inaccessible during the November 2024 sampling event due to on-site construction activities and health and safety concerns related to pond closure.

1.3.4 Actions to Resolve Problems

Confirmation samples were collected on 22 December 2023 at CCR-AP-1R for radium analysis following the November 2023 sampling event to verify initial results obtained. Confirmation sample results remained elevated, and results were included in the November 2023 statistical analysis and are provided in Table 2. Radium results remained slightly elevated at CCR-AP-1R during the May 2024 sampling event and have returned to normal baseline as of the November 2024 sampling event. Radium will continue to be monitored closely at monitoring well CCR-AP-1R.

Monitoring well CCR-AP-6 was observed to be dry as a result of construction dewatering efforts associated with the ongoing EAP closure-by-removal. Water levels are expected to recover following the termination of dewatering activities, and therefore, no action is required at this time.

Monitoring well CCR-AP-5I was assessed for damage by downhole camera and verified to be intact below the ground surface, with damage being limited to the surface finishing. The monitoring well was re-developed and sampled on 19 December 2024, and surface finishing was repaired by a licensed driller on 23 December 2024.

Monitoring wells CCR-AP-8, CCR-AP-8I, and CCR-AP-3 locations were inaccessible during the November 2024 sampling event due to obstructions related to EAP closure activities coupled with health and safety concerns. Location CCR-AP-8I was able to be accessed and sampled on 19 December 2024. Efforts to complete sampling at monitoring well locations CCR-AP-3 and CCR-AP-8 are still ongoing at the close of the 2024 reporting period, and results will be included in the 2025 annual report.

1.3.5 Project Key Activities for Upcoming Year

Key activities to be completed in 2025 include the following:

- Continue semiannual groundwater monitoring in accordance with 40 CFR § 257.95.
- Complete statistical analyses of the semiannual groundwater sampling results within 90-days of sampling and analysis as required by 40 CFR § 257.93(h)(2).
- Select a remedy that, at a minimum, meets the standards outlined in 40 CFR § 257.97(b) and considers the evaluation factors in 40 CFR § 257.97(c).
- As part of the selected remedy the Southern Indiana Gas and Electric Company will develop a schedule for implementing and completing remedial activities as defined in 40 CFR § 257.97(d).
- Prepare semiannual and annual progress reports, as necessary, describing the progress in selecting and designing the remedy as outlined in 40 CFR § 257.97(a).
- Following remedy selection initiate remedial activities and implement the corrective action groundwater monitoring program as outlined in 40 CFR § 257.98.

1.4 40 CFR § 257.90(e) – INFORMATION

At a minimum, the annual groundwater monitoring and corrective action report must contain the following information, to the extent available.

1.4.1 40 CFR § 257.90(e)(1)

A map, aerial image, or diagram showing the CCR unit and all background (or upgradient) and downgradient monitoring wells, to include the well identification numbers, that are part of the groundwater monitoring program for the CCR unit.

As required by 40 CFR § 257.90(e)(1), a map showing the location of the EAP and associated upgradient, downgradient and nature and extent monitoring wells is presented on Figure 1. Groundwater elevation contours for the May 2024 sampling event are presented on Figure 2. Groundwater elevation contours for the November 2024 sampling event are presented on Figure 3.

1.4.2 40 CFR § 257.90(e)(2)

Identification of any monitoring wells that were installed or decommissioned during the preceding year, along with a narrative description of why those actions were taken.

No monitoring wells were installed or decommissioned during the 2024 reporting period.

1.4.3 40 CFR § 257.90(e)(3)

In addition to all the monitoring data obtained under § 257.90 through § 257.98, a summary including the number of groundwater samples that were collected for analysis for each background and downgradient well, the dates the samples were collected, and whether the sample was required by the detection monitoring or assessment monitoring programs.

In accordance with 40 CFR § 257.95(b) and § 257.95(d)(1), two independent samples from each background and downgradient monitoring well were collected and analyzed. A summary table including the sample names, dates of sample collection, reason for sample collection (detection or assessment), and monitoring data obtained for the groundwater monitoring program for the EAP is presented in Table 2.

1.4.4 40 CFR § 257.90(e)(4)

A narrative discussion of any transition between monitoring programs (e.g., the date and circumstances for transitioning from detection monitoring to assessment monitoring in addition to identifying the constituent(s) detected at a statistically significant increase over background levels).

Statistical analysis of Appendix IV constituents was completed for the November 2023 and May 2024 sampling events as described in 40 CFR § 257.93(h)(2) and demonstrate that molybdenum remains the only constituent at a SSL to be observed downgradient of the EAP, which is consistent with previous results. As a result, the monitoring program did not change, and the EAP remained in assessment monitoring throughout 2024. Statistical analysis for the November 2024 sampling event is ongoing and will be completed within 90 days after sampling and analysis to determine if a statistically significant increase over background has occurred.

1.4.5 40 CFR § 257.90(e)(5)

Other information required to be included in the annual report as specified in § 257.90 through § 257.98.

Other information including development of groundwater protection standards, recording of groundwater monitoring results in the operating record, and an evaluation of alternate sources was discussed in prior annual reports.

TABLES

TABLE 1
GROUNDWATER MONITORING WELL LOCATION AND CONSTRUCTION DETAILS
EAST ASH POND
F.B. CULLEY GENERATING STATION
WARRICK COUNTY, INDIANA

Well ID	Date Installed	Easting	Northing	Top of Pad Elevation (ft NAVD88)	Top of Riser Elevation (ft NAVD88)	Surface Grout (ft bgs)	Bentonite (ft bgs)	Sand Pack (ft bgs)	Screen Zone (ft bgs)	Top of Screen (ft NAVD88)	Bottom of Screen (ft NAVD88)	Screen Length (ft)	Well Radius (in)	Status
Background Wells														
CCR-AP-1R	March 2016	2883429.87	969939.89	438.20	441.64	1.0 - 51.0	51.0 - 53.0	53.0 - 65.0	55.0 - 65.0	383.5	373.5	10	2	Active
CCR-AP-7	March 2016	2883090.62	970774.82	429.50	432.41	1.0 - 16.0	16.0 - 18.0	18.0 - 30.0	20.0 - 30.0	409.5	399.5	10	2	Active
CCR-AP-9	February 2017	2883998.88	969768.96	445.58	448.53	1.0 - 56.0	56.0 - 58.0	58.0 - 70.0	60.0 - 70.0	385.6	375.6	10	2	Active
East Ash Pond Wells														
CCR-AP-2	December 2015	2884168.88	969117.46	394.40	394.02	1.0 - 30.5	30.5 - 32.5	32.5 - 45.0	36.0 - 46.0	358.4	348.4	10	2	Active
CCR-AP-3	December 2015	2883542.17	969007.88	395.00	394.55	1.0 - 31.0	31.0 - 32.8	32.8 - 45.0	35.0 - 45.0	360.0	350.0	10	2	Active
CCR-AP-4	December 2015	2883281.67	969641.72	395.40	394.98	1.0 - 19.7	19.7 - 22.5	23.0 - 35.5	25.5 - 35.5	369.9	359.9	10	2	Active
CCR-AP-5	December 2015	2884016.86	969379.74	394.90	394.38	1.0 - 28.6	28.6 - 30.6	30.6 - 44.0	34.0 - 44.0	360.9	350.9	10	2	Active
CCR-AP-5I	January 2019	2884022.43	969377.35	394.90	394.59	1.0 - 71.2	71.2 - 73.0	73.0 - 86.0	75.3 - 85.3	319.6	309.3	10	2	Active
CCR-AP-6	March 2016	2883285.02	969122.07	397.10	396.75	1.0 - 31.5	31.5 - 33.0	33.5 - 45.5	35.5 - 45.5	361.6	351.6	10	2	Active
CCR-AP-6I	November 2018	2883289.37	969119.68	397.20	396.88	1.0 - 60.7	60.7 - 62.7	62.7 - 64.7	64.7 - 74.7	332.5	322.2	10	2	Active
CCR-AP-8	February 2017	2883846.86	969045.93	394.00	393.68	1.0 - 31.5	31.5 - 33.0	33.5 - 45.5	35.5 - 45.5	358.5	348.5	10	2	Active
CCR-AP-8I	November 2018	2883853.30	969046.82	393.80	393.46	1.0 - 53.7	53.7 - 56.7	56.7 - 69.0	58.7 - 68.7	334.8	324.8	10	2	Active
CCR-AP-10	January 2019	2883772.84	969536.11	--	402.40	1.0 - 36.5	36.5 - 38.0	38.0 - 50.5	40.2 - 50.2	362.2	352.2	10	2	Abandoned[1]
CCR-AP-11	January 2019	2884485.51	969352.71	--	385.10	1.0 - 40.0	40.0 - 41.8	41.8 - 54.7	44.4 - 54.4	340.7	330.7	10	2	Active
2022 Aquifer Performance Test Wells														
CCR-PW-1	July 2022	2883797.21	969046.55	394.80	394.40	0.0 - 37.0	37.0 - 43.0	43.0 - 70.0	50.0 - 70.0	344.8	324.8	20	16	N/A
CCR-OW-1	June 2022	2883701.02	969027.17	395.00	394.62	0.0 - 1.5	1.5 - 4.4	34.0 - 48.0	36.0 - 46.0	359.0	349.0	10	2	N/A
CCR-OW-1I	June 2022	2883704.95	969027.17	394.90	394.44	0.0 - 1.5	1.5 - 58.0	58.0 - 70.4	60.0 - 70.0	334.9	324.9	10	2	N/A
CCR-OW-2	June 2022	2883773.63	969041.30	394.40	393.97	0.0 - 1.5	1.5 - 33.0	33.0 - 46.0	34.0 - 44.0	360.4	350.4	10	2	N/A
CCR-OW-2I	July 2022	2883777.40	969042.58	394.20	394.08	0.0 - 1.5	1.5 - 54.0	54.0 - 68.0	56.0 - 66.0	338.2	328.2	10	2	N/A
CCR-OW-3	June 2022	2883807.86	969047.93	393.90	393.69	0.0 - 1.5	1.5 - 34.0	34.0 - 47.0	35.0 - 45.0	358.9	348.9	10	2	N/A
CCR-OW-3I	June 2022	2883811.66	969048.75	394.00	393.61	0.0 - 1.5	1.5 - 57.0	57.0 - 70.0	58.0 - 68.0	336.0	326.0	10	2	N/A
CCR-OW-4	June 2022	2883872.53	969059.36	394.10	393.77	0.0 - 1.5	1.5 - 34.0	34.0 - 47.0	36.0 - 46.0	358.1	348.1	10	2	N/A
CCR-OW-4I	June 2022	2883876.12	969059.67	394.10	393.86	0.0 - 1.5	1.5 - 55.0	55.0 - 69.0	58.0 - 68.0	336.1	326.1	10	2	N/A
CCR-OW-5I	July 2022	2883799.69	969110.80	392.00	391.65	0.0 - 1.5	1.5 - 51.0	51.0 - 63.0	58.0 - 63.0	334.0	329.0	5	2	N/A

Notes and Abbreviations:

-- = was not surveyed
bgs = below ground surface
ft = feet
in = inches
N/A = not available
NAVD88 = North American Vertical Datum of 1988
[1] *Monitoring well CCR-AP-10 abandoned January 2022*

TABLE 2
SUMMARY OF GROUNDWATER QUALITY DATA - DECEMBER 2023, MAY AND NOVEMBER 2024
EAST ASH POND
F.B. CULLEY GENERATING STATION
WARRICK COUNTY, INDIANA

Location Group	Action Level	Background						
Location Name	GWPS	CCR-AP-1R	CCR-AP-1R	CCR-AP-1R	CCR-AP-7	CCR-AP-7	CCR-AP-9	CCR-AP-9
Sample Name		CCR-AP-1R-20231222	CCR-AP-1R-20240508	CCR-AP-1R-20241114	CCR-AP-7-20240510	CCR-AP-7-20241115	CCR-AP-9-20240508	CCR-AP-9-20241114
Sample Date		12/22/2023	05/08/2024	11/14/2024	05/10/2024	11/15/2024	05/08/2024	11/14/2024
Lab Sample ID		180-167383-1	180-173844-1	180-182961-1	180-173881-1	180-182934-5	180-173844-8	180-182961-6
Detection Monitoring - EPA Appendix III Constituents (mg/L)								
Boron, Total	4	-	**0.75**	**0.79**	0.1 U	0.1 U	**0.39**	**0.41**
Calcium, Total	NA	-	**61**	**55**	**120**	**120**	**130**	**120**
Chloride	NA	-	**32**	**28**	**43**	**43**	**9.6**	**2.5**
Fluoride	4	-	**0.25 J**	**0.4**	**0.31**	**0.41**	**0.3**	**0.15 J**
pH (lab) (pH units)	NA	-	**7.4 J**	**7.4 J**	**7.2 J**	**7.1 J**	**7.2 J**	**7.2 J**
Sulfate	NA	-	**100**	**160**	**110**	**86**	**130**	2.5 U
Total Dissolved Solids (TDS)	NA	-	**480 J**	**700**	**630**	**600**	**2400 J**	**710**
Assessment Monitoring - EPA Appendix IV Constituents (mg/L)								
Antimony, Total	0.02	-	**0.00073 J**	**0.001 J**	0.002 U	0.002 U	0.002 U	0.002 U
Arsenic, Total	0.038	-	**0.0059**	**0.011**	**0.0009 J**	**0.0042 J**	**0.0039 J**	**0.0022 J**
Barium, Total	2	-	**0.35**	**0.2**	**0.1**	**0.12**	**0.17**	**0.16**
Beryllium, Total	0.01	-	**0.00095 J**	**0.0015**	0.001 U	0.001 U	0.001 U	0.001 U
Cadmium, Total	0.01	-	0.001 U	**0.00034 J**	0.001 U	**0.000097 J**	0.001 U	**0.000077 J**
Chromium, Total	0.16	-	**0.021**	**0.034**	0.005 U	0.005 U	**0.01**	**0.0065**
Cobalt, Total	0.081	-	**0.013**	**0.018**	**0.0003 J**	**0.00036 J**	**0.0061**	**0.0025**
Fluoride	4	-	**0.25 J**	**0.4**	**0.31**	**0.41**	**0.3**	**0.15 J**
Lead, Total	0.094	-	**0.013**	**0.018**	0.001 U	0.001 U	**0.0047**	**0.0024**
Lithium, Total	0.23	-	**0.036**	**0.067**	**0.011**	**0.0098**	**0.038**	**0.035**
Mercury, Total	0.002	-	0.0002 U	0.0002 U	0.0002 U	**0.00032 J-**	0.0002 U	0.0002 U
Molybdenum, Total	0.1	-	**0.0053**	**0.0056**	**0.0013 J**	**0.0011 J**	**0.0017 J**	**0.0017 J**
Selenium, Total	0.05	-	0.005 U	**0.0013 J**	0.005 U	0.005 U	0.005 U	0.005 U
Thallium, Total	0.01	-	0.001 U	**0.00092 J+**	0.001 U	0.001 U	0.001 U	0.001 U
Radiological (pCi/L)								
Radium-226	NA	**5.36 ± 0.809**	**2.32 ± 0.528**	**1.1 J ± 0.397**	**0.337 ± 0.148**	**0.496 ± 0.169**	**3.35 ± 0.626**	**2.63 ± 0.635**
Radium-228	NA	**9.08 ± 2.49**	**4.98 ± 1.34**	2.28 U ± 1.75	0.529 U ± 0.367	0.358 U ± 0.507	**2.98 J ± 0.969**	3.7 U ± 1.55
Radium-226 & 228	12.6	**14.4 ± 2.62**	**7.3 ± 1.44**	3.38 UJ ± 1.79	**0.866 J ± 0.396**	**0.854 J ± 0.534**	**6.33 J ± 1.15**	**6.33 ± 1.68**
Field Parameters								
Temperature (Deg C)	NA	**12.89**	**19.29**	**15.67**	**17.68**	**15.91**	**18.21**	**17.17**
Dissolved Oxygen, Field (mg/L)	NA	**11.72**	**5.36**	**9.7**	**0.05**	**0.22**	**4.44**	**5.01**
Conductivity, Field (mS/cm)	NA	**1.59**	**0.64758**	**0.15311**	**0.6171**	**1.0125**	**1.165**	**0.74**
Oxidation Reduction Potential (ORP), Field (mv)	NA	**-45**	**103**	**9.7**	**-111.4**	**-101.6**	**65.6**	**313.6**
Turbidity, Field (NTU)	NA	**208**	**351**	**1792**	**28.94**	**5.57**	**464**	**764.02**
pH, Field (pH units)	NA	**6.76**	**7.5**	**5.26**	**7.26**	**7.16**	**6.98**	**8.15**

Notes and Abbreviations:

CCR: Coal Combustion Residuals
mg/L: milligram per liter
pCi/L: picoCurie per liter
Deg C: Degrees Celsius
mS/cm: milliSiemen per centimeter
mv: millivolts
NTU: Nephelometric Turbidity Units
NA: not available
U: not detected, value is the laboratory reporting limit
U: activity level below the Minimum Detectable Concentration (Radiological)
J: value is estimated
J+: value is estimated with a potential high bias
USEPA: United States Environmental Protection Agency
GWPS: Ground Water Protection Standard

*Results in **bold** are detected*
Shaded values indicate a GWPS exceedance

USEPA. 2020. Final Rule: Disposal of Coal Combustion Residuals from Electric Utilities. December 14. 40 CFR Part 257.
https://www.epa.gov/coalash/coal-ash-rule

TABLE 2
SUMMARY OF GROUNDWATER QUALITY DATA - DECEMBER 2023, MAY AND NOVEM
EAST ASH POND
F.B. CULLEY GENERATING STATION
WARRICK COUNTY, INDIANA

Location Group	Action Level	Downgradient									
Location Name	GWPS	CCR-AP-2	CCR-AP-2	CCR-AP-3	CCR-AP-4	CCR-AP-4	CCR-AP-5	CCR-AP-5	CCR-AP-5	CCR-AP-5	CCR-AP-5I
Sample Name		CCR-AP-2-20240508	CCR-AP-2-20241114	CCR-AP-3-20240507	CCR-AP-4-20240508	CCR-AP-4R-20241114	CCR-AP-5-20240513	DUP 1-20240513	CCR-AP-5-20241114	DUP 1-20241114	CCR-AP-5I-20240513
Sample Date		05/08/2024	11/14/2024	05/07/2024	05/08/2024	11/14/2024	05/13/2024	05/13/2024	11/14/2024	11/14/2024	05/13/2024
Lab Sample ID		180-173844-2	180-182961-2	180-173844-3	180-173844-4	180-182961-3	180-174082-1	180-174082-3	180-182961-4	180-182961-8	180-174082-2
Detection Monitoring - EPA Appendix III Constituents (mg/L)											
Boron, Total	4	**8.1**	**9.2**	**0.28**	**1.1**	**0.58**	**17**	**17**	**11**	**12**	**12**
Calcium, Total	NA	**230**	**230**	**150**	**130**	**140**	**260**	**260**	**200**	**200**	**270**
Chloride	NA	**250**	**190**	**27**	**32**	**26**	**150**	**160**	**51**	**54**	**280**
Fluoride	4	**0.27**	**0.24**	**0.35**	**0.61**	**0.89**	**0.84**	**0.83**	**1.7**	**1.8**	**0.32**
pH (lab) (pH units)	NA	**6.7 J**	**6.8 J**	**7.1 J**	**7 J**	**6.9 J**	**7.1 J**	**7.1 J**	**7.7 J**	**7.6 J**	**6.9 J**
Sulfate	NA	**340**	**420**	**32**	**73**	**12**	**620**	**640**	**450**	**450**	**640**
Total Dissolved Solids (TDS)	NA	**1500 J**	**1500**	**730 J**	**690 J**	**740**	**1600 J**	**1700**	**1200**	**1200**	**1800 J**
Assessment Monitoring - EPA Appendix IV Constituents (mg/L)											
Antimony, Total	0.02	**0.0011 J**	0.002 U	0.002 U	0.002 U	**0.00096 J**	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U
Arsenic, Total	0.038	**0.025**	**0.0021 J**	**0.051**	**0.027**	**0.089**	**0.00085 J**	0.005 U	**0.0013 J**	**0.0015 J**	0.005 U
Barium, Total	2	**0.83**	**0.045**	**0.38**	**0.53**	**0.52**	**0.046**	**0.045**	**0.053**	**0.051**	**0.027**
Beryllium, Total	0.01	**0.0037**	0.001 U	0.001 U	0.001 U	**0.00099 J**	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U
Cadmium, Total	0.01	**0.003**	**0.00011 J**	0.001 U	0.001 U	**0.00045 J**	0.001 U	0.001 U	**0.0001 J**	**0.000088 J**	0.001 U
Chromium, Total	0.16	**0.11**	**0.0024 J**	**0.0031 J**	0.005 U	**0.027**	**0.002 J**	0.005 U	0.005 U	0.005 U	0.005 U
Cobalt, Total	0.081	**0.048**	**0.008**	**0.0061**	**0.0028**	**0.014**	**0.0025**	**0.0022**	**0.0023**	**0.0023**	**0.00051 J**
Fluoride	4	**0.27**	**0.24**	**0.35**	**0.61**	**0.89**	**0.84**	**0.83**	**1.7**	**1.8**	**0.32**
Lead, Total	0.094	**0.056**	**0.0013**	**0.00097 J**	0.001 U	**0.019**	**0.00068 J**	0.001 U	0.001 U	0.001 U	0.001 U
Lithium, Total	0.23	**0.085**	**0.0038 J**	**0.0028 J**	**0.0045 J**	**0.02**	**0.056**	**0.058**	**0.08**	**0.083**	**0.035**
Mercury, Total	0.002	**0.00016 J**	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U
Molybdenum, Total	0.1	**0.0065**	0.005 U	**0.0093**	**0.017**	**0.0073**	**0.15**	**0.15**	**0.34**	**0.34**	**0.0026 J**
Selenium, Total	0.05	**0.0027 J**	0.005 U	**0.0016 J**	0.005 U	**0.0018 J**	**0.00095 J**	0.005 U	0.005 U	0.005 U	0.005 U
Thallium, Total	0.01	**0.001**	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U
Radiological (pCi/L)											
Radium-226	NA	**1.65 ± 0.442**	0.401 U ± 0.306	**0.4 ± 0.18**	**0.337 ± 0.17**	0.852 U ± 0.379	**0.424 ± 0.286**	0.182 U ± 0.181	0.158 U ± 0.103	0.212 U ± 0.125	**0.249 ± 0.18**
Radium-228	NA	1.57 U ± 0.852	1.42 U ± 1.51	0.495 U ± 0.461	0.869 U ± 0.646	0.598 U ± 1.24	0.452 U ± 0.509	**0.983 ± 0.583**	-0.153 U ± 0.355	0.46 U ± 0.453	**1.08 ± 0.435**
Radium-226 & 228	12.6	**3.22 J+ ± 0.96**	1.82 U ± 1.54	**0.896 J ± 0.495**	**1.21 J ± 0.668**	1.45 UJ ± 1.3	**0.877 J ± 0.584**	**1.17 J ± 0.61**	0.158 UJ ± 0.37	0.673 UJ ± 0.47	**1.33 ± 0.471**
Field Parameters											
Temperature (Deg C)	NA	**18.11**	**14.14**	**20.93**	**18.22**	**14.31**	**18.31**	**18.31**	**14.45**	**14.45**	**18.21**
Dissolved Oxygen, Field (mg/L)	NA	**4.54**	**9.99**	**5.07**	**4.85**	**3.36**	**4.5**	**4.5**	**1.02**	**1.02**	**2.83**
Conductivity, Field (mS/cm)	NA	**2.201**	**0.07**	**1.582**	**1.261**	**0.07**	**2.281**	**2.281**	**1.233**	**1.233**	**2.641**
Oxidation Reduction Potential (ORP), Field (mv)	NA	**71.6**	**60.6**	**-125.2**	**-120.2**	**209.4**	**300.5**	**300.5**	**-59.6**	**-59.6**	**51.8**
Turbidity, Field (NTU)	NA	**9.503**	**0**	**138**	**30**	**0**	**72**	**72**	**11.21**	**11.21**	**120**
pH, Field (pH units)	NA	**8.97**	**7.32**	**6.84**	**6.83**	**7.95**	**7.11**	**7.11**	**7.08**	**7.08**	**6.72**

Notes and Abbreviations:

CCR: Coal Combustion Residuals
mg/L: milligram per liter
pCi/L: picoCurie per liter
Deg C: Degrees Celsius
mS/cm: milliSiemen per centimeter
mv: millivolts
NTU: Nephelometric Turbidity Units
NA: not available
U: not detected, value is the laboratory reporting limit
U: activity level below the Minimum Detectable Concentration (Radiological)
J: value is estimated
J+: value is estimated with a potential high bias
USEPA: United States Environmental Protection Agency
GWPS: Ground Water Protection Standard

Results in ***bold*** *are detected*
Shaded values indicate a GWPS exceedance

USEPA. 2020. Final Rule: Disposal of Coal Combustion Residuals from Electric Utilities. December 14. 40 CFR Part 257.
https://www.epa.gov/coalash/coal-ash-rule

TABLE 2
SUMMARY OF GROUNDWATER QUALITY DATA - DECEMBER 2023, MAY AND NOVEM
EAST ASH POND
F.B. CULLEY GENERATING STATION
WARRICK COUNTY, INDIANA

Location Group	Action Level	Down-Gradient						
Location Name	GWPS	CCR-AP-6	CCR-AP-6I	CCR-AP-6I	CCR-AP-8	CCR-AP-8I	CCR-AP-11	CCR-AP-11
Sample Name		CCR-AP-6-20240507	CCR-AP-6I-20240507	CCR-AP-6I-20241113	CCR-AP-8-20240510	CCR-AP-8I-20240508	CCR-AP-11-20240510	CCR-AP-11-20241115
Sample Date		05/07/2024	05/07/2024	11/13/2024	05/10/2024	05/08/2024	05/10/2024	11/15/2024
Lab Sample ID		180-173844-5	180-173844-6	180-182961-5	180-173881-2	180-173844-7	180-173881-3	180-182961-7
Detection Monitoring - EPA Appendix III Constituents (mg/L)								
Boron, Total	4	**0.66**	**15**	**0.14**	**0.13**	**33**	**0.3**	**0.45**
Calcium, Total	NA	**110**	**250**	**46**	**140**	**490**	**120**	**140**
Chloride	NA	**36**	**87**	**31**	**25**	**180**	**26**	**29**
Fluoride	4	**0.37**	**0.13**	**0.2**	**0.22**	**0.12 J**	**0.3**	**0.34**
pH (lab) (pH units)	NA	**7.2 J**	**7.4 J**	**7.6 J**	**7.1 J**	**7.3 J**	**6.5 J**	**6.2 J**
Sulfate	NA	**46**	**430**	**140**	**2.7**	**1100**	**450**	**610**
Total Dissolved Solids (TDS)	NA	**530**	**1200 J**	**350**	**770**	**2400 J**	**900**	**1200**
Assessment Monitoring - EPA Appendix IV Constituents (mg/L)								
Antimony, Total	0.02	**0.00082 J**	0.002 U	0.002 U	**0.00064 J**	0.002 U	0.002 U	0.002 U
Arsenic, Total	0.038	**0.057**	**0.0057**	0.005 U	**0.013**	**0.0013 J**	**0.0056**	**0.051**
Barium, Total	2	**0.43**	**0.041**	**0.21**	**0.27**	**0.34**	**0.15**	**0.23**
Beryllium, Total	0.01	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U
Cadmium, Total	0.01	0.001 U	**0.00028 J**	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U
Chromium, Total	0.16	**0.0027 J**	0.005 U	0.005 U	**0.0039 J**	0.005 U	**0.0016 J**	**0.0021 J**
Cobalt, Total	0.081	**0.0034**	**0.00062 J**	**0.00085 J**	**0.0044**	**0.00065 J**	**0.036**	**0.065**
Fluoride	4	**0.37**	**0.13**	**0.2**	**0.22**	**0.12 J**	**0.3**	**0.34**
Lead, Total	0.094	**0.0012**	0.001 U	0.001 U	**0.003**	0.001 U	**0.00059 J**	**0.00051 J**
Lithium, Total	0.23	**0.0057 J**	**0.083**	**0.0049 J**	**0.0039 J**	**0.17**	**0.0048 J**	**0.0043 J**
Mercury, Total	0.002	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U
Molybdenum, Total	0.1	**0.043**	**0.86**	**0.02**	**0.012**	**0.29**	0.005 U	0.005 U
Selenium, Total	0.05	0.005 U	0.005 U	0.005 U	**0.0021 J**	0.005 U	0.005 U	0.005 U
Thallium, Total	0.01	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U
Radiological (pCi/L)								
Radium-226	NA	**0.541 ± 0.233**	0.159 U ± 0.115	0.0927 U ± 0.106	**0.489 ± 0.21**	**0.804 ± 0.228**	**0.292 ± 0.148**	0.243 U ± 0.163
Radium-228	NA	0.169 U ± 0.446	0.536 U ± 0.37	0.844 U ± 0.465	0.589 U ± 0.508	1.15 U ± 0.572	0.562 U ± 0.348	0.965 U ± 0.656
Radium-226 & 228	12.6	0.71 UJ ± 0.503	0.695 UJ ± 0.387	0.937 UJ ± 0.477	**1.08 J ± 0.55**	**1.95 J+ ± 0.616**	**0.854 J+ ± 0.378**	1.21 UJ ± 0.676
Field Parameters								
Temperature (Deg C)	NA	**19.79**	**18.2**	**19.25**	**18.56**	**19.72**	**21.43**	**12.05**
Dissolved Oxygen, Field (mg/L)	NA	**3.65**	**0.15**	**0.2**	**0.25**	**6.7**	**0.36**	**1.63**
Conductivity, Field (mS/cm)	NA	**1.105**	**1.6373**	**0.46525**	**1.429**	**3.0125**	**1.3368**	**1.1029**
Oxidation Reduction Potential (ORP), Field (mv)	NA	**-146.7**	**-78.3**	**-28.6**	**-76.3**	**-140.1**	**-24.8**	**-57.5**
Turbidity, Field (NTU)	NA	**93**	**1.18**	**0**	**140**	**91.67**	**88.4**	**93.11**
pH, Field (pH units)	NA	**7.19**	**7.37**	**7.38**	**6.9**	**5.68**	**6.26**	**6.33**

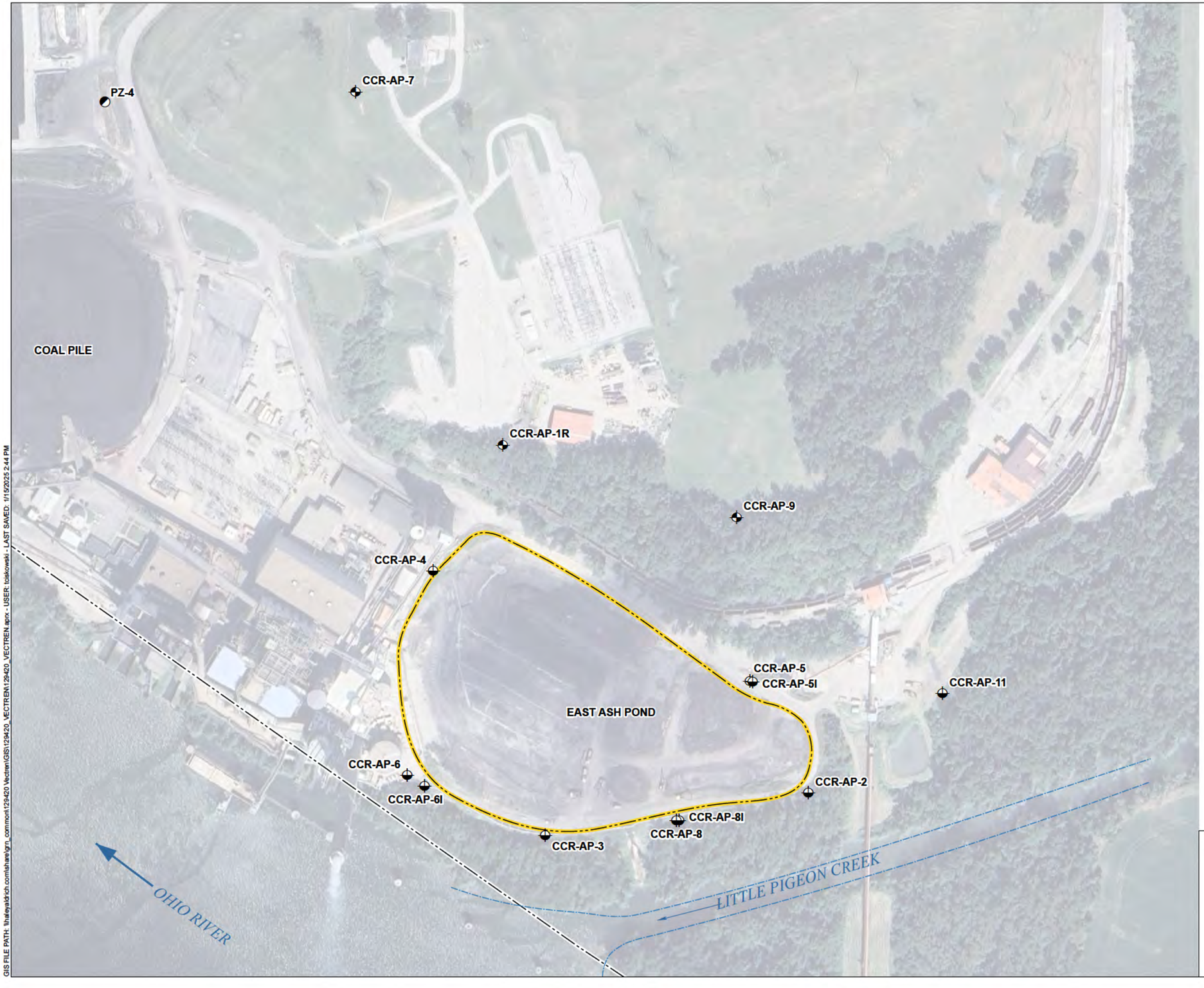
Notes and Abbreviations:

CCR: Coal Combustion Residuals
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pCi/L: picoCurie per liter
Deg C: Degrees Celsius
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mv: millivolts
NTU: Nephelometric Turbidity Units
NA: not available
U: not detected, value is the laboratory reporting limit
U: activity level below the Minimum Detectable Concentration (Radiological)
J: value is estimated
J+: value is estimated with a potential high bias
USEPA: United States Environmental Protection Agency
GWPS: Ground Water Protection Standard

*Results in **bold** are detected*
Shaded values indicate a GWPS exceedance

USEPA. 2020. Final Rule: Disposal of Coal Combustion Residuals from Electric Utilities. December 14. 40 CFR Part 257.
https://www.epa.gov/coalash/coal-ash-rule

FIGURES



LEGEND

- UPGRADIENT MONITORING WELL
- DOWNGRADIENT MONITORING WELL
- PIEZOMETER
- CREEK BOUNDARY
- UNIT BOUNDARY
- APPROXIMATE PROPERTY BOUNDARY

NOTES

1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE.
2. CCR = COAL COMBUSTION RESIDUALS
3. AERIAL IMAGERY SOURCE: GOOGLE, 10 AUGUST 2024

N

0 230 460
SCALE IN FEET

HALEY ALDRICH

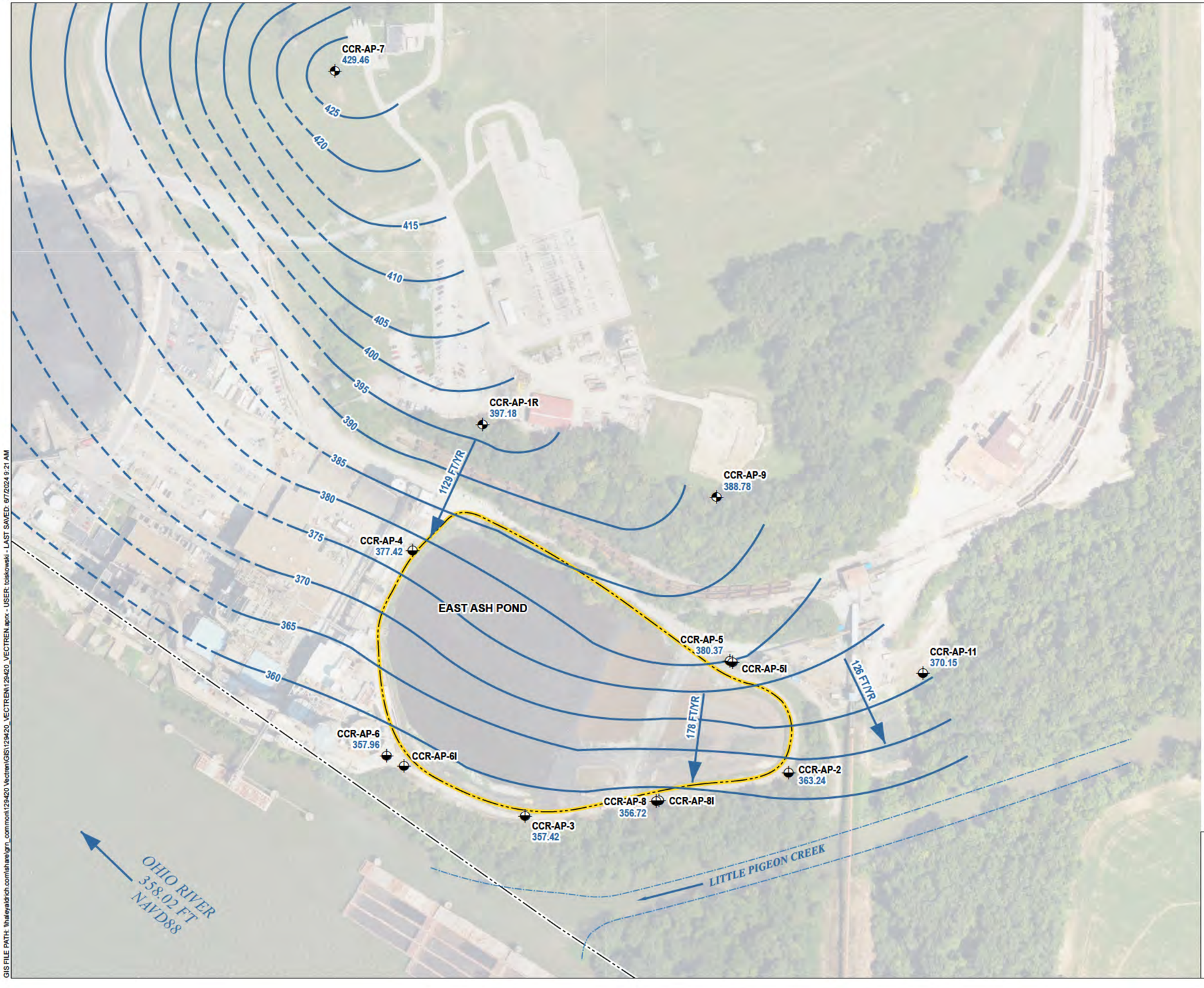
EAST ASH POND
F.B. CULLEY GENERATING STATION
WARRICK COUNTY, INDIANA

GROUNDWATER MONITORING WELL LOCATIONS - EAST ASH POND

JANUARY 2025

FIGURE 1

GIS FILE PATH: \\haleyaldrich.com\share\grn_common\129420 Vectren\GIS\129420_VECTREN\129420_VECTREN.aprx - USER: tolskowski - LAST SAVED: 1/15/2025 2:44 PM



LEGEND

- UPGRADIENT GROUNDWATER MONITORING WELL
- DOWNGRADIENT GROUNDWATER MONITORING WELL
- GROUNDWATER FLOW DIRECTION
- CREEK BOUNDARY
- GROUNDWATER ELEVATION CONTOUR, 5-FT INTERVAL, DASHED WHERE INFERRED
- APPROXIMATE UNIT BOUNDARY
- APPROXIMATE PROPERTY BOUNDARY

NOTES

1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE.

2. DEFINITIONS:
CCR = COAL COMBUSTION RESIDUALS
ND = NO DATA
NAVD88 = NORTH AMERICAN VERTICAL DATUM OF 1988

3. WATER LEVELS GAGED ON 6 MAY 2024

4. OHIO RIVER LEVEL COLLECTED BY USGS OWENSBORO GAGE #03303502 ON 6 MAY 2024 AT 12:00 PM

5. GROUNDWATER VELOCITY SHOWN IN FEET PER YEAR

6. $V = \frac{K(i)}{n_e}$

V = GROUNDWATER VELOCITY (FT/YR)
K = HYDRAULIC CONDUCTIVITY (FT/YR)
i = GROUNDWATER GRADIENT
n_e = EFFECTIVE POROSITY

7. AERIAL IMAGERY SOURCE: HEXAGON, 25 JULY 2023

N

0 230 460
SCALE IN FEET

HALEY ALDRICH

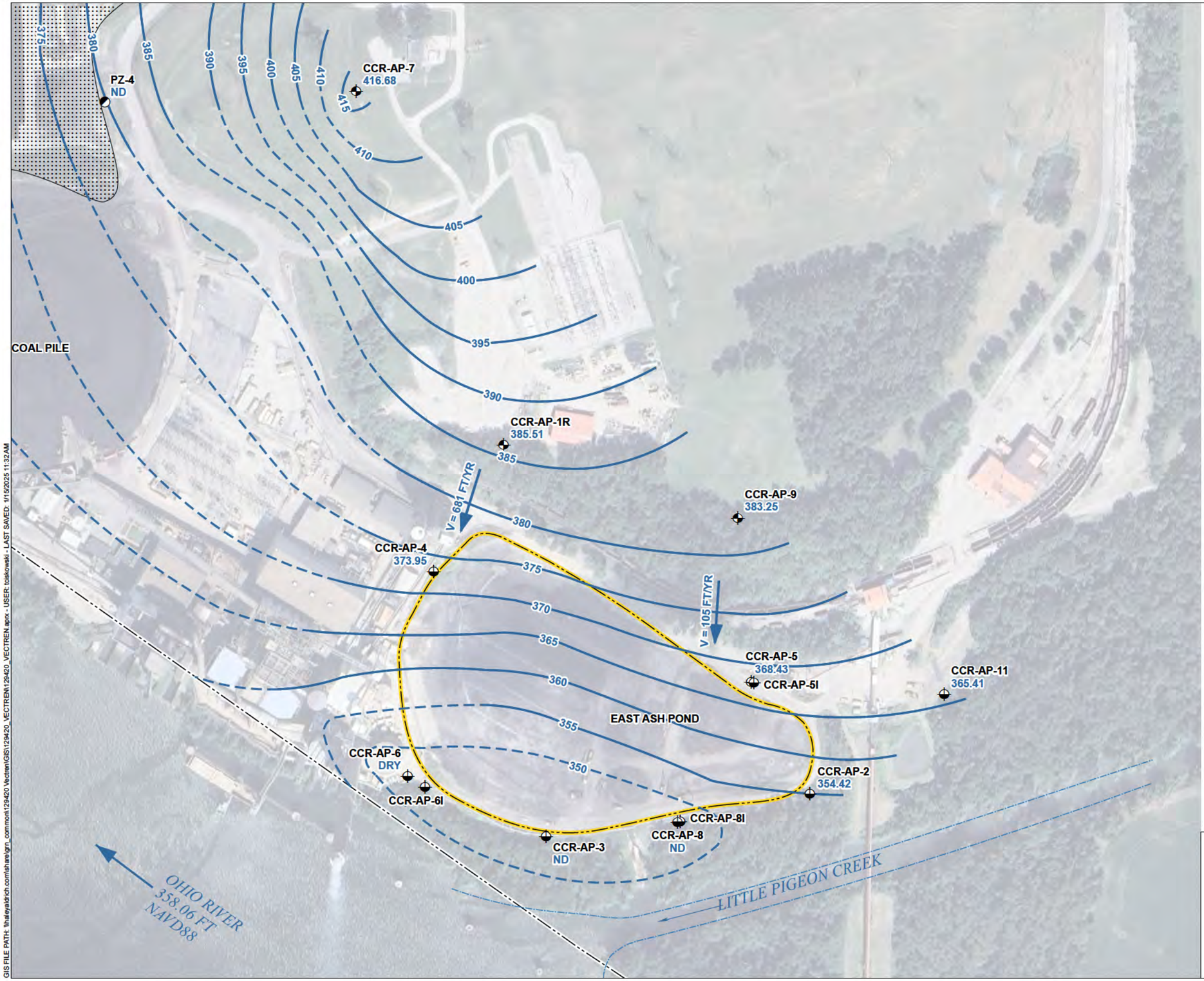
EAST ASH POND
F.B. CULLEY GENERATING STATION
WARRICK COUNTY, INDIANA

SHALLOW GROUNDWATER CONFIGURATION - EAST ASH POND - MAY 2024

JANUARY 2025

FIGURE 2

GIS FILE PATH: \\haleyaldrich.com\share\grn_common\129420 Vectren\GIS\129420_VECTREN129420_VECTREN.aprx - USER: tciakowski - LAST SAVED: 6/7/2024 9:21 AM



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LEGEND

- UPGRADIENT MONITORING WELL
- DOWNGRADIENT MONITORING WELL
- PIEZOMETER
- GROUNDWATER FLOW DIRECTION
- GROUNDWATER ELEVATION CONTOUR, 5-FT INTERVAL, DASHED WHERE INFERRED
- CREEK BOUNDARY
- APPROXIMATE LIMITS OF WEST ASH POND CCR REMOVAL
- UNIT BOUNDARY
- APPROXIMATE PROPERTY BOUNDARY

NOTES

1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE.

2. DEFINITIONS:
CCR = COAL COMBUSTION RESIDUALS
ND = NO DATA
NAVD88 = NORTH AMERICAN VERTICAL DATUM OF 1988

3. WATER LEVELS GAGED ON 11 NOVEMBER 2024.

4. OHIO RIVER LEVEL COLLECTED BY USGS OWENSBORO GAGE #03303502 ON 11 NOVEMBER 2024 AT 12:00 PM.

5. GROUNDWATER VELOCITY SHOWN IN FEET PER YEAR.

6. $V = \frac{k(i)}{n_e}$

V = GROUNDWATER VELOCITY (FT/YR)
K = HYDRAULIC CONDUCTIVITY (FT/YR)
i = GROUNDWATER GRADIENT
n_e = EFFECTIVE POROSITY

7. AERIAL IMAGERY SOURCE: GOOGLE, 10 AUGUST 2024

N

0 230 460
SCALE IN FEET

HALEY ALDRICH

EAST ASH POND
F.B. CULLEY GENERATING STATION
WARRICK COUNTY, INDIANA

SHALLOW GROUNDWATER CONFIGURATION - EAST ASH POND NOVEMBER 2024

JANUARY 2025

FIGURE 3

APPENDIX A
Summary of Statistical Analysis

HALEY & ALDRICH, INC.
400 Augusta St.
Suite 100
Greenville, SC. 29601
864.214.8771

TECHNICAL MEMORANDUM

25 April 2024
File No. 0129420-032

TO: Southern Indiana Gas and Electric Company

FROM: Haley & Aldrich, Inc.
Todd Plating, Senior Project Manager
Steven F. Putrich, P.E., Project Principal

SUBJECT: Statistical Evaluation of the November 2023 Semi-annual Groundwater Assessment Monitoring Data
Southern Indiana Gas and Electric Company
East Ash Pond
F.B. Culley Generating Station; Warrick County, Indiana

Pursuant to Title 40 Code of Federal Regulations (40 CFR) § 257.93 and § 257.95 (Rule), this memorandum summarizes the statistical evaluation of the analytical results for the November 2023 semi-annual assessment monitoring event for the F.B. Culley Generating Station (FBC) East Ash Pond (EAP). Haley & Aldrich, Inc. (Haley & Aldrich) completed this statistical evaluation to determine if Appendix IV groundwater monitoring constituents have been detected in downgradient wells at statistically significant levels (SSL) greater than Groundwater Protection Standards (GWPS), consistent with the requirements in 40 CFR § 257.95.

Methods used during this statistical analysis are described in Haley & Aldrich's 2017 *Statistical Data Analysis Plan for the F.B. Culley Generating Station*. A summary of how applicable performance standards described in 40 CFR § 257.93 (g) were achieved include:

- 40 CFR § 257.93 (g) (1) - Data set distribution was evaluated using basic summary statistics, graphical methods, and the Shapiro-Wilks Test of Normality. Parametric methods were used where normal distributions were identified. Those data sets were evaluated for outliers using box plots, Dixon's test and Rosner's test. Outlier identification and data set distribution groups are summarized in Attachment A.
- 40 CFR § 257.93 (g) (2) – Not applicable
- 40 CFR § 257.93 (g) (3) – Not applicable

- 40 CFR § 257.93 (g) (4) – Levels of confidence and additional supporting information for the use of tolerance intervals and prediction limits are included in Attachment A.
- 40 CFR § 257.93 (g) (5) – Non-detect values were accounted for by simple substitution, where the detection limit replaced the non-detect result. Non-detect values are identified and summarized in Attachment A.
- 40 CFR § 257.93 (g) (6) – Time series plots for groundwater monitoring wells included in this evaluation were reviewed to identify potential seasonal variability. No additional statistics to account for seasonality of spatial variability were necessary.

Data from the groundwater sampling event for the downgradient monitoring wells (CCR-AP-2 through CCR-AP-6 and CCR-AP-8) were compared to the GWPS established from the background dataset for the upgradient monitoring wells (CCR-AP-1R, CCR-AP-7, and CCR-AP-9) for detected Appendix IV constituents. GWPS for each of the Appendix IV constituents have been set equal to the highest value of the maximum contaminant level (MCL), regional screening level (RSL), or background concentration. The results of the assessment monitoring statistical evaluation are discussed below and provided in Attachment A.

Development of Groundwater Protection Standard

The Rule provides four specific options for statistical evaluation of groundwater quality data collected at a coal combustion residual (CCR) unit (40 CFR §257.93(f) (1-4)). Haley & Aldrich certified the tolerance limit (TL) as the statistical method used for developing background concentration for the GWPS on 14 January 2019. As noted above, the GWPS for each of the Appendix IV constituents have been set equal to the highest value of the MCL, RSL, or background concentration. The most recent groundwater sampling result from each compliance well was compared to the GWPS to determine if additional statistical testing is warranted.

STATISTICAL EVALUATION

An interwell statistical evaluation was used to identify SSLs (Table 1). An interwell evaluation compares the most recent values from downgradient compliance wells to a background dataset composed of upgradient well data. Because the CCR unit is in assessment monitoring, no statistical evaluations were conducted on Appendix III (detection monitoring) constituents.

The parametric TL method was used to complete statistical evaluations of the referenced dataset. The TL procedure is one in which a concentration limit for each constituent is established from the distribution of the background data, with a minimum 95 percent confidence level. The upper endpoint of a tolerance interval is called the UTL. Depending on the data distribution, parametric or non-parametric TL procedures are used to evaluate groundwater monitoring data. Parametric TLs utilize normally distributed data or data normalized via a transformation of the sample background data used to construct the limit. If the data are non-normal and a transformation is not indicated, non-parametric procedures (order statistics or bootstrap methods) are used to calculate the TL. If all the background data are non-detect, a maximum reporting limit may serve as an appropriate UTL.

These statistical evaluations were conducted using the background dataset for all detected Appendix IV constituents using parametric TL. If an Appendix IV constituent concentration from the November 2023 sampling event was greater than the GWPS, the lower confidence limit (LCL) for the downgradient well constituent was used to evaluate if an SSL was indicated. The LCL is the lower end of the confidence interval range, which is an estimated concentration range intended to contain the true mean or median of the population from which the sample is drawn. The confidence interval range is designed to locate the true population mean or median with a high degree of statistical confidence, or conversely, with a low probability of error.

The UTLs were calculated from the background well dataset using the EnvStats (version 2.8.1) R programming package after testing for outlier sample results that would warrant removal from the dataset based on likely error in sampling or measurement. Statistical outlier tests for the background data were performed using the outliers (version 0.15) R programming package, and a visual inspection of the data was performed using box plots and distribution plots for the downgradient sample data. No sample data were identified as outliers that warranted removal from the dataset.

BACKGROUND DISTRIBUTIONS

The groundwater analytical results for each sampling event from the background sample locations were combined to calculate the UTL for each detected Appendix IV constituent. The variability and distribution of the pooled dataset was evaluated to determine the method for UTL calculation. The background concentrations were periodically updated per the document *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance, March 2009* (Unified Guidance).

TREND SUMMARY

Mann Kendall trend analyses were performed on data sets from downgradient wells of sufficient sample size. Results of the trend analysis are included as Table 2. Trends indicated for constituents identified as SSLs are summarized below:

- Molybdenum was determined to be increasing at monitoring well locations CCR-AP-2 and CCR-AP-4R. Analytical results at those locations are below the GWPS.
- Molybdenum was determined to be stable at upgradient location CCR-AP-1R and downgradient locations CCR-AP-6 and CCR-AP-8.
- Molybdenum was determined to be decreasing at upgradient locations CCR-AP-7 and CCR-AP-9, along with downgradient locations CCR-AP-3 and CCR-AP-5.

RESULTS OF APPENDIX IV DOWNGRADIENT STATISTICAL COMPARISONS

The sample concentrations from the downgradient wells for each of the detected Appendix IV constituents from the November 2023 assessment monitoring event were compared to their respective GWPS (Attachment A). LCLs were calculated where constituents were detected at concentrations greater than the GWPS. An SSL is indicated when the LCL is greater than the GWPS. SSLs are summarized in the table below. Based on previous compliance sampling events and statistical evaluations, interwell comparisons were used to evaluate constituents not subject to an Alternative

Source Demonstration (ASD) in downgradient monitoring wells. Because a successful ASD was completed for arsenic, an intrawell statistical analysis was used to evaluate that constituent.

The results of the statistical analyses conducted for detected Appendix IV constituents confirm that molybdenum remains the only SSL downgradient of the EAP. As a result, the EAP will remain in Assessment Monitoring.

Table 1. Statistically Significant Level Summary – Appendix IV Constituents

Location ID	Trend	Constituent	Newly Identified SSL	Concentration (mg/L)
CCR-AP-5	Decrease	Molybdenum	No	0.14

Notes:
mg/L= milligrams per liter

Enclosure:

Table 2 – Trend Summary
Attachment A - Assessment Monitoring Statistical Analysis Summary – November 2023

G:\129420 Vectren\Deliverables\FB_Culley\East Ash Pond\SSL Notification\2023-11 Nov Sampling SSL Memo\2024-0425 FBC EAP Statistical Evaluation Summary_F.docx

Table 2. Trend Summary

Location	Chemical	Units	Identified Trends		Trend Analysis on All Available Data					Trend Analysis on Recent Data				
			Trend (All Data)	Trend (Recent Data)	Results, n	Detected Results, n	Max Concentration	Sen Slope (magnitude per year)	p-value	*Results, n	*Detected Results, n	*Max Concentration	*Sen Slope (magnitude per year)	*p-value
CCR-AP-1R	Antimony, Total	mg/L	No Trend	Stable	22	16	0.01	1.92e-05	0.41	8	8	0.0041	-8.8e-05	0.618
CCR-AP-2	Antimony, Total	mg/L	No Trend	No Trend	22	13	0.01	2e-05	0.138	8	8	0.0079	0.000105	0.319
CCR-AP-3	Antimony, Total	mg/L	Not Evaluated - Majority of data (>50%) non-detect	Not Evaluated - Majority of data (>50%) non-detect	21	5	0.005	NA	NA	8	3	0.005	NA	NA
CCR-AP-4R	Antimony, Total	mg/L	Not Evaluated - Majority of data (>50%) non-detect	No Trend	21	7	0.028	NA	NA	8	5	0.028	0.000188	0.61
CCR-AP-5	Antimony, Total	mg/L	Not Evaluated - Majority of data (>50%) non-detect	Probably Increasing	21	6	0.01	NA	NA	8	5	0.0047	0.000172	0.0746
CCR-AP-6	Antimony, Total	mg/L	No Trend	No Trend	21	12	0.018	0	0.636	8	6	0.018	0.000134	0.308
CCR-AP-7	Antimony, Total	mg/L	Not Evaluated - Majority of data (>50%) non-detect	Not Evaluated - Only one detected result	23	3	0.0025	NA	NA	8	1	0.0025	NA	NA
CCR-AP-8	Antimony, Total	mg/L	Stable	No Trend	21	15	0.0046	-1.77e-05	0.195	8	7	0.0046	2.11e-05	0.902
CCR-AP-9	Antimony, Total	mg/L	No Trend	No Trend	20	15	0.01	0	1	8	6	0.01	-0.000162	0.536
CCR-AP-1R	Arsenic, Total	mg/L	Increasing	Stable	22	22	0.038	0.000708	0.00675	8	8	0.034	-0.001	0.711
CCR-AP-2	Arsenic, Total	mg/L	Increasing	Probably Increasing	22	22	0.048	0.00145	7.69e-05	8	8	0.048	0.005	0.0635
CCR-AP-3	Arsenic, Total	mg/L	Increasing	Stable	21	21	0.095	0.000818	0.0136	8	8	0.095	0	1
CCR-AP-4R	Arsenic, Total	mg/L	Increasing	No Trend	21	21	0.33	0.00618	0.000782	8	8	0.33	0.00325	0.902
CCR-AP-5	Arsenic, Total	mg/L	Increasing	Increasing	20	18	0.024	0.000226	0.00181	8	8	0.024	0.00204	0.00277
CCR-AP-6	Arsenic, Total	mg/L	Increasing	Stable	21	21	0.12	0.00206	0.0117	8	8	0.12	0	0.694
CCR-AP-7	Arsenic, Total	mg/L	Decreasing	Stable	23	23	0.018	-0.000232	0.0173	8	8	0.015	-0.000733	0.135
CCR-AP-8	Arsenic, Total	mg/L	Increasing	Stable	21	21	0.12	0.00294	0.000422	8	8	0.12	-0.00333	0.12
CCR-AP-9	Arsenic, Total	mg/L	No Trend	Stable	20	20	0.032	0.000226	0.153	8	8	0.02	-0.000633	0.454
CCR-AP-1R	Barium, Total	mg/L	Increasing	Stable	22	22	0.59	0.00842	0.0452	8	8	0.32	-0.00667	0.902
CCR-AP-2	Barium, Total	mg/L	Increasing	Increasing	22	22	0.64	0.015	0.00519	8	8	0.64	0.08	0.0187
CCR-AP-3	Barium, Total	mg/L	No Trend	No Trend	21	21	0.49	0.002	0.114	8	8	0.49	0.00167	1
CCR-AP-4R	Barium, Total	mg/L	No Trend	No Trend	21	21	1.4	0.00333	0.628	8	8	1.4	0.0317	0.618
CCR-AP-5	Barium, Total	mg/L	Increasing	Probably Increasing	21	21	0.2	0.00358	0.000124	8	8	0.2	0.0161	0.0635
CCR-AP-6	Barium, Total	mg/L	Stable	Decreasing	21	21	0.69	-0.00258	0.332	8	8	0.69	-0.015	0.0461
CCR-AP-7	Barium, Total	mg/L	Decreasing	Stable	23	23	0.19	-0.00222	0.019	8	8	0.19	-0.00625	0.212
CCR-AP-8	Barium, Total	mg/L	Decreasing	Decreasing	21	21	0.68	-0.01	0.00202	8	8	0.57	-0.0317	0.0461
CCR-AP-9	Barium, Total	mg/L	Increasing	Stable	20	20	0.72	0.00812	0.04	8	8	0.39	-0.00167	1
CCR-AP-1R	Beryllium, Total	mg/L	Increasing	Stable	22	22	0.0066	0.00018	0.00679	8	8	0.0061	-0.000292	0.711
CCR-AP-2	Beryllium, Total	mg/L	Increasing	No Trend	22	22	0.0077	0.00016	0.000244	8	8	0.0077	0.000707	0.386
CCR-AP-3	Beryllium, Total	mg/L	Not Evaluated - Only one detected result	Not Evaluated - Only one detected result	21	1	0.00056	NA	NA	8	1	0.00056	NA	NA
CCR-AP-4R	Beryllium, Total	mg/L	Increasing	Stable	21	15	0.0017	2.13e-05	0.0071	8	4	0.0017	-2.14e-06	0.507
CCR-AP-5	Beryllium, Total	mg/L	Not Evaluated - Majority of data (>50%) non-detect	Not Evaluated - Only one detected result	21	6	0.005	NA	NA	8	1	0.0016	NA	NA
CCR-AP-6	Beryllium, Total	mg/L	No Trend	Not Evaluated - Majority of data (>50%) non-detect	21	13	0.0025	8.82e-06	0.188	8	3	0.00096	NA	NA
CCR-AP-7	Beryllium, Total	mg/L	Not Evaluated - Majority of data (>50%) non-detect	Not Evaluated - Only one detected result	23	7	0.00075	NA	NA	8	1	0.0005	NA	NA
CCR-AP-8	Beryllium, Total	mg/L	Not Evaluated - Majority of data (>50%) non-detect	Not Evaluated - Majority of data (>50%) non-detect	21	6	0.0005	NA	NA	8	2	0.0005	NA	NA
CCR-AP-9	Beryllium, Total	mg/L	Increasing	Stable	20	19	0.005	4.6e-05	0.021	8	7	0.005	-3.25e-05	0.902
CCR-AP-1R	Cadmium, Total	mg/L	Not Evaluated - Majority of data (>50%) non-detect	Decreasing	22	10	0.005	NA	NA	8	6	0.0025	-4.87e-05	0.0354
CCR-AP-2	Cadmium, Total	mg/L	Increasing	No Trend	22	19	0.0066	5.47e-05	0.014	8	8	0.0066	0.000164	0.454
CCR-AP-3	Cadmium, Total	mg/L	Not Evaluated - Only one detected result	Not Evaluated - Only one detected result	21	1	0.0005	NA	NA	8	1	0.0005	NA	NA
CCR-AP-4R	Cadmium, Total	mg/L	Not Evaluated - Majority of data (>50%) non-detect	Stable	21	10	0.0025	NA	NA	8	4	0.00079	0	1
CCR-AP-5	Cadmium, Total	mg/L	No Trend	No Trend	21	16	0.005	7.35e-06	0.564	8	5	0.0014	5.88e-05	0.445
CCR-AP-6	Cadmium, Total	mg/L	No Trend	Not Evaluated - Majority of data (>50%) non-detect	21	13	0.0011	0	0.298	8	2	0.0011	NA	NA
CCR-AP-7	Cadmium, Total	mg/L	Not Evaluated - Majority of data (>50%) non-detect	Not Evaluated - No detected results	23	2	0.0005	NA	NA	8	0	0.0005	NA	NA
CCR-AP-8	Cadmium, Total	mg/L	Not Evaluated - Majority of data (>50%) non-detect	No Trend	21	6	0.00064	NA	NA	8	4	0.00064	0	0.592
CCR-AP-9	Cadmium, Total	mg/L	Increasing	Not Evaluated - Majority of data (>50%) non-detect	20	11	0.005	2.36e-05	0.00351	8	2	0.005	NA	NA
CCR-AP-1R	Chromium, Total	mg/L	Increasing	No Trend	22	22	0.16	0.00312	0.0152	8	8	0.11	0.0028	0.902
CCR-AP-2	Chromium, Total	mg/L	Increasing	Increasing	22	22	0.14	0.004	0.000307	8	8	0.14	0.0163	0.0187
CCR-AP-3	Chromium, Total	mg/L	No Trend	No Trend	21	17	0.014	3.61e-05	0.15	8	7	0.014	0.000138	0.618
CCR-AP-4R	Chromium, Total	mg/L	No Trend	No Trend	20	18	0.0493	0.000386	0.144	8	7	0.0493	0.000317	0.902
CCR-AP-5	Chromium, Total	mg/L	Not Evaluated - Majority of data (>50%) non-detect	Probably Increasing	21	5	0.056	NA	NA	8	4	0.056	0.00236	0.0842

Abbreviations: CF = confidence facotr; CV = coefficient of variation; mg/L = milligrams per liter; pCi/L = picocuries per liter.

Notes: *Recent data defined as the 8 most recent data points. MK = Mann Kendall Trend Test. Secular Trend Classification based on Aziz (2003) guidance and MK Results. Thiel-Sen slope and p-value evaluated at 95% confidence level to confirm MK trends.

Additional information about trend analysis provided in Attachment A.

			Identified Trends		Trend Analysis on All Available Data					Trend Analysis on Recent Data				
Location	Chemical	Units	Trend (All Data)	Trend (Recent Data)	Results, n	Detected Results, n	Max Concentration	Sen Slope (magnitude per year)	p-value	*Results, n	*Detected Results, n	*Max Concentration	*Sen Slope (magnitude per year)	*p-value
CCR-AP-6	Chromium, Total	mg/L	Stable	No Trend	21	20	0.043	-0.000148	0.545	8	7	0.043	-0.00035	0.536
CCR-AP-7	Chromium, Total	mg/L	No Trend	Not Evaluated - Only one detected result	23	12	0.019	0	0.808	8	1	0.0062	NA	NA
CCR-AP-8	Chromium, Total	mg/L	No Trend	No Trend	20	18	0.014	9.72e-06	0.922	8	7	0.014	-0.000287	0.618
CCR-AP-9	Chromium, Total	mg/L	Increasing	No Trend	20	20	0.15	0.00129	0.0052	8	8	0.045	0.00108	0.803
CCR-AP-1R	Cobalt, Total	mg/L	Increasing	Stable	22	22	0.081	0.00192	0.00523	8	8	0.08	-0.000633	0.902
CCR-AP-2	Cobalt, Total	mg/L	Increasing	Probably Increasing	22	22	0.091	0.00164	5.41e-05	8	8	0.091	0.00774	0.0635
CCR-AP-3	Cobalt, Total	mg/L	Decreasing	No Trend	21	21	0.0094	-0.000195	0.000258	8	8	0.0092	0.0001	0.902
CCR-AP-4R	Cobalt, Total	mg/L	No Trend	Stable	21	21	0.0175	1.44e-05	0.856	8	8	0.0175	-0.000179	0.902
CCR-AP-5	Cobalt, Total	mg/L	Decreasing	Increasing	21	21	0.01	-0.000355	0.00225	8	8	0.01	0.000712	0.0461
CCR-AP-6	Cobalt, Total	mg/L	Stable	Stable	21	21	0.019	-0.000168	0.264	8	8	0.019	-0.000147	0.711
CCR-AP-7	Cobalt, Total	mg/L	Decreasing	No Trend	23	21	0.015	-9e-05	0.013	8	6	0.0049	2.47e-05	0.902
CCR-AP-8	Cobalt, Total	mg/L	Decreasing	Stable	21	21	0.017	-0.000475	0.000275	8	8	0.012	-0.000545	0.536
CCR-AP-9	Cobalt, Total	mg/L	Increasing	Stable	20	20	0.047	0.000341	0.0286	8	8	0.023	0	1
CCR-AP-1R	Fluoride	mg/L	Decreasing	Decreasing	22	22	0.81	-0.00692	0.00594	8	8	0.63	-0.02	0.00609
CCR-AP-2	Fluoride	mg/L	Increasing	No Trend	22	22	0.69	0.0167	0.000171	8	8	0.69	0.03	0.618
CCR-AP-3	Fluoride	mg/L	Stable	Stable	21	20	0.93	-0.0105	0.183	8	8	0.57	-0.0179	0.266
CCR-AP-4R	Fluoride	mg/L	No Trend	No Trend	21	20	0.64	0.005	0.333	8	8	0.64	0.0117	0.902
CCR-AP-5	Fluoride	mg/L	Increasing	No Trend	21	21	2.3	0.05	0.000765	8	8	2.3	0.139	0.258
CCR-AP-6	Fluoride	mg/L	Stable	No Trend	21	21	0.69	-0.00375	0.694	8	8	0.69	0.009	0.902
CCR-AP-7	Fluoride	mg/L	Increasing	No Trend	22	22	0.72	0.00875	0.019	8	8	0.72	0.0267	0.618
CCR-AP-8	Fluoride	mg/L	No Trend	No Trend	21	20	1.1	0.00764	0.238	8	8	1.1	0.0333	0.319
CCR-AP-9	Fluoride	mg/L	No Trend	No Trend	20	20	0.42	0.00172	0.415	8	8	0.39	0.0045	0.618
CCR-AP-1R	Lead, Total	mg/L	Increasing	Stable	22	22	0.094	0.00194	0.00572	8	8	0.078	0.00025	1
CCR-AP-2	Lead, Total	mg/L	Increasing	Increasing	22	22	0.1	0.0025	0.000271	8	8	0.1	0.0101	0.0354
CCR-AP-3	Lead, Total	mg/L	Increasing	No Trend	21	17	0.01	2.23e-05	0.0314	8	7	0.01	0.000132	0.536
CCR-AP-4R	Lead, Total	mg/L	No Trend	Stable	21	21	0.039	0.000167	0.29	8	8	0.039	-0.00045	0.902
CCR-AP-5	Lead, Total	mg/L	Not Evaluated - Majority of data (>50%) non-detect	No Trend	21	8	0.02	NA	NA	8	6	0.02	0.000821	0.212
CCR-AP-6	Lead, Total	mg/L	Stable	No Trend	21	21	0.041	-8.22e-05	0.763	8	8	0.041	-4e-05	1
CCR-AP-7	Lead, Total	mg/L	Probably Decreasing	Not Evaluated - Majority of data (>50%) non-detect	23	14	0.02	-3.36e-05	0.0935	8	3	0.006	NA	NA
CCR-AP-8	Lead, Total	mg/L	No Trend	Stable	21	20	0.0076	3.33e-05	0.38	8	7	0.0061	-0.000133	0.711
CCR-AP-9	Lead, Total	mg/L	Increasing	Stable	20	20	0.041	0.000571	0.0193	8	8	0.025	-0.000425	0.803
CCR-AP-1R	Lithium, Total	mg/L	Increasing	No Trend	22	22	0.23	0.004	0.0139	8	8	0.15	0.0049	0.618
CCR-AP-2	Lithium, Total	mg/L	Probably Increasing	Increasing	22	17	0.125	0.0016	0.0508	8	8	0.11	0.0132	0.0187
CCR-AP-3	Lithium, Total	mg/L	Not Evaluated - Majority of data (>50%) non-detect	Not Evaluated - Majority of data (>50%) non-detect	21	3	0.025	NA	NA	8	3	0.0043	NA	NA
CCR-AP-4R	Lithium, Total	mg/L	Stable	No Trend	21	15	0.047	-0.000219	0.375	8	7	0.025	0.000538	0.536
CCR-AP-5	Lithium, Total	mg/L	Decreasing	No Trend	21	21	0.15	-0.00563	1.3e-05	8	8	0.072	0.00214	0.536
CCR-AP-6	Lithium, Total	mg/L	Not Evaluated - Majority of data (>50%) non-detect	No Trend	21	10	0.125	NA	NA	8	5	0.018	-0.000182	0.454
CCR-AP-7	Lithium, Total	mg/L	Decreasing	Stable	23	23	0.039	-0.000211	0.006	8	8	0.018	-0.00045	0.711
CCR-AP-8	Lithium, Total	mg/L	Not Evaluated - Majority of data (>50%) non-detect	Not Evaluated - Only one detected result	21	5	0.025	NA	NA	8	1	0.0067	NA	NA
CCR-AP-9	Lithium, Total	mg/L	Increasing	Stable	20	20	0.12	0.000858	0.0345	8	8	0.072	-0.00217	0.711
CCR-AP-1R	Mercury, Total	mg/L	Not Evaluated - No detected results	Not Evaluated - No detected results	21	0	0.001	NA	NA	8	0	0.001	NA	NA
CCR-AP-2	Mercury, Total	mg/L	Not Evaluated - Majority of data (>50%) non-detect	Increasing	21	8	0.00071	NA	NA	8	6	0.00071	4.8e-05	0.0327
CCR-AP-3	Mercury, Total	mg/L	Not Evaluated - No detected results	Not Evaluated - No detected results	20	0	0.00025	NA	NA	8	0	0.00025	NA	NA
CCR-AP-4R	Mercury, Total	mg/L	Not Evaluated - No detected results	Not Evaluated - No detected results	20	0	0.00025	NA	NA	8	0	0.00025	NA	NA
CCR-AP-5	Mercury, Total	mg/L	Not Evaluated - Majority of data (>50%) non-detect	Not Evaluated - Majority of data (>50%) non-detect	20	3	0.0016	NA	NA	8	3	0.0016	NA	NA
CCR-AP-6	Mercury, Total	mg/L	Not Evaluated - Majority of data (>50%) non-detect	Not Evaluated - Majority of data (>50%) non-detect	20	2	0.00041	NA	NA	8	2	0.00041	NA	NA
CCR-AP-7	Mercury, Total	mg/L	Not Evaluated - No detected results	Not Evaluated - No detected results	20	0	0.00025	NA	NA	8	0	0.00025	NA	NA
CCR-AP-8	Mercury, Total	mg/L	Not Evaluated - Only one detected result	Not Evaluated - Only one detected result	20	1	0.00026	NA	NA	8	1	0.00026	NA	NA
CCR-AP-9	Mercury, Total	mg/L	Not Evaluated - No detected results	Not Evaluated - No detected results	19	0	0.0001	NA	NA	8	0	0.0001	NA	NA
CCR-AP-1R	Molybdenum, Total	mg/L	Stable	Stable	22	22	0.023	-2.5e-05	0.755	8	8	0.023	-0.000264	0.212
CCR-AP-2	Molybdenum, Total	mg/L	Increasing	No Trend	22	22	0.01	0.000358	2.01e-05	8	8	0.01	0.000533	0.108
CCR-AP-3	Molybdenum, Total	mg/L	Decreasing	No Trend	21	21	0.025	-0.0003	0.0074	8	8	0.025	0.000213	0.803
CCR-AP-4R	Molybdenum, Total	mg/L	Increasing	No Trend	21	18	0.01	0.000113	0.0312	8	5	0.01	0.00025	0.61
CCR-AP-5	Molybdenum, Total	mg/L	Decreasing	Stable	21	21	0.53	-0.0121	0.00266	8	8	0.34	-0.015	0.53
CCR-AP-6	Molybdenum, Total	mg/L	Stable	Stable	21	21	0.037	-7.74e-05	0.738	8	8	0.037	-0.0005	0.454
CCR-AP-7	Molybdenum, Total	mg/L	Decreasing	No Trend	23	22	0.013	-0.00025	1.8e-05	8	7	0.0025	7.32e-05	0.803
CCR-AP-8	Molybdenum, Total	mg/L	Stable	Stable	21	21	0.029	0	0.903	8	8	0.029	-8.33e-05	1
CCR-AP-9	Molybdenum, Total	mg/L	Decreasing	No Trend	20	18	0.025	-0.000292	0.00428	8	6	0.025	-0.00025	0.386
CCR-AP-1R	Radium-226 & 228	pCi/L	No Trend	No Trend	20	20	14.4	0.0993	0.23	8	8	14.4	1.6	0.266
CCR-AP-2	Radium-226 & 228	pCi/L	No Trend	No Trend	20	19	5.53	0.00427	0.974	8	7	5.53	0.252	0.711
CCR-AP-3	Radium-226 & 228	pCi/L	No Trend	No Trend	19	18	4.87	0.0048	1	8	7	4.87	0.189	0.386

Abbreviations: CF = confidence facotr; CV = coefficient of variation; mg/L = milligrams per liter; pCi/L = picocuries per liter.

Notes: *Recent data defined as the 8 most recent data points. MK = Mann Kendall Trend Test. Secular Trend Classification based on Aziz (2003) guidance and MK Results. Thiel-Sen slope and p-value evaluated at 95% confidence level to confirm MK trends.

Additional information about trend analysis provided in Attachment A.

			Identified Trends		Trend Analysis on All Available Data					Trend Analysis on Recent Data				
Location	Chemical	Units	Trend (All Data)	Trend (Recent Data)	Results, n	Detected Results, n	Max Concentration	Sen Slope (magnitude per year)	p-value	*Results, n	*Detected Results, n	*Max Concentration	*Sen Slope (magnitude per year)	*p-value
CCR-AP-4R	Radium-226 & 228	pCi/L	No Trend	No Trend	19	19	30	0.03	0.675	8	8	30	0.324	0.174
CCR-AP-5	Radium-226 & 228	pCi/L	No Trend	Increasing	19	19	5.54	0.0501	0.363	8	8	5.54	0.683	0.00937
CCR-AP-6	Radium-226 & 228	pCi/L	No Trend	No Trend	19	19	10.2	0.0118	0.576	8	8	3.21	0.2	0.266
CCR-AP-7	Radium-226 & 228	pCi/L	Stable	Increasing	20	20	1.72	-0.0163	0.417	8	8	1.44	0.161	0.0187
CCR-AP-8	Radium-226 & 228	pCi/L	Stable	No Trend	18	18	2.88	-0.0145	0.544	8	8	2.88	0.0846	0.711
CCR-AP-9	Radium-226 & 228	pCi/L	Probably Increasing	No Trend	18	18	12.6	0.154	0.0956	8	8	12.6	0.583	0.386
CCR-AP-1R	Selenium, Total	mg/L	Not Evaluated - Majority of data (>50%) non-detect	No Trend	22	10	0.025	NA	NA	8	5	0.0125	-0.0002	0.135
CCR-AP-2	Selenium, Total	mg/L	Increasing	No Trend	22	15	0.026	0.000171	0.0115	8	7	0.013	0.00035	0.386
CCR-AP-3	Selenium, Total	mg/L	Probably Increasing	No Trend	21	20	0.0068	1.79e-05	0.0752	8	8	0.003	1.25e-05	0.421
CCR-AP-4R	Selenium, Total	mg/L	Probably Increasing	No Trend	21	11	0.031	2.84e-05	0.0717	8	4	0.0036	0.000108	0.18
CCR-AP-5	Selenium, Total	mg/L	Not Evaluated - Majority of data (>50%) non-detect	Increasing	21	7	0.025	NA	NA	8	6	0.02	0.0004	0.00609
CCR-AP-6	Selenium, Total	mg/L	No Trend	Stable	21	17	0.0125	9.55e-06	0.563	8	7	0.003	-0.000123	0.386
CCR-AP-7	Selenium, Total	mg/L	Not Evaluated - Majority of data (>50%) non-detect	Not Evaluated - Only one detected result	21	3	0.0028	NA	NA	8	1	0.0028	NA	NA
CCR-AP-8	Selenium, Total	mg/L	No Trend	Stable	21	18	0.007	6.11e-06	0.693	8	8	0.0051	-0.00015	0.266
CCR-AP-9	Selenium, Total	mg/L	Not Evaluated - Majority of data (>50%) non-detect	Not Evaluated - Majority of data (>50%) non-detect	20	6	0.025	NA	NA	8	2	0.025	NA	NA
CCR-AP-1R	Thallium, Total	mg/L	Increasing	No Trend	22	16	0.0027	3.13e-05	0.0187	8	5	0.0027	1.5e-05	0.618
CCR-AP-2	Thallium, Total	mg/L	Increasing	No Trend	22	19	0.0076	5.6e-05	6.75e-05	8	7	0.0076	0.000117	0.379
CCR-AP-3	Thallium, Total	mg/L	Not Evaluated - Only one detected result	Not Evaluated - No detected results	21	1	0.001	NA	NA	8	0	0.001	NA	NA
CCR-AP-4R	Thallium, Total	mg/L	Not Evaluated - Majority of data (>50%) non-detect	Not Evaluated - Majority of data (>50%) non-detect	21	10	0.0025	NA	NA	8	2	0.001	NA	NA
CCR-AP-5	Thallium, Total	mg/L	Not Evaluated - Majority of data (>50%) non-detect	No Trend	21	7	0.005	NA	NA	8	4	0.00096	1.5e-05	0.507
CCR-AP-6	Thallium, Total	mg/L	Not Evaluated - Majority of data (>50%) non-detect	Not Evaluated - No detected results	21	8	0.0025	NA	NA	8	0	0.001	NA	NA
CCR-AP-7	Thallium, Total	mg/L	Not Evaluated - Majority of data (>50%) non-detect	Not Evaluated - No detected results	23	4	0.001	NA	NA	8	0	0.001	NA	NA
CCR-AP-8	Thallium, Total	mg/L	Not Evaluated - Majority of data (>50%) non-detect	Not Evaluated - No detected results	21	5	0.001	NA	NA	8	0	0.001	NA	NA
CCR-AP-9	Thallium, Total	mg/L	Not Evaluated - Majority of data (>50%) non-detect	Not Evaluated - No detected results	20	9	0.005	NA	NA	8	0	0.005	NA	NA

Abbreviations: CF = confidence facotr; CV = coefficient of variation; mg/L = milligrams per liter; pCi/L = picocuries per liter.

Notes: *Recent data defined as the 8 most recent data points. MK = Mann Kendall Trend Test. Secular Trend Classification based on Aziz (2003) guidance and MK Results. Thiel-Sen slope and p-value evaluated at 95% confidence level to confirm MK trends.

Additional information about trend analysis provided in Attachment A.

ATTACHMENT A
Assessment Monitoring Statistical Analysis Summary – November 2023

Table A-1. Descriptive Statistics

Location	Constituent	Units	n	n, non-detects	percent of non-detects	max	min	mean	median	standard deviation	variance	reporting limit range	date range
CCR-AP-1R	Antimony, Total	mg/L	22	6	27	0.02000	0.00053	0.0036	0.0017	0.0057	3.2e-05	0.002 - 0.02	2016-06-10 to 2023-11-02
CCR-AP-2	Antimony, Total	mg/L	22	9	41	0.02000	0.00024	0.00357	0.002	0.0046	2.1e-05	0.002 - 0.02	2016-06-10 to 2023-11-02
CCR-AP-3	Antimony, Total	mg/L	21	16	76	0.00500	0.00031	0.00195	0.002	0.00087	7.6e-07	0.002 - 0.002	2016-06-10 to 2023-11-02
CCR-AP-4R	Antimony, Total	mg/L	21	14	67	0.02800	0.0004	0.00343	0.002	0.0059	3.5e-05	0.002 - 0.01	2016-06-10 to 2023-11-02
CCR-AP-5	Antimony, Total	mg/L	21	15	71	0.02000	5.8e-05	0.00273	0.002	0.0041	1.6e-05	0.002 - 0.02	2016-06-10 to 2023-11-02
CCR-AP-6	Antimony, Total	mg/L	21	9	43	0.01800	0.00042	0.00254	0.0017	0.0041	1.7e-05	0.002 - 0.01	2016-06-10 to 2023-11-02
CCR-AP-7	Antimony, Total	mg/L	23	20	87	0.00500	0.00016	0.00194	0.002	0.00084	7.1e-07	0.002 - 0.005	2016-06-10 to 2023-11-06
CCR-AP-8	Antimony, Total	mg/L	21	6	29	0.00460	0.0004	0.00135	0.0011	0.00097	9.5e-07	0.002 - 0.002	2017-03-09 to 2023-11-02
CCR-AP-9	Antimony, Total	mg/L	20	5	25	0.02000	0.00061	0.00437	0.0014	0.006	3.6e-05	0.002 - 0.02	2017-03-09 to 2023-05-23
CCR-AP-1R	Arsenic, Total	mg/L	22	0	0	0.03800	0.0024	0.0166	0.0135	0.011	0.00013	NA	2016-06-10 to 2023-11-02
CCR-AP-2	Arsenic, Total	mg/L	22	0	0	0.04800	0.0016	0.0155	0.013	0.013	0.00016	NA	2016-06-10 to 2023-11-02
CCR-AP-3	Arsenic, Total	mg/L	21	0	0	0.09500	0.058	0.0765	0.077	0.0087	7.6e-05	NA	2016-06-10 to 2023-11-02
CCR-AP-4R	Arsenic, Total	mg/L	21	0	0	0.33000	0.027	0.115	0.086	0.081	0.0065	NA	2016-06-10 to 2023-11-02
CCR-AP-5	Arsenic, Total	mg/L	20	2	10	0.02400	0.00039	0.00458	0.00105	0.0073	5.3e-05	0.001 - 0.01	2016-06-10 to 2023-11-02
CCR-AP-6	Arsenic, Total	mg/L	21	0	0	0.12000	0.04	0.0943	0.1	0.022	0.00046	NA	2016-06-10 to 2023-11-02
CCR-AP-7	Arsenic, Total	mg/L	23	0	0	0.01800	0.00066	0.00588	0.0055	0.0041	1.7e-05	NA	2016-06-10 to 2023-11-06
CCR-AP-8	Arsenic, Total	mg/L	21	0	0	0.12000	0.044	0.0898	0.095	0.022	0.00048	NA	2017-03-09 to 2023-11-02
CCR-AP-9	Arsenic, Total	mg/L	20	0	0	0.03200	0.0031	0.0104	0.00875	0.0063	4e-05	NA	2017-03-09 to 2023-05-23
CCR-AP-1R	Barium, Total	mg/L	22	0	0	0.59000	0.05	0.228	0.18	0.16	0.024	NA	2016-06-10 to 2023-11-02
CCR-AP-2	Barium, Total	mg/L	22	0	0	0.64000	0.038	0.25	0.235	0.17	0.029	NA	2016-06-10 to 2023-11-02
CCR-AP-3	Barium, Total	mg/L	21	0	0	0.49000	0.38	0.431	0.43	0.032	0.001	NA	2016-06-10 to 2023-11-02
CCR-AP-4R	Barium, Total	mg/L	21	0	0	1.40000	0.45	0.703	0.63	0.25	0.061	NA	2016-06-10 to 2023-11-02
CCR-AP-5	Barium, Total	mg/L	21	0	0	0.20000	0.029	0.062	0.041	0.045	0.002	NA	2016-06-10 to 2023-11-02
CCR-AP-6	Barium, Total	mg/L	21	0	0	0.69000	0.48	0.582	0.58	0.066	0.0044	NA	2016-06-10 to 2023-11-02
CCR-AP-7	Barium, Total	mg/L	23	0	0	0.19000	0.076	0.128	0.12	0.029	0.00083	NA	2016-06-10 to 2023-11-06
CCR-AP-8	Barium, Total	mg/L	21	0	0	0.68000	0.31	0.543	0.57	0.096	0.0091	NA	2017-03-09 to 2023-11-02
CCR-AP-9	Barium, Total	mg/L	20	0	0	0.72000	0.13	0.293	0.27	0.12	0.015	NA	2017-03-09 to 2023-05-23
CCR-AP-1R	Beryllium, Total	mg/L	22	0	0	0.00660	0.00011	0.0027	0.0021	0.0022	4.7e-06	NA	2016-06-10 to 2023-11-02
CCR-AP-2	Beryllium, Total	mg/L	22	0	0	0.00770	0.00014	0.0021	0.0018	0.0021	4.2e-06	NA	2016-06-10 to 2023-11-02
CCR-AP-3	Beryllium, Total	mg/L	21	20	95	0.00100	0.00056	0.000979	0.001	9.6e-05	9.2e-09	0.001 - 0.001	2016-06-10 to 2023-11-02
CCR-AP-4R	Beryllium, Total	mg/L	21	6	29	0.00170	0.00014	0.000693	0.00061	0.00044	1.9e-07	0.001 - 0.001	2016-06-10 to 2023-11-02
CCR-AP-5	Beryllium, Total	mg/L	21	15	71	0.01000	0.00017	0.00133	0.001	0.002	4e-06	0.001 - 0.01	2016-06-10 to 2023-11-02
CCR-AP-6	Beryllium, Total	mg/L	21	8	38	0.00500	0.00011	0.000796	0.0005	0.001	1e-06	0.0005 - 0.005	2016-06-10 to 2023-11-02
CCR-AP-7	Beryllium, Total	mg/L	23	16	70	0.00100	6.7e-05	0.00075	0.001	0.00037	1.4e-07	0.0005 - 0.001	2016-06-10 to 2023-11-06
CCR-AP-8	Beryllium, Total	mg/L	21	15	71	0.00100	0.00016	0.000763	0.001	0.00035	1.2e-07	0.0005 - 0.001	2017-03-09 to 2023-11-02
CCR-AP-9	Beryllium, Total	mg/L	20	1	5	0.01000	0.00017	0.00146	0.00091	0.0022	4.7e-06	0.01 - 0.01	2017-03-09 to 2023-05-23
CCR-AP-1R	Cadmium, Total	mg/L	22	12	55	0.01000	8.1e-05	0.00207	0.001	0.003	9e-06	0.001 - 0.01	2016-06-10 to 2023-11-02
CCR-AP-2	Cadmium, Total	mg/L	22	3	14	0.01000	0.00011	0.00197	0.000875	0.0025	6.2e-06	0.005 - 0.01	2016-06-10 to 2023-11-02
CCR-AP-3	Cadmium, Total	mg/L	21	20	95	0.00100	0.00038	0.00097	0.001	0.00014	1.8e-08	0.001 - 0.001	2016-06-10 to 2023-11-02
CCR-AP-4R	Cadmium, Total	mg/L	21	11	52	0.00500	0.00014	0.000883	0.001	0.001	1e-06	0.001 - 0.005	2016-06-10 to 2023-11-02
CCR-AP-5	Cadmium, Total	mg/L	21	5	24	0.01000	0.00015	0.00106	0.00057	0.0021	4.3e-06	0.001 - 0.01	2016-06-10 to 2023-11-02
CCR-AP-6	Cadmium, Total	mg/L	21	8	38	0.00110	9.4e-05	0.000621	0.00052	0.00037	1.4e-07	0.001 - 0.001	2016-06-10 to 2023-11-02
CCR-AP-7	Cadmium, Total	mg/L	23	21	91	0.00100	0.00014	0.000911	0.001	0.00024	5.8e-08	0.0005 - 0.001	2016-06-10 to 2023-11-06
CCR-AP-8	Cadmium, Total	mg/L	21	15	71	0.00100	0.00016	0.000796	0.001	0.00034	1.2e-07	0.001 - 0.001	2017-03-09 to 2023-11-02
CCR-AP-9	Cadmium, Total	mg/L	20	9	45	0.01000	7.9e-05	0.00184	0.00031	0.0031	9.9e-06	0.001 - 0.01	2017-03-09 to 2023-05-23
CCR-AP-1R	Chromium, Total	mg/L	22	0	0	0.16000	0.0019	0.0573	0.0455	0.047	0.0022	NA	2016-06-10 to 2023-11-02
CCR-AP-2	Chromium, Total	mg/L	22	0	0	0.14000	0.003	0.0414	0.034	0.035	0.0012	NA	2016-06-10 to 2023-11-02
CCR-AP-3	Chromium, Total	mg/L	21	4	19	0.01400	0.0018	0.00297	0.0021	0.0026	6.8e-06	0.002 - 0.002	2016-06-10 to 2023-11-02
CCR-AP-4R	Chromium, Total	mg/L	20	2	10	0.05800	0.0015	0.013	0.00785	0.015	0.00022	0.002 - 0.0034	2016-06-10 to 2023-11-02
CCR-AP-5	Chromium, Total	mg/L	21	16	76	0.05600	0.0014	0.00694	0.002	0.013	0.00017	0.002 - 0.02	2016-06-10 to 2023-11-02
CCR-AP-6	Chromium, Total	mg/L	21	1	5	0.04300	0.0019	0.0133	0.0098	0.011	0.00012	0.002 - 0.002	2016-06-10 to 2023-11-02
CCR-AP-7	Chromium, Total	mg/L	23	11	48	0.01900	0.00047	0.00385	0.002	0.004	1.6e-05	0.002 - 0.01	2016-06-10 to 2023-11-06
CCR-AP-8	Chromium, Total	mg/L	20	2	10	0.01400	0.0012	0.00432	0.0029	0.0035	1.2e-05	0.002 - 0.0034	2017-03-09 to 2023-11-02
CCR-AP-9	Chromium, Total	mg/L	20	0	0	0.15000	0.0042	0.0262	0.017	0.032	0.00099	NA	2017-03-09 to 2023-05-23
CCR-AP-1R	Cobalt, Total	mg/L	22	0	0	0.08100	0.0015	0.0318	0.027	0.026	0.00067	NA	2016-06-10 to 2023-11-02
CCR-AP-2	Cobalt, Total	mg/L	22	0	0	0.09100	0.0073	0.0277	0.022	0.02	0.00039	NA	2016-06-10 to 2023-11-02
CCR-AP-3	Cobalt, Total	mg/L	21	0	0	0.00940	0.004	0.00602	0.0056	0.0016	2.5e-06	NA	2016-06-10 to 2023-11-02
CCR-AP-4R	Cobalt, Total	mg/L	21	0	0	0.02100	0.00071	0.00701	0.0055	0.0056	3.1e-05	NA	2016-06-10 to 2023-11-02
CCR-AP-5	Cobalt, Total	mg/L	21	0	0	0.01000	0.00036	0.00407	0.0041	0.0026	6.8e-06	NA	2016-06-10 to 2023-11-02
CCR-AP-6	Cobalt, Total	mg/L	21	0	0	0.01900	0.0034	0.00879	0.0075	0.0044	1.9e-05	NA	2016-06-10 to 2023-11-02
CCR-AP-7	Cobalt, Total	mg/L	23	2	9	0.01500	0.00021	0.00226	0.001	0.0032	1e-05	0.0005 - 0.002	2016-06-10 to 2023-11-06
CCR-AP-8	Cobalt, Total	mg/L	21	0	0	0.01700	0.0026	0.00876	0.0082	0.0038	1.5e-05	NA	2017-03-09 to 2023-11-02
CCR-AP-9	Cobalt, Total	mg/L	20	0	0	0.04700	0.0062	0.0152	0.014	0.0085	7.2e-05	NA	2017-03-09 to 2023-05-23
CCR-AP-1R	Fluoride	mg/L	22	0	0	0.81000	0.34	0.506	0.485	0.096	0.0091	NA	2016-06-10 to 2023-11-02
CCR-AP-2	Fluoride	mg/L	22	0	0	0.69000	0.11	0.366	0.31	0.15	0.023	NA	2016-06-10 to 2023-11-02
CCR-AP-3	Fluoride	mg/L	21	1	5	0.93000	0.1	0.404	0.39	0.19	0.036	0.1 - 0.1	2016-06-10 to 2023-11-02
CCR-AP-4R	Fluoride	mg/L	21	1	5	0.64000	0.1	0.379	0.37	0.11	0.012	0.1 - 0.1	2016-06-10 to 2023-11-02
CCR-AP-5	Fluoride	mg/L	21	0	0	2.30000	0.58	1.29	1.2	0.45	0.2	NA	2016-06-10 to 2023-11-02
CCR-AP-6	Fluoride	mg/L	21	0	0	0.69000	0.24	0.496	0.48	0.13	0.017	NA	2016-06-10 to 2023-11-02
CCR-AP-7	Fluoride	mg/L	22	0	0	0.72000	0.14	0.334	0.295	0.13	0.018	NA	2016-08-12 to 2023-11-06
CCR-AP-8	Fluoride	mg/L	21	1	5	1.10000	0.1	0.326	0.28	0.21	0.043	0.1 - 0.1	2017-03-09 to 2023-11-02
CCR-AP-9	Fluoride	mg/L	20	0	0	0.42000	0.14	0.33	0.345	0.065	0.0043	NA	2017-03-09 to 2023-05-23
CCR-AP-1R	Lead, Total	mg/L	22	0	0	0.09400	0.0011	0.0348	0.028	0.028	0.0008	NA	2016-06-10 to 2023-11-02
CCR-AP-2	Lead, Total	mg/L	22	0	0	0.10000	0.0023	0.028	0.0225	0.025	0.00061	NA	2016-06-10 to 2023-11-02

Note:

Units: mg/L = milligrams per liter, pCi/L = picocuries per liter

Location	Constituent	Units	n	n, non-detects	percent of non-detects	max	min	mean	median	standard deviation	variance	reporting limit range	date range
CCR-AP-3	Lead, Total	mg/L	21	4	19	0.01000	0.00021	0.00122	0.00078	0.002	4.2e-06	0.001 - 0.001	2016-06-10 to 2023-11-02
CCR-AP-4R	Lead, Total	mg/L	21	0	0	0.04700	0.00052	0.0105	0.0048	0.013	0.00016	NA	2016-06-10 to 2023-11-02
CCR-AP-5	Lead, Total	mg/L	21	13	62	0.02000	9.9e-05	0.00262	0.001	0.0047	2.2e-05	0.001 - 0.01	2016-06-10 to 2023-11-02
CCR-AP-6	Lead, Total	mg/L	21	0	0	0.04100	0.00039	0.00993	0.0071	0.0096	9.2e-05	NA	2016-06-10 to 2023-11-02
CCR-AP-7	Lead, Total	mg/L	23	9	39	0.02000	0.00013	0.00299	0.001	0.0044	1.9e-05	0.001 - 0.003	2016-06-10 to 2023-11-06
CCR-AP-8	Lead, Total	mg/L	21	1	5	0.00760	0.00027	0.00218	0.0017	0.0018	3.3e-06	0.003 - 0.003	2017-03-09 to 2023-11-02
CCR-AP-9	Lead, Total	mg/L	20	0	0	0.04100	0.0025	0.0128	0.0105	0.0089	7.9e-05	NA	2017-03-09 to 2023-05-23
CCR-AP-1R	Lithium, Total	mg/L	22	0	0	0.23000	0.035	0.094	0.0805	0.054	0.0029	NA	2016-06-10 to 2023-11-02
CCR-AP-2	Lithium, Total	mg/L	22	5	23	0.25000	0.01	0.0514	0.0395	0.051	0.0026	0.05 - 0.25	2016-06-10 to 2023-11-02
CCR-AP-3	Lithium, Total	mg/L	21	18	86	0.05000	0.0021	0.0241	0.005	0.023	0.00053	0.005 - 0.05	2016-06-10 to 2023-11-02
CCR-AP-4R	Lithium, Total	mg/L	21	6	29	0.05000	0.0028	0.0212	0.011	0.019	0.00037	0.005 - 0.05	2016-06-10 to 2023-11-02
CCR-AP-5	Lithium, Total	mg/L	21	0	0	0.15000	0.009	0.093	0.095	0.042	0.0018	NA	2016-06-10 to 2023-11-02
CCR-AP-6	Lithium, Total	mg/L	21	11	52	0.25000	0.0014	0.034	0.014	0.053	0.0029	0.005 - 0.25	2016-06-10 to 2023-11-02
CCR-AP-7	Lithium, Total	mg/L	23	0	0	0.03900	0.007	0.0135	0.011	0.0068	4.7e-05	NA	2016-06-10 to 2023-11-06
CCR-AP-8	Lithium, Total	mg/L	21	16	76	0.05000	0.0031	0.023	0.008	0.022	0.00048	0.005 - 0.05	2017-03-09 to 2023-11-02
CCR-AP-9	Lithium, Total	mg/L	20	0	0	0.12000	0.029	0.0478	0.0405	0.02	0.00042	NA	2017-03-09 to 2023-05-23
CCR-AP-1R	Mercury, Total	mg/L	21	21	100	0.00200	0.0002	0.000314	0.0002	0.0004	1.6e-07	0.0002 - 0.002	2016-06-10 to 2023-11-02
CCR-AP-2	Mercury, Total	mg/L	21	13	62	0.00071	0.00015	0.000243	0.0002	0.00013	1.6e-08	0.0002 - 0.0002	2016-06-10 to 2023-11-02
CCR-AP-3	Mercury, Total	mg/L	20	20	100	0.00050	0.0002	0.000215	0.0002	6.7e-05	4.5e-09	0.0002 - 0.0005	2016-06-10 to 2023-11-02
CCR-AP-4R	Mercury, Total	mg/L	20	20	100	0.00050	0.0002	0.000225	0.0002	7.9e-05	6.2e-09	0.0002 - 0.0005	2016-06-10 to 2023-11-02
CCR-AP-5	Mercury, Total	mg/L	20	17	85	0.00160	0.0002	0.000311	0.0002	0.00034	1.2e-07	0.0002 - 0.0002	2016-06-10 to 2023-11-02
CCR-AP-6	Mercury, Total	mg/L	20	18	90	0.00050	0.00017	0.000224	0.0002	8.1e-05	6.5e-09	0.0002 - 0.0005	2016-06-10 to 2023-11-02
CCR-AP-7	Mercury, Total	mg/L	20	20	100	0.00050	0.0002	0.000215	0.0002	6.7e-05	4.5e-09	0.0002 - 0.0005	2016-06-10 to 2023-11-06
CCR-AP-8	Mercury, Total	mg/L	20	19	95	0.00050	0.0002	0.000218	0.0002	6.8e-05	4.6e-09	0.0002 - 0.0005	2017-03-09 to 2023-11-02
CCR-AP-9	Mercury, Total	mg/L	19	19	100	0.00020	0.0002	0.0002	0.0002	0	0	0.0002 - 0.0002	2017-03-09 to 2023-05-23
CCR-AP-1R	Molybdenum, Total	mg/L	22	0	0	0.02300	0.0047	0.00945	0.0086	0.004	1.6e-05	NA	2016-06-10 to 2023-11-02
CCR-AP-2	Molybdenum, Total	mg/L	22	0	0	0.01000	0.00094	0.0047	0.0047	0.0027	7.5e-06	NA	2016-06-10 to 2023-11-02
CCR-AP-3	Molybdenum, Total	mg/L	21	0	0	0.02500	0.0065	0.0112	0.01	0.0039	1.5e-05	NA	2016-06-10 to 2023-11-02
CCR-AP-4R	Molybdenum, Total	mg/L	21	3	14	0.01000	0.00071	0.00318	0.0022	0.0026	6.9e-06	0.005 - 0.005	2016-06-10 to 2023-11-02
CCR-AP-5	Molybdenum, Total	mg/L	21	0	0	0.53000	0.046	0.294	0.33	0.12	0.014	NA	2016-06-10 to 2023-11-02
CCR-AP-6	Molybdenum, Total	mg/L	21	0	0	0.03700	0.015	0.0248	0.024	0.0056	3.2e-05	NA	2016-06-10 to 2023-11-02
CCR-AP-7	Molybdenum, Total	mg/L	23	1	4	0.01300	0.0011	0.00377	0.0025	0.0031	9.3e-06	0.005 - 0.005	2016-06-10 to 2023-11-06
CCR-AP-8	Molybdenum, Total	mg/L	21	0	0	0.02900	0.0029	0.0145	0.014	0.0055	3e-05	NA	2017-03-09 to 2023-11-02
CCR-AP-9	Molybdenum, Total	mg/L	20	2	10	0.05000	0.0018	0.00779	0.00495	0.01	0.00011	0.005 - 0.05	2017-03-09 to 2023-05-23
CCR-AP-1R	Radium-226 & 228	pCi/L	20	0	0	14.40000	0.862	4.75	4.58	3.3	11	NA	2016-06-10 to 2023-12-22
CCR-AP-2	Radium-226 & 228	pCi/L	20	1	5	5.53000	0.444	2.07	1.79	1.4	2.1	0.444 - 0.444	2016-06-10 to 2023-11-02
CCR-AP-3	Radium-226 & 228	pCi/L	19	1	5	4.87000	0.593	1.79	1.7	1.2	1.3	2.98 - 2.98	2016-06-10 to 2023-11-02
CCR-AP-4R	Radium-226 & 228	pCi/L	19	0	0	30.00000	1.07	3.9	2.4	6.4	41	NA	2016-06-10 to 2023-11-02
CCR-AP-5	Radium-226 & 228	pCi/L	19	0	0	5.54000	0.292	1.25	0.64	1.4	1.9	NA	2016-06-10 to 2023-11-02
CCR-AP-6	Radium-226 & 228	pCi/L	19	0	0	10.20000	0.351	2.47	1.68	2.2	4.9	NA	2016-06-10 to 2023-11-02
CCR-AP-7	Radium-226 & 228	pCi/L	20	0	0	1.72000	0.126	0.847	0.716	0.46	0.21	NA	2016-06-10 to 2023-11-06
CCR-AP-8	Radium-226 & 228	pCi/L	18	0	0	2.88000	0.449	1.46	1.48	0.66	0.43	NA	2017-03-09 to 2023-11-02
CCR-AP-9	Radium-226 & 228	pCi/L	18	0	0	12.60000	0.934	3.56	2.87	2.9	8.5	NA	2017-03-09 to 2023-05-23
CCR-AP-1R	Selenium, Total	mg/L	22	12	55	0.05000	0.00045	0.0114	0.005	0.015	0.00023	0.005 - 0.05	2016-06-10 to 2023-11-02
CCR-AP-2	Selenium, Total	mg/L	22	7	32	0.05000	0.00044	0.00882	0.005	0.012	0.00013	0.005 - 0.05	2016-06-10 to 2023-11-02
CCR-AP-3	Selenium, Total	mg/L	21	1	5	0.00680	0.00062	0.00223	0.0019	0.0013	1.7e-06	0.005 - 0.005	2016-06-10 to 2023-11-02
CCR-AP-4R	Selenium, Total	mg/L	21	10	48	0.03100	0.0009	0.00468	0.005	0.0063	3.9e-05	0.005 - 0.005	2016-06-10 to 2023-11-02
CCR-AP-5	Selenium, Total	mg/L	21	14	67	0.05000	0.0018	0.0076	0.005	0.01	0.00011	0.005 - 0.05	2016-06-10 to 2023-11-02
CCR-AP-6	Selenium, Total	mg/L	21	4	19	0.02500	0.001	0.00345	0.0019	0.0051	2.6e-05	0.005 - 0.025	2016-06-10 to 2023-11-02
CCR-AP-7	Selenium, Total	mg/L	21	18	86	0.00500	0.00035	0.00447	0.005	0.0014	1.9e-06	0.005 - 0.005	2016-06-10 to 2023-11-06
CCR-AP-8	Selenium, Total	mg/L	21	3	14	0.00700	0.0014	0.00271	0.0019	0.0016	2.7e-06	0.005 - 0.005	2017-03-09 to 2023-11-02
CCR-AP-9	Selenium, Total	mg/L	20	14	70	0.05000	0.001	0.0089	0.005	0.012	0.00014	0.005 - 0.05	2017-03-09 to 2023-05-23
CCR-AP-1R	Thallium, Total	mg/L	22	6	27	0.00500	7.9e-05	0.00102	0.0009	0.0011	1.2e-06	0.001 - 0.005	2016-06-10 to 2023-11-02
CCR-AP-2	Thallium, Total	mg/L	22	3	14	0.00760	4.8e-05	0.00117	0.000825	0.0018	3.1e-06	0.001 - 0.005	2016-06-10 to 2023-11-02
CCR-AP-3	Thallium, Total	mg/L	21	20	95	0.00200	0.0001	0.001	0.001	0.0003	9e-08	0.001 - 0.002	2016-06-10 to 2023-11-02
CCR-AP-4R	Thallium, Total	mg/L	21	11	52	0.00500	6.1e-05	0.000847	0.001	0.0011	1.2e-06	0.001 - 0.005	2016-06-10 to 2023-11-02
CCR-AP-5	Thallium, Total	mg/L	21	14	67	0.01000	6.5e-05	0.00119	0.001	0.0021	4.2e-06	0.001 - 0.01	2016-06-10 to 2023-11-02
CCR-AP-6	Thallium, Total	mg/L	21	13	62	0.00500	4.7e-05	0.000906	0.001	0.0011	1.1e-06	0.001 - 0.005	2016-06-10 to 2023-11-02
CCR-AP-7	Thallium, Total	mg/L	23	19	83	0.00200	6.6e-05	0.000906	0.001	0.0004	1.6e-07	0.001 - 0.002	2016-06-10 to 2023-11-06
CCR-AP-8	Thallium, Total	mg/L	21	16	76	0.00200	5.8e-05	0.00084	0.001	0.00046	2.1e-07	0.001 - 0.002	2017-03-09 to 2023-11-02
CCR-AP-9	Thallium, Total	mg/L	20	11	55	0.01000	9.8e-05	0.00133	0.001	0.0023	5.3e-06	0.001 - 0.01	2017-03-09 to 2023-05-23

Note:

Units: mg/L = milligrams per liter, pCi/L = picocuries per liter

Table A-2. Results of Shapiro-Wilk Test for Normality

				Shapiro-Wilk Test for Normality (R programming, package = stats, version 4.3.3, function = shapiro.test, non-detects substituted by 0.5*reporting limit)				Shapiro-Wilk Test for Lognormality on select datasets (R programming, package = stats, version 4.3.3, function = shapiro.test, non-detects substituted by 0.5*reporting limit, datasets log transformed)			
Location	**Constituent**	**n**	**n, non-detects**	**W statistic**	**p-value**	**Data Normality (significance level = 0.05)**	**Data Normality (significance level = 0.01)**	**W statistic**	**p-value**	**Data Normality (significance level = 0.05)**	**Data Normality (significance level = 0.01)**
CCR-AP-1R	Antimony, Total	22	6	0.6372	3.43e-06	Not normal	Not normal	NA	NA	NA	NA
CCR-AP-2	Antimony, Total	22	9	0.7025	2.11e-05	Not normal	Not normal	NA	NA	NA	NA
CCR-AP-3	Antimony, Total	21	16	0.4273	4.64e-08	Not normal	Not normal	NA	NA	NA	NA
CCR-AP-4R	Antimony, Total	21	14	0.3258	7.13e-09	Not normal	Not normal	NA	NA	NA	NA
CCR-AP-5	Antimony, Total	21	15	0.4615	9.16e-08	Not normal	Not normal	NA	NA	NA	NA
CCR-AP-6	Antimony, Total	21	9	0.368	1.52e-08	Not normal	Not normal	NA	NA	NA	NA
CCR-AP-7	Antimony, Total	23	20	0.4792	5.46e-08	Not normal	Not normal	NA	NA	NA	NA
CCR-AP-8	Antimony, Total	21	6	0.5705	9.75e-07	Not normal	Not normal	NA	NA	NA	NA
CCR-AP-9	Antimony, Total	20	5	0.7053	4.53e-05	Not normal	Not normal	NA	NA	NA	NA
CCR-AP-1R	Arsenic, Total	22	0	0.9073	0.0417	Not normal	Normal	NA	NA	NA	NA
CCR-AP-2	Arsenic, Total	22	0	0.8965	0.02527	Not normal	Normal	NA	NA	NA	NA
CCR-AP-3	Arsenic, Total	21	0	0.983	0.9612	Normal	Normal	NA	NA	NA	NA
CCR-AP-4R	Arsenic, Total	21	0	0.7996	0.0006464	Not normal	Not normal	0.9723	0.7831	Lognormal	Lognormal
CCR-AP-5	Arsenic, Total	20	2	0.5848	2.06e-06	Not normal	Not normal	0.8687	0.01113	Not normal	Lognormal
CCR-AP-6	Arsenic, Total	21	0	0.8715	0.01018	Not normal	Normal	NA	NA	NA	NA
CCR-AP-7	Arsenic, Total	23	0	0.8686	0.006032	Not normal	Not normal	NA	NA	NA	NA
CCR-AP-8	Arsenic, Total	21	0	0.9448	0.2712	Normal	Normal	NA	NA	NA	NA
CCR-AP-9	Arsenic, Total	20	0	0.7489	0.000164	Not normal	Not normal	NA	NA	NA	NA
CCR-AP-1R	Barium, Total	22	0	0.8819	0.01312	Not normal	Normal	NA	NA	NA	NA
CCR-AP-2	Barium, Total	22	0	0.9119	0.05174	Normal	Normal	NA	NA	NA	NA
CCR-AP-3	Barium, Total	21	0	0.9521	0.3731	Normal	Normal	NA	NA	NA	NA
CCR-AP-4R	Barium, Total	21	0	0.7672	0.0002157	Not normal	Not normal	NA	NA	NA	NA
CCR-AP-5	Barium, Total	21	0	0.7223	5.29e-05	Not normal	Not normal	NA	NA	NA	NA
CCR-AP-6	Barium, Total	21	0	0.9457	0.282	Normal	Normal	NA	NA	NA	NA
CCR-AP-7	Barium, Total	23	0	0.9567	0.3997	Normal	Normal	NA	NA	NA	NA
CCR-AP-8	Barium, Total	21	0	0.9349	0.1722	Normal	Normal	NA	NA	NA	NA
CCR-AP-9	Barium, Total	20	0	0.7778	0.00041	Not normal	Not normal	NA	NA	NA	NA
CCR-AP-1R	Beryllium, Total	22	0	0.89	0.01882	Not normal	Normal	NA	NA	NA	NA
CCR-AP-2	Beryllium, Total	22	0	0.786	0.0003046	Not normal	Not normal	NA	NA	NA	NA
CCR-AP-3	Beryllium, Total	21	20	0.2284	1.4e-09	Not normal	Not normal	NA	NA	NA	NA
CCR-AP-4R	Beryllium, Total	21	6	0.8028	0.0007251	Not normal	Not normal	NA	NA	NA	NA
CCR-AP-5	Beryllium, Total	21	15	0.3958	2.54e-08	Not normal	Not normal	NA	NA	NA	NA
CCR-AP-6	Beryllium, Total	21	8	0.5847	1.36e-06	Not normal	Not normal	NA	NA	NA	NA
CCR-AP-7	Beryllium, Total	23	16	0.7676	0.0001213	Not normal	Not normal	NA	NA	NA	NA
CCR-AP-8	Beryllium, Total	21	15	0.6685	1.14e-05	Not normal	Not normal	NA	NA	NA	NA
CCR-AP-9	Beryllium, Total	20	1	0.667	1.59e-05	Not normal	Not normal	NA	NA	NA	NA
CCR-AP-1R	Cadmium, Total	22	12	0.6371	3.42e-06	Not normal	Not normal	NA	NA	NA	NA
CCR-AP-2	Cadmium, Total	22	3	0.7407	6.75e-05	Not normal	Not normal	NA	NA	NA	NA
CCR-AP-3	Cadmium, Total	21	20	0.2284	1.4e-09	Not normal	Not normal	NA	NA	NA	NA
CCR-AP-4R	Cadmium, Total	21	11	0.5419	5.07e-07	Not normal	Not normal	NA	NA	NA	NA
CCR-AP-5	Cadmium, Total	21	5	0.4804	1.35e-07	Not normal	Not normal	NA	NA	NA	NA
CCR-AP-6	Cadmium, Total	21	8	0.8228	0.001493	Not normal	Not normal	NA	NA	NA	NA
CCR-AP-7	Cadmium, Total	23	21	0.4204	1.62e-08	Not normal	Not normal	NA	NA	NA	NA
CCR-AP-8	Cadmium, Total	21	15	0.6751	1.37e-05	Not normal	Not normal	NA	NA	NA	NA
CCR-AP-9	Cadmium, Total	20	9	0.5945	2.58e-06	Not normal	Not normal	NA	NA	NA	NA
CCR-AP-1R	Chromium, Total	22	0	0.8994	0.02887	Not normal	Normal	NA	NA	NA	NA
CCR-AP-2	Chromium, Total	22	0	0.8946	0.0232	Not normal	Normal	NA	NA	NA	NA
CCR-AP-3	Chromium, Total	21	4	0.5135	2.71e-07	Not normal	Not normal	NA	NA	NA	NA
CCR-AP-4R	Chromium, Total	20	2	0.7581	0.0002188	Not normal	Not normal	NA	NA	NA	NA
CCR-AP-5	Chromium, Total	21	16	0.4313	5.02e-08	Not normal	Not normal	NA	NA	NA	NA
CCR-AP-6	Chromium, Total	21	1	0.8563	0.005455	Not normal	Not normal	NA	NA	NA	NA
CCR-AP-7	Chromium, Total	23	11	0.5967	8.3e-07	Not normal	Not normal	NA	NA	NA	NA
CCR-AP-8	Chromium, Total	20	2	0.7875	0.0005657	Not normal	Not normal	NA	NA	NA	NA
CCR-AP-9	Chromium, Total	20	0	0.5688	1.42e-06	Not normal	Not normal	NA	NA	NA	NA
CCR-AP-1R	Cobalt, Total	22	0	0.8809	0.01255	Not normal	Normal	NA	NA	NA	NA
CCR-AP-2	Cobalt, Total	22	0	0.7759	0.000215	Not normal	Not normal	0.9796	0.909	Lognormal	Lognormal
CCR-AP-3	Cobalt, Total	21	0	0.9188	0.08221	Normal	Normal	NA	NA	NA	NA
CCR-AP-4R	Cobalt, Total	21	0	0.8624	0.007	Not normal	Not normal	NA	NA	NA	NA
CCR-AP-5	Cobalt, Total	21	0	0.9529	0.3867	Normal	Normal	NA	NA	NA	NA

				Shapiro-Wilk Test for Normality (R programming, package = stats, version 4.3.3, function = shapiro.test, non-detects substituted by 0.5*reporting limit)				Shapiro-Wilk Test for Lognormality on select datasets (R programming, package = stats, version 4.3.3, function = shapiro.test, non-detects substituted by 0.5*reporting limit, datasets log transformed)			
Location	**Constituent**	**n**	**n, non-detects**	**W statistic**	**p-value**	**Data Normality (significance level = 0.05)**	**Data Normality (significance level = 0.01)**	**W statistic**	**p-value**	**Data Normality (significance level = 0.05)**	**Data Normality (significance level = 0.01)**
CCR-AP-6	Cobalt, Total	21	0	0.912	0.06001	Normal	Normal	NA	NA	NA	NA
CCR-AP-7	Cobalt, Total	23	2	0.6111	1.2e-06	Not normal	Not normal	NA	NA	NA	NA
CCR-AP-8	Cobalt, Total	21	0	0.9659	0.6413	Normal	Normal	NA	NA	NA	NA
CCR-AP-9	Cobalt, Total	20	0	0.6873	2.74e-05	Not normal	Not normal	NA	NA	NA	NA
CCR-AP-1R	Fluoride	44	0	0.8774	0.0002353	Not normal	Not normal	NA	NA	NA	NA
CCR-AP-2	Fluoride	44	0	0.9309	0.01121	Not normal	Normal	NA	NA	NA	NA
CCR-AP-3	Fluoride	42	2	0.9362	0.02117	Not normal	Normal	NA	NA	NA	NA
CCR-AP-4R	Fluoride	42	2	0.9349	0.0191	Not normal	Normal	NA	NA	NA	NA
CCR-AP-5	Fluoride	42	0	0.8864	0.0005783	Not normal	Not normal	NA	NA	NA	NA
CCR-AP-6	Fluoride	42	0	0.9448	0.04207	Not normal	Normal	NA	NA	NA	NA
CCR-AP-7	Fluoride	44	0	0.8676	0.0001266	Not normal	Not normal	NA	NA	NA	NA
CCR-AP-8	Fluoride	42	2	0.7346	2.33e-07	Not normal	Not normal	NA	NA	NA	NA
CCR-AP-9	Fluoride	40	0	0.8556	0.0001233	Not normal	Not normal	NA	NA	NA	NA
CCR-AP-1R	Lead, Total	22	0	0.8984	0.02756	Not normal	Normal	NA	NA	NA	NA
CCR-AP-2	Lead, Total	22	0	0.8718	0.008464	Not normal	Not normal	0.944	0.2388	Lognormal	Lognormal
CCR-AP-3	Lead, Total	21	4	0.3724	1.65e-08	Not normal	Not normal	NA	NA	NA	NA
CCR-AP-4R	Lead, Total	21	0	0.7147	4.23e-05	Not normal	Not normal	NA	NA	NA	NA
CCR-AP-5	Lead, Total	21	13	0.4576	8.46e-08	Not normal	Not normal	NA	NA	NA	NA
CCR-AP-6	Lead, Total	21	0	0.8002	0.0006598	Not normal	Not normal	NA	NA	NA	NA
CCR-AP-7	Lead, Total	23	9	0.5867	6.47e-07	Not normal	Not normal	NA	NA	NA	NA
CCR-AP-8	Lead, Total	21	1	0.7841	0.0003785	Not normal	Not normal	NA	NA	NA	NA
CCR-AP-9	Lead, Total	20	0	0.8278	0.002312	Not normal	Not normal	NA	NA	NA	NA
CCR-AP-1R	Lithium, Total	22	0	0.9014	0.03172	Not normal	Normal	NA	NA	NA	NA
CCR-AP-2	Lithium, Total	22	5	0.7974	0.0004551	Not normal	Not normal	NA	NA	NA	NA
CCR-AP-3	Lithium, Total	21	18	0.6543	7.82e-06	Not normal	Not normal	NA	NA	NA	NA
CCR-AP-4R	Lithium, Total	21	6	0.8691	0.009226	Not normal	Not normal	NA	NA	NA	NA
CCR-AP-5	Lithium, Total	21	0	0.9559	0.4379	Normal	Normal	NA	NA	NA	NA
CCR-AP-6	Lithium, Total	21	11	0.5462	5.58e-07	Not normal	Not normal	NA	NA	NA	NA
CCR-AP-7	Lithium, Total	23	0	0.6987	1.35e-05	Not normal	Not normal	NA	NA	NA	NA
CCR-AP-8	Lithium, Total	21	16	0.7165	4.45e-05	Not normal	Not normal	NA	NA	NA	NA
CCR-AP-9	Lithium, Total	20	0	0.7294	9.11e-05	Not normal	Not normal	NA	NA	NA	NA
CCR-AP-1R	Mercury, Total	21	21	NA	NA	Not Evaluated - All Non-Detect Results	Not Evaluated - All Non-Detect Results	NA	NA	NA	NA
CCR-AP-2	Mercury, Total	21	13	0.603	2.12e-06	Not normal	Not normal	NA	NA	NA	NA
CCR-AP-3	Mercury, Total	20	20	NA	NA	Not Evaluated - All Non-Detect Results	Not Evaluated - All Non-Detect Results	NA	NA	NA	NA
CCR-AP-4R	Mercury, Total	20	20	NA	NA	Not Evaluated - All Non-Detect Results	Not Evaluated - All Non-Detect Results	NA	NA	NA	NA
CCR-AP-5	Mercury, Total	20	17	0.3998	4.45e-08	Not normal	Not normal	NA	NA	NA	NA
CCR-AP-6	Mercury, Total	20	18	0.4141	5.81e-08	Not normal	Not normal	NA	NA	NA	NA
CCR-AP-7	Mercury, Total	20	20	NA	NA	Not Evaluated - All Non-Detect Results	Not Evaluated - All Non-Detect Results	NA	NA	NA	NA
CCR-AP-8	Mercury, Total	20	19	0.3551	1.98e-08	Not normal	Not normal	NA	NA	NA	NA
CCR-AP-9	Mercury, Total	19	19	NA	NA	Not Evaluated - All Non-Detect Results	Not Evaluated - All Non-Detect Results	NA	NA	NA	NA
CCR-AP-1R	Molybdenum, Total	22	0	0.8283	0.001438	Not normal	Not normal	NA	NA	NA	NA
CCR-AP-2	Molybdenum, Total	22	0	0.9395	0.1932	Normal	Normal	NA	NA	NA	NA
CCR-AP-3	Molybdenum, Total	21	0	0.7939	0.0005304	Not normal	Not normal	NA	NA	NA	NA
CCR-AP-4R	Molybdenum, Total	21	3	0.6974	2.56e-05	Not normal	Not normal	NA	NA	NA	NA
CCR-AP-5	Molybdenum, Total	21	0	0.9467	0.2945	Normal	Normal	0.8362	0 002481	Not normal	Not normal
CCR-AP-6	Molybdenum, Total	21	0	0.9694	0.7203	Normal	Normal	NA	NA	NA	NA
CCR-AP-7	Molybdenum, Total	23	1	0.773	0.0001462	Not normal	Not normal	NA	NA	NA	NA
CCR-AP-8	Molybdenum, Total	21	0	0.9174	0.0771	Normal	Normal	NA	NA	NA	NA
CCR-AP-9	Molybdenum, Total	20	2	0.7168	6.3e-05	Not normal	Not normal	NA	NA	NA	NA
CCR-AP-1R	Radium-226 & 228	38	0	0.9063	0.003864	Not normal	Not normal	NA	NA	NA	NA
CCR-AP-1R	Radium-226 & 228	2	0	NA	NA	Not Evaluated - All Non-Detect Results	Not Evaluated - All Non-Detect Results	NA	NA	NA	NA
CCR-AP-2	Radium-226 & 228	40	2	0.8682	0.0002567	Not normal	Not normal	NA	NA	NA	NA
CCR-AP-3	Radium-226 & 228	38	2	0.81	1.68e-05	Not normal	Not normal	NA	NA	NA	NA
CCR-AP-4R	Radium-226 & 228	38	0	0.3859	1.94e-11	Not normal	Not normal	NA	NA	NA	NA
CCR-AP-5	Radium-226 & 228	38	0	0.6799	7.95e-08	Not normal	Not normal	NA	NA	NA	NA
CCR-AP-6	Radium-226 & 228	38	0	0.6464	2.51e-08	Not normal	Not normal	NA	NA	NA	NA

Location	Constituent	n	n, non-detects	Shapiro-Wilk Test for Normality (R programming, package = stats, version 4.3.3, function = shapiro.test, non-detects substituted by 0.5*reporting limit) W statistic	p-value	Data Normality (significance level = 0.05)	Data Normality (significance level = 0.01)	Shapiro-Wilk Test for Lognormality on select datasets (R programming, package = stats, version 4.3.3, function = shapiro.test, non-detects substituted by 0.5*reporting limit, datasets log transformed) W statistic	p-value	Data Normality (significance level = 0.05)	Data Normality (significance level = 0.01)
CCR-AP-7	Radium-226 & 228	40	0	0.9303	0.01645	Not normal	Normal	NA	NA	NA	NA
CCR-AP-8	Radium-226 & 228	36	0	0.9631	0.2682	Normal	Normal	NA	NA	NA	NA
CCR-AP-9	Radium-226 & 228	36	0	0.7516	2.03e-06	Not normal	Not normal	NA	NA	NA	NA
CCR-AP-1R	Selenium, Total	22	12	0.6681	7.89e-06	Not normal	Not normal	NA	NA	NA	NA
CCR-AP-2	Selenium, Total	22	7	0.7224	3.82e-05	Not normal	Not normal	NA	NA	NA	NA
CCR-AP-3	Selenium, Total	21	1	0.5491	5.96e-07	Not normal	Not normal	NA	NA	NA	NA
CCR-AP-4R	Selenium, Total	21	10	0.3121	5.63e-09	Not normal	Not normal	NA	NA	NA	NA
CCR-AP-5	Selenium, Total	21	14	0.4836	1.44e-07	Not normal	Not normal	NA	NA	NA	NA
CCR-AP-6	Selenium, Total	21	4	0.5151	2.81e-07	Not normal	Not normal	NA	NA	NA	NA
CCR-AP-7	Selenium, Total	21	18	0.4041	2.97e-08	Not normal	Not normal	NA	NA	NA	NA
CCR-AP-8	Selenium, Total	21	3	0.631	4.26e-06	Not normal	Not normal	NA	NA	NA	NA
CCR-AP-9	Selenium, Total	20	14	0.6214	4.95e-06	Not normal	Not normal	NA	NA	NA	NA
CCR-AP-1R	Thallium, Total	22	6	0.8126	0.0007934	Not normal	Not normal	NA	NA	NA	NA
CCR-AP-2	Thallium, Total	22	3	0.5215	2.11e-07	Not normal	Not normal	NA	NA	NA	NA
CCR-AP-3	Thallium, Total	21	20	0.4303	4.92e-08	Not normal	Not normal	NA	NA	NA	NA
CCR-AP-4R	Thallium, Total	21	11	0.6065	2.31e-06	Not normal	Not normal	NA	NA	NA	NA
CCR-AP-5	Thallium, Total	21	14	0.3788	1.85e-08	Not normal	Not normal	NA	NA	NA	NA
CCR-AP-6	Thallium, Total	21	13	0.6003	1.99e-06	Not normal	Not normal	NA	NA	NA	NA
CCR-AP-7	Thallium, Total	23	19	0.6225	1.61e-06	Not normal	Not normal	NA	NA	NA	NA
CCR-AP-8	Thallium, Total	21	16	0.7117	3.87e-05	Not normal	Not normal	NA	NA	NA	NA
CCR-AP-9	Thallium, Total	20	11	0.5154	4.39e-07	Not normal	Not normal	NA	NA	NA	NA

Table A-3. Results of Rosner/Dixon Test for Outliers

				Rosner or Dixon Test for Outliers (R programming, package = outliers, version 0.15, function = dixon.test or rosnerTest, non-detects substituted by 0.5*reporting limit)					
Location	Chemical	n	n_nd	Outlier Test	Statistic.Out	P.value.Out	Alternative	Statistical.Outlier	Outlier Removed
CCR-AP-1R	Antimony, Total	22	6	Dixon	0.5302	0.01366	highest value 0.01 is an outlier	Yes	No
CCR-AP-2	Antimony, Total	22	9	Dixon	0.5476	0.007539	highest value 0.01 is an outlier	Yes	No
CCR-AP-3	Antimony, Total	21	16	Dixon	0.9662	0	highest value 0.005 is an outlier	Yes	No
CCR-AP-4R	Antimony, Total	21	14	Dixon	0.9134	0	highest value 0.028 is an outlier	Yes	No
CCR-AP-5	Antimony, Total	21	15	Dixon	0.8111	0	highest value 0.01 is an outlier	Yes	No
CCR-AP-6	Antimony, Total	21	9	Dixon	0.9304	0	highest value 0.018 is an outlier	Yes	No
CCR-AP-7	Antimony, Total	23	20	Dixon	0.8982	0	highest value 0.0025 is an outlier	Yes	No
CCR-AP-8	Antimony, Total	21	6	Dixon	0.7729	0	highest value 0.0046 is an outlier	Yes	No
CCR-AP-9	Antimony, Total	20	5	Dixon	0.2278	0.9895	highest value 0.01 is an outlier	No	NA
CCR-AP-1R	Arsenic, Total	22	0	Dixon	0.1194	0.4192	highest value 0.038 is an outlier	No	NA
CCR-AP-2	Arsenic, Total	22	0	Dixon	0.3463	0.3107	highest value 0.048 is an outlier	No	NA
CCR-AP-3	Arsenic, Total	21	0	Dixon	0.3214	0.4391	lowest value 0.058 is an outlier	No	NA
CCR-AP-4R	Arsenic, Total	21	0	Dixon	0.4912	0.03981	highest value 0.33 is an outlier	Yes	No
CCR-AP-5	Arsenic, Total	20	2	Dixon	0.6319	0	highest value 0.024 is an outlier	Yes	No
CCR-AP-6	Arsenic, Total	21	0	Dixon	0.2857	0.6068	lowest value 0.04 is an outlier	No	NA
CCR-AP-7	Arsenic, Total	23	0	Dixon	0.5926	0	highest value 0.018 is an outlier	Yes	No
CCR-AP-8	Arsenic, Total	21	0	Dixon	0.2424	0.8592	lowest value 0.044 is an outlier	No	NA
CCR-AP-9	Arsenic, Total	20	0	Dixon	0.6489	0	highest value 0.032 is an outlier	Yes	No
CCR-AP-1R	Barium, Total	22	0	Dixon	0.2358	0.8565	highest value 0.59 is an outlier	No	NA
CCR-AP-2	Barium, Total	22	0	Dixon	0.2051	0.9493	highest value 0.64 is an outlier	No	NA
CCR-AP-3	Barium, Total	21	0	Dixon	0.1111	0.3494	highest value 0.49 is an outlier	No	NA
CCR-AP-4R	Barium, Total	21	0	Dixon	0.5455	0.01186	highest value 1.4 is an outlier	Yes	No
CCR-AP-5	Barium, Total	21	0	Dixon	0.4762	0.05385	highest value 0.2 is an outlier	No	NA
CCR-AP-6	Barium, Total	21	0	Dixon	0	0	highest value 0.69 is an outlier	Yes	No
CCR-AP-7	Barium, Total	23	0	Dixon	0.3333	0.3311	highest value 0.19 is an outlier	No	NA
CCR-AP-8	Barium, Total	21	0	Dixon	0.3529	0.3171	lowest value 0.31 is an outlier	No	NA
CCR-AP-9	Barium, Total	20	0	Dixon	0.6471	0	highest value 0.72 is an outlier	Yes	No
CCR-AP-1R	Beryllium, Total	22	0	Dixon	0.1637	0.6843	highest value 0.0066 is an outlier	No	NA
CCR-AP-2	Beryllium, Total	22	0	Dixon	0.3794	0.2069	highest value 0.0077 is an outlier	No	NA
CCR-AP-3	Beryllium, Total	21	20	Dixon	1	0	highest value 0 00056 is an outlier	Yes	No
CCR-AP-4R	Beryllium, Total	21	6	Dixon	0.3922	0.1971	highest value 0.0017 is an outlier	No	NA
CCR-AP-5	Beryllium, Total	21	15	Dixon	0.8918	0	highest value 0.005 is an outlier	Yes	No
CCR-AP-6	Beryllium, Total	21	8	Dixon	0.7974	0	highest value 0.0025 is an outlier	Yes	No
CCR-AP-7	Beryllium, Total	23	16	Dixon	0.1917	0.8982	lowest value 0.000067 is an outlier	No	NA
CCR-AP-8	Beryllium, Total	21	15	Dixon	0.1765	0.7338	lowest value 0 00016 is an outlier	No	NA
CCR-AP-9	Beryllium, Total	20	1	Dixon	0.7064	0	highest value 0.005 is an outlier	Yes	No
CCR-AP-1R	Cadmium, Total	22	12	Dixon	0.523	0.01631	highest value 0.005 is an outlier	Yes	No
CCR-AP-2	Cadmium, Total	22	3	Dixon	0.6592	0	highest value 0.0066 is an outlier	Yes	No
CCR-AP-3	Cadmium, Total	21	20	Dixon	1	0	lowest value 0.00038 is an outlier	Yes	No
CCR-AP-4R	Cadmium, Total	21	11	Dixon	0.7716	0	highest value 0.0025 is an outlier	Yes	No
CCR-AP-5	Cadmium, Total	21	5	Dixon	0.7851	0	highest value 0.005 is an outlier	Yes	No
CCR-AP-6	Cadmium, Total	21	8	Dixon	0.6304	0	highest value 0.0011 is an outlier	Yes	No
CCR-AP-7	Cadmium, Total	23	21	Dixon	0.5	0.02229	lowest value 0.00014 is an outlier	Yes	No
CCR-AP-8	Cadmium, Total	21	15	Dixon	0.08824	0 229	lowest value 0.00016 is an outlier	No	NA
CCR-AP-9	Cadmium, Total	20	9	Dixon	0.5112	0.03283	highest value 0.005 is an outlier	Yes	No
CCR-AP-1R	Chromium, Total	22	0	Dixon	0.2667	0.6731	highest value 0.16 is an outlier	No	NA
CCR-AP-2	Chromium, Total	22	0	Dixon	0.4255	0.1073	highest value 0.14 is an outlier	No	NA
CCR-AP-3	Chromium, Total	21	4	Dixon	0.7615	0	highest value 0.014 is an outlier	Yes	No
CCR-AP-4R	Chromium, Total	20	2	Dixon	0.5329	0.02096	highest value 0.058 is an outlier	Yes	No
CCR-AP-5	Chromium, Total	21	16	Dixon	0.8364	0	highest value 0.056 is an outlier	Yes	No
CCR-AP-6	Chromium, Total	21	1	Dixon	0.3509	0.3244	highest value 0.043 is an outlier	No	NA
CCR-AP-7	Chromium, Total	23	11	Dixon	0.7167	0	highest value 0.019 is an outlier	Yes	No
CCR-AP-8	Chromium, Total	20	2	Dixon	0.5635	0.009447	highest value 0.014 is an outlier	Yes	No
CCR-AP-9	Chromium, Total	20	0	Dixon	0.7436	0	highest value 0.15 is an outlier	Yes	No
CCR-AP-1R	Cobalt, Total	22	0	Dixon	0.07989	0.2086	highest value 0.081 is an outlier	No	NA
CCR-AP-2	Cobalt, Total	22	0	Dixon	0.6375	0	highest value 0.091 is an outlier	Yes	No
CCR-AP-3	Cobalt, Total	21	0	Dixon	0.28	0.6377	highest value 0.0094 is an outlier	No	NA
CCR-AP-4R	Cobalt, Total	21	0	Dixon	0.4145	0.1459	highest value 0.021 is an outlier	No	NA
CCR-AP-5	Cobalt, Total	21	0	Dixon	0.327	0.4161	highest value 0.01 is an outlier	No	NA
CCR-AP-6	Cobalt, Total	21	0	Dixon	0.3378	0.3734	highest value 0.019 is an outlier	No	NA
CCR-AP-7	Cobalt, Total	23	2	Dixon	0.6594	0	highest value 0.015 is an outlier	Yes	No
CCR-AP-8	Cobalt, Total	21	0	Dixon	0.3623	0 285	highest value 0.017 is an outlier	No	NA
CCR-AP-9	Cobalt, Total	20	0	Dixon	0.7179	0	highest value 0.047 is an outlier	Yes	No
CCR-AP-1R	Fluoride	22	0	Dixon	0.561	0.002602	highest value 0.81 is an outlier	Yes	No

Rosner or Dixon Test for Outliers (R programming, package = outliers, version 0.15, function = dixon.test or rosnerTest, non-detects substituted by 0.5*reporting limit)

Location	Chemical	n	n_nd	Outlier Test	Statistic.Out	P.value.Out	Alternative	Statistical.Outlier	Outlier Removed
CCR-AP-2	Fluoride	22	0	Dixon	0.3043	0.4808	highest value 0.69 is an outlier	No	NA
CCR-AP-3	Fluoride	21	1	Dixon	0.5	0.03305	highest value 0.93 is an outlier	Yes	No
CCR-AP-4R	Fluoride	21	1	Dixon	0.5455	0.01186	lowest value 0.05 is an outlier	Yes	No
CCR-AP-5	Fluoride	21	0	Dixon	0.2158	0.9746	highest value 2.3 is an outlier	No	NA
CCR-AP-6	Fluoride	21	0	Dixon	0.2791	0.6428	lowest value 0.24 is an outlier	No	NA
CCR-AP-7	Fluoride	22	0	Dixon	0.46	0.06051	highest value 0.72 is an outlier	No	NA
CCR-AP-8	Fluoride	21	1	Dixon	0.7473	0	highest value 1.1 is an outlier	Yes	No
CCR-AP-9	Fluoride	20	0	Dixon	0.48	0.06152	lowest value 0.14 is an outlier	No	NA
CCR-AP-1R	Lead, Total	22	0	Dixon	0.2064	0.9577	highest value 0.094 is an outlier	No	NA
CCR-AP-2	Lead, Total	22	0	Dixon	0.5041	0.02474	highest value 0.1 is an outlier	Yes	No
CCR-AP-3	Lead, Total	21	4	Dixon	0.8912	0	highest value 0.01 is an outlier	Yes	No
CCR-AP-4R	Lead, Total	21	0	Dixon	0.5752	0.001029	highest value 0.047 is an outlier	Yes	No
CCR-AP-5	Lead, Total	21	13	Dixon	0.7572	0	highest value 0.02 is an outlier	Yes	No
CCR-AP-6	Lead, Total	21	0	Dixon	0.5398	0.0138	highest value 0.041 is an outlier	Yes	No
CCR-AP-7	Lead, Total	23	9	Dixon	0.6051	0	highest value 0.02 is an outlier	Yes	No
CCR-AP-8	Lead, Total	21	1	Dixon	0.6125	0	highest value 0.0076 is an outlier	Yes	No
CCR-AP-9	Lead, Total	20	0	Dixon	0.4802	0.06127	highest value 0.041 is an outlier	No	NA
CCR-AP-1R	Lithium, Total	22	0	Dixon	0.3608	0.2619	highest value 0.23 is an outlier	No	NA
CCR-AP-2	Lithium, Total	22	5	Dixon	0.3889	0.1825	highest value 0.125 is an outlier	No	NA
CCR-AP-3	Lithium, Total	21	18	Dixon	0	0	highest value 0.025 is an outlier	Yes	No
CCR-AP-4R	Lithium, Total	21	6	Dixon	0.4989	0.03386	highest value 0.047 is an outlier	Yes	No
CCR-AP-5	Lithium, Total	21	0	Dixon	0.1844	0.7837	lowest value 0.009 is an outlier	No	NA
CCR-AP-6	Lithium, Total	21	11	Dixon	0.8163	0	highest value 0.125 is an outlier	Yes	No
CCR-AP-7	Lithium, Total	23	0	Dixon	0.6355	0	highest value 0.039 is an outlier	Yes	No
CCR-AP-8	Lithium, Total	21	16	Dixon	0	0	highest value 0.025 is an outlier	Yes	No
CCR-AP-9	Lithium, Total	20	0	Dixon	0.6437	0	highest value 0.12 is an outlier	Yes	No
CCR-AP-1R	Mercury, Total	21	21	Dixon	NA	NA	Not Evlauated - All results are non-detect	NA	NA
CCR-AP-2	Mercury, Total	21	13	Dixon	0.541	0.0134	highest value 0 00071 is an outlier	Yes	No
CCR-AP-3	Mercury, Total	20	20	Dixon	NA	NA	Not Evlauated - All results are non-detect	NA	NA
CCR-AP-4R	Mercury, Total	20	20	Dixon	NA	NA	Not Evlauated - All results are non-detect	NA	NA
CCR-AP-5	Mercury, Total	20	17	Dixon	0.8533	0	highest value 0.0016 is an outlier	Yes	No
CCR-AP-6	Mercury, Total	20	18	Dixon	0.7742	0	highest value 0 00041 is an outlier	Yes	No
CCR-AP-7	Mercury, Total	20	20	Dixon	NA	NA	Not Evlauated - All results are non-detect	NA	NA
CCR-AP-8	Mercury, Total	20	19	Dixon	1	0	highest value 0 00026 is an outlier	Yes	No
CCR-AP-9	Mercury, Total	19	19	Dixon	NA	NA	Not Evlauated - All results are non-detect	NA	NA
CCR-AP-1R	Molybdenum, Total	22	0	Dixon	0.5882	0	highest value 0.023 is an outlier	Yes	No
CCR-AP-2	Molybdenum, Total	22	0	Dixon	0.2558	0.7355	highest value 0.01 is an outlier	No	NA
CCR-AP-3	Molybdenum, Total	21	0	Dixon	0.6145	0	highest value 0.025 is an outlier	Yes	No
CCR-AP-4R	Molybdenum, Total	21	3	Dixon	0.5954	0	highest value 0.01 is an outlier	Yes	No
CCR-AP-5	Molybdenum, Total	21	0	Dixon	0.2733	0.6752	lowest value 0.046 is an outlier	No	NA
CCR-AP-6	Molybdenum, Total	21	0	Dixon	0.2105	0.9425	highest value 0.037 is an outlier	No	NA
CCR-AP-7	Molybdenum, Total	23	1	Dixon	0.4138	0.1122	highest value 0.013 is an outlier	No	NA
CCR-AP-8	Molybdenum, Total	21	0	Dixon	0.4712	0.05917	highest value 0.029 is an outlier	No	NA
CCR-AP-9	Molybdenum, Total	20	2	Dixon	0.6278	0	highest value 0.025 is an outlier	Yes	No
CCR-AP-1R	Radium-226 & 228	20	0	Dixon	0.5301	0.02225	highest value 14.4 is an outlier	Yes	No
CCR-AP-2	Radium-226 & 228	20	1	Dixon	0.47	0.07269	highest value 5.53 is an outlier	No	NA
CCR-AP-3	Radium-226 & 228	19	1	Dixon	0.5436	0.02151	highest value 4.87 is an outlier	Yes	No
CCR-AP-4R	Radium-226 & 228	19	0	Dixon	0.8959	0	highest value 30 is an outlier	Yes	No
CCR-AP-5	Radium-226 & 228	19	0	Dixon	0.5277	0.03011	highest value 5.54 is an outlier	Yes	No
CCR-AP-6	Radium-226 & 228	19	0	Dixon	0.7767	0	highest value 10.2 is an outlier	Yes	No
CCR-AP-7	Radium-226 & 228	20	0	Dixon	0.2152	0 935	highest value 1.72 is an outlier	No	NA
CCR-AP-8	Radium-226 & 228	18	0	Dixon	0.3621	0.3958	highest value 2.88 is an outlier	No	NA
CCR-AP-9	Radium-226 & 228	18	0	Dixon	0.58	0.01299	highest value 12.6 is an outlier	Yes	No
CCR-AP-1R	Selenium, Total	22	12	Dixon	0	0	highest value 0.025 is an outlier	Yes	No
CCR-AP-2	Selenium, Total	22	7	Dixon	0.4049	0.1462	highest value 0.026 is an outlier	No	NA
CCR-AP-3	Selenium, Total	21	1	Dixon	0.8269	0	highest value 0.0068 is an outlier	Yes	No
CCR-AP-4R	Selenium, Total	21	10	Dixon	0.9532	0	highest value 0.031 is an outlier	Yes	No
CCR-AP-5	Selenium, Total	21	14	Dixon	0.7867	0	highest value 0.025 is an outlier	Yes	No
CCR-AP-6	Selenium, Total	21	4	Dixon	0.8407	0	highest value 0.0125 is an outlier	Yes	No
CCR-AP-7	Selenium, Total	21	18	Dixon	1	0	lowest value 0 00035 is an outlier	Yes	No
CCR-AP-8	Selenium, Total	21	3	Dixon	0.6909	0	highest value 0.007 is an outlier	Yes	No
CCR-AP-9	Selenium, Total	20	14	Dixon	0.5297	0.02246	highest value 0.025 is an outlier	Yes	No
CCR-AP-1R	Thallium, Total	22	6	Dixon	0.4977	0.02832	highest value 0.0027 is an outlier	Yes	No
CCR-AP-2	Thallium, Total	22	3	Dixon	0.8445	0	highest value 0.0076 is an outlier	Yes	No
CCR-AP-3	Thallium, Total	21	20	Dixon	1	0	highest value 0.001 is an outlier	Yes	No
CCR-AP-4R	Thallium, Total	21	11	Dixon	0.8207	0	highest value 0.0025 is an outlier	Yes	No

Rosner or Dixon Test for Outliers (R programming, package = outliers, version 0.15, function = dixon.test or rosnerTest, non-detects substituted by 0.5*reporting limit)

Location	Chemical	n	n_nd	Outlier Test	Statistic.Out	P.value.Out	Alternative	Statistical.Outlier	Outlier Removed
CCR-AP-5	Thallium, Total	21	14	Dixon	0.9298	0	highest value 0.005 is an outlier	Yes	No
CCR-AP-6	Thallium, Total	21	13	Dixon	0.8299	0	highest value 0.0025 is an outlier	Yes	No
CCR-AP-7	Thallium, Total	23	19	Dixon	0.5482	0.003983	highest value 0.001 is an outlier	Yes	No
CCR-AP-8	Thallium, Total	21	16	Dixon	0.5453	0.01192	highest value 0.001 is an outlier	Yes	No
CCR-AP-9	Thallium, Total	20	11	Dixon	0.8221	0	highest value 0.005 is an outlier	Yes	No

Table A-4. Results of Mann Kendall and Thiel Sen Trend Tests

		Mann Kendall Trends			Secular Trend Evaluation for All Data									Secular Trend Evaluation for Recent Data (subset of 8 most recent data points)								
					Mann-Kendall Test (R programming, package = Kendall, version = 2.2.1, function = MannKendall, non-detects substituted by 0.5*reporting limit)							Thiel-Sen Test (R programming, package = trend, version = 1.1.6, function = sens.slope, non-detects substituted by 0.5*reporting limit)		Mann-Kendall Test (R programming, package = Kendall, version = 2.2.1, function = MannKendall, non-detects substituted by 0.5*reporting limit)							Thiel-Sen Test (R programming, package = trend, version = 1.1.6, function = sens.slope, non-detects substituted by 0.5*reporting limit)	
Location	Constituent	Trends, All Data	Trends, Recent Data	Seasonal Mann Kendall Used	n	n, detected results	Coefficient of Variance	Kendall's Tau	p-value	Confidence Factor	Kendall Score (S)	Sen Slope (mg/L per year)	p-value	n	n, detected results	recent data date range	Coefficient of Variance	Kendall's Tau	p-value	Confidence Factor	Kendall Score (S)	Sen Slope (mg/L per year)	p-value
CCR-AP-1R	Antimony, Total	No Trend	Stable	No	22	16	1.18	0.133	0.41	59	30	0.0000192	0.41	8	8	2020-11-13 to 2023-11-02	0.658	-0.182	0.618	38.2	-5	-0.000088	0.618
CCR-AP-2	Antimony, Total	No Trend	No Trend	No	22	13	1.05	0.239	0.138	86.2	53	0.00002	0.138	8	8	2020-11-12 to 2023-11-02	1.01	0.327	0.319	68.1	9	0.000105	0.319
CCR-AP-3	Antimony, Total	Not Evaluated - Majority of data (>50%) non-detect.	Not Evaluated - Majority of data (>50%) non-detect.	No	21	5	0.783	NA	NA	NA	NA	NA	NA	8	3	2020-05-20 to 2023-11-02	0.878	NA	NA	NA	NA	NA	NA
CCR-AP-4R	Antimony, Total	Not Evaluated - Majority of data (>50%) non-detect.	No Trend	No	21	7	2.3	NA	NA	NA	NA	NA	NA	8	5	2020-05-20 to 2023-11-02	1.99	0.189	0.61	39	5	0.000188	0.61
CCR-AP-5	Antimony, Total	Not Evaluated - Majority of data (>50%) non-detect.	Probably Increasing	No	21	6	1.34	NA	NA	NA	NA	NA	NA	8	5	2020-05-19 to 2023-11-02	0.916	0.567	0.0746	92.5	15	0.000172	0.0746
CCR-AP-6	Antimony, Total	No Trend	No Trend	No	21	12	1.99	0.0837	0.636	36.4	16	0	0.636	8	6	2020-05-20 to 2023-11-02	2	0.34	0.308	69.2	9	0.000134	0.308
CCR-AP-7	Antimony, Total	Not Evaluated - Majority of data (>50%) non-detect.	Not Evaluated - Only one detected result.	No	23	3	0.375	NA	NA	NA	NA	NA	NA	8	1	2020-05-18 to 2023-11-06	0.465	NA	NA	NA	NA	NA	NA
CCR-AP-8	Antimony, Total	Stable	No Trend	No	21	15	0.826	-0.217	0.195	80.5	-43	-0.0000177	0.195	8	7	2020-05-20 to 2023-11-02	1.15	0.0714	0.902	9 8	2	0.0000211	0.902
CCR-AP-9	Antimony, Total	No Trend	No Trend	No	20	15	1.07	0	1	0	0	0	1	8	6	2019-10-22 to 2023-05-23	1	-0.214	0.536	46.4	-6	-0.000162	0.536
CCR-AP-1R	Arsenic, Total	Increasing	Stable	No	22	22	0.69	0.422	0.00675	99.3	97	0.000708	0.00675	8	8	2020-11-13 to 2023-11-02	0.45	-0.143	0.711	28.9	-4	-0 001	0.711
CCR-AP-2	Arsenic, Total	Increasing	Probably Increasing	No	22	22	0.828	0.616	0.0000769	100	141	0.00145	0.0000769	8	8	2020-11-12 to 2023-11-02	0.604	0.571	0.0635	93.7	16	0.005	0.0635
CCR-AP-3	Arsenic, Total	Increasing	Stable	No	21	21	0.114	0.402	0.0136	98.6	82	0.000818	0.0136	8	8	2020-05-20 to 2023-11-02	0.0802	-0.0378	1	0	-1	0	1
CCR-AP-4R	Arsenic, Total	Increasing	No Trend	No	21	21	0.7	0.538	0.000782	99.9	112	0.00618	0.000782	8	8	2020-05-20 to 2023-11-02	0.521	0.0714	0.902	9 8	2	0 00325	0.902
CCR-AP-5	Arsenic, Total	Increasing	Increasing	No	20	18	1.67	0.515	0.00181	99.8	97	0.000226	0.00181	8	8	2020-05-19 to 2023-11-02	1.05	0.909	0.00277	99.7	25	0 00204	0 00277
CCR-AP-6	Arsenic, Total	Increasing	Stable	No	21	21	0.228	0.419	0.0117	98.8	83	0.00206	0.0117	8	8	2020-05-20 to 2023-11-02	0.0759	-0.161	0.694	30.6	-4	0	0.694
CCR-AP-7	Arsenic, Total	Decreasing	Stable	No	23	23	0.701	-0.363	0.0173	98.3	-91	-0.000232	0.0173	8	8	2020-05-18 to 2023-11-06	0.972	-0.473	0.135	86.5	-13	-0.000733	0.135
CCR-AP-8	Arsenic, Total	Increasing	Stable	No	21	21	0.243	0.572	0.000422	100	117	0.00294	0.000422	8	8	2020-05-20 to 2023-11-02	0.169	-0.512	0.12	88	-13	-0.00333	0.12
CCR-AP-9	Arsenic, Total	No Trend	Stable	No	20	20	0.604	0.239	0.153	84.7	45	0.000226	0.153	8	8	2019-10-22 to 2023-05-23	0.415	-0.255	0.454	54.6	-7	-0.000633	0.454
CCR-AP-1R	Barium, Total	Increasing	Stable	No	22	22	0.684	0.312	0.0452	95.5	72	0.00842	0.0452	8	8	2020-11-13 to 2023-11-02	0.343	-0.0714	0.902	9 8	-2	-0.00667	0.902
CCR-AP-2	Barium, Total	Increasing	Increasing	No	22	22	0.678	0.436	0.00519	99.5	100	0.015	0.00519	8	8	2020-11-12 to 2023-11-02	0.617	0.714	0.0187	98.1	20	0.08	0.0187
CCR-AP-3	Barium, Total	No Trend	No Trend	No	21	21	0.0734	0.261	0.114	88.6	53	0.002	0.114	8	8	2020-05-20 to 2023-11-02	0.0765	0.0364	1	0	1	0 00167	1
CCR-AP-4R	Barium, Total	No Trend	No Trend	No	21	21	0.351	0.0823	0.628	37.2	17	0.00333	0.628	8	8	2020-05-20 to 2023-11-02	0.416	0.182	0.618	38.2	5	0.0317	0.618
CCR-AP-5	Barium, Total	Increasing	Probably Increasing	No	21	21	0.723	0.612	0.000124	100	128	0.00358	0.000124	8	8	2020-05-19 to 2023-11-02	0.558	0.571	0.0635	93.7	16	0.0161	0.0635
CCR-AP-6	Barium, Total	Stable	Decreasing	No	21	21	0.114	-0.161	0.332	66.8	-33	-0.00258	0.332	8	8	2020-05-20 to 2023-11-02	0.126	-0.618	0.0461	95.4	-17	-0 015	0.0461
CCR-AP-7	Barium, Total	Decreasing	Stable	No	23	23	0.224	-0.367	0.019	98.1	-89	-0.00222	0.019	8	8	2020-05-18 to 2023-11-06	0.302	-0.4	0.212	78.8	-11	-0.00625	0.212
CCR-AP-8	Barium, Total	Decreasing	Decreasing	No	21	21	0.176	-0.496	0.00202	99.8	-103	-0.01	0.00202	8	8	2020-05-20 to 2023-11-02	0.197	-0.618	0.0461	95.4	-17	-0 0317	0.0461
CCR-AP-9	Barium, Total	Increasing	Stable	No	20	20	0.416	0.344	0.04	96	64	0.00812	0.04	8	8	2019-10-22 to 2023-05-23	0.267	-0.0364	1	0	-1	-0.00167	1
CCR-AP-1R	Beryllium, Total	Increasing	Stable	No	22	22	0.804	0.42	0.00679	99.3	97	0.00018	0.00679	8	8	2020-11-13 to 2023-11-02	0.518	-0.143	0.711	28.9	-4	-0.000292	0.711
CCR-AP-2	Beryllium, Total	Increasing	No Trend	No	22	22	0.981	0.57	0.000244	100	131	0.00016	0.000244	8	8	2020-11-12 to 2023-11-02	0.736	0.286	0.386	61.4	8	0.000707	0.386
CCR-AP-3	Beryllium, Total	Not Evaluated - Only one detected result.	Not Evaluated - Only one detected result.	No	21	1	0.026	NA	NA	NA	NA	NA	NA	8	1	2020-05-20 to 2023-11-02	0.0418	NA	NA	NA	NA	NA	NA
CCR-AP-4R	Beryllium, Total	Increasing	Stable	No	21	15	0.713	0.44	0.0071	99.3	89	0.0000213	0.0071	8	4	2020-05-20 to 2023-11-02	0.62	-0.242	0.507	49.3	-6	-0.00000214	0.507
CCR-AP-5	Beryllium, Total	Not Evaluated - Majority of data (>50%) non-detect.	Not Evaluated - Only one detected result.	No	21	6	1.33	NA	NA	NA	NA	NA	NA	8	1	2020-05-19 to 2023-11-02	0.61	NA	NA	NA	NA	NA	NA
CCR-AP-6	Beryllium, Total	No Trend	Not Evaluated - Majority of data (>50%) non-detect.	No	21	13	0.946	0.218	0.188	81.2	44	0.00000882	0.188	8	3	2020-05-20 to 2023-11-02	0.544	NA	NA	NA	NA	NA	NA
CCR-AP-7	Beryllium, Total	Not Evaluated - Majority of data (>50%) non-detect.	Not Evaluated - Only one detected result.	No	23	7	0.415	NA	NA	NA	NA	NA	NA	8	1	2020-05-18 to 2023-11-06	0.253	NA	NA	NA	NA	NA	NA
CCR-AP-8	Beryllium, Total	Not Evaluated - Majority of data (>50%) non-detect.	Not Evaluated - Majority of data (>50%) non-detect.	No	21	6	0.302	NA	NA	NA	NA	NA	NA	8	2	2020-05-20 to 2023-11-02	0.295	NA	NA	NA	NA	NA	NA
CCR-AP-9	Beryllium, Total	Increasing	Stable	No	20	19	1.01	0.383	0.021	97.9	72	0.000046	0.021	8	7	2019-10-22 to 2023-05-23	0.898	-0.0714	0.902	9 8	-2	-0.0000325	0.902
CCR-AP-1R	Cadmium, Total	Not Evaluated - Majority of data (>50%) non-detect.	Decreasing	No	22	10	1.31	NA	NA	NA	NA	NA	NA	8	6	2020-11-13 to 2023-11-02	1.27	-0.643	0.0354	96.5	-18	-0.0000487	0.0354

Note:
Mann Kendall Trends are classified based on Aziz (2003) guidance.

		Mann Kendall Trends			Secular Trend Evaluation for All Data									Secular Trend Evaluation for Recent Data (subset of 8 most recent data points)								
					Mann-Kendall Test (R programming, package = Kendall, version = 2.2.1, function = MannKendall, non-detects substituted by 0.5*reporting limit)							Thiel-Sen Test (R programming, package = trend, version = 1.1.6, function = sens.slope, non-detects substituted by 0.5*reporting limit)		Mann-Kendall Test (R programming, package = Kendall, version = 2.2.1, function = MannKendall, non-detects substituted by 0.5*reporting limit)							Thiel-Sen Test (R programming, package = trend, version = 1.1.6, function = sens.slope, non-detects substituted by 0.5*reporting limit)	
Location	Constituent	Trends, All Data	Trends, Recent Data	Seasonal Mann Kendall Used	n	n, detected results	Coefficient of Variance	Kendall's Tau	p-value	Confidence Factor	Kendall Score (S)	Sen Slope (mg/L per year)	p-value	n	n, detected results	recent data date range	Coefficient of Variance	Kendall's Tau	p-value	Confidence Factor	Kendall Score (S)	Sen Slope (mg/L per year)	p-value
CCR-AP-2	Cadmium, Total	Increasing	No Trend	No	22	19	1.04	0.383	0.014	98.6	88	0.0000547	0.014	8	8	2020-11-12 to 2023-11-02	1.07	0.255	0.454	54.6	7	0.000164	0.454
CCR-AP-3	Cadmium, Total	Not Evaluated - Only one detected result.	Not Evaluated - Only one detected result.	No	21	1	0.053	NA	NA	NA	NA	NA	NA	8	1	2020-05-20 to 2023-11-02	0.0875	NA	NA	NA	NA	NA	NA
CCR-AP-4R	Cadmium, Total	Not Evaluated - Majority of data (>50%) non-detect.	Stable	No	21	10	0.922	NA	NA	NA	NA	NA	NA	8	4	2020-05-20 to 2023-11-02	0.309	0	1	0	0	0	1
CCR-AP-5	Cadmium, Total	No Trend	No Trend	No	21	16	1.41	0.0971	0.564	43.6	20	0.00000735	0.564	8	5	2020-05-19 to 2023-11-02	0.559	0.265	0.445	55.5	7	0.0000588	0.445
CCR-AP-6	Cadmium, Total	No Trend	Not Evaluated - Majority of data (>50%) non-detect.	No	21	13	0.499	0.178	0.298	70.2	34	0	0.298	8	2	2020-05-20 to 2023-11-02	0.52	NA	NA	NA	NA	NA	NA
CCR-AP-7	Cadmium, Total	Not Evaluated - Majority of data (>50%) non-detect.	Not Evaluated - No detected results.	No	23	2	0.203	NA	NA	NA	NA	NA	NA	8	0	2020-05-18 to 2023-11-06	0.189	NA	No detected results.	NA	NA	NA	No detected results.
CCR-AP-8	Cadmium, Total	Not Evaluated - Majority of data (>50%) non-detect.	No Trend	No	21	6	0.308	NA	NA	NA	NA	NA	NA	8	4	2020-05-20 to 2023-11-02	0.383	0.206	0.592	40.8	5	0	0.592
CCR-AP-9	Cadmium, Total	Increasing	Not Evaluated - Majority of data (>50%) non-detect.	No	20	11	1.6	0.492	0.00351	99.6	90	0.0000236	0.00351	8	2	2019-10-22 to 2023-05-23	1.33	NA	NA	NA	NA	NA	NA
CCR-AP-1R	Chromium, Total	Increasing	No Trend	No	22	22	0.826	0.378	0.0152	98.5	87	0.00312	0.0152	8	8	2020-11-13 to 2023-11-02	0.448	0.0714	0.902	9 8	2	0.0028	0.902
CCR-AP-2	Chromium, Total	Increasing	Increasing	No	22	22	0.85	0.558	0.000307	100	129	0.004	0.000307	8	8	2020-11-12 to 2023-11-02	0.709	0.714	0.0187	98.1	20	0.0163	0.0187
CCR-AP-3	Chromium, Total	No Trend	No Trend	No	21	17	0.979	0.24	0.15	85	48	0.0000361	0.15	8	7	2020-05-20 to 2023-11-02	1.11	0.182	0.618	38.2	5	0.000138	0.618
CCR-AP-4R	Chromium, Total	No Trend	No Trend	No	20	18	0.885	0.243	0.144	85.6	46	0.000386	0.144	8	7	2020-05-20 to 2023-11-02	0.858	0.0714	0.902	9 8	2	0.000317	0.902
CCR-AP-5	Chromium, Total	Not Evaluated - Majority of data (>50%) non-detect.	Probably Increasing	No	21	5	2.27	NA	NA	NA	NA	NA	NA	8	4	2020-05-19 to 2023-11-02	1.63	0.564	0.0842	91.6	14	0 00236	0.0842
CCR-AP-6	Chromium, Total	Stable	No Trend	No	21	20	0.833	-0.101	0.545	45.5	-21	-0.000148	0.545	8	7	2020-05-20 to 2023-11-02	1.33	-0.214	0.536	46.4	-6	-0.00035	0.536
CCR-AP-7	Chromium, Total	No Trend	Not Evaluated - Only one detected result.	No	23	12	1.27	0.0422	0.808	19.2	10	0	0.808	8	1	2020-05-18 to 2023-11-06	0.805	NA	NA	NA	NA	NA	NA
CCR-AP-8	Chromium, Total	No Trend	No Trend	No	20	18	0.851	0.0212	0.922	7.8	4	0.00000972	0.922	8	7	2020-05-20 to 2023-11-02	1.01	-0.182	0.618	38.2	-5	-0.000287	0.618
CCR-AP-9	Chromium, Total	Increasing	No Trend	No	20	20	1.2	0.462	0.0052	99.5	87	0.00129	0.0052	8	8	2019-10-22 to 2023-05-23	0.491	0.109	0.803	19.7	3	0 00108	0.803
CCR-AP-1R	Cobalt, Total	Increasing	Stable	No	22	22	0.816	0.434	0.00523	99.5	100	0.00192	0.00523	8	8	2020-11-13 to 2023-11-02	0.561	-0.0714	0.902	9 8	-2	-0.000633	0.902
CCR-AP-2	Cobalt, Total	Increasing	Probably Increasing	No	22	22	0.717	0.627	0.0000541	100	144	0.00164	0.0000541	8	8	2020-11-12 to 2023-11-02	0.654	0.571	0.0635	93.7	16	0 00774	0.0635
CCR-AP-3	Cobalt, Total	Decreasing	No Trend	No	21	21	0.261	-0.581	0.000258	100	-122	-0.000195	0.000258	8	8	2020-05-20 to 2023-11-02	0.324	0.0714	0.902	9 8	2	0.0001	0.902
CCR-AP-4R	Cobalt, Total	No Trend	Stable	Yes	21	21	0.623	0.0334	0.856	14.4	7	0.0000144	0.856	8	8	2020-05-20 to 2023-11-02	0.671	-0.0714	0.902	9 8	-2	-0.000179	0.902
CCR-AP-5	Cobalt, Total	Decreasing	Increasing	No	21	21	0.639	-0.49	0.00225	99.8	-102	-0.000355	0.00225	8	8	2020-05-19 to 2023-11-02	1.22	0.618	0.0461	95.4	17	0.000712	0.0461
CCR-AP-6	Cobalt, Total	Stable	Stable	No	21	21	0.502	-0.181	0.264	73.6	-38	-0.000168	0.264	8	8	2020-05-20 to 2023-11-02	0.738	-0.143	0.711	28.9	-4	-0.000147	0.711
CCR-AP-7	Cobalt, Total	Decreasing	No Trend	No	23	21	1.47	-0.377	0.013	98.7	-95	-0.00009	0.013	8	6	2020-05-18 to 2023-11-06	1.4	0.0714	0.902	9 8	2	0.0000247	0.902
CCR-AP-8	Cobalt, Total	Decreasing	Stable	No	21	21	0.439	-0.586	0.000275	100	-121	-0.000475	0.000275	8	8	2020-05-20 to 2023-11-02	0.509	-0.214	0.536	46.4	-6	-0.000545	0.536
CCR-AP-9	Cobalt, Total	Increasing	Stable	No	20	20	0.556	0.368	0.0286	97.1	68	0.000341	0.0286	8	8	2019-10-22 to 2023-05-23	0.281	-0.0378	1	0	-1	0	1
CCR-AP-1R	Fluoride	Decreasing	Decreasing	No	22	22	0.189	-0.435	0.00594	99.4	-98	-0.00692	0.00594	8	8	2020-11-13 to 2023-11-02	0.163	-0.837	0.00609	99.4	-23	-0.02	0 00609
CCR-AP-2	Fluoride	Increasing	No Trend	No	22	22	0.415	0.586	0.000171	100	134	0.0167	0.000171	8	8	2020-11-12 to 2023-11-02	0.255	0.182	0.618	38.2	5	0.03	0.618
CCR-AP-3	Fluoride	Stable	Stable	No	21	20	0.482	-0.216	0.183	81.7	-45	-0.0105	0.183	8	8	2020-05-20 to 2023-11-02	0.402	-0.357	0.266	73.4	-10	-0 0179	0.266
CCR-AP-4R	Fluoride	No Trend	No Trend	No	21	20	0.314	0.158	0.333	66.7	33	0.005	0.333	8	8	2020-05-20 to 2023-11-02	0.279	0.0714	0.902	9 8	2	0.0117	0.902
CCR-AP-5	Fluoride	Increasing	No Trend	No	21	21	0.349	0.544	0.000765	99.9	112	0.05	0.000765	8	8	2020-05-19 to 2023-11-02	0.312	0.371	0.258	74.2	10	0.139	0.258
CCR-AP-6	Fluoride	Stable	No Trend	No	21	21	0.263	-0.067	0.694	30.6	-14	-0.00375	0.694	8	8	2020-05-20 to 2023-11-02	0.303	0.0714	0.902	9 8	2	0.009	0.902
CCR-AP-7	Fluoride	Increasing	No Trend	No	22	22	0.397	0.368	0.019	98.1	84	0.00875	0.019	8	8	2020-05-18 to 2023-11-06	0.333	0.182	0.618	38.2	5	0.0267	0.618
CCR-AP-8	Fluoride	No Trend	No Trend	No	21	20	0.648	0.192	0.238	76.2	40	0.00764	0.238	8	8	2020-05-20 to 2023-11-02	0.757	0.327	0.319	68.1	9	0.0333	0.319
CCR-AP-9	Fluoride	No Trend	No Trend	No	20	20	0.198	0.14	0.415	58.5	26	0.00172	0.415	8	8	2019-10-22 to 2023-05-23	0.199	0.182	0.618	38.2	5	0.0045	0.618
CCR-AP-1R	Lead, Total	Increasing	Stable	No	22	22	0.815	0.429	0.00572	99.4	99	0.00194	0.00572	8	8	2020-11-13 to 2023-11-02	0.541	0	1	0	0	0 00025	1
CCR-AP-2	Lead, Total	Increasing	Increasing	No	22	22	0.883	0.566	0.000271	100	130	0.0025	0.000271	8	8	2020-11-12 to 2023-11-02	0.736	0.643	0.0354	96.5	18	0.0101	0.0354
CCR-AP-3	Lead, Total	Increasing	No Trend	No	21	17	1.85	0.348	0.0314	96.9	72	0.0000223	0.0314	8	7	2020-05-20 to 2023-11-02	1.61	0.214	0.536	46.4	6	0.000132	0.536
CCR-AP-4R	Lead, Total	No Trend	Stable	Yes	21	21	0.908	0.173	0.29	71	36	0.000167	0.29	8	8	2020-05-20 to 2023-11-02	0.856	-0.0714	0.902	9 8	-2	-0.00045	0.902

Note:
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		Mann Kendall Trends			Secular Trend Evaluation for All Data									Secular Trend Evaluation for Recent Data (subset of 8 most recent data points)								
					Mann-Kendall Test (R programming, package = Kendall, version = 2.2.1, function = MannKendall, non-detects substituted by 0.5*reporting limit)							Thiel-Sen Test (R programming, package = trend, version = 1.1.6, function = sens.slope, non-detects substituted by 0.5*reporting limit)		Mann-Kendall Test (R programming, package = Kendall, version = 2.2.1, function = MannKendall, non-detects substituted by 0.5*reporting limit)							Thiel-Sen Test (R programming, package = trend, version = 1.1.6, function = sens.slope, non-detects substituted by 0.5*reporting limit)	
Location	Constituent	Trends, All Data	Trends, Recent Data	Seasonal Mann Kendall Used	n	n, detected results	Coefficient of Variance	Kendall's Tau	p-value	Confidence Factor	Kendall Score (S)	Sen Slope (mg/L per year)	p-value	n	n, detected results	recent data date range	Coefficient of Variance	Kendall's Tau	p-value	Confidence Factor	Kendall Score (S)	Sen Slope (mg/L per year)	p-value
CCR-AP-5	Lead, Total	Not Evaluated - Majority of data (>50%) non-detect.	No Trend	No	21	8	2.17	NA	NA	NA	NA	NA	NA	8	6	2020-05-19 to 2023-11-02	1.7	0.4	0.212	78.8	11	0.000821	0.212
CCR-AP-6	Lead, Total	Stable	No Trend	No	21	21	0.966	-0.0525	0.763	23.7	-11	-0.0000822	0.763	8	8	2020-05-20 to 2023-11-02	1.6	0	1	0	0	-0.00004	1
CCR-AP-7	Lead, Total	Probably Decreasing	Not Evaluated - Majority of data (>50%) non-detect.	No	23	14	1.64	-0.265	0.0935	90.6	-63	-0.0000336	0.0935	8	3	2020-05-18 to 2023-11-06	1.48	NA	NA	NA	NA	NA	NA
CCR-AP-8	Lead, Total	No Trend	Stable	No	21	20	0.855	0.144	0.38	62	30	0.0000333	0.38	8	7	2020-05-20 to 2023-11-02	0.876	-0.143	0.711	28.9	-4	-0.000133	0.711
CCR-AP-9	Lead, Total	Increasing	Stable	No	20	20	0.695	0.387	0.0193	98.1	73	0.000571	0.0193	8	8	2019-10-22 to 2023-05-23	0.412	-0.109	0.803	19.7	-3	-0.000425	0.803
CCR-AP-1R	Lithium, Total	Increasing	No Trend	No	22	22	0.571	0.385	0.0139	98.6	88	0.004	0.0139	8	8	2020-11-13 to 2023-11-02	0.31	0.182	0.618	38.2	5	0.0049	0.618
CCR-AP-2	Lithium, Total	Probably Increasing	Increasing	No	22	17	0.757	0.308	0.0508	94.9	70	0.0016	0.0508	8	8	2020-11-12 to 2023-11-02	0.733	0.714	0.0187	98.1	20	0.0132	0.0187
CCR-AP-3	Lithium, Total	Not Evaluated - Majority of data (>50%) non-detect.	Not Evaluated - Majority of data (>50%) non-detect.	No	21	3	0.923	NA	NA	NA	NA	NA	NA	8	3	2020-05-20 to 2023-11-02	0.262	NA	NA	NA	NA	NA	NA
CCR-AP-4R	Lithium, Total	Stable	No Trend	No	21	15	0.75	-0.149	0.375	62.5	-30	-0.000219	0.375	8	7	2020-05-20 to 2023-11-02	0.852	0.214	0.536	46.4	6	0.000538	0.536
CCR-AP-5	Lithium, Total	Decreasing	No Trend	No	21	21	0.452	-0.699	0.000013	100	-145	-0.00563	0.000013	8	8	2020-05-19 to 2023-11-02	0.466	0.214	0.536	46.4	6	0 00214	0.536
CCR-AP-6	Lithium, Total	Not Evaluated - Majority of data (>50%) non-detect.	No Trend	No	21	10	1.35	NA	NA	NA	NA	NA	NA	8	5	2020-05-20 to 2023-11-02	1.09	-0.255	0.454	54.6	-7	-0.000182	0.454
CCR-AP-7	Lithium, Total	Decreasing	Stable	No	23	23	0.508	-0.427	0.006	99.4	-104	-0.000211	0.006	8	8	2020-05-18 to 2023-11-06	0.336	-0.143	0.711	28.9	-4	-0.00045	0.711
CCR-AP-8	Lithium, Total	Not Evaluated - Majority of data (>50%) non-detect.	Not Evaluated - Only one detected result.	No	21	5	0.854	NA	NA	NA	NA	NA	NA	8	1	2020-05-20 to 2023-11-02	0.468	NA	NA	NA	NA	NA	NA
CCR-AP-9	Lithium, Total	Increasing	Stable	No	20	20	0.427	0.351	0.0345	96.5	66	0.000858	0.0345	8	8	2019-10-22 to 2023-05-23	0.262	-0.143	0.711	28.9	-4	-0.00217	0.711
CCR-AP-1R	Mercury, Total	Not Evaluated - No detected results.	Not Evaluated - No detected results.	No	21	0	1.26	NA	No detected results.	NA	NA	NA	No detected results.	8	0	2020-11-13 to 2023-11-02	1.24	NA	No detected results.	NA	NA	NA	No detected results.
CCR-AP-2	Mercury, Total	Not Evaluated - Majority of data (>50%) non-detect.	Increasing	No	21	8	0.862	NA	NA	NA	NA	NA	NA	8	6	2020-11-12 to 2023-11-02	0.798	0.667	0.0327	96.7	18	0.000048	0.0327
CCR-AP-3	Mercury, Total	Not Evaluated - No detected results.	Not Evaluated - No detected results.	No	20	0	0.312	NA	No detected results.	NA	NA	NA	No detected results.	8	0	2020-05-20 to 2023-11-02	0.447	NA	No detected results.	NA	NA	NA	No detected results.
CCR-AP-4R	Mercury, Total	Not Evaluated - No detected results.	Not Evaluated - No detected results.	No	20	0	0.35	NA	No detected results.	NA	NA	NA	No detected results.	8	0	2020-05-20 to 2023-11-02	0.447	NA	No detected results.	NA	NA	NA	No detected results.
CCR-AP-5	Mercury, Total	Not Evaluated - Majority of data (>50%) non-detect.	Not Evaluated - Majority of data (>50%) non-detect.	No	20	3	1.64	NA	NA	NA	NA	NA	NA	8	3	2020-05-19 to 2023-11-02	1.33	NA	NA	NA	NA	NA	NA
CCR-AP-6	Mercury, Total	Not Evaluated - Majority of data (>50%) non-detect.	Not Evaluated - Majority of data (>50%) non-detect.	No	20	2	0.6	NA	NA	NA	NA	NA	NA	8	2	2020-05-20 to 2023-11-02	0.676	NA	NA	NA	NA	NA	NA
CCR-AP-7	Mercury, Total	Not Evaluated - No detected results.	Not Evaluated - No detected results.	No	20	0	0.312	NA	No detected results.	NA	NA	NA	No detected results.	8	0	2020-05-18 to 2023-11-06	0.447	NA	No detected results.	NA	NA	NA	No detected results.
CCR-AP-8	Mercury, Total	Not Evaluated - Only one detected result.	Not Evaluated - Only one detected result.	No	20	1	0.413	NA	NA	NA	NA	NA	NA	8	1	2020-05-20 to 2023-11-02	0.517	NA	NA	NA	NA	NA	NA
CCR-AP-9	Mercury, Total	Not Evaluated - No detected results.	Not Evaluated - No detected results.	No	19	0	0	NA	No detected results.	NA	NA	NA	No detected results.	8	0	2019-10-22 to 2023-05-23	0	NA	No detected results.	NA	NA	NA	No detected results.
CCR-AP-1R	Molybdenum, Total	Stable	Stable	No	22	22	0.426	-0.053	0.755	24.5	-12	-0.000025	0.755	8	8	2020-11-13 to 2023-11-02	0.577	-0.4	0.212	78.8	-11	-0.000264	0.212
CCR-AP-2	Molybdenum, Total	Increasing	No Trend	No	22	22	0.584	0.662	0.00002	100	152	0.000358	0.0000201	8	8	2020-11-12 to 2023-11-02	0.307	0.5	0.108	89.2	14	0.000533	0.108
CCR-AP-3	Molybdenum, Total	Decreasing	No Trend	No	21	21	0.349	-0.438	0.0074	99.3	-89	-0.0003	0.0074	8	8	2020-05-20 to 2023-11-02	0.563	0.109	0.803	19.7	3	0.000213	0.803
CCR-AP-4R	Molybdenum, Total	Increasing	No Trend	No	21	18	0.892	0.35	0.0312	96.9	72	0.000113	0.0312	8	5	2020-05-20 to 2023-11-02	0.794	0.189	0.61	39	5	0 00025	0.61
CCR-AP-5	Molybdenum, Total	Decreasing	Stable	No	21	21	0.405	-0.488	0.00266	99.7	-100	-0.0121	0.00266	8	8	2020-05-19 to 2023-11-02	0.471	-0.222	0 53	47	-6	-0 015	0.53
CCR-AP-6	Molybdenum, Total	Stable	Stable	No	21	21	0.226	-0.0586	0.738	26.2	-12	-0.0000774	0.738	8	8	2020-05-20 to 2023-11-02	0.285	-0.255	0.454	54.6	-7	-0.0005	0.454
CCR-AP-7	Molybdenum, Total	Decreasing	No Trend	No	23	22	0.833	-0.652	0.000018	100	-163	-0.00025	0.000018	8	7	2020-05-18 to 2023-11-06	0.259	0.109	0.803	19.7	3	0.0000732	0.803
CCR-AP-8	Molybdenum, Total	Stable	Stable	No	21	21	0.377	-0.0248	0.903	9.7	-5	0	0.903	8	8	2020-05-20 to 2023-11-02	0.503	-0.0364	1	0	-1	-0.0000833	1

Note:
Mann Kendall Trends are classified based on Aziz (2003) guidance.

		Mann Kendall Trends			Secular Trend Evaluation for All Data									Secular Trend Evaluation for Recent Data (subset of 8 most recent data points)								
					Mann-Kendall Test (R programming, package = Kendall, version = 2.2.1, function = MannKendall, non-detects substituted by 0.5*reporting limit)							Thiel-Sen Test (R programming, package = trend, version = 1.1.6, function = sens.slope, non-detects substituted by 0.5*reporting limit)		Mann-Kendall Test (R programming, package = Kendall, version = 2.2.1, function = MannKendall, non-detects substituted by 0.5*reporting limit)							Thiel-Sen Test (R programming, package = trend, version = 1.1.6, function = sens.slope, non-detects substituted by 0.5*reporting limit)	
Location	Constituent	Trends, All Data	Trends, Recent Data	Seasonal Mann Kendall Used	n	n, detected results	Coefficient of Variance	Kendall's Tau	p-value	Confidence Factor	Kendall Score (S)	Sen Slope (mg/L per year)	p-value	n	n, detected results	recent data date range	Coefficient of Variance	Kendall's Tau	p-value	Confidence Factor	Kendall Score (S)	Sen Slope (mg/L per year)	p-value
CCR-AP-9	Molybdenum, Total	Decreasing	No Trend	No	20	18	0.812	-0.47	0.00428	99.6	-89	-0.000292	0.00428	8	6	2019-10-22 to 2023-05-23	1.3	-0.286	0.386	61.4	-8	-0.00025	0.386
CCR-AP-1R	Radium-226 & 228	No Trend	No Trend	No	20	20	0.7	0.2	0.23	77	38	0.0993	0.23	8	8	2020-05-19 to 2023-12-22	0.766	0.357	0.266	73.4	10	1.6	0.266
CCR-AP-2	Radium-226 & 228	No Trend	No Trend	No	20	19	0.71	0.0105	0.974	2.6	2	0.00427	0.974	8	7	2020-05-20 to 2023-11-02	0.821	0.143	0.711	28.9	4	0.252	0.711
CCR-AP-3	Radium-226 & 228	No Trend	No Trend	No	19	18	0.652	0.00585	1	0	1	0.0048	1	8	7	2020-05-20 to 2023-11-02	0.781	0.286	0.386	61.4	8	0.189	0.386
CCR-AP-4R	Radium-226 & 228	No Trend	No Trend	No	19	19	1.65	0.076	0.675	32.5	13	0.03	0.675	8	8	2020-05-20 to 2023-11-02	1.66	0.429	0.174	82.6	12	0.324	0.174
CCR-AP-5	Radium-226 & 228	No Trend	Increasing	No	19	19	1.1	0.158	0.363	63.7	27	0.0501	0.363	8	8	2020-05-19 to 2023-11-02	0.9	0.786	0.00937	99.1	22	0.683	0 00937
CCR-AP-6	Radium-226 & 228	No Trend	No Trend	No	19	19	0.893	0.0994	0.576	42.4	17	0.0118	0.576	8	8	2020-05-20 to 2023-11-02	0.509	0.357	0.266	73.4	10	0.2	0.266
CCR-AP-7	Radium-226 & 228	Stable	Increasing	No	20	20	0.547	-0.137	0.417	58.3	-26	-0.0163	0.417	8	8	2020-05-18 to 2023-11-06	0.676	0.714	0.0187	98.1	20	0.161	0.0187
CCR-AP-8	Radium-226 & 228	Stable	No Trend	No	18	18	0.451	-0.111	0.544	45.6	-17	-0.0145	0.544	8	8	2020-05-20 to 2023-11-02	0.477	0.143	0.711	28.9	4	0 0846	0.711
CCR-AP-9	Radium-226 & 228	Probably Increasing	No Trend	No	18	18	0.821	0.294	0.0956	90.4	45	0.154	0.0956	8	8	2019-10-22 to 2023-05-23	0.779	0.286	0.386	61.4	8	0.583	0.386
CCR-AP-1R	Selenium, Total	Not Evaluated - Majority of data (>50%) non-detect.	No Trend	No	22	10	1.26	NA	NA	NA	NA	NA	NA	8	5	2020-11-13 to 2023-11-02	1.01	-0.473	0.135	86.5	-13	-0.0002	0.135
CCR-AP-2	Selenium, Total	Increasing	No Trend	No	22	15	1.13	0.399	0.0115	98.9	90	0.000171	0.0115	8	7	2020-11-12 to 2023-11-02	0.772	0.286	0.386	61.4	8	0 00035	0.386
CCR-AP-3	Selenium, Total	Probably Increasing	No Trend	No	21	20	0.549	0.296	0.0752	92.5	59	0.0000179	0.0752	8	8	2020-05-20 to 2023-11-02	0.209	0.289	0.421	57.9	7	0.0000125	0.421
CCR-AP-4R	Selenium, Total	Probably Increasing	No Trend	No	21	11	1.82	0.31	0.0717	92.8	57	0.0000284	0.0717	8	4	2020-05-20 to 2023-11-02	0.242	0.454	0.18	82	11	0.000108	0.18
CCR-AP-5	Selenium, Total	Not Evaluated - Majority of data (>50%) non-detect.	Increasing	No	21	7	1.25	NA	NA	NA	NA	NA	NA	8	6	2020-05-19 to 2023-11-02	1.16	0.837	0.00609	99.4	23	0.0004	0 00609
CCR-AP-6	Selenium, Total	No Trend	Stable	No	21	17	0.989	0.0981	0.563	43.7	20	0.00000955	0.563	8	7	2020-05-20 to 2023-11-02	0.363	-0.286	0.386	61.4	-8	-0.000123	0.386
CCR-AP-7	Selenium, Total	Not Evaluated - Majority of data (>50%) non-detect.	Not Evaluated - Only one detected result.	No	21	3	0.258	NA	NA	NA	NA	NA	NA	8	1	2020-05-18 to 2023-11-06	0.0418	NA	NA	NA	NA	NA	NA
CCR-AP-8	Selenium, Total	No Trend	Stable	No	21	18	0.566	0.0687	0.693	30.7	14	0.00000611	0.693	8	8	2020-05-20 to 2023-11-02	0.527	-0.357	0.266	73.4	-10	-0.00015	0.266
CCR-AP-9	Selenium, Total	Not Evaluated - Majority of data (>50%) non-detect.	Not Evaluated - Majority of data (>50%) non-detect.	No	20	6	1.17	NA	NA	NA	NA	NA	NA	8	2	2019-10-22 to 2023-05-23	1.27	NA	NA	NA	NA	NA	NA
CCR-AP-1R	Thallium, Total	Increasing	No Trend	No	22	16	0.924	0.371	0.0187	98.1	84	0.0000313	0.0187	8	5	2020-11-13 to 2023-11-02	0.85	0.182	0.618	38.2	5	0.000015	0.618
CCR-AP-2	Thallium, Total	Increasing	No Trend	No	22	19	1.56	0.621	0.0000675	100	142	0.000056	0.0000675	8	7	2020-11-12 to 2023-11-02	1.41	0.296	0.379	62.1	8	0.000117	0.379
CCR-AP-3	Thallium, Total	Not Evaluated - Only one detected result.	Not Evaluated - No detected results.	No	21	1	0.283	NA	NA	NA	NA	NA	NA	8	0	2020-05-20 to 2023-11-02	0.314	NA	No detected results.	NA	NA	NA	No detected results.
CCR-AP-4R	Thallium, Total	Not Evaluated - Majority of data (>50%) non-detect.	Not Evaluated - Majority of data (>50%) non-detect.	No	21	10	1.12	NA	NA	NA	NA	NA	NA	8	2	2020-05-20 to 2023-11-02	0.342	NA	NA	NA	NA	NA	NA
CCR-AP-5	Thallium, Total	Not Evaluated - Majority of data (>50%) non-detect.	No Trend	No	21	7	1.59	NA	NA	NA	NA	NA	NA	8	4	2020-05-19 to 2023-11-02	0.579	0.242	0.507	49.3	6	0.000015	0.507
CCR-AP-6	Thallium, Total	Not Evaluated - Majority of data (>50%) non-detect.	Not Evaluated - No detected results.	No	21	8	1.09	NA	NA	NA	NA	NA	NA	8	0	2020-05-20 to 2023-11-02	0.314	NA	No detected results.	NA	NA	NA	No detected results.
CCR-AP-7	Thallium, Total	Not Evaluated - Majority of data (>50%) non-detect.	Not Evaluated - No detected results.	No	23	4	0.399	NA	NA	NA	NA	NA	NA	8	0	2020-05-18 to 2023-11-06	0.314	NA	No detected results.	NA	NA	NA	No detected results.
CCR-AP-8	Thallium, Total	Not Evaluated - Majority of data (>50%) non-detect.	Not Evaluated - No detected results.	No	21	5	0.483	NA	NA	NA	NA	NA	NA	8	0	2020-05-20 to 2023-11-02	0.314	NA	No detected results.	NA	NA	NA	No detected results.
CCR-AP-9	Thallium, Total	Not Evaluated - Majority of data (>50%) non-detect.	Not Evaluated - No detected results.	No	20	9	1.55	NA	NA	NA	NA	NA	NA	8	0	2019-10-22 to 2023-05-23	1.25	NA	No detected results.	NA	NA	NA	No detected results.

Note:
Mann Kendall test run on seasonally adjusted data if seasonal trend identified. Seasonal trends identified based on Kruskall Wallis test and time series plots, where n seasons = 4 and (Dec-Feb, Mar-May, Jun-Aug, Sept-Nov).

Note:
Mann Kendall Trends are classified based on Aziz (2003) guidance.

Table A-5. Intrawell Arsenic Prediction Limit Calculations

			Baseline Data Characterization [a]												Prediction Limits		Parametric UPL Calculation Statistics			Non-Parametric UPL Calculation Statistics	
Location	Constituent	Units	Baseline Distribution [a]	Prediction Interval Calculation	min baseline sample date	max baseline sample sample	n	n, non-detects	max	mean	standard deviation	Trend (Baseline Data)	degrees of freedom	future samples (M)	Prediction Limit Calculation Method	UPL	confidence level (%)	t (percentile of student's t-test)	t quantile	actual confidence level (%)	false positive rate (%)
CCR-AP-2	Arsenic, Total	mg/L	Normal (Baseline, 95% Confidence)	Parametric	2016-06-10	2023-07-28	21	0	0.048	0.0143	0.0119	Increasing	20	4	Parametric Prediction Limit for M Future Values (USEPA, 2009 - Chapter 18.2.1)	0.0526	99	0.9975	3.153	NA	NA
CCR-AP-3	Arsenic, Total	mg/L	Normal (Baseline, 95% Confidence)	Parametric	2016-06-10	2023-05-23	20	0	0.095	0.0759	0.00848	Increasing	19	4	Parametric Prediction Limit for M Future Values (USEPA, 2009 - Chapter 18.2.1)	0.103	99	0.9975	3.174	NA	NA
CCR-AP-4R	Arsenic, Total	mg/L	Normal (Baseline, ln Trans, 95% Confidence)	Parametric (ln Transformed Data)	2016-06-10	2023-05-23	20	0	0.33	0.112	0.081	Increasing	19	4	Parametric Prediction Limit for M Future Values (USEPA, 2009 - Chapter 18.2.1)	0.707	99	0.9975	3.174	NA	NA
CCR-AP-5	Arsenic, Total	mg/L	Not normal (Baseline, ln Trans, 95% Confidence)	Non-Parametric	2016-06-10	2023-05-25	19	2	0.024	0.00355	0.00584	Increasing	18	4	Non-Parametric Prediction Limit for M Future Values (USEPA, 2009 - Chapter 18.3.1)	0.024	NA	NA	NA	82.6	17.4
CCR-AP-6	Arsenic, Total	mg/L	Normal (Baseline, 95% Confidence)	Parametric	2016-06-10	2023-05-23	20	0	0.12	0.0942	0.0221	Increasing	19	4	Parametric Prediction Limit for M Future Values (USEPA, 2009 - Chapter 18.2.1)	0.166	99	0.9975	3.174	NA	NA
CCR-AP-8	Arsenic, Total	mg/L	Normal (Baseline, 95% Confidence)	Parametric	2017-03-09	2023-05-25	20	0	0.12	0.091	0.0216	Increasing	19	4	Parametric Prediction Limit for M Future Values (USEPA, 2009 - Chapter 18.2.1)	0.161	99	0.9975	3.174	NA	NA

Note:

[a] Baseline data refer to the entire statistical dataset, except the 4 most recent data points. The 4 most recent data points are considered 'compliance' or 'recent' samples. Baseline datasets were re-tested for outliers, secular trends, and data normality. No outliers were removed.
Prediction limits calculated using simple replacement with the reporting limit for non-detect results.

Table A-6. Confidence Intervals

			Confidence Interval (CI) Dataset						CI Calculation [a]			SSL Confirmation		Non-Parametric CI Statistics (if applicable)	
Location	Constituent	Units	n	max (Rank n)	min (Rank 1)	median	mean	standard deviation	CI calculation method	degrees of freedom	95% Confidence LCL	GWPS	LCL > GWPS?	bootstrap iterations	bootstrap median
CCR-AP-2	Cobalt, Total	mg/L	22	0.091	0.0073	0.022	0.0277	0.02	Calculation of the Confidence Interval Around the Lognormal Mean (Parametric)	21	0.0175	0.081	No	NA	NA
CCR-AP-2	Lead, Total	mg/L	22	0.100	0.0023	0.0225	0.028	0.025	Calculation of the Confidence Interval Around the Lognormal Mean (Parametric)	21	0.0111	0.094	No	NA	NA
CCR-AP-5	Molybdenum, Total	mg/L	21	0.530	0.046	0.33	0.294	0.12	Calculation of the Confidence Interval Around the Normal Mean (Parametric)	20	0.239	0.100	Yes	NA	NA

Note:

Confidence intervals are calculated for analyte/well pairs with GWPS exceedances in the November 2023 dataset.

[a] The 95% lower confience level (LCL) is compared to the Groundwater Protection Standard (GWPS) to confirm a statistically significant level (SSL). The 99% confidence interval is also shown for purposes of comparison. UCL = upper confidence level.

Table A-7. Groundwater Protection Standard (GWPS) Summary

Background Location	Constituent	Units	Background Threshold Value (BTV)	BTV Type	MCL/RSL	GWPS	GWPS Source	BTV Calculation Method
CCR-AP-1R, CCR-AP-7, CCR-AP-9	Antimony, Total	mg/L	0.02	Interwell UTL	0.006	0.02	BTV	Non-Parametric Tolerance Limits (USEPA, 2009 - Chapter 17.2.2)
CCR-AP-2	Arsenic, Total	mg/L	0.0526	Intrawell UPL	0.01	0.0526	BTV	Parametric Prediction Limit for M Future Values (USEPA, 2009 - Chapter 18.2.1)
CCR-AP-3	Arsenic, Total	mg/L	0.103	Intrawell UPL	0.01	0.103	BTV	Parametric Prediction Limit for M Future Values (USEPA, 2009 - Chapter 18.2.1)
CCR-AP-4R	Arsenic, Total	mg/L	0.707	Intrawell UPL	0.01	0.707	BTV	Parametric Prediction Limit for M Future Values (USEPA, 2009 - Chapter 18.2.1)
CCR-AP-5	Arsenic, Total	mg/L	0.024	Intrawell UPL	0.01	0.024	BTV	Non-Parametric Prediction Limit for M Future Values (USEPA, 2009 - Chapter 18.3.1)
CCR-AP-6	Arsenic, Total	mg/L	0.166	Intrawell UPL	0.01	0.166	BTV	Parametric Prediction Limit for M Future Values (USEPA, 2009 - Chapter 18.2.1)
CCR-AP-8	Arsenic, Total	mg/L	0.161	Intrawell UPL	0.01	0.161	BTV	Parametric Prediction Limit for M Future Values (USEPA, 2009 - Chapter 18.2.1)
CCR-AP-1R, CCR-AP-7, CCR-AP-9	Barium, Total	mg/L	0.72	Interwell UTL	2	2	MCL/RSL	Non-Parametric Tolerance Limits (USEPA, 2009 - Chapter 17.2.2)
CCR-AP-1R, CCR-AP-7, CCR-AP-9	Beryllium, Total	mg/L	0.01	Interwell UTL	0.004	0.01	BTV	Non-Parametric Tolerance Limits (USEPA, 2009 - Chapter 17.2.2)
CCR-AP-1R, CCR-AP-7, CCR-AP-9	Cadmium, Total	mg/L	0.01	Interwell UTL	0.005	0.01	BTV	Non-Parametric Tolerance Limits (USEPA, 2009 - Chapter 17.2.2)
CCR-AP-1R, CCR-AP-7, CCR-AP-9	Chromium, Total	mg/L	0.16	Interwell UTL	0.1	0.16	BTV	Non-Parametric Tolerance Limits (USEPA, 2009 - Chapter 17.2.2)
CCR-AP-1R, CCR-AP-7, CCR-AP-9	Cobalt, Total	mg/L	0.081	Interwell UTL	0.006	0.081	BTV	Non-Parametric Tolerance Limits (USEPA, 2009 - Chapter 17.2.2)
CCR-AP-1R, CCR-AP-7, CCR-AP-9	Fluoride	mg/L	0.681	Interwell UTL	4	4	MCL/RSL	Parametric Tolerance Limits (USEPA, 2009 - Chapter 17.2.1)
CCR-AP-1R, CCR-AP-7, CCR-AP-9	Lead, Total	mg/L	0.094	Interwell UTL	0.015	0.094	BTV	Non-Parametric Tolerance Limits (USEPA, 2009 - Chapter 17.2.2)
CCR-AP-1R, CCR-AP-7, CCR-AP-9	Lithium, Total	mg/L	0 23	Interwell UTL	0.04	0 23	BTV	Non-Parametric Tolerance Limits (USEPA, 2009 - Chapter 17.2.2)
CCR-AP-1R, CCR-AP-7, CCR-AP-9	Mercury, Total	mg/L	0.002	Interwell UTL	0.002	0.002	BTV = MCL/RSL	Non-Parametric Tolerance Limits (USEPA, 2009 - Chapter 17.2.2)
CCR-AP-1R, CCR-AP-7, CCR-AP-9	Molybdenum, Total	mg/L	0.05	Interwell UTL	0.1	0.1	MCL/RSL	Non-Parametric Tolerance Limits (USEPA, 2009 - Chapter 17.2.2)
CCR-AP-1R, CCR-AP-7, CCR-AP-9	Radium-226 & 228	pCi/L	12.6	Interwell UTL	5	12.6	BTV	Non-Parametric Tolerance Limits (USEPA, 2009 - Chapter 17.2.2)
CCR-AP-1R, CCR-AP-7, CCR-AP-9	Selenium, Total	mg/L	0.05	Interwell UTL	0.05	0.05	BTV = MCL/RSL	Non-Parametric Tolerance Limits (USEPA, 2009 - Chapter 17.2.2)
CCR-AP-1R, CCR-AP-7, CCR-AP-9	Thallium, Total	mg/L	0.01	Interwell UTL	0.002	0.01	BTV	Non-Parametric Tolerance Limits (USEPA, 2009 - Chapter 17.2.2)

Background Threshold Values (BTVs) include Upper Threshold Limits (UTLs) calculated from pooled/interwell background data and Upper Prediction Limits (UPLs) for Arsenic calculated from intrawell data. Groundwater Protection Standard (GWPS) is the maximum value between the BTV and the Maximum Contaminant Level/Regional Screening Level (MCL/RSL).

Table A-8. Groundwater Protection Standard (GWPS) Comparison Table

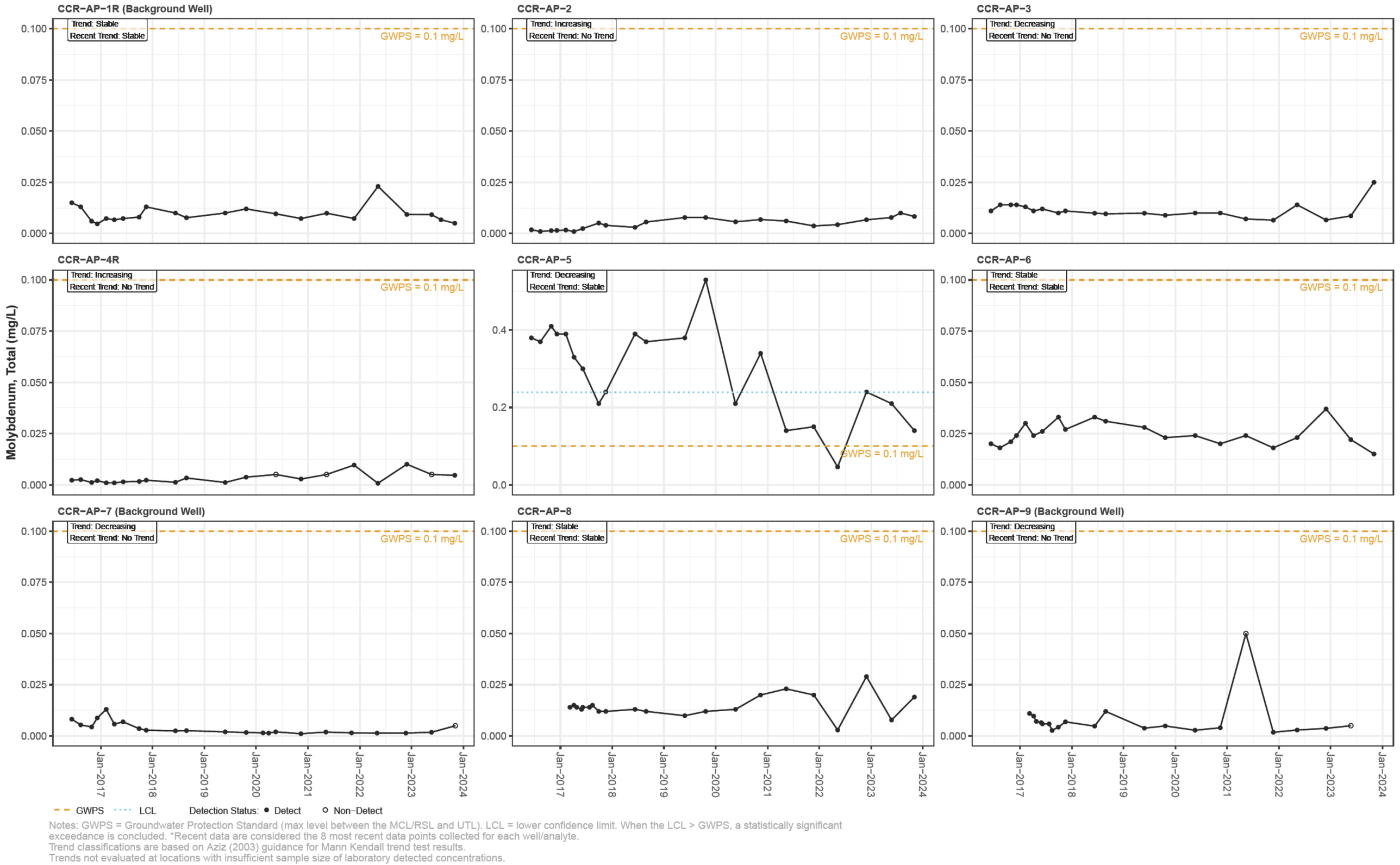
Location	Constituent	Units	Sample Date	Sample Result	Background Threshold Value (BTV)	BTV Type	GWPS	GWPS Exceedance	LCL	SSL Confirmed
CCR-AP-2	Antimony, Total	mg/L	2023-11-02	0.0013 J	0.02	Interwell UTL	0.02	No	NA	No
CCR-AP-3	Antimony, Total	mg/L	2023-11-02	0.005	0.02	Interwell UTL	0.02	No	NA	No
CCR-AP-4R	Antimony, Total	mg/L	2023-11-02	0.0031 J	0.02	Interwell UTL	0.02	No	NA	No
CCR-AP-5	Antimony, Total	mg/L	2023-11-02	0.0024 J	0.02	Interwell UTL	0.02	No	NA	No
CCR-AP-6	Antimony, Total	mg/L	2023-11-02	0.00066 J	0.02	Interwell UTL	0.02	No	NA	No
CCR-AP-8	Antimony, Total	mg/L	2023-11-02	0.00057 J	0.02	Interwell UTL	0.02	No	NA	No
CCR-AP-2	Arsenic, Total	mg/L	2023-11-02	0.04	0.0526	Intrawell UPL	0.0526	No	NA	No
CCR-AP-3	Arsenic, Total	mg/L	2023-11-02	0.089	0.103	Intrawell UPL	0.103	No	NA	No
CCR-AP-4R	Arsenic, Total	mg/L	2023-11-02	0.19	0.707	Intrawell UPL	0.707	No	NA	No
CCR-AP-5	Arsenic, Total	mg/L	2023-11-02	0.024	0.024	Intrawell UPL	0.024	No	NA	No
CCR-AP-6	Arsenic, Total	mg/L	2023-11-02	0.096	0.166	Intrawell UPL	0.166	No	NA	No
CCR-AP-8	Arsenic, Total	mg/L	2023-11-02	0.065	0.161	Intrawell UPL	0.161	No	NA	No
CCR-AP-2	Barium, Total	mg/L	2023-11-02	0.64	0.72	Interwell UTL	2	No	NA	No
CCR-AP-3	Barium, Total	mg/L	2023-11-02	0.48	0.72	Interwell UTL	2	No	NA	No
CCR-AP-4R	Barium, Total	mg/L	2023-11-02	0.92	0.72	Interwell UTL	2	No	NA	No
CCR-AP-5	Barium, Total	mg/L	2023-11-02	0.2	0.72	Interwell UTL	2	No	NA	No
CCR-AP-6	Barium, Total	mg/L	2023-11-02	0.48	0.72	Interwell UTL	2	No	NA	No
CCR-AP-8	Barium, Total	mg/L	2023-11-02	0.31	0.72	Interwell UTL	2	No	NA	No
CCR-AP-2	Beryllium, Total	mg/L	2023-11-02	0.0072	0.01	Interwell UTL	0.01	No	NA	No
CCR-AP-3	Beryllium, Total	mg/L	2023-11-02	0.00056	0.01	Interwell UTL	0.01	No	NA	No
CCR-AP-4R	Beryllium, Total	mg/L	2023-11-02	0.00047 J	0.01	Interwell UTL	0.01	No	NA	No
CCR-AP-5	Beryllium, Total	mg/L	2023-11-02	0.0016	0.01	Interwell UTL	0.01	No	NA	No
CCR-AP-6	Beryllium, Total	mg/L	2023-11-02	0.0005 U	0.01	Interwell UTL	0.01	No	NA	No
CCR-AP-8	Beryllium, Total	mg/L	2023-11-02	0.0005 U	0.01	Interwell UTL	0.01	No	NA	No
CCR-AP-2	Cadmium, Total	mg/L	2023-11-02	0.0023	0.01	Interwell UTL	0.01	No	NA	No
CCR-AP-3	Cadmium, Total	mg/L	2023-11-02	0.00038 J	0.01	Interwell UTL	0.01	No	NA	No
CCR-AP-4R	Cadmium, Total	mg/L	2023-11-02	0.0003 J	0.01	Interwell UTL	0.01	No	NA	No
CCR-AP-5	Cadmium, Total	mg/L	2023-11-02	0.0014	0.01	Interwell UTL	0.01	No	NA	No
CCR-AP-6	Cadmium, Total	mg/L	2023-11-02	0.000094 J	0.01	Interwell UTL	0.01	No	NA	No
CCR-AP-8	Cadmium, Total	mg/L	2023-11-02	0.00016 J	0.01	Interwell UTL	0.01	No	NA	No
CCR-AP-2	Chromium, Total	mg/L	2023-11-02	0.14	0.16	Interwell UTL	0.16	No	NA	No
CCR-AP-3	Chromium, Total	mg/L	2023-11-02	0.014	0.16	Interwell UTL	0.16	No	NA	No
CCR-AP-4R	Chromium, Total	mg/L	2023-11-02	0.012	0.16	Interwell UTL	0.16	No	NA	No
CCR-AP-5	Chromium, Total	mg/L	2023-11-02	0.056	0.16	Interwell UTL	0.16	No	NA	No
CCR-AP-6	Chromium, Total	mg/L	2023-11-02	0.0047 J	0.16	Interwell UTL	0.16	No	NA	No
CCR-AP-8	Chromium, Total	mg/L	2023-11-02	0.0016 J	0.16	Interwell UTL	0.16	No	NA	No
CCR-AP-2	Cobalt, Total	mg/L	2023-11-02	0.091	0.081	Interwell UTL	0.081	Yes	0.0175	No
CCR-AP-3	Cobalt, Total	mg/L	2023-11-02	0.0092	0.081	Interwell UTL	0.081	No	NA	No
CCR-AP-4R	Cobalt, Total	mg/L	2023-11-02	0.0049	0.081	Interwell UTL	0.081	No	NA	No
CCR-AP-5	Cobalt, Total	mg/L	2023-11-02	0.01	0.081	Interwell UTL	0.081	No	NA	No
CCR-AP-6	Cobalt, Total	mg/L	2023-11-02	0.0047	0.081	Interwell UTL	0.081	No	NA	No
CCR-AP-8	Cobalt, Total	mg/L	2023-11-02	0.0032	0.081	Interwell UTL	0.081	No	NA	No
CCR-AP-2	Fluoride	mg/L	2023-11-02	0.55	0.681	Interwell UTL	4	No	NA	No
CCR-AP-3	Fluoride	mg/L	2023-11-02	0.23	0.681	Interwell UTL	4	No	NA	No
CCR-AP-4R	Fluoride	mg/L	2023-11-02	0.48	0.681	Interwell UTL	4	No	NA	No
CCR-AP-5	Fluoride	mg/L	2023-11-02	2.3	0.681	Interwell UTL	4	No	NA	No
CCR-AP-6	Fluoride	mg/L	2023-11-02	0.51	0.681	Interwell UTL	4	No	NA	No
CCR-AP-8	Fluoride	mg/L	2023-11-02	1.1	0.681	Interwell UTL	4	No	NA	No
CCR-AP-2	Lead, Total	mg/L	2023-11-02	0.1	0.094	Interwell UTL	0.094	Yes	0.0111	No
CCR-AP-3	Lead, Total	mg/L	2023-11-02	0.01	0.094	Interwell UTL	0.094	No	NA	No
CCR-AP-4R	Lead, Total	mg/L	2023-11-02	0.011	0.094	Interwell UTL	0.094	No	NA	No
CCR-AP-5	Lead, Total	mg/L	2023-11-02	0.02	0.094	Interwell UTL	0.094	No	NA	No
CCR-AP-6	Lead, Total	mg/L	2023-11-02	0.0027 J	0.094	Interwell UTL	0.094	No	NA	No
CCR-AP-8	Lead, Total	mg/L	2023-11-02	0.003 U	0.094	Interwell UTL	0.094	No	NA	No
CCR-AP-2	Lithium, Total	mg/L	2023-11-02	0.11	0.23	Interwell UTL	0.23	No	NA	No
CCR-AP-3	Lithium, Total	mg/L	2023-11-02	0.0043 J	0.23	Interwell UTL	0.23	No	NA	No
CCR-AP-4R	Lithium, Total	mg/L	2023-11-02	0.0067	0.23	Interwell UTL	0.23	No	NA	No
CCR-AP-5	Lithium, Total	mg/L	2023-11-02	0.059	0.23	Interwell UTL	0.23	No	NA	No
CCR-AP-6	Lithium, Total	mg/L	2023-11-02	0.002 J	0.23	Interwell UTL	0.23	No	NA	No
CCR-AP-8	Lithium, Total	mg/L	2023-11-02	0.005 U	0.23	Interwell UTL	0.23	No	NA	No
CCR-AP-2	Mercury, Total	mg/L	2023-11-02	0.00042 J	0.002	Interwell UTL	0.002	No	NA	No

Background Threshold Values (BTVs) include Upper Threshold Limits (UTLs) calculated from pooled/interwell background data and Upper Prediction Limits (UPLs) for Arsenic calculated from intrawell data. Groundwater Protection Standard (GWPS) is the maximum value between the BTV and the Maximum Contaminant Level/Regional Screening Level (MCL/RSL). Lower Confidence Limit (LCL) calculated if the event sample result exceeds the GWPS. If the LCL is greater than the GWPS, a Statistically Significant Level (SSL) is confirmed.

Location	Constituent	Units	Sample Date	Sample Result	Background Threshold Value (BTV)	BTV Type	GWPS	GWPS Exceedance	LCL	SSL Confirmed
CCR-AP-3	Mercury, Total	mg/L	2023-11-02	0.0005 U	0.002	Interwell UTL	0.002	No	NA	No
CCR-AP-4R	Mercury, Total	mg/L	2023-11-02	0.0005 U	0.002	Interwell UTL	0.002	No	NA	No
CCR-AP-5	Mercury, Total	mg/L	2023-11-02	0.0016	0.002	Interwell UTL	0.002	No	NA	No
CCR-AP-6	Mercury, Total	mg/L	2023-11-02	0.0005 U	0.002	Interwell UTL	0.002	No	NA	No
CCR-AP-8	Mercury, Total	mg/L	2023-11-02	0.0005 U	0.002	Interwell UTL	0.002	No	NA	No
CCR-AP-2	Molybdenum, Total	mg/L	2023-11-02	0.0083	0.05	Interwell UTL	0.1	No	NA	No
CCR-AP-3	Molybdenum, Total	mg/L	2023-11-02	0.025	0.05	Interwell UTL	0.1	No	NA	No
CCR-AP-4R	Molybdenum, Total	mg/L	2023-11-02	0.0046 J	0.05	Interwell UTL	0.1	No	NA	No
CCR-AP-5	Molybdenum, Total	mg/L	2023-11-02	0.14	0.05	Interwell UTL	0.1	Yes	0.239	Yes
CCR-AP-6	Molybdenum, Total	mg/L	2023-11-02	0.015	0.05	Interwell UTL	0.1	No	NA	No
CCR-AP-8	Molybdenum, Total	mg/L	2023-11-02	0.019	0.05	Interwell UTL	0.1	No	NA	No
CCR-AP-2	Radium-226 & 228	pCi/L	2023-11-02	3.23 J+	12.6	Interwell UTL	12.6	No	NA	No
CCR-AP-3	Radium-226 & 228	pCi/L	2023-11-02	2 64 U	12.6	Interwell UTL	12.6	No	NA	No
CCR-AP-4R	Radium-226 & 228	pCi/L	2023-11-02	5 26 U	12.6	Interwell UTL	12.6	No	NA	No
CCR-AP-5	Radium-226 & 228	pCi/L	2023-11-02	5.54 J+	12.6	Interwell UTL	12.6	No	NA	No
CCR-AP-6	Radium-226 & 228	pCi/L	2023-11-02	2.72 U	12.6	Interwell UTL	12.6	No	NA	No
CCR-AP-8	Radium-226 & 228	pCi/L	2023-11-02	2.1 U	12.6	Interwell UTL	12.6	No	NA	No
CCR-AP-2	Selenium, Total	mg/L	2023-11-02	0.013	0.05	Interwell UTL	0.05	No	NA	No
CCR-AP-3	Selenium, Total	mg/L	2023-11-02	0.003 J	0.05	Interwell UTL	0.05	No	NA	No
CCR-AP-4R	Selenium, Total	mg/L	2023-11-02	0.0036 J	0.05	Interwell UTL	0.05	No	NA	No
CCR-AP-5	Selenium, Total	mg/L	2023-11-02	0.02	0.05	Interwell UTL	0.05	No	NA	No
CCR-AP-6	Selenium, Total	mg/L	2023-11-02	0.0012 J	0.05	Interwell UTL	0.05	No	NA	No
CCR-AP-8	Selenium, Total	mg/L	2023-11-02	0.0016 J	0.05	Interwell UTL	0.05	No	NA	No
CCR-AP-2	Thallium, Total	mg/L	2023-11-02	0.0012 J	0.01	Interwell UTL	0.01	No	NA	No
CCR-AP-3	Thallium, Total	mg/L	2023-11-02	0.002 U	0.01	Interwell UTL	0.01	No	NA	No
CCR-AP-4R	Thallium, Total	mg/L	2023-11-02	0.002 U	0.01	Interwell UTL	0.01	No	NA	No
CCR-AP-5	Thallium, Total	mg/L	2023-11-02	0.00096 J	0.01	Interwell UTL	0.01	No	NA	No
CCR-AP-6	Thallium, Total	mg/L	2023-11-02	0.002 U	0.01	Interwell UTL	0.01	No	NA	No
CCR-AP-8	Thallium, Total	mg/L	2023-11-02	0.002 U	0.01	Interwell UTL	0.01	No	NA	No

Background Threshold Values (BTVs) include Upper Threshold Limits (UTLs) calculated from pooled/interwell background data and Upper Prediction Limits (UPLs) for Arsenic calculated from intrawell data. Groundwater Protection Standard (GWPS) is the maximum value between the BTV and the Maximum Contaminant Level/Regional Screening Level (MCL/RSL). Lower Confidence Limit (LCL) calculated if the event sample result exceeds the GWPS. If the LCL is greater than the GWPS, a Statistically Significant Level (SSL) is confirmed.

Assessment Monitoring Trend Analysis for Molybdenum, Total



Notes: GWPS = Groundwater Protection Standard (max level between the MCL/RSL and UTL). LCL = lower confidence limit. When the LCL > GWPS, a statistically significant exceedance is concluded. *Recent data are considered the 8 most recent data points collected for each well/analyte.
Trend classifications are based on Aziz (2003) guidance for Mann Kendall trend test results.
Trends not evaluated at locations with insufficient sample size of laboratory detected concentrations.

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TECHNICAL MEMORANDUM

17 September 2024
File No. 0129420-032

TO: Southern Indiana Gas and Electric Company

FROM: Haley & Aldrich, Inc.
Todd Plating, Senior Project Manager
Steven F. Putrich, P.E., Project Principal

SUBJECT: Statistical Evaluation of the May 2024 Semi-annual Groundwater Assessment Monitoring Data
Southern Indiana Gas and Electric Company
East Ash Pond
F.B. Culley Generating Station; Warrick County, Indiana

Pursuant to Title 40 Code of Federal Regulations (40 CFR) § 257.93 and § 257.95 (Rule), this memorandum summarizes the statistical evaluation of the analytical results for the May 2024 semi-annual assessment monitoring event for the F.B. Culley Generating Station (FBC) East Ash Pond (EAP). Haley & Aldrich, Inc. (Haley & Aldrich) completed this statistical evaluation to determine if Appendix IV groundwater monitoring constituents have been detected in downgradient wells at statistically significant levels (SSL) greater than Groundwater Protection Standards (GWPS), consistent with the requirements in 40 CFR § 257.95.

Methods used during this statistical analysis are described in Haley & Aldrich's 2017 *Statistical Data Analysis Plan for the F.B. Culley Generating Station*. A summary of how applicable performance standards described in 40 CFR § 257.93 (g) were achieved include:

- 40 CFR § 257.93 (g) (1) - Data set distributions were evaluated using basic summary statistics, graphical methods including probability plots, and the Shapiro-Wilk Test for Normality. Data sets were also evaluated for statistical outliers using box plots and either Dixon's Q Test for Outliers or Rosner's Outlier Test depending on sample size. Outlier identification and data set distribution groups are summarized in Attachment A. For background limit calculations, parametric methods were used for normally distributed data sets and non-parametric methods were used for non-normally distributed data sets.
- 40 CFR § 257.93 (g) (2) – Not applicable
- 40 CFR § 257.93 (g) (3) – Not applicable

- 40 CFR § 257.93 (g) (4) – Levels of confidence and additional supporting information for the use of tolerance intervals and prediction limits are included in Attachment A.
- 40 CFR § 257.93 (g) (5) – Non-detect values were accounted for by simple substitution, where the reporting limit replaced the non-detect result. Non-detect values are identified and summarized in Attachment A.
- 40 CFR § 257.93 (g) (6) – Time series plots for groundwater monitoring wells included in this evaluation were reviewed to identify potential seasonal variability. Temporal trends were evaluated using the non-parametric Mann-Kendall Trend Test and Theil-Sen Estimator.

Data from the groundwater sampling event for the downgradient monitoring wells (CCR-AP-2 through CCR-AP-6 and CCR-AP-8) were compared to the GWPS established from the background dataset for the upgradient monitoring wells (CCR-AP-1R, CCR-AP-7, and CCR-AP-9) for detected Appendix IV constituents. The GWPS for each of the Appendix IV constituents has been set equal to the highest value among the maximum contaminant level (MCL), regional screening level (RSL), and background threshold value (BTV). The results of the assessment monitoring statistical evaluation are discussed below and provided in Attachment A.

Development of Groundwater Protection Standard

The Rule provides four specific options for statistical evaluation of groundwater quality data collected at a coal combustion residual (CCR) unit (40 CFR §257.93(f) (1-4)). Haley & Aldrich certified the tolerance limit (TL) as the statistical method used for developing BTVs on 14 January 2019. An alternate source demonstration was performed for arsenic on 13 September 2019, certifying the prediction limit (PL) as the statistical method for developing arsenic BTVs. As noted above, the GWPS for each of the Appendix IV constituents has been set equal to the highest value of the MCL, RSL, or BTV (either the TL or PL). The most recent groundwater sampling result from each compliance well was compared to the GWPS to determine if additional statistical testing is warranted.

STATISTICAL EVALUATION

BTVs are periodically updated per the document *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance, March 2009* (Unified Guidance). Prior to calculating BTVs, data were evaluated for outlier results, data distribution, and spatial and temporal variability. Potential outlier sample results that would warrant removal from the data set based on likely error in sampling or measurement were identified through statistical outlier using the outliers (version 0.15) R programming package and either the Dixon's or Rosner's Test for Outliers. Potential outliers were further evaluated by visual inspection of box plots and probability plots, and field forms and analytical laboratory reports were reviewed as necessary. No sample data were identified as outliers that warranted removal from the dataset.

Background data distributions were assessed using the stats (version 4.3.3) R programming package and either the Shapiro-Wilk or Shapiro-Francia Test for Normality. Data distributions were further evaluated by visual inspection of probability and distribution plots. Data distributions inform appropriate BTV calculation methods.

Background and downgradient data sets were evaluated for spatial and temporal variability by visual inspection of box plots and time series plots and using the Mann-Kendall Trend Tests (Kendall R programming package, version 2.2.1) and Theil-Sen Estimator (trend R programming package, version 1.1.6). Spatial and temporal variability in background data sets inform appropriate BTV calculation methods.

Note that the CCR unit is in assessment monitoring, so Appendix III (detection monitoring) constituents were not evaluated.

Interwell Background Evaluation

An interwell statistical evaluation was used to determine the TL and identify potential SSLs for detected Appendix IV constituents, except arsenic (Table 1). The interwell evaluation compares the most recent value from downgradient compliance wells to a background dataset composed of pooled upgradient well data. TLs were calculated from the pooled background well dataset utilizing R programming language and the EnvStats (version 2.8.1) and tolerance (version 2.0.0) packages. The TL procedure is one in which a concentration limit for each constituent is established from the distribution of the background data, with a minimum 95 percent confidence level. The upper endpoint of a tolerance interval is called the UTL. Depending on the data distribution, parametric or non-parametric TL procedures are used. Parametric TLs utilize normally distributed data or data normalized via a transformation of the background data used to construct the limit. If the data are non-normal and a transformation is not indicated, non-parametric procedures (order statistics or bootstrap methods) are used to calculate the TL. If all the background data are non-detect, a maximum reporting limit may serve as an appropriate UTL.

Intrawell Background Evaluation for Arsenic

For arsenic, an intrawell statistical evaluation was used to determine the PL and identify potential SSLs. The intrawell evaluation compares the most recent data point from each downgradient compliance well to its well-specific background dataset, composed of data collected from the same well prior to the most recent sampling event. PLs were calculated from the well-specific background dataset utilizing R programming language and the stats (version 4.3.3) package. The PL procedure is one in which a concentration limit for each constituent at each downgradient well is established from the distribution of the background data, with a minimum 95 percent confidence level. The upper endpoint of a prediction interval is called the UPL. Depending on the data distribution, parametric or non-parametric PL procedures are used. Parametric PLs utilize normally distributed data or data normalized via a transformation of the background data used to construct the limit. If the data are non-normal and a transformation is not indicated, non-parametric procedures (order statistics or bootstrap methods) are used to calculate the PL. Note that the PL accounts for future variability based on existing data, so it is possible for the PL to be greater than the maximum measured background concentration.

GWPS Comparison and LCL Calculations

The lower confidence limits (LCL) were calculated for any Appendix IV constituent measured in a downgradient well during the May 2024 sampling event at a concentration greater than the GWPS. The LCL is the lower end of the confidence interval range, which is an estimated concentration range

intended to contain the true mean or median of the population from which the sample is drawn. The confidence interval range is designed to locate the true population mean or median with a high degree of statistical confidence, or conversely, with a low probability of error. An SSL is indicated when the downgradient well/constituent-specific LCL is greater than the GWPS.

TREND SUMMARY

Mann Kendall trend analyses were performed on data sets from downgradient wells of sufficient sample size as described above. Results of the trend analysis are summarized in Table 2. Trends indicated for constituents identified as SSLs are summarized below:

- Molybdenum was determined to be increasing at monitoring well locations CCR-AP-2 and CCR-AP-4R. Analytical results at those locations are below the GWPS.
- Molybdenum was determined to be stable at upgradient location CCR-AP-1R and downgradient location CCR-AP-8. No trend established at CCR-AP-6.
- Molybdenum was determined to be decreasing at upgradient locations CCR-AP-7 and CCR-AP-9, along with downgradient locations CCR-AP-3 and CCR-AP-5.

RESULTS OF APPENDIX IV DOWNGRADIENT STATISTICAL COMPARISONS

The sample concentrations from the downgradient wells for each of the detected Appendix IV constituents from the May 2024 assessment monitoring event were compared to their respective GWPS (Attachment A). LCLs were calculated where constituents were detected at concentrations greater than the GWPS. An SSL is indicated when the LCL is greater than the GWPS. SSLs are summarized in the table below. Based on previous compliance sampling events and statistical evaluations, interwell comparisons were used to evaluate constituents not subject to an Alternative Source Demonstration (ASD) in downgradient monitoring wells. Because a successful ASD was completed for arsenic, an intrawell statistical analysis was used to evaluate that constituent.

The results of the statistical analyses conducted for detected Appendix IV constituents confirm that molybdenum remains the only SSL downgradient of the EAP. As a result, the EAP will remain in Assessment Monitoring.

Table 1. Statistically Significant Level Summary – Appendix IV Constituents

Location ID	Trend	Constituent	Newly Identified SSL	Concentration (mg/L)
CCR-AP-5	Decrease	Molybdenum	No	0.15

Notes:
mg/L= milligrams per liter

Enclosure:

Table 2 – Trend Summary
Attachment A - Assessment Monitoring Statistical Analysis Summary – May 2024

TABLES

Table 2. Trend Summary

Location	Chemical	Units	Identified Trends		Trend Analysis on All Available Data					Trend Analysis on Recent Data				
			Trend (All Data)	Trend (Recent Data)	Results, n	Detected Results, n	Max Concentration	Sen Slope (magnitude per year)	p-value	*Results, n	*Detected Results, n	*Max Concentration	*Sen Slope (magnitude per year)	*p-value
CCR-AP-1R	Antimony, Total	mg/L	No Trend	Probably Decreasing	23	17	0.01	5e-06	0.69	8	8	0.0041	-0.000243	0.0635
CCR-AP-2	Antimony, Total	mg/L	No Trend	No Trend	23	14	0.01	1.58e-05	0.191	8	8	0.0079	4.85e-05	0.803
CCR-AP-3	Antimony, Total	mg/L	Not Evaluated - Majority of data (>50%) non-detect	Not Evaluated - Majority of data (>50%) non-detect	22	5	0.005	NA	NA	8	3	0.005	NA	NA
CCR-AP-4R	Antimony, Total	mg/L	Not Evaluated - Majority of data (>50%) non-detect	No Trend	22	7	0.028	NA	NA	8	5	0.028	0	1
CCR-AP-5	Antimony, Total	mg/L	Not Evaluated - Majority of data (>50%) non-detect	No Trend	22	6	0.01	NA	NA	8	5	0.0047	0.000114	0.126
CCR-AP-6	Antimony, Total	mg/L	No Trend	No Trend	22	13	0.018	0	0.861	8	6	0.018	0	1
CCR-AP-7	Antimony, Total	mg/L	Not Evaluated - Majority of data (>50%) non-detect	Not Evaluated - No detected results	24	3	0.0025	NA	NA	8	0	0.0025	NA	NA
CCR-AP-8	Antimony, Total	mg/L	Stable	No Trend	22	16	0.0046	-1.92e-05	0.128	8	7	0.0046	-6.89e-05	0.386
CCR-AP-9	Antimony, Total	mg/L	No Trend	No Trend	21	15	0.01	-2.94e-06	0.785	8	6	0.01	-0.000108	0.536
CCR-AP-1R	Arsenic, Total	mg/L	Increasing	Decreasing	23	23	0.038	0.000577	0.0302	8	8	0.034	-0.00287	0.0354
CCR-AP-2	Arsenic, Total	mg/L	Increasing	Increasing	23	23	0.048	0.00133	4.64e-05	8	8	0.048	0.005	0.0354
CCR-AP-3	Arsenic, Total	mg/L	Probably Increasing	Stable	22	22	0.095	0.000625	0.0883	8	8	0.095	-0.00213	0.445
CCR-AP-4R	Arsenic, Total	mg/L	Increasing	Stable	22	22	0.33	0.00529	0.0101	8	8	0.33	-0.00778	0.711
CCR-AP-5	Arsenic, Total	mg/L	Increasing	No Trend	21	19	0.024	0.00014	0.0037	8	8	0.024	0.00165	0.212
CCR-AP-6	Arsenic, Total	mg/L	Probably Increasing	Stable	22	22	0.12	0.00171	0.0711	8	8	0.12	-0.00117	0.369
CCR-AP-7	Arsenic, Total	mg/L	Decreasing	Stable	24	24	0.018	-0.000242	0.00678	8	8	0.0062	-0.000525	0.319
CCR-AP-8	Arsenic, Total	mg/L	Increasing	Decreasing	22	22	0.12	0.0023	0.00706	8	8	0.12	-0.00958	0.0226
CCR-AP-9	Arsenic, Total	mg/L	No Trend	Stable	21	21	0.032	0.000129	0.432	8	8	0.02	-0.00142	0.174
CCR-AP-1R	Barium, Total	mg/L	Increasing	Stable	23	23	0.59	0.00909	0.0247	8	8	0.35	-0.00667	0.902
CCR-AP-2	Barium, Total	mg/L	Increasing	Increasing	23	23	0.83	0.0186	0.00138	8	8	0.83	0.105	0.000837
CCR-AP-3	Barium, Total	mg/L	No Trend	Stable	22	22	0.49	0.00125	0.364	8	8	0.49	-0.00633	0.386
CCR-AP-4R	Barium, Total	mg/L	No Trend	Stable	22	22	1.4	0	0.955	8	8	1.4	-0.005	1
CCR-AP-5	Barium, Total	mg/L	Increasing	No Trend	22	22	0.2	0.00312	0.000217	8	8	0.2	0.00945	0.536
CCR-AP-6	Barium, Total	mg/L	Stable	Decreasing	22	22	0.69	-0.004	0.133	8	8	0.69	-0.0167	0.0248
CCR-AP-7	Barium, Total	mg/L	Decreasing	Stable	24	24	0.19	-0.00226	0.00921	8	8	0.13	-0.00367	0.61
CCR-AP-8	Barium, Total	mg/L	Decreasing	Decreasing	22	22	0.68	-0.0114	0.00051	8	8	0.57	-0.0367	0.0126
CCR-AP-9	Barium, Total	mg/L	No Trend	Stable	21	21	0.72	0.00481	0.172	8	8	0.39	-0.0138	0.454
CCR-AP-1R	Beryllium, Total	mg/L	Increasing	Decreasing	23	23	0.0066	0.000138	0.0175	8	8	0.0061	-0.000662	0.0354
CCR-AP-2	Beryllium, Total	mg/L	Increasing	No Trend	23	23	0.0077	0.000162	0.000114	8	8	0.0077	0.000532	0.386
CCR-AP-3	Beryllium, Total	mg/L	Not Evaluated - Only one detected result	Not Evaluated - Only one detected result	22	1	0.00056	NA	NA	8	1	0.00056	NA	NA
CCR-AP-4R	Beryllium, Total	mg/L	Increasing	Stable	22	15	0.0017	1.69e-05	0.00759	8	4	0.0017	-1.29e-05	0.232
CCR-AP-5	Beryllium, Total	mg/L	Not Evaluated - Majority of data (>50%) non-detect	Not Evaluated - Only one detected result	22	6	0.005	NA	NA	8	1	0.0016	NA	NA
CCR-AP-6	Beryllium, Total	mg/L	No Trend	Not Evaluated - Majority of data (>50%) non-detect	22	13	0.0025	8e-06	0.151	8	2	0.00096	NA	NA
CCR-AP-7	Beryllium, Total	mg/L	Not Evaluated - Majority of data (>50%) non-detect	Not Evaluated - No detected results	24	7	0.00075	NA	NA	8	0	0.0005	NA	NA
CCR-AP-8	Beryllium, Total	mg/L	Not Evaluated - Majority of data (>50%) non-detect	Not Evaluated - Only one detected result	22	6	0.0005	NA	NA	8	1	0.0005	NA	NA
CCR-AP-9	Beryllium, Total	mg/L	Probably Increasing	Stable	21	19	0.005	3.14e-05	0.0846	8	6	0.005	-0.000113	0.386
CCR-AP-1R	Cadmium, Total	mg/L	Not Evaluated - Majority of data (>50%) non-detect	No Trend	23	10	0.005	NA	NA	8	6	0.0025	-4.25e-05	0.386
CCR-AP-2	Cadmium, Total	mg/L	Increasing	No Trend	23	20	0.0066	6.25e-05	0.0055	8	8	0.0066	0.000237	0.174
CCR-AP-3	Cadmium, Total	mg/L	Not Evaluated - Only one detected result	Not Evaluated - Only one detected result	22	1	0.0005	NA	NA	8	1	0.0005	NA	NA
CCR-AP-4R	Cadmium, Total	mg/L	Not Evaluated - Majority of data (>50%) non-detect	Stable	22	10	0.0025	NA	NA	8	4	0.00079	0	1
CCR-AP-5	Cadmium, Total	mg/L	No Trend	No Trend	22	16	0.005	4.55e-06	0.57	8	5	0.0014	2.46e-05	0.61
CCR-AP-6	Cadmium, Total	mg/L	No Trend	Not Evaluated - Majority of data (>50%) non-detect	22	13	0.0011	0	0.272	8	2	0.0011	NA	NA
CCR-AP-7	Cadmium, Total	mg/L	Not Evaluated - Majority of data (>50%) non-detect	Not Evaluated - No detected results	24	2	0.0005	NA	NA	8	0	0.0005	NA	NA
CCR-AP-8	Cadmium, Total	mg/L	Not Evaluated - Majority of data (>50%) non-detect	Not Evaluated - Majority of data (>50%) non-detect	22	6	0.00064	NA	NA	8	3	0.00064	NA	NA
CCR-AP-9	Cadmium, Total	mg/L	Increasing	Not Evaluated - Majority of data (>50%) non-detect	21	11	0.005	2.26e-05	0.00325	8	2	0.005	NA	NA
CCR-AP-1R	Chromium, Total	mg/L	Increasing	Stable	23	23	0.16	0.00236	0.0322	8	8	0.11	-0.00746	0.174
CCR-AP-2	Chromium, Total	mg/L	Increasing	Increasing	23	23	0.14	0.00423	9.28e-05	8	8	0.14	0.0176	0.00198
CCR-AP-3	Chromium, Total	mg/L	Probably Increasing	No Trend	22	18	0.014	5e-05	0.0868	8	7	0.014	0.000225	0.212
CCR-AP-4R	Chromium, Total	mg/L	No Trend	Stable	21	18	0.0488	0.000267	0.123	8	7	0.0488	-0.000137	0.902
CCR-AP-5	Chromium, Total	mg/L	Not Evaluated - Majority of data (>50%) non-detect	No Trend	22	6	0.056	NA	NA	8	5	0.056	0.000875	0.203

Abbreviations: mg/L = milligrams per liter; n = sample count; pCi/L = picocuries per liter.

Notes: *Recent data defined as the 8 most recent data points. MK = Mann Kendall Trend Test. Secular Trend Classification based on Aziz (2003) guidance and MK Results. Thiel-Sen slope and p-value evaluated at 95% confidence level to confirm MK trends.

Additional information about trend analysis provided in Attachment A.

Location	Chemical	Units	Identified Trends		Trend Analysis on All Available Data					Trend Analysis on Recent Data				
			Trend (All Data)	Trend (Recent Data)	Results, n	Detected Results, n	Max Concentration	Sen Slope (magnitude per year)	p-value	*Results, n	*Detected Results, n	*Max Concentration	*Sen Slope (magnitude per year)	*p-value
CCR-AP-6	Chromium, Total	mg/L	Stable	No Trend	22	21	0.043	-0.000237	0.296	8	7	0.043	-0.00066	0.536
CCR-AP-7	Chromium, Total	mg/L	No Trend	Not Evaluated - No detected results	24	12	0.019	0	0.723	8	0	0.005	NA	NA
CCR-AP-8	Chromium, Total	mg/L	No Trend	Stable	21	19	0.014	1.61e-05	0.832	8	7	0.014	-0.000237	0.711
CCR-AP-9	Chromium, Total	mg/L	Increasing	Stable	21	21	0.15	0.000926	0.0252	8	8	0.045	-0.000571	0.803
CCR-AP-1R	Cobalt, Total	mg/L	Increasing	Probably Decreasing	23	23	0.081	0.00169	0.015	8	8	0.08	-0.0058	0.0635
CCR-AP-2	Cobalt, Total	mg/L	Increasing	Increasing	23	23	0.091	0.0017	2.08e-05	8	8	0.091	0.00704	0.0187
CCR-AP-3	Cobalt, Total	mg/L	Decreasing	No Trend	22	22	0.0094	-0.000175	0.000877	8	8	0.0092	0.000236	0.386
CCR-AP-4R	Cobalt, Total	mg/L	No Trend	Stable	22	22	0.0173	2.43e-05	0.714	8	8	0.0173	-0.000189	0.902
CCR-AP-5	Cobalt, Total	mg/L	Decreasing	No Trend	22	22	0.01	-0.00032	0.00189	8	8	0.01	0.000558	0.212
CCR-AP-6	Cobalt, Total	mg/L	Stable	Stable	22	22	0.019	-0.00022	0.108	8	8	0.019	-0.000417	0.212
CCR-AP-7	Cobalt, Total	mg/L	Decreasing	No Trend	24	22	0.015	-8.48e-05	0.00631	8	6	0.001	2.47e-05	0.536
CCR-AP-8	Cobalt, Total	mg/L	Decreasing	Stable	22	22	0.017	-0.000467	0.000149	8	8	0.012	-0.000658	0.386
CCR-AP-9	Cobalt, Total	mg/L	No Trend	Stable	21	21	0.047	0.00025	0.153	8	8	0.023	-0.001	0.445
CCR-AP-1R	Fluoride	mg/L	Decreasing	Decreasing	23	23	0.81	-0.00818	0.00158	8	8	0.63	-0.0314	0.00277
CCR-AP-2	Fluoride	mg/L	Increasing	Stable	23	23	0.69	0.0143	0.00136	8	8	0.69	-0.0357	0.319
CCR-AP-3	Fluoride	mg/L	Stable	Stable	22	21	0.93	-0.00933	0.185	8	8	0.57	-0.0104	0.711
CCR-AP-4R	Fluoride	mg/L	No Trend	Probably Increasing	22	21	0.64	0.00667	0.15	8	8	0.61	0.0383	0.0635
CCR-AP-5	Fluoride	mg/L	Increasing	Stable	22	22	2.3	0.0429	0.00782	8	8	2.3	0	1
CCR-AP-6	Fluoride	mg/L	Stable	Stable	22	22	0.69	-0.00467	0.446	8	8	0.69	-0.005	1
CCR-AP-7	Fluoride	mg/L	Increasing	Stable	23	23	0.72	0.00667	0.0212	8	8	0.72	-0.021	0.536
CCR-AP-8	Fluoride	mg/L	No Trend	No Trend	22	21	1.1	0.00438	0.366	8	8	1.1	0.01	0.454
CCR-AP-9	Fluoride	mg/L	No Trend	Stable	21	21	0.42	0.00118	0.693	8	8	0.39	-0.0065	0.454
CCR-AP-1R	Lead, Total	mg/L	Increasing	Stable	23	23	0.094	0.00173	0.0162	8	8	0.078	-0.00715	0.108
CCR-AP-2	Lead, Total	mg/L	Increasing	Increasing	23	23	0.1	0.0025	0.000102	8	8	0.1	0.0101	0.00937
CCR-AP-3	Lead, Total	mg/L	Increasing	No Trend	22	18	0.01	2.67e-05	0.0203	8	7	0.01	0.000151	0.266
CCR-AP-4R	Lead, Total	mg/L	No Trend	Stable	22	21	0.0386	0.000142	0.397	8	7	0.0386	-0.000692	0.386
CCR-AP-5	Lead, Total	mg/L	Not Evaluated - Majority of data (>50%) non-detect	No Trend	22	9	0.02	NA	NA	8	7	0.02	0.0003	0.174
CCR-AP-6	Lead, Total	mg/L	No Trend	No Trend	22	22	0.041	-0.000167	0.446	8	8	0.041	-0.000437	0.902
CCR-AP-7	Lead, Total	mg/L	Probably Decreasing	Not Evaluated - Majority of data (>50%) non-detect	24	14	0.02	-3.32e-05	0.0621	8	2	0.0015	NA	NA
CCR-AP-8	Lead, Total	mg/L	No Trend	No Trend	22	21	0.0076	3.83e-05	0.224	8	7	0.0061	3.75e-05	0.902
CCR-AP-9	Lead, Total	mg/L	Probably Increasing	Stable	21	21	0.041	0.000426	0.0904	8	8	0.025	-0.00173	0.386
CCR-AP-1R	Lithium, Total	mg/L	Probably Increasing	Stable	23	23	0.23	0.00307	0.0639	8	8	0.15	-0.00804	0.319
CCR-AP-2	Lithium, Total	mg/L	Increasing	Increasing	23	18	0.125	0.002	0.0211	8	8	0.11	0.014	0.00198
CCR-AP-3	Lithium, Total	mg/L	Not Evaluated - Majority of data (>50%) non-detect	No Trend	22	4	0.025	NA	NA	8	4	0.0043	0	0.894
CCR-AP-4R	Lithium, Total	mg/L	Stable	Stable	22	16	0.047	-0.000262	0.231	8	7	0.025	-0.0002	1
CCR-AP-5	Lithium, Total	mg/L	Decreasing	No Trend	22	22	0.15	-0.00514	9.12e-06	8	8	0.072	0.002	0.711
CCR-AP-6	Lithium, Total	mg/L	Decreasing	No Trend	22	11	0.125	-0.00127	6.5e-05	8	5	0.018	3.57e-05	1
CCR-AP-7	Lithium, Total	mg/L	Decreasing	No Trend	24	24	0.039	-0.0002	0.00968	8	8	0.011	0.000204	0.319
CCR-AP-8	Lithium, Total	mg/L	Not Evaluated - Majority of data (>50%) non-detect	Not Evaluated - Majority of data (>50%) non-detect	22	6	0.025	NA	NA	8	2	0.0067	NA	NA
CCR-AP-9	Lithium, Total	mg/L	Probably Increasing	Stable	21	21	0.12	0.000554	0.0845	8	8	0.064	-0.000625	0.902
CCR-AP-1R	Mercury, Total	mg/L	Not Evaluated - No detected results	Not Evaluated - No detected results	22	0	0.001	NA	NA	8	0	0.001	NA	NA
CCR-AP-2	Mercury, Total	mg/L	Not Evaluated - Majority of data (>50%) non-detect	Probably Increasing	22	9	0.00071	NA	NA	8	6	0.00071	4.05e-05	0.0809
CCR-AP-3	Mercury, Total	mg/L	Not Evaluated - No detected results	Not Evaluated - No detected results	21	0	0.00025	NA	NA	8	0	0.00025	NA	NA
CCR-AP-4R	Mercury, Total	mg/L	Not Evaluated - No detected results	Not Evaluated - No detected results	21	0	0.00025	NA	NA	8	0	0.00025	NA	NA
CCR-AP-5	Mercury, Total	mg/L	Not Evaluated - Majority of data (>50%) non-detect	Not Evaluated - Majority of data (>50%) non-detect	21	3	0.0016	NA	NA	8	3	0.0016	NA	NA
CCR-AP-6	Mercury, Total	mg/L	Not Evaluated - Majority of data (>50%) non-detect	Not Evaluated - Majority of data (>50%) non-detect	21	2	0.00041	NA	NA	8	2	0.00041	NA	NA
CCR-AP-7	Mercury, Total	mg/L	Not Evaluated - No detected results	Not Evaluated - No detected results	21	0	0.00025	NA	NA	8	0	0.00025	NA	NA
CCR-AP-8	Mercury, Total	mg/L	Not Evaluated - Only one detected result	Not Evaluated - Only one detected result	21	1	0.00026	NA	NA	8	1	0.00026	NA	NA
CCR-AP-9	Mercury, Total	mg/L	Not Evaluated - No detected results	Not Evaluated - No detected results	20	0	0.0001	NA	NA	8	0	0.0001	NA	NA
CCR-AP-1R	Molybdenum, Total	mg/L	Stable	Decreasing	23	23	0.023	-7.78e-05	0.442	8	8	0.023	-0.000758	0.0354
CCR-AP-2	Molybdenum, Total	mg/L	Increasing	No Trend	23	23	0.01	0.000331	2.61e-05	8	8	0.01	0.0005	0.108
CCR-AP-3	Molybdenum, Total	mg/L	Decreasing	No Trend	22	22	0.025	-0.000262	0.00494	8	8	0.025	0.000371	0.536
CCR-AP-4R	Molybdenum, Total	mg/L	Increasing	No Trend	22	19	0.017	0.000153	0.00918	8	6	0.017	0.0011	0.319
CCR-AP-5	Molybdenum, Total	mg/L	Decreasing	Stable	22	22	0.53	-0.012	0.00136	8	8	0.34	-0.0138	0.706
CCR-AP-6	Molybdenum, Total	mg/L	No Trend	No Trend	22	22	0.043	0	0.821	8	8	0.043	0.00117	0.711
CCR-AP-7	Molybdenum, Total	mg/L	Decreasing	No Trend	24	23	0.013	-0.000227	5.4e-06	8	7	0.0025	5.18e-05	0.803
CCR-AP-8	Molybdenum, Total	mg/L	Stable	Stable	22	22	0.029	0	0.668	8	8	0.029	-0.000971	0.454
CCR-AP-9	Molybdenum, Total	mg/L	Decreasing	No Trend	21	19	0.025	-0.0003	0.0011	8	6	0.025	-0.00025	0.266
CCR-AP-1R	Radium-226 & 228	pCi/L	No Trend	No Trend	21	21	14.4	0.124	0.124	8	8	14.4	1.24	0.266
CCR-AP-2	Radium-226 & 228	pCi/L	No Trend	No Trend	21	21	5.53	0.0183	0.695	8	8	5.53	0.222	0.711
CCR-AP-3	Radium-226 & 228	pCi/L	No Trend	No Trend	20	20	4.87	0.00597	0.922	8	8	4.87	0.0326	0.902
CCR-AP-4R	Radium-226 & 228	pCi/L	No Trend	No Trend	20	20	30	-0.0041	0.974	8	8	30	0.117	0.711
CCR-AP-5	Radium-226 & 228	pCi/L	No Trend	No Trend	20	20	5.54	0.0379	0.315	8	8	5.54	0.506	0.108

Abbreviations: mg/L = milligrams per liter; n = sample count; pCi/L = picocuries per liter.

Notes: *Recent data defined as the 8 most recent data points. MK = Mann Kendall Trend Test. Secular Trend Classification based on Aziz (2003) guidance and MK Results. Thiel-Sen slope and p-value evaluated at 95% confidence level to confirm MK trends.

Additional information about trend analysis provided in Attachment A.

Location	Chemical	Units	Identified Trends		Trend Analysis on All Available Data					Trend Analysis on Recent Data				
			Trend (All Data)	Trend (Recent Data)	Results, n	Detected Results, n	Max Concentration	Sen Slope (magnitude per year)	p-value	*Results, n	*Detected Results, n	*Max Concentration	*Sen Slope (magnitude per year)	*p-value
CCR-AP-6	Radium-226 & 228	pCi/L	Stable	Stable	20	19	10.2	-0.000548	1	8	7	3.21	-0.00971	1
CCR-AP-7	Radium-226 & 228	pCi/L	Stable	Increasing	21	21	1.72	-0.0149	0.487	8	8	1.44	0.117	0.0354
CCR-AP-8	Radium-226 & 228	pCi/L	Stable	Stable	19	19	2.88	-0.0164	0.441	8	8	2.88	-0.0715	0.902
CCR-AP-9	Radium-226 & 228	pCi/L	Increasing	No Trend	19	19	12.6	0.182	0.0424	8	8	12.6	0.644	0.266
CCR-AP-1R	Selenium, Total	mg/L	Not Evaluated - Majority of data (>50%) non-detect	No Trend	23	10	0.025	NA	NA	8	5	0.0125	-0.0003	0.319
CCR-AP-2	Selenium, Total	mg/L	Increasing	No Trend	23	16	0.026	0.00012	0.018	8	7	0.013	0.000105	0.536
CCR-AP-3	Selenium, Total	mg/L	No Trend	No Trend	22	21	0.0068	1.11e-05	0.23	8	8	0.003	0	0.898
CCR-AP-4R	Selenium, Total	mg/L	Probably Increasing	Not Evaluated - Majority of data (>50%) non-detect	22	11	0.031	1.67e-05	0.0561	8	3	0.0036	NA	NA
CCR-AP-5	Selenium, Total	mg/L	Not Evaluated - Majority of data (>50%) non-detect	No Trend	22	8	0.025	NA	NA	8	6	0.02	0.000312	0.319
CCR-AP-6	Selenium, Total	mg/L	No Trend	Stable	22	17	0.0125	2e-05	0.378	8	6	0.003	-1e-05	1
CCR-AP-7	Selenium, Total	mg/L	Not Evaluated - Majority of data (>50%) non-detect	Not Evaluated - No detected results	22	3	0.0028	NA	NA	8	0	0.0025	NA	NA
CCR-AP-8	Selenium, Total	mg/L	No Trend	Stable	22	19	0.007	7.14e-06	0.609	8	8	0.0051	-1.25e-05	1
CCR-AP-9	Selenium, Total	mg/L	Not Evaluated - Majority of data (>50%) non-detect	Not Evaluated - Majority of data (>50%) non-detect	21	6	0.025	NA	NA	8	2	0.025	NA	NA
CCR-AP-1R	Thallium, Total	mg/L	Increasing	Stable	23	16	0.0027	2.6e-05	0.0357	8	5	0.0027	-1.1e-05	0.803
CCR-AP-2	Thallium, Total	mg/L	Increasing	No Trend	23	20	0.0076	5e-05	5.15e-05	8	8	0.0076	6.75e-05	0.803
CCR-AP-3	Thallium, Total	mg/L	Not Evaluated - Only one detected result	Not Evaluated - No detected results	22	1	0.001	NA	NA	8	0	0.001	NA	NA
CCR-AP-4R	Thallium, Total	mg/L	Not Evaluated - Majority of data (>50%) non-detect	Not Evaluated - Majority of data (>50%) non-detect	22	10	0.0025	NA	NA	8	2	0.001	NA	NA
CCR-AP-5	Thallium, Total	mg/L	Not Evaluated - Majority of data (>50%) non-detect	No Trend	22	7	0.005	NA	NA	8	4	0.00096	5.67e-05	0.232
CCR-AP-6	Thallium, Total	mg/L	Not Evaluated - Majority of data (>50%) non-detect	Not Evaluated - No detected results	22	8	0.0025	NA	NA	8	0	0.001	NA	NA
CCR-AP-7	Thallium, Total	mg/L	Not Evaluated - Majority of data (>50%) non-detect	Not Evaluated - No detected results	24	4	0.001	NA	NA	8	0	0.001	NA	NA
CCR-AP-8	Thallium, Total	mg/L	Not Evaluated - Majority of data (>50%) non-detect	Not Evaluated - No detected results	22	5	0.001	NA	NA	8	0	0.001	NA	NA
CCR-AP-9	Thallium, Total	mg/L	Not Evaluated - Majority of data (>50%) non-detect	Not Evaluated - No detected results	21	9	0.005	NA	NA	8	0	0.005	NA	NA

Abbreviations: mg/L = milligrams per liter; n = sample count; pCi/L = picocuries per liter.

Notes: *Recent data defined as the 8 most recent data points. MK = Mann Kendall Trend Test. Secular Trend Classification based on Aziz (2003) guidance and MK Results. Thiel-Sen slope and p-value evaluated at 95% confidence level to confirm MK trends.

Additional information about trend analysis provided in Attachment A.

ATTACHMENT A
Assessment Monitoring Statistical Analysis Summary – May 2024

Table A-1. Descriptive Statistics

Location	Constituent	Units	n	n, non-detects	percent of non-detects	max	min	mean	median	standard deviation	variance	reporting limit range	date range
CCR-AP-1R	Antimony, Total	mg/L	23	6	26	0.02000	0.00053	0.00347	0.0015	0.0056	3.1e-05	0.002 - 0.02	2016-06-10 to 2024-05-08
CCR-AP-2	Antimony, Total	mg/L	23	9	39	0.02000	0.00024	0.00347	0.002	0.0045	2.1e-05	0.002 - 0.02	2016-06-10 to 2024-05-08
CCR-AP-3	Antimony, Total	mg/L	22	17	77	0.00500	0.00031	0.00195	0.002	0.00085	7.2e-07	0.002 - 0.002	2016-06-10 to 2024-05-07
CCR-AP-4R	Antimony, Total	mg/L	22	15	68	0.02800	0.0004	0.00336	0.002	0.0058	3.4e-05	0.002 - 0.01	2016-06-10 to 2024-05-08
CCR-AP-5	Antimony, Total	mg/L	22	16	73	0.02000	5.8e-05	0.0027	0.002	0.004	1.6e-05	0.002 - 0.02	2016-06-10 to 2024-05-13
CCR-AP-6	Antimony, Total	mg/L	22	9	41	0.01800	0.00042	0.00246	0.00155	0.004	1.6e-05	0.002 - 0.01	2016-06-10 to 2024-05-07
CCR-AP-7	Antimony, Total	mg/L	24	21	88	0.00500	0.00016	0.00194	0.002	0.00082	6.8e-07	0.002 - 0.005	2016-06-10 to 2024-05-10
CCR-AP-8	Antimony, Total	mg/L	22	6	27	0.00460	0.0004	0.00132	0.00105	0.00096	9.2e-07	0.002 - 0.002	2017-03-09 to 2024-05-10
CCR-AP-9	Antimony, Total	mg/L	21	6	29	0.02000	0.00061	0.00425	0.0014	0.0059	3.4e-05	0.002 - 0.02	2017-03-09 to 2024-05-08
CCR-AP-1R	Arsenic, Total	mg/L	23	0	0	0.03800	0.0024	0.0162	0.012	0.011	0.00013	NA	2016-06-10 to 2024-05-08
CCR-AP-2	Arsenic, Total	mg/L	23	0	0	0.04800	0.0016	0.0159	0.013	0.013	0.00016	NA	2016-06-10 to 2024-05-08
CCR-AP-3	Arsenic, Total	mg/L	22	0	0	0.09500	0.051	0.0754	0.077	0.01	0.0001	NA	2016-06-10 to 2024-05-07
CCR-AP-4R	Arsenic, Total	mg/L	22	0	0	0.33000	0.027	0.111	0.086	0.081	0.0066	NA	2016-06-10 to 2024-05-08
CCR-AP-5	Arsenic, Total	mg/L	21	2	10	0.02400	0.00039	0.0044	0.001	0.0072	5.1e-05	0.001 - 0.01	2016-06-10 to 2024-05-13
CCR-AP-6	Arsenic, Total	mg/L	22	0	0	0.12000	0.04	0.0926	0.1	0.022	0.0005	NA	2016-06-10 to 2024-05-07
CCR-AP-7	Arsenic, Total	mg/L	24	0	0	0.01800	0.00066	0.00567	0.00515	0.0042	1.7e-05	NA	2016-06-10 to 2024-05-10
CCR-AP-8	Arsenic, Total	mg/L	22	0	0	0.12000	0.013	0.0863	0.0925	0.027	0.00072	NA	2017-03-09 to 2024-05-10
CCR-AP-9	Arsenic, Total	mg/L	21	0	0	0.03200	0.0031	0.0101	0.0087	0.0063	4e-05	NA	2017-03-09 to 2024-05-08
CCR-AP-1R	Barium, Total	mg/L	23	0	0	0.59000	0.05	0.233	0.2	0.15	0.024	NA	2016-06-10 to 2024-05-08
CCR-AP-2	Barium, Total	mg/L	23	0	0	0.83000	0.038	0.275	0.24	0.2	0.042	NA	2016-06-10 to 2024-05-08
CCR-AP-3	Barium, Total	mg/L	22	0	0	0.49000	0.38	0.429	0.425	0.033	0.0011	NA	2016-06-10 to 2024-05-07
CCR-AP-4R	Barium, Total	mg/L	22	0	0	1.40000	0.45	0.695	0.63	0.24	0.059	NA	2016-06-10 to 2024-05-08
CCR-AP-5	Barium, Total	mg/L	22	0	0	0.20000	0.029	0.0613	0.0415	0.044	0.0019	NA	2016-06-10 to 2024-05-13
CCR-AP-6	Barium, Total	mg/L	22	0	0	0.69000	0.43	0.575	0.575	0.072	0.0052	NA	2016-06-10 to 2024-05-07
CCR-AP-7	Barium, Total	mg/L	24	0	0	0.19000	0.076	0.127	0.12	0.029	0.00082	NA	2016-06-10 to 2024-05-10
CCR-AP-8	Barium, Total	mg/L	22	0	0	0.68000	0.27	0.531	0.565	0.11	0.012	NA	2017-03-09 to 2024-05-10
CCR-AP-9	Barium, Total	mg/L	21	0	0	0.72000	0.13	0.287	0.27	0.12	0.015	NA	2017-03-09 to 2024-05-08
CCR-AP-1R	Beryllium, Total	mg/L	23	0	0	0.00660	0.00011	0.00262	0.002	0.0021	4.6e-06	NA	2016-06-10 to 2024-05-08
CCR-AP-2	Beryllium, Total	mg/L	23	0	0	0.00770	0.00014	0.00217	0.0019	0.002	4.2e-06	NA	2016-06-10 to 2024-05-08
CCR-AP-3	Beryllium, Total	mg/L	22	21	95	0.00100	0.00056	0.00098	0.001	9.4e-05	8.8e-09	0.001 - 0.001	2016-06-10 to 2024-05-07
CCR-AP-4R	Beryllium, Total	mg/L	22	7	32	0.00170	0.00014	0.000707	0.000725	0.00043	1.9e-07	0.001 - 0.001	2016-06-10 to 2024-05-08
CCR-AP-5	Beryllium, Total	mg/L	22	16	73	0.01000	0.00017	0.00132	0.001	0.002	3.9e-06	0.001 - 0.01	2016-06-10 to 2024-05-13
CCR-AP-6	Beryllium, Total	mg/L	22	9	41	0.00500	0.00011	0.000805	0.000575	0.00099	9.9e-07	0.0005 - 0.005	2016-06-10 to 2024-05-07
CCR-AP-7	Beryllium, Total	mg/L	24	17	71	0.00100	6.7e-05	0.00076	0.001	0.00037	1.4e-07	0.0005 - 0.001	2016-06-10 to 2024-05-10
CCR-AP-8	Beryllium, Total	mg/L	22	16	73	0.00100	0.00016	0.000774	0.001	0.00035	1.2e-07	0.0005 - 0.001	2017-03-09 to 2024-05-10
CCR-AP-9	Beryllium, Total	mg/L	21	2	10	0.01000	0.00017	0.00144	0.00092	0.0021	4.5e-06	0.001 - 0.01	2017-03-09 to 2024-05-08
CCR-AP-1R	Cadmium, Total	mg/L	23	13	57	0.01000	8.1e-05	0.00202	0.001	0.0029	8.7e-06	0.001 - 0.01	2016-06-10 to 2024-05-08
CCR-AP-2	Cadmium, Total	mg/L	23	3	13	0.01000	0.00011	0.00202	0.00089	0.0024	6e-06	0.005 - 0.01	2016-06-10 to 2024-05-08
CCR-AP-3	Cadmium, Total	mg/L	22	21	95	0.00100	0.00038	0.000972	0.001	0.00013	1.7e-08	0.001 - 0.001	2016-06-10 to 2024-05-07
CCR-AP-4R	Cadmium, Total	mg/L	22	12	55	0.00500	0.00014	0.000888	0.001	0.00099	9.7e-07	0.001 - 0.005	2016-06-10 to 2024-05-08
CCR-AP-5	Cadmium, Total	mg/L	22	6	27	0.01000	0.00015	0.00106	0.00057	0.002	4.1e-06	0.001 - 0.01	2016-06-10 to 2024-05-13
CCR-AP-6	Cadmium, Total	mg/L	22	9	41	0.00110	9.4e-05	0.000638	0.00056	0.00037	1.4e-07	0.001 - 0.001	2016-06-10 to 2024-05-07
CCR-AP-7	Cadmium, Total	mg/L	24	22	92	0.00100	0.00014	0.000915	0.001	0.00024	5.6e-08	0.0005 - 0.001	2016-06-10 to 2024-05-10
CCR-AP-8	Cadmium, Total	mg/L	22	16	73	0.00100	0.00016	0.000805	0.001	0.00034	1.1e-07	0.001 - 0.001	2017-03-09 to 2024-05-10
CCR-AP-9	Cadmium, Total	mg/L	21	10	48	0.01000	7.9e-05	0.0018	0.0004	0.0031	9.4e-06	0.001 - 0.01	2017-03-09 to 2024-05-08
CCR-AP-1R	Chromium, Total	mg/L	23	0	0	0.16000	0.0019	0.0557	0.036	0.047	0.0022	NA	2016-06-10 to 2024-05-08
CCR-AP-2	Chromium, Total	mg/L	23	0	0	0.14000	0.003	0.0444	0.035	0.037	0.0014	NA	2016-06-10 to 2024-05-08
CCR-AP-3	Chromium, Total	mg/L	22	4	18	0.01400	0.0018	0.00297	0.0021	0.0026	6.5e-06	0.002 - 0.002	2016-06-10 to 2024-05-07
CCR-AP-4R	Chromium, Total	mg/L	21	3	14	0.05800	0.0015	0.0126	0.0076	0.014	0.00021	0.002 - 0.005	2016-06-10 to 2024-05-08
CCR-AP-5	Chromium, Total	mg/L	22	16	73	0.05600	0.0014	0.00672	0.002	0.013	0.00016	0.002 - 0.02	2016-06-10 to 2024-05-13
CCR-AP-6	Chromium, Total	mg/L	22	1	5	0.04300	0.0019	0.0128	0.0095	0.011	0.00012	0.002 - 0.002	2016-06-10 to 2024-05-07
CCR-AP-7	Chromium, Total	mg/L	24	12	50	0.01900	0.00047	0.00389	0.002	0.0039	1.5e-05	0.002 - 0.01	2016-06-10 to 2024-05-10
CCR-AP-8	Chromium, Total	mg/L	21	2	10	0.01400	0.0012	0.0043	0.0029	0.0034	1.2e-05	0.002 - 0.0034	2017-03-09 to 2024-05-10
CCR-AP-9	Chromium, Total	mg/L	21	0	0	0.15000	0.0042	0.0254	0.016	0.031	0.00096	NA	2017-03-09 to 2024-05-08
CCR-AP-1R	Cobalt, Total	mg/L	23	0	0	0.08100	0.0015	0.031	0.019	0.026	0.00066	NA	2016-06-10 to 2024-05-08
CCR-AP-2	Cobalt, Total	mg/L	23	0	0	0.09100	0.0073	0.0286	0.023	0.02	0.00039	NA	2016-06-10 to 2024-05-08
CCR-AP-3	Cobalt, Total	mg/L	22	0	0	0.00940	0.004	0.00603	0.00565	0.0015	2.4e-06	NA	2016-06-10 to 2024-05-07
CCR-AP-4R	Cobalt, Total	mg/L	22	0	0	0.02100	0.00071	0.00682	0.0052	0.0055	3.1e-05	NA	2016-06-10 to 2024-05-08
CCR-AP-5	Cobalt, Total	mg/L	22	0	0	0.01000	0.00036	0.004	0.00365	0.0026	6.6e-06	NA	2016-06-10 to 2024-05-13
CCR-AP-6	Cobalt, Total	mg/L	22	0	0	0.01900	0.0034	0.00855	0.0074	0.0045	2e-05	NA	2016-06-10 to 2024-05-07
CCR-AP-7	Cobalt, Total	mg/L	24	2	8	0.01500	0.00021	0.00218	0.000935	0.0032	1e-05	0.0005 - 0.002	2016-06-10 to 2024-05-10
CCR-AP-8	Cobalt, Total	mg/L	22	0	0	0.01700	0.0026	0.00856	0.0081	0.0039	1.5e-05	NA	2017-03-09 to 2024-05-10
CCR-AP-9	Cobalt, Total	mg/L	21	0	0	0.04700	0.0061	0.0148	0.014	0.0085	7.2e-05	NA	2017-03-09 to 2024-05-08
CCR-AP-1R	Fluoride	mg/L	23	0	0	0.81000	0.25	0.495	0.48	0.11	0.012	NA	2016-06-10 to 2024-05-08
CCR-AP-2	Fluoride	mg/L	23	0	0	0.69000	0.11	0.362	0.3	0.15	0.022	NA	2016-06-10 to 2024-05-08
CCR-AP-3	Fluoride	mg/L	22	1	5	0.93000	0.1	0.401	0.375	0.19	0.034	0.1 - 0.1	2016-06-10 to 2024-05-07
CCR-AP-4R	Fluoride	mg/L	22	1	5	0.64000	0.1	0.389	0.38	0.12	0.014	0.1 - 0.1	2016-06-10 to 2024-05-08
CCR-AP-5	Fluoride	mg/L	22	0	0	2.30000	0.58	1.27	1.2	0.45	0.2	NA	2016-06-10 to 2024-05-13
CCR-AP-6	Fluoride	mg/L	22	0	0	0.69000	0.24	0.49	0.47	0.13	0.017	NA	2016-06-10 to 2024-05-07
CCR-AP-7	Fluoride	mg/L	23	0	0	0.72000	0.14	0.333	0.3	0.13	0.017	NA	2016-08-12 to 2024-05-10
CCR-AP-8	Fluoride	mg/L	22	1	5	1.10000	0.1	0.321	0.27	0.2	0.041	0.1 - 0.1	2017-03-09 to 2024-05-10
CCR-AP-9	Fluoride	mg/L	21	0	0	0.42000	0.14	0.329	0.34	0.064	0.0041	NA	2017-03-09 to 2024-05-08
CCR-AP-1R	Lead, Total	mg/L	23	0	0	0.09400	0.0011	0.0339	0.02	0.028	0.00079	NA	2016-06-10 to 2024-05-08
CCR-AP-2	Lead, Total	mg/L	23	0	0	0.10000	0.0023	0.0292	0.026	0.025	0.00062	NA	2016-06-10 to 2024-05-08

Note:
Units: mg/L = milligrams per liter, pCi/L = picocuries per liter

Location	Constituent	Units	n	n, non-detects	percent of non-detects	max	min	mean	median	standard deviation	variance	reporting limit range	date range
CCR-AP-3	Lead, Total	mg/L	22	4	18	0.01000	0.00021	0.0012	0.00085	0.002	4e-06	0.001 - 0.001	2016-06-10 to 2024-05-07
CCR-AP-4R	Lead, Total	mg/L	22	1	5	0.04700	0.00052	0.0101	0.0047	0.012	0.00015	0.001 - 0.001	2016-06-10 to 2024-05-08
CCR-AP-5	Lead, Total	mg/L	22	13	59	0.02000	9.9e-05	0.00253	0.001	0.0046	2.1e-05	0.001 - 0.01	2016-06-10 to 2024-05-13
CCR-AP-6	Lead, Total	mg/L	22	0	0	0.04100	0.00039	0.00953	0.00685	0.0095	9.1e-05	NA	2016-06-10 to 2024-05-07
CCR-AP-7	Lead, Total	mg/L	24	10	42	0.02000	0.00013	0.00291	0.001	0.0043	1.9e-05	0.001 - 0.003	2016-06-10 to 2024-05-10
CCR-AP-8	Lead, Total	mg/L	22	1	5	0.00760	0.00027	0.00222	0.0019	0.0018	3.1e-06	0.003 - 0.003	2017-03-09 to 2024-05-10
CCR-AP-9	Lead, Total	mg/L	21	0	0	0.04100	0.0025	0.0124	0.01	0.0088	7.8e-05	NA	2017-03-09 to 2024-05-08
CCR-AP-1R	Lithium, Total	mg/L	23	0	0	0.23000	0.035	0.0914	0.076	0.054	0.0029	NA	2016-06-10 to 2024-05-08
CCR-AP-2	Lithium, Total	mg/L	23	5	22	0.25000	0.01	0.0528	0.043	0.05	0.0025	0.05 - 0.25	2016-06-10 to 2024-05-08
CCR-AP-3	Lithium, Total	mg/L	22	18	82	0.05000	0.0021	0.0231	0.005	0.023	0.00052	0.005 - 0.05	2016-06-10 to 2024-05-07
CCR-AP-4R	Lithium, Total	mg/L	22	6	27	0.05000	0.0028	0.0205	0.0105	0.019	0.00036	0.005 - 0.05	2016-06-10 to 2024-05-08
CCR-AP-5	Lithium, Total	mg/L	22	0	0	0.15000	0.009	0.0914	0.0945	0.042	0.0017	NA	2016-06-10 to 2024-05-13
CCR-AP-6	Lithium, Total	mg/L	22	11	50	0.25000	0.0014	0.0327	0.014	0.052	0.0028	0.005 - 0.25	2016-06-10 to 2024-05-07
CCR-AP-7	Lithium, Total	mg/L	24	0	0	0.03900	0.007	0.0134	0.011	0.0067	4.5e-05	NA	2016-06-10 to 2024-05-10
CCR-AP-8	Lithium, Total	mg/L	22	16	73	0.05000	0.0031	0.0221	0.00735	0.022	0.00047	0.005 - 0.05	2017-03-09 to 2024-05-10
CCR-AP-9	Lithium, Total	mg/L	21	0	0	0.12000	0.029	0.0473	0.04	0.02	0.0004	NA	2017-03-09 to 2024-05-08
CCR-AP-1R	Mercury, Total	mg/L	22	22	100	0.00200	0.0002	0.000309	0.0002	0.00039	1.5e-07	0.0002 - 0.002	2016-06-10 to 2024-05-08
CCR-AP-2	Mercury, Total	mg/L	22	13	59	0.00071	0.00015	0.000239	0.0002	0.00013	1.6e-08	0.0002 - 0.0002	2016-06-10 to 2024-05-08
CCR-AP-3	Mercury, Total	mg/L	21	21	100	0.00050	0.0002	0.000214	0.0002	6.5e-05	4.3e-09	0.0002 - 0.0005	2016-06-10 to 2024-05-07
CCR-AP-4R	Mercury, Total	mg/L	21	21	100	0.00050	0.0002	0.000224	0.0002	7.7e-05	5.9e-09	0.0002 - 0.0005	2016-06-10 to 2024-05-08
CCR-AP-5	Mercury, Total	mg/L	21	18	86	0.00160	0.0002	0.000306	0.0002	0.00033	1.1e-07	0.0002 - 0.0002	2016-06-10 to 2024-05-13
CCR-AP-6	Mercury, Total	mg/L	21	19	90	0.00050	0.00017	0.000223	0.0002	7.9e-05	6.2e-09	0.0002 - 0.0005	2016-06-10 to 2024-05-07
CCR-AP-7	Mercury, Total	mg/L	21	21	100	0.00050	0.0002	0.000214	0.0002	6.5e-05	4.3e-09	0.0002 - 0.0005	2016-06-10 to 2024-05-10
CCR-AP-8	Mercury, Total	mg/L	21	20	95	0.00050	0.0002	0.000217	0.0002	6.6e-05	4.4e-09	0.0002 - 0.0005	2017-03-09 to 2024-05- 0
CCR-AP-9	Mercury, Total	mg/L	20	20	100	0.00020	0.0002	0.0002	0.0002	0	0	0.0002 - 0.0002	2017-03-09 to 2024-05-08
CCR-AP-1R	Molybdenum, Total	mg/L	23	0	0	0.02300	0.0047	0.00927	0.008	0.004	1.6e-05	NA	2016-06-10 to 2024-05-08
CCR-AP-2	Molybdenum, Total	mg/L	23	0	0	0.01000	0.00094	0.00478	0.0051	0.0027	7.3e-06	NA	2016-06-10 to 2024-05-08
CCR-AP-3	Molybdenum, Total	mg/L	22	0	0	0.02500	0.0065	0.0112	0.01	0.0039	1.5e-05	NA	2016-06-10 to 2024-05-07
CCR-AP-4R	Molybdenum, Total	mg/L	22	3	14	0.01700	0.00071	0.00381	0.00235	0.0039	1.5e-05	0.005 - 0.005	2016-06-10 to 2024-05-08
CCR-AP-5	Molybdenum, Total	mg/L	22	0	0	0.53000	0.046	0.287	0.315	0.12	0.014	NA	2016-06-10 to 2024-05-13
CCR-AP-6	Molybdenum, Total	mg/L	22	0	0	0.04300	0.015	0.0256	0.024	0.0067	4.5e-05	NA	2016-06-10 to 2024-05-07
CCR-AP-7	Molybdenum, Total	mg/L	24	1	4	0.01300	0.0011	0.00367	0.00225	0.003	9.2e-06	0.005 - 0.005	2016-06-10 to 2024-05-10
CCR-AP-8	Molybdenum, Total	mg/L	22	0	0	0.02900	0.0029	0.0144	0.0135	0.0054	2.9e-05	NA	2017-03-09 to 2024-05-10
CCR-AP-9	Molybdenum, Total	mg/L	21	2	10	0.05000	0.0017	0.0075	0.0049	0.01	0.0001	0.005 - 0.05	2017-03-09 to 2024-05-08
CCR-AP-1R	Radium-226 & 228	pCi/L	21	0	0	14.40000	0.862	4.87	5	3.3	11	NA	2016-06-10 to 2024-05-08
CCR-AP-2	Radium-226 & 228	pCi/L	21	0	0	5.53000	0.444	2.12	1.91	1.4	2	NA	2016-06-10 to 2024-05-08
CCR-AP-3	Radium-226 & 228	pCi/L	20	0	0	4.87000	0.593	1.75	1.67	1.1	1.3	NA	2016-06-10 to 2024-05-07
CCR-AP-4R	Radium-226 & 228	pCi/L	20	0	0	30.00000	1.07	3.76	2.39	6.3	39	NA	2016-06-10 to 2024-05-08
CCR-AP-5	Radium-226 & 228	pCi/L	20	0	0	5.54000	0.292	1.24	0.686	1.3	1.8	NA	2016-06-10 to 2024-05-13
CCR-AP-6	Radium-226 & 228	pCi/L	20	1	5	10.20000	0.351	2.38	1.64	2.2	4.8	0.71 - 0.71	2016-06-10 to 2024-05-07
CCR-AP-7	Radium-226 & 228	pCi/L	21	0	0	1.72000	0.126	0.847	0.764	0.45	0.2	NA	2016-06-10 to 2024-05-10
CCR-AP-8	Radium-226 & 228	pCi/L	19	0	0	2.88000	0.449	1.44	1.43	0.65	0.42	NA	2017-03-09 to 2024-05-10
CCR-AP-9	Radium-226 & 228	pCi/L	19	0	0	12.60000	0.934	3.7	3.13	2.9	8.5	NA	2017-03-09 to 2024-05-08
CCR-AP-1R	Selenium, Total	mg/L	23	13	57	0.05000	0.00045	0.0111	0.005	0.015	0.00022	0.005 - 0.05	2016-06-10 to 2024-05-08
CCR-AP-2	Selenium, Total	mg/L	23	7	30	0.05000	0.00044	0.00856	0.005	0.011	0.00013	0.005 - 0.05	2016-06-10 to 2024-05-08
CCR-AP-3	Selenium, Total	mg/L	22	1	5	0.00680	0.00062	0.0022	0.00185	0.0013	1.7e-06	0.005 - 0.005	2016-06-10 to 2024-05-07
CCR-AP-4R	Selenium, Total	mg/L	22	11	50	0.03100	0.0009	0.00469	0.005	0.0061	3.7e-05	0.005 - 0.005	2016-06-10 to 2024-05-08
CCR-AP-5	Selenium, Total	mg/L	22	14	64	0.05000	0.00095	0.00729	0.005	0.01	0.0001	0.005 - 0.05	2016-06-10 to 2024-05-13
CCR-AP-6	Selenium, Total	mg/L	22	5	23	0.02500	0.001	0.00352	0.0019	0.005	2.5e-05	0.005 - 0.025	2016-06-10 to 2024-05-07
CCR-AP-7	Selenium, Total	mg/L	22	19	86	0.00500	0.00035	0.00449	0.005	0.0014	1.9e-06	0.005 - 0.005	2016-06-10 to 2024-05-10
CCR-AP-8	Selenium, Total	mg/L	22	3	14	0.00700	0.0014	0.00269	0.00195	0.0016	2.6e-06	0.005 - 0.005	2017-03-09 to 2024-05-10
CCR-AP-9	Selenium, Total	mg/L	21	15	71	0.05000	0.001	0.00871	0.005	0.011	0.00013	0.005 - 0.05	2017-03-09 to 2024-05-08
CCR-AP-1R	Thallium, Total	mg/L	23	7	30	0.00500	7.9e-05	0.00102	0.00094	0.0011	1.2e-06	0.001 - 0.005	2016-06-10 to 2024-05-08
CCR-AP-2	Thallium, Total	mg/L	23	3	13	0.00760	4.8e-05	0.00116	0.00086	0.0017	2.9e-06	0.001 - 0.005	2016-06-10 to 2024-05-08
CCR-AP-3	Thallium, Total	mg/L	22	21	95	0.00200	0.0001	0.001	0.001	0.00029	8.6e-08	0.001 - 0.002	2016-06-10 to 2024-05-07
CCR-AP-4R	Thallium, Total	mg/L	22	12	55	0.00500	6.1e-05	0.000854	0.001	0.0011	1.1e-06	0.001 - 0.005	2016-06-10 to 2024-05-08
CCR-AP-5	Thallium, Total	mg/L	22	15	68	0.01000	6.5e-05	0.00118	0.001	0.002	4e-06	0.001 - 0.01	2016-06-10 to 2024-05-13
CCR-AP-6	Thallium, Total	mg/L	22	14	64	0.00500	4.7e-05	0.00091	0.001	0.001	1.1e-06	0.001 - 0.005	2016-06-10 to 2024-05-07
CCR-AP-7	Thallium, Total	mg/L	24	20	83	0.00200	6.6e-05	0.00091	0.001	0.00039	1.5e-07	0.001 - 0.002	2016-06-10 to 2024-05-10
CCR-AP-8	Thallium, Total	mg/L	22	17	77	0.00200	5.8e-05	0.000848	0.001	0.00045	2.1e-07	0.001 - 0.002	2017-03-09 to 2024-05-10
CCR-AP-9	Thallium, Total	mg/L	21	12	57	0.01000	9.8e-05	0.00132	0.001	0.0022	5e-06	0.001 - 0.01	2017-03-09 to 2024-05-08

Note:

Units: mg/L = milligrams per liter, pCi/L = picocuries per liter

Table A-2. Results of Shapiro-Wilk Test for Normality

				Shapiro-Wilk Test for Normality (R programming, package = stats, version 4.3.3, function = shapiro.test, non-detects substituted by 0.5*reporting limit)			
Location	**Constituent**	**n**	**n, non-detects**	**W statistic**	**p-value**	**Data Normality (significance level = 0.05)**	**Data Normality (significance level = 0.01)**
CCR-AP-1R	Antimony, Total	23	6	0.6265	1.784e-06	Not normal	Not normal
CCR-AP-2	Antimony, Total	23	9	0.6888	1.006e-05	Not normal	Not normal
CCR-AP-3	Antimony, Total	22	17	0.4157	2.326e-08	Not normal	Not normal
CCR-AP-4R	Antimony, Total	22	15	0.3165	3.688e-09	Not normal	Not normal
CCR-AP-5	Antimony, Total	22	16	0.4493	4.54e-08	Not normal	Not normal
CCR-AP-6	Antimony, Total	22	9	0.3591	7.95e-09	Not normal	Not normal
CCR-AP-7	Antimony, Total	24	21	0.4676	2.773e-08	Not normal	Not normal
CCR-AP-8	Antimony, Total	22	6	0.5652	5.718e-07	Not normal	Not normal
CCR-AP-9	Antimony, Total	21	6	0.691	2.129e-05	Not normal	Not normal
CCR-AP-1R	Arsenic, Total	23	0	0.8961	0.021	Not normal	Normal
CCR-AP-2	Arsenic, Total	23	0	0.9125	0.0462	Not normal	Normal
CCR-AP-3	Arsenic, Total	22	0	0.9744	0.8093	Normal	Normal
CCR-AP-4R	Arsenic, Total	22	0	0.8037	0.0005726	Not normal	Not normal
CCR-AP-5	Arsenic, Total	21	2	0.5714	9.967e-07	Not normal	Not normal
CCR-AP-6	Arsenic, Total	22	0	0.8796	0.01186	Not normal	Normal
CCR-AP-7	Arsenic, Total	24	0	0.8692	0.005084	Not normal	Not normal
CCR-AP-8	Arsenic, Total	22	0	0.9174	0.06726	Normal	Normal
CCR-AP-9	Arsenic, Total	21	0	0.7604	0.000173	Not normal	Not normal
CCR-AP-1R	Barium, Total	23	0	0.8989	0.02394	Not normal	Normal
CCR-AP-2	Barium, Total	23	0	0.8889	0.01501	Not normal	Normal
CCR-AP-3	Barium, Total	22	0	0.9503	0.3198	Normal	Normal
CCR-AP-4R	Barium, Total	22	0	0.7588	0.0001211	Not normal	Not normal
CCR-AP-5	Barium, Total	22	0	0.7146	3.019e-05	Not normal	Not normal
CCR-AP-6	Barium, Total	22	0	0.9674	0.6512	Normal	Normal
CCR-AP-7	Barium, Total	24	0	0.9503	0.2751	Normal	Normal
CCR-AP-8	Barium, Total	22	0	0.9151	0.0602	Normal	Normal
CCR-AP-9	Barium, Total	21	0	0.7867	0.0004142	Not normal	Not normal
CCR-AP-1R	Beryllium, Total	23	0	0.8822	0.01104	Not normal	Normal
CCR-AP-2	Beryllium, Total	23	0	0.8159	0.0006964	Not normal	Not normal
CCR-AP-3	Beryllium, Total	22	21	0.2215	7.417e-10	Not normal	Not normal
CCR-AP-4R	Beryllium, Total	22	7	0.794	0.0004033	Not normal	Not normal
CCR-AP-5	Beryllium, Total	22	16	0.3849	1.285e-08	Not normal	Not normal
CCR-AP-6	Beryllium, Total	22	9	0.5777	7.704e-07	Not normal	Not normal
CCR-AP-7	Beryllium, Total	24	17	0.7544	5.779e-05	Not normal	Not normal
CCR-AP-8	Beryllium, Total	22	16	0.6549	5.496e-06	Not normal	Not normal
CCR-AP-9	Beryllium, Total	21	2	0.6582	8.678e-06	Not normal	Not normal
CCR-AP-1R	Cadmium, Total	23	13	0.625	1.719e-06	Not normal	Not normal
CCR-AP-2	Cadmium, Total	23	3	0.7746	0.0001545	Not normal	Not normal
CCR-AP-3	Cadmium, Total	22	21	0.2215	7.417e-10	Not normal	Not normal
CCR-AP-4R	Cadmium, Total	22	12	0.5325	2.694e-07	Not normal	Not normal
CCR-AP-5	Cadmium, Total	22	6	0.4708	7.068e-08	Not normal	Not normal
CCR-AP-6	Cadmium, Total	22	9	0.8129	0.0008008	Not normal	Not normal
CCR-AP-7	Cadmium, Total	24	22	0.41	8.382e-09	Not normal	Not normal
CCR-AP-8	Cadmium, Total	22	16	0.6608	6.456e-06	Not normal	Not normal
CCR-AP-9	Cadmium, Total	21	10	0.5865	1.424e-06	Not normal	Not normal
CCR-AP-1R	Chromium, Total	23	0	0.8898	0.01567	Not normal	Normal
CCR-AP-2	Chromium, Total	23	0	0.9044	0.0312	Not normal	Normal
CCR-AP-3	Chromium, Total	22	4	0.5175	1.927e-07	Not normal	Not normal
CCR-AP-4R	Chromium, Total	21	3	0.7448	0.0001054	Not normal	Not normal
CCR-AP-5	Chromium, Total	22	16	0.4236	2.715e-08	Not normal	Not normal
CCR-AP-6	Chromium, Total	22	1	0.8493	0.003296	Not normal	Not normal
CCR-AP-7	Chromium, Total	24	12	0.5935	5.231e-07	Not normal	Not normal
CCR-AP-8	Chromium, Total	21	2	0.7905	0.0004714	Not normal	Not normal
CCR-AP-9	Chromium, Total	21	0	0.5599	7.632e-07	Not normal	Not normal
CCR-AP-1R	Cobalt, Total	23	0	0.8723	0.007094	Not normal	Not normal
CCR-AP-2	Cobalt, Total	23	0	0.8126	0.0006138	Not normal	Not normal
CCR-AP-3	Cobalt, Total	22	0	0.9257	0.09982	Normal	Normal
CCR-AP-4R	Cobalt, Total	22	0	0.8527	0.003791	Not normal	Not normal
CCR-AP-5	Cobalt, Total	22	0	0.952	0.3465	Normal	Normal
CCR-AP-6	Cobalt, Total	22	0	0.9072	0.04147	Not normal	Normal
CCR-AP-7	Cobalt, Total	24	2	0.6018	6.475e-07	Not normal	Not normal
CCR-AP-8	Cobalt, Total	22	0	0.9632	0.5559	Normal	Normal
CCR-AP-9	Cobalt, Total	21	0	0.7025	2.961e-05	Not normal	Not normal

Location	Constituent	n	n, non-detects	Shapiro-Wilk Test for Normality (R programming, package = stats, version 4.3.3, function = shapiro.test, non-detects substituted by 0.5*reporting limit) W statistic	p-value	Data Normality (significance level = 0.05)	Data Normality (significance level = 0.01)
CCR-AP-1R	Fluoride	23	0	0.9213	0.07115	Normal	Normal
CCR-AP-2	Fluoride	23	0	0.9305	0.1119	Normal	Normal
CCR-AP-3	Fluoride	22	1	0.9465	0.2689	Normal	Normal
CCR-AP-4R	Fluoride	22	1	0.9542	0.3822	Normal	Normal
CCR-AP-5	Fluoride	22	0	0.8948	0.0234	Not normal	Normal
CCR-AP-6	Fluoride	22	0	0.9547	0.3907	Normal	Normal
CCR-AP-7	Fluoride	23	0	0.8706	0.006579	Not normal	Not normal
CCR-AP-8	Fluoride	22	1	0.7377	6.14e-05	Not normal	Not normal
CCR-AP-9	Fluoride	21	0	0.8795	0.01428	Not normal	Normal
CCR-AP-1R	Lead, Total	23	0	0.8885	0.01477	Not normal	Normal
CCR-AP-2	Lead, Total	23	0	0.8932	0.01834	Not normal	Normal
CCR-AP-3	Lead, Total	22	4	0.3698	9.685e-09	Not normal	Not normal
CCR-AP-4R	Lead, Total	22	1	0.7108	2.696e-05	Not normal	Not normal
CCR-AP-5	Lead, Total	22	13	0.4478	4.403e-08	Not normal	Not normal
CCR-AP-6	Lead, Total	22	0	0.7959	0.0004312	Not normal	Not normal
CCR-AP-7	Lead, Total	24	10	0.5745	3.247e-07	Not normal	Not normal
CCR-AP-8	Lead, Total	22	1	0.7999	0.0004983	Not normal	Not normal
CCR-AP-9	Lead, Total	21	0	0.8248	0.00161	Not normal	Not normal
CCR-AP-1R	Lithium, Total	23	0	0.8904	0.01611	Not normal	Normal
CCR-AP-2	Lithium, Total	23	5	0.8238	0.0009454	Not normal	Not normal
CCR-AP-3	Lithium, Total	22	18	0.6503	4.862e-06	Not normal	Not normal
CCR-AP-4R	Lithium, Total	22	6	0.8597	0.005068	Not normal	Not normal
CCR-AP-5	Lithium, Total	22	0	0.959	0.4688	Normal	Normal
CCR-AP-6	Lithium, Total	22	11	0.5415	3.306e-07	Not normal	Not normal
CCR-AP-7	Lithium, Total	24	0	0.6882	7.068e-06	Not normal	Not normal
CCR-AP-8	Lithium, Total	22	16	0.7121	2.802e-05	Not normal	Not normal
CCR-AP-9	Lithium, Total	21	0	0.7177	4.613e-05	Not normal	Not normal
CCR-AP-1R	Mercury, Total	22	22	NA	NA	Not Evaluated - All Non-Detect Results	Not Evaluated - All Non-Detect Results
CCR-AP-2	Mercury, Total	22	13	0.605	1.504e-06	Not normal	Not normal
CCR-AP-3	Mercury, Total	21	21	NA	NA	Not Evaluated - All Non-Detect Results	Not Evaluated - All Non-Detect Results
CCR-AP-4R	Mercury, Total	21	21	NA	NA	Not Evaluated - All Non-Detect Results	Not Evaluated - All Non-Detect Results
CCR-AP-5	Mercury, Total	21	18	0.3882	2.203e-08	Not normal	Not normal
CCR-AP-6	Mercury, Total	21	19	0.4021	2.861e-08	Not normal	Not normal
CCR-AP-7	Mercury, Total	21	21	NA	NA	Not Evaluated - All Non-Detect Results	Not Evaluated - All Non-Detect Results
CCR-AP-8	Mercury, Total	21	20	0.3451	1.004e-08	Not normal	Not normal
CCR-AP-9	Mercury, Total	20	20	NA	NA	Not Evaluated - All Non-Detect Results	Not Evaluated - All Non-Detect Results
CCR-AP-1R	Molybdenum, Total	23	0	0.8294	0.001176	Not normal	Not normal
CCR-AP-2	Molybdenum, Total	23	0	0.9418	0.1959	Normal	Normal
CCR-AP-3	Molybdenum, Total	22	0	0.7873	0.0003192	Not normal	Not normal
CCR-AP-4R	Molybdenum, Total	22	3	0.6477	4.534e-06	Not normal	Not normal
CCR-AP-5	Molybdenum, Total	22	0	0.9452	0.2524	Normal	Normal
CCR-AP-6	Molybdenum, Total	22	0	0.9466	0.2706	Normal	Normal
CCR-AP-7	Molybdenum, Total	24	1	0.763	7.748e-05	Not normal	Not normal
CCR-AP-8	Molybdenum, Total	22	0	0.9074	0.04182	Not normal	Normal
CCR-AP-9	Molybdenum, Total	21	2	0.7209	5.078e-05	Not normal	Not normal
CCR-AP-1R	Selenium, Total	23	13	0.656	3.959e-06	Not normal	Not normal
CCR-AP-2	Selenium, Total	23	7	0.709	1.835e-05	Not normal	Not normal
CCR-AP-3	Selenium, Total	22	1	0.5438	3.48e-07	Not normal	Not normal
CCR-AP-4R	Selenium, Total	22	11	0.3046	2.992e-09	Not normal	Not normal
CCR-AP-5	Selenium, Total	22	14	0.4949	1.178e-07	Not normal	Not normal
CCR-AP-6	Selenium, Total	22	5	0.5132	1.751e-07	Not normal	Not normal
CCR-AP-7	Selenium, Total	22	19	0.3932	1.504e-08	Not normal	Not normal
CCR-AP-8	Selenium, Total	22	3	0.6241	2.443e-06	Not normal	Not normal
CCR-AP-9	Selenium, Total	21	15	0.6062	2.291e-06	Not normal	Not normal
CCR-AP-1R	Thallium, Total	23	7	0.8031	0.0004302	Not normal	Not normal
CCR-AP-2	Thallium, Total	23	3	0.5188	1.303e-07	Not normal	Not normal
CCR-AP-3	Thallium, Total	22	21	0.4181	2.437e-08	Not normal	Not normal
CCR-AP-4R	Thallium, Total	22	12	0.6002	1.334e-06	Not normal	Not normal
CCR-AP-5	Thallium, Total	22	15	0.3699	9.697e-09	Not normal	Not normal
CCR-AP-6	Thallium, Total	22	14	0.5929	1.115e-06	Not normal	Not normal
CCR-AP-7	Thallium, Total	24	20	0.6096	7.913e-07	Not normal	Not normal

Location	Constituent	n	n, non-detects	Shapiro-Wilk Test for Normality (R programming, package = stats, version 4.3.3, function = shapiro.test, non-detects substituted by 0.5*reporting limit) W statistic	p-value	Data Normality (significance level = 0.05)	Data Normality (significance level = 0.01)
CCR-AP-8	Thallium, Total	22	17	0.698	1.845e-05	Not normal	Not normal
CCR-AP-9	Thallium, Total	21	12	0.5047	2.249e-07	Not normal	Not normal

Table A-3. Results of Rosner/Dixon Test for Outliers

				Rosner or Dixon Test for Outliers (R programming, package = outliers, version 0.15, function = dixon.test or rosnerTest, non-detects substituted by 0.5*reporting limit)					
Location	Constituent	n	n, non-detects	Outlier Test	statistic	p-value	Alternative Hypothesis	Statistical Outlier (significance level = 0.05)	Outlier Removed
CCR-AP-1R	Antimony, Total	23	6	Dixon	0.5302	0.01059	highest value 0.01 is an outlier	Yes	No
CCR-AP-2	Antimony, Total	23	9	Dixon	0.5476	0.004206	highest value 0.01 is an outlier	Yes	No
CCR-AP-3	Antimony, Total	22	17	Dixon	0.9662	0	highest value 0.005 is an outlier	Yes	No
CCR-AP-4R	Antimony, Total	22	15	Dixon	0.9134	0	highest value 0.028 is an outlier	Yes	No
CCR-AP-5	Antimony, Total	22	16	Dixon	0.8111	0	highest value 0.01 is an outlier	Yes	No
CCR-AP-6	Antimony, Total	22	9	Dixon	0.9304	0	highest value 0.018 is an outlier	Yes	No
CCR-AP-7	Antimony, Total	24	21	Dixon	0.8982	0	highest value 0.0025 is an outlier	Yes	No
CCR-AP-8	Antimony, Total	22	6	Dixon	0.7729	0	highest value 0.0046 is an outlier	Yes	No
CCR-AP-9	Antimony, Total	21	6	Dixon	0.2278	0.9512	highest value 0.01 is an outlier	No	NA
CCR-AP-1R	Arsenic, Total	23	0	Dixon	0.1194	0.4373	highest value 0.038 is an outlier	No	NA
CCR-AP-2	Arsenic, Total	23	0	Dixon	0.3463	0.2847	highest value 0.048 is an outlier	No	NA
CCR-AP-3	Arsenic, Total	22	0	Dixon	0.4286	0.1023	lowest value 0.051 is an outlier	No	NA
CCR-AP-4R	Arsenic, Total	22	0	Dixon	0.4762	0.04417	highest value 0.33 is an outlier	Yes	No
CCR-AP-5	Arsenic, Total	21	2	Dixon	0.6319	0	highest value 0.024 is an outlier	Yes	No
CCR-AP-6	Arsenic, Total	22	0	Dixon	0.2714	0.6465	lowest value 0.04 is an outlier	No	NA
CCR-AP-7	Arsenic, Total	24	0	Dixon	0.5614	0	highest value 0.018 is an outlier	Yes	No
CCR-AP-8	Arsenic, Total	22	0	Dixon	0.4021	0.1522	lowest value 0.013 is an outlier	No	NA
CCR-AP-9	Arsenic, Total	21	0	Dixon	0.6415	0	highest value 0.032 is an outlier	Yes	No
CCR-AP-1R	Barium, Total	23	0	Dixon	0.2358	0.8196	highest value 0.59 is an outlier	No	NA
CCR-AP-2	Barium, Total	23	0	Dixon	0.3484	0.2777	highest value 0.83 is an outlier	No	NA
CCR-AP-3	Barium, Total	22	0	Dixon	0.1	0.31	highest value 0.49 is an outlier	No	NA
CCR-AP-4R	Barium, Total	22	0	Dixon	0.5455	0.00835	highest value 1.4 is an outlier	Yes	No
CCR-AP-5	Barium, Total	22	0	Dixon	0.4762	0.04417	highest value 0.2 is an outlier	Yes	No
CCR-AP-6	Barium, Total	22	0	Dixon	0.2308	0.8875	lowest value 0.43 is an outlier	No	NA
CCR-AP-7	Barium, Total	24	0	Dixon	0.3333	0.3081	highest value 0.19 is an outlier	No	NA
CCR-AP-8	Barium, Total	22	0	Dixon	0.2632	0.693	lowest value 0.27 is an outlier	No	NA
CCR-AP-9	Barium, Total	21	0	Dixon	0.6226	0	highest value 0.72 is an outlier	Yes	No
CCR-AP-1R	Beryllium, Total	23	0	Dixon	0.1637	0.7129	highest value 0.0066 is an outlier	No	NA
CCR-AP-2	Beryllium, Total	23	0	Dixon	0.3794	0.1859	highest value 0.0077 is an outlier	No	NA
CCR-AP-3	Beryllium, Total	22	21	Dixon	1	0	highest value 0.00056 is an outlier	Yes	No
CCR-AP-4R	Beryllium, Total	22	7	Dixon	0.3922	0.1746	highest value 0.0017 is an outlier	No	NA
CCR-AP-5	Beryllium, Total	22	16	Dixon	0.8918	0	highest value 0.005 is an outlier	Yes	No
CCR-AP-6	Beryllium, Total	22	9	Dixon	0.7974	0	highest value 0.0025 is an outlier	Yes	No
CCR-AP-7	Beryllium, Total	24	17	Dixon	0.1917	0.9362	lowest value 0.000067 is an outlier	No	NA
CCR-AP-8	Beryllium, Total	22	16	Dixon	0.1765	0.7648	lowest value 0.00016 is an outlier	No	NA
CCR-AP-9	Beryllium, Total	21	2	Dixon	0.7064	0	highest value 0.005 is an outlier	Yes	No
CCR-AP-1R	Cadmium, Total	23	13	Dixon	0.523	0.01304	highest value 0.005 is an outlier	Yes	No
CCR-AP-2	Cadmium, Total	23	3	Dixon	0.5788	0	highest value 0.0066 is an outlier	Yes	No
CCR-AP-3	Cadmium, Total	22	21	Dixon	1	0	lowest value 0.00038 is an outlier	Yes	No
CCR-AP-4R	Cadmium, Total	22	12	Dixon	0.7716	0	highest value 0.0025 is an outlier	Yes	No
CCR-AP-5	Cadmium, Total	22	6	Dixon	0.7851	0	highest value 0.005 is an outlier	Yes	No
CCR-AP-6	Cadmium, Total	22	9	Dixon	0.6304	0	highest value 0.0011 is an outlier	Yes	No
CCR-AP-7	Cadmium, Total	24	22	Dixon	0.5	0.01865	lowest value 0.00014 is an outlier	Yes	No
CCR-AP-8	Cadmium, Total	22	16	Dixon	0.08824	0.2487	lowest value 0.00016 is an outlier	No	NA
CCR-AP-9	Cadmium, Total	21	10	Dixon	0.5112	0.02629	highest value 0.005 is an outlier	Yes	No
CCR-AP-1R	Chromium, Total	23	0	Dixon	0.2667	0.6398	highest value 0.16 is an outlier	No	NA
CCR-AP-2	Chromium, Total	23	0	Dixon	0.2935	0.5017	highest value 0.14 is an outlier	No	NA
CCR-AP-3	Chromium, Total	22	4	Dixon	0.7615	0	highest value 0.014 is an outlier	Yes	No
CCR-AP-4R	Chromium, Total	21	3	Dixon	0.5329	0.01637	highest value 0.058 is an outlier	Yes	No
CCR-AP-5	Chromium, Total	22	16	Dixon	0.8364	0	highest value 0.056 is an outlier	Yes	No
CCR-AP-6	Chromium, Total	22	1	Dixon	0.3474	0.3069	highest value 0.043 is an outlier	No	NA
CCR-AP-7	Chromium, Total	24	12	Dixon	0.7167	0	highest value 0.019 is an outlier	Yes	No
CCR-AP-8	Chromium, Total	21	2	Dixon	0.5635	0.005373	highest value 0.014 is an outlier	Yes	No
CCR-AP-9	Chromium, Total	21	0	Dixon	0.7436	0	highest value 0.15 is an outlier	Yes	No
CCR-AP-1R	Cobalt, Total	23	0	Dixon	0.07989	0.2227	highest value 0.081 is an outlier	No	NA
CCR-AP-2	Cobalt, Total	23	0	Dixon	0.5375	0.007963	highest value 0.091 is an outlier	Yes	No
CCR-AP-3	Cobalt, Total	22	0	Dixon	0 28	0.6	highest value 0.0094 is an outlier	No	NA
CCR-AP-4R	Cobalt, Total	22	0	Dixon	0.4145	0.127	highest value 0.021 is an outlier	No	NA
CCR-AP-5	Cobalt, Total	22	0	Dixon	0.327	0.3838	highest value 0.01 is an outlier	No	NA
CCR-AP-6	Cobalt, Total	22	0	Dixon	0.3311	0.3674	highest value 0.019 is an outlier	No	NA
CCR-AP-7	Cobalt, Total	24	2	Dixon	0.6594	0	highest value 0.015 is an outlier	Yes	No

Rosner or Dixon Test for Outliers (R programming, package = outliers, version 0.15, function = dixon.test or rosnerTest, non-detects substituted by 0.5*reporting limit)

Location	Constituent	n	n, non-detects	Outlier Test	statistic	p-value	Alternative Hypothesis	Statistical Outlier (significance level = 0.05)	Outlier Removed
CCR-AP-8	Cobalt, Total	22	0	Dixon	0.3623	0.2572	highest value 0.017 is an outlier	No	NA
CCR-AP-9	Cobalt, Total	21	0	Dixon	0.7035	0	highest value 0.047 is an outlier	Yes	No
CCR-AP-1R	Fluoride	23	0	Dixon	0.5349	0.008932	highest value 0.81 is an outlier	Yes	No
CCR-AP-2	Fluoride	23	0	Dixon	0.3043	0.451	highest value 0.69 is an outlier	No	NA
CCR-AP-3	Fluoride	22	1	Dixon	0.5	0.02699	highest value 0.93 is an outlier	Yes	No
CCR-AP-4R	Fluoride	22	1	Dixon	0.5106	0.02152	lowest value 0.05 is an outlier	Yes	No
CCR-AP-5	Fluoride	22	0	Dixon	0.2055	0.9516	highest value 2.3 is an outlier	No	NA
CCR-AP-6	Fluoride	22	0	Dixon	0.2791	0.605	lowest value 0.24 is an outlier	No	NA
CCR-AP-7	Fluoride	23	0	Dixon	0.46	0.05099	highest value 0.72 is an outlier	No	NA
CCR-AP-8	Fluoride	22	1	Dixon	0.7473	0	highest value 1.1 is an outlier	Yes	No
CCR-AP-9	Fluoride	21	0	Dixon	0.48	0.05	lowest value 0.14 is an outlier	No	NA
CCR-AP-1R	Lead, Total	23	0	Dixon	0.2064	0.9962	highest value 0.094 is an outlier	No	NA
CCR-AP-2	Lead, Total	23	0	Dixon	0.4527	0.05866	highest value 0.1 is an outlier	No	NA
CCR-AP-3	Lead, Total	22	4	Dixon	0.8912	0	highest value 0.01 is an outlier	Yes	No
CCR-AP-4R	Lead, Total	22	1	Dixon	0.5714	0	highest value 0.047 is an outlier	Yes	No
CCR-AP-5	Lead, Total	22	13	Dixon	0.7572	0	highest value 0.02 is an outlier	Yes	No
CCR-AP-6	Lead, Total	22	0	Dixon	0.5276	0.01459	highest value 0.041 is an outlier	Yes	No
CCR-AP-7	Lead, Total	24	10	Dixon	0.6051	0	highest value 0.02 is an outlier	Yes	No
CCR-AP-8	Lead, Total	22	1	Dixon	0.6125	0	highest value 0.0076 is an outlier	Yes	No
CCR-AP-9	Lead, Total	21	0	Dixon	0.4683	0.06241	highest value 0.041 is an outlier	No	NA
CCR-AP-1R	Lithium, Total	23	0	Dixon	0.3608	0.2379	highest value 0.23 is an outlier	No	NA
CCR-AP-2	Lithium, Total	23	5	Dixon	0.3704	0.2099	highest value 0.125 is an outlier	No	NA
CCR-AP-3	Lithium, Total	22	18	Dixon	0	0	highest value 0.025 is an outlier	Yes	No
CCR-AP-4R	Lithium, Total	22	6	Dixon	0.4989	0.02764	highest value 0.047 is an outlier	Yes	No
CCR-AP-5	Lithium, Total	22	0	Dixon	0.1844	0.8154	lowest value 0.009 is an outlier	No	NA
CCR-AP-6	Lithium, Total	22	11	Dixon	0.8163	0	highest value 0.125 is an outlier	Yes	No
CCR-AP-7	Lithium, Total	24	0	Dixon	0.6355	0	highest value 0.039 is an outlier	Yes	No
CCR-AP-8	Lithium, Total	22	16	Dixon	0	0	highest value 0.025 is an outlier	Yes	No
CCR-AP-9	Lithium, Total	21	0	Dixon	0.6437	0	highest value 0.12 is an outlier	Yes	No
CCR-AP-1R	Mercury, Total	22	22	Dixon	NA	NA	Not Evlauated - All results are non-detect	NA	NA
CCR-AP-2	Mercury, Total	22	13	Dixon	0.541	0.01001	highest value 0.00071 is an outlier	Yes	No
CCR-AP-3	Mercury, Total	21	21	Dixon	NA	NA	Not Evlauated - All results are non-detect	NA	NA
CCR-AP-4R	Mercury, Total	21	21	Dixon	NA	NA	Not Evlauated - All results are non-detect	NA	NA
CCR-AP-5	Mercury, Total	21	18	Dixon	0.8533	0	highest value 0.0016 is an outlier	Yes	No
CCR-AP-6	Mercury, Total	21	19	Dixon	0.7742	0	highest value 0.00041 is an outlier	Yes	No
CCR-AP-7	Mercury, Total	21	21	Dixon	NA	NA	Not Evlauated - All results are non-detect	NA	NA
CCR-AP-8	Mercury, Total	21	20	Dixon	1	0	highest value 0.00026 is an outlier	Yes	No
CCR-AP-9	Mercury, Total	20	20	Dixon	NA	NA	Not Evlauated - All results are non-detect	NA	NA
CCR-AP-1R	Molybdenum, Total	23	0	Dixon	0.565	0	highest value 0.023 is an outlier	Yes	No
CCR-AP-2	Molybdenum, Total	23	0	Dixon	0.2558	0.7009	highest value 0.01 is an outlier	No	NA
CCR-AP-3	Molybdenum, Total	22	0	Dixon	0.6145	0	highest value 0.025 is an outlier	Yes	No
CCR-AP-4R	Molybdenum, Total	22	3	Dixon	0.4605	0.05997	highest value 0.017 is an outlier	No	NA
CCR-AP-5	Molybdenum, Total	22	0	Dixon	0.359	0.2679	highest value 0.53 is an outlier	No	NA
CCR-AP-6	Molybdenum, Total	22	0	Dixon	0.4	0.1567	highest value 0.043 is an outlier	No	NA
CCR-AP-7	Molybdenum, Total	24	1	Dixon	0.4138	0.09869	highest value 0.013 is an outlier	No	NA
CCR-AP-8	Molybdenum, Total	22	0	Dixon	0.4712	0.04883	highest value 0.029 is an outlier	Yes	No
CCR-AP-9	Molybdenum, Total	21	2	Dixon	0.6222	0	highest value 0.025 is an outlier	Yes	No
CCR-AP-1R	Radium-226 & 228	21	0	Dixon	0.5301	0.01745	highest value 14.4 is an outlier	Yes	No
CCR-AP-2	Radium-226 & 228	21	0	Dixon	0.47	0.06051	highest value 5.53 is an outlier	No	NA
CCR-AP-3	Radium-226 & 228	20	0	Dixon	0.4608	0.08453	highest value 4.87 is an outlier	No	NA
CCR-AP-4R	Radium-226 & 228	20	0	Dixon	0.8934	0	highest value 30 is an outlier	Yes	No
CCR-AP-5	Radium-226 & 228	20	0	Dixon	0.5277	0.0234	highest value 5.54 is an outlier	Yes	No
CCR-AP-6	Radium-226 & 228	20	1	Dixon	0.7758	0	highest value 10.2 is an outlier	Yes	No
CCR-AP-7	Radium-226 & 228	21	0	Dixon	0.2152	0.9709	highest value 1.72 is an outlier	No	NA
CCR-AP-8	Radium-226 & 228	19	0	Dixon	0.3621	0.3545	highest value 2.88 is an outlier	No	NA
CCR-AP-9	Radium-226 & 228	19	0	Dixon	0.5544	0.01698	highest value 12.6 is an outlier	Yes	No
CCR-AP-1R	Selenium, Total	23	13	Dixon	0	0	highest value 0.025 is an outlier	Yes	No
CCR-AP-2	Selenium, Total	23	7	Dixon	0.4049	0.1288	highest value 0.026 is an outlier	No	NA
CCR-AP-3	Selenium, Total	22	1	Dixon	0.8269	0	highest value 0.0068 is an outlier	Yes	No
CCR-AP-4R	Selenium, Total	22	11	Dixon	0.9532	0	highest value 0.031 is an outlier	Yes	No
CCR-AP-5	Selenium, Total	22	14	Dixon	0.7729	0	highest value 0.025 is an outlier	Yes	No
CCR-AP-6	Selenium, Total	22	5	Dixon	0.8407	0	highest value 0.0125 is an outlier	Yes	No
CCR-AP-7	Selenium, Total	22	19	Dixon	1	0	lowest value 0.00035 is an outlier	Yes	No
CCR-AP-8	Selenium, Total	22	3	Dixon	0.6909	0	highest value 0.007 is an outlier	Yes	No

Rosner or Dixon Test for Outliers (R programming, package = outliers, version 0.15, function = dixon.test or rosnerTest, non-detects substituted by 0.5*reporting limit)

Location	Constituent	n	n, non-detects	Outlier Test	statistic	p-value	Alternative Hypothesis	Statistical Outlier (significance level = 0.05)	Outlier Removed
CCR-AP-9	Selenium, Total	21	15	Dixon	0.5297	0.01762	highest value 0.025 is an outlier	Yes	No
CCR-AP-1R	Thallium, Total	23	7	Dixon	0.4977	0.02342	highest value 0.0027 is an outlier	Yes	No
CCR-AP-2	Thallium, Total	23	3	Dixon	0.8445	0	highest value 0.0076 is an outlier	Yes	No
CCR-AP-3	Thallium, Total	22	21	Dixon	1	0	highest value 0.001 is an outlier	Yes	No
CCR-AP-4R	Thallium, Total	22	12	Dixon	0.8207	0	highest value 0.0025 is an outlier	Yes	No
CCR-AP-5	Thallium, Total	22	15	Dixon	0.9298	0	highest value 0.005 is an outlier	Yes	No
CCR-AP-6	Thallium, Total	22	14	Dixon	0.8299	0	highest value 0.0025 is an outlier	Yes	No
CCR-AP-7	Thallium, Total	24	20	Dixon	0.5482	0.00102	highest value 0.001 is an outlier	Yes	No
CCR-AP-8	Thallium, Total	22	17	Dixon	0.5453	0.008424	highest value 0.001 is an outlier	Yes	No
CCR-AP-9	Thallium, Total	21	12	Dixon	0.8221	0	highest value 0.005 is an outlier	Yes	No

Table A-4. Results of Mann Kendall and Thiel Sen Trend Tests

		Mann Kendall Trends			Secular Trend Evaluation for All Data									Secular Trend Evaluation for Recent Data (subset of 8 most recent data points)								
					Mann-Kendall Test (R programming, package = Kendall, version = 2.2.1, function = MannKendall, non-detects substituted by 0.5*reporting limit)							Thiel-Sen Test (R programming, package = trend, version = 1.1.6, function = sens.slope, non-detects substituted by 0.5*reporting limit)		Mann-Kendall Test (R programming, package = Kendall, version = 2.2.1, function = MannKendall, non-detects substituted by 0.5*reporting limit)								Thiel-Sen Test (R programming, package = trend, version = 1.1.6, function = sens.slope, non-detects substituted by 0.5*reporting limit)	
Location	Constituent	Trends, All Data	Trends, Recent Data	Seasonal Mann Kendall Used	n	n, detected results	Coefficient of Variance	Kendall's Tau	p-value	Confidence Factor	Kendall Score (S)	Sen Slope (mg/L per year)	p-value	n	n, detected results	recent data date range	Coefficient of Variance	Kendall's Tau	p-value	Confidence Factor	Kendall Score (S)	Sen Slope (mg/L per year)	p-value
CCR-AP-1R	Antimony, Total	No Trend	Probably Decreasing	No	23	17	1.19	0.0647	0.69	31	16	0.000005	0.69	8	8	2021-05-13 to 2024-05-08	0.688	-0.571	0.0635	93.7	-16	-0.000243	0.0635
CCR-AP-2	Antimony, Total	No Trend	No Trend	No	23	14	1.06	0.205	0.191	80.9	50	0.0000158	0.191	8	8	2021-05-12 to 2024-05-08	1.02	0.109	0.803	19.7	3	0.0000485	0.803
CCR-AP-3	Antimony, Total	Not Evaluated - Majority of data (>50%) non-detect.	Not Evaluated - Majority of data (>50%) non-detect.	No	22	5	0.77	NA	NA	NA	NA	NA	NA	8	3	2020-11-13 to 2024-05-07	0.878	NA	NA	NA	NA	NA	NA
CCR-AP-4R	Antimony, Total	Not Evaluated - Majority of data (>50%) non-detect.	No Trend	No	22	7	2.31	NA	NA	NA	NA	NA	NA	8	5	2020-11-13 to 2024-05-08	1.99	-0.0378	1	0	-1	0	1
CCR-AP-5	Antimony, Total	Not Evaluated - Majority of data (>50%) non-detect.	No Trend	No	22	6	1.33	NA	NA	NA	NA	NA	NA	8	5	2020-11-13 to 2024-05-13	0.916	0.491	0.126	87.4	13	0.000114	0.126
CCR-AP-6	Antimony, Total	No Trend	No Trend	No	22	13	1.99	0.033	0.861	13.9	7	0	0.861	8	6	2020-11-13 to 2024-05-07	1.96	0.0378	1	0	1	0	1
CCR-AP-7	Antimony, Total	Not Evaluated - Majority of data (>50%) non-detect.	Not Evaluated - No detected results.	No	24	3	0.367	NA	NA	NA	NA	NA	NA	8	0	2020-11-12 to 2024-05-10	0.447	NA	No detected results.	NA	NA	NA	No detected results.
CCR-AP-8	Antimony, Total	Stable	No Trend	No	22	16	0.825	-0.246	0.128	87.2	-54	-0.0000192	0.128	8	7	2020-11-12 to 2024-05-10	1.11	-0.286	0.386	61.4	-8	-0.0000689	0.386
CCR-AP-9	Antimony, Total	No Trend	No Trend	No	21	15	1.09	-0.0488	0.785	21.5	-10	-0.00000294	0.785	8	6	2020-05-19 to 2024-05-08	1.18	-0.214	0.536	46.4	-6	-0.000108	0.536
Pooled Background	Antimony, Total	No Trend	Stable	No	68	35	1.22	0.12	0.173	82.7	249	0	0.173	8	5	2023-05-23 to 2024-05-10	0.485	-0.109	0.803	19.7	-3	-0.0000225	0.803
CCR-AP-1R	Arsenic, Total	Increasing	Decreasing	No	23	23	0.708	0.329	0.0302	97	83	0.000577	0.0302	8	8	2021-05-13 to 2024-05-08	0.485	-0.643	0.0354	96.5	-18	-0.00287	0.0354
CCR-AP-2	Arsenic, Total	Increasing	Increasing	No	23	23	0.798	0.618	0.0000465	100	155	0.00133	0.0000464	8	8	2021-05-12 to 2024-05-08	0.59	0.643	0.0354	96.5	18	0.005	0.0354
CCR-AP-3	Arsenic, Total	Probably Increasing	Stable	No	22	22	0.134	0.271	0.0883	91.2	61	0.000625	0.0883	8	8	2020-11-13 to 2024-05-07	0.166	-0.265	0.445	55.5	-7	-0.00213	0.445
CCR-AP-4R	Arsenic, Total	Increasing	Stable	No	22	22	0.728	0.403	0.0101	99	92	0.00529	0.0101	8	8	2020-11-13 to 2024-05-08	0.664	-0.143	0.711	28.9	-4	-0.00778	0.711
CCR-AP-5	Arsenic, Total	Increasing	No Trend	No	21	19	1.71	0.465	0.0037	99.6	97	0.00014	0.0037	8	8	2020-11-13 to 2024-05-13	1.05	0.4	0.212	78.8	11	0.00165	0.212
CCR-AP-6	Arsenic, Total	Probably Increasing	Stable	No	22	22	0.243	0.292	0.0711	92.9	64	0.00171	0.0711	8	8	2020-11-13 to 2024-05-07	0.189	-0.309	0.369	63.1	-8	-0.00117	0.369
CCR-AP-7	Arsenic, Total	Decreasing	Stable	No	24	24	0.733	-0.401	0.00678	99.3	-110	-0.000242	0.00678	8	8	2020-11-12 to 2024-05-10	0.743	-0.327	0.319	68.1	-9	-0.000525	0.319
CCR-AP-8	Arsenic, Total	Increasing	Decreasing	No	22	22	0.311	0.426	0.00706	99.3	96	0.0023	0.00706	8	8	2020-11-12 to 2024-05-10	0.395	-0.718	0.0226	97.7	-19	-0.00958	0.0226
CCR-AP-9	Arsenic, Total	No Trend	Stable	No	21	21	0.623	0.129	0.432	56.8	27	0.000129	0.432	8	8	2020-05-19 to 2024-05-08	0.521	-0.429	0.174	82.6	-12	-0.00142	0.174
Pooled Background	Arsenic, Total	No Trend	Probably Decreasing	No	68	68	0.845	0.0776	0.354	64.6	176	0.0000305	0.354	8	8	2023-05-23 to 2024-05-10	0.742	-0.571	0.0635	93.7	-16	-0.00169	0.0635
CCR-AP-1R	Barium, Total	Increasing	Stable	No	23	23	0.662	0.341	0.0247	97.5	86	0.00909	0.0247	8	8	2021-05-13 to 2024-05-08	0.268	-0.0714	0.902	9.8	-2	-0.00667	0.902
CCR-AP-2	Barium, Total	Increasing	Increasing	No	23	23	0.746	0.485	0.00138	99.9	122	0.0186	0.00138	8	8	2021-05-12 to 2024-05-08	0.678	1	0.000837	99.9	28	0.105	0.000837
CCR-AP-3	Barium, Total	No Trend	Stable	No	22	22	0.0764	0.147	0.364	63.6	33	0.00125	0.364	8	8	2020-11-13 to 2024-05-07	0 0905	-0.286	0.386	61.4	-8	-0.00633	0.386
CCR-AP-4R	Barium, Total	No Trend	Stable	No	22	22	0.35	0.0132	0.955	4.5	3	0	0.955	8	8	2020-11-13 to 2024-05-08	0.424	-0.0364	1	0	-1	-0.005	1
CCR-AP-5	Barium, Total	Increasing	No Trend	No	22	22	0.716	0.575	0.000217	100	132	0.00312	0.000217	8	8	2020-11-13 to 2024-05-13	0.583	0.214	0.536	46.4	6	0.00945	0.536
CCR-AP-6	Barium, Total	Stable	Decreasing	No	22	22	0.126	-0.238	0.133	86.7	-54	-0.004	0.133	8	8	2020-11-13 to 2024-05-07	0.143	-0.691	0.0248	97.5	-19	-0.0167	0.0248
CCR-AP-7	Barium, Total	Decreasing	Stable	No	24	24	0.226	-0.397	0.00921	99.1	-105	-0.00226	0.00921	8	8	2020-11-12 to 2024-05-10	0.161	-0.189	0.61	39	-5	-0.00367	0.61
CCR-AP-8	Barium, Total	Decreasing	Decreasing	No	22	22	0.207	-0.543	0.00051	99.9	-124	-0.0114	0.00051	8	8	2020-11-12 to 2024-05-10	0.25	-0.764	0.0126	98.7	-21	-0.0367	0.0126
CCR-AP-9	Barium, Total	No Trend	Stable	No	21	21	0.424	0.223	0.172	82.8	46	0.00481	0.172	8	8	2020-05-19 to 2024-05-08	0.324	-0.255	0.454	54.6	-7	-0.0138	0.454
Pooled Background	Barium, Total	Probably Increasing	Stable	No	68	68	0.615	0.148	0.0785	92.2	333	0.00102	0.0785	8	8	2023-05-23 to 2024-05-10	0.436	-0.182	0.618	38.2	-5	-0.00875	0.618
CCR-AP-1R	Beryllium, Total	Increasing	Decreasing	No	23	23	0.82	0.36	0.0175	98.2	91	0.000138	0.0175	8	8	2021-05-13 to 2024-05-08	0.504	-0.643	0.0354	96.5	-18	-0.000662	0.0354
CCR-AP-2	Beryllium, Total	Increasing	No Trend	No	23	23	0.94	0.583	0.000114	100	147	0.000162	0.000114	8	8	2021-05-12 to 2024-05-08	0.683	0.286	0.386	61.4	8	0.000532	0.386
CCR-AP-3	Beryllium, Total	Not Evaluated - Only one detected result.	Not Evaluated - Only one detected result.	No	22	1	0.0254	NA	NA	NA	NA	NA	NA	8	1	2020-11-13 to 2024-05-07	0 0418	NA	NA	NA	NA	NA	NA
CCR-AP-4R	Beryllium, Total	Increasing	Stable	No	22	15	0.699	0.427	0.00759	99.2	94	0.0000169	0.00759	8	4	2020-11-13 to 2024-05-08	0.62	-0.403	0.232	76.8	-10	-0.0000129	0.232
CCR-AP-5	Beryllium, Total	Not Evaluated - Majority of data (>50%) non-detect.	Not Evaluated - Only one detected result.	No	22	6	1.32	NA	NA	NA	NA	NA	NA	8	1	2020-11-13 to 2024-05-13	0.61	NA	NA	NA	NA	NA	NA
CCR-AP-6	Beryllium, Total	No Trend	Not Evaluated - Majority of data (>50%) non-detect.	No	22	13	0.925	0.232	0.151	84.9	51	0.000008	0.151	8	2	2020-11-13 to 2024-05-07	0.452	NA	NA	NA	NA	NA	NA

Note:
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		Mann Kendall Trends			Secular Trend Evaluation for All Data									Secular Trend Evaluation for Recent Data (subset of 8 most recent data points)								
					Mann-Kendall Test (R programming, package = Kendall, version = 2.2.1, function = MannKendall, non-detects substituted by 0.5*reporting limit)							Thiel-Sen Test (R programming, package = trend, version = 1.1.6, function = sens.slope, non-detects substituted by 0.5*reporting limit)		Mann-Kendall Test (R programming, package = Kendall, version = 2.2.1, function = MannKendall, non-detects substituted by 0.5*reporting limit)								Thiel-Sen Test (R programming, package = trend, version = 1.1.6, function = sens.slope, non-detects substituted by 0.5*reporting limit)	
Location	Constituent	Trends, All Data	Trends, Recent Data	Seasonal Mann Kendall Used	n	n, detected results	Coefficient of Variance	Kendall's Tau	p-value	Confidence Factor	Kendall Score (S)	Sen Slope (mg/L per year)	p-value	n	n, detected results	recent data date range	Coefficient of Variance	Kendall's Tau	p-value	Confidence Factor	Kendall Score (S)	Sen Slope (mg/L per year)	p-value
CCR-AP-7	Beryllium, Total	Not Evaluated - Majority of data (>50%) non-detect.	Not Evaluated - No detected results.	No	24	7	0.404	NA	NA	NA	NA	NA	NA	8	0	2020-11-12 to 2024-05-10	0.189	NA	No detected results.	NA	NA	NA	No detected results.
CCR-AP-8	Beryllium, Total	Not Evaluated - Majority of data (>50%) non-detect.	Not Evaluated - Only one detected result.	No	22	6	0.295	NA	NA	NA	NA	NA	NA	8	1	2020-11-12 to 2024-05-10	0.237	NA	NA	NA	NA	NA	NA
CCR-AP-9	Beryllium, Total	Probably Increasing	Stable	No	21	19	1.02	0.279	0.0846	91.5	58	0.0000314	0.0846	8	6	2020-05-19 to 2024-05-08	0.971	-0.286	0.386	61.4	-8	-0.000113	0.386
Pooled Background	Beryllium, Total	Increasing	Stable	No	68	49	1.2	0.232	0.00658	99.3	510	0.00000879	0.00658	8	5	2023-05-23 to 2024-05-10	0.801	-0.327	0.319	68.1	-9	-0.000212	0.319
CCR-AP-1R	Cadmium, Total	Not Evaluated - Majority of data (>50%) non-detect.	No Trend	No	23	10	1.32	NA	NA	NA	NA	NA	NA	8	6	2021-05-13 to 2024-05-08	1.27	-0.286	0.386	61.4	-8	-0.0000425	0.386
CCR-AP-2	Cadmium, Total	Increasing	No Trend	No	23	20	0.997	0.421	0.0055	99.5	106	0.0000625	0.0055	8	8	2021-05-12 to 2024-05-08	0.964	0.429	0.174	82.6	12	0.000237	0.174
CCR-AP-3	Cadmium, Total	Not Evaluated - Only one detected result.	Not Evaluated - Only one detected result.	No	22	1	0.0517	NA	NA	NA	NA	NA	NA	8	1	2020-11-13 to 2024-05-07	0 0875	NA	NA	NA	NA	NA	NA
CCR-AP-4R	Cadmium, Total	Not Evaluated - Majority of data (>50%) non-detect.	Stable	No	22	10	0.901	NA	NA	NA	NA	NA	NA	8	4	2020-11-13 to 2024-05-08	0.309	0	1	0	0	0	1
CCR-AP-5	Cadmium, Total	No Trend	No Trend	No	22	16	1.4	0.0934	0.57	43	21	0.00000455	0.57	8	5	2020-11-13 to 2024-05-13	0.559	0.189	0.61	39	5	0.0000246	0.61
CCR-AP-6	Cadmium, Total	No Trend	Not Evaluated - Majority of data (>50%) non-detect.	No	22	13	0.485	0.183	0.272	72.8	38	0	0.272	8	2	2020-11-13 to 2024-05-07	0.52	NA	NA	NA	NA	NA	NA
CCR-AP-7	Cadmium, Total	Not Evaluated - Majority of data (>50%) non-detect.	Not Evaluated - No detected results.	No	24	2	0.199	NA	NA	NA	NA	NA	NA	8	0	2020-11-12 to 2024-05-10	0.189	NA	No detected results.	NA	NA	NA	No detected results.
CCR-AP-8	Cadmium, Total	Not Evaluated - Majority of data (>50%) non-detect.	Not Evaluated - Majority of data (>50%) non-detect.	No	22	6	0.3	NA	NA	NA	NA	NA	NA	8	3	2020-11-12 to 2024-05-10	0.339	NA	NA	NA	NA	NA	NA
CCR-AP-9	Cadmium, Total	Increasing	Not Evaluated - Majority of data (>50%) non-detect.	No	21	11	1.6	0.484	0.00325	99.7	97	0.0000226	0.00325	8	2	2020-05-19 to 2024-05-08	1.59	NA	NA	NA	NA	NA	NA
Pooled Background	Cadmium, Total	Not Evaluated - Majority of data (>50%) non-detect.	Not Evaluated - Majority of data (>50%) non-detect.	No	68	23	1.45	NA	NA	NA	NA	NA	NA	8	3	2023-05-23 to 2024-05-10	0.353	NA	NA	NA	NA	NA	NA
CCR-AP-1R	Chromium, Total	Increasing	Stable	No	23	23	0.841	0.326	0.0322	96.8	82	0.00236	0.0322	8	8	2021-05-13 to 2024-05-08	0.436	-0.429	0.174	82.6	-12	-0.00746	0.174
CCR-AP-2	Chromium, Total	Increasing	Increasing	No	23	23	0.839	0.589	0.0000927	100	149	0.00423	0.0000928	8	8	2021-05-12 to 2024-05-08	0.691	0.929	0.00198	99.8	26	0.0176	0 00198
CCR-AP-3	Chromium, Total	Probably Increasing	No Trend	No	22	18	0.951	0.276	0.0868	91.3	61	0.00005	0.0868	8	7	2020-11-13 to 2024-05-07	1.1	0.4	0.212	78.8	11	0.000225	0.212
CCR-AP-4R	Chromium, Total	No Trend	Stable	Yes	21	18	0.89	0.249	0.123	87.7	52	0.000267	0.123	8	7	2020-11-13 to 2024-05-08	0.87	-0.0714	0.902	9.8	-2	-0.000137	0.902
CCR-AP-5	Chromium, Total	Not Evaluated - Majority of data (>50%) non-detect.	No Trend	No	22	6	2.28	NA	NA	NA	NA	NA	NA	8	5	2020-11-13 to 2024-05-13	1.6	0.416	0.203	79.7	11	0.000875	0.203
CCR-AP-6	Chromium, Total	Stable	No Trend	No	22	21	0.862	-0.166	0.296	70.4	-38	-0.000237	0.296	8	7	2020-11-13 to 2024-05-07	1.44	-0.214	0.536	46.4	-6	-0.00066	0.536
CCR-AP-7	Chromium, Total	No Trend	Not Evaluated - No detected results.	No	24	12	1.26	0.0579	0.723	27.7	15	0	0.723	8	0	2020-11-12 to 2024-05-10	0.679	NA	No detected results.	NA	NA	NA	No detected results.
CCR-AP-8	Chromium, Total	No Trend	Stable	No	21	19	0.832	0.0383	0.832	16.8	8	0.0000161	0.832	8	7	2020-11-12 to 2024-05-10	0.979	-0.143	0.711	28.9	-4	-0.000237	0.711
CCR-AP-9	Chromium, Total	Increasing	Stable	No	21	21	1.22	0.36	0.0252	97.5	75	0.000926	0.0252	8	8	2020-05-19 to 2024-05-08	0.594	-0.109	0.803	19.7	-3	-0.000571	0.803
Pooled Background	Chromium, Total	Probably Increasing	Stable	No	68	56	1.39	0.164	0.0511	94.9	369	0.000156	0.0511	8	6	2023-05-23 to 2024-05-10	0.877	-0.429	0.174	82.6	-12	-0.00456	0.174
CCR-AP-1R	Cobalt, Total	Increasing	Probably Decreasing	No	23	23	0.828	0.369	0.015	98.5	93	0.00169	0.015	8	8	2021-05-13 to 2024-05-08	0.542	-0.571	0.0635	93.7	-16	-0.0058	0.0635
CCR-AP-2	Cobalt, Total	Increasing	Increasing	No	23	23	0.695	0.644	0.0000207	100	162	0.0017	0.0000208	8	8	2021-05-12 to 2024-05-08	0.626	0.714	0.0187	98.1	20	0.00704	0.0187
CCR-AP-3	Cobalt, Total	Decreasing	No Trend	No	22	22	0.255	-0.515	0.000877	99.9	-119	-0.000175	0.000877	8	8	2020-11-13 to 2024-05-07	0.318	0.286	0.386	61.4	8	0.000236	0.386
CCR-AP-4R	Cobalt, Total	No Trend	Stable	Yes	22	22	0.626	0.0607	0.714	28.6	14	0.0000243	0.714	8	8	2020-11-13 to 2024-05-08	0.67	-0.0714	0.902	9.8	-2	-0.000189	0.902
CCR-AP-5	Cobalt, Total	Decreasing	No Trend	No	22	22	0.64	-0.485	0.00189	99.8	-111	-0.00032	0.00189	8	8	2020-11-13 to 2024-05-13	1.06	0.4	0.212	78.8	11	0.000558	0.212
CCR-AP-6	Cobalt, Total	Stable	Stable	No	22	22	0.522	-0.252	0.108	89.2	-58	-0.00022	0.108	8	8	2020-11-13 to 2024-05-07	0.781	-0.4	0.212	78.8	-11	-0.000417	0.212
CCR-AP-7	Cobalt, Total	Decreasing	No Trend	No	24	22	1.51	-0.404	0.00631	99.4	-111	-0.0000848	0.00631	8	6	2020-11-12 to 2024-05-10	0.561	0.214	0.536	46.4	6	0.0000247	0.536
CCR-AP-8	Cobalt, Total	Decreasing	Stable	No	22	22	0.451	-0.595	0.000149	100	-135	-0.000467	0.000149	8	8	2020-11-12 to 2024-05-10	0.542	-0.286	0.386	61.4	-8	-0.000658	0.386
CCR-AP-9	Cobalt, Total	No Trend	Stable	No	21	21	0.574	0.234	0.153	84.7	48	0.00025	0.153	8	8	2020-05-19 to 2024-05-08	0.385	-0.265	0.445	55.5	-7	-0.001	0.445

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		Mann Kendall Trends			Secular Trend Evaluation for All Data										Secular Trend Evaluation for Recent Data (subset of 8 most recent data points)								
					Mann-Kendall Test (R programming, package = Kendall, version = 2.2.1, function = MannKendall, non-detects substituted by 0.5*reporting limit)							Thiel-Sen Test (R programming, package = trend, version = 1.1.6, function = sens.slope, non-detects substituted by 0.5*reporting limit)		Mann-Kendall Test (R programming, package = Kendall, version = 2.2.1, function = MannKendall, non-detects substituted by 0.5*reporting limit)								Thiel-Sen Test (R programming, package = trend, version = 1.1.6, function = sens.slope, non-detects substituted by 0.5*reporting limit)	
Location	Constituent	Trends, All Data	Trends, Recent Data	Seasonal Mann Kendall Used	n	n, detected results	Coefficient of Variance	Kendall's Tau	p-value	Confidence Factor	Kendall Score (S)	Sen Slope (mg/L per year)	p-value	n	n, detected results	recent data date range	Coefficient of Variance	Kendall's Tau	p-value	Confidence Factor	Kendall Score (S)	Sen Slope (mg/L per year)	p-value
Pooled Background	Cobalt, Total	No Trend	Probably Decreasing	No	68	66	1.25	0.0915	0.275	72.5	207	0.0000667	0.275	8	7	2023-05-23 to 2024-05-10	0.893	-0.571	0.0635	93.7	-16	-0.0035	0.0635
CCR-AP-1R	Fluoride	Decreasing	Decreasing	No	23	23	0.217	-0.485	0.00158	99.8	-120	-0.00818	0.00158	8	8	2021-05-13 to 2024-05-08	0.245	-0.909	0.00277	99.7	-25	-0.0314	0 00277
CCR-AP-2	Fluoride	Increasing	Stable	No	23	23	0.414	0.487	0.00136	99.9	122	0.0143	0.00136	8	8	2021-05-12 to 2024-05-08	0.28	-0.327	0.319	68.1	-9	-0.0357	0.319
CCR-AP-3	Fluoride	Stable	Stable	No	22	21	0.474	-0.209	0.185	81.5	-48	-0.00933	0.185	8	8	2020-11-13 to 2024-05-07	0.403	-0.143	0.711	28.9	-4	-0.0104	0.711
CCR-AP-4R	Fluoride	No Trend	Probably Increasing	No	22	21	0.324	0.227	0.15	85	52	0.00667	0.15	8	8	2020-11-13 to 2024-05-08	0.265	0.571	0.0635	93.7	16	0.0383	0.0635
CCR-AP-5	Fluoride	Increasing	Stable	No	22	22	0.354	0.419	0.00782	99.2	95	0.0429	0.00782	8	8	2020-11-13 to 2024-05-13	0.371	0	1	0	0	0	1
CCR-AP-6	Fluoride	Stable	Stable	No	22	22	0.265	-0.122	0.446	55.4	-28	-0.00467	0.446	8	8	2020-11-13 to 2024-05-07	0.318	-0.0364	1	0	-1	-0.005	1
CCR-AP-7	Fluoride	Increasing	Stable	No	23	23	0.389	0.353	0.0212	97.9	88	0.00667	0.0212	8	8	2020-11-12 to 2024-05-10	0.325	-0.214	0.536	46.4	-6	-0.021	0.536
CCR-AP-8	Fluoride	No Trend	No Trend	No	22	21	0.645	0.144	0.366	63.4	33	0.00438	0.366	8	8	2020-11-12 to 2024-05-10	0.79	0.255	0.454	54.6	7	0 01	0.454
CCR-AP-9	Fluoride	No Trend	Stable	No	21	21	0.195	0.0683	0.693	30.7	14	0.00118	0.693	8	8	2020-05-19 to 2024-05-08	0.138	-0.255	0.454	54.6	-7	-0.0065	0.454
Pooled Background	Fluoride	No Trend	Stable	No	67	67	0.335	0.00915	0.918	8.2	20	0	0.918	8	8	2023-05-23 to 2024-05-10	0.182	-0.5	0.108	89.2	-14	-0.019	0.108
CCR-AP-1R	Lead, Total	Increasing	Stable	No	23	23	0.83	0.364	0.0162	98.4	92	0.00173	0.0162	8	8	2021-05-13 to 2024-05-08	0.529	-0.5	0.108	89.2	-14	-0.00715	0.108
CCR-AP-2	Lead, Total	Increasing	Increasing	No	23	23	0.85	0.588	0.000102	100	148	0.0025	0.000102	8	8	2021-05-12 to 2024-05-08	0.697	0.786	0.00937	99.1	22	0.0101	0 00937
CCR-AP-3	Lead, Total	Increasing	No Trend	No	22	18	1.81	0.364	0.0203	98	83	0.0000267	0.0203	8	7	2020-11-13 to 2024-05-07	1.66	0.357	0.266	73.4	10	0.000151	0.266
CCR-AP-4R	Lead, Total	No Trend	Stable	Yes	22	21	0.916	0.135	0.397	60.3	31	0.000142	0.397	8	7	2020-11-13 to 2024-05-08	0.879	-0.286	0.386	61.4	-8	-0.000692	0.386
CCR-AP-5	Lead, Total	Not Evaluated - Majority of data (>50%) non-detect.	No Trend	No	22	9	2.19	NA	NA	NA	NA	NA	NA	8	7	2020-11-13 to 2024-05-13	1.69	0.429	0.174	82.6	12	0.0003	0.174
CCR-AP-6	Lead, Total	No Trend	No Trend	No	22	22	1	-0.121	0.446	55.4	-28	-0.000167	0.446	8	8	2020-11-13 to 2024-05-07	1.71	-0.0714	0.902	9.8	-2	-0.000437	0.902
CCR-AP-7	Lead, Total	Probably Decreasing	Not Evaluated - Majority of data (>50%) non-detect.	No	24	14	1.67	-0.289	0.0621	93.8	-74	-0.0000332	0.0621	8	2	2020-11-12 to 2024-05-10	0.648	NA	NA	NA	NA	NA	NA
CCR-AP-8	Lead, Total	No Trend	No Trend	No	22	21	0.824	0.193	0.224	77.6	44	0.0000383	0.224	8	7	2020-11-12 to 2024-05-10	0.821	0.0714	0.902	9.8	2	0.0000375	0.902
CCR-AP-9	Lead, Total	Probably Increasing	Stable	No	21	21	0.713	0.273	0.0904	91	57	0.000426	0.0904	8	8	2020-05-19 to 2024-05-08	0.529	-0.286	0.386	61.4	-8	-0.00173	0.386
Pooled Background	Lead, Total	No Trend	Stable	No	68	58	1.33	0.0976	0.246	75.4	220	0.0000713	0.246	8	6	2023-05-23 to 2024-05-10	0.961	-0.429	0.174	82.6	-12	-0.0026	0.174
CCR-AP-1R	Lithium, Total	Probably Increasing	Stable	No	23	23	0.588	0.284	0.0639	93.6	71	0.00307	0.0639	8	8	2021-05-13 to 2024-05-08	0.355	-0.327	0.319	68.1	-9	-0.00804	0.319
CCR-AP-2	Lithium, Total	Increasing	Increasing	No	23	18	0.738	0.353	0.0211	97.9	88	0.002	0.0211	8	8	2021-05-12 to 2024-05-08	0.704	0.929	0.00198	99.8	26	0.014	0 00198
CCR-AP-3	Lithium, Total	Not Evaluated - Majority of data (>50%) non-detect.	No Trend	No	22	4	0.949	NA	NA	NA	NA	NA	NA	8	4	2020-11-13 to 2024-05-07	0.258	0.0806	0.894	10.6	2	0	0.894
CCR-AP-4R	Lithium, Total	Stable	Stable	No	22	16	0.772	-0.193	0.231	76.9	-43	-0.000262	0.231	8	7	2020-11-13 to 2024-05-08	0.854	0	1	0	0	-0.0002	1
CCR-AP-5	Lithium, Total	Decreasing	No Trend	No	22	22	0.458	-0.692	0.00000912	100	-158	-0.00514	0.00000912	8	8	2020-11-13 to 2024-05-13	0.462	0.143	0.711	28.9	4	0.002	0.711
CCR-AP-6	Lithium, Total	Decreasing	No Trend	No	22	11	1.37	-0.639	0.000065	100	-140	-0.00127	0.000065	8	5	2020-11-13 to 2024-05-07	1.05	0.0364	1	0	1	0.0000357	1
CCR-AP-7	Lithium, Total	Decreasing	No Trend	No	24	24	0.502	-0.394	0.00968	99	-104	-0.0002	0.00968	8	8	2020-11-12 to 2024-05-10	0.164	0.327	0.319	68.1	9	0.000204	0.319
CCR-AP-8	Lithium, Total	Not Evaluated - Majority of data (>50%) non-detect.	Not Evaluated - Majority of data (>50%) non-detect.	No	22	6	0.873	NA	NA	NA	NA	NA	NA	8	2	2020-11-12 to 2024-05-10	0.44	NA	NA	NA	NA	NA	NA
CCR-AP-9	Lithium, Total	Probably Increasing	Stable	No	21	21	0.423	0.279	0.0845	91.5	58	0.000554	0.0845	8	8	2020-05-19 to 2024-05-08	0.23	-0.0714	0.902	9.8	-2	-0.000625	0.902
Pooled Background	Lithium, Total	No Trend	Stable	No	68	68	0.924	0.062	0.461	53.9	140	0.0000833	0.461	8	8	2023-05-23 to 2024-05-10	0.734	-0.4	0.212	78.8	-11	-0.00864	0.212
CCR-AP-1R	Mercury, Total	Not Evaluated - No detected results.	Not Evaluated - No detected results.	No	22	0	1.25	NA	No detected results.	NA	NA	NA	No detected results.	8	0	2021-05-13 to 2024-05-08	1.24	NA	No detected results.	NA	NA	NA	No detected results.
CCR-AP-2	Mercury, Total	Not Evaluated - Majority of data (>50%) non-detect.	Probably Increasing	No	22	9	0.846	NA	NA	NA	NA	NA	NA	8	6	2021-05-12 to 2024-05-08	0.792	0.546	0.0809	91.9	15	0.0000405	0.0809
CCR-AP-3	Mercury, Total	Not Evaluated - No detected results.	Not Evaluated - No detected results.	No	21	0	0.306	NA	No detected results.	NA	NA	NA	No detected results.	8	0	2020-11-13 to 2024-05-07	0.447	NA	No detected results.	NA	NA	NA	No detected results.
CCR-AP-4R	Mercury, Total	Not Evaluated - No detected results.	Not Evaluated - No detected results.	No	21	0	0.343	NA	No detected results.	NA	NA	NA	No detected results.	8	0	2020-11-13 to 2024-05-08	0.447	NA	No detected results.	NA	NA	NA	No detected results.
CCR-AP-5	Mercury, Total	Not Evaluated - Majority of data (>50%) non-detect.	Not Evaluated - Majority of data (>50%) non-detect.	No	21	3	1.65	NA	NA	NA	NA	NA	NA	8	3	2020-11-13 to 2024-05-13	1.33	NA	NA	NA	NA	NA	NA
CCR-AP-6	Mercury, Total	Not Evaluated - Majority of data (>50%) non-detect.	Not Evaluated - Majority of data (>50%) non-detect.	No	21	2	0.593	NA	NA	NA	NA	NA	NA	8	2	2020-11-13 to 2024-05-07	0.676	NA	NA	NA	NA	NA	NA
CCR-AP-7	Mercury, Total	Not Evaluated - No detected results.	Not Evaluated - No detected results.	No	21	0	0.306	NA	No detected results.	NA	NA	NA	No detected results.	8	0	2020-11-12 to 2024-05-10	0.447	NA	No detected results.	NA	NA	NA	No detected results.
CCR-AP-8	Mercury, Total	Not Evaluated - Only one detected result.	Not Evaluated - Only one detected result.	No	21	1	0.406	NA	NA	NA	NA	NA	NA	8	1	2020-11-12 to 2024-05-10	0.517	NA	NA	NA	NA	NA	NA

Note:
Mann Kendall Trends are classified based on Aziz (2003) guidance.

		Mann Kendall Trends			Secular Trend Evaluation for All Data									Secular Trend Evaluation for Recent Data (subset of 8 most recent data points)								
					Mann-Kendall Test (R programming, package = Kendall, version = 2.2.1, function = MannKendall, non-detects substituted by 0.5*reporting limit)							Thiel-Sen Test (R programming, package = trend, version = 1.1.6, function = sens.slope, non-detects substituted by 0.5*reporting limit)		Mann-Kendall Test (R programming, package = Kendall, version = 2.2.1, function = MannKendall, non-detects substituted by 0.5*reporting limit)							Thiel-Sen Test (R programming, package = trend, version = 1.1.6, function = sens.slope, non-detects substituted by 0.5*reporting limit)	
Location	Constituent	Trends, All Data	Trends, Recent Data	Seasonal Mann Kendall Used	n	n, detected results	Coefficient of Variance	Kendall's Tau	p-value	Confidence Factor	Kendall Score (S)	Sen Slope (mg/L per year)	p-value	n	n, detected results	recent data date range	Coefficient of Variance	Kendall's Tau	p-value	Confidence Factor	Kendall Score (S)	Sen Slope (mg/L per year)	p-value
CCR-AP-9	Mercury, Total	Not Evaluated - No detected results.	Not Evaluated - No detected results.	No	20	0	0	NA	No detected results.	NA	NA	NA	No detected results.	8	0	2020-05-19 to 2024-05-08	0	NA	No detected results.	NA	NA	NA	No detected results.
Pooled Background	Mercury, Total	Not Evaluated - No detected results.	Not Evaluated - No detected results.	No	63	0	0.963	NA	No detected results.	NA	NA	NA	No detected results.	8	0	2023-05-23 to 2024-05-10	0.505	NA	No detected results.	NA	NA	NA	No detected results.
CCR-AP-1R	Molybdenum, Total	Stable	Decreasing	No	23	23	0.434	-0.121	0.442	55.8	-30	-0.0000778	0.442	8	8	2021-05-13 to 2024-05-08	0.61	-0.643	0.0354	96.5	-18	-0.000758	0.0354
CCR-AP-2	Molybdenum, Total	Increasing	No Trend	No	23	23	0.567	0.636	0.0000261	100	160	0.000331	0.0000261	8	8	2021-05-12 to 2024-05-08	0.309	0.5	0.108	89.2	14	0.0005	0.108
CCR-AP-3	Molybdenum, Total	Decreasing	No Trend	No	22	22	0.345	-0.446	0.00494	99.5	-100	-0.000262	0.00494	8	8	2020-11-13 to 2024-05-07	0.57	0.214	0.536	46.4	6	0.000371	0.536
CCR-AP-4R	Molybdenum, Total	Increasing	No Trend	No	22	19	1.12	0.41	0.00918	99.1	93	0.000153	0.00918	8	6	2020-11-13 to 2024-05-08	0.89	0.327	0.319	68.1	9	0.0011	0.319
CCR-AP-5	Molybdenum, Total	Decreasing	Stable	No	22	22	0.418	-0.506	0.00136	99.9	-114	-0.012	0.00136	8	8	2020-11-13 to 2024-05-13	0.492	-0.148	0.706	29.4	-4	-0.0138	0.706
CCR-AP-6	Molybdenum, Total	No Trend	No Trend	No	22	22	0.262	0.0398	0.821	17.9	9	0	0.821	8	8	2020-11-13 to 2024-05-07	0.383	0.143	0.711	28.9	4	0.00117	0.711
CCR-AP-7	Molybdenum, Total	Decreasing	No Trend	No	24	23	0.848	-0.674	0.0000054	100	-184	-0.000227	0.0000054	8	7	2020-11-12 to 2024-05-10	0.274	0.109	0.803	19.7	3	0.0000518	0.803
CCR-AP-8	Molybdenum, Total	Stable	Stable	No	22	22	0.372	-0.0726	0.668	33.2	-16	0	0.668	8	8	2020-11-12 to 2024-05-10	0.511	-0.255	0.454	54.6	-7	-0.000971	0.454
CCR-AP-9	Molybdenum, Total	Decreasing	No Trend	No	21	19	0.837	-0.52	0.0011	99.9	-109	-0.0003	0.0011	8	6	2020-05-19 to 2024-05-08	1.42	-0.357	0.266	73.4	-10	-0.00025	0.266
Pooled Background	Molybdenum, Total	Decreasing	Decreasing	No	68	65	0.747	-0.286	0.0006	99.9	-649	-0.0000761	0.0006	8	6	2023-05-23 to 2024-05-10	0.647	-0.618	0.0461	95.4	-17	-0.001	0.0461
CCR-AP-1R	Radium-226 & 228	No Trend	No Trend	No	21	21	0.675	0.248	0.124	87.6	52	0.124	0.124	8	8	2020-11-13 to 2024-05-08	0.675	0.357	0.266	73.4	10	1.24	0.266
CCR-AP-2	Radium-226 & 228	No Trend	No Trend	No	21	21	0.675	0.0667	0.695	30.5	14	0.0183	0.695	8	8	2020-11-12 to 2024-05-08	0.685	0.143	0.711	28.9	4	0.222	0.711
CCR-AP-3	Radium-226 & 228	No Trend	No Trend	No	20	20	0.652	0.0211	0.922	7.8	4	0.00597	0.922	8	8	2020-11-13 to 2024-05-07	0.733	0.0714	0.902	9.8	2	0.0326	0.902
CCR-AP-4R	Radium-226 & 228	No Trend	No Trend	No	20	20	1.67	-0.0105	0.974	2.6	-2	-0.0041	0.974	8	8	2020-11-13 to 2024-05-08	1.67	0.143	0.711	28.9	4	0.117	0.711
CCR-AP-5	Radium-226 & 228	No Trend	No Trend	No	20	20	1.09	0.168	0.315	68.5	32	0.0379	0.315	8	8	2020-11-13 to 2024-05-13	0.846	0.5	0.108	89.2	14	0.506	0.108
CCR-AP-6	Radium-226 & 228	Stable	Stable	No	20	19	0.929	0	1	0	0	-0.000548	1	8	7	2020-11-13 to 2024-05-07	0.621	0	1	0	0	-0.00971	1
CCR-AP-7	Radium-226 & 228	Stable	Increasing	No	21	21	0.533	-0.114	0.487	51.3	-24	-0.0149	0.487	8	8	2020-11-12 to 2024-05-10	0.58	0.643	0.0354	96.5	18	0.117	0.0354
CCR-AP-8	Radium-226 & 228	Stable	Stable	No	19	19	0.448	-0.135	0.441	55.9	-23	-0.0164	0.441	8	8	2020-11-12 to 2024-05-10	0.478	-0.0714	0.902	9.8	-2	-0.0715	0.902
CCR-AP-9	Radium-226 & 228	Increasing	No Trend	No	19	19	0.786	0.345	0.0424	95.8	59	0.182	0.0424	8	8	2020-05-19 to 2024-05-08	0.712	0.357	0.266	73.4	10	0.644	0.266
Pooled Background	Radium-226 & 228	No Trend	No Trend	No	61	61	0.971	0.108	0.22	78	198	0.0163	0.22	8	8	2023-05-22 to 2024-05-10	0.981	0.182	0.618	38.2	5	0.142	0.618
CCR-AP-1R	Selenium, Total	Not Evaluated - Majority of data (>50%) non-detect.	No Trend	No	23	10	1.27	NA	NA	NA	NA	NA	NA	8	5	2021-05-13 to 2024-05-08	1.01	-0.327	0.319	68.1	-9	-0.0003	0.319
CCR-AP-2	Selenium, Total	Increasing	No Trend	No	23	16	1.14	0.364	0.018	98.2	90	0.00012	0.018	8	7	2021-05-12 to 2024-05-08	0.796	0.214	0.536	46.4	6	0.000105	0.536
CCR-AP-3	Selenium, Total	No Trend	No Trend	No	22	21	0.545	0.196	0.23	77	43	0.0000111	0.23	8	8	2020-11-13 to 2024-05-07	0.224	0.0772	0.898	10.2	2	0	0.898
CCR-AP-4R	Selenium, Total	Probably Increasing	Not Evaluated - Majority of data (>50%) non-detect.	No	22	11	1.8	0.321	0.0561	94.4	64	0.0000167	0.0561	8	3	2020-11-13 to 2024-05-08	0.212	NA	NA	NA	NA	NA	NA
CCR-AP-5	Selenium, Total	Not Evaluated - Majority of data (>50%) non-detect.	No Trend	No	22	8	1.28	NA	NA	NA	NA	NA	NA	8	6	2020-11-13 to 2024-05-13	1.2	0.327	0.319	68.1	9	0.000312	0.319
CCR-AP-6	Selenium, Total	No Trend	Stable	No	22	17	0.965	0.143	0.378	62.2	32	0.00002	0.378	8	6	2020-11-13 to 2024-05-07	0.373	-0.0364	1	0	-1	-0.00001	1
CCR-AP-7	Selenium, Total	Not Evaluated - Majority of data (>50%) non-detect.	Not Evaluated - No detected results.	No	22	3	0.252	NA	NA	NA	NA	NA	NA	8	0	2020-11-12 to 2024-05-10	0	NA	No detected results.	NA	NA	NA	No detected results.
CCR-AP-8	Selenium, Total	No Trend	Stable	No	22	19	0.556	0.0849	0.609	39.1	19	0.00000714	0.609	8	8	2020-11-12 to 2024-05-10	0.538	-0.0364	1	0	-1	-0.0000125	1

Note:
Mann Kendall Trends are classified based on Aziz (2003) guidance.

		Mann Kendall Trends			Secular Trend Evaluation for All Data									Secular Trend Evaluation for Recent Data (subset of 8 most recent data points)							
					Mann-Kendall Test (R programming, package = Kendall, version = 2.2.1, function = MannKendall, non-detects substituted by 0.5*reporting limit)							Thiel-Sen Test (R programming, package = trend, version = 1.1.6, function = sens.slope, non-detects substituted by 0.5*reporting limit)		Mann-Kendall Test (R programming, package = Kendall, version = 2.2.1, function = MannKendall, non-detects substituted by 0.5*reporting limit)							Thiel-Sen Test (R programming, package = trend, version = 1.1.6, function = sens.slope, non-detects substituted by 0.5*reporting limit)	
Location	Constituent	Trends, All Data	Trends, Recent Data	Seasonal Mann Kendall Used	n	n, detected results	Coefficient of Variance	Kendall's Tau	p-value	Confidence Factor	Kendall Score (S)	Sen Slope (mg/L per year)	p-value	n	n, detected results	recent data date range	Coefficient of Variance	Kendall's Tau	p-value	Confidence Factor	Kendall Score (S)	Sen Slope (mg/L per year)	p-value
CCR-AP-9	Selenium, Total	Not Evaluated - Majority of data (>50%) non-detect.	Not Evaluated - Majority of data (>50%) non-detect.	No	21	6	1.17	NA	NA	NA	NA	NA	NA	8	2	2020-05-19 to 2024-05-08	1.52	NA	NA	NA	NA	NA	NA
Pooled Background	Selenium, Total	Not Evaluated - Majority of data (>50%) non-detect.	Not Evaluated - Majority of data (>50%) non-detect.	No	66	19	1.31	NA	NA	NA	NA	NA	NA	8	3	2023-05-23 to 2024-05-10	0.398	NA	NA	NA	NA	NA	NA
CCR-AP-1R	Thallium, Total	Increasing	Stable	No	23	16	0.919	0.325	0.0357	96.4	80	0.000026	0.0357	8	5	2021-05-13 to 2024-05-08	0.85	-0.109	0.803	19.7	-3	-0.000011	0.803
CCR-AP-2	Thallium, Total	Increasing	No Trend	No	23	20	1.52	0.615	0.0000515	100	154	0.00005	0.0000515	8	8	2021-05-12 to 2024-05-08	1.35	0.109	0.803	19.7	3	0.0000675	0.803
CCR-AP-3	Thallium, Total	Not Evaluated - Only one detected result.	Not Evaluated - No detected results.	No	22	1	0.277	NA	NA	NA	NA	NA	NA	8	0	2020-11-13 to 2024-05-07	0.314	NA	No detected results.	NA	NA	NA	No detected results.
CCR-AP-4R	Thallium, Total	Not Evaluated - Majority of data (>50%) non-detect.	Not Evaluated - Majority of data (>50%) non-detect.	No	22	10	1.09	NA	NA	NA	NA	NA	NA	8	2	2020-11-13 to 2024-05-08	0.342	NA	NA	NA	NA	NA	NA
CCR-AP-5	Thallium, Total	Not Evaluated - Majority of data (>50%) non-detect.	No Trend	No	22	7	1.57	NA	NA	NA	NA	NA	NA	8	4	2020-11-13 to 2024-05-13	0.579	0.403	0.232	76.8	10	0.0000567	0.232
CCR-AP-6	Thallium, Total	Not Evaluated - Majority of data (>50%) non-detect.	Not Evaluated - No detected results.	No	22	8	1.06	NA	NA	NA	NA	NA	NA	8	0	2020-11-13 to 2024-05-07	0.314	NA	No detected results.	NA	NA	NA	No detected results.
CCR-AP-7	Thallium, Total	Not Evaluated - Majority of data (>50%) non-detect.	Not Evaluated - No detected results.	No	24	4	0.389	NA	NA	NA	NA	NA	NA	8	0	2020-11-12 to 2024-05-10	0.314	NA	No detected results.	NA	NA	NA	No detected results.
CCR-AP-8	Thallium, Total	Not Evaluated - Majority of data (>50%) non-detect.	Not Evaluated - No detected results.	No	22	5	0.469	NA	NA	NA	NA	NA	NA	8	0	2020-11-12 to 2024-05-10	0.314	NA	No detected results.	NA	NA	NA	No detected results.
CCR-AP-9	Thallium, Total	Not Evaluated - Majority of data (>50%) non-detect.	Not Evaluated - No detected results.	No	21	9	1.53	NA	NA	NA	NA	NA	NA	8	0	2020-05-19 to 2024-05-08	1.5	NA	No detected results.	NA	NA	NA	No detected results.
Pooled Background	Thallium, Total	Not Evaluated - Majority of data (>50%) non-detect.	Not Evaluated - Only one detected result.	No	68	29	1.15	NA	NA	NA	NA	NA	NA	8	1	2023-05-23 to 2024-05-10	0.356	NA	NA	NA	NA	NA	NA

Note:
Mann Kendall test run on seasonally adjusted data if seasonal trend identified. Seasonal trends identified based on Kruskall Wallis test and time series plots, where n seasons = 4 and (Dec-Feb, Mar-May, Jun-Aug, Sept-Nov).

Note:
Mann Kendall Trends are classified based on Aziz (2003) guidance.

Table A-5. Upper Tolerance Limits (UTLs) & Updated Groundwater Protection Standards (GWPS)

		Interwell Background Data Characterization [a]												Groundwater Protection Standard (GWPS) Determination				UTL Calculation Details		
Constituent	Units	n	n, non-detects	max reporting limit	max detected value	mean	median	min sample date	max sample date	standard deviation	coefficient of variation	Mann Kendall trend	normalizing data transformation (if any)	UTL	UTL Result Detection Status [b]	MCL/RSL	GWPS	GWPS Source	UTL calculation method	UTL calculation details	Minimum Coverage (%)
Antimony, Total	mg/L	68	33	0.02	0.0079	0.00317	0.002	2016-06-10	2024-05-10	0.00465	1.47	No Trend	NA - Original Data	0.02	No	0.006	0.02	BTV	Non-Parametric Tolerance Limits (USEPA, 2009 - Chapter 17.2.2)	Maximum Value (ND = RL, Non-discriminatory of detection status)	95.7
Barium, Total	mg/L	68	0	NA	0.72	0.212	0.165	2016-06-10	2024-05-10	0.13	0.615	Probably Increasing	NA - Original Data	0.72	Yes	2	2	MCL/RSL	Non-Parametric Tolerance Limits (USEPA, 2009 - Chapter 17.2.2)	Maximum Value (ND = RL, Non-discriminatory of detection status)	95.7
Beryllium, Total	mg/L	68	19	0.01	0.0066	0.0016	0.001	2016-06-10	2024-05-10	0.00188	1.17	Increasing	NA - Original Data	0.01	No	0.004	0.01	BTV	Non-Parametric Tolerance Limits (USEPA, 2009 - Chapter 17.2.2)	Maximum Value (ND = RL, Non-discriminatory of detection status)	95.7
Cadmium, Total	mg/L	68	45	0.01	0.00087	0.00156	0.001	2016-06-10	2024-05-10	0.00243	1.56	No Trend	NA - Original Data	0.01	No	0.005	0.01	BTV	Non-Parametric Tolerance Limits (USEPA, 2009 - Chapter 17.2.2)	Maximum Value (ND = RL, Non-discriminatory of detection status)	95.7
Chromium, Total	mg/L	68	12	0.01	0.16	0.0281	0.012	2016-06-10	2024-05-10	0.0385	1.37	Increasing	NA - Original Data	0.16	Yes	0.1	0.16	BTV	Non-Parametric Tolerance Limits (USEPA, 2009 - Chapter 17.2.2)	Maximum Value (ND = RL, Non-discriminatory of detection status)	95.7
Cobalt, Total	mg/L	68	2	0.002	0.081	0.0158	0.0098	2016-06-10	2024-05-10	0.0197	1.24	No Trend	NA - Original Data	0.081	Yes	0.006	0.081	BTV	Non-Parametric Tolerance Limits (USEPA, 2009 - Chapter 17.2.2)	Maximum Value (ND = RL, Non-discriminatory of detection status)	95.7
Fluoride	mg/L	67	0	NA	0.81	0.387	0.36	2016-06-10	2024-05-10	0.13	0.335	No Trend	NA - Original Data	0.646	NA	4	4	MCL/RSL	Parametric Tolerance Limits (USEPA, 2009 - Chapter 17.2.1)	Background mean + K * Background Standard Deviation	NA
Lead, Total	mg/L	68	10	0.003	0.094	0.0163	0.0085	2016-06-10	2024-05-10	0.0215	1.32	No Trend	NA - Original Data	0.094	Yes	0.015	0.094	BTV	Non-Parametric Tolerance Limits (USEPA, 2009 - Chapter 17.2.2)	Maximum Value (ND = RL, Non-discriminatory of detection status)	95.7
Lithium, Total	mg/L	68	0	NA	0.23	0.0502	0.0385	2016-06-10	2024-05-10	0.0464	0.924	No Trend	NA - Original Data	0.23	Yes	0.04	0.23	BTV	Non-Parametric Tolerance Limits (USEPA, 2009 - Chapter 17.2.2)	Maximum Value (ND = RL, Non-discriminatory of detection status)	95.7
Mercury, Total	mg/L	63	63	0.002	NA	0.000243	0.0002	2016-06-10	2024-05-10	0.000234	0.963	All non-detect results.	NA - Original Data	0.002	No	0.002	0.002	BTV = MCL/RSL	Non-Parametric Tolerance Limits (USEPA, 2009 - Chapter 17.2.2)	Maximum Value (ND = RL, Non-discriminatory of detection status)	95.4
Molybdenum, Total	mg/L	68	3	0.05	0.023	0.00675	0.0056	2016-06-10	2024-05-10	0.0067	0.993	Decreasing	NA - Original Data	0.05	No	0.1	0.1	MCL/RSL	Non-Parametric Tolerance Limits (USEPA, 2009 - Chapter 17.2.2)	Maximum Value (ND = RL, Non-discriminatory of detection status)	95.7
Radium-226 & 228	pCi/L	61	0	NA	14.4	3.12	1.93	2016-06-10	2024-05-10	3.03	0.971	No Trend	NA - Original Data	14.4	Yes	5	14.4	BTV	Non-Parametric Tolerance Limits (USEPA, 2009 - Chapter 17.2.2)	Maximum Value (ND = RL, Non-discriminatory of detection status)	95.2
Selenium, Total	mg/L	66	47	0.05	0.025	0.00815	0.005	2016-06-10	2024-05-10	0.0111	1.37	No Trend	NA - Original Data	0.05	No	0.05	0.05	BTV = MCL/RSL	Non-Parametric Tolerance Limits (USEPA, 2009 - Chapter 17.2.2)	Maximum Value (ND = RL, Non-discriminatory of detection status)	95.6
Thallium, Total	mg/L	68	39	0.01	0.0027	0.00107	0.001	2016-06-10	2024-05-10	0.0014	1.31	Increasing	NA - Original Data	0.01	No	0.002	0.01	BTV	Non-Parametric Tolerance Limits (USEPA, 2009 - Chapter 17.2.2)	Maximum Value (ND = RL, Non-discriminatory of detection status)	95.7

Note:

[a] Interwell background datasets are analyte specific and include data collected from background wells (CCR-AP-1R, CCR-AP-7, and CCR-AP-9). Interwell background datasets were re-tested for outliers, secular trends, and data normality. No outliers were removed.

[b] In some cases, the maximum value selected as the UTL is a non-detect result with an elevated reporting limit.

Units = mg/L, milligrams per liter. pCi/L = picocuries per liter.

Table A-5. Intrawell Arsenic Prediction Limit Calculations

			Baseline Data Characterization [a]												Prediction Limits		Parametric UPL Calculation Statistics			Non-Parametric UPL Calculation Statistics	
Location	Constituent	Units	Baseline Distribution [a]	Prediction Interval Calculation	min baseline sample date	compliance sample sample	n	n, non-detects	max	mean	standard deviation	Trend (Baseline Data)	degrees of freedom	future samples (M)	Prediction Limit Calculation Method	UPL	confidence level (%)	t (percentile of student's t-test)	t quantile	actual confidence level (%)	false positive rate (%)
CCR-AP-2	Arsenic, Total	mg/L	Normal (Baseline, 95% Confidence)	Parametric	2016-06-10	2023-07-28	21	0	0.048	0.0143	0.0119	Increasing	20	4	Parametric Prediction Limit for M Future Values (USEPA, 2009 - Chapter 18.2.1)	0.0526	99	0.9975	3.153	NA	NA
CCR-AP-3	Arsenic, Total	mg/L	Normal (Baseline, 95% Confidence)	Parametric	2016-06-10	2023-05-23	20	0	0.095	0.0759	0.00848	Increasing	19	4	Parametric Prediction Limit for M Future Values (USEPA, 2009 - Chapter 18.2.1)	0.103	99	0.9975	3.174	NA	NA
CCR-AP-4R	Arsenic, Total	mg/L	Normal (Baseline, ln Trans, 95% Confidence)	Parametric (ln Transformed Data)	2016-06-10	2023-05-23	20	0	0.33	0.112	0.081	Increasing	19	4	Parametric Prediction Limit for M Future Values (USEPA, 2009 - Chapter 18.2.1)	0.707	99	0.9975	3.174	NA	NA
CCR-AP-5	Arsenic, Total	mg/L	Not normal (Baseline, ln Trans, 95% Confidence)	Non-Parametric	2016-06-10	2023-05-25	19	2	0.024	0.00355	0.00584	Increasing	18	4	Non-Parametric Prediction Limit for M Future Values (USEPA, 2009 - Chapter 18.3.1)	0.024	NA	NA	NA	82.6	17.4
CCR-AP-6	Arsenic, Total	mg/L	Normal (Baseline, 95% Confidence)	Parametric	2016-06-10	2023-05-23	20	0	0.12	0.0942	0.0221	Increasing	19	4	Parametric Prediction Limit for M Future Values (USEPA, 2009 - Chapter 18.2.1)	0.166	99	0.9975	3.174	NA	NA
CCR-AP-8	Arsenic, Total	mg/L	Normal (Baseline, 95% Confidence)	Parametric	2017-03-09	2023-05-25	20	0	0.12	0.091	0.0216	Increasing	19	4	Parametric Prediction Limit for M Future Values (USEPA, 2009 - Chapter 18.2.1)	0.161	99	0.9975	3.174	NA	NA

Note:

[a] Baseline data refer to the entire statistical dataset, except the most recent data point (May 2023). The most recent data points is considered a 'compliance' or 'recent' sample. Baseline datasets were re-tested for outliers, secular trends, and data normality. No outliers were removed. Prediction limits calculated using simple replacement with the reporting limit for non-detect results.

Table A-6. Confidence Intervals

			Confidence Interval (CI) Dataset						CI Calculation [a]			SSL Confirmation		Non-Parametric CI Statistics (if applicable)	
Location	Constituent	Units	n	max (Rank n)	min (Rank 1)	median	mean	standard deviation	CI calculation method	degrees of freedom	95% Confidence LCL	GWPS	LCL > GWPS?	bootstrap iterations	bootstrap median
CCR-AP-5	Molybdenum, Total	mg/L	22	0.53	0.046	0.315	0.287	0.12	Calculation of the Confidence Interval Around the Normal Mean (Parametric)	21	0.234	0.1	Yes	NA	NA

Note:

Confidence intervals are calculated for analyte/well pairs with GWPS exceedances in the sampling event dataset.

[a] The 95% lower confience level (LCL) is compared to the Groundwater Protection Standard (GWPS) to confirm a statistically significant level (SSL). The 99% confidence interval is also shown for purposes of comparison. UCL = upper confidence level.

Table A-7. Groundwater Protection Standard (GWPS) Summary

Background Location	Constituent	Units	Background Threshold Value (BTV)	BTV Type	MCL/RSL	GWPS	GWPS Source	BTV Calculation Method
CCR-AP-1R, CCR-AP-7, CCR-AP-9	Antimony, Total	mg/L	0.02	Interwell UTL	0.006	0.02	BTV	Non-Parametric Tolerance Limits (USEPA, 2009 - Chapter 17.2.2)
CCR-AP-2	Arsenic, Total	mg/L	0.0526	Intrawell UPL	0.01	0.0526	BTV	Parametric Prediction Limit for M Future Values (USEPA, 2009 - Chapter 18.2.1)
CCR-AP-3	Arsenic, Total	mg/L	0.103	Intrawell UPL	0.01	0.103	BTV	Parametric Prediction Limit for M Future Values (USEPA, 2009 - Chapter 18.2.1)
CCR-AP-4R	Arsenic, Total	mg/L	0.707	Intrawell UPL	0.01	0.707	BTV	Parametric Prediction Limit for M Future Values (USEPA, 2009 - Chapter 18.2.1)
CCR-AP-5	Arsenic, Total	mg/L	0.024	Intrawell UPL	0.01	0.024	BTV	Non-Parametric Prediction Limit for M Future Values (USEPA, 2009 - Chapter 18.3.1)
CCR-AP-6	Arsenic, Total	mg/L	0.166	Intrawell UPL	0.01	0.166	BTV	Parametric Prediction Limit for M Future Values (USEPA, 2009 - Chapter 18.2.1)
CCR-AP-8	Arsenic, Total	mg/L	0.161	Intrawell UPL	0.01	0.161	BTV	Parametric Prediction Limit for M Future Values (USEPA, 2009 - Chapter 18.2.1)
CCR-AP-1R, CCR-AP-7, CCR-AP-9	Barium, Total	mg/L	0.72	Interwell UTL	2	2	MCL/RSL	Non-Parametric Tolerance Limits (USEPA, 2009 - Chapter 17.2.2)
CCR-AP-1R, CCR-AP-7, CCR-AP-9	Beryllium, Total	mg/L	0.01	Interwell UTL	0.004	0.01	BTV	Non-Parametric Tolerance Limits (USEPA, 2009 - Chapter 17.2.2)
CCR-AP-1R, CCR-AP-7, CCR-AP-9	Cadmium, Total	mg/L	0.01	Interwell UTL	0.005	0.01	BTV	Non-Parametric Tolerance Limits (USEPA, 2009 - Chapter 17.2.2)
CCR-AP-1R, CCR-AP-7, CCR-AP-9	Chromium, Total	mg/L	0.16	Interwell UTL	0.1	0.16	BTV	Non-Parametric Tolerance Limits (USEPA, 2009 - Chapter 17.2.2)
CCR-AP-1R, CCR-AP-7, CCR-AP-9	Cobalt, Total	mg/L	0.081	Interwell UTL	0.006	0.081	BTV	Non-Parametric Tolerance Limits (USEPA, 2009 - Chapter 17.2.2)
CCR-AP-1R, CCR-AP-7, CCR-AP-9	Fluoride	mg/L	0.646	Interwell UTL	4	4	MCL/RSL	Parametric Tolerance Limits (USEPA, 2009 - Chapter 17.2.1)
CCR-AP-1R, CCR-AP-7, CCR-AP-9	Lead, Total	mg/L	0.094	Interwell UTL	0.015	0.094	BTV	Non-Parametric Tolerance Limits (USEPA, 2009 - Chapter 17.2.2)
CCR-AP-1R, CCR-AP-7, CCR-AP-9	Lithium, Total	mg/L	0.23	Interwell UTL	0.04	0.23	BTV	Non-Parametric Tolerance Limits (USEPA, 2009 - Chapter 17.2.2)
CCR-AP-1R, CCR-AP-7, CCR-AP-9	Mercury, Total	mg/L	0.002	Interwell UTL	0.002	0.002	BTV = MCL/RSL	Non-Parametric Tolerance Limits (USEPA, 2009 - Chapter 17.2.2)
CCR-AP-1R, CCR-AP-7, CCR-AP-9	Molybdenum, Total	mg/L	0.05	Interwell UTL	0.1	0.1	MCL/RSL	Non-Parametric Tolerance Limits (USEPA, 2009 - Chapter 17.2.2)
CCR-AP-1R, CCR-AP-7, CCR-AP-9	Radium-226 & 228	pCi/L	14.4	Interwell UTL	5	14.4	BTV	Non-Parametric Tolerance Limits (USEPA, 2009 - Chapter 17.2.2)
CCR-AP-1R, CCR-AP-7, CCR-AP-9	Selenium, Total	mg/L	0.05	Interwell UTL	0.05	0.05	BTV = MCL/RSL	Non-Parametric Tolerance Limits (USEPA, 2009 - Chapter 17.2.2)
CCR-AP-1R, CCR-AP-7, CCR-AP-9	Thallium, Total	mg/L	0.01	Interwell UTL	0.002	0.01	BTV	Non-Parametric Tolerance Limits (USEPA, 2009 - Chapter 17.2.2)

Background Threshold Values (BTVs) include Upper Threshold Limits (UTLs) calculated from pooled/interwell background data and Upper Prediction Limits (UPLs) for Arsenic calculated from intrawell data. Groundwater Protection Standard (GWPS) is the maximum value between the BTV and the Maximum Contaminant Level/Regional Screening Level (MCL/RSL).

Table A-8. Groundwater Protection Standard (GWPS) Comparison Table

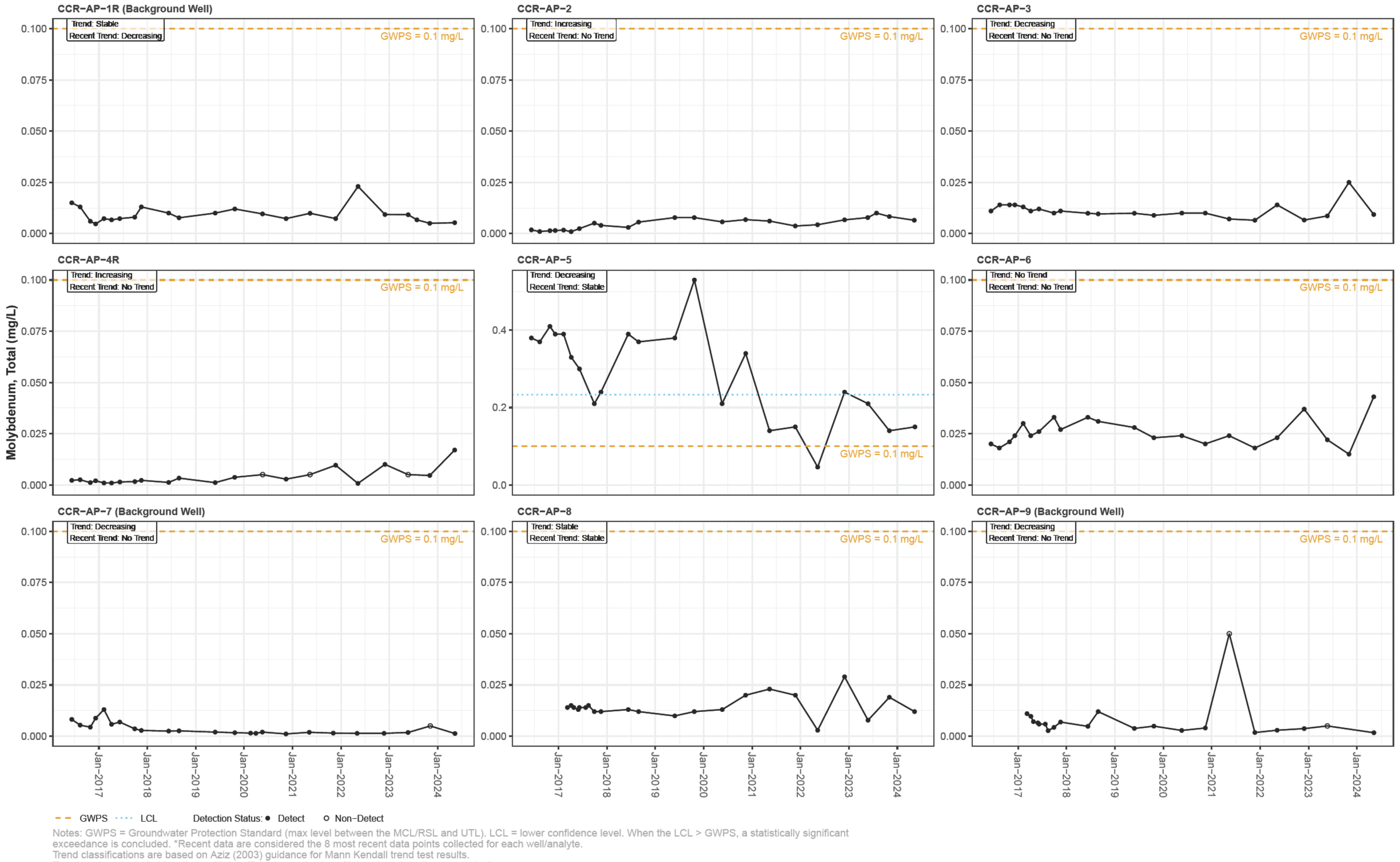
Location	Constituent	Units	Sample Date	Sample Result	Background Threshold Value (BTV)	BTV Type	GWPS	GWPS Exceedance	LCL	SSL Confirmed
CCR-AP-5	Molybdenum, Total	mg/L	2024-05-13	0.15	0.05	Interwell UTL	0.1	Yes	0.234	Yes
CCR-AP-2	Antimony, Total	mg/L	2024-05-08	0.0011 J	0.02	Interwell UTL	0.02	No	NA	No
CCR-AP-3	Antimony, Total	mg/L	2024-05-07	0.002 U	0.02	Interwell UTL	0.02	No	NA	No
CCR-AP-4R	Antimony, Total	mg/L	2024-05-08	0.002 U	0.02	Interwell UTL	0.02	No	NA	No
CCR-AP-5	Antimony, Total	mg/L	2024-05-13	0.002 U	0.02	Interwell UTL	0.02	No	NA	No
CCR-AP-6	Antimony, Total	mg/L	2024-05-07	0.00082 J	0.02	Interwell UTL	0.02	No	NA	No
CCR-AP-8	Antimony, Total	mg/L	2024-05-10	0.00064 J	0.02	Interwell UTL	0.02	No	NA	No
CCR-AP-2	Arsenic, Total	mg/L	2024-05-08	0.025	0.0526	Intrawell UPL	0.0526	No	NA	No
CCR-AP-3	Arsenic, Total	mg/L	2024-05-07	0.051	0.103	Intrawell UPL	0.103	No	NA	No
CCR-AP-4R	Arsenic, Total	mg/L	2024-05-08	0.027	0.707	Intrawell UPL	0.707	No	NA	No
CCR-AP-5	Arsenic, Total	mg/L	2024-05-13	0.00085 J	0.024	Intrawell UPL	0.024	No	NA	No
CCR-AP-6	Arsenic, Total	mg/L	2024-05-07	0.057	0.166	Intrawell UPL	0.166	No	NA	No
CCR-AP-8	Arsenic, Total	mg/L	2024-05-10	0.013	0.161	Intrawell UPL	0.161	No	NA	No
CCR-AP-2	Barium, Total	mg/L	2024-05-08	0.83	0.72	Interwell UTL	2	No	NA	No
CCR-AP-3	Barium, Total	mg/L	2024-05-07	0.38	0.72	Interwell UTL	2	No	NA	No
CCR-AP-4R	Barium, Total	mg/L	2024-05-08	0.53	0.72	Interwell UTL	2	No	NA	No
CCR-AP-5	Barium, Total	mg/L	2024-05-13	0.046	0.72	Interwell UTL	2	No	NA	No
CCR-AP-6	Barium, Total	mg/L	2024-05-07	0.43	0.72	Interwell UTL	2	No	NA	No
CCR-AP-8	Barium, Total	mg/L	2024-05-10	0.27	0.72	Interwell UTL	2	No	NA	No
CCR-AP-2	Beryllium, Total	mg/L	2024-05-08	0.0037	0.01	Interwell UTL	0.01	No	NA	No
CCR-AP-3	Beryllium, Total	mg/L	2024-05-07	0.001 U	0.01	Interwell UTL	0.01	No	NA	No
CCR-AP-4R	Beryllium, Total	mg/L	2024-05-08	0.001 U	0.01	Interwell UTL	0.01	No	NA	No
CCR-AP-5	Beryllium, Total	mg/L	2024-05-13	0.001 U	0.01	Interwell UTL	0.01	No	NA	No
CCR-AP-6	Beryllium, Total	mg/L	2024-05-07	0.001 U	0.01	Interwell UTL	0.01	No	NA	No
CCR-AP-8	Beryllium, Total	mg/L	2024-05-10	0.001 U	0.01	Interwell UTL	0.01	No	NA	No
CCR-AP-2	Cadmium, Total	mg/L	2024-05-08	0.003	0.01	Interwell UTL	0.01	No	NA	No
CCR-AP-3	Cadmium, Total	mg/L	2024-05-07	0.001 U	0.01	Interwell UTL	0.01	No	NA	No
CCR-AP-4R	Cadmium, Total	mg/L	2024-05-08	0.001 U	0.01	Interwell UTL	0.01	No	NA	No
CCR-AP-5	Cadmium, Total	mg/L	2024-05-13	0.001 U	0.01	Interwell UTL	0.01	No	NA	No
CCR-AP-6	Cadmium, Total	mg/L	2024-05-07	0.001 U	0.01	Interwell UTL	0.01	No	NA	No
CCR-AP-8	Cadmium, Total	mg/L	2024-05-10	0.001 U	0.01	Interwell UTL	0.01	No	NA	No
CCR-AP-2	Chromium, Total	mg/L	2024-05-08	0.11	0.16	Interwell UTL	0.16	No	NA	No
CCR-AP-3	Chromium, Total	mg/L	2024-05-07	0.0031 J	0.16	Interwell UTL	0.16	No	NA	No
CCR-AP-4R	Chromium, Total	mg/L	2024-05-08	0.005 U	0.16	Interwell UTL	0.16	No	NA	No
CCR-AP-5	Chromium, Total	mg/L	2024-05-13	0.002 J	0.16	Interwell UTL	0.16	No	NA	No
CCR-AP-6	Chromium, Total	mg/L	2024-05-07	0.0027 J	0.16	Interwell UTL	0.16	No	NA	No
CCR-AP-8	Chromium, Total	mg/L	2024-05-10	0.0039 J	0.16	Interwell UTL	0.16	No	NA	No
CCR-AP-2	Cobalt, Total	mg/L	2024-05-08	0.048	0.081	Interwell UTL	0.081	No	NA	No
CCR-AP-3	Cobalt, Total	mg/L	2024-05-07	0.0061	0.081	Interwell UTL	0.081	No	NA	No
CCR-AP-4R	Cobalt, Total	mg/L	2024-05-08	0.0028	0.081	Interwell UTL	0.081	No	NA	No
CCR-AP-5	Cobalt, Total	mg/L	2024-05-13	0.0025	0.081	Interwell UTL	0.081	No	NA	No
CCR-AP-6	Cobalt, Total	mg/L	2024-05-07	0.0034	0.081	Interwell UTL	0.081	No	NA	No
CCR-AP-8	Cobalt, Total	mg/L	2024-05-10	0.0044	0.081	Interwell UTL	0.081	No	NA	No
CCR-AP-2	Fluoride	mg/L	2024-05-08	0.27	0.646	Interwell UTL	4	No	NA	No
CCR-AP-3	Fluoride	mg/L	2024-05-07	0.35	0.646	Interwell UTL	4	No	NA	No
CCR-AP-4R	Fluoride	mg/L	2024-05-08	0.61	0.646	Interwell UTL	4	No	NA	No
CCR-AP-5	Fluoride	mg/L	2024-05-13	0.84	0.646	Interwell UTL	4	No	NA	No
CCR-AP-6	Fluoride	mg/L	2024-05-07	0.37	0.646	Interwell UTL	4	No	NA	No
CCR-AP-8	Fluoride	mg/L	2024-05-10	0.22	0.646	Interwell UTL	4	No	NA	No
CCR-AP-2	Lead, Total	mg/L	2024-05-08	0.056	0.094	Interwell UTL	0.094	No	NA	No
CCR-AP-3	Lead, Total	mg/L	2024-05-07	0.00097 J	0.094	Interwell UTL	0.094	No	NA	No
CCR-AP-4R	Lead, Total	mg/L	2024-05-08	0.001 U	0.094	Interwell UTL	0.094	No	NA	No
CCR-AP-5	Lead, Total	mg/L	2024-05-13	0.00068 J	0.094	Interwell UTL	0.094	No	NA	No
CCR-AP-6	Lead, Total	mg/L	2024-05-07	0.0012	0.094	Interwell UTL	0.094	No	NA	No
CCR-AP-8	Lead, Total	mg/L	2024-05-10	0.003	0.094	Interwell UTL	0.094	No	NA	No
CCR-AP-2	Lithium, Total	mg/L	2024-05-08	0.085	0 23	Interwell UTL	0.23	No	NA	No
CCR-AP-3	Lithium, Total	mg/L	2024-05-07	0.0028 J	0 23	Interwell UTL	0.23	No	NA	No
CCR-AP-4R	Lithium, Total	mg/L	2024-05-08	0.0045 J	0 23	Interwell UTL	0.23	No	NA	No
CCR-AP-5	Lithium, Total	mg/L	2024-05-13	0.056	0 23	Interwell UTL	0.23	No	NA	No
CCR-AP-6	Lithium, Total	mg/L	2024-05-07	0.0057 J	0 23	Interwell UTL	0.23	No	NA	No
CCR-AP-8	Lithium, Total	mg/L	2024-05-10	0.0039 J	0 23	Interwell UTL	0.23	No	NA	No

Background Threshold Values (BTVs) include Upper Threshold Limits (UTLs) calculated from pooled/interwell background data and Upper Prediction Limits (UPLs) for Arsenic calculated from intrawell data. Groundwater Protection Standard (GWPS) is the maximum value between the BTV and the Maximum Contaminant Level/Regional Screening Level (MCL/RSL). Lower Confidence Limit (LCL) calculated if the event sample result exceeds the GWPS. If the LCL is greater than the GWPS, a Statistically Significant Level (SSL) is confirmed.

Location	Constituent	Units	Sample Date	Sample Result	Background Threshold Value (BTV)	BTV Type	GWPS	GWPS Exceedance	LCL	SSL Confirmed
CCR-AP-2	Mercury, Total	mg/L	2024-05-08	0.00016 J	0.002	Interwell UTL	0.002	No	NA	No
CCR-AP-3	Mercury, Total	mg/L	2024-05-07	0.0002 U	0.002	Interwell UTL	0.002	No	NA	No
CCR-AP-4R	Mercury, Total	mg/L	2024-05-08	0.0002 U	0.002	Interwell UTL	0.002	No	NA	No
CCR-AP-5	Mercury, Total	mg/L	2024-05-13	0.0002 U	0.002	Interwell UTL	0.002	No	NA	No
CCR-AP-6	Mercury, Total	mg/L	2024-05-07	0.0002 U	0.002	Interwell UTL	0.002	No	NA	No
CCR-AP-8	Mercury, Total	mg/L	2024-05-10	0.0002 U	0.002	Interwell UTL	0.002	No	NA	No
CCR-AP-2	Molybdenum, Total	mg/L	2024-05-08	0.0065	0.05	Interwell UTL	0.1	No	NA	No
CCR-AP-3	Molybdenum, Total	mg/L	2024-05-07	0.0093	0.05	Interwell UTL	0.1	No	NA	No
CCR-AP-4R	Molybdenum, Total	mg/L	2024-05-08	0.017	0.05	Interwell UTL	0.1	No	NA	No
CCR-AP-6	Molybdenum, Total	mg/L	2024-05-07	0.043	0.05	Interwell UTL	0.1	No	NA	No
CCR-AP-8	Molybdenum, Total	mg/L	2024-05-10	0.012	0.05	Interwell UTL	0.1	No	NA	No
CCR-AP-2	Radium-226 & 228	pCi/L	2024-05-08	3.22 J+	14.4	Interwell UTL	14.4	No	NA	No
CCR-AP-3	Radium-226 & 228	pCi/L	2024-05-07	0.896 J	14.4	Interwell UTL	14.4	No	NA	No
CCR-AP-4R	Radium-226 & 228	pCi/L	2024-05-08	1.21 J	14.4	Interwell UTL	14.4	No	NA	No
CCR-AP-5	Radium-226 & 228	pCi/L	2024-05-13	0.877 J	14.4	Interwell UTL	14.4	No	NA	No
CCR-AP-6	Radium-226 & 228	pCi/L	2024-05-07	0.71 UJ	14.4	Interwell UTL	14.4	No	NA	No
CCR-AP-8	Radium-226 & 228	pCi/L	2024-05-10	1.08 J	14.4	Interwell UTL	14.4	No	NA	No
CCR-AP-2	Selenium, Total	mg/L	2024-05-08	0.0027 J	0.05	Interwell UTL	0.05	No	NA	No
CCR-AP-3	Selenium, Total	mg/L	2024-05-07	0.0016 J	0.05	Interwell UTL	0.05	No	NA	No
CCR-AP-4R	Selenium, Total	mg/L	2024-05-08	0.005 U	0.05	Interwell UTL	0.05	No	NA	No
CCR-AP-5	Selenium, Total	mg/L	2024-05-13	0.00095 J	0.05	Interwell UTL	0.05	No	NA	No
CCR-AP-6	Selenium, Total	mg/L	2024-05-07	0.005 U	0.05	Interwell UTL	0.05	No	NA	No
CCR-AP-8	Selenium, Total	mg/L	2024-05-10	0.0021 J	0.05	Interwell UTL	0.05	No	NA	No
CCR-AP-2	Thallium, Total	mg/L	2024-05-08	0.001	0.01	Interwell UTL	0.01	No	NA	No
CCR-AP-3	Thallium, Total	mg/L	2024-05-07	0.001 U	0.01	Interwell UTL	0.01	No	NA	No
CCR-AP-4R	Thallium, Total	mg/L	2024-05-08	0.001 U	0.01	Interwell UTL	0.01	No	NA	No
CCR-AP-5	Thallium, Total	mg/L	2024-05-13	0.001 U	0.01	Interwell UTL	0.01	No	NA	No
CCR-AP-6	Thallium, Total	mg/L	2024-05-07	0.001 U	0.01	Interwell UTL	0.01	No	NA	No
CCR-AP-8	Thallium, Total	mg/L	2024-05-10	0.001 U	0.01	Interwell UTL	0.01	No	NA	No

Background Threshold Values (BTVs) include Upper Threshold Limits (UTLs) calculated from pooled/interwell background data and Upper Prediction Limits (UPLs) for Arsenic calculated from intrawell data. Groundwater Protection Standard (GWPS) is the maximum value between the BTV and the Maximum Contaminant Level/Regional Screening Level (MCL/RSL). Lower Confidence Limit (LCL) calculated if the event sample result exceeds the GWPS. If the LCL is greater than the GWPS, a Statistically Significant Level (SSL) is confirmed.

Assessment Monitoring Trend Analysis for Molybdenum, Total



Notes: GWPS = Groundwater Protection Standard (max level between the MCL/RSL and UTL). LCL = lower confidence level. When the LCL > GWPS, a statistically significant exceedance is concluded. *Recent data are considered the 8 most recent data points collected for each well/analyte.
Trend classifications are based on Aziz (2003) guidance for Mann Kendall trend test results.
Trends not evaluated at locations with insufficient sample size of laboratory detection concentrations.

APPENDIX B
Field Forms

HALEY & ALDRICH

GROUNDWATER SAMPLING RECORD

Page 1 of 1

PROJECT	Vectren Culley	H&A FILE NO.	
LOCATION	Newburgh IN	PROJECT MGR.	
CLIENT	Vectren	FIELD REP	Hayley Tarin
CONTRACTOR	ATLAS	DATE	12-22-23

GROUNDWATER SAMPLING INFORMATION

Well No.		CCR-AP-1R					
Water Depth (ft)		53.83					
Time							
Product							
Depth Of Well (ft)							
Inside Diameter (in)		2					
Standing Water Depth (ft) [1]							
Volume Of Water In Well (gal)							
Purging Device		sleeve					
Volume of Bailer/Pump Capacity							
Cleaning Procedure							
Bails Removed/ Volume Removed							
Time Purging Started							
Time Purging Stopped							
Sampling Device							
Cleaning Procedure							
TIME SAMPLES TAKEN	VOA						
	ABN						
	Metals						
		Sample	12:25				
PARAMETERS	Time	12:25					
	DTW	53.83					
	pH	6.76					
	Conductivity	1.59 mS/cm					
	Turbidity	208					
	Dissolved Oxygen	11.72					
	Temp, ^{0}C	12.89					
	ORP	-45					

Remarks: (ie: field filtrations, persons communicated with at site, etc.)

1. Standing Water Depth = Depth of Well - Water Depth

Form 3005

CENTERPOINT ENERGY - FB CULLEY STATION
EAST ASH POND
CCR Groundwater Sampling Event
Gauging Date: May 6, 2024
Atlas Project No. 170LF01647

WELL ID	DATE	TIME	DTW FROM TOC
East Ash Pond Wells			
CCR-AP-2	5/6/2024	10:35	30.73
CCR-AP-3R	5/6/2024	13:30	37.12
CCR-AP-4R	5/6/2024	10:40	17.49
CCR-AP-5	5/6/2024	10:25	13.95
CCR-AP-5I	5/6/2024	10:26	12.29
CCR-AP-6	5/6/2024	13:40	38.75
CCR-AP-6I	5/6/2024	13:40	39.25
CCR-AP-8	5/6/2024	14:00	37.11
CCR-AP-8I	5/6/2024	14:00	28.82
CCR-AP-11	5/6/2024	10:30	14.95
Background Wells			
CCR-AP-1R	5/6/2024	10:10	44.46
CCR-AP-7	5/6/2024	10:00	4.65
CCR-AP-9	5/6/2024	10:15	59.91

NOTES
DTW= Depth to Water
TOC= Top of Casing

Low-Flow Test Report:

Test Date / Time: 5/7/2024 1:24:14 PM
Project: Culley East
Operator Name: Hayley Torres

Location Name: CCR-AP-6I **Well Diameter: 2 in** **Casing Type: Pvc** **Screen Length: 10 ft** **Top of Screen: 64.7 ft** **Total Depth: 74.7 ft** **Initial Depth to Water: 39.02 ft**	**Pump Type: Mp-50** **Pump Intake From TOC: 69.7 m** **Estimated Total Volume Pumped: 10260 ml** **Flow Cell Volume: 130 ml** **Final Flow Rate: 380 ml/min** **Final Draw Down: 0 ft**	**Instrument Used: Aqua TROLL 600** **Serial Number: 651925**

Test Notes:

Low-Flow Readings:

Date Time	Elapsed Time	pH	Temperature	Specific Conductivity	RDO Concentration	Turbidity	ORP	Depth to Water	Flow
		+/- 0.1	+/- 3 %	+/- 3 %	+/- 10 %	+/- 10 %	+/- 10	+/- 5	
5/7/2024 1:24 PM	00:00	7.48 pH	18.54 °C	3,396.7 µS/cm	6.75 mg/L	1.86 NTU	241.1 mV	39.02 ft	380.00 ml/min
5/7/2024 1:27 PM	03:00	7.32 pH	18.19 °C	1,691.0 µS/cm	0.47 mg/L	6.64 NTU	-39.5 mV	39.02 ft	380.00 ml/min
5/7/2024 1:30 PM	06:00	7.30 pH	18.13 °C	1,587.9 µS/cm	0.27 mg/L	6.12 NTU	-54.7 mV	39.02 ft	380.00 ml/min
5/7/2024 1:33 PM	09:00	7.31 pH	18.16 °C	1,559.1 µS/cm	0.21 mg/L	8.17 NTU	-63.0 mV	39.02 ft	380.00 ml/min
5/7/2024 1:36 PM	12:00	7.33 pH	18.18 °C	1,563.2 µS/cm	0.18 mg/L	5.30 NTU	-69.0 mV	39.02 ft	380.00 ml/min
5/7/2024 1:39 PM	15:00	7.34 pH	18.17 °C	1,570.0 µS/cm	0.17 mg/L	4.14 NTU	-73.7 mV	39.02 ft	380.00 ml/min
5/7/2024 1:42 PM	18:00	7.35 pH	18.14 °C	1,581.9 µS/cm	0.16 mg/L	1.52 NTU	-76.8 mV	39.02 ft	380.00 ml/min
5/7/2024 1:45 PM	21:00	7.36 pH	18.15 °C	1,621.2 µS/cm	0.15 mg/L	1.55 NTU	-78.1 mV	39.02 ft	380.00 ml/min
5/7/2024 1:48 PM	24:00	7.36 pH	18.23 °C	1,631.3 µS/cm	0.15 mg/L	1.44 NTU	-78.2 mV	39.02 ft	380.00 ml/min
5/7/2024 1:51 PM	27:00	7.37 pH	18.20 °C	1,637.3 µS/cm	0.15 mg/L	1.18 NTU	-78.3 mV	39.02 ft	380.00 ml/min

Samples

Sample ID:	Description:

Low-Flow Test Report:

Test Date / Time: 5/10/2024 11:20:07 AM
Project: Culley East (2)
Operator Name: Hayley Torres

Location Name: CCR-AP-7 **Well Diameter: 2 in** **Casing Type: Pvc** **Screen Length: 10 ft** **Top of Screen: 20 ft** **Total Depth: 30 ft** **Initial Depth to Water: 4.30 ft**	**Pump Type: Mp-50** **Pump Intake From TOC: 25 ft** **Estimated Total Volume Pumped: 1221.25 ml** **Flow Cell Volume: 130 ml** **Final Flow Rate: 25 ml/min** **Final Draw Down: 1.05 ft**	**Instrument Used: Aqua TROLL 600** **Serial Number: 651925**

Test Notes:

Low-Flow Readings:

Date Time	Elapsed Time	pH	Temperature	Specific Conductivity	RDO Concentration	Turbidity	ORP	Depth to Water	Flow
		+/- 0.1	+/- 3 %	+/- 3 %	+/- 10 %	+/- 10 %	+/- 10	+/- 5	
5/10/2024 11:20 AM	00:00	7.00 pH	19.18 °C	1,056.6 µS/cm	4.74 mg/L	66.84 NTU	157.9 mV	4.30 ft	25.00 ml/min
5/10/2024 11:23 AM	03:00	6.99 pH	18.83 °C	1,063.3 µS/cm	3.87 mg/L	44.60 NTU	153.3 mV		25.00 ml/min
5/10/2024 11:26 AM	06:00	6.98 pH	18.81 °C	1,076.7 µS/cm	3.46 mg/L	43.47 NTU	149.2 mV		25.00 ml/min
5/10/2024 11:26 AM	06:51	6.97 pH	18.88 °C	1,078.4 µS/cm	3.36 mg/L	35.10 NTU	148.3 mV		25.00 ml/min
5/10/2024 11:29 AM	09:51	6.97 pH	18.48 °C	1,077.8 µS/cm	3.15 mg/L	52.53 NTU	144.6 mV	4.53 ft	25.00 ml/min
5/10/2024 11:32 AM	12:51	6.97 pH	18.25 °C	1,073.9 µS/cm	3.01 mg/L	65.32 NTU	141.0 mV		25.00 ml/min
5/10/2024 11:35 AM	15:51	6.96 pH	18.69 °C	1,087.4 µS/cm	2.91 mg/L	84.98 NTU	136.2 mV		25.00 ml/min
5/10/2024 11:38 AM	18:51	6.96 pH	19.14 °C	1,092.0 µS/cm	2.81 mg/L	110.98 NTU	132.2 mV		25.00 ml/min
5/10/2024 11:41 AM	21:51	6.96 pH	18.86 °C	1,072.3 µS/cm	3.01 mg/L	27.95 NTU	127.0 mV		25.00 ml/min
5/10/2024 11:44 AM	24:51	6.96 pH	18.75 °C	1,070.2 µS/cm	2.81 mg/L	22.61 NTU	122.0 mV		25.00 ml/min
5/10/2024 11:47 AM	27:51	6.95 pH	19.24 °C	1,067.7 µS/cm	2.69 mg/L	30.75 NTU	118.3 mV	4.81 ft	25.00 ml/min
5/10/2024 11:50 AM	30:51	6.94 pH	18.61 °C	1,084.2 µS/cm	2.71 mg/L	52.52 NTU	113.7 mV		25.00 ml/min
5/10/2024 11:53 AM	33:51	6.95 pH	17.87 °C	1,075.5 µS/cm	3.34 mg/L	19.81 NTU	111.5 mV		25.00 ml/min
5/10/2024 11:56 AM	36:51	6.95 pH	18.03 °C	1,079.4 µS/cm	2.89 mg/L	23.27 NTU	99.1 mV		25.00 ml/min
5/10/2024 11:59 AM	39:51	6.95 pH	17.69 °C	1,071.0 µS/cm	2.81 mg/L	22.64 NTU	78.2 mV		25.00 ml/min
5/10/2024 12:02 PM	42:51	6.96 pH	18.24 °C	1,081.4 µS/cm	2.79 mg/L	26.44 NTU	62.7 mV		25.00 ml/min

5/10/2024 12:05 PM	45:51	6.96 pH	18.17 °C	1,071.6 µS/cm	2.72 mg/L	28.84 NTU	60.0 mV		25.00 ml/min
5/10/2024 12:08 PM	48:51	6.96 pH	18.49 °C	1,075.0 µS/cm	2.72 mg/L	39.15 NTU	58.3 mV	5.35 ft	25.00 ml/min

Samples

Sample ID:	Description:

Created using VuSitu from In-Situ, Inc.

Low-Flow Test Report:

Test Date / Time: 5/8/2024 11:39:13 AM
Project: Culley - East AP-8I 5-8-24
Operator Name: Mykah Bertram

Location Name: CCR-AP-8I **Latitude: 37.90845038** **Longitude: -87.322731** **Well Diameter: 2 in** **Casing Type: Pvc** **Screen Length: 10 ft** **Top of Screen: 58.7 ft** **Total Depth: 68.7 ft** **Initial Depth to Water: 37.09 ft**	**Pump Type: Bladder** **Pump Intake From TOC: 63.7 ft** **Estimated Total Volume Pumped: 10200 ml** **Flow Cell Volume: 130 ml** **Final Flow Rate: 200 ml/min** **Final Draw Down: 0.01 ft**	**Instrument Used: Aqua TROLL 600** **Serial Number: 651965**

Test Notes:

Low-Flow Readings:

Date Time	Elapsed Time	pH	Temperature	Specific Conductivity	RDO Concentration	Turbidity	ORP	Depth to Water	Flow
		+/- 0.1	+/- 3 %	+/- 3 %	+/- 10 %	+/- 10 %	+/- 10	+/- 5	
5/8/2024 11:39 AM	00:00	5.63 pH	19.40 °C	2,740.3 µS/cm	6.51 mg/L	74.55 NTU	-144.0 mV	37.09 ft	200.00 ml/min
5/8/2024 11:42 AM	03:00	5.65 pH	19.26 °C	2,766.1 µS/cm	6.82 mg/L	76.23 NTU	-143.6 mV	37.10 ft	200.00 ml/min
5/8/2024 11:45 AM	06:00	5.66 pH	19.51 °C	2,796.3 µS/cm	6.77 mg/L	76.90 NTU	-143.6 mV	37.11 ft	200.00 ml/min
5/8/2024 11:48 AM	09:00	5.66 pH	19.32 °C	2,820.1 µS/cm	6.84 mg/L	79.30 NTU	-142.9 mV	37.10 ft	200.00 ml/min
5/8/2024 11:51 AM	12:00	5.65 pH	19.59 °C	2,844.0 µS/cm	6.55 mg/L	76.47 NTU	-142.5 mV	37.09 ft	200.00 ml/min
5/8/2024 11:54 AM	15:00	5.65 pH	19.36 °C	2,884.2 µS/cm	6.71 mg/L	76.87 NTU	-141.9 mV	37.08 ft	200.00 ml/min
5/8/2024 11:57 AM	18:00	5.65 pH	19.66 °C	2,897.0 µS/cm	6.77 mg/L	80.21 NTU	-141.4 mV	37.08 ft	200.00 ml/min
5/8/2024 12:00 PM	21:00	5.66 pH	19.43 °C	2,917.8 µS/cm	6.68 mg/L	75.99 NTU	-141.3 mV	37.08 ft	200.00 ml/min
5/8/2024 12:03 PM	24:00	5.65 pH	19.56 °C	2,936.2 µS/cm	6.45 mg/L	81.82 NTU	-140.8 mV	37.09 ft	200.00 ml/min
5/8/2024 12:06 PM	27:00	5.66 pH	19.34 °C	2,946.7 µS/cm	6.75 mg/L	84.13 NTU	-140.4 mV	37.09 ft	200.00 ml/min
5/8/2024 12:09 PM	30:00	5.65 pH	19.54 °C	2,962.3 µS/cm	6.59 mg/L	93.12 NTU	-139.7 mV	37.09 ft	200.00 ml/min
5/8/2024 12:12 PM	33:00	5.67 pH	19.49 °C	2,971.8 µS/cm	6.63 mg/L	91.81 NTU	-139.1 mV	37.10 ft	200.00 ml/min
5/8/2024 12:15 PM	36:00	5.66 pH	19.50 °C	2,982.5 µS/cm	6.52 mg/L	86.54 NTU	-138.8 mV	37.10 ft	200.00 ml/min
5/8/2024 12:18 PM	39:00	5.67 pH	19.55 °C	2,988.7 µS/cm	6.47 mg/L	94.23 NTU	-138.7 mV	37.11 ft	200.00 ml/min
5/8/2024 12:21 PM	42:00	5.67 pH	19.48 °C	2,997.1 µS/cm	6.61 mg/L	87.89 NTU	-138.0 mV	37.11 ft	200.00 ml/min

5/8/2024 12:24 PM	45:00	5.67 pH	19.57 °C	3,004.9 µS/cm	6.40 mg/L	82.25 NTU	-137.4 mV	37.13 ft	200.00 ml/min
5/8/2024 12:27 PM	48:00	5.67 pH	19.46 °C	3,007.6 µS/cm	6.53 mg/L	82.50 NTU	-137.2 mV	37.13 ft	200.00 ml/min
5/8/2024 12:30 PM	51:00	5.68 pH	19.72 °C	3,012.5 µS/cm	6.70 mg/L	91.67 NTU	-140.1 mV	37.10 ft	200.00 ml/min

Samples

Sample ID:	Description:

Created using VuSitu from In-Situ, Inc.

Low-Flow Test Report:

Test Date / Time: 5/10/2024 2:27:37 PM
Project: Culley East (3)
Operator Name: Hayley Torres

Location Name: CCR-AP-11 **Well Diameter: 2 in** **Casing Type: Pvc** **Screen Length: 10 ft** **Top of Screen: 44.4 ft** **Total Depth: 54.4 ft** **Initial Depth to Water: 15.22 ft**	**Pump Type: Mp-50** **Pump Intake From TOC: 49.4 ft** **Estimated Total Volume Pumped: 1050 ml** **Flow Cell Volume: 130 ml** **Final Flow Rate: 25 ml/min** **Final Draw Down: 0.36 ft**	**Instrument Used: Aqua TROLL 600** **Serial Number: 651925**

Test Notes:

Low-Flow Readings:

Date Time	Elapsed Time	pH	Temperature	Specific Conductivity	RDO Concentration	Turbidity	ORP	Depth to Water	Flow
		+/- 0.1	+/- 3 %	+/- 3 %	+/- 10 %	+/- 10 %	+/- 10	+/- 5	
5/10/2024 2:27 PM	00:00	6.34 pH	19.24 °C	1,360.1 µS/cm	1.37 mg/L	336.45 NTU	-29.6 mV	15.22 ft	25.00 ml/min
5/10/2024 2:30 PM	03:00	6.33 pH	19.29 °C	1,359.2 µS/cm	1.04 mg/L	290.56 NTU	-27.8 mV		25.00 ml/min
5/10/2024 2:33 PM	06:00	6.33 pH	19.30 °C	1,348.3 µS/cm	0.92 mg/L	265.67 NTU	-27.3 mV		25.00 ml/min
5/10/2024 2:36 PM	09:00	6.32 pH	19.33 °C	1,360.6 µS/cm	0.89 mg/L	215.56 NTU	-26.9 mV		25.00 ml/min
5/10/2024 2:39 PM	12:00	6.31 pH	20.59 °C	1,338.6 µS/cm	0.83 mg/L	213.22 NTU	-28.8 mV	15.58 ft	25.00 ml/min
5/10/2024 2:42 PM	15:00	6.30 pH	21.82 °C	1,345.6 µS/cm	0.73 mg/L	199.96 NTU	-29.5 mV		25.00 ml/min
5/10/2024 2:45 PM	18:00	6.29 pH	22.24 °C	1,354.6 µS/cm	0.64 mg/L	161.26 NTU	-29.2 mV		25.00 ml/min
5/10/2024 2:48 PM	21:00	6.29 pH	21.67 °C	1,339.1 µS/cm	0.59 mg/L	117.67 NTU	-27.9 mV		25.00 ml/min
5/10/2024 2:51 PM	24:00	6.28 pH	22.22 °C	1,352.2 µS/cm	0.55 mg/L	101.81 NTU	-28.0 mV		25.00 ml/min
5/10/2024 2:54 PM	27:00	6.28 pH	22.25 °C	1,358.1 µS/cm	0.50 mg/L	96.22 NTU	-28.1 mV		25.00 ml/min
5/10/2024 2:57 PM	30:00	6.27 pH	22.39 °C	1,353.3 µS/cm	0.46 mg/L	89.89 NTU	-27.8 mV		25.00 ml/min
5/10/2024 3:00 PM	33:00	6.27 pH	22.57 °C	1,347.1 µS/cm	0.43 mg/L	91.46 NTU	-27.8 mV		25.00 ml/min
5/10/2024 3:03 PM	36:00	6.27 pH	22.95 °C	1,367.1 µS/cm	0.41 mg/L	72.80 NTU	-27.9 mV		25.00 ml/min
5/10/2024 3:06 PM	39:00	6.26 pH	21.58 °C	1,361.7 µS/cm	0.39 mg/L	75.78 NTU	-26.0 mV		25.00 ml/min
5/10/2024 3:09 PM	42:00	6.26 pH	21.43 °C	1,336.8 µS/cm	0.36 mg/L	88.40 NTU	-24.8 mV		25.00 ml/min

Samples

Sample ID:	Description:

LOW FLOW SAMPLING FORM

PROJECT	F.B. Culley Generating Station - East Ash Pond	H&A FILE NO.	0129420
LOCATION	Newburgh, Indiana	PROJECT MGR.	Neal Kochis
CLIENT	Southern Indiana Gas and Electric Company	FIELD REP.	Hayley T
CONTRACTOR	Atlas	SAMPLING DATE	5-8-24

Sampling Data:		Well Depth as Built:	65.0 ft	Well Diameter:	2.0 in	Sampling Device:	Hydrasleeve
Well ID:	CCR-AP-1R	Well Depth Measured:	ft	Initial Depth To Water:	44.46 ft	Field Parameter Device:	
Start time:		Depth To Top Of Screen:	55.0 ft	Depth Of Pump Intake:	ft	Tubing Present In Well:	☐ Yes ☒ No
Finish Time:	11:20	Depth To Bottom Of Scree	65.0 ft	Measuring Point:	Top of Casing (TOC)	Tubing Type:	Polyethylene

Elapsed Time (24 hour)	Depth To Water From Casing (ft)	Pump Setting (ml/min) or (gal/min)	Purge Rate (ml/min) or (gal/min)	Cumulative Purge Vol. (liters) or (gal)	Temp-erature (°F) or (°C)	pH	Conduct-ivity (µS/cm)	Dissolved Oxygen (mg/L)	Turbidity (NTU)	ORP/eH (mv)	Comments
Stabilized within →		[100 mL/min] to [500 mL/min]		-	NA	[+/- 0.1]	[+/- 3%]	[+/- 10%]	[+/- 10%]	[+/- 10]	
0	44.46				19.29	7.50	647.58	5.36	351	1030	

LOW FLOW SAMPLING FORM

PROJECT	F.B. Culley Generating Station - East Ash Pond	H&A FILE NO.	0129420
LOCATION	Newburgh, Indiana	PROJECT MGR.	Neal Kochis
CLIENT	Southern Indiana Gas and Electric Company	FIELD REP.	Hayley T
CONTRACTOR	Atlas	SAMPLING DATE	5-8-24

Sampling Data:		Well Depth as Built:	46.0 ft	Well Diameter:	2.0 in	Sampling Device:	Hydrasleeve
Well ID:	CCR-AP-2	Well Depth Measured:	ft	Initial Depth To Water:	30.73 ft	Field Parameter Device:	
Start time:		Depth To Top Of Screen:	36.0 ft	Depth Of Pump Intake:	ft	Tubing Present In Well:	☐ Yes ☒ No
Finish Time:	10:20	Depth To Bottom Of Scree	46.0 ft	Measuring Point:	Top of Casing (TOC)	Tubing Type:	Polyethylene

Elapsed Time (24 hour)	Depth To Water From Casing (ft)	Pump Setting (ml/min) or (gal/min)	Purge Rate (ml/min) or (gal/min)	Cumulative Purge Vol. (liters) or (gal)	Temp-erature (°F) or (°C)	pH mV pH	Conduct-ivity (µS/cm)	Dissolved Oxygen (mg/L)	Turbidity (NTU)	ORP/eH (mv)	Comments
Stabilized within →		[100 mL/min] to [500 mL/min]		-	NA	[+/- 0.1]	[+/- 3%]	[+/- 10%]	[+/- 10%]	[+/- 10]	
0	30.73				18.11	8.98	2201	4.54	9503	71.6	actual pH cut off
Sample ID:	CCR-AP-2			Date:	5-8-24	Time:	10:20	QAQC Samples:			

well volume = 3.14 (PI) x radius² x height of water column. 2 in well = 0.163 gal/ft, 3 in = 0.367 gal/ft 4 in = 0.653 gal/ft, 6 in = 1.469 gal/ft, 1 cu. ft. = 7.48 gal, 1 gal = 3.785 L, 1L = 0.264 gal, 0.5L/min = 0.132 gal/min

LOW FLOW SAMPLING FORM

HALEY ALDRICH

Page 1 of 1

PROJECT	F.B. Culley Generating Station - East Ash Pond	H&A FILE NO.	0129420
LOCATION	Newburgh, Indiana	PROJECT MGR.	Neal Kochis
CLIENT	Southern Indiana Gas and Electric Company	FIELD REP.	Hayley T
CONTRACTOR	Atlas	SAMPLING DATE	5-7-24

Sampling Data:		Well Depth as Built:	45.0 ft	Well Diameter:	2.0 in	Sampling Device:	Hydrasleeve
Well ID:	CCR-AP-3	Well Depth Measured:	ft	Initial Depth To Water:	37.12 ft	Field Parameter Device:	
Start time:		Depth To Top Of Screen:	35.0 ft	Depth Of Pump Intake:	ft	Tubing Present In Well:	☐ Yes ☒ No
Finish Time:	1400	Depth To Bottom Of Scree	45.0 ft	Measuring Point:	Top of Casing (TOC)	Tubing Type:	Polyethylene

Elapsed Time (24 hour)	Depth To Water From Casing (ft)	Pump Setting (ml/min) or (gal/min)	Purge Rate (ml/min) or (gal/min)	Cumulative Purge Vol. (liters) or (gal)	Temp-erature (°F) or (°C)	pH	Conduct-ivity µS/cm	Dissolved Oxygen (mg/L)	Turbidity (NTU)	ORP/eH (mv)	Comments
Stabilized within →		[100 mL/min] to [500 mL/min]		-	NA	[+/- 0.1]	[+/- 3%]	[+/- 10%]	[+/- 10%]	[+/- 10]	
0	37.12				20.93	6.84	~~1583~~ 1582	5.07	138	-125.8	

LOW FLOW SAMPLING FORM

HALEY ALDRICH

PROJECT	F.B. Culley Generating Station - East Ash Pond	H&A FILE NO.	0129420
LOCATION	Newburgh, Indiana	PROJECT MGR.	Neal Kochis
CLIENT	Southern Indiana Gas and Electric Company	FIELD REP.	Hayley Tolles
CONTRACTOR	Atlas	SAMPLING DATE	5-8-24

Sampling Data:		Well Depth as Built:	35.5 ft	Well Diameter:	2.0 in	Sampling Device:	Hydrasleeve
Well ID:	CCR-AP-4	Well Depth Measured:	ft	Initial Depth To Water:	17.49 ft	Field Parameter Device:	
Start time:		Depth To Top Of Screen:	25.5 ft	Depth Of Pump Intake:	ft	Tubing Present In Well:	☐ Yes ☒ No
Finish Time:	9:45	Depth To Bottom Of Scree	35.5 ft	Measuring Point:	Top of Casing (TOC)	Tubing Type:	Polyethylene

Elapsed Time (24 hour)	Depth To Water From Casing (ft)	Pump Setting (ml/min) or (gal/min)	Purge Rate (ml/min) or (gal/min)	Cumulative Purge Vol. (liters) or (gal)	Temp-erature (°F) or (°C)	pH	Conduct-ivity (µs/cm)	Dissolved Oxygen (mg/L)	Turbidity (NTU)	ORP/eH (mv)	Comments
Stabilized within →		[100 mL/min] to [500 mL/min]		-	NA	[+/- 0.1]	[+/- 3%]	[+/- 10%]	[+/- 10%]	[+/- 10]	
0	17.49				18.22	6.83	1261	4.85	30	-120.2	Only 1 1-L collected

LOW FLOW SAMPLING FORM

HALEY ALDRICH

Page 1 of 1

PROJECT	F.B. Culley Generating Station - East Ash Pond	H&A FILE NO.	0129420
LOCATION	Newburgh, Indiana	PROJECT MGR.	Neal Kochis
CLIENT	Southern Indiana Gas and Electric Company	FIELD REP.	Hayley T
CONTRACTOR	Atlas	SAMPLING DATE	5-14-24

Sampling Data:

Well ID:	CCR-AP-5	Well Depth as Built:	44.0 ft	Well Diameter:	2.0 in	Sampling Device:	Bladder Pump
Start time:	14:24	Well Depth Measured:	ft	Initial Depth To Water:	11.99 ft	Field Parameter Device:	
Finish Time:		Depth To Top Of Screen:	34.0 ft	Depth Of Pump Intake:	39 ft	Tubing Present In Well:	☐ Yes ☒ No
		Depth To Bottom Of Scree	44.0 ft	Measuring Point:	Top of Casing (TOC)	Tubing Type:	Polyethylene

Elapsed Time (24 hour)	Depth To Water From Casing (ft)	Pump Setting (ml/min) or (gal/min)	Purge Rate (ml/min) or (gal/min)	Cumulative Purge Vol. (liters) or (gal)	Temp-erature (°F) or (°C)	pH	Conduct-ivity (µS/cm)	Dissolved Oxygen (mg/L)	Turbidity (NTU)	ORP/eH (mv)	Comments
Stabilized within →		[100 mL/min] to [500 mL/min]		-	NA	[+/- 0.1]	[+/- 3%]	[+/- 10%]	[+/- 10%]	[+/- 10]	
0	11.99		160		18.31	7.11	2281	4.5	72	300.5	5-13 Purged 1 WV = 3.42 gal purged 12:15 - 13:15 5gal/3min 100gal purged then sampled Dup 1 Taken
3											
6											
9											
12											
15											
18											

Sample ID:	CCR-AP-5	Date:	5-13-24	Time:	13:17	QAQC Samples:	DUP-1

well volume = 3.14 (PI) x radius² x height of water column. 2 in well = 0.163 gal/ft, 3 in = 0.367 gal/ft 4 in = 0.653 gal/ft, 6 in = 1.469 gal/ft, 1 cu. ft. = 7.48 gal, 1 gal = 3.785 L, 1L = 0.264 gal, 0.5L/min = 0.132 gal/min

LOW FLOW SAMPLING FORM

PROJECT	F.B. Culley Generating Station - East Ash Pond	H&A FILE NO.	0129420
LOCATION	Newburgh, Indiana	PROJECT MGR.	Neal Kochis
CLIENT	Southern Indiana Gas and Electric Company	FIELD REP.	Hayley Tolley
CONTRACTOR	Atlas	SAMPLING DATE	5-11-2024

Sampling Data:		Well Depth as Built:	85.3 ft	Well Diameter:	2.0 in	Sampling Device:	Bladder Pump
Well ID:	CCR-AP-5I	Well Depth Measured:	ft	Initial Depth To Water:	13.78 ft	Field Parameter Device:	
Start time:	12:00	Depth To Top Of Screen:	75.3 ft	Depth Of Pump Intake:	80.5 ft	Tubing Present In Well:	☒ Yes ☐ No
Finish Time:	13:36	Depth To Bottom Of Scree	85.3 ft	Measuring Point:	Top of Casing (TOC)	Tubing Type:	Polyethylene

Elapsed Time (24 hour)	Depth To Water From Casing (ft)	Pump Setting (ml/min) or (gal/min)	Purge Rate (ml/min) or (gal/min)	Cumulative Purge Vol. (liters) or (gal)	Temp-erature (°F) or (°C)	pH	Conduct-ivity (µS/cm)	Dissolved Oxygen (mg/L)	Turbidity (NTU)	ORP/eH (mv)	Comments
Stabilized within →		[100 mL/min] to [500 mL/min]		-	NA	[+/- 0.1]	[+/- 3%]	[+/- 10%]	[+/- 10%]	[+/- 10]	
0	13.78		60	5760mL	20.26	6.74	2671	0.77	265	306.2	5/11 ~~Dup 1 Taken~~ Sampling ruined by nearby construction equipment shaking ground
3					20.88	6.72	~~2683~~	0.59	1728	45.2	
6					21.45	6.72	2691	0.57	1077	21.0	
9	13.71				19.66	6.76	2688	1.90	669	48.0	
12					19.29	6.73	2698	1.55	325	62.7	Purging 5-13
15					19.17	6.73	2700	1.53	170	69.5	1 wv = 11.65
18	13.84				19.49	6.72	2710	1.48	133	66.4	13:20 - 14:00
21					19.55	6.72	2711	1.38	124	55.7	5gal/3min
24					19.57	6.72	2714	1.33	115	47.5	purged 67 gal then sampled
27					19.59	6.72	2716	1.25	101	40.5	
30					19.61	6.71	2721	1.21	91	33.8	final data on page 3
33	13.85				19.61	6.71	2721	1.13	98	23.6	
36					19.54	6.71	2727	1.08	93	15.0	
39					19.56	6.71	2738	1.03	86	10.0	
42					19.47	6.71	2743	0.96	105	5.8	
45	13.89				19.48	6.71	2743	0.90	92	3.3	
48					19.51	6.71	2757	0.86	77	0.3	
51					19.45	6.71	2741	0.81	88	-2.5	
Sample ID:	CCR-AP-5I		Date:	5-11-24	Time:	14:30	QAQC Samples:				

well volume = 3.14 (PI) x radius² x height of water column. 2 in well = 0.163 gal/ft, 3 in = 0.367 gal/ft 4 in = 0.653 gal/ft, 6 in = 1.469 gal/ft, 1 cu. ft. = 7.48 gal, 1 gal = 3.785 L, 1L = 0.264 gal, 0.5L/min = 0.132 gal/min

Field Parameters

Well Number CCRAP-5I

	1	2	3	4	5	6	7
Time	54	57	60	63	66	69	72
PH (su)	6.71	6.71	6.71	6.71	6.71	6.71	6.71
Temp (C)	19.46	19.45	19.48	19.41	19.43	19.42	19.40
Conductivity	2731	2738	2720	2721	2711	2702	2679
D.O. (mg/L)	0.78	0.75	0.68	0.64	0.62	0.58	0.55
Turbidity (NTU)	90	80	88	95	95	92	88
ORP (mV)	-6.2	-9.7	-12.3	-16.0	-18.8	-22.0	-27.4
Water Lvl (DTW)	13.89			13.89			

Well Number

	1	2	3	4	5	6	7
Time	75	78	81	84	87	90	93
PH (su)	6.71	6.71	6.72	6.72	6.72	6.72	6.72
Temp (C)	19.45	19.33	19.33	19.50	19.39	19.39	19.37
Conductivity	2696	2693	2691	2722	2720	2726	2735
D.O. (mg/L)	0.51	0.51	0.48	0.57	0.49	0.42	0.40
Turbidity (NTU)	82	93	101	232	94	110	119
ORP (mV)	-27.9	-30.4	-32.4	-34.4	-35.8	-37.2	-38.3
Water Lvl (DTW)	13.89			13.89			13.89

Well Number

	1	2	3	4	5	6	7
Time	96						
PH (su)	6.72						
Temp (C)	19.36						
Conductivity	2741						
D.O. (mg/L)	0.39						
Turbidity (NTU)	95						
ORP (mV)	-38.6						
Water Lvl (DTW)							

Well Number

	1	2	3	4	5	6	7
Time							
PH (su)							
Temp (C)							
Conductivity							
D.O. (mg/L)							
Turbidity (NTU)							
ORP (mV)							
Water Lvl (DTW)							

LOW FLOW SAMPLING FORM

PROJECT	F.B. Culley Generating Station - East Ash Pond	H&A FILE NO.	0129420
LOCATION	Newburgh, Indiana	PROJECT MGR.	Neal Kochis
CLIENT	Southern Indiana Gas and Electric Company	FIELD REP.	Hayley T
CONTRACTOR	Atlas	SAMPLING DATE	5-13-24

Sampling Data:		Well Depth as Built:	85.3 ft	Well Diameter:	2.0 in	Sampling Device:	Bladder Pump
Well ID:	CCR-AP-5I	Well Depth Measured:	ft	Initial Depth To Water:	13.78 ft	Field Parameter Device:	
Start time:		Depth To Top Of Screen:	75.3 ft	Depth Of Pump Intake:	ft	Tubing Present In Well:	☒ Yes ☐ No
Finish Time:	14:02	Depth To Bottom Of Scree	85.3 ft	Measuring Point:	Top of Casing (TOC)	Tubing Type:	Polyethylene

Elapsed Time (24 hour)	Depth To Water From Casing (ft)	Pump Setting (ml/min) or (gal/min)	Purge Rate (ml/min) or (gal/min)	Cumulative Purge Vol. (liters) or (gal)	Temp-erature (°F) or (°C)	pH	Conduct-ivity (µS/cm)	Dissolved Oxygen (mg/L)	Turbidity (NTU)	ORP/eH (mv)	Comments
Stabilized within →		[100 mL/min] to [500 mL/min]		-	NA	[+/- 0.1]	[+/- 3%]	[+/- 10%]	[+/- 10%]	[+/- 10]	
0					18.21	6.72	2641	2.83	120	51.8	Final data purged for 40mins @ 5gal/3min 67 gal total
Sample ID:	CCR-AP-5I			Date:	5-13	Time:	~~14:02~~ 14:02	QAQC Samples:			

well volume = 3.14 (PI) x radius² x height of water column. 2 in well = 0.163 gal/ft, 3 in = 0.367 gal/ft 4 in = 0.653 gal/ft, 6 in = 1.469 gal/ft, 1 cu. ft. = 7.48 gal, 1 gal = 3.785 L, 1L = 0.264 gal, 0.5L/min = 0.132 gal/min

LOW FLOW SAMPLING FORM

HALEY ALDRICH

PROJECT	F.B. Culley Generating Station - East Ash Pond	H&A FILE NO.	0129420
LOCATION	Newburgh, Indiana	PROJECT MGR.	Neal Kochis
CLIENT	Southern Indiana Gas and Electric Company	FIELD REP.	Hayley T
CONTRACTOR	Atlas	SAMPLING DATE	5-7-24

Sampling Data:		Well Depth as Built:	45.5 ft	Well Diameter:	2.0 in	Sampling Device:	Hydrasleeve
Well ID:	CCR-AP-6	Well Depth Measured:	ft	Initial Depth To Water:	38.75 ft	Field Parameter Device:	
Start time:		Depth To Top Of Screen:	35.5 ft	Depth Of Pump Intake:	ft	Tubing Present In Well:	☐ Yes ☒ No
Finish Time:	13:30	Depth To Bottom Of Scree	45.5 ft	Measuring Point:	Top of Casing (TOC)	Tubing Type:	Polyethylene

Elapsed Time (24 hour)	Depth To Water From Casing (ft)	Pump Setting (ml/min) or (gal/min)	Purge Rate (ml/min) or (gal/min)	Cumulative Purge Vol. (liters) or (gal)	Temp-erature (°F) or (°C)	pH	Conduct-ivity µS/cm	Dissolved Oxygen (mg/L)	Turbidity (NTU)	ORP/eH (mv)	Comments
Stabilized within →		[100 mL/min] to [500 mL/min]		-	NA	[+/- 0.1]	[+/- 3%]	[+/- 10%]	[+/- 10%]	[+/- 10]	
0	38.75				14.79	7.19	1105	3.65	93	-146.7	
Sample ID:	CCR-AP-6		Date:	5-7-24	Time:	13:30	QAQC Samples:				

well volume = 3.14 (PI) x radius² x height of water column. 2 in well = 0.163 gal/ft, 3 in = 0.367 gal/ft 4 in = 0.653 gal/ft, 6 in = 1.469 gal/ft, 1 cu. ft. = 7.48 gal, 1 gal = 3.785 L, 1L = 0.264 gal, 0.5L/min = 0.132 gal/min

LOW FLOW SAMPLING FORM

PROJECT	F.B. Culley Generating Station - East Ash Pond	H&A FILE NO.	0129420
LOCATION	Newburgh, Indiana	PROJECT MGR.	Neal Kochis
CLIENT	Southern Indiana Gas and Electric Company	FIELD REP.	Mayling T
CONTRACTOR	Atlas	SAMPLING DATE	5-7-24

Sampling Data:		Well Depth as Built:	74.7 ft	Well Diameter:	2.0 in	Sampling Device:	Bladder Pump
Well ID:	CCR-AP-6I	Well Depth Measured:	ft	Initial Depth To Water:	39.02 ft	Field Parameter Device:	
Start time:	12:24	Depth To Top Of Screen:	64.7 ft	Depth Of Pump Intake:	69.7 ft	Tubing Present In Well:	☒ Yes ☐ No
Finish Time:	12:51	Depth To Bottom Of Scree	74.7 ft	Measuring Point:	Top of Casing (TOC)	Tubing Type:	Polyethylene

Elapsed Time (24 hour)	Depth To Water From Casing (ft)	Pump Setting (ml/min) or (gal/min)	Purge Rate (ml/min) or (gal/min)	Cumulative Purge Vol. (liters) or (gal)	Temp-erature (°F) or (°C)	pH	Conduct-ivity µS (µs/cm)	Dissolved Oxygen (mg/L)	Turbidity (NTU)	ORP/eH (mv)	Comments
Stabilized within →		[100 mL/min] to [500 mL/min]		-	NA	[+/- 0.1]	[+/- 3%]	[+/- 10%]	[+/- 10%]	[+/- 10]	
12:24	39.02	[illegible]	380		18.54	7.48	3396	6.75	1.86	241.1	
12:27	39.02				18.49	7.32	1694	0.47	6.64	-39.5	
12:30	39.02				18.13	7.30	1587	0.27	6.1	-54.7	
12:33	39.02				18.16	7.31	1559	0.21	8.1	-63.0	
12:36	39.02				18.18	7.33	1563	0.18	5.3	-69.0	
12:39	39.02				18.17	7.34	1570	0.17	4.1	-73.7	
12:42	39.02				18.14	7.35	1581	0.16	1.5	-76.8	
12:45	39.02				18.15	7.36	1621	0.15	1.5	-78.1	
12:48	39.02				18.23	7.36	1631	0.15	1.4	-78.2	
12:51	39.02			10260	18.20	7.367	1637	0.15	1.1	-78.3	
Sample ID:	CCR-AP-6I			Date:	5-7-24	Time:	13:15	QAQC Samples:			

well volume = 3.14 (PI) x radius² x height of water column. 2 in well = 0.163 gal/ft, 3 in = 0.367 gal/ft 4 in = 0.653 gal/ft, 6 in = 1.469 gal/ft, 1 cu. ft. = 7.48 gal, 1 gal = 3.785 L, 1L = 0.264 gal, 0.5L/min = 0.132 gal/min

LOW FLOW SAMPLING FORM

HALEY ALDRICH

Page 1 of 1

PROJECT	F.B. Culley Generating Station - East Ash Pond	H&A FILE NO.	0129420
LOCATION	Newburgh, Indiana	PROJECT MGR.	Neal Kochis
CLIENT	Southern Indiana Gas and Electric Company	FIELD REP.	Hayley Boller
CONTRACTOR	Atlas	SAMPLING DATE	5-10-2024

Sampling Data:		Well Depth as Built:	30.0 ft	Well Diameter:	2.0 in	Sampling Device:	Bladder Pump
Well ID:	CCR-AP-7	Well Depth Measured:	ft	Initial Depth To Water:	4.30 ft	Field Parameter Device:	
Start time:	10:20	Depth To Top Of Screen:	20.0 ft	Depth Of Pump Intake:	25 ft	Tubing Present In Well:	☐ Yes ☒ No
Finish Time:	11:08	Depth To Bottom Of Scree	30.0 ft	Measuring Point:	Top of Casing (TOC)	Tubing Type:	Polyethylene

Elapsed Time (24 hour)	Depth To Water From Casing (ft)	Pump Setting (ml/min) or (gal/min)	Purge Rate (ml/min) or (gal/min)	Cumulative Purge Vol. (liters) or (gal)	Temp-erature (°F) or (°C)	pH	Conduct-ivity (µS/cm or mS/cm)	Dissolved Oxygen (mg/L)	Turbidity (NTU)	ORP/eH (mv)	Comments
Stabilized within →		[100 mL/min] to [500 mL/min]		-	NA	[+/- 0.1]	[+/- 3%]	[+/- 10%]	[+/- 10%]	[+/- 10]	
0	4.30		25mL	1221mL	19.18	7.0	1056	4.74	66	157.9	
3					18.83	6.99	1063	3.87	44	153.3	
6					18.81	6.98	1076	3.46	43	149.2	
7					18.88	6.97	1078	3.36	44	148.3	← Ipad froze?
10	4.53				18.48	6.97	1077	3.15	52	144.6	
13					18.25	6.97	1073	3.01	65	141.0	
16					18.69	6.96	1087	2.91	84	136.2	
19					19.14	6.96	1092	2.81	110	132.2	
22					18.86	6.96	1072	3.01	27	127.0	
25					18.75	6.96	1070	2.81	22	122.0	
28	4.81				19.24	6.95	1067	2.69	30	118.7	
31					18.61	6.94	1084	2.71	52	113.7	
34					17.87	6.95	1075	3.34	19	111.5	
37					18.03	6.95	1079	2.89	23	99.1	
40					17.69	6.95	1071	2.81	22	78.2	
43					18.24	6.96	1081	2.79	26	62.7	
46	5.35				18.49	6.96	1075	2.72	34	58.3	
Sample ID:	CCR-AP-7			Date:	5-10-24	Time:	12:00	QAQC Samples:			

well volume = 3.14 (PI) x radius² x height of water column. 2 in well = 0.163 gal/ft, 3 in = 0.367 gal/ft 4 in = 0.653 gal/ft, 6 in = 1.469 gal/ft, 1 cu. ft. = 7.48 gal, 1 gal = 3.785 L, 1L = 0.264 gal, 0.5L/min = 0.132 gal/min

LOW FLOW SAMPLING FORM

Page | of

PROJECT	F.B. Culley Generating Station - East Ash Pond	H&A FILE NO.	0129420
LOCATION	Newburgh, Indiana	PROJECT MGR.	Neal Kochis
CLIENT	Southern Indiana Gas and Electric Company	FIELD REP.	Hayley D
CONTRACTOR	Atlas	SAMPLING DATE	5-10-24

Sampling Data:

Well ID:	CCR-AP-8	Well Depth as Built:	45.5 ft	Well Diameter:	2.0 in	Sampling Device:	Bladder Pump
Start time:		Well Depth Measured:	ft	Initial Depth To Water:	36.42 ft	Field Parameter Device:	
Finish Time:	15:30	Depth To Top Of Screen:	35.5 ft	Depth Of Pump Intake:	40.5 ft	Tubing Present In Well:	☐ Yes ☒ No
		Depth To Bottom Of Scree	45.5 ft	Measuring Point:	Top of Casing (TOC)	Tubing Type:	Polyethylene

Elapsed Time (24 hour)	Depth To Water From Casing (ft)	Pump Setting (ml/min) or (gal/min)	Purge Rate (ml/min) or (gal/min)	Cumulative Purge Vol. (liters) or (gal)	Temp-erature (°F) or (°C)	pH	Conduct-ivity µS (mS/cm)	Dissolved Oxygen (mg/L)	Turbidity (NTU)	ORP/eH (mv)	Comments
Stabilized within →		[100 mL/min] to [500 mL/min]		-	NA	[+/- 0.1]	[+/- 3%]	[+/- 10%]	[+/- 10%]	[+/- 10]	
0	36.42				18.56	6.90	1429	0.25	140	-76.3	

Sample ID:	CCR-AP-8	Date:	5-10-24	Time:	15:31	QAQC Samples:

well volume = 3.14 (PI) x radius² x height of water column. 2 in well = 0.163 gal/ft, 3 in = 0.367 gal/ft 4 in = 0.653 gal/ft, 6 in = 1.469 gal/ft, 1 cu. ft. = 7.48 gal, 1 gal = 3.785 l, 1L = 0.264 gal, 0.5l/min = 0.132 gal/min

LOW FLOW SAMPLING FORM

HALEY ALDRICH

PROJECT	F.B. Culley Generating Station - East Ash Pond	H&A FILE NO.	0129420
LOCATION	Newburgh, Indiana	PROJECT MGR.	Neal Kochis
CLIENT	Southern Indiana Gas and Electric Company	FIELD REP.	Mikah B
CONTRACTOR	Atlas	SAMPLING DATE	5-8-24

Sampling Data:		Well Depth as Built:	68.7 ft	Well Diameter:	2.0 in	Sampling Device:	Bladder Pump
Well ID:	CCR-AP-8I	Well Depth Measured:	ft	Initial Depth To Water:	37.09 ft	Field Parameter Device:	
Start time:	1039	Depth To Top Of Screen:	58.7 ft	Depth Of Pump Intake:	63.7 ft	Tubing Present In Well:	☐ Yes ☐ No
Finish Time:	1130	Depth To Bottom Of Scree	68.7 ft	Measuring Point:	Top of Casing (TOC)	Tubing Type:	Polyethylene

Elapsed Time (24 hour)	Depth To Water From Casing (ft)	Pump Setting ~~(ml/min)~~ or ~~(ml/min)~~ or (gal/min)	Purge Rate ~~(ml/min)~~ or ~~(ml/min)~~ or (gal/min)	Cumulative Purge Vol. (liters) or (gal)	Temp-erature (°F) or ~~(°C)~~	pH	Conduct-ivity µS (ms/cm)	Dissolved Oxygen (mg/L)	Turbidity (NTU)	ORP/eH (mv)	Comments
Stabilized within →		[100 mL/min] to [500 mL/min]		-	NA	[+/- 0.1]	[+/- 3%]	[+/- 10%]	[+/- 10%]	[+/- 10]	
1039	37.09	200mL	200mL	10200mL	19.40	5.63	2740.3	6.51	74.55	-144.0	
1042	37.10				19.26	5.65	2766.1	6.82	76.23	-143.6	
1045	37.11				19.61	5.66	2796.3	6.77	76.90	-143.6	
1048	37.10				19.32	5.66	2820.1	6.64	79.30	-142.9	
1051	37.09				19.59	5.65	2844.0	6.55	76.47	-142.5	
1054	37.08				19.36	5.65	2864.2	6.71	76.87	-141.9	
1057	37.08				19.66	5.65	2897.0	6.77	80.21	-141.4	
1100	37.08				19.43	5.66	2917.8	6.68	75.99	-141.3	
1103	37.09				19.56	5.65	2936.2	6.45	81.80	-140.8	
1106	37.09				19.34	5.66	2946.7	6.75	84.13	-140.4	
1109	37.09				19.54	5.65	2962.3	6.59	93.12	-139.7	
1112	37.10				19.49	5.67	2971.8	6.63	91.81	-139.1	
1115	37.10				19.50	5.66	2982.5	6.52	86.54	-138.8	
1118	37.11				19.55	5.67	2988.7	6.47	94.23	-138.7	
1121	37.11				19.48	5.67	2997.1	6.61	87.89	-138.0	
1124	37.13				19.59	5.67	3004.9	6.40	82.25	-137.4	
1127	37.13				19.46	5.67	3007.6	6.53	82.50	-137.2	
1130	37.10				19.72	5.68	3012.5	6.70	91.67	-140.1	
Sample ID:	CCR-AP-8I			Date:	5-8-24	Time:	11:40	QAQC Samples:			

well volume = 3.14 (PI) x radius² x height of water column. 2 in well = 0.163 gal/ft, 3 in = 0.367 gal/ft 4 in = 0.653 gal/ft, 6 in = 1.469 gal/ft, 1 cu. ft. = 7.48 gal, 1 gal = 3.785 L, 1L = 0.264 gal, 0.5L/min = 0.132 gal/min

LOW FLOW SAMPLING FORM

PROJECT	F.B. Culley Generating Station - East Ash Pond	H&A FILE NO.	0129420
LOCATION	Newburgh, Indiana	PROJECT MGR.	Neal Kochis
CLIENT	Southern Indiana Gas and Electric Company	FIELD REP.	Hayley Tolles
CONTRACTOR	Atlas	SAMPLING DATE	5-8-24

Sampling Data:		Well Depth as Built:	70.0 ft	Well Diameter:	2.0 in	Sampling Device:	Bladder Pump
Well ID:	CCR-AP-9	Well Depth Measured:	ft	Initial Depth To Water:	59.91 ft	Field Parameter Device:	
Start time:		Depth To Top Of Screen:	60.0 ft	Depth Of Pump Intake:	ft	Tubing Present In Well:	☐ Yes ☒ No
Finish Time:	12:00	Depth To Bottom Of Scree	70.0 ft	Measuring Point:	Top of Casing (TOC)	Tubing Type:	Polyethylene

Elapsed Time (24 hour)	Depth To Water From Casing (ft)	Pump Setting (ml/min) or (gal/min)	Purge Rate (ml/min) or (gal/min)	Cumulative Purge Vol. (liters) or (gal)	Temp-erature (°F) or (°C)	pH	Conduct-ivity (µS/cm)	Dissolved Oxygen (mg/L)	Turbidity (NTU)	ORP/eH (mv)	Comments
Stabilized within →		[100 mL/min] to [500 mL/min]		-	NA	[+/- 0.1]	[+/- 3%]	[+/- 10%]	[+/- 10%]	[+/- 10]	
0	59.91				18.21	6.98	1165	4.44	464	65.6	ONLY 1 1-L taken

Sample ID:	CCR-AP-9	Date:	5-8-24	Time:	12:00	QAQC Samples:	

well volume = 3.14 (PI) x radius² x height of water column. 2 in well = 0.163 gal/ft, 3 in = 0.367 gal/ft 4 in = 0.653 gal/ft, 6 in = 1.469 gal/ft, 1 cu. ft. = 7.48 gal, 1 gal = 3.785 L, 1L = 0.264 gal, 0.5L/min = 0.132 gal/min

LOW FLOW SAMPLING FORM

HALEY ALDRICH

PROJECT	F.B. Culley Generating Station - East Ash Pond	H&A FILE NO.	0129420
LOCATION	Newburgh, Indiana	PROJECT MGR.	Neal Kochis
CLIENT	Southern Indiana Gas and Electric Company	FIELD REP.	Hayley T
CONTRACTOR	Atlas	SAMPLING DATE	

Sampling Data:		Well Depth as Built:	54.4 ft	Well Diameter:	2.0 in	Sampling Device:	Bladder Pump
Well ID:	CCR-AP-11	Well Depth Measured:	ft	Initial Depth To Water:	15.22 ft	Field Parameter Device:	
Start time:	13:27	Depth To Top Of Screen:	44.4 ft	Depth Of Pump Intake:	49.4 ft	Tubing Present In Well:	☐ Yes ☒ No
Finish Time:	14:09	Depth To Bottom Of Scree	54.4 ft	Measuring Point:	Top of Casing (TOC)	Tubing Type:	Polyethylene

Elapsed Time (24 hour)	Depth To Water From Casing (ft)	Pump Setting (ml/min) or (gal/min)	Purge Rate (ml/min) or (gal/min)	Cumulative Purge Vol. (liters) or (gal)	Temp-erature (°F) or (°C)	pH	Conduct-ivity (µS/cm)	Dissolved Oxygen (mg/L)	Turbidity (NTU)	ORP/eH (mv)	Comments
Stabilized within →		[100 mL/min] to [500 mL/min]		-	NA	[+/- 0.1]	[+/- 3%]	[+/- 10%]	[+/- 10%]	[+/- 10]	
0	15.22		25	1050mL	19.24	6.34	1360	1.37	336	-29.6	
3					19.29	6.33	1359	1.04	290	-27.8	
6					19.30	6.33	1348	0.92	265	-27.3	
9					19.33	6.32	1360	0.89	215	-26.9	
12	15.58				20.59	6.31	1338	0.83	213	-28.8	
15					21.82	6.30	1345	0.73	199	-29.5	
18					22.24	6.29	1354	0.64	161	-29.2	
21					21.67	6.29	1339	0.59	117	-27.9	
24					22.22	6.28	1352	0.55	101	-28.0	
27					22.25	6.28	1358	0.50	96	-28.1	
30					22.39	6.27	1353	0.46	89	-27.8	
33					22.57	6.27	1347	0.43	91	-27.8	
36					22.95	6.27	1367	0.41	72	-27.9	
39					21.58	6.26	1361	0.39	75	-26.8	
42					21.43	6.26	1336	0.36	88	-27.8	

Sample ID:	CCR-AP-11	Date:	5-10-24	Time:	14:45	QAQC Samples:

well volume = 3.14 (PI) x radius² x height of water column. 2 in well = 0.163 gal/ft, 3 in = 0.367 gal/ft 4 in = 0.653 gal/ft, 6 in = 1.469 gal/ft, 1 cu. ft. = 7.48 gal, 1 gal = 3.785 L, 1L = 0.264 gal, 0.5L/min = 0.132 gal/min

CENTERPOINT ENERGY - FB CULLEY STATION
EAST ASH POND
CCR Groundwater Sampling Event
Gauging Date: November 11, 2024
Atlas Project No. 170LF01647

WELL ID	DATE	TIME	TOP OF CASING ELEVATION (FT-MSL)	DTW FROM TOC	STATIC WATER ELEVATION (FT-MSL)
East Ash Pond Wells					
CCR-AP-2	11/11/2024	16:31	394.02	39.60	354.42
CCR-AP-3R	Couldn't Locate/Not Gauged		394.55	-	-
CCR-AP-4R	11/11/2024	15:10	394.98	21.03	373.95
CCR-AP-5	11/11/2024	16:34	394.38	25.95	368.43
CCR-AP-5I	Damaged Pad, Cant Gauge		394.59	-	-
CCR-AP-6	11/11/2024	15:40	396.75	DRY TO SLEEVE (45.15)	<351.60
CCR-AP-6I	11/11/2024	15:35	396.88	58.45	338.43
CCR-AP-8	Couldn't Locate/Not Gauged		393.68	-	-
CCR-AP-8I	Couldn't Locate/Not Gauged		393.46	-	-
CCR-AP-11	11/11/2024	14:58	385.10	19.69	365.41
Background Wells					
CCR-AP-1R	11/11/2024	13:51	441.64	56.13	385.51
CCR-AP-7	11/11/2024	13:37	434.11	15.73	418.38
CCR-AP-9	11/11/2024	14:42	448.69	65.28	383.41

NOTES

DTW= Depth to Water

TOC= Top of Casing

What was originally thought to be the CCR-AP-8/8I nest during gauging on November 11, 2024 was actually an observation well nest.

CCR-AP-3 is believed to be covered under the excavation water management piping system. CCR-AP-8 and CCR-AP-8I were located by H&A and Atlas personnel under this equipment on November 14, 2024.

Low-Flow Test Report:

Test Date / Time: 11/14/2024 7:01:07 AM
Project: CULLEY EAST POND NOV 2024 GWM
Operator Name: M. BRETING

Location Name: CCR-AP-1R **Latitude:** **Longitude:** **Well Diameter: 2 in** **Casing Type: PVC** **Screen Length: 10 ft** **Top of Screen: 55 ft** **Total Depth: 65 ft** **Initial Depth to Water: 55.85 ft**	**Pump Type: Hydrasleeve** **Tubing Type: HDPE** **Flow Cell Volume: 130 ml** **Final Draw Down: 0 ft**	**Instrument Used: Aqua TROLL 500** **Serial Number: 625772**

Test Notes:

Weather Conditions:
Cloudy 52 degrees

Low-Flow Readings:

Date Time	Elapsed Time	pH	Temperature	Specific Conductivity	RDO Concentration	Turbidity	ORP	Depth to Water
		+/- 0.1	+/- 3 %	+/- 3 %	+/- 10 %	+/- 10 %	+/- 10	+/- 0.3
11/14/2024 7:01 AM	00:00	5.13 pH	15.75 °C	132.12 µS/cm	9.71 mg/L	3,464.2 NTU	-8.8 mV	55.85 ft
11/14/2024 7:04 AM	03:00	5.19 pH	15.71 °C	150.15 µS/cm	9.69 mg/L	2,625.1 NTU	1.3 mV	55.85 ft
11/14/2024 7:07 AM	06:00	5.26 pH	15.67 °C	153.11 µS/cm	9.70 mg/L	1,792.4 NTU	9.7 mV	55.85 ft

Samples

Sample ID:	Description:
CCR-AP-1R	

Created using VuSitu from In-Situ, Inc.

Low-Flow Test Report:

Test Date / Time: 11/14/2024 8:34:15 AM
Project: CULLEY EAST POND NOV 2024 GWM (2)
Operator Name: M. BRETING

Location Name: CCR-AP-2 **Latitude:** **Longitude:** **Well Diameter: 2 in** **Screen Length: 10 ft** **Top of Screen: 36 ft** **Total Depth: 46 ft**	**Pump Type: Hydrasleeve** **Tubing Type: HDPE** **Flow Cell Volume: 130 ml**	**Instrument Used: Aqua TROLL 500** **Serial Number: 625772**

Test Notes:

Weather Conditions:
Cloudy 55 degrees rain approaching

Low-Flow Readings:

Date Time	Elapsed Time	pH	Temperature	Specific Conductivity	RDO Concentration	Turbidity	ORP	Depth to Water
		+/- 0.1	+/- 3 %	+/- 3 %	+/- 10 %	+/- 10 %	+/- 10	+/- 0.3
11/14/2024 8:34 AM	00:00	7.37 pH	14.20 °C	0.07 µS/cm	9.98 mg/L	0.00 NTU	50.5 mV	
11/14/2024 8:37 AM	03:00	7.35 pH	14.16 °C	0.07 µS/cm	9.98 mg/L	0.00 NTU	56.0 mV	
11/14/2024 8:40 AM	06:00	7.32 pH	14.14 °C	0.07 µS/cm	9.99 mg/L	0.00 NTU	60.6 mV	

Samples

Sample ID:	Description:
CCR-AP-2	

Low-Flow Test Report:

Test Date / Time: 11/14/2024 1:28:03 PM
Project: CULLEY EAST POND NOV 2024 GWM (7)
Operator Name: M. BRETING

Location Name: CCR-AP-4R **Latitude:** **Longitude:** **Well Diameter: 2 in** **Casing Type: PVC** **Screen Length: 10 ft** **Top of Screen: 25.5 ft** **Total Depth: 35.5 ft** **Initial Depth to Water: 20.56 ft**	**Pump Type: Hydrasleeve** **Tubing Type: HDPE** **Flow Cell Volume: 130 ml** **Final Draw Down: 0 ft**	**Instrument Used: Aqua TROLL 500** **Serial Number: 625772**

Test Notes:

Low-Flow Readings:

Date Time	Elapsed Time	pH	Temperature	Specific Conductivity	RDO Concentration	Turbidity	ORP	Depth to Water
		+/- 0.1	+/- 3 %	+/- 3 %	+/- 10 %	+/- 10 %	+/- 10	+/- 0.3
11/14/2024 1:28 PM	00:00	8.26 pH	14.24 °C	0.07 µS/cm	7.98 mg/L	0.01 NTU	136.9 mV	20.56 ft
11/14/2024 1:31 PM	03:00	8.27 pH	14.34 °C	0.07 µS/cm	4.93 mg/L	0.00 NTU	171.8 mV	20.56 ft
11/14/2024 1:34 PM	06:00	8.16 pH	14.39 °C	0.07 µS/cm	3.86 mg/L	0.00 NTU	188.5 mV	20.56 ft
11/14/2024 1:37 PM	09:00	8.09 pH	14.39 °C	0.07 µS/cm	3.53 mg/L	0.00 NTU	197.8 mV	20.56 ft
11/14/2024 1:40 PM	12:00	8.01 pH	14.36 °C	0.07 µS/cm	3.41 mg/L	0.00 NTU	204.4 mV	20.56 ft
11/14/2024 1:43 PM	15:00	7.95 pH	14.31 °C	0.07 µS/cm	3.36 mg/L	0.00 NTU	209.4 mV	20.56 ft

Samples

Sample ID:	Description:
CCR-AP-4R	

Created using VuSitu from In-Situ, Inc.

Low-Flow Test Report:

Test Date / Time: 11/14/2024 2:46:26 PM
Project: CULLEY EAST POND NOV 2024 GWM (3)
Operator Name: M. BRETING

Location Name: CCR-AP-5 **Latitude:** **Longitude:** **Well Diameter: 2 in** **Casing Type: PVC** **Screen Length: 10 ft** **Top of Screen: 34.0 ft** **Total Depth: 44.0 ft** **Initial Depth to Water: 24.96 ft**	**Pump Type: SAMPLE PRO PORTABLE BLADDER PUMP** **Tubing Type: HDPE** **Pump Intake From TOC: 39.0 ft** **Estimated Total Volume Pumped: 11190 ml** **Flow Cell Volume: 130 ml** **Final Flow Rate: 200 ml/min** **Final Draw Down: 0.07 ft**	**Instrument Used: Aqua TROLL 500** **Serial Number: 625772**

Test Notes:

Weather Conditions:
Cloudy 55 degrees

Low-Flow Readings:

Date Time	Elapsed Time	pH	Temperature	Specific Conductivity	RDO Concentration	Turbidity	ORP	Depth to Water	Flow
		+/- 0.1	+/- 3 %	+/- 3 %	+/- 10 %	+/- 10 %	+/- 10	+/- 0.3	
11/14/2024 2:46 PM	00:00	7.06 pH	15.36 °C	1,282.5 µS/cm	4.63 mg/L	468.05 NTU	-11.0 mV	25.01 ft	200.00 ml/min
11/14/2024 2:49 PM	03:00	7.07 pH	15.29 °C	1,276.1 µS/cm	4.17 mg/L	422.11 NTU	-18.5 mV	25.05 ft	200.00 ml/min
11/14/2024 2:52 PM	06:00	7.07 pH	15.26 °C	1,271.0 µS/cm	3.75 mg/L	394.92 NTU	-25.5 mV	25.05 ft	200.00 ml/min
11/14/2024 2:55 PM	09:00	7.07 pH	15.04 °C	1,264.9 µS/cm	3.42 mg/L	372.93 NTU	-30.6 mV		200.00 ml/min
11/14/2024 2:58 PM	12:00	7.07 pH	14.86 °C	1,260.1 µS/cm	3.12 mg/L	316.26 NTU	-36.3 mV		200.00 ml/min
11/14/2024 3:01 PM	15:00	7.07 pH	14.98 °C	1,258.2 µS/cm	2.82 mg/L	228.73 NTU	-41.1 mV	25.03 ft	200.00 ml/min
11/14/2024 3:04 PM	18:00	7.07 pH	14.96 °C	1,258.1 µS/cm	2.55 mg/L	167.47 NTU	-47.5 mV		200.00 ml/min
11/14/2024 3:07 PM	21:00	7.08 pH	14.93 °C	1,255.0 µS/cm	2.33 mg/L	157.91 NTU	-51.7 mV		200.00 ml/min
11/14/2024 3:10 PM	24:00	7.08 pH	15.00 °C	1,254.6 µS/cm	2.12 mg/L	96.64 NTU	-54.9 mV	25.03 ft	200.00 ml/min
11/14/2024 3:13 PM	27:00	7.08 pH	15.06 °C	1,253.1 µS/cm	1.91 mg/L	76.15 NTU	-56.3 mV		200.00 ml/min
11/14/2024 3:16 PM	30:00	7.08 pH	14.95 °C	1,250.5 µS/cm	1.75 mg/L	63.23 NTU	-57.7 mV		200.00 ml/min
11/14/2024 3:19 PM	33:00	7.08 pH	15.18 °C	1,249.9 µS/cm	1.57 mg/L	49.53 NTU	-59.7 mV	25.03 ft	200.00 ml/min
11/14/2024 3:22 PM	36:00	7.08 pH	15.17 °C	1,246.8 µS/cm	1.44 mg/L	33.96 NTU	-63.1 mV		200.00 ml/min

11/14/2024 3:25 PM	39:00	7.08 pH	15.11 °C	1,244.7 µS/cm	1.32 mg/L	36.93 NTU	-64.6 mV	25.03 ft	200.00 ml/min
11/14/2024 3:28 PM	42:00	7.08 pH	15.08 °C	1,242.4 µS/cm	1.20 mg/L	28.55 NTU	-66.5 mV		200.00 ml/min
11/14/2024 3:31 PM	45:00	7.08 pH	14.91 °C	1,240.3 µS/cm	1.09 mg/L	21.28 NTU	-67.1 mV		200.00 ml/min
11/14/2024 3:34 PM	48:00	7.08 pH	14.77 °C	1,238.6 µS/cm	1.00 mg/L	23.20 NTU	-68.6 mV	25.03 ft	200.00 ml/min
11/14/2024 3:37 PM	51:00	7.08 pH	14.69 °C	1,237.3 µS/cm	0.94 mg/L	10.18 NTU	-63.2 mV		200.00 ml/min
11/14/2024 3:40 PM	54:00	7.08 pH	14.55 °C	1,234.7 µS/cm	0.98 mg/L	12.24 NTU	-60.5 mV		200.00 ml/min
11/14/2024 3:42 PM	55:57	7.08 pH	14.45 °C	1,233.0 µS/cm	1.02 mg/L	11.21 NTU	-59.6 mV	25.03 ft	200.00 ml/min

Samples

Sample ID:	Description:
CCR-AP-5; DUP-1	

Created using VuSitu from In-Situ, Inc.

Low-Flow Test Report:

Test Date / Time: 11/13/2024 9:20:06 AM
Project: CULLEY EAST POND NOV 2024 GWM
Operator Name: M. BRETING

Location Name: CCR-AP-6I **Latitude:** **Longitude:** **Well Diameter: 2 in** **Casing Type: PVC** **Screen Length: 10 ft** **Top of Screen: 64.7 ft** **Total Depth: 74.7 ft** **Initial Depth to Water: 58.53 ft**	**Pump Type: Dedicated** **Tubing Type: HDPE** **Pump Intake From TOC: 69.7 ft** **Estimated Total Volume Pumped: 6300 ml** **Flow Cell Volume: 130 ml** **Final Flow Rate: 350 ml/min** **Final Draw Down: 0.00 ft**	**Instrument Used: Aqua TROLL 500** **Serial Number: 625772**

Test Notes:

Weather Conditions:
Cloudy 50 degrees chance rain later today

Low-Flow Readings:

Date Time	Elapsed Time	pH	Temperature	Specific Conductivity	RDO Concentration	Turbidity	ORP	Depth to Water	Flow
		+/- 0.1	+/- 3 %	+/- 3 %	+/- 10 %	+/- 10 %	+/- 10	+/- 0.3	
11/13/2024 9:20 AM	00:00	7.29 pH	19.35 °C	570.20 µS/cm	1.47 mg/L	0.04 NTU	-78.4 mV	58.53 ft	350.00 ml/min
11/13/2024 9:23 AM	03:00	7.34 pH	19.14 °C	483.29 µS/cm	0.46 mg/L	0.00 NTU	-50.3 mV		350.00 ml/min
11/13/2024 9:26 AM	06:00	7.34 pH	18.87 °C	475.73 µS/cm	0.56 mg/L	0.00 NTU	-37.8 mV	58.53 ft	350.00 ml/min
11/13/2024 9:29 AM	09:00	7.35 pH	19.24 °C	467.33 µS/cm	0.27 mg/L	0.12 NTU	-33.7 mV		350.00 ml/min
11/13/2024 9:32 AM	12:00	7.36 pH	19.18 °C	466.21 µS/cm	0.22 mg/L	0.00 NTU	-31.1 mV		350.00 ml/min
11/13/2024 9:35 AM	15:00	7.37 pH	19.23 °C	465.81 µS/cm	0.21 mg/L	0.00 NTU	-29.4 mV	58.53 ft	350.00 ml/min
11/13/2024 9:38 AM	18:00	7.38 pH	19.25 °C	465.25 µS/cm	0.20 mg/L	0.00 NTU	-28.6 mV	58.53 ft	350.00 ml/min

Samples

Sample ID:	Description:
CCR-AP-6I	

Low-Flow Test Report:

Test Date / Time: 11/14/2024 11:01:46 AM
Project: CULLEY EAST POND NOV 2024 GWM (6)
Operator Name: M. BRETING

Location Name: CCR-AP-9 **Latitude:** **Longitude:** **Casing Type: PVC** **Screen Length: 10 ft** **Top of Screen: 60 ft** **Total Depth: 70 ft**	**Pump Type: Hydrasleeve** **Tubing Type: HDPE** **Flow Cell Volume: 130 ml**	**Instrument Used: Aqua TROLL 500** **Serial Number: 625772**

Test Notes:

Low-Flow Readings:

Date Time	Elapsed Time	pH	Temperature	Specific Conductivity	RDO Concentration	Turbidity	ORP	Depth to Water
		+/- 0.1	+/- 3 %	+/- 3 %	+/- 10 %	+/- 10 %	+/- 10	+/- 0.3
11/14/2024 11:01 AM	00:00	8.43 pH	17.10 °C	1.67 µS/cm	6.26 mg/L	1,200.2 NTU	320.4 mV	
11/14/2024 11:04 AM	03:00	8.23 pH	17.08 °C	1.06 µS/cm	5.17 mg/L	940.50 NTU	313.9 mV	
11/14/2024 11:07 AM	06:00	8.15 pH	17.17 °C	0.74 µS/cm	5.01 mg/L	764.02 NTU	313.6 mV	

Samples

Sample ID:	Description:
CCR-AP-9	

Created using VuSitu from In-Situ, Inc.

Low-Flow Test Report:

Test Date / Time: 11/15/2024 7:03:17 AM
Project: CULLEY EAST POND NOV 2024 GWM (8)
Operator Name: M. BRETING

Location Name: CCR-AP-11 **Latitude:** **Longitude:** **Well Diameter: 2 in** **Casing Type: PVC** **Screen Length: 10 ft** **Top of Screen: 44.4 ft** **Total Depth: 54.4 ft** **Initial Depth to Water: 18.77 ft**	**Pump Type: SAMPLE PRO PORTABLE BLADDER PUMP** **Tubing Type: HDPE** **Pump Intake From TOC: 49.4 ft** **Estimated Total Volume Pumped: 5080.667 ml** **Flow Cell Volume: 130 ml** **Final Flow Rate: 50 ml/min** **Final Draw Down: 1.38 ft**	**Instrument Used: Aqua TROLL 500** **Serial Number: 625772**

Test Notes:
Drawdown stabilized

Weather Conditions:
Cloudy 45 degrees

Low-Flow Readings:

Date Time	Elapsed Time	pH	Temperature	Specific Conductivity	RDO Concentration	Turbidity	ORP	Depth to Water	Flow
		+/- 0.1	+/- 3 %	+/- 3 %	+/- 10 %	+/- 10 %	+/- 10	+/- 0.3	
11/15/2024 7:03 AM	00:00	6.10 pH	13.42 °C	1,209.0 µS/cm	1.03 mg/L	188.20 NTU	-59.5 mV	19.30 ft	40.00 ml/min
11/15/2024 7:06 AM	03:00	6.10 pH	13.49 °C	1,204.7 µS/cm	1.05 mg/L	171.32 NTU	-58.0 mV		40.00 ml/min
11/15/2024 7:09 AM	06:00	6.10 pH	13.43 °C	1,200.1 µS/cm	1.06 mg/L	152.37 NTU	-56.1 mV	19.28 ft	40.00 ml/min
11/15/2024 7:12 AM	09:00	6.11 pH	13.35 °C	1,196.1 µS/cm	1.11 mg/L	130.31 NTU	-55.4 mV		40.00 ml/min
11/15/2024 7:13 AM	10:01	6.11 pH	13.31 °C	1,194.3 µS/cm	1.13 mg/L	124.84 NTU	-55.1 mV		40.00 ml/min
11/15/2024 7:16 AM	13:01	6.12 pH	13.17 °C	1,189.7 µS/cm	1.17 mg/L	123.15 NTU	-54.5 mV	19.26 ft	40.00 ml/min
11/15/2024 7:19 AM	16:01	6.12 pH	12.97 °C	1,185.1 µS/cm	1.23 mg/L	115.69 NTU	-53.7 mV		40.00 ml/min
11/15/2024 7:22 AM	19:01	6.12 pH	12.73 °C	1,179.7 µS/cm	1.29 mg/L	107.77 NTU	-51.0 mV	19.25 ft	40.00 ml/min
11/15/2024 7:25 AM	22:01	6.13 pH	12.47 °C	1,175.0 µS/cm	1.33 mg/L	102.99 NTU	-49.0 mV		40.00 ml/min
11/15/2024 7:28 AM	25:01	6.13 pH	12.19 °C	1,170.8 µS/cm	1.38 mg/L	107.52 NTU	-48.0 mV	19.20 ft	40.00 ml/min
11/15/2024 7:31 AM	28:01	6.11 pH	13.55 °C	1,175.2 µS/cm	1.32 mg/L	156.52 NTU	-49.6 mV		40.00 ml/min
11/15/2024 7:34 AM	31:01	6.12 pH	13.86 °C	1,178.7 µS/cm	1.27 mg/L	151.71 NTU	-54.4 mV		40.00 ml/min
11/15/2024 7:37 AM	34:01	6.14 pH	13.69 °C	1,174.6 µS/cm	1.33 mg/L	128.86 NTU	-54.4 mV		

11/15/2024 7:40 AM	37:01	6.26 pH	13.84 °C	1,173.5 µS/cm	3.87 mg/L	198.25 NTU	-51.3 mV		
11/15/2024 7:43 AM	40:01	6.21 pH	14.20 °C	791.51 µS/cm	3.65 mg/L	135.91 NTU	-52.7 mV		
11/15/2024 7:46 AM	43:01	6.24 pH	13.50 °C	1,163.4 µS/cm	3.78 mg/L	126.97 NTU	-49.5 mV	19.85 ft	40.00 ml/min
11/15/2024 7:49 AM	46:01	6.23 pH	13.25 °C	1,154.0 µS/cm	3.39 mg/L	117.30 NTU	-50.5 mV	19.78 ft	40.00 ml/min
11/15/2024 7:52 AM	49:01	6.22 pH	12.56 °C	1,145.4 µS/cm	2.82 mg/L	110.95 NTU	-51.6 mV	19.79 ft	40.00 ml/min
11/15/2024 7:55 AM	52:01	6.21 pH	12.11 °C	1,146.8 µS/cm	2.47 mg/L	115.74 NTU	-52.2 mV		50.00 ml/min
11/15/2024 7:58 AM	55:01	6.21 pH	12.03 °C	1,145.1 µS/cm	2.34 mg/L	115.28 NTU	-51.9 mV	19.95 ft	50.00 ml/min
11/15/2024 8:01 AM	58:01	6.21 pH	11.98 °C	1,141.8 µS/cm	2.35 mg/L	109.84 NTU	-51.0 mV	19.95 ft	50.00 ml/min
11/15/2024 8:04 AM	01:01:01	6.21 pH	12.59 °C	1,143.9 µS/cm	2.15 mg/L	92.72 NTU	-52.5 mV	19.87 ft	50.00 ml/min
11/15/2024 8:07 AM	01:04:01	6.22 pH	12.80 °C	1,140.0 µS/cm	2.08 mg/L	121.87 NTU	-51.7 mV		50.00 ml/min
11/15/2024 8:10 AM	01:07:01	6.23 pH	13.12 °C	1,139.9 µS/cm	1.77 mg/L	94.41 NTU	-55.8 mV		50.00 ml/min
11/15/2024 8:13 AM	01:10:01	6.25 pH	12.83 °C	1,134.5 µS/cm	1.61 mg/L	107.82 NTU	-56.9 mV	20.12 ft	50.00 ml/min
11/15/2024 8:16 AM	01:13:01	6.29 pH	12.40 °C	1,129.4 µS/cm	2.87 mg/L	121.12 NTU	-51.8 mV		50.00 ml/min
11/15/2024 8:19 AM	01:16:01	6.28 pH	12.35 °C	1,127.4 µS/cm	3.69 mg/L	132.89 NTU	-48.2 mV	20.13 ft	50.00 ml/min
11/15/2024 8:22 AM	01:19:01	6.28 pH	12.27 °C	1,123.5 µS/cm	3.57 mg/L	136.25 NTU	-48.1 mV		50.00 ml/min
11/15/2024 8:25 AM	01:22:01	6.28 pH	12.29 °C	1,122.6 µS/cm	3.19 mg/L	134.04 NTU	-49.4 mV	20.15 ft	50.00 ml/min
11/15/2024 8:28 AM	01:25:01	6.29 pH	12.30 °C	1,119.4 µS/cm	2.90 mg/L	112.55 NTU	-50.8 mV		50.00 ml/min
11/15/2024 8:31 AM	01:28:01	6.30 pH	12.19 °C	1,115.8 µS/cm	2.63 mg/L	98.48 NTU	-51.9 mV	20.15 ft	50.00 ml/min
11/15/2024 8:34 AM	01:31:01	6.30 pH	12.09 °C	1,112.6 µS/cm	2.34 mg/L	91.42 NTU	-53.0 mV		50.00 ml/min
11/15/2024 8:37 AM	01:34:01	6.31 pH	12.03 °C	1,110.8 µS/cm	2.13 mg/L	87.40 NTU	-54.0 mV		50.00 ml/min
11/15/2024 8:40 AM	01:37:01	6.31 pH	11.95 °C	1,108.6 µS/cm	1.99 mg/L	87.49 NTU	-54.5 mV	20.15 ft	50.00 ml/min
11/15/2024 8:43 AM	01:40:01	6.32 pH	11.90 °C	1,107.3 µS/cm	1.88 mg/L	95.71 NTU	-55.3 mV		50.00 ml/min
11/15/2024 8:46 AM	01:43:01	6.32 pH	11.91 °C	1,105.3 µS/cm	1.81 mg/L	99.77 NTU	-56.0 mV		50.00 ml/min
11/15/2024 8:49 AM	01:46:01	6.33 pH	11.89 °C	1,103.5 µS/cm	1.74 mg/L	86.53 NTU	-56.4 mV	20.15 ft	50.00 ml/min
11/15/2024 8:52 AM	01:49:01	6.33 pH	11.93 °C	1,103.0 µS/cm	1.69 mg/L	94.57 NTU	-56.9 mV		50.00 ml/min
11/15/2024 8:55 AM	01:52:01	6.33 pH	12.05 °C	1,102.9 µS/cm	1.63 mg/L	93.51 NTU	-57.5 mV	20.15 ft	50.00 ml/min

Samples

Sample ID:	Description:

CCR-AP-11	

Created using VuSitu from In-Situ, Inc.

HALEY ALDRICH

LOW FLOW SAMPLING FORM

PROJECT	F.B. Culley Generating Station - East Ash Pond	H&A FILE NO.	0129420
LOCATION	Newburgh, Indiana	PROJECT MGR.	Neal Kochis
CLIENT	Southern Indiana Gas and Electric Company	FIELD REP.	M. Gracey
CONTRACTOR	Atlas	SAMPLING DATE	11/14/24

Sampling Data:		Well Depth as Built:	65.0 ft	Well Diameter:	2.0 in	Sampling Device:	Hydrasleeve
Well ID:	CCR-AP-1R	Well Depth Measured:	ft	Initial Depth To Water:	55.85 ft	Field Parameter Device:	Aquatroll 500
Start time:	0645	Depth To Top Of Screen:	55.0 ft	Depth Of Pump Intake:	ft	Tubing Present In Well:	☐ Yes ☐ No
Finish Time:	0650	Depth To Bottom Of Scree	65.0 ft	Measuring Point:	Top of Casing (TOC)	Tubing Type:	Polyethylene

Elapsed Time (24 hour)	Depth To Water From Casing (ft)	Pump Setting (ml/min) or (gal/min)	Purge Rate (ml/min) or (gal/min)	Cumulative Purge Vol. (liters) or (gal)	Temp-erature (°F) or (°C)	pH	Conduct-ivity (ms/cm)	Dissolved Oxygen (mg/L)	Turbidity (NTU)	ORP/eH (mv)	Comments
Stabilized within →		[100 mL/min] to [500 mL/min]		-	NA	[+/- 0.1]	[+/- 3%]	[+/- 10%]	[+/- 10%]	[+/- 10]	
0701					15.75	5.13	132.12	9.71	3464.2	-8.8	
0704					15.71	5.19	150.15	9.69	2625.1	1.3	
0707					15.67	5.26	153.11	9.70	1792.4	9.7	
Sample ID:	CCR-AP-1R			Date:	11/14/24	Time:	0645	QAQC Samples:	—		

well volume = 3.14 (PI) x radius² x height of water column. 2 in well = 0.163 gal/ft, 3 in = 0.367 gal/ft 4 in = 0.653 gal/ft, 6 in = 1.469 gal/ft, 1 cu. ft. = 7.48 gal, 1 gal = 3.785 L, 1L = 0.264 gal, 0.5L/min = 0.132 gal/min

HALEY ALDRICH

LOW FLOW SAMPLING FORM

PROJECT	F.B. Culley Generating Station - East Ash Pond	H&A FILE NO.	0129420
LOCATION	Newburgh, Indiana	PROJECT MGR.	Neal Kochis
CLIENT	Southern Indiana Gas and Electric Company	FIELD REP.	M. Bratton
CONTRACTOR	Atlas	SAMPLING DATE	11/14/24

Sampling Data:		Well Depth as Built:	46.0 ft	Well Diameter:	2.0 in	Sampling Device:	Hydrasleeve
Well ID:	CCR-AP-2	Well Depth Measured:	ft	Initial Depth To Water:	38.14 ft	Field Parameter Device:	Aquatroll 500
Start time:	08:05	Depth To Top Of Screen:	36.0 ft	Depth Of Pump Intake:	ft	Tubing Present In Well:	☐ Yes ☑ No
Finish Time:	08:20	Depth To Bottom Of Scree	46.0 ft	Measuring Point:	Top of Casing (TOC)	Tubing Type:	~~Polyethylene~~ Hydrasleeve

Elapsed Time (24 hour)	Depth To Water From Casing (ft)	Pump Setting (ml/min) or (gal/min)	Purge Rate (ml/min) or (gal/min)	Cumulative Purge Vol. (liters) or (gal)	Temp-erature (°F) or (°C)	pH	Conduct-ivity (ms/cm)	Dissolved Oxygen (mg/L)	Turbidity (NTU)	ORP/eH (mv)	Comments
Stabilized within →		[100 mL/min] to [500 mL/min]		-	NA	[+/- 0.1]	[+/- 3%]	[+/- 10%]	[+/- 10%]	[+/- 10]	
8:34					14.20	7.37	0.07	9.98	0.06	50.5	
8:37					14.16	7.35	0.07	9.88	0.00	56.0	
8:40					14.14	7.32	0.07	9.89	0.00	60.6	

Sample ID:	CCR-AP-2	Date:	11/14/24	Time:	0805	QAQC Samples:	—

well volume = 3.14 (PI) x radius² x height of water column. 2 in well = 0.163 gal/ft, 3 in = 0.367 gal/ft 4 in = 0.653 gal/ft, 6 in = 1.469 gal/ft, 1 cu. ft. = 7.48 gal, 1 gal = 3.785 L 1L = 0.264 gal, 0.5L/min = 0.132 gal/min

HALEY ALDRICH

LOW FLOW SAMPLING FORM

PROJECT	F.B. Culley Generating Station - East Ash Pond	H&A FILE NO.	0129420
LOCATION	Newburgh, Indiana	PROJECT MGR.	Neal Kochis
CLIENT	Southern Indiana Gas and Electric Company	FIELD REP.	M. Bacon
CONTRACTOR	Atlas	SAMPLING DATE	11/14/24

Sampling Data:		Well Depth as Built:	35.5 ft	Well Diameter:	2.0 in	Sampling Device:	Hydrasleeve
Well ID:	CCR-AP-4	Well Depth Measured:	ft	Initial Depth To Water:	20.56 ft	Field Parameter Device:	Aqua TROLL 500
Start time:	13:20	Depth To Top Of Screen:	25.5 ft	Depth Of Pump Intake:	ft	Tubing Present In Well:	☐ Yes ☐ No
Finish Time:	13:30	Depth To Bottom Of Scree	35.5 ft	Measuring Point:	Top of Casing (TOC)	Tubing Type:	Polyethylene

Elapsed Time (24 hour)	Depth To Water From Casing (ft)	Pump Setting (ml/min) or (gal/min)	Purge Rate (ml/min) or (gal/min)	Cumulative Purge Vol. (liters) or (gal)	Temp-erature (°F) or (°C)	pH	Conduct-ivity (ms/cm)	Dissolved Oxygen (mg/L)	Turbidity (NTU)	ORP/eH (mv)	Comments
Stabilized within →		[100 mL/min] to [500 mL/min]		-	NA	[+/- 0.1]	[+/- 3%]	[+/- 10%]	[+/- 10%]	[+/- 10]	
13:28					14.24	8.26	0.07	2.98	0.01	136.9	
13:31					14.34	8.27	0.07	4.93	0.00	171.8	
13:34					14.39	8.16	0.07	3.86	0.00	188.5	
13:37					14.39	8.09	0.07	3.53	0.00	197.8	
13:40					14.36	8.01	0.07	3.41	0.00	204.4	
13:43					14.31	7.95	0.07	3.36	0.00	209.4	
Sample ID:	CCR-AP-4R			Date:	11/14/24	Time:	1320	QAQC Samples:	—		

well volume = 3.14 (PI) x radius² x height of water column. 2 in well = 0.163 gal/ft, 3 in = 0.367 gal/ft 4 in = 0.653 gal/ft, 6 in = 1.469 gal/ft, 1 cu. ft. = 7.48 gal, 1 gal = 3.785 L. 1L = 0.264 gal, 0.5L/min = 0.132 gal/min

HALEY ALDRICH

LOW FLOW SAMPLING FORM

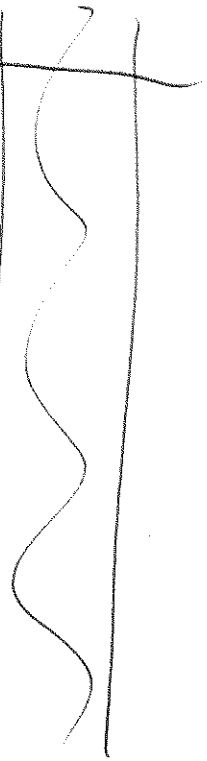
PROJECT	F.B. Culley Generating Station - East Ash Pond	H&A FILE NO.	0129420
LOCATION	Newburgh, Indiana	PROJECT MGR.	Neal Kochis
CLIENT	Southern Indiana Gas and Electric Company	FIELD REP.	M. Greving
CONTRACTOR	Atlas	SAMPLING DATE	11/14/24

Sampling Data:		Well Depth as Built:	44.0 ft	Well Diameter:	2.0 in	Sampling Device:	Bladder Pump
Well ID:	CCR-AP-5	Well Depth Measured:	ft	Initial Depth To Water:	24.96 ft	Field Parameter Device:	Aquatroll 500
Start time:	1545	Depth To Top Of Screen:	34.0 ft	Depth Of Pump Intake:	ft	Tubing Present In Well:	☐ Yes ☒ No
Finish Time:	1625	Depth To Bottom Of Scree	44.0 ft	Measuring Point:	Top of Casing (TOC)	Tubing Type:	Polyethylene

Elapsed Time (24 hour)	Depth To Water From Casing (ft)	Pump Setting (ml/min) or (gal/min)	Purge Rate (ml/min) or (gal/min)	Cumulative Purge Vol. (liters) or (gal)	Temp-erature (°F) or (°C)	pH	Conduct-ivity (ms/cm)	Dissolved Oxygen (mg/L)	Turbidity (NTU)	ORP/eH (mv)	Comments
Stabilized within →		[100 mL/min] to [500 mL/min]		-	NA	[+/- 0.1]	[+/- 3%]	[+/- 10%]	[+/- 10%]	[+/- 10]	
1446	25.01		200		15.36	7.06	1252.5	4.63	468.05	-11.0	
1449	25.05		200		15.29	7.07	1276.1	4.17	422.11	-18.5	
1452	25.05		200		15.26	7.07	1271.0	3.75	394.92	-25.5	
1455			200		15.04	7.07	1264.9	3.42	372.93	-30.6	
1458			200		14.86	7.07	1260.1	3.12	346.26	-36.3	
1501	25.03		200		14.98	7.07	1258.2	2.82	228.73	-41.1	
1504			200		14.96	7.07	1258.1	2.55	167.47	-47.5	
1507			200		14.93	7.08	1255.0	2.33	157.91	-51.7	
1510	25.03		200		15.00	7.08	1254.6	2.12	96.64	-54.9	
1513			200		15.06	7.08	1253.1	1.91	76.15	-56.3	
1516			200		14.95	7.08	1250.5	1.75	63.23	-57.7	
1519	25.03		200		15.18	7.08	1249.9	1.57	49.53	-59.2	DUP-1 collected at this well
1522			200		15.17	7.08	1246.8	1.44	33.96	-63.1	
1525	25.03		200		15.11	7.08	1244.7	1.32	36.93	-64.6	
1528			200		15.08	7.08	1242.4	1.20	28.55	-66.5	
1531			200		14.91	7.08	1240.3	1.09	21.28	-67.1	
1534	25.03		200		14.77	7.08	1238.6	1.00	23.20	-68.6	
1537			200		14.69	7.08	1237.3	0.94	10.18	-63.2	
Sample ID:	CCR-AP-5			Date:	11/14/24	Time:	1545	QAQC Samples:		DUP-1	

well volume = 3.14 (PI) x radius² x height of water column. 2 in well = 0.163 gal/ft, 3 in = 0.367 gal/ft 4 in = 0.653 gal/ft, 6 in = 1.469 gal/ft, 1 cu. ft. = 7.48 gal, 1 gal = 3.785 L 1L = 0.264 gal, 0.5L/min = 0.132 gal/min

Time	DTW	Purge Rate	Cumul. Purge	T	pH	SpC	DO	Turb	ORP
						1234.7			
1540				14.55	7.08	~~1233.0~~	0.98	12.24	-60.5
1542	25.03		11190 ml	14.45	7.08	1233.0	1.02	11.21	-59.6



HALEY ALDRICH

LOW FLOW SAMPLING FORM

PROJECT	F.B. Culley Generating Station - East Ash Pond	H&A FILE NO.	0129420
LOCATION	Newburgh, Indiana	PROJECT MGR.	Neal Kochis
CLIENT	Southern Indiana Gas and Electric Company	FIELD REP.	M. BRETING
CONTRACTOR	Atlas	SAMPLING DATE	11/13/24

Sampling Data:		Well Depth as Built:	45.5 ft	Well Diameter:	2.0 in	Sampling Device:	Hydrasleeve
Well ID:	CCR-AP-6	Well Depth Measured:	ft	Initial Depth To Water:	Orq to 44.7 ft	Field Parameter Device:	—
Start time:		Depth To Top Of Screen:	35.5 ft	Depth Of Pump Intake:	(Top sleeve) ft	Tubing Present In Well:	☐ Yes ☐ No
Finish Time:		Depth To Bottom Of Scree	45.5 ft	Measuring Point:	Top of Casing (TOC)	Tubing Type:	Polyethylene

Elapsed Time (24 hour)	Depth To Water From Casing (ft)	Pump Setting (ml/min) or (gal/min)	Purge Rate (ml/min) or (gal/min)	Cumulative Purge Vol. (liters) or (gal)	Temp-erature (°F) or (°C)	pH	Conduct-ivity (ms/cm)	Dissolved Oxygen (mg/L)	Turbidity (NTU)	ORP/eH (mv)	Comments
Stabilized within →		[100 mL/min] to [500 mL/min]		-	NA	[+/- 0.1]	[+/- 3%]	[+/- 10%]	[+/- 10%]	[+/- 10]	
	Orq TO	44.7 ft									Orq TO TOTAL Depth
											ASSE by Hydrasleeve
											Packer by Hydrasleeve,
											confirmed no
											water present.

Sample ID:		Date:	11/13/24	Time:	0910	QAQC Samples:	—

well volume = 3.14 (PI) x radius² x height of water column. 2 in well = 0.163 gal/ft, 3 in = 0.367 gal/ft 4 in = 0.653 gal/ft, 6 in = 1.469 gal/ft, 1 cu. ft. = 7.48 gal, 1 gal = 3.785 L, 1L = 0.264 gal, 0.5L/min = 0.132 gal/min

HALEY ALDRICH

LOW FLOW SAMPLING FORM

PROJECT	F.B. Culley Generating Station - East Ash Pond	H&A FILE NO.	0129420
LOCATION	Newburgh, Indiana	PROJECT MGR.	Neal Kochis
CLIENT	Southern Indiana Gas and Electric Company	FIELD REP.	M. Bratina
CONTRACTOR	Atlas	SAMPLING DATE	11/13/24

Sampling Data:		Well Depth as Built:	74.7 ft	Well Diameter:	2.0 in	Sampling Device:	Bladder Pump
Well ID:	CCR-AP-6I	Well Depth Measured:	ft	Initial Depth To Water:	58.53 ft	Field Parameter Device:	Aquatroll 500
Start time:	8:41	Depth To Top Of Screen:	64.7 ft	Depth Of Pump Intake:	ft	Tubing Present In Well:	☑ Yes ☐ No
Finish Time:	8:52	Depth To Bottom Of Scree	74.7 ft	Measuring Point:	Top of Casing (TOC)	Tubing Type:	Polyethylene

Elapsed Time (24 hour)	Depth To Water From Casing (ft)	Pump Setting (ml/min) or (gal/min)	Purge Rate (ml/min) or (gal/min)	Cumulative Purge Vol. (liters) or (gal)	Temp-erature (°F) or (°C)	pH	Conduct-ivity (ms/cm)	Dissolved Oxygen (mg/L)	Turbidity (NTU)	ORP/eH (mv)	Comments
8 Stabilized within →		[100 mL/min] to [500 mL/min]		-	NA	[+/- 0.1]	[+/- 3%]	[+/- 10%]	[+/- 10%]	[+/- 10]	
8 920	58.53	350	350		19.35	7.29	570.20	1.47	0.54	-78.4	
8 923			350		19.14	7.34	453.29	0.46	0.00	-50.3	
8 926	58.53		350		18.87	7.34	475.73	0.56	0.00	-37.8	
8 929			350		19.24	7.35	467.33	0.27	0.12	-33.7	
8 932			350		19.18	7.36	466.21	0.22	0.00	-31.1	
8 935	58.53		350		19.23	7.37	465.81	0.21	0.00	-29.4	
X 8 938	58.53		350		19.25	7.38	465.25	0.20	0.00	-28.6	

Sample ID:	CCR-AP-6I	Date:	11/13/24	Time:	941	QAQC Samples:	—

well volume = 3.14 (PI) x radius² x height of water column, 2 in well = 0.163 gal/ft, 3 in = 0.367 gal/ft 4 in = 0.653 gal/ft, 6 in = 1.469 gal/ft, 1 cu. ft. = 7.48 gal, 1 gal = 3.785 L, 1L = 0.264 gal, 0.5L/min = 0.132 gal/min

(941 cotton)

HALEY ALDRICH

LOW FLOW SAMPLING FORM

PROJECT	F.B. Culley Generating Station - East Ash Pond	H&A FILE NO.	0129420
LOCATION	Newburgh, Indiana	PROJECT MGR.	Neal Kochis
CLIENT	Southern Indiana Gas and Electric Company	FIELD REP.	M. Bielitz
CONTRACTOR	Atlas	SAMPLING DATE	11/14/24

Sampling Data:		Well Depth as Built:	70.0 ft	Well Diameter:	2.0 in	Sampling Device:	Bladder Pump
Well ID:	CCR-AP-9	Well Depth Measured:	ft	Initial Depth To Water:	65.06 ft	Field Parameter Device:	
Start time:	10:50	Depth To Top Of Screen:	60.0 ft	Depth Of Pump Intake:	ft	Tubing Present In Well:	☐ Yes ☐ No
Finish Time:	11:00	Depth To Bottom Of Scree	70.0 ft	Measuring Point:	Top of Casing (TOC)	Tubing Type:	Polyethylene

Elapsed Time (24 hour)	Depth To Water From Casing (ft)	Pump Setting (ml/min) or (gal/min)	Purge Rate (ml/min) or (gal/min)	Cumulative Purge Vol. (liters) or (gal)	Temp-erature (°F) or (°C)	pH	Conduct-ivity (ms/cm)	Dissolved Oxygen (mg/L)	Turbidity (NTU)	ORP/eH (mv)	Comments
Stabilized within →		[100 mL/min] to [500 mL/min]		-	NA	[+/- 0.1]	[+/- 3%]	[+/- 10%]	[+/- 10%]	[+/- 10]	
11:01					17.10	8.43	1.67	6.26	1200.2	320.4	
11:04					17.28	8.23	1.06	5.17	940.50	313.9	
11:07					17.17	8.15	0.74	5.01	764.02	312.6	
Sample ID:	CCR-AP-9			Date:	11/14/24	Time:	1050	QAQC Samples:	—		

well volume = 3.14 (PI) x radius² x height of water column. 2 in well = 0.163 gal/ft, 3 in = 0.367 gal/ft 4 in = 0.653 gal/ft, 6 in = 1.469 gal/ft, 1 cu. ft. = 7.48 gal, 1 gal = 3.785 L, 1L = 0.264 gal, 0.5L/min = 0.132 gal/min

LOW FLOW SAMPLING FORM

HALEY ALDRICH

PROJECT	F.B. Culley Generating Station - East Ash Pond	H&A FILE NO.	0129420
LOCATION	Newburgh, Indiana	PROJECT MGR.	Neal Kochis
CLIENT	Southern Indiana Gas and Electric Company	FIELD REP.	M. Gretling
CONTRACTOR	Atlas	SAMPLING DATE	11/15/24

Sampling Data:		Well Depth as Built:	54.4 ft	Well Diameter:	2.0 in	Sampling Device:	Bladder Pump
Well ID:	CCR-AP-11	Well Depth Measured:	ft	Initial Depth To Water:	18.77 ft	Field Parameter Device:	
Start time:	0858	Depth To Top Of Screen:	44.4 ft	Depth Of Pump Intake:	ft	Tubing Present In Well:	☐ Yes ☐ No
Finish Time:	11:10	Depth To Bottom Of Scree	54.4 ft	Measuring Point:	Top of Casing (TOC)	Tubing Type:	Polyethylene

Elapsed Time (24 hour)	Depth To Water From Casing (ft)	Pump Setting (ml/min) or (gal/min)	Purge Rate (ml/min) or (gal/min)	Cumulative Purge Vol. (liters) or (gal)	Temp-erature (°F) or (°C)	pH	Conduct-ivity (ms/cm)	Dissolved Oxygen (mg/L)	Turbidity (NTU)	ORP/eH (mv)	Comments
Stabilized within →		[100 mL/min] to [500 mL/min]		-	NA	[+/- 0.1]	[+/- 3%]	[+/- 10%]	[+/- 10%]	[+/- 10]	
703	19.30		40		13.42	6.10	1209.0	1.03	188.20	-59.5	Initially set flow
706			40		13.49	6.10	1209.7	1.05	171.32	-58.0	To ~75 ml/min
709	19.28		40		13.43	6.10	1200.1	1.06	154.37	-56.1	Ch. G starting up Then
712			40		13.35	6.11	1196.1	1.11	130.31	-55.4	bleed down to ~40 ml/
Lost Communication at 10 minutes in, Reestablished											min.
7:16	19.26		40		13.17	6.12	1189.7	1.17	123.15	-54.5	
7:19			40		12.97	6.12	1185.1	1.23	115.69	-53.7	
7:22	19.25		40		12.73	6.12	1179.7	1.29	107.77	-51.0	
7:25			40		12.47	6.13	1175.0	1.33	102.99	-49.0	
7:28	19.20		40		12.19	6.13	1170.8	1.38	107.52	-48.0	
7:31			40		13.55	6.11	1175.2	1.32	156.52	-49.6	
7:34			40		13.86	6.12	1178.7	1.27	151.71	-54.4	
Compressor 5503 135 PSI - Reading between 734-744 should be ignored, no flow											
7:46	19.85		40		13.50	6.26	1163.4	3.78	126.97	-49.5	
7:49	19.78		40		13.25	6.23	1154.0	3.39	117.30	-50.5	
7:52	19.79		40		12.56	6.22	1145.4	2.82	110.95	-51.6	Field Blank 1
7:55			~~40~~ 50		12.11	6.21	1146.8	2.47	115.74	-52.2	Collected 1155 1155
7:58	~~19.84~~		50		12.03	6.21	1145.1	2.34	115.28	-51.9	near AP-11

Sample ID:	CCR-AP-11	Date:	11/15/24	Time:	08:58	QAQC Samples:	—

well volume = 3.14 (PI) x radius² x height of water column. 2 in well = 0.163 gal/ft, 3 in = ~~0.367 gal/ft~~ 4 in = 0.653 gal/ft, 6 in = 1.469 gal/ft, 1 cu. ft. = 7.48 gal, 1 gal = 3.785 L, 1L = 0.264 gal, 0.5L/min = 0.132 gal/min

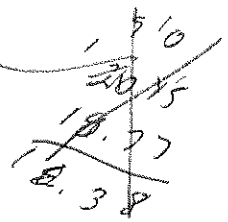
cdj cycle

19.95

CCR-AP-11

Time	OTW	Pump Setting	Purge Rate	Cumul Purge	T	pH	SpC	DO	Turb	ORP
8:01	19.95		50		11.98	6.21	1141.8	2.35	109.84	-51.0
8:04	19.87		50		12.59	6.21	1143.9	2.15	92.72	-52.5
8:07			50		12.50	6.22	1140.0	2.08	121.87	-51.7
8:10			50		13.12	6.23	1139.9	1.77	94.41	-55.8
8:13	20.12		50		12.83	6.25	1134.5	1.61	132.82	-56.9
8:16			50		12.40	6.29	1129.4	2.87	121.82	-51.8
8:19	20.13		50		12.35	6.28	1127.4	3.69	132.89	-48.2
8:22			50		12.27	6.28	1123.5	3.57	136.25	-48.1
825	20.15		50		12.29	6.28	1122.6	3.19	134.04	-49.4
828			50		12.30	6.29	1119.4	2.90	112.55	-50.8
831	20.15		50		12.15	6.30	1115.8	2.63	98.48	-51.9

Compressor stuck ignore 8:10 Reading



CCR
AP-11

	DTW	Purge Rate	Cumul Purge	T	pH	SpC	DO	Turb	ORP
834		50		12.09	6.30	1112.6	2.34	91.42	-53.0
837		50		12.03	6.31	1110.8	2.13	87.40	-54.0
840	20.15	50		11.95	6.31	1108.6	1.99	87.19	-54.5
843		50		11.90	6.32	1107.3	1.88	95.71	-55.3
846		50		11.91	6.32	1105.3	1.81	99.77	-56.0
849	20.15	50		11.89	6.33	1103.5	1.74	86.53	-56.4
852		50		11.93	6.33	1103.0	1.69	94.57	-56.9
855	20.15	50	5081 ml	12.05	6.33	1102.9	1.63	93.51	-57.5

HALEY ALDRICH

LOW FLOW SAMPLING FORM

Page 1 of 1

PROJECT	A.B. Brown Generating Station	**H&A FILE NO.**	0129420
LOCATION	Evansville, Indiana	**PROJECT MGR.**	Neal Kochis
CLIENT	Southern Indiana Gas and Electric Company	**FIELD REP**	F. Reed
CONTRACTOR	N/A	**DATE**	12/19/24

Sampling Data:

Well ID:	CCR-AP-1R	Well Depth as Built:		ft	Well Diameter:	2	in	Purging Device:	Hydrasleeve
Start time:	11:00	Well Depth Measured:	65.76	ft	Initial Depth To Water:	59.62	ft	Field Parameter Device:	Horiba U-52
Finish Time:	12:20	Depth To Top Of Screen:		ft	Depth Of Pump Intake:	-	ft	Tubing Present In Well:	☐ Yes ☒ No
		Depth To Bottom Of Screen:		ft	Measuring Point:	Top of Casing (TOC)		Tubing Type:	N/A

Time (24 hour)	Depth to Water (ft TOC)	Pump Setting (mL/min)	Purge Rate (mL/min)	Cumulative Purge Volume (Liters)	Temperature (°F)	pH	Conductivity (mS/cm)	Dissolved Oxygen (mg/L)	Turbidity (NTU)	ORP (mV)	Comments
Stabilized within →		[100 mL/min] to [500 mL/min]		--	N/A	[+/- 0.1]	[+/- 3%]	[+/- 10%]	[+/- 10%]	[+/- 10]	
* Grab sampled with a Hydrasleeve *											
12:00	-	-	-	-	17.08	6.89	1.03	1.75	>800	132	
											CCR-AP-1R-121924
											Sample Time: 11:40

well volume = 3.14 (PI) x radius^2 x height of water column 2 in well = 0.163 gal/ft, 3 in = 0.367 gal/ft 4 in = 0.653 gal/ft, 6 in = 1.469 gal/ft, 1 cu. ft. = 7.48 gal, 1 gal = 3.785 L, 1L = 0.264 gal, 0.5L/min = 0.132 gal/min

Form 3010

HALEY ALDRICH

LOW FLOW SAMPLING FORM

PROJECT	A.B. Brown Generating Station	**H&A FILE NO.**	0129420
LOCATION	Evansville, Indiana	**PROJECT MGR.**	Neal Kochis
CLIENT	Southern Indiana Gas and Electric Company	**FIELD REP**	F. Reed
CONTRACTOR	N/A	**DATE**	12/19/24

Sampling Data:

Well ID	CCR-AP-2	Well Depth as Built	ft	Well Diameter	2	in	Purging Device	Hydrasleeve	
Start time	13:35	Well Depth Measured	45.40 ft	Initial Depth To Water	35.78	ft	Field Parameter Device	Horiba U-52	
Finish Time	19:10	Depth To Top Of Screen	ft	Depth Of Pump Intake	–	ft	Tubing Present In Well	☐ Yes ☒ No	
		Depth To Bottom Of Screen	ft	Measuring Point	Top of Casing (TOC)		Tubing Type	N/A	

Time (24 hour)	Depth to Water (ft TOC)	Pump Setting (mL/min)	Purge Rate (mL/min)	Cumulative Purge Volume (Liters)	Temperature (°F)	pH	Conductivity (mS/cm)	Dissolved Oxygen (mg/L)	Turbidity (NTU)	ORP (mV)	Comments
Stabilized within →		[100 mL/min] to [500 mL/min]		--	N/A	[+/- 0.1]	[+/- 3%]	[+/- 10%]	[+/- 10%]	[+/- 10]	
		* Grab sampled with a Hydrasleeve *									
19:05	–	–	–	–	15.88	6.28	2.01	1.80	341	27	
											CCR-AP-2-121924
											Sample Time: 13:50

well volume = 3.14 (PI) x radius^2 x height of water column 2 in well = 0.163 gal/ft. 3 in = 0.367 gal/ft 4 in = 0.653 gal/ft. 6 in = 1.469 gal/ft. 1 cu. ft. = 7.48 gal. 1 gal = 3.785 L. 1L = 0.264 gal. 0.5L/min = 0.132 gal/min

Form 3010

HALEY ALDRICH

LOW FLOW SAMPLING FORM

PROJECT	A.B. Brown Generating Station	**H&A FILE NO.**	0129420
LOCATION	Evansville, Indiana	**PROJECT MGR.**	Neal Kochis
CLIENT	Southern Indiana Gas and Electric Company	**FIELD REP**	F. Reed
CONTRACTOR	N/A	**DATE**	12/19/24

Sampling Data:

Well ID:	CCR-AP-4	Well Depth as Built:	ft	Well Diameter:	2 in	Purging Device:	Hydra sleeve
Start time:	12:30	Well Depth Measured:	35.03 ft	Initial Depth To Water:	21.65 ft	Field Parameter Device:	Horiba U-52
Finish Time:		Depth To Top Of Screen:	ft	Depth Of Pump Intake:	– ft	Tubing Present In Well:	☐ Yes ☒ No
		Depth To Bottom Of Screen:	ft	Measuring Point:	Top of Casing (TOC)	Tubing Type:	N/A

Time (24 hour)	Depth to Water (ft TOC)	Pump Setting (mL/min)	Purge Rate (mL/min)	Cumulative Purge Volume (Liters)	Temperature (°F)	pH	Conductivity (mS/cm)	Dissolved Oxygen (mg/L)	Turbidity (NTU)	ORP (mV)	Comments
Stabilized within →		[100 mL/min] to	[500 mL/min]	--	N/A	[+/- 0.1]	[+/- 3%]	[+/- 10%]	[+/- 10%]	[+/- 10]	
	*	Grab Sampled	with	a	Hydra sleeve	*					
13:15	–	–	–	–	18.43	6.29	1.01	2.15	83.1	2.11	
											CCR-AP-4-121924
											Sample Time: 12:50

well volume = 3.14 (PI) x radius^2 x height of water column 2 in well = 0.163 gal/ft. 3 in = 0.367 gal/ft 4 in = 0.653 gal/ft. 6 in = 1.469 gal/ft. 1 cu ft = 7.48 gal. 1 gal = 3.785 L. 1L = 0.264 gal. 0.5L/min = 0.132 gal/min

LOW FLOW SAMPLING FORM

HALEY ALDRICH

PROJECT	A.B. Brown Generating Station	**H&A FILE NO.**	0129420
LOCATION	Evansville, Indiana	**PROJECT MGR.**	Neal Kochis
CLIENT	Southern Indiana Gas and Electric Company	**FIELD REP**	F. Reed
CONTRACTOR	N/A	**DATE**	12/19/24

Sampling Data:

Well ID:	CCR-AP-5I	Well Depth as Built:	ft	Well Diameter:	2 in	Purging Device:	Tornado / Bladder
Start time:	16:12	Well Depth Measured:	85.40 ft	Initial Depth To Water:	25.93 ft	Field Parameter Device:	Horiba U-52
Finish Time:	19:00	Depth To Top Of Screen:	ft	Depth Of Pump Intake:	ft	Tubing Present In Well:	☐ Yes ☑ No
		Depth To Bottom Of Screen:	ft	Measuring Point:	Top of Casing (TOC)	Tubing Type:	Polyethylene

Time (24 hour)	Depth to Water (ft TOC)	Pump Setting (mL/min)	Purge Rate (mL/min)	Cumulative Purge Volume (Liters)	Temperature (°C)	pH	Conductivity (mS/cm)	Dissolved Oxygen (mg/L)	Turbidity (NTU)	ORP (mV)	Comments
Stabilized within →		[100 mL/min] to [500 mL/min]		--	N/A	[+/- 0.1]	[+/- 3%]	[+/- 10%]	[+/- 10%]	[+/- 10]	
* Pumped 32 gallons out prior to taking parameters and sampling. 3 well volumes = 29.10 gallons *											
17:50	30.94	Set up dedicated pump									
17:58	31.05	-	200	1.0	16.50	6.68	2.32	1.13	394	20	
18:03	29.03	-	200	2.0	16.64	6.68	2.33	0.82	147	11	
18:08	28.52	-	200	3.0	16.70	6.67	2.34	0.43	134	2	
18:13	28.18	-	200	4.0	16.76	6.67	2.35	0.32	137	-1	
											CCR-AP-5I-121924
											Sample Time: 18:15

well volume = 3.14 (PI) x radius^2 x height of water column 2 in well = 0.163 gal/ft, 3 in = 0.367 gal/ft 4 in = 0.653 gal/ft, 6 in = 1.469 gal/ft, 1 cu ft = 7.48 gal, 1 gal = 3.785 L, 1L = 0.264 gal, 0.5L/min = 0.132 gal/min

Form 3010

HALEY ALDRICH

LOW FLOW SAMPLING FORM

PROJECT	A.B. Brown Generating Station	**H&A FILE NO.**	0129420
LOCATION	Evansville, Indiana	**PROJECT MGR.**	Neal Kochis
CLIENT	Southern Indiana Gas and Electric Company	**FIELD REP**	F. Reed
CONTRACTOR	N/A	**DATE**	12/19/24

Sampling Data:

Well ID:	CCR-AP-8I	Well Depth as Built:	ft	Well Diameter:	2 in	Purging Device:	Bladder
Start time:	14:45	Well Depth Measured:	ft	Initial Depth To Water:	53.64 ft	Field Parameter Device:	Horiba U-52
Finish Time:	16:10	Depth To Top Of Screen:	ft	Depth Of Pump ~~Intake~~ Top:	60.90 ft	Tubing Present In Well:	☒ Yes ☐ No
		Depth To Bottom Of Screen:	ft	Measuring Point:	Top of Casing (TOC)	Tubing Type:	Polyethylene

Time (24 hour)	Depth to Water (ft TOC)	Pump Setting (mL/min)	Purge Rate (mL/min)	Cumulative Purge Volume (Liters)	Temperature (~~°F~~) (°C)	pH	Conductivity (mS/cm)	Dissolved Oxygen (mg/L)	Turbidity (NTU)	ORP (mV)	Comments
Stabilized within →		[100 mL/min] to	[500 mL/min]	--	N/A	[+/- 0.1]	[+/- 3%]	[+/- 10%]	[+/- 10%]	[+/- 10]	
15:13	53.64	—	400	~2.0	16.51	6.58	1.02	0.00	4.5	-137	
15:18	53.64	—	400	~4.0	16.76	6.60	0.769	0.00	0.7	-162	
15:23	53.64	—	400	6.0	16.77	6.59	0.756	0.00	0.0	-175	
15:28	53.64	—	400	8.0	16.74	6.57	0.754	0.00	0.0	-186	
15:33	53.64	—	400	10.0	16.70	6.57	0.752	0.00	0.0	-195	
15:38	53.64	—	400	12.0	16.73	6.58	0.752	0.00	0.0	-200	
15:43	53.64	—	400	14.00	16.79	6.58	0.751	0.00	0.0	-204	
											CCR-AP-8I - 121924
											Sample Time: 15:45
											~15 L Purged

well volume = 3.14 (PI) x radius^2 x height of water column. 2 in well = 0.163 gal/ft, 3 in = 0.367 gal/ft, 4 in = 0.653 gal/ft, 6 in = 1.469 gal/ft, 1 cu. ft. = 7.48 gal, 1 gal = 3.785 L, 1L = 0.264 gal, 0.5L/min = 0.132 gal/min

APPENDIX C
Laboratory Analytical Reports

eurofins | Environment Testing

ANALYTICAL REPORT

PREPARED FOR

Attn: Todd Plating
Haley & Aldrich, Inc.
400 Augusta Street
Suite 100
Greenville, South Carolina 29601

Generated 1/26/2024 7:58:08 AM

JOB DESCRIPTION

CCR Groundwater Monitoring FB Culley East
FB Culley East

JOB NUMBER

180-167383-1

Eurofins Pittsburgh
301 Alpha Drive
RIDC Park
Pittsburgh PA 15238

See page two for job notes and contact information.

my EOL

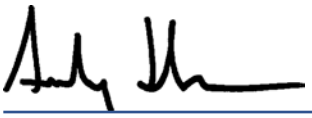
Job Notes

This report may not be reproduced except in full, and with written approval from the laboratory. The results relate only to the samples tested. For questions please contact the Project Manager at the e-mail address or telephone number listed on this page.

PA Lab ID: 02-00416

The test results in this report relate only to the samples as received by the laboratory and will meet all requirements of the methodology, with any exceptions noted. This report shall not be reproduced except in full, without the express written approval of the laboratory. All questions should be directed to the Eurofins Pittsburgh Project Manager.

Authorization



Generated
1/26/2024 7:58:08 AM

Authorized for release by
Andy Johnson, Senior Project Manager
Andy.Johnson@et.eurofinsus.com
(615)818-9567

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Job ID: 180-167383-1 Eurofins Pittsburgh

Job Narrative
180-167383-1

Analytical test results meet all requirements of the associated regulatory program listed on the Accreditation/Certification Summary Page unless otherwise noted under the individual analysis. Data qualifiers are applied to indicate exceptions. Noncompliant quality control (QC) is further explained in narrative comments.

- Matrix QC may not be reported if insufficient sample or site-specific QC samples were not submitted. In these situations, to demonstrate precision and accuracy at a batch level, a LCS/LCSD may be performed, unless otherwise specified in the method.
- Surrogate and/or isotope dilution analyte recoveries (if applicable) which are outside of the QC window are confirmed unless attributed to a dilution or otherwise noted in the narrative.

Regulated compliance samples (e.g. SDWA, NPDES) must comply with the associated agency requirements/permits.

Receipt
The sample was received on 12/23/2023 10:10 AM. Unless otherwise noted below, the sample arrived in good condition, and, where required, properly preserved and on ice. The temperature of the cooler at receipt time was 3.8°C

Receipt Exceptions
The container label for the following sample did not match the information listed on the Chain-of-Custody (COC): CCR-AP-1R (180-167383-1). The container labels list CCR-AP-1, while the COC lists CCR-AP-1R.

Gas Flow Proportional Counter
Method 9320_Ra228: Radium-228 batch 642707
The detection goal was not met for the following sample(s). Sample was prepped at a reduced volume due to the presence of matrix interferences: CCR-AP-1R (180-167383-1). Analytical results are reported with the detection limit achieved.

No additional analytical or quality issues were noted, other than those described above or in the Definitions/ Glossary page.

Rad
No additional analytical or quality issues were noted, other than those described above or in the Definitions/ Glossary page.

Definitions/Glossary

Client: Haley & Aldrich, Inc.
Project/Site: CCR Groundwater Monitoring FB Culley East

Job ID: 180-167383-1
SDG: FB Culley East

Qualifiers

Rad

Qualifier	Qualifier Description
G	The Sample MDC is greater than the requested RL.
U	Result is less than the sample detection limit.

Glossary

Abbreviation	These commonly used abbreviations may or may not be present in this report.
¤	Listed under the "D" column to designate that the result is reported on a dry weight basis
%R	Percent Recovery
CFL	Contains Free Liquid
CFU	Colony Forming Unit
CNF	Contains No Free Liquid
DER	Duplicate Error Ratio (normalized absolute difference)
Dil Fac	Dilution Factor
DL	Detection Limit (DoD/DOE)
DL, RA, RE, IN	Indicates a Dilution, Re-analysis, Re-extraction, or additional Initial metals/anion analysis of the sample
DLC	Decision Level Concentration (Radiochemistry)
EDL	Estimated Detection Limit (Dioxin)
LOD	Limit of Detection (DoD/DOE)
LOQ	Limit of Quantitation (DoD/DOE)
MCL	EPA recommended "Maximum Contaminant Level"
MDA	Minimum Detectable Activity (Radiochemistry)
MDC	Minimum Detectable Concentration (Radiochemistry)
MDL	Method Detection Limit
ML	Minimum Level (Dioxin)
MPN	Most Probable Number
MQL	Method Quantitation Limit
NC	Not Calculated
ND	Not Detected at the reporting limit (or MDL or EDL if shown)
NEG	Negative / Absent
POS	Positive / Present
PQL	Practical Quantitation Limit
PRES	Presumptive
QC	Quality Control
RER	Relative Error Ratio (Radiochemistry)
RL	Reporting Limit or Requested Limit (Radiochemistry)
RPD	Relative Percent Difference, a measure of the relative difference between two points
TEF	Toxicity Equivalent Factor (Dioxin)
TEQ	Toxicity Equivalent Quotient (Dioxin)
TNTC	Too Numerous To Count

Accreditation/Certification Summary

Client: Haley & Aldrich, Inc.
Project/Site: CCR Groundwater Monitoring FB Culley East

Job ID: 180-167383-1
SDG: FB Culley East

Laboratory: Eurofins St. Louis

All accreditations/certifications held by this laboratory are listed. Not all accreditations/certifications are applicable to this report.

Authority	Program	Identification Number	Expiration Date
Alaska (UST)	State	20-001	05-06-25
ANAB	Dept. of Defense ELAP	L2305	04-06-25
ANAB	Dept. of Energy	L2305.01	04-06-25
ANAB	ISO/IEC 17025	L2305	04-06-25
Arizona	State	AZ0813	12-08-24
California	Los Angeles County Sanitation Districts	10259	06-30-22 *
California	State	2886	06-30-24
Connecticut	State	PH-0241	03-31-25
Florida	NELAP	E87689	06-30-24
HI - RadChem Recognition	State	n/a	06-30-24
Illinois	NELAP	200023	11-30-24
Iowa	State	373	12-01-24
Kansas	NELAP	E-10236	10-31-24
Kentucky (DW)	State	KY90125	12-31-24
Kentucky (WW)	State	KY90125 (Permit KY0004049)	12-31-24
Louisiana	NELAP	04080	06-30-22 *
Louisiana (All)	NELAP	04080	06-30-24
Louisiana (DW)	State	LA011	12-31-24
Maryland	State	310	09-30-24
Massachusetts	State	M-MO054	06-30-24
MI - RadChem Recognition	State	9005	06-30-24
Missouri	State	780	06-30-25
Nevada	State	MO000542020-1	07-31-24
New Jersey	NELAP	MO002	06-30-24
New Mexico	State	MO00054	06-30-24
New York	NELAP	11616	03-31-24
North Carolina (DW)	State	29700	07-31-24
North Dakota	State	R-207	06-30-24
Oklahoma	NELAP	9997	08-31-24
Oregon	NELAP	4157	09-01-24
Pennsylvania	NELAP	68-00540	02-28-24
South Carolina	State	85002001	06-30-24
Texas	NELAP	T104704193	07-31-24
US Fish & Wildlife	US Federal Programs	058448	07-31-24
USDA	US Federal Programs	P330-17-00028	05-18-26
Utah	NELAP	MO000542021-14	07-31-24
Virginia	NELAP	10310	06-15-25
Washington	State	C592	08-30-24
West Virginia DEP	State	381	01-31-24

* Accreditation/Certification renewal pending - accreditation/certification considered valid.

Sample Summary

Client: Haley & Aldrich, Inc.
Project/Site: CCR Groundwater Monitoring FB Culley East

Job ID: 180-167383-1
SDG: FB Culley East

Lab Sample ID	Client Sample ID	Matrix	Collected	Received
180-167383-1	CCR-AP-1R	Water	12/22/23 12:25	12/23/23 10:10

Method Summary

Client: Haley & Aldrich, Inc.
Project/Site: CCR Groundwater Monitoring FB Culley East

Job ID: 180-167383-1
SDG: FB Culley East

Method	Method Description	Protocol	Laboratory
9315	Radium-226 (GFPC)	SW846	EET SL
9320	Radium-228 (GFPC)	SW846	EET SL
Ra226_Ra228	Combined Radium-226 and Radium-228	TAL-STL	EET SL
PrecSep_0	Preparation, Precipitate Separation	None	EET SL
PrecSep-21	Preparation, Precipitate Separation (21-Day In-Growth)	None	EET SL

Protocol References:

None = None

SW846 = "Test Methods For Evaluating Solid Waste, Physical/Chemical Methods", Third Edition, November 1986 And Its Updates.

TAL-STL = TestAmerica Laboratories, St. Louis, Facility Standard Operating Procedure.

Laboratory References:

EET SL = Eurofins St. Louis, 13715 Rider Trail North, Earth City, MO 63045, TEL (314)298-8566

Lab Chronicle

Client: Haley & Aldrich, Inc.
Project/Site: CCR Groundwater Monitoring FB Culley East

Job ID: 180-167383-1
SDG: FB Culley East

Client Sample ID: CCR-AP-1R

Date Collected: 12/22/23 12:25
Date Received: 12/23/23 10:10

Lab Sample ID: 180-167383-1

Matrix: Water

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	PrecSep-21			492.86 mL	1.0 g	642705	01/02/24 11:10	KAC	EET SL
Total/NA	Analysis	9315		1			645314	01/24/24 14:17	FLC	EET SL
	Instrument ID: GFPCRED									
Total/NA	Prep	PrecSep_0			492.86 mL	1.0 g	642707	01/02/24 11:14	KAC	EET SL
Total/NA	Analysis	9320		1			644701	01/18/24 11:42	FLC	EET SL
	Instrument ID: GFPCRED									
Total/NA	Analysis	Ra226_Ra228		1			645161	01/24/24 15:58	SCB	EET SL
	Instrument ID: NOEQUIP									

Laboratory References:

EET SL = Eurofins St. Louis, 13715 Rider Trail North, Earth City, MO 63045, TEL (314)298-8566

Analyst References:

Lab: EET SL

Batch Type: Prep

KAC = Kevin Cox

Batch Type: Analysis

FLC = Fernando Cruz

SCB = Sarah Bernsen

Client Sample ID: CCR-AP-1R
Date Collected: 12/22/23 12:25
Date Received: 12/23/23 10:10

Lab Sample ID: 180-167383-1
Matrix: Water

Method: SW846 9315 - Radium-226 (GFPC)

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Radium-226	5.36		0.649	0.809	1.00	0.285	pCi/L	01/02/24 11:10	01/24/24 14:17	1

Carrier	*%Yield*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Ba Carrier	*82.8*		*30 - 110*	*01/02/24 11:10*	*01/24/24 14:17*	*1*

Method: SW846 9320 - Radium-228 (GFPC)

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Radium-228	9.08	G	2.35	2.49	1.00	2.44	pCi/L	01/02/24 11:14	01/18/24 11:42	1

Carrier	*%Yield*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Ba Carrier	*82.8*		*30 - 110*	*01/02/24 11:14*	*01/18/24 11:42*	*1*
Y Carrier	*37.4*		*30 - 110*	*01/02/24 11:14*	*01/18/24 11:42*	*1*

Method: TAL-STL Ra226_Ra228 - Combined Radium-226 and Radium-228

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Combined Radium 226 + 228	14.4		2.44	2.62	5.00	2.44	pCi/L		01/24/24 15:58	1

Method: 9315 - Radium-226 (GFPC)

Lab Sample ID: MB 160-642705/1-A
Matrix: Water
Analysis Batch: 645440

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 642705

Analyte	MB Result	MB Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Radium-226	-0.03135	U	0.0829	0.0829	1.00	0.176	pCi/L	01/02/24 11:10	01/24/24 11:53	1

Carrier	*MB %Yield*	*MB Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Ba Carrier	*87.1*		*30 - 110*	*01/02/24 11:10*	*01/24/24 11:53*	*1*

Lab Sample ID: LCS 160-642705/2-A
Matrix: Water
Analysis Batch: 645441

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 642705

Analyte			Spike Added	LCS Result	LCS Qual	Total Uncert. (2σ+/-)	RL	MDC	Unit	%Rec	%Rec Limits		
Radium-226			11.3	11.30		1.19	1.00	0.155	pCi/L	100	75 - 125		

Carrier	*LCS %Yield*	*LCS Qualifier*	*Limits*
Ba Carrier	*87.6*		*30 - 110*

Method: 9320 - Radium-228 (GFPC)

Lab Sample ID: MB 160-642707/1-A
Matrix: Water
Analysis Batch: 644701

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 642707

Analyte	MB Result	MB Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Radium-228	0.05854	U	0.310	0.310	1.00	0.565	pCi/L	01/02/24 11:14	01/18/24 11:38	1

Carrier	*MB %Yield*	*MB Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Ba Carrier	*87.1*		*30 - 110*	*01/02/24 11:14*	*01/18/24 11:38*	*1*
Y Carrier	*78.9*		*30 - 110*	*01/02/24 11:14*	*01/18/24 11:38*	*1*

Lab Sample ID: LCS 160-642707/2-A
Matrix: Water
Analysis Batch: 644701

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 642707

Analyte			Spike Added	LCS Result	LCS Qual	Total Uncert. (2σ+/-)	RL	MDC	Unit	%Rec	%Rec Limits		
Radium-228			9.29	10.58		1.41	1.00	0.505	pCi/L	114	75 - 125		

Carrier	*LCS %Yield*	*LCS Qualifier*	*Limits*
Ba Carrier	*87.6*		*30 - 110*
Y Carrier	*79.6*		*30 - 110*

QC Association Summary

Client: Haley & Aldrich, Inc.
Project/Site: CCR Groundwater Monitoring FB Culley East

Job ID: 180-167383-1
SDG: FB Culley East

Rad

Prep Batch: 642705

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-167383-1	CCR-AP-1R	Total/NA	Water	PrecSep-21	
MB 160-642705/1-A	Method Blank	Total/NA	Water	PrecSep-21	
LCS 160-642705/2-A	Lab Control Sample	Total/NA	Water	PrecSep-21	

Prep Batch: 642707

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-167383-1	CCR-AP-1R	Total/NA	Water	PrecSep_0	
MB 160-642707/1-A	Method Blank	Total/NA	Water	PrecSep_0	
LCS 160-642707/2-A	Lab Control Sample	Total/NA	Water	PrecSep_0	

Eurofins Pittsburgh
301 Alpha Drive RIDC Park
Pittsburgh, PA 15238
Phone: 412-963-7058 Fax 412-963-2468

Chain of Custody Record

370472 eurofins Environment Testing

HARRISBURG PA

Client Information	Sampler: Hayley Torres	Lab PM: Johnson, Andy	Carrier Tracking No(s):	COC No: 180-97701-17191.1
Client Contact: Mark Breting	Phone:	E-Mail: Andy.Johnson@et.eurofinsus.com	State of Origin: IN	Page: Page 1 of 1
Company: Atlas Technical Consultants LLC	PWSID:			Job #:
Address: 7988 Centerpoint Drive Suite 100	Due Date Requested:			
City: Indianapolis	TAT Requested (days):			
State, Zip: IN, 46256	Compliance Project: Δ Yes Δ No			
Phone:	PO #: 0129420-032-001-01			
Email: mark.breting@atcassociates.com	WO #: See Chain			
Project Name: CCR Groundwater Monitoring FB Culley	Project #: 18016014			
Site:	SSOW#:			

Analysis Requested

Preservation Codes:
A - HCL, B - NaOH, C - Zn Acetate, D - Nitric Acid, E - NaHSO4, F - MeOH, G - Amchlor, H - Ascorbic Acid, I - Ice, J - DI Water, K - EDTA, L - EDA, M - Hexane, N - None, O - AsNaO2, P - Na2O4S, Q - Na2SO3, R - Na2S2O3, S - H2SO4, T - TSP Dodecahydrate, U - Acetone, V - MCAA, W - pH 4-5, Y - Trizma, Z - other (specify)
Other:

Sample Identification	Sample Date	Sample Time	Sample Type (C=comp, G=grab)	Matrix (W=water, S=solid, O=waste/oil, BT=Tissue, A=Air)	Field Filtered Sample (Yes or No)	Perform MS/MSD (Yes or No)	9040C, 9056A_ORGFM_28D		6020A, 7470A	2540C_Calcd - TDS by 2540C	9315_Ra226, 9320_Ra228		Total Number of containers	Special Instructions/Note:
			Preservation Code:				N	D	N		D			
CCR-AP-1R	12-22-23	12:25	G	W	N	N					✓			

180-167383 Chain of Custody

Possible Hazard Identification
☒ Non-Hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown ☐ Radiological

Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)
☐ Return To Client ☒ Disposal By Lab ☐ Archive For _____ Months

Deliverable Requested: I, II, III, IV, Other (specify)

Special Instructions/QC Requirements.

Empty Kit Relinquished by:	Date:	Time:	Method of Shipment:

	Relinquished by	Date/Time	Company	Received by	Date/Time	Company
1	Hayley Torres	12-22-23 / 13:30	ATLAS	Fedex	12-22-23 / 13:30	
2					12-23-23 1010	ED.TMG
3		Date/Time:			Date/Time.	

Custody Seals Intact: Δ Yes Δ No | Custody Seal No.:

Cooler Temperature(s) °C and Other Remarks:

Ver: 06/08/2021


434 MTW EXP 08/24
ORIGIN ID:GTYA (317) 313-8306
MARK BRETING
CENTER POINT ENERGY CULLEY
3711 DARLINGTON ROAD
NEWBURGH, IN 47630
UNITED STATES US
SHIP DATE: 19DEC23
ACTWGT: 33.00 LB MAN
CAD: 0128689/CAFE3511
TO SAMPLE RECEIVING
EUROFINS ENVIRONMENT TESTING NE
301 ALPHA DRIVE
RIDC PARK
PITTSBURGH PA 152382907
(412) 963-7058
INV:
PO:
REF:
DEPT:
RMA:
Uncorrected temp °C
Thermometer ID 4.4 21
CF -0.1 Initials DB
PT-WI-SR-001 effective 11/8/18
RT 634 1 13:30 A
7717 12.23
FZ
FedEx
TRK# 0221 6772 2900 7717
SATURDAY 1:30P
PRIORITY OVERNIGHT
XO AGCA
15238
PA-US
PIT
EXP 04/24


180-167383 Waybill

Eurofins Pittsburgh
301 Alpha Drive RIDC Park
Pittsburgh, PA 15238
Phone: 412-963-7058 Fax: 412-963-2468

Chain of Custody Record

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Client Information (Sub Contract Lab)	Sampler:	Lab PM: Johnson, Andy	Carrier Tracking No(s):	COC No: 180-502839.1
Client Contact: Shipping/Receiving	Phone:	E-Mail: Andy.Johnson@et.eurofinsus.com	State of Origin: Indiana	Page: Page 1 of 1
Company: TestAmerica Laboratories, Inc.		Accreditations Required (See note):		Job #: 180-167383-1
Address: 13715 Rider Trail North, ,	Due Date Requested: 1/30/2024			
City: Earth City	TAT Requested (days):			
State, Zip: MO, 63045				
Phone: 314-298-8566(Tel) 314-298-8757(Fax)	PO #:			
Email:	WO #:			
Project Name: CCR Groundwater Monitoring FB Culley East	Project #: 18016014			
Site:	SSOW#:			

Analysis Requested

Preservation Codes:

A - HCL, B - NaOH, C - Zn Acetate, D - Nitric Acid, E - NaHSO4, F - MeOH, G - Amchlor, H - Ascorbic Acid, I - Ice, J - DI Water, K - EDTA, L - EDA, M - Hexane, N - None, O - AsNaO2, P - Na2O4S, Q - Na2SO3, R - Na2S2O3, S - H2SO4, T - TSP Dodecahydrate, U - Acetone, V - MCAA, W - pH 4-5, Y - Trizma, Z - other (specify)

Other:

Sample Identification - Client ID (Lab ID)	Sample Date	Sample Time	Sample Type (C=comp, G=grab)	Matrix (W=water, S=solid, O=waste/oil, BT=Tissue, A=Air)	Field Filtered Sample (Yes or No)	Perform MS/MSD (Yes or No)	9315_Ra226/PrecSep_21 Standard Target List	9320_Ra228/PrecSep_0 Standard Target List	Ra226Ra228_GFPC	Total Number of containers	Special Instructions/Note:
			Preservation Code:								
CCR-AP-1R (180-167383-1)	12/22/23	12:25 Eastern		Water			X	X	X	2	

Note: Since laboratory accreditations are subject to change, Eurofins Pittsburgh places the ownership of method, analyte & accreditation compliance upon our subcontract laboratories. This sample shipment is forwarded under chain-of-custody. If the laboratory does not currently maintain accreditation in the State of Origin listed above for analysis/tests/matrix being analyzed, the samples must be shipped back to the Eurofins Pittsburgh laboratory or other instructions will be provided. Any changes to accreditation status should be brought to Eurofins Pittsburgh attention immediately. If all requested accreditations are current to date, return the signed Chain of Custody attesting to said compliance to Eurofins Pittsburgh.

Possible Hazard Identification: Unconfirmed	Sample Disposal (A fee may be assessed if samples are retained longer than 1 month): ☐ Return To Client ☐ Disposal By Lab ☐ Archive For ____ Months
Deliverable Requested: I, II, III, IV, Other (specify) Primary Deliverable Rank: 2	Special Instructions/QC Requirements:

Empty Kit Relinquished by:	Date:	Time:	Method of Shipment:

Relinquished by:	Date/Time:	Company	Received by:	Date/Time:	Company
Relinquished by: FEDEX	Date/Time:	Company	Received by: Sierra Woodington FEDEX	Date/Time: DEC 28 2023 0910	Company: ENSR
Relinquished by:	Date/Time:	Company	Received by:	Date/Time:	Company

Custody Seals Intact: Δ Yes Δ No	Custody Seal No.:	Cooler Temperature(s) °C and Other Remarks:

Ver: 06/08/2021

1/26/2024

Login Sample Receipt Checklist

Client: Haley & Aldrich, Inc.

Job Number: 180-167383-1
SDG Number: FB Culley East

Login Number: 167383
List Number: 1
Creator: Watson, Debbie

List Source: Eurofins Pittsburgh

Question	Answer	Comment
Radioactivity wasn't checked or is </= background as measured by a survey meter.	N/A	
The cooler's custody seal, if present, is intact.	True	
Sample custody seals, if present, are intact.	True	
The cooler or samples do not appear to have been compromised or tampered with.	True	
Samples were received on ice.	True	
Cooler Temperature is acceptable.	True	
Cooler Temperature is recorded.	True	
COC is present.	True	
COC is filled out in ink and legible.	True	
COC is filled out with all pertinent information.	True	
Is the Field Sampler's name present on COC?	True	
There are no discrepancies between the containers received and the COC.	False	
Samples are received within Holding Time (excluding tests with immediate HTs)	True	
Sample containers have legible labels.	True	
Containers are not broken or leaking.	True	
Sample collection date/times are provided.	True	
Appropriate sample containers are used.	True	
Sample bottles are completely filled.	True	
Sample Preservation Verified.	True	
There is sufficient vol. for all requested analyses, incl. any requested MS/MSDs	True	
Containers requiring zero headspace have no headspace or bubble is <6mm (1/4").	True	
Multiphasic samples are not present.	True	
Samples do not require splitting or compositing.	True	
Residual Chlorine Checked.	N/A	

Login Sample Receipt Checklist

Client: Haley & Aldrich, Inc.

Job Number: 180-167383-1
SDG Number: FB Culley East

Login Number: 167383
List Number: 2
Creator: Worthington, Sierra M

List Source: Eurofins St. Louis
List Creation: 12/28/23 11:06 AM

Question	Answer	Comment
Radioactivity wasn't checked or is </= background as measured by a survey meter.	True	
The cooler's custody seal, if present, is intact.	True	
Sample custody seals, if present, are intact.	True	
The cooler or samples do not appear to have been compromised or tampered with.	True	
Samples were received on ice.	N/A	
Cooler Temperature is acceptable.	True	
Cooler Temperature is recorded.	True	
COC is present.	True	
COC is filled out in ink and legible.	True	
COC is filled out with all pertinent information.	True	
Is the Field Sampler's name present on COC?	True	
There are no discrepancies between the containers received and the COC.	True	
Samples are received within Holding Time (excluding tests with immediate HTs)	True	
Sample containers have legible labels.	True	
Containers are not broken or leaking.	True	
Sample collection date/times are provided.	True	
Appropriate sample containers are used.	True	
Sample bottles are completely filled.	True	
Sample Preservation Verified.	True	
There is sufficient vol. for all requested analyses, incl. any requested MS/MSDs	True	
Containers requiring zero headspace have no headspace or bubble is <6mm (1/4").	N/A	
Multiphasic samples are not present.	True	
Samples do not require splitting or compositing.	True	
Residual Chlorine Checked.	N/A	

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ANALYTICAL REPORT

PREPARED FOR

Attn: Todd Plating
Haley & Aldrich, Inc.
400 Augusta Street
Suite 100
Greenville, South Carolina 29601

Generated 6/14/2024 2:50:14 PM

JOB DESCRIPTION

CCR Groundwater Monitoring FB Culley East
FB Culley East

JOB NUMBER

180-173844-1

Eurofins Pittsburgh
301 Alpha Drive
RIDC Park
Pittsburgh PA 15238

See page two for job notes and contact information.

my EOL

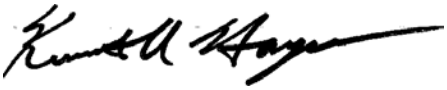
Job Notes

This report may not be reproduced except in full, and with written approval from the laboratory. The results relate only to the samples tested. For questions please contact the Project Manager at the e-mail address or telephone number listed on this page.

PA Lab ID: 02-00416

The test results in this report relate only to the samples as received by the laboratory and will meet all requirements of the methodology, with any exceptions noted. This report shall not be reproduced except in full, without the express written approval of the laboratory. All questions should be directed to the Eurofins Pittsburgh Project Manager.

Authorization



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Authorized for release by
Ken Hayes, Project Manager II
Ken.Hayes@et.eurofinsus.com
Designee for
Andy Johnson, Senior Project Manager
Andy.Johnson@et.eurofinsus.com
(615)818-9567

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Job ID: 180-173844-1 Eurofins Pittsburgh

Job Narrative
180-173844-1

Analytical test results meet all requirements of the associated regulatory program listed on the Accreditation/Certification Summary Page unless otherwise noted under the individual analysis. Data qualifiers are applied to indicate exceptions. Noncompliant quality control (QC) is further explained in narrative comments.

- Matrix QC may not be reported if insufficient sample or site-specific QC samples were not submitted. In these situations, to demonstrate precision and accuracy at a batch level, a LCS/LCSD may be performed, unless otherwise specified in the method.
- Surrogate and/or isotope dilution analyte recoveries (if applicable) which are outside of the QC window are confirmed unless attributed to a dilution or otherwise noted in the narrative.

Regulated compliance samples (e.g. SDWA, NPDES) must comply with the associated agency requirements/permits.

Receipt
The samples were received on 5/10/2024 9:30 AM. Unless otherwise noted below, the samples arrived in good condition, and, where required, properly preserved and on ice. The temperatures of the 3 coolers at receipt time were 3.0°C, 4.0°C and 4.2°C.

Receipt Exceptions
The reference method requires samples to have a pH of less than 2. The following sample was received with a pH of 7: CCR-AP-2 (180-173844-2). The sample was adjusted to the appropriate pH in the laboratory.

Affected container:
A-2

This container was not received. CCR-AP-8I (180-173844-7)

A second 500mL unpreserved container was received for this sample.
CCR-AP-9 (180-173844-8)

The sample in this container is a different color than the sample material in the other containers.

CCR-AP-9 (180-173844-8)

The container label for the following sample container was collected on 5/8/2024 at 1200 but the COC says this sample was collected on 5/8/2024 at 1140. CCR-AP-9 (180-173844-8).

Sample containers are not completely filled. CCR-AP-4 (180-173844-4) and CCR-AP-9 (180-173844-8)

Gas Flow Proportional Counter
Method 9320_Ra228: Radium-228 prep batch 160-661792:

The detection goal was not met for the following samples due to the reduced sample volume attributed to the presence of matrix interferences: CCR-AP-1R (180-173844-1), CCR-AP-2 (180-173844-2) and CCR-AP-9 (180-173844-8) . Analytical results are reported with the detection limit achieved.

No additional analytical or quality issues were noted, other than those described above or in the Definitions/ Glossary page.

Rad
No additional analytical or quality issues were noted, other than those described above or in the Definitions/ Glossary page.

Job ID: 180-173844-2 Eurofins Pittsburgh

Job Narrative
180-173844-2

Analytical test results meet all requirements of the associated regulatory program listed on the Accreditation/Certification Summary Page unless otherwise noted under the individual analysis. Data qualifiers are applied to indicate exceptions. Noncompliant quality control (QC) is further explained in narrative comments.

- Matrix QC may not be reported if insufficient sample or site-specific QC samples were not submitted. In these situations, to demonstrate precision and accuracy at a batch level, a LCS/LCSD may be performed, unless otherwise specified in the method.
- Surrogate and/or isotope dilution analyte recoveries (if applicable) which are outside of the QC window are confirmed unless attributed to a dilution or otherwise noted in the narrative.

Regulated compliance samples (e.g. SDWA, NPDES) must comply with the associated agency requirements/permits.

Receipt
The samples were received on 5/10/2024 9:30 AM. Unless otherwise noted below, the samples arrived in good condition, and, where required, properly preserved and on ice. The temperatures of the 3 coolers at receipt time were 3.0°C, 4.0°C and 4.2°C.

Receipt Exceptions
The reference method requires samples to have a pH of less than 2. The container for radiological testing for the following sample was received with a pH of 7: CCR-AP-2 (180-173844-2). This container was adjusted to the appropriate pH in the laboratory.

A second 500mL unpreserved container was received for this sample. CCR-AP-9 (180-173844-8)

The sample in one of the 500ml unpreserved containers is a different color than the sample material in the other containers. CCR-AP-9 (180-173844-8)

The container label for the following sample container shows that it was collected on 5/8/2024 at 1200 but the COC says this sample was collected on 5/8/2024 at 1140. CCR-AP-9 (180-173844-8).

Sample containers are not completely filled. CCR-AP-4 (180-173844-4) and CCR-AP-9 (180-173844-8)

Per client instruction, the ID for sample -7 was changed to CCR-AP-8I.

HPLC/IC
Method 9056A_ORGFM_28D: The following sample was diluted to bring the concentration of target analytes within the calibration range: CCR-AP-6I (180-173844-6). Elevated reporting limits (RLs) are provided.

Method 9056A_ORGFM_28D: The following samples were diluted due to the nature of the sample matrix: CCR-AP-1R (180-173844-1), CCR-AP-2 (180-173844-2), CCR-AP-8I (180-173844-7), (180-173881-D-1), (180-173881-D-1 MS) and (180-173881-D-1 MSD). Elevated reporting limits (RLs) are provided.

No additional analytical or quality issues were noted, other than those described above or in the Definitions/ Glossary page.

Metals
No additional analytical or quality issues were noted, other than those described above or in the Definitions/ Glossary page.

General Chemistry
Method 2540C_Calcd: Use of a larger volume of sample resulted in overload of the filter; therefore, a sample volume less than 100mL was utilized for this procedure and produced less than the 200mg dried residue specified by the SM 2540C Total Dissolved Solids reference method. The following samples were impacted: CCR-AP-1R (180-173844-1) and CCR-AP-2 (180-173844-2).

Method 2540C_Calcd: The sample did not reach a stable weight following 3 cycles of heating, cooling, and desiccation. The cycle 3 weight was used to calculate the Total Dissolved Solids for the sample result. CCR-AP-3 (180-173844-3) and CCR-AP-6I (180-173844-6)

Method 2540C_Calcd: The sample did not reach a stable weight following 3 cycles of heating, cooling, and desiccation. The cycle 3 weight was used to calculate the Total Dissolved Solids for the sample result. CCR-AP-2 (180-173844-2), CCR-AP-4

Job ID: 180-173844-2 (Continued) Eurofins Pittsburgh

(180-173844-4), CCR-AP-8I (180-173844-7) and CCR-AP-9 (180-173844-8)

No additional analytical or quality issues were noted, other than those described above or in the Definitions/ Glossary page.

Definitions/Glossary

Client: Haley & Aldrich, Inc.
Project/Site: CCR Groundwater Monitoring FB Culley East

Job ID: 180-173844-1
SDG: FB Culley East

Qualifiers

HPLC/IC

Qualifier	Qualifier Description
J	Result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value.

Metals

Qualifier	Qualifier Description
J	Result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value.

General Chemistry

Qualifier	Qualifier Description
HF	Parameter with a holding time of 15 minutes. Test performed by laboratory at client's request. Sample was analyzed outside of hold time.

Rad

Qualifier	Qualifier Description
G	The Sample MDC is greater than the requested RL.
U	Result is less than the sample detection limit.

Glossary

Abbreviation	These commonly used abbreviations may or may not be present in this report.
¤	Listed under the "D" column to designate that the result is reported on a dry weight basis
%R	Percent Recovery
CFL	Contains Free Liquid
CFU	Colony Forming Unit
CNF	Contains No Free Liquid
DER	Duplicate Error Ratio (normalized absolute difference)
Dil Fac	Dilution Factor
DL	Detection Limit (DoD/DOE)
DL, RA, RE, IN	Indicates a Dilution, Re-analysis, Re-extraction, or additional Initial metals/anion analysis of the sample
DLC	Decision Level Concentration (Radiochemistry)
EDL	Estimated Detection Limit (Dioxin)
LOD	Limit of Detection (DoD/DOE)
LOQ	Limit of Quantitation (DoD/DOE)
MCL	EPA recommended "Maximum Contaminant Level"
MDA	Minimum Detectable Activity (Radiochemistry)
MDC	Minimum Detectable Concentration (Radiochemistry)
MDL	Method Detection Limit
ML	Minimum Level (Dioxin)
MPN	Most Probable Number
MQL	Method Quantitation Limit
NC	Not Calculated
ND	Not Detected at the reporting limit (or MDL or EDL if shown)
NEG	Negative / Absent
POS	Positive / Present
PQL	Practical Quantitation Limit
PRES	Presumptive
QC	Quality Control
RER	Relative Error Ratio (Radiochemistry)
RL	Reporting Limit or Requested Limit (Radiochemistry)
RPD	Relative Percent Difference, a measure of the relative difference between two points
TEF	Toxicity Equivalent Factor (Dioxin)
TEQ	Toxicity Equivalent Quotient (Dioxin)
TNTC	Too Numerous To Count

Accreditation/Certification Summary

Client: Haley & Aldrich, Inc.
Project/Site: CCR Groundwater Monitoring FB Culley East

Job ID: 180-173844-1
SDG: FB Culley East

Laboratory: Eurofins Pittsburgh

All accreditations/certifications held by this laboratory are listed. Not all accreditations/certifications are applicable to this report.

Authority	Program	Identification Number	Expiration Date
Arkansas DEQ	State	19-033-0	06-27-24
California	State	2891	04-30-24 *
Connecticut	State	PH-0688	09-30-24
Florida	NELAP	E871008	06-30-24
Georgia	State	PA 02-00416	04-30-25
Illinois	NELAP	004375	07-31-25
Kansas	NELAP	E-10350	01-31-25
Kentucky (UST)	State	162013	04-30-23 *
Kentucky (WW)	State	KY98043	12-31-24
Louisiana	NELAP	04041	06-30-22 *
Louisiana (All)	NELAP	04041	06-30-24
Maine	State	PA00164	03-06-26
Minnesota	NELAP	042-999-482	12-31-24
New Hampshire	NELAP	2030	04-04-24 *
New Jersey	NELAP	PA005	06-30-24
New York	NELAP	11182	04-01-25
North Carolina (WW/SW)	State	434	12-31-24
North Dakota	State	R-227	04-30-24 *
Oregon	NELAP	PA-2151	02-06-25
Pennsylvania	NELAP	02-00416	04-30-25
Rhode Island	State	LAO00362	01-01-25
South Carolina	State	89014	04-30-25
Texas	NELAP	T104704528	03-31-25
US Fish & Wildlife	US Federal Programs	058448	03-31-24 *
USDA	US Federal Programs	P330-16-00211	04-11-26
Utah	NELAP	PA001462019-8	05-31-24
Virginia	NELAP	10043	07-14-24
West Virginia DEP	State	142	01-31-25
Wisconsin	State	998027800	08-31-24

Laboratory: Eurofins Cleveland

All accreditations/certifications held by this laboratory are listed. Not all accreditations/certifications are applicable to this report.

Authority	Program	Identification Number	Expiration Date
California	State	2927	02-28-25
Georgia	State	4062	02-27-25
Illinois	NELAP	200004	07-31-24
Iowa	State	421	06-01-25
Kentucky (UST)	State	112225	02-27-25
Kentucky (WW)	State	KY98016	12-30-24
Minnesota	NELAP	039-999-348	12-31-24
New Jersey	NELAP	OH001	06-30-24
New York	NELAP	10975	04-02-25
Ohio VAP	State	ORELAP 4062	02-27-25
Oregon	NELAP	4062	02-27-25
Pennsylvania	NELAP	68-00340	08-31-24
Texas	NELAP	T104704517-22-19	08-31-24
USDA	US Federal Programs	P330-18-00281	01-05-27
Virginia	NELAP	460175	09-14-24
West Virginia DEP	State	210	12-31-24

* Accreditation/Certification renewal pending - accreditation/certification considered valid.

Accreditation/Certification Summary

Client: Haley & Aldrich, Inc.
Project/Site: CCR Groundwater Monitoring FB Culley East

Job ID: 180-173844-1
SDG: FB Culley East

Laboratory: Eurofins St. Louis

All accreditations/certifications held by this laboratory are listed. Not all accreditations/certifications are applicable to this report.

Authority	Program	Identification Number	Expiration Date
Alaska (UST)	State	20-001	05-06-25
ANAB	Dept. of Defense ELAP	L2305	04-06-25
ANAB	Dept. of Energy	L2305.01	04-08-25
ANAB	ISO/IEC 17025	L2305	04-06-25
Arizona	State	AZ0813	12-08-24
California	Los Angeles County Sanitation Districts	10259	06-30-22 *
California	State	2886	06-30-24
Connecticut	State	PH-0241	03-31-25
Florida	NELAP	E87689	06-30-24
HI - RadChem Recognition	State	n/a	06-30-24
Illinois	NELAP	200023	11-30-24
Iowa	State	373	12-01-24
Kansas	NELAP	E-10236	10-31-24
Kentucky (DW)	State	KY90125	12-31-24
Kentucky (WW)	State	KY90125 (Permit KY0004049)	12-31-24
Louisiana	NELAP	04080	06-30-22 *
Louisiana (All)	NELAP	04080	06-30-24
Louisiana (DW)	State	LA011	12-31-24
Maryland	State	310	09-30-24
Massachusetts	State	M-MO054	06-30-24
MI - RadChem Recognition	State	9005	06-30-24
Missouri	State	780	06-30-25
Nevada	State	MO00054	07-31-24
New Jersey	NELAP	MO002	06-30-24
New Mexico	State	MO00054	06-30-24
New York	NELAP	11616	03-31-25
North Carolina (DW)	State	29700	07-31-24
North Dakota	State	R-207	06-30-24
Oklahoma	NELAP	9997	08-31-24
Oregon	NELAP	4157	09-01-24
Pennsylvania	NELAP	68-00540	02-28-25
South Carolina	State	85002001	06-30-24
Texas	NELAP	T104704193	07-31-24
US Fish & Wildlife	US Federal Programs	058448	07-31-24
USDA	US Federal Programs	P330-17-00028	05-18-26
Utah	NELAP	MO00054	07-31-24
Virginia	NELAP	460230	06-15-25
Washington	State	C592	08-30-24
West Virginia DEP	State	381	10-31-24

* Accreditation/Certification renewal pending - accreditation/certification considered valid.

Sample Summary

Client: Haley & Aldrich, Inc.
Project/Site: CCR Groundwater Monitoring FB Culley East

Job ID: 180-173844-1
SDG: FB Culley East

Lab Sample ID	Client Sample ID	Matrix	Collected	Received
180-173844-1	CCR-AP-1R	Water	05/08/24 11:20	05/10/24 09:30
180-173844-2	CCR-AP-2	Water	05/08/24 10:20	05/10/24 09:30
180-173844-3	CCR-AP-3	Water	05/07/24 14:00	05/10/24 09:30
180-173844-4	CCR-AP-4	Water	05/08/24 09:45	05/10/24 09:30
180-173844-5	CCR-AP-6	Water	05/07/24 13:30	05/10/24 09:30
180-173844-6	CCR-AP-6I	Water	05/07/24 13:15	05/10/24 09:30
180-173844-7	CCR-AP-8I	Water	05/08/24 11:40	05/10/24 09:30
180-173844-8	CCR-AP-9	Water	05/08/24 12:00	05/10/24 09:30

Method Summary

Client: Haley & Aldrich, Inc.
Project/Site: CCR Groundwater Monitoring FB Culley East

Job ID: 180-173844-1
SDG: FB Culley East

Method	Method Description	Protocol	Laboratory
9315	Radium-226 (GFPC)	SW846	EET SL
9320	Radium-228 (GFPC)	SW846	EET SL
Ra226_Ra228	Combined Radium-226 and Radium-228	TAL-STL	EET SL
PrecSep_0	Preparation, Precipitate Separation	None	EET SL
PrecSep-21	Preparation, Precipitate Separation (21-Day In-Growth)	None	EET SL

Protocol References:

None = None

SW846 = "Test Methods For Evaluating Solid Waste, Physical/Chemical Methods", Third Edition, November 1986 And Its Updates.

TAL-STL = TestAmerica Laboratories, St. Louis, Facility Standard Operating Procedure.

Laboratory References:

EET SL = Eurofins St. Louis, 13715 Rider Trail North, Earth City, MO 63045, TEL (314)298-8566

Lab Chronicle

Client: Haley & Aldrich, Inc.
Project/Site: CCR Groundwater Monitoring FB Culley East

Job ID: 180-173844-1
SDG: FB Culley East

Client Sample ID: CCR-AP-1R

Lab Sample ID: 180-173844-1

Date Collected: 05/08/24 11:20
Matrix: Water
Date Received: 05/10/24 09:30

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	EPA 9056A		5	1 mL	1 mL	468668	05/15/24 17:58	AM	EET PIT
	Instrument ID: CHICS2100B									
Total Recoverable	Prep	3005A			50 mL	50 mL	613145	05/15/24 14:00	GK	EET CLE
Total Recoverable	Analysis	EPA 6010D		1			613436	05/17/24 04:12	KLC	EET CLE
	Instrument ID: I9									
Total Recoverable	Prep	3005A			50 mL	50 mL	613145	05/15/24 14:00	GK	EET CLE
Total Recoverable	Analysis	EPA 6020B		1			613785	05/20/24 13:36	RKT	EET CLE
	Instrument ID: I14									
Total/NA	Prep	7470A			25 mL	25 mL	468856	05/16/24 13:30	SJM	EET PIT
Total/NA	Analysis	EPA 7470A		1			469200	05/20/24 11:29	MTW	EET PIT
	Instrument ID: HGY									
Total/NA	Analysis	EPA 9040C		1			468497	05/13/24 16:30	SNR	EET PIT
	Instrument ID: OZ									
Total/NA	Analysis	SM 2540C		1	50 mL	100 mL	468592	05/14/24 14:01	LWM	EET PIT
	Instrument ID: NOEQUIP									
Total/NA	Prep	PrecSep-21			503.71 mL	1.0 g	661791	05/15/24 09:14	MLT	EET SL
Total/NA	Analysis	9315		1			665614	06/10/24 16:48	SCB	EET SL
	Instrument ID: GFPCBLUE									
Total/NA	Prep	PrecSep_0			503.71 mL	1.0 g	661792	05/15/24 09:17	MLT	EET SL
Total/NA	Analysis	9320		1			665182	06/07/24 11:52	SCB	EET SL
	Instrument ID: GFPCPURPLE									
Total/NA	Analysis	Ra226_Ra228		1			665833	06/12/24 08:25	FLC	EET SL
	Instrument ID: NOEQUIP									

Client Sample ID: CCR-AP-2

Lab Sample ID: 180-173844-2

Date Collected: 05/08/24 10:20
Matrix: Water
Date Received: 05/10/24 09:30

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	EPA 9056A		1	1 mL	1 mL	468668	05/15/24 22:53	AM	EET PIT
	Instrument ID: CHICS2100B									
Total/NA	Analysis	EPA 9056A		10	1 mL	1 mL	468668	05/15/24 23:08	AM	EET PIT
	Instrument ID: CHICS2100B									
Total Recoverable	Prep	3005A			50 mL	50 mL	613145	05/15/24 14:00	GK	EET CLE
Total Recoverable	Analysis	EPA 6010D		1			613436	05/17/24 04:17	KLC	EET CLE
	Instrument ID: I9									
Total Recoverable	Prep	3005A			50 mL	50 mL	613145	05/15/24 14:00	GK	EET CLE
Total Recoverable	Analysis	EPA 6020B		1			613785	05/20/24 13:38	RKT	EET CLE
	Instrument ID: I14									
Total/NA	Prep	7470A			25 mL	25 mL	468856	05/16/24 13:30	SJM	EET PIT
Total/NA	Analysis	EPA 7470A		1			469200	05/20/24 11:30	MTW	EET PIT
	Instrument ID: HGY									
Total/NA	Analysis	EPA 9040C		1			468497	05/13/24 16:25	SNR	EET PIT
	Instrument ID: OZ									

Lab Chronicle

Client: Haley & Aldrich, Inc.
Project/Site: CCR Groundwater Monitoring FB Culley East

Job ID: 180-173844-1
SDG: FB Culley East

Client Sample ID: CCR-AP-2

Date Collected: 05/08/24 10:20
Date Received: 05/10/24 09:30

Lab Sample ID: 180-173844-2

Matrix: Water

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	SM 2540C		1	50 mL	100 mL	468592	05/14/24 14:01	LWM	EET PIT
Total/NA	Prep	PrecSep-21			508.03 mL	1.0 g	661791	05/15/24 09:14	MLT	EET SL
Total/NA	Analysis	9315		1			665590	06/10/24 16:39	SCB	EET SL
	Instrument ID: GFPCPURPLE									
Total/NA	Prep	PrecSep_0			508.03 mL	1.0 g	661792	05/15/24 09:17	MLT	EET SL
Total/NA	Analysis	9320		1			665182	06/07/24 11:52	SCB	EET SL
	Instrument ID: GFPCPURPLE									
Total/NA	Analysis	Ra226_Ra228		1			665833	06/12/24 08:25	FLC	EET SL
	Instrument ID: NOEQUIP									

Client Sample ID: CCR-AP-3

Date Collected: 05/07/24 14:00
Date Received: 05/10/24 09:30

Lab Sample ID: 180-173844-3

Matrix: Water

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	EPA 9056A		1	1 mL	1 mL	468504	05/15/24 05:12	M1D	EET PIT
	Instrument ID: INTEGRION									
Total Recoverable	Prep	3005A			50 mL	50 mL	613145	05/15/24 14:00	GK	EET CLE
Total Recoverable	Analysis	EPA 6010D		1			613436	05/17/24 04:21	KLC	EET CLE
	Instrument ID: I9									
Total Recoverable	Prep	3005A			50 mL	50 mL	613145	05/15/24 14:00	GK	EET CLE
Total Recoverable	Analysis	EPA 6020B		1			613785	05/20/24 13:41	RKT	EET CLE
	Instrument ID: I14									
Total/NA	Prep	7470A			25 mL	25 mL	468856	05/16/24 13:30	SJM	EET PIT
Total/NA	Analysis	EPA 7470A		1			469200	05/20/24 11:31	MTW	EET PIT
	Instrument ID: HGY									
Total/NA	Analysis	EPA 9040C		1			468497	05/13/24 17:37	SNR	EET PIT
	Instrument ID: OZ									
Total/NA	Analysis	SM 2540C		1	100 mL	100 mL	468587	05/14/24 13:45	LWM	EET PIT
	Instrument ID: NOEQUIP									
Total/NA	Prep	PrecSep-21			751.56 mL	1.0 g	661791	05/15/24 09:14	MLT	EET SL
Total/NA	Analysis	9315		1			665297	06/10/24 19:02	SCB	EET SL
	Instrument ID: GFPCRED									
Total/NA	Prep	PrecSep_0			751.56 mL	1.0 g	661792	05/15/24 09:17	MLT	EET SL
Total/NA	Analysis	9320		1			665182	06/07/24 11:52	SCB	EET SL
	Instrument ID: GFPCPURPLE									
Total/NA	Analysis	Ra226_Ra228		1			665833	06/12/24 08:25	FLC	EET SL
	Instrument ID: NOEQUIP									

Lab Chronicle

Client: Haley & Aldrich, Inc.
Project/Site: CCR Groundwater Monitoring FB Culley East

Job ID: 180-173844-1
SDG: FB Culley East

Client Sample ID: CCR-AP-4

Date Collected: 05/08/24 09:45
Date Received: 05/10/24 09:30

Lab Sample ID: 180-173844-4

Matrix: Water

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	EPA 9056A		1	1 mL	1 mL	468668	05/15/24 21:54	AM	EET PIT
	Instrument ID: CHICS2100B									
Total Recoverable	Prep	3005A			50 mL	50 mL	613145	05/15/24 14:00	GK	EET CLE
Total Recoverable	Analysis	EPA 6010D		1			613436	05/17/24 04:25	KLC	EET CLE
	Instrument ID: I9									
Total Recoverable	Prep	3005A			50 mL	50 mL	613145	05/15/24 14:00	GK	EET CLE
Total Recoverable	Analysis	EPA 6020B		1			613785	05/20/24 13:43	RKT	EET CLE
	Instrument ID: I14									
Total/NA	Prep	7470A			25 mL	25 mL	468856	05/16/24 13:30	SJM	EET PIT
Total/NA	Analysis	EPA 7470A		1			469200	05/20/24 11:36	MTW	EET PIT
	Instrument ID: HGY									
Total/NA	Analysis	EPA 9040C		1			468497	05/13/24 17:33	SNR	EET PIT
	Instrument ID: OZ									
Total/NA	Analysis	SM 2540C		1	100 mL	100 mL	468592	05/14/24 14:01	LWM	EET PIT
	Instrument ID: NOEQUIP									
Total/NA	Prep	PrecSep-21			750.32 mL	1.0 g	661791	05/15/24 09:14	MLT	EET SL
Total/NA	Analysis	9315		1			665297	06/10/24 19:03	SCB	EET SL
	Instrument ID: GFPCRED									
Total/NA	Prep	PrecSep_0			750.32 mL	1.0 g	661792	05/15/24 09:17	MLT	EET SL
Total/NA	Analysis	9320		1			665182	06/07/24 11:52	SCB	EET SL
	Instrument ID: GFPCPURPLE									
Total/NA	Analysis	Ra226_Ra228		1			665833	06/12/24 08:25	FLC	EET SL
	Instrument ID: NOEQUIP									

Client Sample ID: CCR-AP-6

Date Collected: 05/07/24 13:30
Date Received: 05/10/24 09:30

Lab Sample ID: 180-173844-5

Matrix: Water

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	EPA 9056A		1	1 mL	1 mL	468504	05/15/24 01:30	M1D	EET PIT
	Instrument ID: INTEGRION									
Total Recoverable	Prep	3005A			50 mL	50 mL	613145	05/15/24 14:00	GK	EET CLE
Total Recoverable	Analysis	EPA 6010D		1			613436	05/17/24 04:38	KLC	EET CLE
	Instrument ID: I9									
Total Recoverable	Prep	3005A			50 mL	50 mL	613145	05/15/24 14:00	GK	EET CLE
Total Recoverable	Analysis	EPA 6020B		1			613785	05/20/24 13:46	RKT	EET CLE
	Instrument ID: I14									
Total/NA	Prep	7470A			25 mL	25 mL	468856	05/16/24 13:30	SJM	EET PIT
Total/NA	Analysis	EPA 7470A		1			469200	05/20/24 11:37	MTW	EET PIT
	Instrument ID: HGY									
Total/NA	Analysis	EPA 9040C		1			468497	05/13/24 17:28	SNR	EET PIT
	Instrument ID: OZ									
Total/NA	Analysis	SM 2540C		1	100 mL	100 mL	468587	05/14/24 13:45	LWM	EET PIT
	Instrument ID: NOEQUIP									

Lab Chronicle

Client: Haley & Aldrich, Inc.
Project/Site: CCR Groundwater Monitoring FB Culley East

Job ID: 180-173844-1
SDG: FB Culley East

Client Sample ID: CCR-AP-6

Date Collected: 05/07/24 13:30
Date Received: 05/10/24 09:30

Lab Sample ID: 180-173844-5

Matrix: Water

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	PrecSep-21			751.17 mL	1.0 g	661791	05/15/24 09:14	MLT	EET SL
Total/NA	Analysis	9315		1			665297	06/10/24 19:03	SCB	EET SL
	Instrument ID: GFPCRED									
Total/NA	Prep	PrecSep_0			751.17 mL	1.0 g	661792	05/15/24 09:17	MLT	EET SL
Total/NA	Analysis	9320		1			665181	06/07/24 11:39	SCB	EET SL
	Instrument ID: GFPCORANGE									
Total/NA	Analysis	Ra226_Ra228		1			665833	06/12/24 08:25	FLC	EET SL
	Instrument ID: NOEQUIP									

Client Sample ID: CCR-AP-6I

Date Collected: 05/07/24 13:15
Date Received: 05/10/24 09:30

Lab Sample ID: 180-173844-6

Matrix: Water

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	EPA 9056A		1	1 mL	1 mL	468504	05/14/24 23:21	M1D	EET PIT
	Instrument ID: INTEGRION									
Total/NA	Analysis	EPA 9056A		10	1 mL	1 mL	468504	05/14/24 23:39	M1D	EET PIT
	Instrument ID: INTEGRION									
Total Recoverable	Prep	3005A			50 mL	50 mL	613145	05/15/24 14:00	GK	EET CLE
Total Recoverable	Analysis	EPA 6010D		5			613436	05/17/24 08:23	KLC	EET CLE
	Instrument ID: I9									
Total Recoverable	Prep	3005A			50 mL	50 mL	613145	05/15/24 14:00	GK	EET CLE
Total Recoverable	Analysis	EPA 6020B		1			613785	05/20/24 13:49	RKT	EET CLE
	Instrument ID: I14									
Total/NA	Prep	7470A			25 mL	25 mL	468856	05/16/24 13:30	SJM	EET PIT
Total/NA	Analysis	EPA 7470A		1			469200	05/20/24 11:38	MTW	EET PIT
	Instrument ID: HGY									
Total/NA	Analysis	EPA 9040C		1			468300	05/11/24 10:21	BAB	EET PIT
	Instrument ID: OZ									
Total/NA	Analysis	SM 2540C		1	100 mL	100 mL	468587	05/14/24 13:45	LWM	EET PIT
	Instrument ID: NOEQUIP									
Total/NA	Prep	PrecSep-21			998.97 mL	1.0 g	661791	05/15/24 09:14	MLT	EET SL
Total/NA	Analysis	9315		1			665297	06/10/24 19:03	SCB	EET SL
	Instrument ID: GFPCRED									
Total/NA	Prep	PrecSep_0			998.97 mL	1.0 g	661792	05/15/24 09:17	MLT	EET SL
Total/NA	Analysis	9320		1			665181	06/07/24 13:04	SCB	EET SL
	Instrument ID: GFPCORANGE									
Total/NA	Analysis	Ra226_Ra228		1			665833	06/12/24 08:25	FLC	EET SL
	Instrument ID: NOEQUIP									

Lab Chronicle

Client: Haley & Aldrich, Inc.
Project/Site: CCR Groundwater Monitoring FB Culley East

Job ID: 180-173844-1
SDG: FB Culley East

Client Sample ID: CCR-AP-8I
Date Collected: 05/08/24 11:40
Date Received: 05/10/24 09:30

Lab Sample ID: 180-173844-7
Matrix: Water

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	EPA 9056A		2	1 mL	1 mL	468668	05/15/24 19:41	AM	EET PIT
	Instrument ID: CHICS2100B									
Total/NA	Analysis	EPA 9056A		20	1 mL	1 mL	468668	05/15/24 19:56	AM	EET PIT
	Instrument ID: CHICS2100B									
Total Recoverable	Prep	3005A			50 mL	50 mL	613145	05/15/24 14:00	GK	EET CLE
Total Recoverable	Analysis	EPA 6010D		5			613436	05/17/24 08:27	KLC	EET CLE
	Instrument ID: I9									
Total Recoverable	Prep	3005A			50 mL	50 mL	613145	05/15/24 14:00	GK	EET CLE
Total Recoverable	Analysis	EPA 6020B		1			613785	05/20/24 13:51	RKT	EET CLE
	Instrument ID: I14									
Total/NA	Prep	7470A			25 mL	25 mL	468856	05/16/24 13:30	SJM	EET PIT
Total/NA	Analysis	EPA 7470A		1			469200	05/20/24 11:39	MTW	EET PIT
	Instrument ID: HGY									
Total/NA	Analysis	EPA 9040C		1			468497	05/13/24 17:23	SNR	EET PIT
	Instrument ID: OZ									
Total/NA	Analysis	SM 2540C		1	50 mL	100 mL	468592	05/14/24 14:01	LWM	EET PIT
	Instrument ID: NOEQUIP									
Total/NA	Prep	PrecSep-21			750.38 mL	1.0 g	661791	05/15/24 09:14	MLT	EET SL
Total/NA	Analysis	9315		1			665297	06/10/24 19:04	SCB	EET SL
	Instrument ID: GFPCRED									
Total/NA	Prep	PrecSep_0			750.38 mL	1.0 g	661792	05/15/24 09:17	MLT	EET SL
Total/NA	Analysis	9320		1			665181	06/07/24 11:39	SCB	EET SL
	Instrument ID: GFPCORANGE									
Total/NA	Analysis	Ra226_Ra228		1			665833	06/12/24 08:25	FLC	EET SL
	Instrument ID: NOEQUIP									

Client Sample ID: CCR-AP-9
Date Collected: 05/08/24 12:00
Date Received: 05/10/24 09:30

Lab Sample ID: 180-173844-8
Matrix: Water

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	EPA 9056A		1	1 mL	1 mL	468668	05/15/24 22:24	AM	EET PIT
	Instrument ID: CHICS2100B									
Total Recoverable	Prep	3005A			50 mL	50 mL	613145	05/15/24 14:00	GK	EET CLE
Total Recoverable	Analysis	EPA 6010D		1			613436	05/17/24 04:56	KLC	EET CLE
	Instrument ID: I9									
Total Recoverable	Prep	3005A			50 mL	50 mL	613145	05/15/24 14:00	GK	EET CLE
Total Recoverable	Analysis	EPA 6020B		1			613785	05/20/24 13:54	RKT	EET CLE
	Instrument ID: I14									
Total/NA	Prep	7470A			25 mL	25 mL	468860	05/16/24 13:30	SJM	EET PIT
Total/NA	Analysis	EPA 7470A		1			469200	05/20/24 11:03	MTW	EET PIT
	Instrument ID: HGY									
Total/NA	Analysis	EPA 9040C		1			468300	05/11/24 11:29	BAB	EET PIT
	Instrument ID: OZ									

Lab Chronicle

Client: Haley & Aldrich, Inc.
Project/Site: CCR Groundwater Monitoring FB Culley East

Job ID: 180-173844-1
SDG: FB Culley East

Client Sample ID: CCR-AP-9

Date Collected: 05/08/24 12:00
Date Received: 05/10/24 09:30

Lab Sample ID: 180-173844-8

Matrix: Water

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	SM 2540C		1	50 mL	100 mL	468592	05/14/24 14:01	LWM	EET PIT
Total/NA	Prep	PrecSep-21			505.77 mL	1.0 g	661791	05/15/24 09:14	MLT	EET SL
Total/NA	Analysis	9315		1	1.0 mL	1.0 mL	665297	06/10/24 19:05	SCB	EET SL
	Instrument ID: GFPCRED									
Total/NA	Prep	PrecSep_0			505.77 mL	1.0 g	661792	05/15/24 09:17	MLT	EET SL
Total/NA	Analysis	9320		1			665181	06/07/24 11:40	SCB	EET SL
	Instrument ID: GFPCORANGE									
Total/NA	Analysis	Ra226_Ra228		1			665833	06/12/24 08:25	FLC	EET SL
	Instrument ID: NOEQUIP									

Laboratory References:

EET SL = Eurofins St. Louis, 13715 Rider Trail North, Earth City, MO 63045, TEL (314)298-8566

Analyst References:

Lab: EET CLE
- Batch Type: Prep
  - GK = Grace Kessler
- Batch Type: Analysis
  - KLC = Karen Counts
  - RKT = Roger Toth

Lab: EET PIT
- Batch Type: Prep
  - SJM = Shannon Mueller
- Batch Type: Analysis
  - AM = Adzuira Musule
  - BAB = Brooke Batyi
  - LWM = Leslie McIntire
  - M1D = Maureen Donlin
  - MTW = Michael Wesoloski
  - SNR = Sabra Richart

Lab: EET SL
- Batch Type: Prep
  - MLT = Michaela Tiemeyer
- Batch Type: Analysis
  - FLC = Fernando Cruz
  - SCB = Sarah Bernsen

Client Sample ID: CCR-AP-1R
Date Collected: 05/08/24 11:20
Date Received: 05/10/24 09:30

Lab Sample ID: 180-173844-1
Matrix: Water

Method: SW846 EPA 9056A - Anions, Ion Chromatography

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Chloride	32		5.0	3.6	mg/L			05/15/24 17:58	5
Fluoride	0.25	J	0.50	0.13	mg/L			05/15/24 17:58	5
Sulfate	100		5.0	3.8	mg/L			05/15/24 17:58	5

Method: SW846 EPA 6010D - Metals (ICP) - Total Recoverable

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Boron	0.75		0.10	0.057	mg/L		05/15/24 14:00	05/17/24 04:12	1

Method: SW846 EPA 6020B - Metals (ICP/MS) - Total Recoverable

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Antimony	0.00073	J	0.0020	0.00057	mg/L		05/15/24 14:00	05/20/24 13:36	1
Arsenic	0.0059		0.0050	0.00075	mg/L		05/15/24 14:00	05/20/24 13:36	1
Barium	0.35		0.0050	0.0022	mg/L		05/15/24 14:00	05/20/24 13:36	1
Beryllium	0.00095	J	0.0010	0.00062	mg/L		05/15/24 14:00	05/20/24 13:36	1
Cadmium	ND		0.0010	0.00020	mg/L		05/15/24 14:00	05/20/24 13:36	1
Calcium	61		1.0	0.25	mg/L		05/15/24 14:00	05/20/24 13:36	1
Chromium	0.021		0.0050	0.0012	mg/L		05/15/24 14:00	05/20/24 13:36	1
Cobalt	0.013		0.0010	0.00019	mg/L		05/15/24 14:00	05/20/24 13:36	1
Lead	0.013		0.0010	0.00045	mg/L		05/15/24 14:00	05/20/24 13:36	1
Lithium	0.036		0.0080	0.0017	mg/L		05/15/24 14:00	05/20/24 13:36	1
Molybdenum	0.0053		0.0050	0.0011	mg/L		05/15/24 14:00	05/20/24 13:36	1
Selenium	ND		0.0050	0.00089	mg/L		05/15/24 14:00	05/20/24 13:36	1
Thallium	ND		0.0010	0.00020	mg/L		05/15/24 14:00	05/20/24 13:36	1

Method: SW846 EPA 7470A - Mercury (CVAA)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	ND		0.00020	0.00013	mg/L		05/16/24 13:30	05/20/24 11:29	1

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Dissolved Solids (SM 2540C)	480		20	20	mg/L			05/14/24 14:01	1

Analyte	Result	Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
pH (SW846 EPA 9040C)	7.4	HF	0.1	0.1	SU			05/13/24 16:30	1

Method: SW846 9315 - Radium-226 (GFPC)

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Radium-226	2.32		0.485	0.528	1.00	0.289	pCi/L	05/15/24 09:14	06/10/24 16:48	1

Carrier	*%Yield*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Ba Carrier	*83.1*		*30 - 110*	*05/15/24 09:14*	*06/10/24 16:48*	*1*

Method: SW846 9320 - Radium-228 (GFPC)

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Radium-228	4.98	G	1.26	1.34	1.00	1.35	pCi/L	05/15/24 09:17	06/07/24 11:52	1

Carrier	*%Yield*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Ba Carrier	*83.1*		*30 - 110*	*05/15/24 09:17*	*06/07/24 11:52*	*1*

Client Sample ID: CCR-AP-1R
Lab Sample ID: 180-173844-1

Date Collected: 05/08/24 11:20
Matrix: Water
Date Received: 05/10/24 09:30

Method: SW846 9320 - Radium-228 (GFPC) (Continued)

Carrier	*%Yield*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Y Carrier	*75.9*		*30 - 110*	*05/15/24 09:17*	*06/07/24 11:52*	*1*

Method: TAL-STL Ra226_Ra228 - Combined Radium-226 and Radium-228

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Combined Radium 226 + 228	**7.30**		1.35	1.44	5.00	1.35	pCi/L		06/12/24 08:25	1

Client Sample ID: CCR-AP-2

Date Collected: 05/08/24 10:20
Date Received: 05/10/24 09:30

Lab Sample ID: 180-173844-2

Matrix: Water

Method: SW846 EPA 9056A - Anions, Ion Chromatography

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Chloride	250		10	7.1	mg/L			05/15/24 23:08	10
Fluoride	0.27		0.10	0.026	mg/L			05/15/24 22:53	1
Sulfate	340		10	7.6	mg/L			05/15/24 23:08	10

Method: SW846 EPA 6010D - Metals (ICP) - Total Recoverable

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Boron	8.1		0.10	0.057	mg/L		05/15/24 14:00	05/17/24 04:17	1

Method: SW846 EPA 6020B - Metals (ICP/MS) - Total Recoverable

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Antimony	0.0011	J	0.0020	0.00057	mg/L		05/15/24 14:00	05/20/24 13:38	1
Arsenic	0.025		0.0050	0.00075	mg/L		05/15/24 14:00	05/20/24 13:38	1
Barium	0.83		0.0050	0.0022	mg/L		05/15/24 14:00	05/20/24 13:38	1
Beryllium	0.0037		0.0010	0.00062	mg/L		05/15/24 14:00	05/20/24 13:38	1
Cadmium	0.0030		0.0010	0.00020	mg/L		05/15/24 14:00	05/20/24 13:38	1
Calcium	230		1.0	0.25	mg/L		05/15/24 14:00	05/20/24 13:38	1
Chromium	0.11		0.0050	0.0012	mg/L		05/15/24 14:00	05/20/24 13:38	1
Cobalt	0.048		0.0010	0.00019	mg/L		05/15/24 14:00	05/20/24 13:38	1
Lead	0.056		0.0010	0.00045	mg/L		05/15/24 14:00	05/20/24 13:38	1
Lithium	0.085		0.0080	0.0017	mg/L		05/15/24 14:00	05/20/24 13:38	1
Molybdenum	0.0065		0.0050	0.0011	mg/L		05/15/24 14:00	05/20/24 13:38	1
Selenium	0.0027	J	0.0050	0.00089	mg/L		05/15/24 14:00	05/20/24 13:38	1
Thallium	0.0010		0.0010	0.00020	mg/L		05/15/24 14:00	05/20/24 13:38	1

Method: SW846 EPA 7470A - Mercury (CVAA)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	0.00016	J	0.00020	0.00013	mg/L		05/16/24 13:30	05/20/24 11:30	1

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Dissolved Solids (SM 2540C)	1500		20	20	mg/L			05/14/24 14:01	1

Analyte	Result	Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
pH (SW846 EPA 9040C)	6.7	HF	0.1	0.1	SU			05/13/24 16:25	1

Method: SW846 9315 - Radium-226 (GFPC)

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Radium-226	1.65		0.417	0.442	1.00	0.351	pCi/L	05/15/24 09:14	06/10/24 16:39	1

Carrier	*%Yield*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Ba Carrier	*85.1*		*30 - 110*	*05/15/24 09:14*	*06/10/24 16:39*	*1*

Method: SW846 9320 - Radium-228 (GFPC)

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Radium-228	1.57	G	0.840	0.852	1.00	1.16	pCi/L	05/15/24 09:17	06/07/24 11:52	1

Carrier	*%Yield*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Ba Carrier	*85.1*		*30 - 110*	*05/15/24 09:17*	*06/07/24 11:52*	*1*

Client Sample ID: CCR-AP-2
Date Collected: 05/08/24 10:20
Date Received: 05/10/24 09:30

Lab Sample ID: 180-173844-2
Matrix: Water

Method: SW846 9320 - Radium-228 (GFPC) (Continued)

Carrier	*%Yield*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Y Carrier	*72.1*		*30 - 110*	*05/15/24 09:17*	*06/07/24 11:52*	*1*

Method: TAL-STL Ra226_Ra228 - Combined Radium-226 and Radium-228

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Combined Radium 226 + 228	**3.22**		0.938	0.960	5.00	1.16	pCi/L		06/12/24 08:25	1

Client Sample ID: CCR-AP-3
Lab Sample ID: 180-173844-3

Date Collected: 05/07/24 14:00
Matrix: Water
Date Received: 05/10/24 09:30

Method: SW846 EPA 9056A - Anions, Ion Chromatography

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Chloride	27		1.0	0.71	mg/L			05/15/24 05:12	1
Fluoride	0.35		0.10	0.026	mg/L			05/15/24 05:12	1
Sulfate	32		1.0	0.76	mg/L			05/15/24 05:12	1

Method: SW846 EPA 6010D - Metals (ICP) - Total Recoverable

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Boron	0.28		0.10	0.057	mg/L		05/15/24 14:00	05/17/24 04:21	1

Method: SW846 EPA 6020B - Metals (ICP/MS) - Total Recoverable

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Antimony	ND		0.0020	0.00057	mg/L		05/15/24 14:00	05/20/24 13:41	1
Arsenic	0.051		0.0050	0.00075	mg/L		05/15/24 14:00	05/20/24 13:41	1
Barium	0.38		0.0050	0.0022	mg/L		05/15/24 14:00	05/20/24 13:41	1
Beryllium	ND		0.0010	0.00062	mg/L		05/15/24 14:00	05/20/24 13:41	1
Cadmium	ND		0.0010	0.00020	mg/L		05/15/24 14:00	05/20/24 13:41	1
Calcium	150		1.0	0.25	mg/L		05/15/24 14:00	05/20/24 13:41	1
Chromium	0.0031	J	0.0050	0.0012	mg/L		05/15/24 14:00	05/20/24 13:41	1
Cobalt	0.0061		0.0010	0.00019	mg/L		05/15/24 14:00	05/20/24 13:41	1
Lead	0.00097	J	0.0010	0.00045	mg/L		05/15/24 14:00	05/20/24 13:41	1
Lithium	0.0028	J	0.0080	0.0017	mg/L		05/15/24 14:00	05/20/24 13:41	1
Molybdenum	0.0093		0.0050	0.0011	mg/L		05/15/24 14:00	05/20/24 13:41	1
Selenium	0.0016	J	0.0050	0.00089	mg/L		05/15/24 14:00	05/20/24 13:41	1
Thallium	ND		0.0010	0.00020	mg/L		05/15/24 14:00	05/20/24 13:41	1

Method: SW846 EPA 7470A - Mercury (CVAA)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	ND		0.00020	0.00013	mg/L		05/16/24 13:30	05/20/24 11:31	1

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Dissolved Solids (SM 2540C)	730		10	10	mg/L			05/14/24 13:45	1

Analyte	Result	Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
pH (SW846 EPA 9040C)	7.1	HF	0.1	0.1	SU			05/13/24 17:37	1

Method: SW846 9315 - Radium-226 (GFPC)

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Radium-226	0.400		0.176	0.180	1.00	0.183	pCi/L	05/15/24 09:14	06/10/24 19:02	1

Carrier	*%Yield*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Ba Carrier	*86.1*		*30 - 110*	*05/15/24 09:14*	*06/10/24 19:02*	*1*

Method: SW846 9320 - Radium-228 (GFPC)

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Radium-228	0.495	U	0.459	0.461	1.00	0.722	pCi/L	05/15/24 09:17	06/07/24 11:52	1

Carrier	*%Yield*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Ba Carrier	*86.1*		*30 - 110*	*05/15/24 09:17*	*06/07/24 11:52*	*1*

Client Sample ID: CCR-AP-3
Date Collected: 05/07/24 14:00
Date Received: 05/10/24 09:30

Lab Sample ID: 180-173844-3
Matrix: Water

Method: SW846 9320 - Radium-228 (GFPC) (Continued)

Carrier	*%Yield*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Y Carrier	*74.4*		*30 - 110*	*05/15/24 09:17*	*06/07/24 11:52*	*1*

Method: TAL-STL Ra226_Ra228 - Combined Radium-226 and Radium-228

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Combined Radium 226 + 228	**0.896**		0.492	0.495	5.00	0.722	pCi/L		06/12/24 08:25	1

Client Sample ID: CCR-AP-4
Date Collected: 05/08/24 09:45
Date Received: 05/10/24 09:30

Lab Sample ID: 180-173844-4
Matrix: Water

Method: SW846 EPA 9056A - Anions, Ion Chromatography

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Chloride	**32**		1.0	0.71	mg/L			05/15/24 21:54	1
Fluoride	**0.61**		0.10	0.026	mg/L			05/15/24 21:54	1
Sulfate	**73**		1.0	0.76	mg/L			05/15/24 21:54	1

Method: SW846 EPA 6010D - Metals (ICP) - Total Recoverable

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Boron	**1.1**		0.10	0.057	mg/L		05/15/24 14:00	05/17/24 04:25	1

Method: SW846 EPA 6020B - Metals (ICP/MS) - Total Recoverable

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Antimony	ND		0.0020	0.00057	mg/L		05/15/24 14:00	05/20/24 13:43	1
Arsenic	**0.027**		0.0050	0.00075	mg/L		05/15/24 14:00	05/20/24 13:43	1
Barium	**0.53**		0.0050	0.0022	mg/L		05/15/24 14:00	05/20/24 13:43	1
Beryllium	ND		0.0010	0.00062	mg/L		05/15/24 14:00	05/20/24 13:43	1
Cadmium	ND		0.0010	0.00020	mg/L		05/15/24 14:00	05/20/24 13:43	1
Calcium	**130**		1.0	0.25	mg/L		05/15/24 14:00	05/20/24 13:43	1
Chromium	ND		0.0050	0.0012	mg/L		05/15/24 14:00	05/20/24 13:43	1
Cobalt	**0.0028**		0.0010	0.00019	mg/L		05/15/24 14:00	05/20/24 13:43	1
Lead	ND		0.0010	0.00045	mg/L		05/15/24 14:00	05/20/24 13:43	1
Lithium	**0.0045**	**J**	0.0080	0.0017	mg/L		05/15/24 14:00	05/20/24 13:43	1
Molybdenum	**0.017**		0.0050	0.0011	mg/L		05/15/24 14:00	05/20/24 13:43	1
Selenium	ND		0.0050	0.00089	mg/L		05/15/24 14:00	05/20/24 13:43	1
Thallium	ND		0.0010	0.00020	mg/L		05/15/24 14:00	05/20/24 13:43	1

Method: SW846 EPA 7470A - Mercury (CVAA)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	ND		0.00020	0.00013	mg/L		05/16/24 13:30	05/20/24 11:36	1

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Dissolved Solids (SM 2540C)	**690**		10	10	mg/L			05/14/24 14:01	1

Analyte	Result	Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
pH (SW846 EPA 9040C)	**7.0**	**HF**	0.1	0.1	SU			05/13/24 17:33	1

Method: SW846 9315 - Radium-226 (GFPC)

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Radium-226	**0.337**		0.167	0.170	1.00	0.186	pCi/L	05/15/24 09:14	06/10/24 19:03	1

Carrier	*%Yield*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Ba Carrier	*83.6*		*30 - 110*	*05/15/24 09:14*	*06/10/24 19:03*	*1*

Method: SW846 9320 - Radium-228 (GFPC)

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Radium-228	0.869	U	0.641	0.646	1.00	0.985	pCi/L	05/15/24 09:17	06/07/24 11:52	1

Carrier	*%Yield*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Ba Carrier	*83.6*		*30 - 110*	*05/15/24 09:17*	*06/07/24 11:52*	*1*

Client Sample ID: CCR-AP-4
Date Collected: 05/08/24 09:45
Date Received: 05/10/24 09:30

Lab Sample ID: 180-173844-4
Matrix: Water

Method: SW846 9320 - Radium-228 (GFPC) (Continued)

Carrier	%Yield	Qualifier	Limits	Prepared	Analyzed	Dil Fac
Y Carrier	75.5		30 - 110	05/15/24 09:17	06/07/24 11:52	1

Method: TAL-STL Ra226_Ra228 - Combined Radium-226 and Radium-228

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Combined Radium 226 + 228	1.21		0.662	0.668	5.00	0.985	pCi/L		06/12/24 08:25	1

Client Sample ID: CCR-AP-6

Date Collected: 05/07/24 13:30
Date Received: 05/10/24 09:30

Lab Sample ID: 180-173844-5

Matrix: Water

Method: SW846 EPA 9056A - Anions, Ion Chromatography

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Chloride	36		1.0	0.71	mg/L			05/15/24 01:30	1
Fluoride	0.37		0.10	0.026	mg/L			05/15/24 01:30	1
Sulfate	46		1.0	0.76	mg/L			05/15/24 01:30	1

Method: SW846 EPA 6010D - Metals (ICP) - Total Recoverable

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Boron	0.66		0.10	0.057	mg/L		05/15/24 14:00	05/17/24 04:38	1

Method: SW846 EPA 6020B - Metals (ICP/MS) - Total Recoverable

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Antimony	0.00082	J	0.0020	0.00057	mg/L		05/15/24 14:00	05/20/24 13:46	1
Arsenic	0.057		0.0050	0.00075	mg/L		05/15/24 14:00	05/20/24 13:46	1
Barium	0.43		0.0050	0.0022	mg/L		05/15/24 14:00	05/20/24 13:46	1
Beryllium	ND		0.0010	0.00062	mg/L		05/15/24 14:00	05/20/24 13:46	1
Cadmium	ND		0.0010	0.00020	mg/L		05/15/24 14:00	05/20/24 13:46	1
Calcium	110		1.0	0.25	mg/L		05/15/24 14:00	05/20/24 13:46	1
Chromium	0.0027	J	0.0050	0.0012	mg/L		05/15/24 14:00	05/20/24 13:46	1
Cobalt	0.0034		0.0010	0.00019	mg/L		05/15/24 14:00	05/20/24 13:46	1
Lead	0.0012		0.0010	0.00045	mg/L		05/15/24 14:00	05/20/24 13:46	1
Lithium	0.0057	J	0.0080	0.0017	mg/L		05/15/24 14:00	05/20/24 13:46	1
Molybdenum	0.043		0.0050	0.0011	mg/L		05/15/24 14:00	05/20/24 13:46	1
Selenium	ND		0.0050	0.00089	mg/L		05/15/24 14:00	05/20/24 13:46	1
Thallium	ND		0.0010	0.00020	mg/L		05/15/24 14:00	05/20/24 13:46	1

Method: SW846 EPA 7470A - Mercury (CVAA)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	ND		0.00020	0.00013	mg/L		05/16/24 13:30	05/20/24 11:37	1

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Dissolved Solids (SM 2540C)	530		10	10	mg/L			05/14/24 13:45	1

Analyte	Result	Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
pH (SW846 EPA 9040C)	7.2	HF	0.1	0.1	SU			05/13/24 17:28	1

Method: SW846 9315 - Radium-226 (GFPC)

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Radium-226	0.541		0.228	0.233	1.00	0.274	pCi/L	05/15/24 09:14	06/10/24 19:03	1

Carrier	*%Yield*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Ba Carrier	*85.6*		*30 - 110*	*05/15/24 09:14*	*06/10/24 19:03*	*1*

Method: SW846 9320 - Radium-228 (GFPC)

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Radium-228	0.169	U	0.446	0.446	1.00	0.789	pCi/L	05/15/24 09:17	06/07/24 11:39	1

Carrier	*%Yield*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Ba Carrier	*85.6*		*30 - 110*	*05/15/24 09:17*	*06/07/24 11:39*	*1*

Client Sample ID: CCR-AP-6
Lab Sample ID: 180-173844-5

Date Collected: 05/07/24 13:30
Matrix: Water
Date Received: 05/10/24 09:30

Method: SW846 9320 - Radium-228 (GFPC) (Continued)

Carrier	*%Yield*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Y Carrier	*78.9*		*30 - 110*	*05/15/24 09:17*	*06/07/24 11:39*	*1*

Method: TAL-STL Ra226_Ra228 - Combined Radium-226 and Radium-228

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Combined Radium 226 + 228	0.710	U	0.501	0.503	5.00	0.789	pCi/L		06/12/24 08:25	1

Client Sample ID: CCR-AP-6I

Date Collected: 05/07/24 13:15
Date Received: 05/10/24 09:30

Lab Sample ID: 180-173844-6

Matrix: Water

Method: SW846 EPA 9056A - Anions, Ion Chromatography

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Chloride	**87**		1.0	0.71	mg/L			05/14/24 23:21	1
Fluoride	**0.13**		0.10	0.026	mg/L			05/14/24 23:21	1
Sulfate	**430**		10	7.6	mg/L			05/14/24 23:39	10

Method: SW846 EPA 6010D - Metals (ICP) - Total Recoverable

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Boron	**15**		0.50	0.29	mg/L		05/15/24 14:00	05/17/24 08:23	5

Method: SW846 EPA 6020B - Metals (ICP/MS) - Total Recoverable

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Antimony	ND		0.0020	0.00057	mg/L		05/15/24 14:00	05/20/24 13:49	1
Arsenic	**0.0057**		0.0050	0.00075	mg/L		05/15/24 14:00	05/20/24 13:49	1
Barium	**0.041**		0.0050	0.0022	mg/L		05/15/24 14:00	05/20/24 13:49	1
Beryllium	ND		0.0010	0.00062	mg/L		05/15/24 14:00	05/20/24 13:49	1
Cadmium	**0.00028**	**J**	0.0010	0.00020	mg/L		05/15/24 14:00	05/20/24 13:49	1
Calcium	**250**		1.0	0.25	mg/L		05/15/24 14:00	05/20/24 13:49	1
Chromium	ND		0.0050	0.0012	mg/L		05/15/24 14:00	05/20/24 13:49	1
Cobalt	**0.00062**	**J**	0.0010	0.00019	mg/L		05/15/24 14:00	05/20/24 13:49	1
Lead	ND		0.0010	0.00045	mg/L		05/15/24 14:00	05/20/24 13:49	1
Lithium	**0.083**		0.0080	0.0017	mg/L		05/15/24 14:00	05/20/24 13:49	1
Molybdenum	**0.86**		0.0050	0.0011	mg/L		05/15/24 14:00	05/20/24 13:49	1
Selenium	ND		0.0050	0.00089	mg/L		05/15/24 14:00	05/20/24 13:49	1
Thallium	ND		0.0010	0.00020	mg/L		05/15/24 14:00	05/20/24 13:49	1

Method: SW846 EPA 7470A - Mercury (CVAA)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	ND		0.00020	0.00013	mg/L		05/16/24 13:30	05/20/24 11:38	1

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Dissolved Solids (SM 2540C)	**1200**		10	10	mg/L			05/14/24 13:45	1

Analyte	Result	Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
pH (SW846 EPA 9040C)	**7.4**	**HF**	0.1	0.1	SU			05/11/24 10:21	1

Method: SW846 9315 - Radium-226 (GFPC)

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Radium-226	0.159	U	0.114	0.115	1.00	0.161	pCi/L	05/15/24 09:14	06/10/24 19:03	1

Carrier	*%Yield*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Ba Carrier	*90.0*		*30 - 110*	*05/15/24 09:14*	*06/10/24 19:03*	*1*

Method: SW846 9320 - Radium-228 (GFPC)

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Radium-228	**0.536**		0.366	0.370	1.00	0.535	pCi/L	05/15/24 09:17	06/07/24 13:04	1

Carrier	*%Yield*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Ba Carrier	*90.0*		*30 - 110*	*05/15/24 09:17*	*06/07/24 13:04*	*1*

Client Sample ID: CCR-AP-6I
Date Collected: 05/07/24 13:15
Date Received: 05/10/24 09:30

Lab Sample ID: 180-173844-6
Matrix: Water

Method: SW846 9320 - Radium-228 (GFPC) (Continued)

Carrier	*%Yield*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Y Carrier	*78.9*		*30 - 110*	*05/15/24 09:17*	*06/07/24 13:04*	*1*

Method: TAL-STL Ra226_Ra228 - Combined Radium-226 and Radium-228

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Combined Radium 226 + 228	**0.695**		0.383	0.387	5.00	0.535	pCi/L		06/12/24 08:25	1

Client Sample ID: CCR-AP-8I

Date Collected: 05/08/24 11:40
Date Received: 05/10/24 09:30

Lab Sample ID: 180-173844-7

Matrix: Water

Method: SW846 EPA 9056A - Anions, Ion Chromatography

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Chloride	**180**		2.0	1.4	mg/L			05/15/24 19:41	2
Fluoride	**0.12**	**J**	0.20	0.052	mg/L			05/15/24 19:41	2
Sulfate	**1100**		20	15	mg/L			05/15/24 19:56	20

Method: SW846 EPA 6010D - Metals (ICP) - Total Recoverable

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Boron	**33**		0.50	0.29	mg/L		05/15/24 14:00	05/17/24 08:27	5

Method: SW846 EPA 6020B - Metals (ICP/MS) - Total Recoverable

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Antimony	ND		0.0020	0.00057	mg/L		05/15/24 14:00	05/20/24 13:51	1
Arsenic	**0.0013**	**J**	0.0050	0.00075	mg/L		05/15/24 14:00	05/20/24 13:51	1
Barium	**0.34**		0.0050	0.0022	mg/L		05/15/24 14:00	05/20/24 13:51	1
Beryllium	ND		0.0010	0.00062	mg/L		05/15/24 14:00	05/20/24 13:51	1
Cadmium	ND		0.0010	0.00020	mg/L		05/15/24 14:00	05/20/24 13:51	1
Calcium	**490**		1.0	0.25	mg/L		05/15/24 14:00	05/20/24 13:51	1
Chromium	ND		0.0050	0.0012	mg/L		05/15/24 14:00	05/20/24 13:51	1
Cobalt	**0.00065**	**J**	0.0010	0.00019	mg/L		05/15/24 14:00	05/20/24 13:51	1
Lead	ND		0.0010	0.00045	mg/L		05/15/24 14:00	05/20/24 13:51	1
Lithium	**0.17**		0.0080	0.0017	mg/L		05/15/24 14:00	05/20/24 13:51	1
Molybdenum	**0.29**		0.0050	0.0011	mg/L		05/15/24 14:00	05/20/24 13:51	1
Selenium	ND		0.0050	0.00089	mg/L		05/15/24 14:00	05/20/24 13:51	1
Thallium	ND		0.0010	0.00020	mg/L		05/15/24 14:00	05/20/24 13:51	1

Method: SW846 EPA 7470A - Mercury (CVAA)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	ND		0.00020	0.00013	mg/L		05/16/24 13:30	05/20/24 11:39	1

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Dissolved Solids (SM 2540C)	**2400**		20	20	mg/L			05/14/24 14:01	1

Analyte	Result	Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
pH (SW846 EPA 9040C)	**7.3**	**HF**	0.1	0.1	SU			05/13/24 17:23	1

Method: SW846 9315 - Radium-226 (GFPC)

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Radium-226	**0.804**		0.216	0.228	1.00	0.153	pCi/L	05/15/24 09:14	06/10/24 19:04	1

Carrier	*%Yield*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Ba Carrier	*99.0*		*30 - 110*	*05/15/24 09:14*	*06/10/24 19:04*	*1*

Method: SW846 9320 - Radium-228 (GFPC)

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Radium-228	**1.15**		0.562	0.572	1.00	0.787	pCi/L	05/15/24 09:17	06/07/24 11:39	1

Carrier	*%Yield*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Ba Carrier	*99.0*		*30 - 110*	*05/15/24 09:17*	*06/07/24 11:39*	*1*

Client Sample ID: CCR-AP-8I
Date Collected: 05/08/24 11:40
Date Received: 05/10/24 09:30

Lab Sample ID: 180-173844-7
Matrix: Water

Method: SW846 9320 - Radium-228 (GFPC) (Continued)

Carrier	*%Yield*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Y Carrier	*74.0*		*30 - 110*	*05/15/24 09:17*	*06/07/24 11:39*	*1*

Method: TAL-STL Ra226_Ra228 - Combined Radium-226 and Radium-228

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Combined Radium 226 + 228	**1.95**		0.602	0.616	5.00	0.787	pCi/L		06/12/24 08:25	1

Client Sample ID: CCR-AP-9

Date Collected: 05/08/24 12:00
Date Received: 05/10/24 09:30

Lab Sample ID: 180-173844-8

Matrix: Water

Method: SW846 EPA 9056A - Anions, Ion Chromatography

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Chloride	9.6		1.0	0.71	mg/L			05/15/24 22:24	1
Fluoride	0.30		0.10	0.026	mg/L			05/15/24 22:24	1
Sulfate	130		1.0	0.76	mg/L			05/15/24 22:24	1

Method: SW846 EPA 6010D - Metals (ICP) - Total Recoverable

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Boron	0.39		0.10	0.057	mg/L		05/15/24 14:00	05/17/24 04:56	1

Method: SW846 EPA 6020B - Metals (ICP/MS) - Total Recoverable

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Antimony	ND		0.0020	0.00057	mg/L		05/15/24 14:00	05/20/24 13:54	1
Arsenic	0.0039	J	0.0050	0.00075	mg/L		05/15/24 14:00	05/20/24 13:54	1
Barium	0.17		0.0050	0.0022	mg/L		05/15/24 14:00	05/20/24 13:54	1
Beryllium	ND		0.0010	0.00062	mg/L		05/15/24 14:00	05/20/24 13:54	1
Cadmium	ND		0.0010	0.00020	mg/L		05/15/24 14:00	05/20/24 13:54	1
Calcium	130		1.0	0.25	mg/L		05/15/24 14:00	05/20/24 13:54	1
Chromium	0.010		0.0050	0.0012	mg/L		05/15/24 14:00	05/20/24 13:54	1
Cobalt	0.0061		0.0010	0.00019	mg/L		05/15/24 14:00	05/20/24 13:54	1
Lead	0.0047		0.0010	0.00045	mg/L		05/15/24 14:00	05/20/24 13:54	1
Lithium	0.038		0.0080	0.0017	mg/L		05/15/24 14:00	05/20/24 13:54	1
Molybdenum	0.0017	J	0.0050	0.0011	mg/L		05/15/24 14:00	05/20/24 13:54	1
Selenium	ND		0.0050	0.00089	mg/L		05/15/24 14:00	05/20/24 13:54	1
Thallium	ND		0.0010	0.00020	mg/L		05/15/24 14:00	05/20/24 13:54	1

Method: SW846 EPA 7470A - Mercury (CVAA)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	ND		0.00020	0.00013	mg/L		05/16/24 13:30	05/20/24 11:03	1

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Dissolved Solids (SM 2540C)	2400		20	20	mg/L			05/14/24 14:01	1

Analyte	Result	Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
pH (SW846 EPA 9040C)	7.2	HF	0.1	0.1	SU			05/11/24 11:29	1

Method: SW846 9315 - Radium-226 (GFPC)

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Radium-226	3.35		0.549	0.626	1.00	0.272	pCi/L	05/15/24 09:14	06/10/24 19:05	1

Carrier	*%Yield*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Ba Carrier	*90.5*		*30 - 110*	*05/15/24 09:14*	*06/10/24 19:05*	*1*

Method: SW846 9320 - Radium-228 (GFPC)

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Radium-228	2.98	G	0.929	0.969	1.00	1.07	pCi/L	05/15/24 09:17	06/07/24 11:40	1

Carrier	*%Yield*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Ba Carrier	*90.5*		*30 - 110*	*05/15/24 09:17*	*06/07/24 11:40*	*1*

Client Sample ID: CCR-AP-9
Lab Sample ID: 180-173844-8

Date Collected: 05/08/24 12:00
Matrix: Water
Date Received: 05/10/24 09:30

Method: SW846 9320 - Radium-228 (GFPC) (Continued)

Carrier	*%Yield*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Y Carrier	*78.9*		*30 - 110*	*05/15/24 09:17*	*06/07/24 11:40*	*1*

Method: TAL-STL Ra226_Ra228 - Combined Radium-226 and Radium-228

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Combined Radium 226 + 228	**6.33**		1.08	1.15	5.00	1.07	pCi/L		06/12/24 08:25	1

Method: EPA 9056A - Anions, Ion Chromatography

Lab Sample ID: MB 180-468504/45
Matrix: Water
Analysis Batch: 468504

Client Sample ID: Method Blank
Prep Type: Total/NA

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Chloride	ND		1.0	0.71	mg/L			05/14/24 23:58	1
Fluoride	ND		0.10	0.026	mg/L			05/14/24 23:58	1
Sulfate	ND		1.0	0.76	mg/L			05/14/24 23:58	1

Lab Sample ID: MB 180-468504/6
Matrix: Water
Analysis Batch: 468504

Client Sample ID: Method Blank
Prep Type: Total/NA

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Chloride	ND		1.0	0.71	mg/L			05/14/24 11:05	1
Fluoride	ND		0.10	0.026	mg/L			05/14/24 11:05	1
Sulfate	ND		1.0	0.76	mg/L			05/14/24 11:05	1

Lab Sample ID: LCS 180-468504/46
Matrix: Water
Analysis Batch: 468504

Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec Limits
Chloride	50.0	50.3		mg/L		101	80 - 120
Fluoride	2.50	2.52		mg/L		101	80 - 120
Sulfate	50.0	49.9		mg/L		100	80 - 120

Lab Sample ID: LCS 180-468504/7
Matrix: Water
Analysis Batch: 468504

Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec Limits
Chloride	50.0	50.0		mg/L		100	80 - 120
Fluoride	2.50	2.53		mg/L		101	80 - 120
Sulfate	50.0	49.7		mg/L		99	80 - 120

Lab Sample ID: MB 180-468668/6
Matrix: Water
Analysis Batch: 468668

Client Sample ID: Method Blank
Prep Type: Total/NA

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Chloride	ND		1.0	0.71	mg/L			05/15/24 10:48	1
Fluoride	ND		0.10	0.026	mg/L			05/15/24 10:48	1
Sulfate	ND		1.0	0.76	mg/L			05/15/24 10:48	1

Lab Sample ID: LCS 180-468668/7
Matrix: Water
Analysis Batch: 468668

Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec Limits
Chloride	50.0	50.2		mg/L		100	80 - 120
Fluoride	2.50	2.49		mg/L		99	80 - 120
Sulfate	50.0	49.9		mg/L		100	80 - 120

Method: EPA 6010D - Metals (ICP)

Lab Sample ID: MB 240-613145/1-A
Matrix: Water
Analysis Batch: 613436

Client Sample ID: Method Blank
Prep Type: Total Recoverable
Prep Batch: 613145

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Boron	ND		0.10	0.057	mg/L		05/15/24 14:00	05/17/24 03:00	1

Lab Sample ID: LCS 240-613145/2-A
Matrix: Water
Analysis Batch: 613436

Client Sample ID: Lab Control Sample
Prep Type: Total Recoverable
Prep Batch: 613145

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec Limits
Boron	1.00	1.04		mg/L		104	80 - 120

Method: EPA 6020B - Metals (ICP/MS)

Lab Sample ID: MB 240-613145/1-A
Matrix: Water
Analysis Batch: 613785

Client Sample ID: Method Blank
Prep Type: Total Recoverable
Prep Batch: 613145

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Antimony	ND		0.0020	0.00057	mg/L		05/15/24 14:00	05/20/24 12:45	1
Arsenic	ND		0.0050	0.00075	mg/L		05/15/24 14:00	05/20/24 12:45	1
Barium	ND		0.0050	0.0022	mg/L		05/15/24 14:00	05/20/24 12:45	1
Beryllium	ND		0.0010	0.00062	mg/L		05/15/24 14:00	05/20/24 12:45	1
Cadmium	ND		0.0010	0.00020	mg/L		05/15/24 14:00	05/20/24 12:45	1
Calcium	ND		1.0	0.25	mg/L		05/15/24 14:00	05/20/24 12:45	1
Chromium	ND		0.0050	0.0012	mg/L		05/15/24 14:00	05/20/24 12:45	1
Cobalt	ND		0.0010	0.00019	mg/L		05/15/24 14:00	05/20/24 12:45	1
Lead	ND		0.0010	0.00045	mg/L		05/15/24 14:00	05/20/24 12:45	1
Lithium	ND		0.0080	0.0017	mg/L		05/15/24 14:00	05/20/24 12:45	1
Molybdenum	ND		0.0050	0.0011	mg/L		05/15/24 14:00	05/20/24 12:45	1
Selenium	ND		0.0050	0.00089	mg/L		05/15/24 14:00	05/20/24 12:45	1
Thallium	ND		0.0010	0.00020	mg/L		05/15/24 14:00	05/20/24 12:45	1

Lab Sample ID: LCS 240-613145/3-A
Matrix: Water
Analysis Batch: 613785

Client Sample ID: Lab Control Sample
Prep Type: Total Recoverable
Prep Batch: 613145

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec Limits
Antimony	0.100	0.0942		mg/L		94	80 - 120
Arsenic	1.00	0.944		mg/L		94	80 - 120
Barium	1.00	0.933		mg/L		93	80 - 120
Beryllium	0.500	0.468		mg/L		94	80 - 120
Cadmium	0.500	0.479		mg/L		96	80 - 120
Calcium	25.0	24.5		mg/L		98	80 - 120
Chromium	0.500	0.481		mg/L		96	80 - 120
Cobalt	0.500	0.482		mg/L		96	80 - 120
Lead	0.500	0.488		mg/L		98	80 - 120
Lithium	0.500	0.518		mg/L		104	80 - 120
Molybdenum	0.500	0.469		mg/L		94	80 - 120
Selenium	1.00	0.951		mg/L		95	80 - 120
Thallium	1.00	0.970		mg/L		97	80 - 120

Method: EPA 7470A - Mercury (CVAA)

Lab Sample ID: MB 180-468856/1-A
Matrix: Water
Analysis Batch: 469200

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 468856

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	ND		0.00020	0.00013	mg/L		05/16/24 13:30	05/20/24 11:08	1

Lab Sample ID: LCS 180-468856/2-A
Matrix: Water
Analysis Batch: 469200

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 468856

Analyte			Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec Limits		
Mercury			0.00250	0.00260		mg/L		104	80 - 120		

Lab Sample ID: MB 180-468860/1-A
Matrix: Water
Analysis Batch: 469200

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 468860

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	ND		0.00020	0.00013	mg/L		05/16/24 13:30	05/20/24 10:35	1

Lab Sample ID: LCS 180-468860/2-A
Matrix: Water
Analysis Batch: 469200

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 468860

Analyte			Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec Limits		
Mercury			0.00250	0.00254		mg/L		101	80 - 120		

Method: EPA 9040C - pH

Lab Sample ID: LCS 180-468300/1
Matrix: Water
Analysis Batch: 468300

Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Analyte			Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec Limits		
pH			7.00	7.0		SU		100	99 - 101		

Lab Sample ID: 180-173844-6 DU
Matrix: Water
Analysis Batch: 468300

Client Sample ID: CCR-AP-6I
Prep Type: Total/NA

Analyte	Sample Result	Sample Qualifier		DU Result	DU Qualifier	Unit	D			RPD	RPD Limit
pH	7.4	HF		7.4		SU				0.1	2

Lab Sample ID: LCS 180-468497/1
Matrix: Water
Analysis Batch: 468497

Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Analyte			Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec Limits		
pH			7.00	7.0		SU		100	99 - 101		

Method: SM 2540C - Solids, Total Dissolved (TDS)

Lab Sample ID: MB 180-468587/1
Matrix: Water
Analysis Batch: 468587

Client Sample ID: Method Blank
Prep Type: Total/NA

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Dissolved Solids	ND		10	10	mg/L			05/14/24 13:45	1

Lab Sample ID: LCS 180-468587/2
Matrix: Water
Analysis Batch: 468587

Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec Limits
Total Dissolved Solids	417	426		mg/L		102	85 - 115

Lab Sample ID: MB 180-468592/1
Matrix: Water
Analysis Batch: 468592

Client Sample ID: Method Blank
Prep Type: Total/NA

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Dissolved Solids	ND		10	10	mg/L			05/14/24 14:01	1

Lab Sample ID: LCS 180-468592/2
Matrix: Water
Analysis Batch: 468592

Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec Limits
Total Dissolved Solids	417	424		mg/L		102	85 - 115

Method: 9315 - Radium-226 (GFPC)

Lab Sample ID: MB 160-661791/1-A
Matrix: Water
Analysis Batch: 665297

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 661791

Analyte	MB Result	MB Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Radium-226	0.01654	U	0.0608	0.0608	1.00	0.121	pCi/L	05/15/24 09:14	06/10/24 16:32	1

Carrier	*MB %Yield*	*MB Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Ba Carrier	*94.0*		*30 - 110*	*05/15/24 09:14*	*06/10/24 16:32*	*1*

Lab Sample ID: LCS 160-661791/2-A
Matrix: Water
Analysis Batch: 665297

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 661791

Analyte	Spike Added	LCS Result	LCS Qual	Total Uncert. (2σ+/-)	RL	MDC	Unit	%Rec	%Rec Limits
Radium-226	11.3	10.47		1.18	1.00	0.156	pCi/L	92	75 - 125

Carrier	*LCS %Yield*	*LCS Qualifier*	*Limits*
Ba Carrier	*78.9*		*30 - 110*

Method: 9320 - Radium-228 (GFPC)

Lab Sample ID: MB 160-661792/1-A
Matrix: Water
Analysis Batch: 665182

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 661792

Analyte	MB Result	MB Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Radium-228	0.5941		0.362	0.367	1.00	0.526	pCi/L	05/15/24 09:17	06/07/24 11:51	1

Carrier	*MB %Yield*	*MB Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Ba Carrier	*94.0*		*30 - 110*	*05/15/24 09:17*	*06/07/24 11:51*	*1*
Y Carrier	*77.4*		*30 - 110*	*05/15/24 09:17*	*06/07/24 11:51*	*1*

Lab Sample ID: LCS 160-661792/2-A
Matrix: Water
Analysis Batch: 665182

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 661792

Analyte			Spike Added	LCS Result	LCS Qual	Total Uncert. (2σ+/-)	RL	MDC	Unit	%Rec	%Rec Limits		
Radium-228			8.87	10.19		1.45	1.00	0.679	pCi/L	115	75 - 125		

Carrier	*LCS %Yield*	*LCS Qualifier*	*Limits*
Ba Carrier	*78.9*		*30 - 110*
Y Carrier	*78.5*		*30 - 110*

HPLC/IC

Analysis Batch: 468504

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-173844-3	CCR-AP-3	Total/NA	Water	EPA 9056A	
180-173844-5	CCR-AP-6	Total/NA	Water	EPA 9056A	
180-173844-6	CCR-AP-6I	Total/NA	Water	EPA 9056A	
180-173844-6	CCR-AP-6I	Total/NA	Water	EPA 9056A	
MB 180-468504/45	Method Blank	Total/NA	Water	EPA 9056A	
MB 180-468504/6	Method Blank	Total/NA	Water	EPA 9056A	
LCS 180-468504/46	Lab Control Sample	Total/NA	Water	EPA 9056A	
LCS 180-468504/7	Lab Control Sample	Total/NA	Water	EPA 9056A	

Analysis Batch: 468668

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-173844-1	CCR-AP-1R	Total/NA	Water	EPA 9056A	
180-173844-2	CCR-AP-2	Total/NA	Water	EPA 9056A	
180-173844-2	CCR-AP-2	Total/NA	Water	EPA 9056A	
180-173844-4	CCR-AP-4	Total/NA	Water	EPA 9056A	
180-173844-7	CCR-AP-8I	Total/NA	Water	EPA 9056A	
180-173844-7	CCR-AP-8I	Total/NA	Water	EPA 9056A	
180-173844-8	CCR-AP-9	Total/NA	Water	EPA 9056A	
MB 180-468668/6	Method Blank	Total/NA	Water	EPA 9056A	
LCS 180-468668/7	Lab Control Sample	Total/NA	Water	EPA 9056A	

Metals

Prep Batch: 468856

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-173844-1	CCR-AP-1R	Total/NA	Water	7470A	
180-173844-2	CCR-AP-2	Total/NA	Water	7470A	
180-173844-3	CCR-AP-3	Total/NA	Water	7470A	
180-173844-4	CCR-AP-4	Total/NA	Water	7470A	
180-173844-5	CCR-AP-6	Total/NA	Water	7470A	
180-173844-6	CCR-AP-6I	Total/NA	Water	7470A	
180-173844-7	CCR-AP-8I	Total/NA	Water	7470A	
MB 180-468856/1-A	Method Blank	Total/NA	Water	7470A	
LCS 180-468856/2-A	Lab Control Sample	Total/NA	Water	7470A	

Prep Batch: 468860

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-173844-8	CCR-AP-9	Total/NA	Water	7470A	
MB 180-468860/1-A	Method Blank	Total/NA	Water	7470A	
LCS 180-468860/2-A	Lab Control Sample	Total/NA	Water	7470A	

Analysis Batch: 469200

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-173844-1	CCR-AP-1R	Total/NA	Water	EPA 7470A	468856
180-173844-2	CCR-AP-2	Total/NA	Water	EPA 7470A	468856
180-173844-3	CCR-AP-3	Total/NA	Water	EPA 7470A	468856
180-173844-4	CCR-AP-4	Total/NA	Water	EPA 7470A	468856
180-173844-5	CCR-AP-6	Total/NA	Water	EPA 7470A	468856
180-173844-6	CCR-AP-6I	Total/NA	Water	EPA 7470A	468856
180-173844-7	CCR-AP-8I	Total/NA	Water	EPA 7470A	468856
180-173844-8	CCR-AP-9	Total/NA	Water	EPA 7470A	468860

Metals (Continued)

Analysis Batch: 469200 (Continued)

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
MB 180-468856/1-A	Method Blank	Total/NA	Water	EPA 7470A	468856
MB 180-468860/1-A	Method Blank	Total/NA	Water	EPA 7470A	468860
LCS 180-468856/2-A	Lab Control Sample	Total/NA	Water	EPA 7470A	468856
LCS 180-468860/2-A	Lab Control Sample	Total/NA	Water	EPA 7470A	468860

Prep Batch: 613145

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-173844-1	CCR-AP-1R	Total Recoverable	Water	3005A	
180-173844-2	CCR-AP-2	Total Recoverable	Water	3005A	
180-173844-3	CCR-AP-3	Total Recoverable	Water	3005A	
180-173844-4	CCR-AP-4	Total Recoverable	Water	3005A	
180-173844-5	CCR-AP-6	Total Recoverable	Water	3005A	
180-173844-6	CCR-AP-6I	Total Recoverable	Water	3005A	
180-173844-7	CCR-AP-8I	Total Recoverable	Water	3005A	
180-173844-8	CCR-AP-9	Total Recoverable	Water	3005A	
MB 240-613145/1-A	Method Blank	Total Recoverable	Water	3005A	
LCS 240-613145/2-A	Lab Control Sample	Total Recoverable	Water	3005A	
LCS 240-613145/3-A	Lab Control Sample	Total Recoverable	Water	3005A	

Analysis Batch: 613436

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-173844-1	CCR-AP-1R	Total Recoverable	Water	EPA 6010D	613145
180-173844-2	CCR-AP-2	Total Recoverable	Water	EPA 6010D	613145
180-173844-3	CCR-AP-3	Total Recoverable	Water	EPA 6010D	613145
180-173844-4	CCR-AP-4	Total Recoverable	Water	EPA 6010D	613145
180-173844-5	CCR-AP-6	Total Recoverable	Water	EPA 6010D	613145
180-173844-6	CCR-AP-6I	Total Recoverable	Water	EPA 6010D	613145
180-173844-7	CCR-AP-8I	Total Recoverable	Water	EPA 6010D	613145
180-173844-8	CCR-AP-9	Total Recoverable	Water	EPA 6010D	613145
MB 240-613145/1-A	Method Blank	Total Recoverable	Water	EPA 6010D	613145
LCS 240-613145/2-A	Lab Control Sample	Total Recoverable	Water	EPA 6010D	613145

Analysis Batch: 613785

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-173844-1	CCR-AP-1R	Total Recoverable	Water	EPA 6020B	613145
180-173844-2	CCR-AP-2	Total Recoverable	Water	EPA 6020B	613145
180-173844-3	CCR-AP-3	Total Recoverable	Water	EPA 6020B	613145
180-173844-4	CCR-AP-4	Total Recoverable	Water	EPA 6020B	613145
180-173844-5	CCR-AP-6	Total Recoverable	Water	EPA 6020B	613145
180-173844-6	CCR-AP-6I	Total Recoverable	Water	EPA 6020B	613145
180-173844-7	CCR-AP-8I	Total Recoverable	Water	EPA 6020B	613145
180-173844-8	CCR-AP-9	Total Recoverable	Water	EPA 6020B	613145
MB 240-613145/1-A	Method Blank	Total Recoverable	Water	EPA 6020B	613145
LCS 240-613145/3-A	Lab Control Sample	Total Recoverable	Water	EPA 6020B	613145

General Chemistry

Analysis Batch: 468300

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-173844-6	CCR-AP-6I	Total/NA	Water	EPA 9040C	
180-173844-8	CCR-AP-9	Total/NA	Water	EPA 9040C	

General Chemistry (Continued)

Analysis Batch: 468300 (Continued)

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
LCS 180-468300/1	Lab Control Sample	Total/NA	Water	EPA 9040C	
180-173844-6 DU	CCR-AP-6I	Total/NA	Water	EPA 9040C	

Analysis Batch: 468497

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-173844-1	CCR-AP-1R	Total/NA	Water	EPA 9040C	
180-173844-2	CCR-AP-2	Total/NA	Water	EPA 9040C	
180-173844-3	CCR-AP-3	Total/NA	Water	EPA 9040C	
180-173844-4	CCR-AP-4	Total/NA	Water	EPA 9040C	
180-173844-5	CCR-AP-6	Total/NA	Water	EPA 9040C	
180-173844-7	CCR-AP-8I	Total/NA	Water	EPA 9040C	
LCS 180-468497/1	Lab Control Sample	Total/NA	Water	EPA 9040C	

Analysis Batch: 468587

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-173844-3	CCR-AP-3	Total/NA	Water	SM 2540C	
180-173844-5	CCR-AP-6	Total/NA	Water	SM 2540C	
180-173844-6	CCR-AP-6I	Total/NA	Water	SM 2540C	
MB 180-468587/1	Method Blank	Total/NA	Water	SM 2540C	
LCS 180-468587/2	Lab Control Sample	Total/NA	Water	SM 2540C	

Analysis Batch: 468592

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-173844-1	CCR-AP-1R	Total/NA	Water	SM 2540C	
180-173844-2	CCR-AP-2	Total/NA	Water	SM 2540C	
180-173844-4	CCR-AP-4	Total/NA	Water	SM 2540C	
180-173844-7	CCR-AP-8I	Total/NA	Water	SM 2540C	
180-173844-8	CCR-AP-9	Total/NA	Water	SM 2540C	
MB 180-468592/1	Method Blank	Total/NA	Water	SM 2540C	
LCS 180-468592/2	Lab Control Sample	Total/NA	Water	SM 2540C	

Rad

Prep Batch: 661791

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-173844-1	CCR-AP-1R	Total/NA	Water	PrecSep-21	
180-173844-2	CCR-AP-2	Total/NA	Water	PrecSep-21	
180-173844-3	CCR-AP-3	Total/NA	Water	PrecSep-21	
180-173844-4	CCR-AP-4	Total/NA	Water	PrecSep-21	
180-173844-5	CCR-AP-6	Total/NA	Water	PrecSep-21	
180-173844-6	CCR-AP-6I	Total/NA	Water	PrecSep-21	
180-173844-7	CCR-AP-8I	Total/NA	Water	PrecSep-21	
180-173844-8	CCR-AP-9	Total/NA	Water	PrecSep-21	
MB 160-661791/1-A	Method Blank	Total/NA	Water	PrecSep-21	
LCS 160-661791/2-A	Lab Control Sample	Total/NA	Water	PrecSep-21	

Prep Batch: 661792

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-173844-1	CCR-AP-1R	Total/NA	Water	PrecSep_0	
180-173844-2	CCR-AP-2	Total/NA	Water	PrecSep_0	
180-173844-3	CCR-AP-3	Total/NA	Water	PrecSep_0	

Rad (Continued)

Prep Batch: 661792 (Continued)

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-173844-4	CCR-AP-4	Total/NA	Water	PrecSep_0	
180-173844-5	CCR-AP-6	Total/NA	Water	PrecSep_0	
180-173844-6	CCR-AP-6I	Total/NA	Water	PrecSep_0	
180-173844-7	CCR-AP-8I	Total/NA	Water	PrecSep_0	
180-173844-8	CCR-AP-9	Total/NA	Water	PrecSep_0	
MB 160-661792/1-A	Method Blank	Total/NA	Water	PrecSep_0	
LCS 160-661792/2-A	Lab Control Sample	Total/NA	Water	PrecSep_0	

Eurofins Pittsburgh
301 Alpha Drive RIDC Park
Pittsburgh, PA 15238
Phone: 412-963-7058 Fax: 412-963-2468

Chain of Custody Record

Virginia Beach Service Center

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Client Information	Sampler: Hayley Torres	Lab PM: Johnson, Andy	Carrier Tracking No(s):	COC No: 180-101847-14505.2
Client Contact: Mark Breting	Phone:	E-Mail: Andy.Johnson@et.eurofinsus.com	State of Origin:	Page: Page 2 of 2
Company: Atlas Technical Consultants LLC	PWSID:	Analysis Requested		Job #:
Address: 7988 Centerpoint Drive Suite 100	Due Date Requested:			Preservation Codes: N - None, D - HNO3
City: Indianapolis	TAT Requested (days):			
State, Zip: IN, 46256	Compliance Project: Δ Yes Δ No			
Phone:	PO #: 0129420-032-001-01			Other:
Email: mark.breting@atcassociates.com	WO #: See Chain			
Project Name: CCR GW Monitoring FB Culley East	Project #: 18016014			
Site: Culley East	SSOW#:			

Sample Identification	Sample Date	Sample Time	Sample Type (C=Comp, G=grab)	Matrix (W=water, S=solid, O=waste/oil, BT=Tissue, A=Air)	Field Filtered Sample (Yes or No)	Perform MS/MSD (Yes or No)	9040C, 9056A_ORGFM_28D	2540C_Calcd - TDS by 2540C	9315_Ra226, 9320_Ra228	6020B - Metals by 6020B	7470A - Hg by 7470A	Total Number of containers	Special Instructions/Note:
			Preservation Code:				N	N	D	D	D		
CCR-AP-1R	5-8-24	11:20	G	W	N		X	X	X	X	X	6	
CCR-AP-2	5-8-24	10:20	G	W	N		X	X	X	X	X	6	
CCR-AP-3	5-7-24	14:00	G	W	N		X	X	X	X	X	6	
CCR-AP-4	5-8-24	9:45	G	W	N		X	X	X	X	X	5	1 1-L Bottle
CCR-AP-6	5-7-24	13:30	G	W	N		X	X	X	X	X	5	1 1-L Bottle
CCR-AP-6T	5-7-24	13:15	G	W	N		X	X	X	X	X	6	
CCR-AP-8	5-8-24	11:40	G	W	N		X	X	X	X	X	6	
CCR-AP-9	5-8-24	12:00	G	W	N		X	X	X	X	X	5	1 1-L Bottle

180-173844 Chain of Custody

Possible Hazard Identification
☐ Non-Hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown ☐ Radiological

Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)
☐ Return To Client ☐ Disposal By Lab ☐ Archive For _____ Months

Deliverable Requested: I, II, III, IV, Other (specify)

Special Instructions/QC Requirements

Empty Kit Relinquished by:	Date:	Time:	Method of Shipment:

Relinquished by:	Date/Time	Company	Received by:	Date/Time	Company
Hayley Torres	5-9-24 / 13:30	ATLAS	Fedex	5-9-24 / 13:30	
Relinquished by:	Date/Time	Company	Received by:	Date/Time	Company
Relinquished by:	Date/Time	Company	Received by:	Date/Time	Company

Custody Seals Intact. Δ Yes Δ No	Custody Seal No :	Cooler Temperature(s) °C and Other Remarks.



180-173844 Waybill



CRAIG KAISER
FB CULLEY VECTREN CORPORATION
3711 DARLINGTON ROAD

NEWBURGH , IN 47630
UNITED STATES US

ACTWGT: 25.00 LB MAN
CAD: 0415933/CAFE3755

Part # 159469-434 MTW EXP 10/24

TO SAMPLE RECEIVING
EUROFINS
301 ALPHA DR

PITTSBURGH PA 15238
(412) 963-7058

INV:
PO:
REF:
DEPT:

RMA:

FedEx Express

FedEx
TRK# 0221 7236 3961 3941

FRI - 10 MAY 10:30A
PRIORITY OVERNIGHT

NX AGCA

15238
PA-US PIT

Part # 156297-435 RRDW2 EXP 01/25

Uncorrected temp 4.0 °C
Thermometer ID 27
CF -0.0 Initials TJ
PT-WI-SR-001 effective 11/8/[illegible]

#3923924 05/09 583J3/C137/9AE3

EUR

PITT

(412) 963-

RE:

RMA:

Uncorrected temp 44 °C

Thermometer ID 20

CF 0.2 Initials RD

PT-WI-SR-001 effective 11/8/18

FedEx

TRK# 0221 7236 3961 3930

FRI – 10 MAY 10:3

PRIORITY OVERNIGI

NX AGCA

1523

PA – US

#3923924 05/09 583J3/C137/9AE3

RT 198

FZ 197

10:30 A

3930

05:10

Page 46 of 49

6/14/2024

Eurofins Pittsburgh
301 Alpha Drive RIDC Park
Pittsburgh, PA 15238
Phone: 412-963-7058 Fax: 412-963-2468

Chain of Custody Record

eurofins Environment Testing

Client Information (Sub Contract Lab)	Sampler:	Lab PM: Johnson, Andy	Carrier Tracking No(s):	COC No: 180-514536.1
Client Contact: Shipping/Receiving	Phone:	E-Mail: Andy.Johnson@et.eurofinsus.com	State of Origin: Indiana	Page: Page 1 of 1
Company: TestAmerica Laboratories, Inc.		Accreditations Required (See note):		Job #: 180-173844-1
Address: 13715 Rider Trail North,	Due Date Requested: 6/13/2024			Preservation Codes: -
City: Earth City	TAT Requested (days):			
State, Zip: MO, 63045				
Phone: 314-298-8566(Tel) 314-298-8757(Fax)	PO #:			
Email:	WO #:			
Project Name: CCR Groundwater Monitoring FB Culley East	Project #: 18016014			
Site:	SSOW#:			Other:

Analysis Requested

Sample Identification - Client ID (Lab ID)	Sample Date	Sample Time	Sample Type (C=Comp, G=grab)	Matrix (W=water, S=solid, O=waste/oil, BT=Tissue, A=Air)	Field Filtered Sample (Yes or No)	Perform MS/MSD (Yes or No)	9315_Ra226/PrecSep_21 Radium-226 (GFPC) by 9315 (21-day decay)	9320_Ra228/PrecSep_0 Radium-228 (GFPC) by 9320	Ra226Ra228_GFPC/ Combined Radium-226 and Radium-228	Total Number of containers	Special Instructions/Note:
			Preservation Code:								
CCR-AP-1R (180-173844-1)	5/8/24	11:20 Eastern		Water			X	X	X	2	
CCR-AP-2 (180-173844-2)	5/8/24	10:20 Eastern		Water			X	X	X	2	
CCR-AP-3 (180-173844-3)	5/7/24	14:00 Eastern		Water			X	X	X	2	
CCR-AP-4 (180-173844-4)	5/8/24	09:45 Eastern		Water			X	X	X	1	
CCR-AP-6 (180-173844-5)	5/7/24	13:30 Eastern		Water			X	X	X	1	
CCR-AP-6I (180-173844-6)	5/7/24	13:15 Eastern		Water			X	X	X	2	
CCR-AP-8 (180-173844-7)	5/8/24	11:40 Eastern		Water			X	X	X	2	
CCR-AP-9 (180-173844-8)	5/8/24	12:00 Eastern		Water			X	X	X	1	

Note: Since laboratory accreditations are subject to change, Eurofins Pittsburgh places the ownership of method, analyte & accreditation compliance upon our subcontract laboratories. This sample shipment is forwarded under chain-of-custody. If the laboratory does not currently maintain accreditation in the State of Origin listed above for analysis/tests/matrix being analyzed, the samples must be shipped back to the Eurofins Pittsburgh laboratory or other instructions will be provided. Any changes to accreditation status should be brought to Eurofins Pittsburgh attention immediately. If all requested accreditations are current to date, return the signed Chain of Custody attesting to said compliance to Eurofins Pittsburgh.

Possible Hazard Identification *Unconfirmed*	***Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)*** ☐ *Return To Client* ☐ *Disposal By Lab* ☐ *Archive For* *Months*
Deliverable Requested: I, II, III, IV, Other (specify) Primary Deliverable Rank: 2	Special Instructions/QC Requirements:

Empty Kit Relinquished by:	Date:	Time:	Method of Shipment:

	Relinquished by:	Date/Time:	Company	Received by:	Date/Time	Company
		5-13-24 17:20		M. Pinette		
	Relinquished by:	Date/Time:	Company	Received by:	Date/Time: MAY 14 2024 0950	Company
	Relinquished by:	Date/Time:	Company	Received by	Date/Time	Company

Custody Seals Intact: Δ Yes Δ No	Custody Seal No.:	Cooler Temperature(s) °C and Other Remarks:

Ver: 06/08/2021

Login Sample Receipt Checklist

Client: Haley & Aldrich, Inc.

Job Number: 180-173844-1
SDG Number: FB Culley East

Login Number: 173844
List Number: 1
Creator: Abernathy, Eric L

List Source: Eurofins Pittsburgh

Question	Answer	Comment
Radioactivity wasn't checked or is </= background as measured by a survey meter.	N/A	
The cooler's custody seal, if present, is intact.	True	
Sample custody seals, if present, are intact.	True	
The cooler or samples do not appear to have been compromised or tampered with.	True	
Samples were received on ice.	True	
Cooler Temperature is acceptable.	True	
Cooler Temperature is recorded.	True	
COC is present.	True	
COC is filled out in ink and legible.	True	
COC is filled out with all pertinent information.	True	
Is the Field Sampler's name present on COC?	True	
There are no discrepancies between the containers received and the COC.	False	
Samples are received within Holding Time (excluding tests with immediate HTs)	True	
Sample containers have legible labels.	True	
Containers are not broken or leaking.	True	
Sample collection date/times are provided.	True	
Appropriate sample containers are used.	True	
Sample bottles are completely filled.	True	
Sample Preservation Verified.	True	
There is sufficient vol. for all requested analyses, incl. any requested MS/MSDs	True	
Containers requiring zero headspace have no headspace or bubble is <6mm (1/4").	True	
Multiphasic samples are not present.	True	
Samples do not require splitting or compositing.	True	
Residual Chlorine Checked.	N/A	

Login Sample Receipt Checklist

Client: Haley & Aldrich, Inc.

Job Number: 180-173844-1
SDG Number: FB Culley East

Login Number: 173844
List Number: 2
Creator: Worthington, Sierra M

List Source: Eurofins St. Louis
List Creation: 05/14/24 01:52 PM

Question	Answer	Comment
Radioactivity wasn't checked or is </= background as measured by a survey meter.	True	
The cooler's custody seal, if present, is intact.	True	
Sample custody seals, if present, are intact.	True	
The cooler or samples do not appear to have been compromised or tampered with.	True	
Samples were received on ice.	N/A	
Cooler Temperature is acceptable.	True	
Cooler Temperature is recorded.	True	
COC is present.	True	
COC is filled out in ink and legible.	True	
COC is filled out with all pertinent information.	True	
Is the Field Sampler's name present on COC?	N/A	
There are no discrepancies between the containers received and the COC.	True	
Samples are received within Holding Time (excluding tests with immediate HTs)	True	
Sample containers have legible labels.	True	
Containers are not broken or leaking.	True	
Sample collection date/times are provided.	True	
Appropriate sample containers are used.	True	
Sample bottles are completely filled.	True	
Sample Preservation Verified.	True	
There is sufficient vol. for all requested analyses, incl. any requested MS/MSDs	True	
Containers requiring zero headspace have no headspace or bubble is <6mm (1/4").	N/A	
Multiphasic samples are not present.	True	
Samples do not require splitting or compositing.	True	
Residual Chlorine Checked.	N/A	

eurofins | Environment Testing

ANALYTICAL REPORT

PREPARED FOR

Attn: Todd Plating
Haley & Aldrich, Inc.
400 Augusta Street
Suite 100
Greenville, South Carolina 29601

Generated 6/19/2024 1:51:24 PM

JOB DESCRIPTION

CCR Groundwater Monitoring FB Culley East
FB Culley East

JOB NUMBER

180-174082-1

Eurofins Pittsburgh
301 Alpha Drive
RIDC Park
Pittsburgh PA 15238

See page two for job notes and contact information.

my EOL

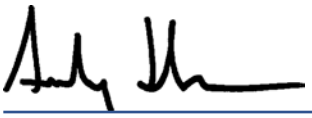
Job Notes

This report may not be reproduced except in full, and with written approval from the laboratory. The results relate only to the samples tested. For questions please contact the Project Manager at the e-mail address or telephone number listed on this page.

PA Lab ID: 02-00416

The test results in this report relate only to the samples as received by the laboratory and will meet all requirements of the methodology, with any exceptions noted. This report shall not be reproduced except in full, without the express written approval of the laboratory. All questions should be directed to the Eurofins Pittsburgh Project Manager.

Authorization



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6/19/2024 1:51:24 PM

Authorized for release by
Andy Johnson, Senior Project Manager
Andy.Johnson@et.eurofinsus.com
(615)818-9567

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Job Narrative
180-174082-1

Analytical test results meet all requirements of the associated regulatory program listed on the Accreditation/Certification Summary Page unless otherwise noted under the individual analysis. Data qualifiers are applied to indicate exceptions. Noncompliant quality control (QC) is further explained in narrative comments.

- Matrix QC may not be reported if insufficient sample or site-specific QC samples were not submitted. In these situations, to demonstrate precision and accuracy at a batch level, a LCS/LCSD may be performed, unless otherwise specified in the method.
- Surrogate and/or isotope dilution analyte recoveries (if applicable) which are outside of the QC window are confirmed unless attributed to a dilution or otherwise noted in the narrative.

Regulated compliance samples (e.g. SDWA, NPDES) must comply with the associated agency requirements/permits.

Receipt
The samples were received on 5/15/2024 9:35 AM. Unless otherwise noted below, the samples arrived in good condition, and, where required, properly preserved and on ice. The temperature of the cooler at receipt time was 4.3°C.

Gas Flow Proportional Counter
No additional analytical or quality issues were noted, other than those described above or in the Definitions/ Glossary page.

Rad
No additional analytical or quality issues were noted, other than those described above or in the Definitions/ Glossary page.

Job ID: 180-174082-2 Eurofins Pittsburgh

Job Narrative
180-174082-2

Analytical test results meet all requirements of the associated regulatory program listed on the Accreditation/Certification Summary Page unless otherwise noted under the individual analysis. Data qualifiers are applied to indicate exceptions. Noncompliant quality control (QC) is further explained in narrative comments.

- Matrix QC may not be reported if insufficient sample or site-specific QC samples were not submitted. In these situations, to demonstrate precision and accuracy at a batch level, a LCS/LCSD may be performed, unless otherwise specified in the method.
- Surrogate and/or isotope dilution analyte recoveries (if applicable) which are outside of the QC window are confirmed unless attributed to a dilution or otherwise noted in the narrative.

Regulated compliance samples (e.g. SDWA, NPDES) must comply with the associated agency requirements/permits.

Receipt
The samples were received on 5/15/2024 9:35 AM. Unless otherwise noted below, the samples arrived in good condition, and, where required, properly preserved and on ice. The temperature of the cooler at receipt time was 4.3°C.

HPLC/IC
Method 9056A_ORGFM_28D: The following samples were diluted due to the nature of the sample matrix: CCR-AP-5 (180-174082-1), CCR-AP-5I (180-174082-2), DUP 1 (180-174082-3), (180-174064-D-1), (180-174064-D-1 MS) and (180-174064-D-1 MSD). Elevated reporting limits (RLs) are provided.

No additional analytical or quality issues were noted, other than those described above or in the Definitions/ Glossary page.

Metals
Method 6020B - Total Recoverable: The continuing calibration verification (CCV) associated with batch 240-614112 recovered above the upper control limit for Beryllium and Antimony. The samples associated with this CCV were below the reporting limit for the affected analytes; therefore, the data have been reported. The associated samples are impacted: CCR-AP-5 (180-174082-1), CCR-AP-5I (180-174082-2) and DUP 1 (180-174082-3).

No additional analytical or quality issues were noted, other than those described above or in the Definitions/ Glossary page.

General Chemistry
Method 2540C_Calcd: The sample did not reach a stable weight following 3 cycles of heating, cooling, and desiccation. The cycle 3 weight was used to calculate the Total Dissolved Solids for the sample result. CCR-AP-5 (180-174082-1) and CCR-AP-5I (180-174082-2)

No additional analytical or quality issues were noted, other than those described above or in the Definitions/ Glossary page.

Definitions/Glossary

Client: Haley & Aldrich, Inc.
Project/Site: CCR Groundwater Monitoring FB Culley East

Job ID: 180-174082-1
SDG: FB Culley East

Qualifiers

Metals

Qualifier	Qualifier Description
^+	Continuing Calibration Verification (CCV) is outside acceptance limits, high biased.
J	Result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value.

General Chemistry

Qualifier	Qualifier Description
HF	Parameter with a holding time of 15 minutes. Test performed by laboratory at client's request. Sample was analyzed outside of hold time.

Rad

Qualifier	Qualifier Description
U	Result is less than the sample detection limit.

Glossary

Abbreviation	These commonly used abbreviations may or may not be present in this report.
¤	Listed under the "D" column to designate that the result is reported on a dry weight basis
%R	Percent Recovery
CFL	Contains Free Liquid
CFU	Colony Forming Unit
CNF	Contains No Free Liquid
DER	Duplicate Error Ratio (normalized absolute difference)
Dil Fac	Dilution Factor
DL	Detection Limit (DoD/DOE)
DL, RA, RE, IN	Indicates a Dilution, Re-analysis, Re-extraction, or additional Initial metals/anion analysis of the sample
DLC	Decision Level Concentration (Radiochemistry)
EDL	Estimated Detection Limit (Dioxin)
LOD	Limit of Detection (DoD/DOE)
LOQ	Limit of Quantitation (DoD/DOE)
MCL	EPA recommended "Maximum Contaminant Level"
MDA	Minimum Detectable Activity (Radiochemistry)
MDC	Minimum Detectable Concentration (Radiochemistry)
MDL	Method Detection Limit
ML	Minimum Level (Dioxin)
MPN	Most Probable Number
MQL	Method Quantitation Limit
NC	Not Calculated
ND	Not Detected at the reporting limit (or MDL or EDL if shown)
NEG	Negative / Absent
POS	Positive / Present
PQL	Practical Quantitation Limit
PRES	Presumptive
QC	Quality Control
RER	Relative Error Ratio (Radiochemistry)
RL	Reporting Limit or Requested Limit (Radiochemistry)
RPD	Relative Percent Difference, a measure of the relative difference between two points
TEF	Toxicity Equivalent Factor (Dioxin)
TEQ	Toxicity Equivalent Quotient (Dioxin)
TNTC	Too Numerous To Count

Accreditation/Certification Summary

Client: Haley & Aldrich, Inc.
Project/Site: CCR Groundwater Monitoring FB Culley East

Job ID: 180-174082-1
SDG: FB Culley East

Laboratory: Eurofins Pittsburgh

All accreditations/certifications held by this laboratory are listed. Not all accreditations/certifications are applicable to this report.

Authority	Program	Identification Number	Expiration Date
Arkansas DEQ	State	19-033-0	06-27-24
California	State	2891	04-30-24 *
Connecticut	State	PH-0688	09-30-24
Florida	NELAP	E871008	06-30-24
Georgia	State	PA 02-00416	04-30-25
Illinois	NELAP	004375	07-31-25
Kansas	NELAP	E-10350	01-31-25
Kentucky (UST)	State	162013	04-30-23 *
Kentucky (WW)	State	KY98043	12-31-24
Louisiana	NELAP	04041	06-30-22 *
Louisiana (All)	NELAP	04041	06-30-24
Maine	State	PA00164	03-06-26
Minnesota	NELAP	042-999-482	12-31-24
New Hampshire	NELAP	2030	04-04-24 *
New Jersey	NELAP	PA005	06-30-24
New York	NELAP	11182	04-01-25
North Carolina (WW/SW)	State	434	12-31-24
North Dakota	State	R-227	04-30-24 *
Oregon	NELAP	PA-2151	02-06-25
Pennsylvania	NELAP	02-00416	04-30-25
Rhode Island	State	LAO00362	01-01-25
South Carolina	State	89014	04-30-25
Texas	NELAP	T104704528	03-31-25
US Fish & Wildlife	US Federal Programs	058448	03-31-24 *
USDA	US Federal Programs	P330-16-00211	04-11-26
Utah	NELAP	PA001462019-8	05-31-24
Virginia	NELAP	10043	07-14-24
West Virginia DEP	State	142	01-31-25
Wisconsin	State	998027800	08-31-24

Laboratory: Eurofins Cleveland

All accreditations/certifications held by this laboratory are listed. Not all accreditations/certifications are applicable to this report.

Authority	Program	Identification Number	Expiration Date
California	State	2927	02-28-25
Georgia	State	4062	02-27-25
Illinois	NELAP	200004	07-31-24
Iowa	State	421	06-01-25
Kentucky (UST)	State	112225	02-27-25
Kentucky (WW)	State	KY98016	12-30-24
Minnesota	NELAP	039-999-348	12-31-24
New Jersey	NELAP	OH001	06-30-24
New York	NELAP	10975	04-02-25
Ohio VAP	State	ORELAP 4062	02-27-25
Oregon	NELAP	4062	02-27-25
Pennsylvania	NELAP	68-00340	08-31-24
Texas	NELAP	T104704517-22-19	08-31-24
USDA	US Federal Programs	P330-18-00281	01-05-27
Virginia	NELAP	460175	09-14-24
West Virginia DEP	State	210	12-31-24

* Accreditation/Certification renewal pending - accreditation/certification considered valid.

Accreditation/Certification Summary

Client: Haley & Aldrich, Inc.
Job ID: 180-174082-1
Project/Site: CCR Groundwater Monitoring FB Culley East
SDG: FB Culley East

Laboratory: Eurofins St. Louis

All accreditations/certifications held by this laboratory are listed. Not all accreditations/certifications are applicable to this report.

Authority	Program	Identification Number	Expiration Date
Alaska (UST)	State	20-001	05-06-25
ANAB	Dept. of Defense ELAP	L2305	04-06-25
ANAB	Dept. of Energy	L2305.01	04-08-25
ANAB	ISO/IEC 17025	L2305	04-06-25
Arizona	State	AZ0813	12-08-24
California	Los Angeles County Sanitation Districts	10259	06-30-22 *
California	State	2886	06-30-24
Connecticut	State	PH-0241	03-31-25
Florida	NELAP	E87689	06-30-24
HI - RadChem Recognition	State	n/a	06-30-24
Illinois	NELAP	200023	11-30-24
Iowa	State	373	12-01-24
Kansas	NELAP	E-10236	10-31-24
Kentucky (DW)	State	KY90125	12-31-24
Kentucky (WW)	State	KY90125 (Permit KY0004049)	12-31-24
Louisiana	NELAP	04080	06-30-22 *
Louisiana (All)	NELAP	04080	06-30-24
Louisiana (DW)	State	LA011	12-31-24
Maryland	State	310	09-30-24
Massachusetts	State	M-MO054	06-30-24
MI - RadChem Recognition	State	9005	06-30-24
Missouri	State	780	06-30-25
Nevada	State	MO00054	07-31-24
New Jersey	NELAP	MO002	06-30-24
New Mexico	State	MO00054	06-30-24
New York	NELAP	11616	03-31-25
North Carolina (DW)	State	29700	07-31-24
North Dakota	State	R-207	06-30-24
Oklahoma	NELAP	9997	08-31-24
Oregon	NELAP	4157	09-01-24
Pennsylvania	NELAP	68-00540	02-28-25
South Carolina	State	85002001	06-30-24
Texas	NELAP	T104704193	07-31-24
US Fish & Wildlife	US Federal Programs	058448	07-31-24
USDA	US Federal Programs	P330-17-00028	05-18-26
Utah	NELAP	MO00054	07-31-24
Virginia	NELAP	460230	06-14-25
Washington	State	C592	08-30-24
West Virginia DEP	State	381	10-31-24

* Accreditation/Certification renewal pending - accreditation/certification considered valid.

Sample Summary

Client: Haley & Aldrich, Inc.
Project/Site: CCR Groundwater Monitoring FB Culley East

Job ID: 180-174082-1
SDG: FB Culley East

Lab Sample ID	Client Sample ID	Matrix	Collected	Received
180-174082-1	CCR-AP-5	Water	05/13/24 13:17	05/15/24 09:35
180-174082-2	CCR-AP-5I	Water	05/13/24 14:02	05/15/24 09:35
180-174082-3	DUP 1	Water	05/13/24 00:01	05/15/24 09:35

Method Summary

Client: Haley & Aldrich, Inc.
Project/Site: CCR Groundwater Monitoring FB Culley East

Job ID: 180-174082-1
SDG: FB Culley East

Method	Method Description	Protocol	Laboratory
9315	Radium-226 (GFPC)	SW846	EET SL
9320	Radium-228 (GFPC)	SW846	EET SL
Ra226_Ra228	Combined Radium-226 and Radium-228	TAL-STL	EET SL
PrecSep_0	Preparation, Precipitate Separation	None	EET SL
PrecSep-21	Preparation, Precipitate Separation (21-Day In-Growth)	None	EET SL

Protocol References:

None = None

SW846 = "Test Methods For Evaluating Solid Waste, Physical/Chemical Methods", Third Edition, November 1986 And Its Updates.

TAL-STL = TestAmerica Laboratories, St. Louis, Facility Standard Operating Procedure.

Laboratory References:

EET SL = Eurofins St. Louis, 13715 Rider Trail North, Earth City, MO 63045, TEL (314)298-8566

Lab Chronicle

Client: Haley & Aldrich, Inc.
Project/Site: CCR Groundwater Monitoring FB Culley East

Job ID: 180-174082-1
SDG: FB Culley East

Client Sample ID: CCR-AP-5

Date Collected: 05/13/24 13:17
Date Received: 05/15/24 09:35

Lab Sample ID: 180-174082-1

Matrix: Water

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	EPA 9056A		1	1 mL	1 mL	468830	05/16/24 15:08	AM	EET PIT
	Instrument ID: CHICS2100B									
Total/NA	Analysis	EPA 9056A		10	1 mL	1 mL	468830	05/16/24 15:22	AM	EET PIT
	Instrument ID: CHICS2100B									
Total Recoverable	Prep	3005A			50 mL	50 mL	613656	05/21/24 05:00	TQ6W	EET CLE
Total Recoverable	Analysis	EPA 6010D		5			615032	05/30/24 10:20	KLC	EET CLE
	Instrument ID: I9									
Total Recoverable	Prep	3005A			50 mL	50 mL	613656	05/21/24 05:00	TQ6W	EET CLE
Total Recoverable	Analysis	EPA 6020B		1			614112	05/22/24 20:26	AJC	EET CLE
	Instrument ID: I10									
Total Recoverable	Prep	3005A			50 mL	50 mL	613656	05/21/24 05:00	TQ6W	EET CLE
Total Recoverable	Analysis	EPA 6020B		1			614474	05/24/24 17:17	AJC	EET CLE
	Instrument ID: I14									
Total/NA	Prep	7470A			25 mL	25 mL	469069	05/18/24 10:45	SJM	EET PIT
Total/NA	Analysis	EPA 7470A		1			469200	05/20/24 14:17	MTW	EET PIT
	Instrument ID: HGY									
Total/NA	Analysis	EPA 9040C		1			468847	05/16/24 10:09	BAB	EET PIT
	Instrument ID: OZ									
Total/NA	Analysis	SM 2540C		1	100 mL	100 mL	468906	05/16/24 16:46	LWM	EET PIT
	Instrument ID: NOEQUIP									
Total/NA	Prep	PrecSep-21			750.57 mL	1.0 g	662403	05/20/24 08:11	MLT	EET SL
Total/NA	Analysis	9315		1			666559	06/17/24 22:59	SWS	EET SL
	Instrument ID: GFPCRED									
Total/NA	Prep	PrecSep_0			750.57 mL	1.0 g	662405	05/20/24 08:15	MLT	EET SL
Total/NA	Analysis	9320		1			666560	06/17/24 12:34	SWS	EET SL
	Instrument ID: GFPCBLUE									
Total/NA	Analysis	Ra226_Ra228		1			666939	06/19/24 00:31	SCB	EET SL
	Instrument ID: NOEQUIP									

Client Sample ID: CCR-AP-5I

Date Collected: 05/13/24 14:02
Date Received: 05/15/24 09:35

Lab Sample ID: 180-174082-2

Matrix: Water

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	EPA 9056A		1	1 mL	1 mL	468830	05/16/24 15:37	AM	EET PIT
	Instrument ID: CHICS2100B									
Total/NA	Analysis	EPA 9056A		10	1 mL	1 mL	468830	05/16/24 15:52	AM	EET PIT
	Instrument ID: CHICS2100B									
Total Recoverable	Prep	3005A			50 mL	50 mL	613656	05/21/24 05:00	TQ6W	EET CLE
Total Recoverable	Analysis	EPA 6010D		5			614072	05/22/24 17:44	KLC	EET CLE
	Instrument ID: I12									
Total Recoverable	Prep	3005A			50 mL	50 mL	613656	05/21/24 05:00	TQ6W	EET CLE
Total Recoverable	Analysis	EPA 6020B		1			614112	05/22/24 20:31	AJC	EET CLE
	Instrument ID: I10									

Lab Chronicle

Client: Haley & Aldrich, Inc.
Project/Site: CCR Groundwater Monitoring FB Culley East

Job ID: 180-174082-1
SDG: FB Culley East

Client Sample ID: CCR-AP-5I

Date Collected: 05/13/24 14:02
Date Received: 05/15/24 09:35

Lab Sample ID: 180-174082-2

Matrix: Water

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total Recoverable	Prep	3005A			50 mL	50 mL	613656	05/21/24 05:00	TQ6W	EET CLE
Total Recoverable	Analysis	EPA 6020B		1			614474	05/24/24 17:19	AJC	EET CLE
	Instrument ID: I14									
Total/NA	Prep	7470A			25 mL	25 mL	469069	05/18/24 10:45	SJM	EET PIT
Total/NA	Analysis	EPA 7470A		1			469200	05/20/24 14:18	MTW	EET PIT
	Instrument ID: HGY									
Total/NA	Analysis	EPA 9040C		1			468847	05/16/24 10:14	BAB	EET PIT
	Instrument ID: OZ									
Total/NA	Analysis	SM 2540C		1	50 mL	100 mL	468906	05/16/24 16:46	LWM	EET PIT
	Instrument ID: NOEQUIP									
Total/NA	Prep	PrecSep-21			997.40 mL	1.0 g	662403	05/20/24 08:11	MLT	EET SL
Total/NA	Analysis	9315		1			666559	06/17/24 22:59	SWS	EET SL
	Instrument ID: GFPCRED									
Total/NA	Prep	PrecSep_0			997.40 mL	1.0 g	662405	05/20/24 08:15	MLT	EET SL
Total/NA	Analysis	9320		1			666560	06/17/24 12:34	SWS	EET SL
	Instrument ID: GFPCBLUE									
Total/NA	Analysis	Ra226_Ra228		1			666939	06/19/24 00:31	SCB	EET SL
	Instrument ID: NOEQUIP									

Client Sample ID: DUP 1

Date Collected: 05/13/24 00:01
Date Received: 05/15/24 09:35

Lab Sample ID: 180-174082-3

Matrix: Water

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	EPA 9056A		1	1 mL	1 mL	468830	05/16/24 16:07	AM	EET PIT
	Instrument ID: CHICS2100B									
Total/NA	Analysis	EPA 9056A		10	1 mL	1 mL	468830	05/16/24 16:21	AM	EET PIT
	Instrument ID: CHICS2100B									
Total Recoverable	Prep	3005A			50 mL	50 mL	613656	05/21/24 05:00	TQ6W	EET CLE
Total Recoverable	Analysis	EPA 6010D		5			614072	05/22/24 17:48	KLC	EET CLE
	Instrument ID: I12									
Total Recoverable	Prep	3005A			50 mL	50 mL	613656	05/21/24 05:00	TQ6W	EET CLE
Total Recoverable	Analysis	EPA 6020B		1			614112	05/22/24 20:35	AJC	EET CLE
	Instrument ID: I10									
Total Recoverable	Prep	3005A			50 mL	50 mL	613656	05/21/24 05:00	TQ6W	EET CLE
Total Recoverable	Analysis	EPA 6020B		1			614474	05/24/24 17:22	AJC	EET CLE
	Instrument ID: I14									
Total/NA	Prep	7470A			25 mL	25 mL	469069	05/18/24 10:45	SJM	EET PIT
Total/NA	Analysis	EPA 7470A		1			469200	05/20/24 14:19	MTW	EET PIT
	Instrument ID: HGY									
Total/NA	Analysis	EPA 9040C		1			468847	05/16/24 10:20	BAB	EET PIT
	Instrument ID: OZ									
Total/NA	Analysis	SM 2540C		1	100 mL	100 mL	468906	05/16/24 16:46	LWM	EET PIT
	Instrument ID: NOEQUIP									

Lab Chronicle

Client: Haley & Aldrich, Inc.
Project/Site: CCR Groundwater Monitoring FB Culley East

Job ID: 180-174082-1
SDG: FB Culley East

Client Sample ID: DUP 1

Date Collected: 05/13/24 00:01
Date Received: 05/15/24 09:35

Lab Sample ID: 180-174082-3

Matrix: Water

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	PrecSep-21			752.80 mL	1.0 g	662403	05/20/24 08:11	MLT	EET SL
Total/NA	Analysis	9315		1			666740	06/18/24 07:43	SWS	EET SL
	Instrument ID: GFPCRED									
Total/NA	Prep	PrecSep_0			752.80 mL	1.0 g	662405	05/20/24 08:15	MLT	EET SL
Total/NA	Analysis	9320		1	1.0 mL	1.0 mL	666560	06/17/24 12:34	SWS	EET SL
	Instrument ID: GFPCBLUE									
Total/NA	Analysis	Ra226_Ra228		1			666939	06/19/24 00:31	SCB	EET SL
	Instrument ID: NOEQUIP									

Laboratory References:

EET SL = Eurofins St. Louis, 13715 Rider Trail North, Earth City, MO 63045, TEL (314)298-8566

Analyst References:

Lab: EET CLE
- Batch Type: Prep
  - TQ6W = Bryan Pere ka
- Batch Type: Analysis
  - AJC = Alexander Colosi
  - KLC = Karen Counts

Lab: EET PIT
- Batch Type: Prep
  - SJM = Shannon Mueller
- Batch Type: Analysis
  - AM = Adzuira Musule
  - BAB = Brooke Batyi
  - LWM = Leslie McIntire
  - MTW = Michael Wesoloski

Lab: EET SL
- Batch Type: Prep
  - MLT = Michaela Tiemeyer
- Batch Type: Analysis
  - SCB = Sarah Bernsen
  - SWS = Seth Stubblefield

Client Sample ID: CCR-AP-5

Date Collected: 05/13/24 13:17
Date Received: 05/15/24 09:35

Lab Sample ID: 180-174082-1

Matrix: Water

Method: SW846 EPA 9056A - Anions, Ion Chromatography

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Chloride	**150**		1.0	0.71	mg/L			05/16/24 15:08	1
Fluoride	**0.84**		0.10	0.026	mg/L			05/16/24 15:08	1
Sulfate	**620**		10	7.6	mg/L			05/16/24 15:22	10

Method: SW846 EPA 6010D - Metals (ICP) - Total Recoverable

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Boron	**17**		0.50	0.29	mg/L		05/21/24 05:00	05/30/24 10:20	5

Method: SW846 EPA 6020B - Metals (ICP/MS) - Total Recoverable

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Antimony	ND	^+	0.0020	0.00057	mg/L		05/21/24 05:00	05/22/24 20:26	1
Arsenic	**0.00085**	**J**	0.0050	0.00075	mg/L		05/21/24 05:00	05/22/24 20:26	1
Barium	**0.046**		0.0050	0.0022	mg/L		05/21/24 05:00	05/22/24 20:26	1
Beryllium	ND	^+	0.0010	0.00062	mg/L		05/21/24 05:00	05/22/24 20:26	1
Cadmium	ND		0.0010	0.00020	mg/L		05/21/24 05:00	05/22/24 20:26	1
Calcium	**260**		1.0	0.25	mg/L		05/21/24 05:00	05/22/24 20:26	1
Chromium	**0.0020**	**J**	0.0050	0.0012	mg/L		05/21/24 05:00	05/22/24 20:26	1
Cobalt	**0.0025**		0.0010	0.00019	mg/L		05/21/24 05:00	05/22/24 20:26	1
Lead	**0.00068**	**J**	0.0010	0.00045	mg/L		05/21/24 05:00	05/22/24 20:26	1
Lithium	**0.056**		0.0080	0.0017	mg/L		05/21/24 05:00	05/24/24 17:17	1
Molybdenum	**0.15**		0.0050	0.0011	mg/L		05/21/24 05:00	05/22/24 20:26	1
Selenium	**0.00095**	**J**	0.0050	0.00089	mg/L		05/21/24 05:00	05/22/24 20:26	1
Thallium	ND		0.0010	0.00020	mg/L		05/21/24 05:00	05/22/24 20:26	1

Method: SW846 EPA 7470A - Mercury (CVAA)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	ND		0.00020	0.00013	mg/L		05/18/24 10:45	05/20/24 14:17	1

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Dissolved Solids (SM 2540C)	**1600**		10	10	mg/L			05/16/24 16:46	1

Analyte	Result	Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
pH (SW846 EPA 9040C)	**7.1**	**HF**	0.1	0.1	SU			05/16/24 10:09	1

Method: SW846 9315 - Radium-226 (GFPC)

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Radium-226	**0.424**		0.283	0.286	1.00	0.366	pCi/L	05/20/24 08:11	06/17/24 22:59	1

Carrier	*%Yield*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Ba Carrier	*77.4*		*30 - 110*	*05/20/24 08:11*	*06/17/24 22:59*	*1*

Method: SW846 9320 - Radium-228 (GFPC)

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Radium-228	0.452	U	0.507	0.509	1.00	0.830	pCi/L	05/20/24 08:15	06/17/24 12:34	1

Carrier	*%Yield*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Ba Carrier	*77.4*		*30 - 110*	*05/20/24 08:15*	*06/17/24 12:34*	*1*

Client Sample ID: CCR-AP-5
Lab Sample ID: 180-174082-1

Date Collected: 05/13/24 13:17
Matrix: Water
Date Received: 05/15/24 09:35

Method: SW846 9320 - Radium-228 (GFPC) (Continued)

Carrier	*%Yield*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Y Carrier	*86.4*		*30 - 110*	*05/20/24 08:15*	*06/17/24 12:34*	*1*

Method: TAL-STL Ra226_Ra228 - Combined Radium-226 and Radium-228

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Combined Radium 226 + 228	**0.877**		0.581	0.584	5.00	0.830	pCi/L		06/19/24 00:31	1

Client Sample ID: CCR-AP-5I

Date Collected: 05/13/24 14:02
Date Received: 05/15/24 09:35

Lab Sample ID: 180-174082-2

Matrix: Water

Method: SW846 EPA 9056A - Anions, Ion Chromatography

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Chloride	**280**		10	7.1	mg/L			05/16/24 15:52	10
Fluoride	**0.32**		0.10	0.026	mg/L			05/16/24 15:37	1
Sulfate	**640**		10	7.6	mg/L			05/16/24 15:52	10

Method: SW846 EPA 6010D - Metals (ICP) - Total Recoverable

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Boron	**12**		0.50	0.29	mg/L		05/21/24 05:00	05/22/24 17:44	5

Method: SW846 EPA 6020B - Metals (ICP/MS) - Total Recoverable

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Antimony	ND	^+	0.0020	0.00057	mg/L		05/21/24 05:00	05/22/24 20:31	1
Arsenic	ND		0.0050	0.00075	mg/L		05/21/24 05:00	05/22/24 20:31	1
Barium	**0.027**		0.0050	0.0022	mg/L		05/21/24 05:00	05/22/24 20:31	1
Beryllium	ND	^+	0.0010	0.00062	mg/L		05/21/24 05:00	05/22/24 20:31	1
Cadmium	ND		0.0010	0.00020	mg/L		05/21/24 05:00	05/22/24 20:31	1
Calcium	**270**		1.0	0.25	mg/L		05/21/24 05:00	05/22/24 20:31	1
Chromium	ND		0.0050	0.0012	mg/L		05/21/24 05:00	05/22/24 20:31	1
Cobalt	**0.00051**	**J**	0.0010	0.00019	mg/L		05/21/24 05:00	05/22/24 20:31	1
Lead	ND		0.0010	0.00045	mg/L		05/21/24 05:00	05/22/24 20:31	1
Lithium	**0.035**		0.0080	0.0017	mg/L		05/21/24 05:00	05/24/24 17:19	1
Molybdenum	**0.0026**	**J**	0.0050	0.0011	mg/L		05/21/24 05:00	05/22/24 20:31	1
Selenium	ND		0.0050	0.00089	mg/L		05/21/24 05:00	05/22/24 20:31	1
Thallium	ND		0.0010	0.00020	mg/L		05/21/24 05:00	05/22/24 20:31	1

Method: SW846 EPA 7470A - Mercury (CVAA)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	ND		0.00020	0.00013	mg/L		05/18/24 10:45	05/20/24 14:18	1

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Dissolved Solids (SM 2540C)	**1800**		20	20	mg/L			05/16/24 16:46	1

Analyte	Result	Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
pH (SW846 EPA 9040C)	**6.9**	**HF**	0.1	0.1	SU			05/16/24 10:14	1

Method: SW846 9315 - Radium-226 (GFPC)

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Radium-226	**0.249**		0.178	0.180	1.00	0.233	pCi/L	05/20/24 08:11	06/17/24 22:59	1

Carrier	*%Yield*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Ba Carrier	*87.6*		*30 - 110*	*05/20/24 08:11*	*06/17/24 22:59*	*1*

Method: SW846 9320 - Radium-228 (GFPC)

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Radium-228	**1.08**		0.424	0.435	1.00	0.549	pCi/L	05/20/24 08:15	06/17/24 12:34	1

Carrier	*%Yield*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Ba Carrier	*87.6*		*30 - 110*	*05/20/24 08:15*	*06/17/24 12:34*	*1*

Client Sample ID: CCR-AP-5I
Date Collected: 05/13/24 14:02
Date Received: 05/15/24 09:35

Lab Sample ID: 180-174082-2
Matrix: Water

Method: SW846 9320 - Radium-228 (GFPC) (Continued)

Carrier	%Yield	Qualifier	Limits	Prepared	Analyzed	Dil Fac
Y Carrier	92.3		30 - 110	05/20/24 08:15	06/17/24 12:34	1

Method: TAL-STL Ra226_Ra228 - Combined Radium-226 and Radium-228

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Combined Radium 226 + 228	1.33		0.460	0.471	5.00	0.549	pCi/L		06/19/24 00:31	1

Client Sample ID: DUP 1

Date Collected: 05/13/24 00:01
Date Received: 05/15/24 09:35

Lab Sample ID: 180-174082-3

Matrix: Water

Method: SW846 EPA 9056A - Anions, Ion Chromatography

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Chloride	**160**		1.0	0.71	mg/L			05/16/24 16:07	1
Fluoride	**0.83**		0.10	0.026	mg/L			05/16/24 16:07	1
Sulfate	**640**		10	7.6	mg/L			05/16/24 16:21	10

Method: SW846 EPA 6010D - Metals (ICP) - Total Recoverable

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Boron	**17**		0.50	0.29	mg/L		05/21/24 05:00	05/22/24 17:48	5

Method: SW846 EPA 6020B - Metals (ICP/MS) - Total Recoverable

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Antimony	ND	^+	0.0020	0.00057	mg/L		05/21/24 05:00	05/22/24 20:35	1
Arsenic	ND		0.0050	0.00075	mg/L		05/21/24 05:00	05/22/24 20:35	1
Barium	**0.045**		0.0050	0.0022	mg/L		05/21/24 05:00	05/22/24 20:35	1
Beryllium	ND	^+	0.0010	0.00062	mg/L		05/21/24 05:00	05/22/24 20:35	1
Cadmium	ND		0.0010	0.00020	mg/L		05/21/24 05:00	05/22/24 20:35	1
Calcium	**260**		1.0	0.25	mg/L		05/21/24 05:00	05/22/24 20:35	1
Chromium	ND		0.0050	0.0012	mg/L		05/21/24 05:00	05/22/24 20:35	1
Cobalt	**0.0022**		0.0010	0.00019	mg/L		05/21/24 05:00	05/22/24 20:35	1
Lead	ND		0.0010	0.00045	mg/L		05/21/24 05:00	05/22/24 20:35	1
Lithium	**0.058**		0.0080	0.0017	mg/L		05/21/24 05:00	05/24/24 17:22	1
Molybdenum	**0.15**		0.0050	0.0011	mg/L		05/21/24 05:00	05/22/24 20:35	1
Selenium	ND		0.0050	0.00089	mg/L		05/21/24 05:00	05/22/24 20:35	1
Thallium	ND		0.0010	0.00020	mg/L		05/21/24 05:00	05/22/24 20:35	1

Method: SW846 EPA 7470A - Mercury (CVAA)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	ND		0.00020	0.00013	mg/L		05/18/24 10:45	05/20/24 14:19	1

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Dissolved Solids (SM 2540C)	**1700**		10	10	mg/L			05/16/24 16:46	1

Analyte	Result	Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
pH (SW846 EPA 9040C)	**7.1**	**HF**	0.1	0.1	SU			05/16/24 10:20	1

Method: SW846 9315 - Radium-226 (GFPC)

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Radium-226	0.182	U	0.181	0.181	1.00	0.269	pCi/L	05/20/24 08:11	06/18/24 07:43	1

Carrier	*%Yield*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Ba Carrier	*82.3*		*30 - 110*	*05/20/24 08:11*	*06/18/24 07:43*	*1*

Method: SW846 9320 - Radium-228 (GFPC)

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Radium-228	**0.983**		0.575	0.583	1.00	0.834	pCi/L	05/20/24 08:15	06/17/24 12:34	1

Carrier	*%Yield*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Ba Carrier	*82.3*		*30 - 110*	*05/20/24 08:15*	*06/17/24 12:34*	*1*

Client Sample ID: DUP 1
Date Collected: 05/13/24 00:01
Date Received: 05/15/24 09:35

Lab Sample ID: 180-174082-3
Matrix: Water

Method: SW846 9320 - Radium-228 (GFPC) (Continued)

Carrier	*%Yield*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Y Carrier	*82.2*		*30 - 110*	*05/20/24 08:15*	*06/17/24 12:34*	*1*

Method: TAL-STL Ra226_Ra228 - Combined Radium-226 and Radium-228

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Combined Radium 226 + 228	**1.17**		0.603	0.610	5.00	0.834	pCi/L		06/19/24 00:31	1

Method: EPA 9056A - Anions, Ion Chromatography

Lab Sample ID: MB 180-468830/6
Matrix: Water
Analysis Batch: 468830

Client Sample ID: Method Blank
Prep Type: Total/NA

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Chloride	ND		1.0	0.71	mg/L			05/16/24 11:07	1
Fluoride	ND		0.10	0.026	mg/L			05/16/24 11:07	1
Sulfate	ND		1.0	0.76	mg/L			05/16/24 11:07	1

Lab Sample ID: LCS 180-468830/7
Matrix: Water
Analysis Batch: 468830

Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec Limits
Chloride	50.0	49.7		mg/L		99	80 - 120
Fluoride	2.50	2.47		mg/L		99	80 - 120
Sulfate	50.0	49.4		mg/L		99	80 - 120

Method: EPA 6010D - Metals (ICP)

Lab Sample ID: MB 240-613656/1-A
Matrix: Water
Analysis Batch: 614072

Client Sample ID: Method Blank
Prep Type: Total Recoverable
Prep Batch: 613656

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Boron	ND		0.10	0.057	mg/L		05/21/24 05:00	05/22/24 15:34	1

Lab Sample ID: LCS 240-613656/2-A
Matrix: Water
Analysis Batch: 614072

Client Sample ID: Lab Control Sample
Prep Type: Total Recoverable
Prep Batch: 613656

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec Limits
Boron	1.00	1.03		mg/L		103	80 - 120

Method: EPA 6020B - Metals (ICP/MS)

Lab Sample ID: MB 240-613656/1-A
Matrix: Water
Analysis Batch: 614112

Client Sample ID: Method Blank
Prep Type: Total Recoverable
Prep Batch: 613656

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Antimony	ND		0.0020	0.00057	mg/L		05/21/24 05:00	05/22/24 19:13	1
Arsenic	ND		0.0050	0.00075	mg/L		05/21/24 05:00	05/22/24 19:13	1
Barium	ND		0.0050	0.0022	mg/L		05/21/24 05:00	05/22/24 19:13	1
Beryllium	ND		0.0010	0.00062	mg/L		05/21/24 05:00	05/22/24 19:13	1
Cadmium	ND		0.0010	0.00020	mg/L		05/21/24 05:00	05/22/24 19:13	1
Calcium	ND		1.0	0.25	mg/L		05/21/24 05:00	05/22/24 19:13	1
Chromium	ND		0.0050	0.0012	mg/L		05/21/24 05:00	05/22/24 19:13	1
Cobalt	ND		0.0010	0.00019	mg/L		05/21/24 05:00	05/22/24 19:13	1
Lead	ND		0.0010	0.00045	mg/L		05/21/24 05:00	05/22/24 19:13	1
Lithium	ND		0.0080	0.0017	mg/L		05/21/24 05:00	05/22/24 19:13	1
Molybdenum	ND		0.0050	0.0011	mg/L		05/21/24 05:00	05/22/24 19:13	1
Selenium	ND		0.0050	0.00089	mg/L		05/21/24 05:00	05/22/24 19:13	1
Thallium	ND		0.0010	0.00020	mg/L		05/21/24 05:00	05/22/24 19:13	1

Method: EPA 6020B - Metals (ICP/MS) (Continued)

Lab Sample ID: LCS 240-613656/3-A
Matrix: Water
Analysis Batch: 614112

Client Sample ID: Lab Control Sample
Prep Type: Total Recoverable
Prep Batch: 613656

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec Limits
Antimony	0.100	0.0932		mg/L		93	80 - 120
Arsenic	1.00	0.895		mg/L		89	80 - 120
Barium	1.00	0.875		mg/L		87	80 - 120
Beryllium	0.500	0.505		mg/L		101	80 - 120
Cadmium	0.500	0.443		mg/L		89	80 - 120
Calcium	25.0	22.2		mg/L		89	80 - 120
Chromium	0.500	0.461		mg/L		92	80 - 120
Cobalt	0.500	0.470		mg/L		94	80 - 120
Lead	0.500	0.484		mg/L		97	80 - 120
Lithium	0.500	0.499		mg/L		100	80 - 120
Molybdenum	0.500	0.455		mg/L		91	80 - 120
Selenium	1.00	0.904		mg/L		90	80 - 120
Thallium	1.00	0.907		mg/L		91	80 - 120

Method: EPA 7470A - Mercury (CVAA)

Lab Sample ID: MB 180-469069/1-A
Matrix: Water
Analysis Batch: 469200

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 469069

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	ND		0.00020	0.00013	mg/L		05/18/24 10:45	05/20/24 14:02	1

Lab Sample ID: LCS 180-469069/2-A
Matrix: Water
Analysis Batch: 469200

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 469069

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec Limits
Mercury	0.00250	0.00239		mg/L		96	80 - 120

Method: EPA 9040C - pH

Lab Sample ID: LCS 180-468847/24
Matrix: Water
Analysis Batch: 468847

Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec Limits
pH	7.00	7.0		SU		100	99 - 101

Method: SM 2540C - Solids, Total Dissolved (TDS)

Lab Sample ID: MB 180-468906/1
Matrix: Water
Analysis Batch: 468906

Client Sample ID: Method Blank
Prep Type: Total/NA

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Dissolved Solids	ND		10	10	mg/L			05/16/24 16:46	1

Method: SM 2540C - Solids, Total Dissolved (TDS) (Continued)

Lab Sample ID: LCS 180-468906/2
Matrix: Water
Analysis Batch: 468906

Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec Limits
Total Dissolved Solids	417	404		mg/L		97	85 - 115

Method: 9315 - Radium-226 (GFPC)

Lab Sample ID: MB 160-662403/1-A
Matrix: Water
Analysis Batch: 666560

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 662403

Analyte	MB Result	MB Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Radium-226	0.07648	U	0.142	0.142	1.00	0.255	pCi/L	05/20/24 08:11	06/17/24 23:06	1

Carrier	*MB %Yield*	*MB Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Ba Carrier	*92.0*		*30 - 110*	*05/20/24 08:11*	*06/17/24 23:06*	*1*

Lab Sample ID: LCS 160-662403/2-A
Matrix: Water
Analysis Batch: 666560

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 662403

Analyte	Spike Added	LCS Result	LCS Qual	Total Uncert. (2σ+/-)	RL	MDC	Unit	%Rec	%Rec Limits
Radium-226	11.3	9.160		1.23	1.00	0.412	pCi/L	81	75 - 125

Carrier	*LCS %Yield*	*LCS Qualifier*	*Limits*
Ba Carrier	*88.8*		*30 - 110*

Method: 9320 - Radium-228 (GFPC)

Lab Sample ID: MB 160-662405/1-A
Matrix: Water
Analysis Batch: 666722

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 662405

Analyte	MB Result	MB Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Radium-228	0.1836	U	0.259	0.259	1.00	0.437	pCi/L	05/20/24 08:15	06/17/24 12:15	1

Carrier	*MB %Yield*	*MB Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Ba Carrier	*92.0*		*30 - 110*	*05/20/24 08:15*	*06/17/24 12:15*	*1*
Y Carrier	*86.0*		*30 - 110*	*05/20/24 08:15*	*06/17/24 12:15*	*1*

Lab Sample ID: LCS 160-662405/2-A
Matrix: Water
Analysis Batch: 666722

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 662405

Analyte	Spike Added	LCS Result	LCS Qual	Total Uncert. (2σ+/-)	RL	MDC	Unit	%Rec	%Rec Limits
Radium-228	8.84	9.439		1.29	1.00	0.535	pCi/L	107	75 - 125

Method: 9320 - Radium-228 (GFPC) (Continued)

Lab Sample ID: LCS 160-662405/2-A
Matrix: Water
Analysis Batch: 666722

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 662405

Carrier	LCS %Yield	LCS Qualifier	Limits
Ba Carrier	88.8		30 - 110
Y Carrier	85.2		30 - 110

HPLC/IC

Analysis Batch: 468830

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-174082-1	CCR-AP-5	Total/NA	Water	EPA 9056A	
180-174082-1	CCR-AP-5	Total/NA	Water	EPA 9056A	
180-174082-2	CCR-AP-5I	Total/NA	Water	EPA 9056A	
180-174082-2	CCR-AP-5I	Total/NA	Water	EPA 9056A	
180-174082-3	DUP 1	Total/NA	Water	EPA 9056A	
180-174082-3	DUP 1	Total/NA	Water	EPA 9056A	
MB 180-468830/6	Method Blank	Total/NA	Water	EPA 9056A	
LCS 180-468830/7	Lab Control Sample	Total/NA	Water	EPA 9056A	

Metals

Prep Batch: 469069

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-174082-1	CCR-AP-5	Total/NA	Water	7470A	
180-174082-2	CCR-AP-5I	Total/NA	Water	7470A	
180-174082-3	DUP 1	Total/NA	Water	7470A	
MB 180-469069/1-A	Method Blank	Total/NA	Water	7470A	
LCS 180-469069/2-A	Lab Control Sample	Total/NA	Water	7470A	

Analysis Batch: 469200

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-174082-1	CCR-AP-5	Total/NA	Water	EPA 7470A	469069
180-174082-2	CCR-AP-5I	Total/NA	Water	EPA 7470A	469069
180-174082-3	DUP 1	Total/NA	Water	EPA 7470A	469069
MB 180-469069/1-A	Method Blank	Total/NA	Water	EPA 7470A	469069
LCS 180-469069/2-A	Lab Control Sample	Total/NA	Water	EPA 7470A	469069

Prep Batch: 613656

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-174082-1	CCR-AP-5	Total Recoverable	Water	3005A	
180-174082-2	CCR-AP-5I	Total Recoverable	Water	3005A	
180-174082-3	DUP 1	Total Recoverable	Water	3005A	
MB 240-613656/1-A	Method Blank	Total Recoverable	Water	3005A	
LCS 240-613656/2-A	Lab Control Sample	Total Recoverable	Water	3005A	
LCS 240-613656/3-A	Lab Control Sample	Total Recoverable	Water	3005A	

Analysis Batch: 614072

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-174082-2	CCR-AP-5I	Total Recoverable	Water	EPA 6010D	613656
180-174082-3	DUP 1	Total Recoverable	Water	EPA 6010D	613656
MB 240-613656/1-A	Method Blank	Total Recoverable	Water	EPA 6010D	613656
LCS 240-613656/2-A	Lab Control Sample	Total Recoverable	Water	EPA 6010D	613656

Analysis Batch: 614112

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-174082-1	CCR-AP-5	Total Recoverable	Water	EPA 6020B	613656
180-174082-2	CCR-AP-5I	Total Recoverable	Water	EPA 6020B	613656
180-174082-3	DUP 1	Total Recoverable	Water	EPA 6020B	613656
MB 240-613656/1-A	Method Blank	Total Recoverable	Water	EPA 6020B	613656
LCS 240-613656/3-A	Lab Control Sample	Total Recoverable	Water	EPA 6020B	613656

QC Association Summary

Client: Haley & Aldrich, Inc.
Project/Site: CCR Groundwater Monitoring FB Culley East

Job ID: 180-174082-1
SDG: FB Culley East

Metals

Analysis Batch: 614474

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-174082-1	CCR-AP-5	Total Recoverable	Water	EPA 6020B	613656
180-174082-2	CCR-AP-5I	Total Recoverable	Water	EPA 6020B	613656
180-174082-3	DUP 1	Total Recoverable	Water	EPA 6020B	613656

Analysis Batch: 615032

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-174082-1	CCR-AP-5	Total Recoverable	Water	EPA 6010D	613656

General Chemistry

Analysis Batch: 468847

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-174082-1	CCR-AP-5	Total/NA	Water	EPA 9040C	
180-174082-2	CCR-AP-5I	Total/NA	Water	EPA 9040C	
180-174082-3	DUP 1	Total/NA	Water	EPA 9040C	
LCS 180-468847/24	Lab Control Sample	Total/NA	Water	EPA 9040C	

Analysis Batch: 468906

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-174082-1	CCR-AP-5	Total/NA	Water	SM 2540C	
180-174082-2	CCR-AP-5I	Total/NA	Water	SM 2540C	
180-174082-3	DUP 1	Total/NA	Water	SM 2540C	
MB 180-468906/1	Method Blank	Total/NA	Water	SM 2540C	
LCS 180-468906/2	Lab Control Sample	Total/NA	Water	SM 2540C	

Rad

Prep Batch: 662403

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-174082-1	CCR-AP-5	Total/NA	Water	PrecSep-21	
180-174082-2	CCR-AP-5I	Total/NA	Water	PrecSep-21	
180-174082-3	DUP 1	Total/NA	Water	PrecSep-21	
MB 160-662403/1-A	Method Blank	Total/NA	Water	PrecSep-21	
LCS 160-662403/2-A	Lab Control Sample	Total/NA	Water	PrecSep-21	

Prep Batch: 662405

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-174082-1	CCR-AP-5	Total/NA	Water	PrecSep_0	
180-174082-2	CCR-AP-5I	Total/NA	Water	PrecSep_0	
180-174082-3	DUP 1	Total/NA	Water	PrecSep_0	
MB 160-662405/1-A	Method Blank	Total/NA	Water	PrecSep_0	
LCS 160-662405/2-A	Lab Control Sample	Total/NA	Water	PrecSep_0	

Eurofins Pittsburgh
301 Alpha Drive RIDC Park
Pittsburgh, PA 15238
Phone. 412-963-7058 Fax. 412-963-2468

Chain of Custody Record

Virginia Beach Service Center

eurofins | Environ

Client Information	Sampler: Hayley Tolles	Lab PM: Johnson, Andy	Carrier Tracking No(s):	COC No: 180-101847-14505 2
Client Contact: Mark Breting	Phone:	E-Mail: Andy Johnson@et.eurofinsus com	State of Origin:	Page: Page 2 of 2
Company: Atlas Technical Consultants LLC	PWSID:	Analysis Requested		Job #:
Address: 7988 Centerpoint Drive Suite 100	Due Date Requested:			Preservation Codes: N - None D - HNO3
City: Indianapolis	TAT Requested (days):			
State, Zip: IN, 46256	Compliance Project: Δ Yes Δ No			
Phone	PO #: 0129420-032-001-01			
Email: mark.breting@atcassociates.com	WO #: See Chain			Other:
Project Name: CCR GW Monitoring FB Culley East	Project #: 18016014			
Site: Culley East	SSOW#:			

Sample Identification	Sample Date	Sample Time	Sample Type (C=Comp, G=grab)	Matrix (W=water, S=solid, O=waste/oil, BT=Tissue, A=Air)	Field Filtered Sample (Yes or No)	Perform MS/MSD (Yes or No)	9040C, 9056A_ORGFM_28D	2540C_Calcd - TDS by 2540C	9315_Ra226, 9320_Ra228	6020B - Metals by 6020B	7470A - Hg by 7470A	Total Number of containers	Special Instructions/Note:
			Preservation Code:				N	N	D	D	D		
CCR-AP-5	5-13-24	13:17	G	W	N		X	X	X	X	X		
CCR-AP-5E	5-13-24	14:02	G	W	N		X	X	X	X	X		
DUP 1	5-13-24		G	W	N		X	X	X	X	X		

180-174082 Chain of Custody

Possible Hazard Identification
☐ Non-Hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown ☐ Radiological

Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)
☐ Return To Client ☐ Disposal By Lab ☐ Archive For _____ Months

Deliverable Requested I, II, III, IV, Other (specify)

Special Instructions/QC Requirements

Empty Kit Relinquished by	Date:	Time	Method of Shipment:

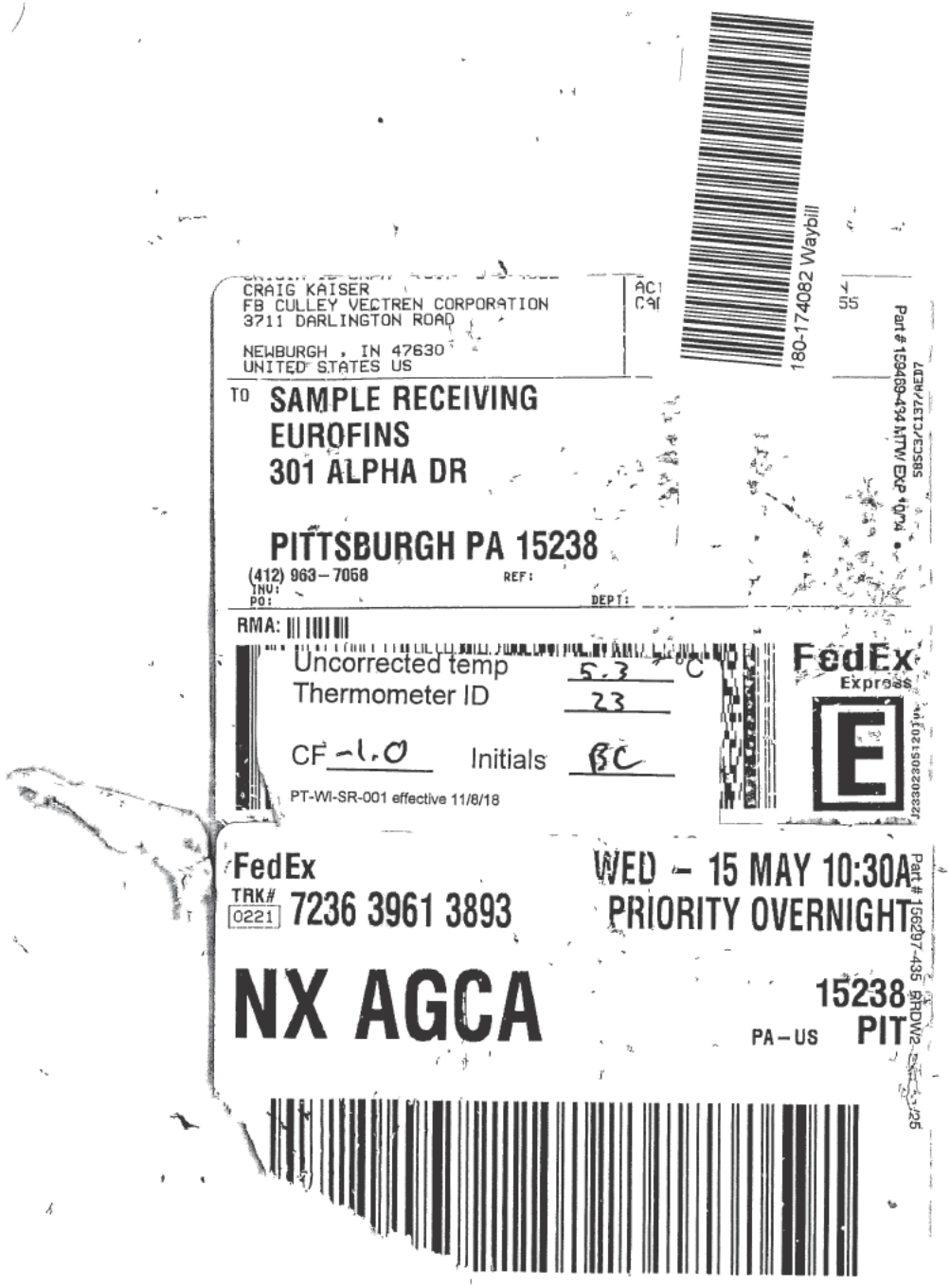
Relinquished by	Date/Time	Company	Received by	Date/Time	Company
Hayley Tolles	5-14-24 / 1200	ATLAS	Fedex	5-14-24 / 1200	
Relinquished by	Date/Time	Company	Received by	Date/Time	Company
				05/15/24 0935	EHINE
Relinquished by	Date/Time	Company	Received by	Date/Time	Company

Custody Seals Intact: Δ Yes Δ No	Custody Seal No.:	Cooler Temperature(s) °C and Other Remarks:

Virginia Beach Service Center

Ver: 06/08/2021

Virginia Beach Service Center


180-174082 Waybill
CRAIG KAISER
FB CULLEY VECTREN CORPORATION
3711 DARLINGTON ROAD
NEWBURGH , IN 47630
UNITED STATES US
TO SAMPLE RECEIVING
EUROFINS
301 ALPHA DR
PITTSBURGH PA 15238
(412) 963-7058
INV:
PO:
REF:
DEPT:
RMA:
Uncorrected temp 5.3 °C
Thermometer ID 23
CF -1.0 Initials BC
PT-WI-SR-001 effective 11/8/18
FedEx Express
FedEx
TRK# 0221 7236 3961 3893
WED - 15 MAY 10:30A
PRIORITY OVERNIGHT
NX AGCA
15238
PA-US
PIT

Eurofins Pittsburgh
301 Alpha Drive RIDC Park
Pittsburgh, PA 15238
Phone: 412-963-7058 Fax: 412-963-2468

Chain of Custody Record

eurofins Environment Testing

Client Information (Sub Contract Lab)	Sampler:	Lab PM: Johnson, Andy	Carrier Tracking No(s):	COC No: 180-514836.1
Client Contact: Shipping/Receiving	Phone:	E-Mail: Andy.Johnson@et.eurofinsus.com	State of Origin: Indiana	Page: Page 1 of 1
Company: TestAmerica Laboratories, Inc.		Accreditations Required (See note):		Job #: 180-174082-1
Address: 13715 Rider Trail North,	Due Date Requested: 5/25/2024			
City: Earth City	TAT Requested (days):			
State, Zip: MO, 63045				
Phone: 314-298-8566(Tel) 314-298-8757(Fax)	PO #:			
Email:	WO #:			
Project Name: CCR Groundwater Monitoring FB Culley East	Project #: 18016014			
Site:	SSOW#:			

Analysis Requested

Sample Identification - Client ID (Lab ID)	Sample Date	Sample Time	Sample Type (C=comp, G=grab)	Matrix (W=water, S=solid, O=waste/oil, BT=Tissue, A=Air)	Field Filtered Sample (Yes or No)	Perform MS/MSD (Yes or No)	9315_Ra226/PrecSep_21 Radium-226 (GFPC) by 9315 (21-day decay)	9320_Ra228/PrecSep_0 Radium-228 (GFPC) by 9320	Ra226Ra228_GFPC/ Combined Radium-226 and Radium-228	Total Number of containers	Special Instructions/Note:
			Preservation Code:								
CCR-AP-5 (180-174082-1)	5/13/24	13:17 Eastern		Water			X	X	X	2	
CCR-AP-5I (180-174082-2)	5/13/24	14:02 Eastern		Water			X	X	X	2	
DUP 1 (180-174082-3)	5/13/24	00:01 Eastern		Water			X	X	X	2	

Preservation Codes: -

Other:

Note: Since laboratory accreditations are subject to change, Eurofins Pittsburgh places the ownership of method, analyte & accreditation compliance upon our subcontract laboratories. This sample shipment is forwarded under chain-of-custody. If the laboratory does not currently maintain accreditation in the State of Origin listed above for analysis/tests/matrix being analyzed, the samples must be shipped back to the Eurofins Pittsburgh laboratory or other instructions will be provided. Any changes to accreditation status should be brought to Eurofins Pittsburgh attention immediately. If all requested accreditations are current to date, return the signed Chain of Custody attesting to said compliance to Eurofins Pittsburgh.

Possible Hazard Identification *Unconfirmed*	***Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)*** ☐ *Return To Client* ☐ *Disposal By Lab* ☐ *Archive For* ____ *Months*
Deliverable Requested: I, II, III, IV, Other (specify) Primary Deliverable Rank: 2	Special Instructions/QC Requirements:

Empty Kit Relinquished by:	Date:	Time:	Method of Shipment:

Relinquished by:	Date/Time:	Company:	Received by:	Date/Time:	Company:
	5/16/24 1700	TAL PITT	Sierra Worthington	MAY 17 2024 0850	EHSO
Relinquished by:	Date/Time:	Company:	Received by:	Date/Time:	Company:
Relinquished by:	Date/Time:	Company:	Received by:	Date/Time:	Company:

Custody Seals Intact: Δ Yes Δ No	Custody Seal No.:	Cooler Temperature(s) °C and Other Remarks:

Ver: 06/08/2021

Login Sample Receipt Checklist

Client: Haley & Aldrich, Inc.

Job Number: 180-174082-1
SDG Number: FB Culley East

Login Number: 174082
List Number: 1
Creator: Abernathy, Eric L

List Source: Eurofins Pittsburgh

Question	Answer	Comment
Radioactivity wasn't checked or is </= background as measured by a survey meter.	N/A	
The cooler's custody seal, if present, is intact.	True	
Sample custody seals, if present, are intact.	True	
The cooler or samples do not appear to have been compromised or tampered with.	True	
Samples were received on ice.	True	
Cooler Temperature is acceptable.	True	
Cooler Temperature is recorded.	True	
COC is present.	True	
COC is filled out in ink and legible.	True	
COC is filled out with all pertinent information.	True	
Is the Field Sampler's name present on COC?	True	
There are no discrepancies between the containers received and the COC.	True	
Samples are received within Holding Time (excluding tests with immediate HTs)	True	
Sample containers have legible labels.	True	
Containers are not broken or leaking.	True	
Sample collection date/times are provided.	True	
Appropriate sample containers are used.	True	
Sample bottles are completely filled.	True	
Sample Preservation Verified.	True	
There is sufficient vol. for all requested analyses, incl. any requested MS/MSDs	True	
Containers requiring zero headspace have no headspace or bubble is <6mm (1/4").	True	
Multiphasic samples are not present.	True	
Samples do not require splitting or compositing.	True	
Residual Chlorine Checked.	N/A	

Login Sample Receipt Checklist

Client: Haley & Aldrich, Inc.

Job Number: 180-174082-1
SDG Number: FB Culley East

Login Number: 174082
List Number: 3
Creator: Worthington, Sierra M

List Source: Eurofins St. Louis
List Creation: 05/17/24 02:07 PM

Question	Answer	Comment
Radioactivity wasn't checked or is </= background as measured by a survey meter.	True	
The cooler's custody seal, if present, is intact.	True	
Sample custody seals, if present, are intact.	True	
The cooler or samples do not appear to have been compromised or tampered with.	True	
Samples were received on ice.	N/A	
Cooler Temperature is acceptable.	True	
Cooler Temperature is recorded.	True	
COC is present.	True	
COC is filled out in ink and legible.	True	
COC is filled out with all pertinent information.	True	
Is the Field Sampler's name present on COC?	N/A	
There are no discrepancies between the containers received and the COC.	True	
Samples are received within Holding Time (excluding tests with immediate HTs)	True	
Sample containers have legible labels.	True	
Containers are not broken or leaking.	True	
Sample collection date/times are provided.	True	
Appropriate sample containers are used.	True	
Sample bottles are completely filled.	True	
Sample Preservation Verified.	True	
There is sufficient vol. for all requested analyses, incl. any requested MS/MSDs	True	
Containers requiring zero headspace have no headspace or bubble is <6mm (1/4").	N/A	
Multiphasic samples are not present.	True	
Samples do not require splitting or compositing.	True	
Residual Chlorine Checked.	N/A	

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ANALYTICAL REPORT

PREPARED FOR

Attn: Todd Plating
Haley & Aldrich, Inc.
400 Augusta Street
Suite 100
Greenville, South Carolina 29601

Generated 6/17/2024 4:43:33 PM

JOB DESCRIPTION

CCR Groundwater Monitoring FB Culley East
FB Culley East

JOB NUMBER

180-173881-1

Eurofins Pittsburgh
301 Alpha Drive
RIDC Park
Pittsburgh PA 15238

See page two for job notes and contact information.

my EOL

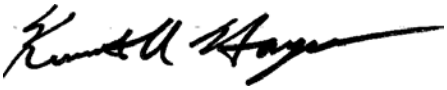
Job Notes

This report may not be reproduced except in full, and with written approval from the laboratory. The results relate only to the samples tested. For questions please contact the Project Manager at the e-mail address or telephone number listed on this page.

PA Lab ID: 02-00416

The test results in this report relate only to the samples as received by the laboratory and will meet all requirements of the methodology, with any exceptions noted. This report shall not be reproduced except in full, without the express written approval of the laboratory. All questions should be directed to the Eurofins Pittsburgh Project Manager.

Authorization



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Authorized for release by
Ken Hayes, Project Manager II
Ken.Hayes@et.eurofinsus.com
Designee for
Andy Johnson, Senior Project Manager
Andy.Johnson@et.eurofinsus.com
(615)818-9567

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Job ID: 180-173881-1 Eurofins Pittsburgh

Job Narrative
180-173881-1

Analytical test results meet all requirements of the associated regulatory program listed on the Accreditation/Certification Summary Page unless otherwise noted under the individual analysis. Data qualifiers are applied to indicate exceptions. Noncompliant quality control (QC) is further explained in narrative comments.

- Matrix QC may not be reported if insufficient sample or site-specific QC samples were not submitted. In these situations, to demonstrate precision and accuracy at a batch level, a LCS/LCSD may be performed, unless otherwise specified in the method.
- Surrogate and/or isotope dilution analyte recoveries (if applicable) which are outside of the QC window are confirmed unless attributed to a dilution or otherwise noted in the narrative.

Regulated compliance samples (e.g. SDWA, NPDES) must comply with the associated agency requirements/permits.

Receipt
The samples were received on 5/11/2024 10:00 AM. Unless otherwise noted below, the samples arrived in good condition, and, where required, properly preserved and on ice. The temperatures of the 2 coolers at receipt time were 2.1°C and 2.6°C.

Gas Flow Proportional Counter
No additional analytical or quality issues were noted, other than those described above or in the Definitions/ Glossary page.

Rad
No additional analytical or quality issues were noted, other than those described above or in the Definitions/ Glossary page.

Job ID: 180-173881-2 Eurofins Pittsburgh

180-173881-2

Analytical test results meet all requirements of the associated regulatory program listed on the Accreditation/Certification Summary Page unless otherwise noted under the individual analysis. Data qualifiers are applied to indicate exceptions. Noncompliant quality control (QC) is further explained in narrative comments.

- Matrix QC may not be reported if insufficient sample or site-specific QC samples were not submitted. In these situations, to demonstrate precision and accuracy at a batch level, a LCS/LCSD may be performed, unless otherwise specified in the method.
- Surrogate and/or isotope dilution analyte recoveries (if applicable) which are outside of the QC window are confirmed unless attributed to a dilution or otherwise noted in the narrative.

Regulated compliance samples (e.g. SDWA, NPDES) must comply with the associated agency requirements/permits.

Receipt
The samples were received on 5/11/2024 10:00 AM. Unless otherwise noted below, the samples arrived in good condition, and, where required, properly preserved and on ice. The temperatures of the 2 coolers at receipt time were 2.1°C and 2.6°C.

HPLC/IC
Method 9056A_ORGFM_28D: The following sample was diluted due to the nature of the sample matrix: CCR-AP-11 (180-173881-3). Elevated reporting limits (RLs) are provided.

No additional analytical or quality issues were noted, other than those described above or in the Definitions/ Glossary page.

Metals
No additional analytical or quality issues were noted, other than those described above or in the Definitions/ Glossary page.

General Chemistry
No additional analytical or quality issues were noted, other than those described above or in the Definitions/ Glossary page.

Definitions/Glossary

Client: Haley & Aldrich, Inc.
Project/Site: CCR Groundwater Monitoring FB Culley East

Job ID: 180-173881-1
SDG: FB Culley East

Qualifiers

Metals

Qualifier	Qualifier Description
4	MS, MSD: The analyte present in the original sample is greater than 4 times the matrix spike concentration; therefore, control limits are not applicable.
J	Result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value.

General Chemistry

Qualifier	Qualifier Description
HF	Parameter with a holding time of 15 minutes. Test performed by laboratory at client's request. Sample was analyzed outside of hold time.

Rad

Qualifier	Qualifier Description
U	Result is less than the sample detection limit.

Glossary

Abbreviation	These commonly used abbreviations may or may not be present in this report.
¤	Listed under the "D" column to designate that the result is reported on a dry weight basis
%R	Percent Recovery
CFL	Contains Free Liquid
CFU	Colony Forming Unit
CNF	Contains No Free Liquid
DER	Duplicate Error Ratio (normalized absolute difference)
Dil Fac	Dilution Factor
DL	Detection Limit (DoD/DOE)
DL, RA, RE, IN	Indicates a Dilution, Re-analysis, Re-extraction, or additional Initial metals/anion analysis of the sample
DLC	Decision Level Concentration (Radiochemistry)
EDL	Estimated Detection Limit (Dioxin)
LOD	Limit of Detection (DoD/DOE)
LOQ	Limit of Quantitation (DoD/DOE)
MCL	EPA recommended "Maximum Contaminant Level"
MDA	Minimum Detectable Activity (Radiochemistry)
MDC	Minimum Detectable Concentration (Radiochemistry)
MDL	Method Detection Limit
ML	Minimum Level (Dioxin)
MPN	Most Probable Number
MQL	Method Quantitation Limit
NC	Not Calculated
ND	Not Detected at the reporting limit (or MDL or EDL if shown)
NEG	Negative / Absent
POS	Positive / Present
PQL	Practical Quantitation Limit
PRES	Presumptive
QC	Quality Control
RER	Relative Error Ratio (Radiochemistry)
RL	Reporting Limit or Requested Limit (Radiochemistry)
RPD	Relative Percent Difference, a measure of the relative difference between two points
TEF	Toxicity Equivalent Factor (Dioxin)
TEQ	Toxicity Equivalent Quotient (Dioxin)
TNTC	Too Numerous To Count

Accreditation/Certification Summary

Client: Haley & Aldrich, Inc.
Project/Site: CCR Groundwater Monitoring FB Culley East

Job ID: 180-173881-1
SDG: FB Culley East

Laboratory: Eurofins Pittsburgh

All accreditations/certifications held by this laboratory are listed. Not all accreditations/certifications are applicable to this report.

Authority	Program	Identification Number	Expiration Date
Arkansas DEQ	State	19-033-0	06-27-24
California	State	2891	04-30-24 *
Connecticut	State	PH-0688	09-30-24
Florida	NELAP	E871008	06-30-24
Georgia	State	PA 02-00416	04-30-25
Illinois	NELAP	004375	07-31-25
Kansas	NELAP	E-10350	01-31-25
Kentucky (UST)	State	162013	04-30-23 *
Kentucky (WW)	State	KY98043	12-31-24
Louisiana	NELAP	04041	06-30-22 *
Louisiana (All)	NELAP	04041	06-30-24
Maine	State	PA00164	03-06-26
Minnesota	NELAP	042-999-482	12-31-24
New Hampshire	NELAP	2030	04-04-24 *
New Jersey	NELAP	PA005	06-30-24
New York	NELAP	11182	04-01-25
North Carolina (WW/SW)	State	434	12-31-24
North Dakota	State	R-227	04-30-24 *
Oregon	NELAP	PA-2151	02-06-25
Pennsylvania	NELAP	02-00416	04-30-25
Rhode Island	State	LAO00362	01-01-25
South Carolina	State	89014	04-30-25
Texas	NELAP	T104704528	03-31-25
US Fish & Wildlife	US Federal Programs	058448	03-31-24 *
USDA	US Federal Programs	P330-16-00211	04-11-26
Utah	NELAP	PA001462019-8	05-31-24
Virginia	NELAP	10043	07-14-24
West Virginia DEP	State	142	01-31-25
Wisconsin	State	998027800	08-31-24

Laboratory: Eurofins Cleveland

All accreditations/certifications held by this laboratory are listed. Not all accreditations/certifications are applicable to this report.

Authority	Program	Identification Number	Expiration Date
California	State	2927	02-28-25
Georgia	State	4062	02-27-25
Illinois	NELAP	200004	07-31-24
Iowa	State	421	06-01-25
Kentucky (UST)	State	112225	02-27-25
Kentucky (WW)	State	KY98016	12-30-24
Minnesota	NELAP	039-999-348	12-31-24
New Jersey	NELAP	OH001	06-30-24
New York	NELAP	10975	04-02-25
Ohio VAP	State	ORELAP 4062	02-27-25
Oregon	NELAP	4062	02-27-25
Pennsylvania	NELAP	68-00340	08-31-24
Texas	NELAP	T104704517-22-19	08-31-24
USDA	US Federal Programs	P330-18-00281	01-05-27
Virginia	NELAP	460175	09-14-24
West Virginia DEP	State	210	12-31-24

* Accreditation/Certification renewal pending - accreditation/certification considered valid.

Accreditation/Certification Summary

Client: Haley & Aldrich, Inc.
Job ID: 180-173881-1
Project/Site: CCR Groundwater Monitoring FB Culley East
SDG: FB Culley East

Laboratory: Eurofins St. Louis

All accreditations/certifications held by this laboratory are listed. Not all accreditations/certifications are applicable to this report.

Authority	Program	Identification Number	Expiration Date
Alaska (UST)	State	20-001	05-06-25
ANAB	Dept. of Defense ELAP	L2305	04-06-25
ANAB	Dept. of Energy	L2305.01	04-08-25
ANAB	ISO/IEC 17025	L2305	04-06-25
Arizona	State	AZ0813	12-08-24
California	Los Angeles County Sanitation Districts	10259	06-30-22 *
California	State	2886	06-30-24
Connecticut	State	PH-0241	03-31-25
Florida	NELAP	E87689	06-30-24
HI - RadChem Recognition	State	n/a	06-30-24
Illinois	NELAP	200023	11-30-24
Iowa	State	373	12-01-24
Kansas	NELAP	E-10236	10-31-24
Kentucky (DW)	State	KY90125	12-31-24
Kentucky (WW)	State	KY90125 (Permit KY0004049)	12-31-24
Louisiana	NELAP	04080	06-30-22 *
Louisiana (All)	NELAP	04080	06-30-24
Louisiana (DW)	State	LA011	12-31-24
Maryland	State	310	09-30-24
Massachusetts	State	M-MO054	06-30-24
MI - RadChem Recognition	State	9005	06-30-24
Missouri	State	780	06-30-25
Nevada	State	MO00054	07-31-24
New Jersey	NELAP	MO002	06-30-24
New Mexico	State	MO00054	06-30-24
New York	NELAP	11616	03-31-25
North Carolina (DW)	State	29700	07-31-24
North Dakota	State	R-207	06-30-24
Oklahoma	NELAP	9997	08-31-24
Oregon	NELAP	4157	09-01-24
Pennsylvania	NELAP	68-00540	02-28-25
South Carolina	State	85002001	06-30-24
Texas	NELAP	T104704193	07-31-24
US Fish & Wildlife	US Federal Programs	058448	07-31-24
USDA	US Federal Programs	P330-17-00028	05-18-26
Utah	NELAP	MO00054	07-31-24
Virginia	NELAP	460230	06-14-24
Washington	State	C592	08-30-24
West Virginia DEP	State	381	10-31-24

* Accreditation/Certification renewal pending - accreditation/certification considered valid.

Sample Summary

Client: Haley & Aldrich, Inc.
Project/Site: CCR Groundwater Monitoring FB Culley East

Job ID: 180-173881-1
SDG: FB Culley East

Lab Sample ID	Client Sample ID	Matrix	Collected	Received
180-173881-1	CCR-AP-7	Water	05/10/24 12:00	05/11/24 10:00
180-173881-2	CCR-AP-8	Water	05/10/24 15:30	05/11/24 10:00
180-173881-3	CCR-AP-11	Water	05/10/24 14:45	05/11/24 10:00
180-173881-4	FIELD BLANK 1	Water	05/10/24 15:45	05/11/24 10:00

Method Summary

Client: Haley & Aldrich, Inc.
Project/Site: CCR Groundwater Monitoring FB Culley East

Job ID: 180-173881-1
SDG: FB Culley East

Method	Method Description	Protocol	Laboratory
9315	Radium-226 (GFPC)	SW846	EET SL
9320	Radium-228 (GFPC)	SW846	EET SL
Ra226_Ra228	Combined Radium-226 and Radium-228	TAL-STL	EET SL
PrecSep_0	Preparation, Precipitate Separation	None	EET SL
PrecSep-21	Preparation, Precipitate Separation (21-Day In-Growth)	None	EET SL

Protocol References:

None = None

SW846 = "Test Methods For Evaluating Solid Waste, Physical/Chemical Methods", Third Edition, November 1986 And Its Updates.

TAL-STL = TestAmerica Laboratories, St. Louis, Facility Standard Operating Procedure.

Laboratory References:

EET SL = Eurofins St. Louis, 13715 Rider Trail North, Earth City, MO 63045, TEL (314)298-8566

Lab Chronicle

Client: Haley & Aldrich, Inc.
Project/Site: CCR Groundwater Monitoring FB Culley East

Job ID: 180-173881-1
SDG: FB Culley East

Client Sample ID: CCR-AP-7

Date Collected: 05/10/24 12:00
Date Received: 05/11/24 10:00

Lab Sample ID: 180-173881-1

Matrix: Water

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	EPA 9056A		1	1 mL	1 mL	468668	05/15/24 16:14	AM	EET PIT
	Instrument ID: CHICS2100B									
Total Recoverable	Prep	3005A			50 mL	50 mL	613145	05/15/24 14:00	GK	EET CLE
Total Recoverable	Analysis	EPA 6010D		1			613436	05/17/24 03:09	KLC	EET CLE
	Instrument ID: I9									
Total Recoverable	Prep	3005A			50 mL	50 mL	613145	05/15/24 14:00	GK	EET CLE
Total Recoverable	Analysis	EPA 6020B		1			613785	05/20/24 12:53	RKT	EET CLE
	Instrument ID: I14									
Total/NA	Prep	7470A			25 mL	25 mL	469056	05/18/24 10:45	SJM	EET PIT
Total/NA	Analysis	EPA 7470A		1			469200	05/20/24 12:41	MTW	EET PIT
	Instrument ID: HGY									
Total/NA	Analysis	EPA 9040C		1			468497	05/13/24 18:05	SNR	EET PIT
	Instrument ID: OZ									
Total/NA	Analysis	SM 2540C		1	100 mL	100 mL	468762	05/15/24 17:28	LWM	EET PIT
	Instrument ID: NOEQUIP									
Total/NA	Prep	PrecSep-21			1006.02 mL	1.0 g	661791	05/15/24 09:14	MLT	EET SL
Total/NA	Analysis	9315		1	1.0 mL	1.0 mL	665614	06/10/24 19:21	SCB	EET SL
	Instrument ID: GFPCBLUE									
Total/NA	Prep	PrecSep_0			1006.02 mL	1.0 g	661792	05/15/24 09:17	MLT	EET SL
Total/NA	Analysis	9320		1			665181	06/07/24 11:40	SCB	EET SL
	Instrument ID: GFPCORANGE									
Total/NA	Analysis	Ra226_Ra228		1			665833	06/12/24 08:25	FLC	EET SL
	Instrument ID: NOEQUIP									

Client Sample ID: CCR-AP-8

Date Collected: 05/10/24 15:30
Date Received: 05/11/24 10:00

Lab Sample ID: 180-173881-2

Matrix: Water

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	EPA 9056A		1	1 mL	1 mL	468668	05/15/24 20:40	AM	EET PIT
	Instrument ID: CHICS2100B									
Total Recoverable	Prep	3005A			50 mL	50 mL	613145	05/15/24 14:00	GK	EET CLE
Total Recoverable	Analysis	EPA 6010D		1			613436	05/17/24 05:00	KLC	EET CLE
	Instrument ID: I9									
Total Recoverable	Prep	3005A			50 mL	50 mL	613145	05/15/24 14:00	GK	EET CLE
Total Recoverable	Analysis	EPA 6020B		1			613785	05/20/24 13:56	RKT	EET CLE
	Instrument ID: I14									
Total/NA	Prep	7470A			25 mL	25 mL	469056	05/18/24 10:45	SJM	EET PIT
Total/NA	Analysis	EPA 7470A		1			469200	05/20/24 12:45	MTW	EET PIT
	Instrument ID: HGY									
Total/NA	Analysis	EPA 9040C		1			468497	05/13/24 18:44	SNR	EET PIT
	Instrument ID: OZ									
Total/NA	Analysis	SM 2540C		1	100 mL	100 mL	468762	05/15/24 17:28	LWM	EET PIT
	Instrument ID: NOEQUIP									

Lab Chronicle

Client: Haley & Aldrich, Inc.
Project/Site: CCR Groundwater Monitoring FB Culley East

Job ID: 180-173881-1
SDG: FB Culley East

Client Sample ID: CCR-AP-8

Date Collected: 05/10/24 15:30
Date Received: 05/11/24 10:00

Lab Sample ID: 180-173881-2

Matrix: Water

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	PrecSep-21			751.75 mL	1.0 g	661791	05/15/24 09:14	MLT	EET SL
Total/NA	Analysis	9315		1			665614	06/10/24 19:22	SCB	EET SL
	Instrument ID: GFPCBLUE									
Total/NA	Prep	PrecSep_0			751.75 mL	1.0 g	661792	05/15/24 09:17	MLT	EET SL
Total/NA	Analysis	9320		1			665181	06/07/24 11:40	SCB	EET SL
	Instrument ID: GFPCORANGE									
Total/NA	Analysis	Ra226_Ra228		1			665833	06/12/24 08:25	FLC	EET SL
	Instrument ID: NOEQUIP									

Client Sample ID: CCR-AP-11

Date Collected: 05/10/24 14:45
Date Received: 05/11/24 10:00

Lab Sample ID: 180-173881-3

Matrix: Water

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	EPA 9056A		1	1 mL	1 mL	468668	05/15/24 20:11	AM	EET PIT
	Instrument ID: CHICS2100B									
Total/NA	Analysis	EPA 9056A		5	1 mL	1 mL	468668	05/15/24 20:25	AM	EET PIT
	Instrument ID: CHICS2100B									
Total Recoverable	Prep	3005A			50 mL	50 mL	613145	05/15/24 14:00	GK	EET CLE
Total Recoverable	Analysis	EPA 6010D		1			613436	05/17/24 05:04	KLC	EET CLE
	Instrument ID: I9									
Total Recoverable	Prep	3005A			50 mL	50 mL	613145	05/15/24 14:00	GK	EET CLE
Total Recoverable	Analysis	EPA 6020B		1			613785	05/20/24 14:04	RKT	EET CLE
	Instrument ID: I14									
Total/NA	Prep	7470A			25 mL	25 mL	469056	05/18/24 10:45	SJM	EET PIT
Total/NA	Analysis	EPA 7470A		1			469200	05/20/24 12:46	MTW	EET PIT
	Instrument ID: HGY									
Total/NA	Analysis	EPA 9040C		1			468497	05/13/24 18:39	SNR	EET PIT
	Instrument ID: OZ									
Total/NA	Analysis	SM 2540C		1	100 mL	100 mL	468762	05/15/24 17:28	LWM	EET PIT
	Instrument ID: NOEQUIP									
Total/NA	Prep	PrecSep-21			999.68 mL	1.0 g	661791	05/15/24 09:14	MLT	EET SL
Total/NA	Analysis	9315		1			665614	06/10/24 19:22	SCB	EET SL
	Instrument ID: GFPCBLUE									
Total/NA	Prep	PrecSep_0			999.68 mL	1.0 g	661792	05/15/24 09:17	MLT	EET SL
Total/NA	Analysis	9320		1			665181	06/07/24 11:41	SCB	EET SL
	Instrument ID: GFPCORANGE									
Total/NA	Analysis	Ra226_Ra228		1			665833	06/12/24 08:25	FLC	EET SL
	Instrument ID: NOEQUIP									

Lab Chronicle

Client: Haley & Aldrich, Inc.
Project/Site: CCR Groundwater Monitoring FB Culley East

Job ID: 180-173881-1
SDG: FB Culley East

Client Sample ID: FIELD BLANK 1

Date Collected: 05/10/24 15:45
Date Received: 05/11/24 10:00

Lab Sample ID: 180-173881-4

Matrix: Water

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	EPA 9056A		1	1 mL	1 mL	468668	05/15/24 21:39	AM	EET PIT
	Instrument ID: CHICS2100B									
Total Recoverable	Prep	3005A			50 mL	50 mL	613145	05/15/24 14:00	GK	EET CLE
Total Recoverable	Analysis	EPA 6010D		1			613436	05/17/24 05:09	KLC	EET CLE
	Instrument ID: I9									
Total Recoverable	Prep	3005A			50 mL	50 mL	613145	05/15/24 14:00	GK	EET CLE
Total Recoverable	Analysis	EPA 6020B		1			613785	05/20/24 14:07	RKT	EET CLE
	Instrument ID: I14									
Total/NA	Prep	7470A			25 mL	25 mL	469056	05/18/24 10:45	SJM	EET PIT
Total/NA	Analysis	EPA 7470A		1			469200	05/20/24 12:47	MTW	EET PIT
	Instrument ID: HGY									
Total/NA	Analysis	EPA 9040C		1			468497	05/13/24 18:26	SNR	EET PIT
	Instrument ID: OZ									
Total/NA	Analysis	SM 2540C		1	100 mL	100 mL	468762	05/15/24 17:28	LWM	EET PIT
	Instrument ID: NOEQUIP									
Total/NA	Prep	PrecSep-21			1002.29 mL	1.0 g	661791	05/15/24 09:14	MLT	EET SL
Total/NA	Analysis	9315		1			665614	06/10/24 19:22	SCB	EET SL
	Instrument ID: GFPCBLUE									
Total/NA	Prep	PrecSep_0			1002.29 mL	1.0 g	661792	05/15/24 09:17	MLT	EET SL
Total/NA	Analysis	9320		1			665181	06/07/24 11:41	SCB	EET SL
	Instrument ID: GFPCORANGE									
Total/NA	Analysis	Ra226_Ra228		1			665833	06/12/24 08:25	FLC	EET SL
	Instrument ID: NOEQUIP									

Laboratory References:

EET SL = Eurofins St. Louis, 13715 Rider Trail North, Earth City, MO 63045, TEL (314)298-8566

Lab Chronicle

Client: Haley & Aldrich, Inc.
Project/Site: CCR Groundwater Monitoring FB Culley East

Job ID: 180-173881-1
SDG: FB Culley East

Analyst References:

Lab: EET CLE
- Batch Type: Prep
  - GK = Grace Kessler
- Batch Type: Analysis
  - KLC = Karen Counts
  - RKT = Roger Toth

Lab: EET PIT
- Batch Type: Prep
  - SJM = Shannon Mueller
- Batch Type: Analysis
  - AM = Adzuira Musule
  - LWM = Leslie McIntire
  - MTW = Michael Wesoloski
  - SNR = Sabra Richart

Lab: EET SL
- Batch Type: Prep
  - MLT = Michaela Tiemeyer
- Batch Type: Analysis
  - FLC = Fernando Cruz
  - SCB = Sarah Bernsen

Client Sample ID: CCR-AP-7

Date Collected: 05/10/24 12:00
Date Received: 05/11/24 10:00

Lab Sample ID: 180-173881-1

Matrix: Water

Method: SW846 EPA 9056A - Anions, Ion Chromatography

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Chloride	**43**		1.0	0.71	mg/L			05/15/24 16:14	1
Fluoride	**0.31**		0.10	0.026	mg/L			05/15/24 16:14	1
Sulfate	**110**		1.0	0.76	mg/L			05/15/24 16:14	1

Method: SW846 EPA 6010D - Metals (ICP) - Total Recoverable

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Boron	ND		0.10	0.057	mg/L		05/15/24 14:00	05/17/24 03:09	1

Method: SW846 EPA 6020B - Metals (ICP/MS) - Total Recoverable

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Antimony	ND		0.0020	0.00057	mg/L		05/15/24 14:00	05/20/24 12:53	1
Arsenic	**0.00090**	**J**	0.0050	0.00075	mg/L		05/15/24 14:00	05/20/24 12:53	1
Barium	**0.10**		0.0050	0.0022	mg/L		05/15/24 14:00	05/20/24 12:53	1
Beryllium	ND		0.0010	0.00062	mg/L		05/15/24 14:00	05/20/24 12:53	1
Cadmium	ND		0.0010	0.00020	mg/L		05/15/24 14:00	05/20/24 12:53	1
Calcium	**120**		1.0	0.25	mg/L		05/15/24 14:00	05/20/24 12:53	1
Chromium	ND		0.0050	0.0012	mg/L		05/15/24 14:00	05/20/24 12:53	1
Cobalt	**0.00030**	**J**	0.0010	0.00019	mg/L		05/15/24 14:00	05/20/24 12:53	1
Lead	ND		0.0010	0.00045	mg/L		05/15/24 14:00	05/20/24 12:53	1
Lithium	**0.011**		0.0080	0.0017	mg/L		05/15/24 14:00	05/20/24 12:53	1
Molybdenum	**0.0013**	**J**	0.0050	0.0011	mg/L		05/15/24 14:00	05/20/24 12:53	1
Selenium	ND		0.0050	0.00089	mg/L		05/15/24 14:00	05/20/24 12:53	1
Thallium	ND		0.0010	0.00020	mg/L		05/15/24 14:00	05/20/24 12:53	1

Method: SW846 EPA 7470A - Mercury (CVAA)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	ND		0.00020	0.00013	mg/L		05/18/24 10:45	05/20/24 12:41	1

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Dissolved Solids (SM 2540C)	**630**		10	10	mg/L			05/15/24 17:28	1

Analyte	Result	Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
pH (SW846 EPA 9040C)	**7.2**	**HF**	0.1	0.1	SU			05/13/24 18:05	1

Method: SW846 9315 - Radium-226 (GFPC)

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Radium-226	**0.337**		0.145	0.148	1.00	0.158	pCi/L	05/15/24 09:14	06/10/24 19:21	1

Carrier	*%Yield*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Ba Carrier	*86.3*		*30 - 110*	*05/15/24 09:14*	*06/10/24 19:21*	*1*

Method: SW846 9320 - Radium-228 (GFPC)

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Radium-228	0.529	U	0.364	0.367	1.00	0.542	pCi/L	05/15/24 09:17	06/07/24 11:40	1

Carrier	*%Yield*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Ba Carrier	*86.3*		*30 - 110*	*05/15/24 09:17*	*06/07/24 11:40*	*1*

Client Sample ID: CCR-AP-7
Lab Sample ID: 180-173881-1

Date Collected: 05/10/24 12:00
Matrix: Water
Date Received: 05/11/24 10:00

Method: SW846 9320 - Radium-228 (GFPC) (Continued)

Carrier	*%Yield*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Y Carrier	*80.0*		*30 - 110*	*05/15/24 09:17*	*06/07/24 11:40*	*1*

Method: TAL-STL Ra226_Ra228 - Combined Radium-226 and Radium-228

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Combined Radium 226 + 228	**0.866**		0.392	0.396	5.00	0.542	pCi/L		06/12/24 08:25	1

Client Sample ID: CCR-AP-8

Date Collected: 05/10/24 15:30
Date Received: 05/11/24 10:00

Lab Sample ID: 180-173881-2

Matrix: Water

Method: SW846 EPA 9056A - Anions, Ion Chromatography

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Chloride	25		1.0	0.71	mg/L			05/15/24 20:40	1
Fluoride	0.22		0.10	0.026	mg/L			05/15/24 20:40	1
Sulfate	2.7		1.0	0.76	mg/L			05/15/24 20:40	1

Method: SW846 EPA 6010D - Metals (ICP) - Total Recoverable

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Boron	0.13		0.10	0.057	mg/L		05/15/24 14:00	05/17/24 05:00	1

Method: SW846 EPA 6020B - Metals (ICP/MS) - Total Recoverable

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Antimony	0.00064	J	0.0020	0.00057	mg/L		05/15/24 14:00	05/20/24 13:56	1
Arsenic	0.013		0.0050	0.00075	mg/L		05/15/24 14:00	05/20/24 13:56	1
Barium	0.27		0.0050	0.0022	mg/L		05/15/24 14:00	05/20/24 13:56	1
Beryllium	ND		0.0010	0.00062	mg/L		05/15/24 14:00	05/20/24 13:56	1
Cadmium	ND		0.0010	0.00020	mg/L		05/15/24 14:00	05/20/24 13:56	1
Calcium	140		1.0	0.25	mg/L		05/15/24 14:00	05/20/24 13:56	1
Chromium	0.0039	J	0.0050	0.0012	mg/L		05/15/24 14:00	05/20/24 13:56	1
Cobalt	0.0044		0.0010	0.00019	mg/L		05/15/24 14:00	05/20/24 13:56	1
Lead	0.0030		0.0010	0.00045	mg/L		05/15/24 14:00	05/20/24 13:56	1
Lithium	0.0039	J	0.0080	0.0017	mg/L		05/15/24 14:00	05/20/24 13:56	1
Molybdenum	0.012		0.0050	0.0011	mg/L		05/15/24 14:00	05/20/24 13:56	1
Selenium	0.0021	J	0.0050	0.00089	mg/L		05/15/24 14:00	05/20/24 13:56	1
Thallium	ND		0.0010	0.00020	mg/L		05/15/24 14:00	05/20/24 13:56	1

Method: SW846 EPA 7470A - Mercury (CVAA)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	ND		0.00020	0.00013	mg/L		05/18/24 10:45	05/20/24 12:45	1

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Dissolved Solids (SM 2540C)	770		10	10	mg/L			05/15/24 17:28	1

Analyte	Result	Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
pH (SW846 EPA 9040C)	7.1	HF	0.1	0.1	SU			05/13/24 18:44	1

Method: SW846 9315 - Radium-226 (GFPC)

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Radium-226	0.489		0.205	0.210	1.00	0.223	pCi/L	05/15/24 09:14	06/10/24 19:22	1

Carrier	*%Yield*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Ba Carrier	*84.8*		*30 - 110*	*05/15/24 09:14*	*06/10/24 19:22*	*1*

Method: SW846 9320 - Radium-228 (GFPC)

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Radium-228	0.589	U	0.505	0.508	1.00	0.791	pCi/L	05/15/24 09:17	06/07/24 11:40	1

Carrier	*%Yield*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Ba Carrier	*84.8*		*30 - 110*	*05/15/24 09:17*	*06/07/24 11:40*	*1*

Client Sample ID: CCR-AP-8
Date Collected: 05/10/24 15:30
Date Received: 05/11/24 10:00

Lab Sample ID: 180-173881-2
Matrix: Water

Method: SW846 9320 - Radium-228 (GFPC) (Continued)

Carrier	*%Yield*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Y Carrier	*77.4*		*30 - 110*	*05/15/24 09:17*	*06/07/24 11:40*	*1*

Method: TAL-STL Ra226_Ra228 - Combined Radium-226 and Radium-228

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Combined Radium 226 + 228	**1.08**		0.545	0.550	5.00	0.791	pCi/L		06/12/24 08:25	1

Client Sample ID: CCR-AP-11

Date Collected: 05/10/24 14:45
Date Received: 05/11/24 10:00

Lab Sample ID: 180-173881-3

Matrix: Water

Method: SW846 EPA 9056A - Anions, Ion Chromatography

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Chloride	**26**		1.0	0.71	mg/L			05/15/24 20:11	1
Fluoride	**0.30**		0.10	0.026	mg/L			05/15/24 20:11	1
Sulfate	**450**		5.0	3.8	mg/L			05/15/24 20:25	5

Method: SW846 EPA 6010D - Metals (ICP) - Total Recoverable

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Boron	**0.30**		0.10	0.057	mg/L		05/15/24 14:00	05/17/24 05:04	1

Method: SW846 EPA 6020B - Metals (ICP/MS) - Total Recoverable

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Antimony	ND		0.0020	0.00057	mg/L		05/15/24 14:00	05/20/24 14:04	1
Arsenic	**0.0056**		0.0050	0.00075	mg/L		05/15/24 14:00	05/20/24 14:04	1
Barium	**0.15**		0.0050	0.0022	mg/L		05/15/24 14:00	05/20/24 14:04	1
Beryllium	ND		0.0010	0.00062	mg/L		05/15/24 14:00	05/20/24 14:04	1
Cadmium	ND		0.0010	0.00020	mg/L		05/15/24 14:00	05/20/24 14:04	1
Calcium	**120**		1.0	0.25	mg/L		05/15/24 14:00	05/20/24 14:04	1
Chromium	**0.0016**	**J**	0.0050	0.0012	mg/L		05/15/24 14:00	05/20/24 14:04	1
Cobalt	**0.036**		0.0010	0.00019	mg/L		05/15/24 14:00	05/20/24 14:04	1
Lead	**0.00059**	**J**	0.0010	0.00045	mg/L		05/15/24 14:00	05/20/24 14:04	1
Lithium	**0.0048**	**J**	0.0080	0.0017	mg/L		05/15/24 14:00	05/20/24 14:04	1
Molybdenum	ND		0.0050	0.0011	mg/L		05/15/24 14:00	05/20/24 14:04	1
Selenium	ND		0.0050	0.00089	mg/L		05/15/24 14:00	05/20/24 14:04	1
Thallium	ND		0.0010	0.00020	mg/L		05/15/24 14:00	05/20/24 14:04	1

Method: SW846 EPA 7470A - Mercury (CVAA)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	ND		0.00020	0.00013	mg/L		05/18/24 10:45	05/20/24 12:46	1

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Dissolved Solids (SM 2540C)	**900**		10	10	mg/L			05/15/24 17:28	1

Analyte	Result	Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
pH (SW846 EPA 9040C)	**6.5**	**HF**	0.1	0.1	SU			05/13/24 18:39	1

Method: SW846 9315 - Radium-226 (GFPC)

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Radium-226	**0.292**		0.146	0.148	1.00	0.184	pCi/L	05/15/24 09:14	06/10/24 19:22	1

Carrier	*%Yield*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Ba Carrier	*89.8*		*30 - 110*	*05/15/24 09:14*	*06/10/24 19:22*	*1*

Method: SW846 9320 - Radium-228 (GFPC)

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Radium-228	**0.562**		0.344	0.348	1.00	0.494	pCi/L	05/15/24 09:17	06/07/24 11:41	1

Carrier	*%Yield*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Ba Carrier	*89.8*		*30 - 110*	*05/15/24 09:17*	*06/07/24 11:41*	*1*

Client Sample ID: CCR-AP-11
Date Collected: 05/10/24 14:45
Date Received: 05/11/24 10:00

Lab Sample ID: 180-173881-3
Matrix: Water

Method: SW846 9320 - Radium-228 (GFPC) (Continued)

Carrier	*%Yield*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Y Carrier	*80.0*		*30 - 110*	*05/15/24 09:17*	*06/07/24 11:41*	*1*

Method: TAL-STL Ra226_Ra228 - Combined Radium-226 and Radium-228

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Combined Radium 226 + 228	**0.854**		0.374	0.378	5.00	0.494	pCi/L		06/12/24 08:25	1

Client Sample ID: FIELD BLANK 1

Date Collected: 05/10/24 15:45
Date Received: 05/11/24 10:00

Lab Sample ID: 180-173881-4

Matrix: Water

Method: SW846 EPA 9056A - Anions, Ion Chromatography

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Chloride	ND		1.0	0.71	mg/L			05/15/24 21:39	1
Fluoride	ND		0.10	0.026	mg/L			05/15/24 21:39	1
Sulfate	ND		1.0	0.76	mg/L			05/15/24 21:39	1

Method: SW846 EPA 6010D - Metals (ICP) - Total Recoverable

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Boron	ND		0.10	0.057	mg/L		05/15/24 14:00	05/17/24 05:09	1

Method: SW846 EPA 6020B - Metals (ICP/MS) - Total Recoverable

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Antimony	ND		0.0020	0.00057	mg/L		05/15/24 14:00	05/20/24 14:07	1
Arsenic	ND		0.0050	0.00075	mg/L		05/15/24 14:00	05/20/24 14:07	1
Barium	ND		0.0050	0.0022	mg/L		05/15/24 14:00	05/20/24 14:07	1
Beryllium	ND		0.0010	0.00062	mg/L		05/15/24 14:00	05/20/24 14:07	1
Cadmium	ND		0.0010	0.00020	mg/L		05/15/24 14:00	05/20/24 14:07	1
Calcium	ND		1.0	0.25	mg/L		05/15/24 14:00	05/20/24 14:07	1
Chromium	ND		0.0050	0.0012	mg/L		05/15/24 14:00	05/20/24 14:07	1
Cobalt	ND		0.0010	0.00019	mg/L		05/15/24 14:00	05/20/24 14:07	1
Lead	ND		0.0010	0.00045	mg/L		05/15/24 14:00	05/20/24 14:07	1
Lithium	ND		0.0080	0.0017	mg/L		05/15/24 14:00	05/20/24 14:07	1
Molybdenum	ND		0.0050	0.0011	mg/L		05/15/24 14:00	05/20/24 14:07	1
Selenium	ND		0.0050	0.00089	mg/L		05/15/24 14:00	05/20/24 14:07	1
Thallium	ND		0.0010	0.00020	mg/L		05/15/24 14:00	05/20/24 14:07	1

Method: SW846 EPA 7470A - Mercury (CVAA)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	ND		0.00020	0.00013	mg/L		05/18/24 10:45	05/20/24 12:47	1

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Dissolved Solids (SM 2540C)	ND		10	10	mg/L			05/15/24 17:28	1

Analyte	Result	Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
pH (SW846 EPA 9040C)	**5.5**	**HF**	0.1	0.1	SU			05/13/24 18:26	1

Method: SW846 9315 - Radium-226 (GFPC)

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Radium-226	-0.0213	U	0.0708	0.0708	1.00	0.163	pCi/L	05/15/24 09:14	06/10/24 19:22	1

Carrier	*%Yield*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Ba Carrier	*82.3*		*30 - 110*	*05/15/24 09:14*	*06/10/24 19:22*	*1*

Method: SW846 9320 - Radium-228 (GFPC)

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Radium-228	-0.0176	U	0.303	0.303	1.00	0.579	pCi/L	05/15/24 09:17	06/07/24 11:41	1

Carrier	*%Yield*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Ba Carrier	*82.3*		*30 - 110*	*05/15/24 09:17*	*06/07/24 11:41*	*1*

Client Sample ID: FIELD BLANK 1
Lab Sample ID: 180-173881-4

Date Collected: 05/10/24 15:45
Matrix: Water
Date Received: 05/11/24 10:00

Method: SW846 9320 - Radium-228 (GFPC) (Continued)

Carrier	*%Yield*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Y Carrier	*80.0*		*30 - 110*	*05/15/24 09:17*	*06/07/24 11:41*	*1*

Method: TAL-STL Ra226_Ra228 - Combined Radium-226 and Radium-228

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Combined Radium 226 + 228	-0.0389	U	0.311	0.311	5.00	0.579	pCi/L		06/12/24 08:25	1

Method: EPA 9056A - Anions, Ion Chromatography

Lab Sample ID: MB 180-468668/6
Matrix: Water
Analysis Batch: 468668

Client Sample ID: Method Blank
Prep Type: Total/NA

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Chloride	ND		1.0	0.71	mg/L			05/15/24 10:48	1
Fluoride	ND		0.10	0.026	mg/L			05/15/24 10:48	1
Sulfate	ND		1.0	0.76	mg/L			05/15/24 10:48	1

Lab Sample ID: LCS 180-468668/7
Matrix: Water
Analysis Batch: 468668

Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec Limits
Chloride	50.0	50.2		mg/L		100	80 - 120
Fluoride	2.50	2.49		mg/L		99	80 - 120
Sulfate	50.0	49.9		mg/L		100	80 - 120

Lab Sample ID: 180-173881-1 MS
Matrix: Water
Analysis Batch: 468668

Client Sample ID: CCR-AP-7
Prep Type: Total/NA

Analyte	Sample Result	Sample Qualifier	Spike Added	MS Result	MS Qualifier	Unit	D	%Rec	%Rec Limits
Chloride	43		250	286		mg/L		97	80 - 120
Fluoride	0.31		12.5	12.2		mg/L		95	80 - 120
Sulfate	110		250	347		mg/L		96	80 - 120

Lab Sample ID: 180-173881-1 MSD
Matrix: Water
Analysis Batch: 468668

Client Sample ID: CCR-AP-7
Prep Type: Total/NA

Analyte	Sample Result	Sample Qualifier	Spike Added	MSD Result	MSD Qualifier	Unit	D	%Rec	%Rec Limits	RPD	RPD Limit
Chloride	43		250	294		mg/L		101	80 - 120	3	15
Fluoride	0.31		12.5	12.6		mg/L		98	80 - 120	3	15
Sulfate	110		250	360		mg/L		101	80 - 120	4	15

Method: EPA 6010D - Metals (ICP)

Lab Sample ID: MB 240-613145/1-A
Matrix: Water
Analysis Batch: 613436

Client Sample ID: Method Blank
Prep Type: Total Recoverable
Prep Batch: 613145

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Boron	ND		0.10	0.057	mg/L		05/15/24 14:00	05/17/24 03:00	1

Lab Sample ID: LCS 240-613145/2-A
Matrix: Water
Analysis Batch: 613436

Client Sample ID: Lab Control Sample
Prep Type: Total Recoverable
Prep Batch: 613145

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec Limits
Boron	1.00	1.04		mg/L		104	80 - 120

Method: EPA 6010D - Metals (ICP) (Continued)

Lab Sample ID: 180-173881-1 MS
Matrix: Water
Analysis Batch: 613436

Client Sample ID: CCR-AP-7
Prep Type: Total Recoverable
Prep Batch: 613145

Analyte	Sample Result	Sample Qualifier	Spike Added	MS Result	MS Qualifier	Unit	D	%Rec	%Rec Limits
Boron	ND		1.00	1.05		mg/L		105	75 - 125

Lab Sample ID: 180-173881-1 MSD
Matrix: Water
Analysis Batch: 613436

Client Sample ID: CCR-AP-7
Prep Type: Total Recoverable
Prep Batch: 613145

Analyte	Sample Result	Sample Qualifier	Spike Added	MSD Result	MSD Qualifier	Unit	D	%Rec	%Rec Limits	RPD	RPD Limit
Boron	ND		1.00	1.10		mg/L		110	75 - 125	4	20

Method: EPA 6020B - Metals (ICP/MS)

Lab Sample ID: MB 240-613145/1-A
Matrix: Water
Analysis Batch: 613785

Client Sample ID: Method Blank
Prep Type: Total Recoverable
Prep Batch: 613145

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Antimony	ND		0.0020	0.00057	mg/L		05/15/24 14:00	05/20/24 12:45	1
Arsenic	ND		0.0050	0.00075	mg/L		05/15/24 14:00	05/20/24 12:45	1
Barium	ND		0.0050	0.0022	mg/L		05/15/24 14:00	05/20/24 12:45	1
Beryllium	ND		0.0010	0.00062	mg/L		05/15/24 14:00	05/20/24 12:45	1
Cadmium	ND		0.0010	0.00020	mg/L		05/15/24 14:00	05/20/24 12:45	1
Calcium	ND		1.0	0.25	mg/L		05/15/24 14:00	05/20/24 12:45	1
Chromium	ND		0.0050	0.0012	mg/L		05/15/24 14:00	05/20/24 12:45	1
Cobalt	ND		0.0010	0.00019	mg/L		05/15/24 14:00	05/20/24 12:45	1
Lead	ND		0.0010	0.00045	mg/L		05/15/24 14:00	05/20/24 12:45	1
Lithium	ND		0.0080	0.0017	mg/L		05/15/24 14:00	05/20/24 12:45	1
Molybdenum	ND		0.0050	0.0011	mg/L		05/15/24 14:00	05/20/24 12:45	1
Selenium	ND		0.0050	0.00089	mg/L		05/15/24 14:00	05/20/24 12:45	1
Thallium	ND		0.0010	0.00020	mg/L		05/15/24 14:00	05/20/24 12:45	1

Lab Sample ID: LCS 240-613145/3-A
Matrix: Water
Analysis Batch: 613785

Client Sample ID: Lab Control Sample
Prep Type: Total Recoverable
Prep Batch: 613145

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec Limits
Antimony	0.100	0.0942		mg/L		94	80 - 120
Arsenic	1.00	0.944		mg/L		94	80 - 120
Barium	1.00	0.933		mg/L		93	80 - 120
Beryllium	0.500	0.468		mg/L		94	80 - 120
Cadmium	0.500	0.479		mg/L		96	80 - 120
Calcium	25.0	24.5		mg/L		98	80 - 120
Chromium	0.500	0.481		mg/L		96	80 - 120
Cobalt	0.500	0.482		mg/L		96	80 - 120
Lead	0.500	0.488		mg/L		98	80 - 120
Lithium	0.500	0.518		mg/L		104	80 - 120
Molybdenum	0.500	0.469		mg/L		94	80 - 120
Selenium	1.00	0.951		mg/L		95	80 - 120
Thallium	1.00	0.970		mg/L		97	80 - 120

Method: EPA 6020B - Metals (ICP/MS) (Continued)

Lab Sample ID: 180-173881-1 MS
Matrix: Water
Analysis Batch: 613785

Client Sample ID: CCR-AP-7
Prep Type: Total Recoverable
Prep Batch: 613145

Analyte	Sample Result	Sample Qualifier	Spike Added	MS Result	MS Qualifier	Unit	D	%Rec	%Rec Limits
Antimony	ND		0.100	0.0971		mg/L		97	80 - 120
Arsenic	0.00090	J	1.00	0.977		mg/L		98	80 - 120
Barium	0.10		1.00	1.06		mg/L		96	80 - 120
Beryllium	ND		0.500	0.473		mg/L		95	80 - 120
Cadmium	ND		0.500	0.488		mg/L		98	80 - 120
Calcium	120		25.0	148	4	mg/L		105	80 - 120
Chromium	ND		0.500	0.494		mg/L		99	80 - 120
Cobalt	0.00030	J	0.500	0.495		mg/L		99	80 - 120
Lead	ND		0.500	0.488		mg/L		98	80 - 120
Lithium	0.011		0.500	0.540		mg/L		106	80 - 120
Molybdenum	0.0013	J	0.500	0.488		mg/L		97	80 - 120
Selenium	ND		1.00	0.960		mg/L		96	80 - 120
Thallium	ND		1.00	0.979		mg/L		98	80 - 120

Lab Sample ID: 180-173881-1 MSD
Matrix: Water
Analysis Batch: 613785

Client Sample ID: CCR-AP-7
Prep Type: Total Recoverable
Prep Batch: 613145

Analyte	Sample Result	Sample Qualifier	Spike Added	MSD Result	MSD Qualifier	Unit	D	%Rec	%Rec Limits	RPD	RPD Limit
Antimony	ND		0.100	0.0966		mg/L		97	80 - 120	0	20
Arsenic	0.00090	J	1.00	0.970		mg/L		97	80 - 120	1	20
Barium	0.10		1.00	1.05		mg/L		95	80 - 120	1	20
Beryllium	ND		0.500	0.468		mg/L		94	80 - 120	1	20
Cadmium	ND		0.500	0.487		mg/L		97	80 - 120	0	20
Calcium	120		25.0	148	4	mg/L		105	80 - 120	0	20
Chromium	ND		0.500	0.494		mg/L		99	80 - 120	0	20
Cobalt	0.00030	J	0.500	0.493		mg/L		99	80 - 120	0	20
Lead	ND		0.500	0.499		mg/L		100	80 - 120	2	20
Lithium	0.011		0.500	0.543		mg/L		106	80 - 120	0	20
Molybdenum	0.0013	J	0.500	0.489		mg/L		98	80 - 120	0	20
Selenium	ND		1.00	0.958		mg/L		96	80 - 120	0	20
Thallium	ND		1.00	0.996		mg/L		100	80 - 120	2	20

Method: EPA 7470A - Mercury (CVAA)

Lab Sample ID: MB 180-469056/1-A
Matrix: Water
Analysis Batch: 469200

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 469056

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	ND		0.00020	0.00013	mg/L		05/18/24 10:45	05/20/24 12:39	1

Lab Sample ID: LCS 180-469056/2-A
Matrix: Water
Analysis Batch: 469200

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 469056

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec Limits
Mercury	0.00250	0.00249		mg/L		100	80 - 120

Method: EPA 7470A - Mercury (CVAA) (Continued)

Lab Sample ID: 180-173881-1 MS
Matrix: Water
Analysis Batch: 469200

Client Sample ID: CCR-AP-7
Prep Type: Total/NA
Prep Batch: 469056

Analyte	Sample Result	Sample Qualifier	Spike Added	MS Result	MS Qualifier	Unit	D	%Rec	%Rec Limits
Mercury	ND		0.00100	0.000930		mg/L		93	75 - 125

Lab Sample ID: 180-173881-1 MSD
Matrix: Water
Analysis Batch: 469200

Client Sample ID: CCR-AP-7
Prep Type: Total/NA
Prep Batch: 469056

Analyte	Sample Result	Sample Qualifier	Spike Added	MSD Result	MSD Qualifier	Unit	D	%Rec	%Rec Limits	RPD	RPD Limit
Mercury	ND		0.00100	0.000943		mg/L		94	75 - 125	1	20

Method: EPA 9040C - pH

Lab Sample ID: LCS 180-468497/24
Matrix: Water
Analysis Batch: 468497

Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec Limits
pH	7.00	7.0		SU		100	99 - 101

Method: SM 2540C - Solids, Total Dissolved (TDS)

Lab Sample ID: MB 180-468762/1
Matrix: Water
Analysis Batch: 468762

Client Sample ID: Method Blank
Prep Type: Total/NA

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Dissolved Solids	ND		10	10	mg/L			05/15/24 17:28	1

Lab Sample ID: LCS 180-468762/2
Matrix: Water
Analysis Batch: 468762

Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec Limits
Total Dissolved Solids	417	418		mg/L		100	85 - 115

Method: 9315 - Radium-226 (GFPC)

Lab Sample ID: MB 160-661791/1-A
Matrix: Water
Analysis Batch: 665297

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 661791

Analyte	MB Result	MB Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Radium-226	0.01654	U	0.0608	0.0608	1.00	0.121	pCi/L	05/15/24 09:14	06/10/24 16:32	1

Carrier	*MB %Yield*	*MB Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Ba Carrier	*94.0*		*30 - 110*	*05/15/24 09:14*	*06/10/24 16:32*	*1*

Method: 9315 - Radium-226 (GFPC) (Continued)

Lab Sample ID: LCS 160-661791/2-A
Matrix: Water
Analysis Batch: 665297

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 661791

Analyte			Spike Added	LCS Result	LCS Qual	Total Uncert. (2σ+/-)	RL	MDC	Unit	%Rec	%Rec Limits		
Radium-226			11.3	10.47		1.18	1.00	0.156	pCi/L	92	75 - 125		

Carrier	*LCS %Yield*	*LCS Qualifier*	*Limits*
Ba Carrier	*78.9*		*30 - 110*

Lab Sample ID: 180-173881-1 DU
Matrix: Water
Analysis Batch: 665614

Client Sample ID: CCR-AP-7
Prep Type: Total/NA
Prep Batch: 661791

Analyte	Sample Result	Sample Qual		DU Result	DU Qual	Total Uncert. (2σ+/-)	RL	MDC	Unit			RER	RER Limit
Radium-226	0.337			0.1424	U	0.122	1.00	0.183	pCi/L			0.72	1

Carrier	*DU %Yield*	*DU Qualifier*	*Limits*
Ba Carrier	*84.6*		*30 - 110*

Method: 9320 - Radium-228 (GFPC)

Lab Sample ID: MB 160-661792/1-A
Matrix: Water
Analysis Batch: 665182

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 661792

Analyte	MB Result	MB Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Radium-228	0.5941		0.362	0.367	1.00	0.526	pCi/L	05/15/24 09:17	06/07/24 11:51	1

Carrier	*MB %Yield*	*MB Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Ba Carrier	*94.0*		*30 - 110*	*05/15/24 09:17*	*06/07/24 11:51*	*1*
Y Carrier	*77.4*		*30 - 110*	*05/15/24 09:17*	*06/07/24 11:51*	*1*

Lab Sample ID: LCS 160-661792/2-A
Matrix: Water
Analysis Batch: 665182

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 661792

Analyte			Spike Added	LCS Result	LCS Qual	Total Uncert. (2σ+/-)	RL	MDC	Unit	%Rec	%Rec Limits		
Radium-228			8.87	10.19		1.45	1.00	0.679	pCi/L	115	75 - 125		

Carrier	*LCS %Yield*	*LCS Qualifier*	*Limits*
Ba Carrier	*78.9*		*30 - 110*
Y Carrier	*78.5*		*30 - 110*

Method: 9320 - Radium-228 (GFPC) (Continued)

Lab Sample ID: 180-173881-1 DU
Matrix: Water
Analysis Batch: 665181

Client Sample ID: CCR-AP-7
Prep Type: Total/NA
Prep Batch: 661792

Analyte	Sample Result	Sample Qual		DU Result	DU Qual	Total Uncert. (2σ+/-)	RL	MDC	Unit			RER	RER Limit
Radium-228	0.529	U		0.8667		0.426	1.00	0.565	pCi/L			0.43	1

Carrier	*DU %Yield*	*DU Qualifier*	*Limits*
Ba Carrier	*84.6*		*30 - 110*
Y Carrier	*78.9*		*30 - 110*

HPLC/IC

Analysis Batch: 468668

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-173881-1	CCR-AP-7	Total/NA	Water	EPA 9056A	
180-173881-2	CCR-AP-8	Total/NA	Water	EPA 9056A	
180-173881-3	CCR-AP-11	Total/NA	Water	EPA 9056A	
180-173881-3	CCR-AP-11	Total/NA	Water	EPA 9056A	
180-173881-4	FIELD BLANK 1	Total/NA	Water	EPA 9056A	
MB 180-468668/6	Method Blank	Total/NA	Water	EPA 9056A	
LCS 180-468668/7	Lab Control Sample	Total/NA	Water	EPA 9056A	
180-173881-1 MS	CCR-AP-7	Total/NA	Water	EPA 9056A	
180-173881-1 MSD	CCR-AP-7	Total/NA	Water	EPA 9056A	

Metals

Prep Batch: 469056

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-173881-1	CCR-AP-7	Total/NA	Water	7470A	
180-173881-2	CCR-AP-8	Total/NA	Water	7470A	
180-173881-3	CCR-AP-11	Total/NA	Water	7470A	
180-173881-4	FIELD BLANK 1	Total/NA	Water	7470A	
MB 180-469056/1-A	Method Blank	Total/NA	Water	7470A	
LCS 180-469056/2-A	Lab Control Sample	Total/NA	Water	7470A	
180-173881-1 MS	CCR-AP-7	Total/NA	Water	7470A	
180-173881-1 MSD	CCR-AP-7	Total/NA	Water	7470A	

Analysis Batch: 469200

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-173881-1	CCR-AP-7	Total/NA	Water	EPA 7470A	469056
180-173881-2	CCR-AP-8	Total/NA	Water	EPA 7470A	469056
180-173881-3	CCR-AP-11	Total/NA	Water	EPA 7470A	469056
180-173881-4	FIELD BLANK 1	Total/NA	Water	EPA 7470A	469056
MB 180-469056/1-A	Method Blank	Total/NA	Water	EPA 7470A	469056
LCS 180-469056/2-A	Lab Control Sample	Total/NA	Water	EPA 7470A	469056
180-173881-1 MS	CCR-AP-7	Total/NA	Water	EPA 7470A	469056
180-173881-1 MSD	CCR-AP-7	Total/NA	Water	EPA 7470A	469056

Prep Batch: 613145

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-173881-1	CCR-AP-7	Total Recoverable	Water	3005A	
180-173881-2	CCR-AP-8	Total Recoverable	Water	3005A	
180-173881-3	CCR-AP-11	Total Recoverable	Water	3005A	
180-173881-4	FIELD BLANK 1	Total Recoverable	Water	3005A	
MB 240-613145/1-A	Method Blank	Total Recoverable	Water	3005A	
LCS 240-613145/2-A	Lab Control Sample	Total Recoverable	Water	3005A	
LCS 240-613145/3-A	Lab Control Sample	Total Recoverable	Water	3005A	
180-173881-1 MS	CCR-AP-7	Total Recoverable	Water	3005A	
180-173881-1 MS	CCR-AP-7	Total Recoverable	Water	3005A	
180-173881-1 MSD	CCR-AP-7	Total Recoverable	Water	3005A	
180-173881-1 MSD	CCR-AP-7	Total Recoverable	Water	3005A	

Analysis Batch: 613436

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-173881-1	CCR-AP-7	Total Recoverable	Water	EPA 6010D	613145

Metals (Continued)

Analysis Batch: 613436 (Continued)

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-173881-2	CCR-AP-8	Total Recoverable	Water	EPA 6010D	613145
180-173881-3	CCR-AP-11	Total Recoverable	Water	EPA 6010D	613145
180-173881-4	FIELD BLANK 1	Total Recoverable	Water	EPA 6010D	613145
MB 240-613145/1-A	Method Blank	Total Recoverable	Water	EPA 6010D	613145
LCS 240-613145/2-A	Lab Control Sample	Total Recoverable	Water	EPA 6010D	613145
180-173881-1 MS	CCR-AP-7	Total Recoverable	Water	EPA 6010D	613145
180-173881-1 MSD	CCR-AP-7	Total Recoverable	Water	EPA 6010D	613145

Analysis Batch: 613785

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-173881-1	CCR-AP-7	Total Recoverable	Water	EPA 6020B	613145
180-173881-2	CCR-AP-8	Total Recoverable	Water	EPA 6020B	613145
180-173881-3	CCR-AP-11	Total Recoverable	Water	EPA 6020B	613145
180-173881-4	FIELD BLANK 1	Total Recoverable	Water	EPA 6020B	613145
MB 240-613145/1-A	Method Blank	Total Recoverable	Water	EPA 6020B	613145
LCS 240-613145/3-A	Lab Control Sample	Total Recoverable	Water	EPA 6020B	613145
180-173881-1 MS	CCR-AP-7	Total Recoverable	Water	EPA 6020B	613145
180-173881-1 MSD	CCR-AP-7	Total Recoverable	Water	EPA 6020B	613145

General Chemistry

Analysis Batch: 468497

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-173881-1	CCR-AP-7	Total/NA	Water	EPA 9040C	
180-173881-2	CCR-AP-8	Total/NA	Water	EPA 9040C	
180-173881-3	CCR-AP-11	Total/NA	Water	EPA 9040C	
180-173881-4	FIELD BLANK 1	Total/NA	Water	EPA 9040C	
LCS 180-468497/24	Lab Control Sample	Total/NA	Water	EPA 9040C	

Analysis Batch: 468762

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-173881-1	CCR-AP-7	Total/NA	Water	SM 2540C	
180-173881-2	CCR-AP-8	Total/NA	Water	SM 2540C	
180-173881-3	CCR-AP-11	Total/NA	Water	SM 2540C	
180-173881-4	FIELD BLANK 1	Total/NA	Water	SM 2540C	
MB 180-468762/1	Method Blank	Total/NA	Water	SM 2540C	
LCS 180-468762/2	Lab Control Sample	Total/NA	Water	SM 2540C	

Rad

Prep Batch: 661791

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-173881-1	CCR-AP-7	Total/NA	Water	PrecSep-21	
180-173881-2	CCR-AP-8	Total/NA	Water	PrecSep-21	
180-173881-3	CCR-AP-11	Total/NA	Water	PrecSep-21	
180-173881-4	FIELD BLANK 1	Total/NA	Water	PrecSep-21	
MB 160-661791/1-A	Method Blank	Total/NA	Water	PrecSep-21	
LCS 160-661791/2-A	Lab Control Sample	Total/NA	Water	PrecSep-21	
180-173881-1 DU	CCR-AP-7	Total/NA	Water	PrecSep-21	

QC Association Summary

Client: Haley & Aldrich, Inc.
Project/Site: CCR Groundwater Monitoring FB Culley East

Job ID: 180-173881-1
SDG: FB Culley East

Rad

Prep Batch: 661792

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-173881-1	CCR-AP-7	Total/NA	Water	PrecSep_0	
180-173881-2	CCR-AP-8	Total/NA	Water	PrecSep_0	
180-173881-3	CCR-AP-11	Total/NA	Water	PrecSep_0	
180-173881-4	FIELD BLANK 1	Total/NA	Water	PrecSep_0	
MB 160-661792/1-A	Method Blank	Total/NA	Water	PrecSep_0	
LCS 160-661792/2-A	Lab Control Sample	Total/NA	Water	PrecSep_0	
180-173881-1 DU	CCR-AP-7	Total/NA	Water	PrecSep_0	

Eurofins Pittsburgh
301 Alpha Drive RIDC Park
Pittsburgh, PA 15238
Phone: 412-963-7058 Fax: 412-963-2468

Chain of Custody Record

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Client Information	Sampler: Hayley Tolles	Lab PM: Johnson, Andy	Carrier Tracking No(s):	COC No.: 180-101847-14505.2
Client Contact: Mark Breting	Phone:	E-Mail: Andy.Johnson@et.eurofinsus.com	State of Origin:	Page: Page 2 of 2
Company: Atlas Technical Consultants LLC	PWSID:			Job #:
Address: 7988 Centerpoint Drive Suite 100	Due Date Requested:			
City: Indianapolis	TAT Requested (days):			
State, Zip: IN, 46256	Compliance Project: Δ Yes Δ No			
Phone:	PO #: 0129420-032-001-01			
Email: mark.breting@atcassociates.com	WO #: See Chain			
Project Name: CCR GW Monitoring FB Culley East	Project #: 18016014			
Site: Culley East	SSOW#:			

Analysis Requested

Preservation Codes:
N - None
D - HNO3

Other:

Sample Identification	Sample Date	Sample Time	Sample Type (C=comp, G=grab)	Matrix (W=water, S=solid, O=waste/oil, BT=Tissue, A=Air)	9040C, 9056A_ORGFM_28D	2540C_Calcd - TDS by 2540C	9315_Ra226, 9320_Ra228	6020B - Metals by 6020B	7470A - Hg by 7470A	Special Instructions/Note:
CCR-AP-7	5-10-24	12:00	G	W	X	X	X	X	X	
CCA-AP-8		15:30	G	W	X	X	X	X	X	
CCR-AP-11		14:45	G	W	X	X	X	X	X	
MS 1		12:00	G	W	X	X	X	X	X	
MSD 1		12:00	G	W	X	X	X	X	X	
Field Blank 1	5-10-24	15:45	G	W	X	X	X	X	X	

180-173881 Chain of Custody

Possible Hazard Identification
☒ Non-Hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown ☐ Radiological

Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)
☐ Return To Client ☒ Disposal By Lab ☐ Archive For _____ Months

Deliverable Requested: I, II, III, IV, Other (specify)

Special Instructions/QC Requirements:

Empty Kit Relinquished by:	Date:	Time:	Method of Shipment:		
Relinquished by: Hayley Tolles	Date/Time: 5-10-24/17:15	Company: ATLAS	Received by: Fedex	Date/Time: 5-10-24/17:15	Company
Relinquished by:	Date/Time:	Company	Received by:	Date/Time: 05/11/24 1000	Company
Relinquished by:	Date/Time:	Company	Received by:	Date/Time:	Company

Custody Seals Intact: Δ Yes Δ No	Custody Seal No.:	Cooler Temperature(s) °C and Other Remarks:

Ver: 06/08/2021



ORIGIN ID:GTYA (317) 579-4082
CRAIG KAISER
FB CULLEY VECTREN CORP
3711 DARLINGTON ROAD

NEWBURGH, IN 47630
UNITED STATES US

SHIP DATE: 06MAY24
ACTWGT: 44.00 LB MAN
CAD: 0129689/CAFE3511

570C3/C137/6F4D

TO SAMPLE RECEIVING
EUROFINS ENVIRONMENT TESTING NE
301 ALPHA DRIVE
RIDC PARK
PITTSBURGH PA 152382907

(412) 963-7058 REF:
INV:
PO: DEPT:

RMA:

Uncorrected temp 2.5 °C
Thermometer ID 2G
CF -0.2 Initials PM
PT-WI-SR-001 effective 11/8/18

FedEx Express

J211020121101uv

Part # 156297-435 RRDW2 EXP 01/25

SATURDAY 12:00P
PRIORITY OVERNIGHT

15238
PIT
PA-US

FedEx
TRK# 0221 6772 2904 7044

XO AGCA

#5579144 05/10 5B3J4/C45B/9AE3

180-173881 Waybill

FedEx
TRK# 0221 6772 2904 7055

XO AGCA

SATURDAY 12:00P
PRIORITY OVERNIGHT

15238
PIT
PA-US

Part # 156297-435 RRDW2 EXP 01/25

Uncorrected temp 2.9 °C
Thermometer ID 17
CF -0.3 Initials

PT-WI-SR-001 effective 11/8/18

*5579149 05/10 5B3J4/C458/9AE3

FedEx Express

J211202121101uv

RMA:

DEPT:

TO SAMPLE RECEIVING
EUROFINS ENVIRONMENT TESTING NE
301 ALPHA DRIVE
RIDC PARK
PITTSBURGH PA 152382907
(412) 963-7058

REF:

INV:
PO:

ORIGIN ID:GTYA (317) 579-4082
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FB CULLEY VECTREN CORP
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SHIP DATE: 06MAY24
ACTWGT: 44.00 LB MAN
CAD: 0128689/CAFE3511

576C9/C137/6F4D

Eurofins Pittsburgh
301 Alpha Drive RIDC Park
Pittsburgh, PA 15238
Phone: 412-963-7058 Fax: 412-963-2468

Chain of Custody Record

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Client Information (Sub Contract Lab)	Sampler:	Lab PM: Johnson, Andy	Carrier Tracking No(s):	COC No: 180-514536.1
Client Contact: Shipping/Receiving	Phone:	E-Mail: Andy.Johnson@et.eurofinsus.com	State of Origin: Indiana	Page: Page 1 of 1
Company: TestAmerica Laboratories, Inc.		Accreditations Required (See note):		Job #: 180-173881-1
Address: 13715 Rider Trail North,	Due Date Requested: 5/23/2024			Preservation Codes:
City: Earth City	TAT Requested (days):			
State, Zip: MO, 63045				
Phone: 314-298-8566(Tel) 314-298-8757(Fax)	PO #:			
Email:	WO #:			
Project Name: CCR Groundwater Monitoring FB Culley East	Project #: 18016014			
Site:	SSOW#:			Other:

Analysis Requested

Sample Identification - Client ID (Lab ID)	Sample Date	Sample Time	Sample Type (C=comp, G=grab)	Matrix (W=water, S=solid, O=waste/oil, BT=Tissue, A=Air)	Field Filtered Sample (Yes or No)	Perform MS/MSD (Yes or No)	9315_Ra226/PrecSep_21 Radium-226 (GFPC) by 9315 (21-day decay)	9320_Ra228/PrecSep_0 Radium-228 (GFPC) by 9320	Ra226Ra228_GFPC/ Combined Radium-226 and Radium-228	Total Number of containers	Special Instructions/Note:
			Preservation Code:								
CCR-AP-7 (180-173881-1DU)	5/10/24	12:00 Eastern	DU	Water			X	X		4	
CCR-AP-8 (180-173881-2)	5/10/24	15:30 Eastern		Water			X	X	X	1	
CCR-AP-11 (180-173881-3)	5/10/24	14:45 Eastern		Water			X	X	X	2	
FIELD BLANK 1 (180-173881-4)	5/10/24	15:45 Eastern		Water			X	X	X	2	

Note: Since laboratory accreditations are subject to change, Eurofins Pittsburgh places the ownership of method, analyte & accreditation compliance upon our subcontract laboratories. This sample shipment is forwarded under chain-of-custody. If the laboratory does not currently maintain accreditation in the State of Origin listed above for analysis/tests/matrix being analyzed, the samples must be shipped back to the Eurofins Pittsburgh laboratory or other instructions will be provided. Any changes to accreditation status should be brought to Eurofins Pittsburgh attention immediately. If all requested accreditations are current to date, return the signed Chain of Custody attesting to said compliance to Eurofins Pittsburgh.

Possible Hazard Identification: Unconfirmed	Sample Disposal (A fee may be assessed if samples are retained longer than 1 month): ☐ Return To Client ☐ Disposal By Lab ☐ Archive For ____ Months
Deliverable Requested: I, II, III, IV, Other (specify) Primary Deliverable Rank: 2	Special Instructions/QC Requirements:

Empty Kit Relinquished by:	Date:	Time:	Method of Shipment:

Relinquished by	Date/Time: 5-13-24 1700	Company: EPINE	Received by	Date/Time:	Company
Relinquished by	Date/Time:	Company	Received by: M. Pinette	Date/Time: MAY 14 2024 0460	Company
Relinquished by:	Date/Time:	Company	Received by:	Date/Time:	Company

Custody Seals Intact: ∆ Yes ∆ No	Custody Seal No.:	Cooler Temperature(s) °C and Other Remarks:

Ver: 06/08/2021

6/17/2024

Login Sample Receipt Checklist

Client: Haley & Aldrich, Inc.

Job Number: 180-173881-1
SDG Number: FB Culley East

Login Number: 173881
List Number: 1
Creator: Abernathy, Eric L

List Source: Eurofins Pittsburgh

Question	Answer	Comment
Radioactivity wasn't checked or is </= background as measured by a survey meter.	N/A	
The cooler's custody seal, if present, is intact.	True	
Sample custody seals, if present, are intact.	True	
The cooler or samples do not appear to have been compromised or tampered with.	True	
Samples were received on ice.	True	
Cooler Temperature is acceptable.	True	
Cooler Temperature is recorded.	True	
COC is present.	True	
COC is filled out in ink and legible.	True	
COC is filled out with all pertinent information.	True	
Is the Field Sampler's name present on COC?	True	
There are no discrepancies between the containers received and the COC.	True	
Samples are received within Holding Time (excluding tests with immediate HTs)	True	
Sample containers have legible labels.	True	
Containers are not broken or leaking.	True	
Sample collection date/times are provided.	True	
Appropriate sample containers are used.	True	
Sample bottles are completely filled.	True	
Sample Preservation Verified.	True	
There is sufficient vol. for all requested analyses, incl. any requested MS/MSDs	True	
Containers requiring zero headspace have no headspace or bubble is <6mm (1/4").	True	
Multiphasic samples are not present.	True	
Samples do not require splitting or compositing.	True	
Residual Chlorine Checked.	N/A	

Login Sample Receipt Checklist

Client: Haley & Aldrich, Inc.

Job Number: 180-173881-1
SDG Number: FB Culley East

Login Number: 173881
List Number: 2
Creator: Worthington, Sierra M

List Source: Eurofins St. Louis
List Creation: 05/14/24 01:52 PM

Question	Answer	Comment
Radioactivity wasn't checked or is </= background as measured by a survey meter.	True	
The cooler's custody seal, if present, is intact.	True	
Sample custody seals, if present, are intact.	True	
The cooler or samples do not appear to have been compromised or tampered with.	True	
Samples were received on ice.	N/A	
Cooler Temperature is acceptable.	True	
Cooler Temperature is recorded.	True	
COC is present.	True	
COC is filled out in ink and legible.	True	
COC is filled out with all pertinent information.	True	
Is the Field Sampler's name present on COC?	N/A	
There are no discrepancies between the containers received and the COC.	True	
Samples are received within Holding Time (excluding tests with immediate HTs)	True	
Sample containers have legible labels.	True	
Containers are not broken or leaking.	True	
Sample collection date/times are provided.	True	
Appropriate sample containers are used.	True	
Sample bottles are completely filled.	True	
Sample Preservation Verified.	True	
There is sufficient vol. for all requested analyses, incl. any requested MS/MSDs	True	
Containers requiring zero headspace have no headspace or bubble is <6mm (1/4").	N/A	
Multiphasic samples are not present.	True	
Samples do not require splitting or compositing.	True	
Residual Chlorine Checked.	N/A	

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ANALYTICAL REPORT

PREPARED FOR

Attn: Todd Plating
Haley & Aldrich, Inc.
400 Augusta Street
Suite 100
Greenville, South Carolina 29601

Generated 12/28/2024 8:35:19 AM

JOB DESCRIPTION

CCR Groundwater Monitoring FB Culley East
FB Culley East

JOB NUMBER

180-182961-1

Eurofins Pittsburgh
301 Alpha Drive
RIDC Park
Pittsburgh PA 15238

See page two for job notes and contact information.

my EOL

Eurofins Pittsburgh

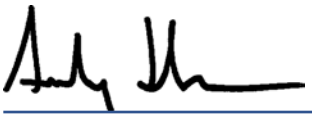
Job Notes

This report may not be reproduced except in full, and with written approval from the laboratory. The results relate only to the samples tested. For questions please contact the Project Manager at the e-mail address or telephone number listed on this page.

PA Lab ID: 02-00416

The test results in this report relate only to the samples as received by the laboratory and will meet all requirements of the methodology, with any exceptions noted. This report shall not be reproduced except in full, without the express written approval of the laboratory. All questions should be directed to the Eurofins Pittsburgh Project Manager.

Authorization



Generated
12/28/2024 8:35:19 AM

Authorized for release by
Andy Johnson, Senior Project Manager
Andy.Johnson@et.eurofinsus.com
(615)818-9567

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Job Narrative
180-182961-1

Analytical test results meet all requirements of the associated regulatory program listed on the Accreditation/Certification Summary Page unless otherwise noted under the individual analysis. Data qualifiers and/or narrative comments are included to explain any exceptions, if applicable.

- Matrix QC may not be reported if insufficient sample is provided or site-specific QC samples were not submitted. In these situations, to demonstrate precision and accuracy at a batch level, a LCS/LCSD may be performed, unless otherwise specified in the method.
- Surrogate and/or isotope dilution analyte recoveries (if applicable) which are outside of the QC window are confirmed unless attributed to a dilution or otherwise noted in the narrative.

Regulated compliance samples (e.g. SDWA, NPDES) must comply with the associated agency requirements/permits.

Receipt
The samples were received on 11/16/2024 9:30 AM. Unless otherwise noted below, the samples arrived in good condition, and, where required, properly preserved and on ice. The temperatures of the 6 coolers at receipt time were 1.6°C, 1.7°C, 2.3°C, 2.7°C, 3.5°C and 4.0°C.

Receipt Exceptions
Only one 1L nitric preserved bottle was received and contained about 600mL of sample volume. CCR-AP-9 (180-182961-6)

Only one 1L nitric preserved container was received and contained about 650mL of sample volume. CCR-AP-2 (180-182961-2)

Only one 1L nitric preserved bottle was received and the container was only filled with about 500mL of sample volume. CCR-AP-1R (180-182961-1)

Only one 1L nitric preserved container was received and contained about 450mL of sample volume. CCR-AP-4 (180-182961-3)

A Chain-of-Custody (COC) was not received with these samples but was provided by the client: CCR-AP-1R (180-182961-1), CCR-AP-2 (180-182961-2), CCR-AP-4 (180-182961-3), CCR-AP-5 (180-182961-4), CCR-AP-6I (180-182961-5), CCR-AP-9 (180-182961-6), CCR-AP-11 (180-182961-7), DUP-1 (180-182961-8) and FIELD BLANK 1 (180-182961-9).

Gas Flow Proportional Counter
Method 9320_Ra228: Radium-228 prep batch 160-689999: The detection goal was not met for the following samples due to the reduced sample volume attributed to the presence of matrix interferences: CCR-AP-1R (180-182961-1), CCR-AP-2 (180-182961-2) and CCR-AP-4 (180-182961-3) . Analytical results are reported with the detection limit achieved.

Method 9320_Ra228: Radium-228 batch 690431: The detection goal was not met for the following sample due to the reduced sample volume attributed to the presence of matrix interferences: CCR-AP-9 (180-182961-6). Analytical results are reported with the detection limit achieved.

Method 9320_Ra228: Radium-228 Prep Batch 160-689999: The sample duplicate (DU) associated with the following samples has a replicate error ratio (RER: 1.1) outside of the upper control limit (1.0): CCR-AP-1R (180-182961-1), CCR-AP-2 (180-182961-2) and CCR-AP-4 (180-182961-3). There is insufficient sample volume to re-prep/re-analyze the samples, so the data have been reported with this narrative.

No additional analytical or quality issues were noted, other than those described above or in the Definitions/ Glossary page.

Rad
No additional analytical or quality issues were noted, other than those described above or in the Definitions/ Glossary page.

Job ID: 180-182961-2 Eurofins Pittsburgh

Job Narrative
180-182961-2

Analytical test results meet all requirements of the associated regulatory program listed on the Accreditation/Certification Summary Page unless otherwise noted under the individual analysis. Data qualifiers and/or narrative comments are included to explain any exceptions, if applicable.

- Matrix QC may not be reported if insufficient sample is provided or site-specific QC samples were not submitted. In these situations, to demonstrate precision and accuracy at a batch level, a LCS/LCSD may be performed, unless otherwise specified in the method.
- Surrogate and/or isotope dilution analyte recoveries (if applicable) which are outside of the QC window are confirmed unless attributed to a dilution or otherwise noted in the narrative.

Regulated compliance samples (e.g. SDWA, NPDES) must comply with the associated agency requirements/permits.

Receipt
The samples were received on 11/16/2024 9:30 AM. Unless otherwise noted below, the samples arrived in good condition, and, where required, properly preserved and on ice. The temperatures of the 6 coolers at receipt time were 1.6°C, 1.7°C, 2.3°C, 2.7°C, 3.5°C and 4.0°C.

Receipt Exceptions
Only one 1L nitric preserved bottle was received and contained about 600mL of sample volume. CCR-AP-9 (180-182961-6)

Only one 1L nitric preserved container was received and contained about 650mL of sample volume. CCR-AP-2 (180-182961-2)

Only one 1L nitric preserved bottle was received and the container was only filled with about 500mL of sample volume. CCR-AP-1R (180-182961-1)

Only one 1L nitric preserved container was received and contained about 450mL of sample volume. CCR-AP-4 (180-182961-3)

A Chain-of-Custody (COC) was not received with these samples: CCR-AP-1R (180-182961-1), CCR-AP-2 (180-182961-2), CCR-AP-4 (180-182961-3), CCR-AP-5 (180-182961-4), CCR-AP-6I (180-182961-5), CCR-AP-9 (180-182961-6), CCR-AP-11 (180-182961-7), DUP-1 (180-182961-8) and FIELD BLANK 1 (180-182961-9) but was provided by the client.

HPLC/IC
Method 9056A_ORGFM_28D: The following samples were diluted to bring the concentration of target analytes within the calibration range: CCR-AP-2 (180-182961-2), CCR-AP-5 (180-182961-4), CCR-AP-9 (180-182961-6), CCR-AP-11 (180-182961-7), DUP-1 (180-182961-8), (180-182934-D-5), (180-182934-D-5 MS) and (180-182934-D-5 MSD). Elevated reporting limits (RLs) are provided.

Method 9056A_ORGFM_28D: The following samples was diluted due to the nature of the sample matrix: CCR-AP-9 (180-182961-6). Elevated reporting limits (RLs) are provided.

No additional analytical or quality issues were noted, other than those described above or in the Definitions/ Glossary page.

Metals
Method 6020B - Total Recoverable: The laboratory control sample (LCS) for preparation batch 240-636038 and analytical batch 240-636305 recovered outside control limits for the following analytes: Thallium. These analytes were biased high in the LCS and were below the reporting limit in the associated samples; therefore, the data have been reported.

No additional analytical or quality issues were noted, other than those described above or in the Definitions/ Glossary page.

General Chemistry
Method 2540C_Calcd: Due to matrix and/or conductivity, initial amount of sample used was reduced. CCR-AP-1R (180-182961-1), CCR-AP-4 (180-182961-3) and CCR-AP-9 (180-182961-6)

No additional analytical or quality issues were noted, other than those described above or in the Definitions/ Glossary page.

Definitions/Glossary

Client: Haley & Aldrich, Inc.
Project/Site: CCR Groundwater Monitoring FB Culley East

Job ID: 180-182961-1
SDG: FB Culley East

Qualifiers

HPLC/IC

Qualifier	Qualifier Description
J	Result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value.

Metals

Qualifier	Qualifier Description
*+	LCS and/or LCSD is outside acceptance limits, high biased.
J	Result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value.

General Chemistry

Qualifier	Qualifier Description
HF	Parameter with a holding time of 15 minutes. Test performed by laboratory at client's request. Sample was analyzed outside of hold time.

Rad

Qualifier	Qualifier Description
G	The Sample MDC is greater than the requested RL.
U	Result is less than the sample detection limit.

Glossary

Abbreviation	These commonly used abbreviations may or may not be present in this report.
☼	Listed under the "D" column to designate that the result is reported on a dry weight basis
%R	Percent Recovery
CFL	Contains Free Liquid
CFU	Colony Forming Unit
CNF	Contains No Free Liquid
DER	Duplicate Error Ratio (normalized absolute difference)
Dil Fac	Dilution Factor
DL	Detection Limit (DoD/DOE)
DL, RA, RE, IN	Indicates a Dilution, Re-analysis, Re-extraction, or additional Initial metals/anion analysis of the sample
DLC	Decision Level Concentration (Radiochemistry)
EDL	Estimated Detection Limit (Dioxin)
LOD	Limit of Detection (DoD/DOE)
LOQ	Limit of Quantitation (DoD/DOE)
MCL	EPA recommended "Maximum Contaminant Level"
MDA	Minimum Detectable Activity (Radiochemistry)
MDC	Minimum Detectable Concentration (Radiochemistry)
MDL	Method Detection Limit
ML	Minimum Level (Dioxin)
MPN	Most Probable Number
MQL	Method Quantitation Limit
NC	Not Calculated
ND	Not Detected at the reporting limit (or MDL or EDL if shown)
NEG	Negative / Absent
POS	Positive / Present
PQL	Practical Quantitation Limit
PRES	Presumptive
QC	Quality Control
RER	Relative Error Ratio (Radiochemistry)
RL	Reporting Limit or Requested Limit (Radiochemistry)
RPD	Relative Percent Difference, a measure of the relative difference between two points
TEF	Toxicity Equivalent Factor (Dioxin)
TEQ	Toxicity Equivalent Quotient (Dioxin)
TNTC	Too Numerous To Count

Accreditation/Certification Summary

Client: Haley & Aldrich, Inc.
Project/Site: CCR Groundwater Monitoring FB Culley East

Job ID: 180-182961-1
SDG: FB Culley East

Laboratory: Eurofins Pittsburgh

All accreditations/certifications held by this laboratory are listed. Not all accreditations/certifications are applicable to this report.

Authority	Program	Identification Number	Expiration Date
Arkansas DEQ	State	19-033-0	06-28-25
California	State	2891	04-30-24 *
Connecticut	State	PH-0688	09-30-24 *
Florida	NELAP	E871008	06-30-25
Georgia	State	PA 02-00416	04-30-25
Illinois	NELAP	004375	07-31-25
Kansas	NELAP	E-10350	01-31-25
Kentucky (UST)	State	162013	04-30-25
Kentucky (WW)	State	KY98043	12-31-24
Louisiana	NELAP	04041	06-30-22 *
Louisiana (All)	NELAP	04041	06-30-25
Maine	State	PA00164	03-06-26
Minnesota	NELAP	042-999-482	12-31-24
New Hampshire	NELAP	2030	04-04-25
New Jersey	NELAP	PA005	06-30-25
New York	NELAP	11182	04-01-25
North Carolina (WW/SW)	State	434	12-31-24
North Dakota	State	R-227	04-30-24 *
Oregon	NELAP	PA-2151	02-06-25
Pennsylvania	NELAP	02-00416	12-05-24
Rhode Island	State	LAO00362	01-01-25
South Carolina	State	89014	11-24-24
Texas	NELAP	T104704528	03-31-25
US Fish & Wildlife	US Federal Programs	058448	04-30-25
USDA	US Federal Programs	P330-16-00211	04-11-26
Utah	NELAP	PA001462024-14	05-31-25
Virginia	NELAP	10043	07-14-24 *
West Virginia DEP	State	142	01-31-25
Wisconsin	State	998027800	08-31-25

Laboratory: Eurofins Cleveland

All accreditations/certifications held by this laboratory are listed. Not all accreditations/certifications are applicable to this report.

Authority	Program	Identification Number	Expiration Date
California	State	2927	02-28-25
Connecticut	State	PH-0806	12-31-26
Georgia	State	4062	02-27-25
Illinois	NELAP	200004	08-31-25
Iowa	State	421	06-01-25
Kentucky (UST)	State	112225	02-27-25
Kentucky (WW)	State	KY98016	12-30-24
Minnesota	NELAP	039-999-348	12-31-25
New Hampshire	NELAP	225024	09-30-25
New Jersey	NELAP	OH001	07-03-25
New York	NELAP	10975	04-02-25
Ohio VAP	State	ORELAP 4062	02-27-25
Oregon	NELAP	4062	02-27-25
Pennsylvania	NELAP	68-00340	08-31-25
Texas	NELAP	T104704517-22-19	08-31-25
USDA	US Federal Programs	P330-18-00281	01-05-27

* Accreditation/Certification renewal pending - accreditation/certification considered valid.

Accreditation/Certification Summary

Client: Haley & Aldrich, Inc.
Job ID: 180-182961-1
Project/Site: CCR Groundwater Monitoring FB Culley East
SDG: FB Culley East

Laboratory: Eurofins Cleveland (Continued)

All accreditations/certifications held by this laboratory are listed. Not all accreditations/certifications are applicable to this report.

Authority	Program	Identification Number	Expiration Date
Virginia	NELAP	460175	09-14-25
West Virginia DEP	State	210	12-31-24

Laboratory: Eurofins St. Louis

All accreditations/certifications held by this laboratory are listed. Not all accreditations/certifications are applicable to this report.

Authority	Program	Identification Number	Expiration Date
Alaska (UST)	State	20-001	05-06-25
ANAB	Dept. of Defense ELAP	L2305	04-06-25
ANAB	Dept. of Energy	L2305.01	04-08-25
ANAB	ISO/IEC 17025	L2305	04-06-25
Arizona	State	AZ0813	12-08-25
California	Los Angeles County Sanitation Districts	10259	06-30-22 *
California	State	2886	06-30-25
Connecticut	State	PH-0241	03-31-25
Florida	NELAP	E87689	06-30-25
HI - RadChem Recognition	State	n/a	06-30-25
Illinois	NELAP	200023	11-30-25
Iowa	State	373	12-01-26
Kansas	NELAP	E-10236	10-31-25
Kentucky (DW)	State	KY90125	12-31-24
Kentucky (WW)	State	KY90125 (Permit KY0004049)	12-31-24
Louisiana	NELAP	04080	06-30-22 *
Louisiana (All)	NELAP	04080	06-30-25
Louisiana (DW)	State	LA011	12-31-24
Maryland	State	310	09-30-25
Massachusetts	State	M-MO054	06-30-25
MI - RadChem Recognition	State	9005	06-30-25
Missouri	State	780	06-30-25
Nevada	State	MO00054	07-31-25
New Jersey	NELAP	MO002	06-30-25
New Mexico	State	MO00054	06-30-25
New York	NELAP	11616	03-31-25
North Carolina (DW)	State	29700	07-31-25
North Dakota	State	R-207	12-31-24
Oklahoma	NELAP	9997	12-31-24
Oregon	NELAP	4157	09-01-25
Pennsylvania	NELAP	68-00540	02-28-25
South Carolina	State	85002001	06-30-25
Texas	NELAP	T104704193	07-31-25
US Fish & Wildlife	US Federal Programs	058448	07-31-25
USDA	US Federal Programs	P330-17-00028	05-18-26
Utah	NELAP	MO00054	07-31-25
Virginia	NELAP	460230	06-14-25
Washington	State	C592	08-30-25
West Virginia DEP	State	381	10-31-25

* Accreditation/Certification renewal pending - accreditation/certification considered valid.

Sample Summary

Client: Haley & Aldrich, Inc.
Project/Site: CCR Groundwater Monitoring FB Culley East

Job ID: 180-182961-1
SDG: FB Culley East

Lab Sample ID	Client Sample ID	Matrix	Collected	Received
180-182961-1	CCR-AP-1R	Water	11/14/24 06:45	11/16/24 09:30
180-182961-2	CCR-AP-2	Water	11/14/24 08:05	11/16/24 09:30
180-182961-3	CCR-AP-4	Water	11/14/24 13:20	11/16/24 09:30
180-182961-4	CCR-AP-5	Water	11/14/24 15:45	11/16/24 09:30
180-182961-5	CCR-AP-6I	Water	11/13/24 08:41	11/16/24 09:30
180-182961-6	CCR-AP-9	Water	11/14/24 10:50	11/16/24 09:30
180-182961-7	CCR-AP-11	Water	11/15/24 08:58	11/16/24 09:30
180-182961-8	DUP-1	Water	11/14/24 00:00	11/16/24 09:30
180-182961-9	FIELD BLANK 1	Water	11/15/24 11:55	11/16/24 09:30

Method Summary

Client: Haley & Aldrich, Inc.
Project/Site: CCR Groundwater Monitoring FB Culley East

Job ID: 180-182961-1
SDG: FB Culley East

Method	Method Description	Protocol	Laboratory
9315	Radium-226 (GFPC)	SW846	EET SL
9320	Radium-228 (GFPC)	SW846	EET SL
Ra226_Ra228	Combined Radium-226 and Radium-228	TAL-STL	EET SL
PrecSep_0	Preparation, Precipitate Separation	None	EET SL
PrecSep-21	Preparation, Precipitate Separation (21-Day In-Growth)	None	EET SL

Protocol References:

None = None

SW846 = "Test Methods For Evaluating Solid Waste, Physical/Chemical Methods", Third Edition, November 1986 And Its Updates.

TAL-STL = TestAmerica Laboratories, St. Louis, Facility Standard Operating Procedure.

Laboratory References:

EET SL = Eurofins St. Louis, 13715 Rider Trail North, Earth City, MO 63045, TEL (314)298-8566

Lab Chronicle

Client: Haley & Aldrich, Inc.
Project/Site: CCR Groundwater Monitoring FB Culley East

Job ID: 180-182961-1
SDG: FB Culley East

Client Sample ID: CCR-AP-1R

Date Collected: 11/14/24 06:45
Date Received: 11/16/24 09:30

Lab Sample ID: 180-182961-1

Matrix: Water

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	EPA 9056A		1	1 mL	1 mL	484985	11/21/24 15:21	SJM	EET PIT
	Instrument ID: CHICS2100B									
Total Recoverable	Prep	3005A			50 mL	50 mL	636038	11/20/24 14:00	S4FJ	EET CLE
Total Recoverable	Analysis	EPA 6010D		1			636493	11/22/24 21:35	KLC	EET CLE
	Instrument ID: I12									
Total Recoverable	Prep	3005A			50 mL	50 mL	636038	11/20/24 14:00	S4FJ	EET CLE
Total Recoverable	Analysis	EPA 6020B		1			636305	11/21/24 19:52	AJC	EET CLE
	Instrument ID: I14									
Total/NA	Prep	7470A			50 mL	50 mL	636040	11/20/24 14:00	S4FJ	EET CLE
Total/NA	Analysis	EPA 7470A		1			636245	11/21/24 12:08	TQ6W	EET CLE
	Instrument ID: H11									
Total/NA	Analysis	EPA 9040C		1			485167	11/23/24 09:44	BAB	EET PIT
	Instrument ID: NOEQUIP									
Total/NA	Analysis	SM 2540C		1	50 mL	100 mL	484667	11/18/24 11:43	EBA	EET PIT
	Instrument ID: NOEQUIP									
Total/NA	Prep	PrecSep-21			507.78 mL	1.0 g	689970	11/22/24 09:22	BCE	EET SL
Total/NA	Analysis	9315		1			693993	12/16/24 20:57	SCB	EET SL
	Instrument ID: GFPCPURPLE									
Total/NA	Prep	PrecSep_0			507.78 mL	1.0 g	689999	11/22/24 12:14	BCE	EET SL
Total/NA	Analysis	9320		1	1.0 mL	1.0 mL	693093	12/11/24 12:45	SCB	EET SL
	Instrument ID: GFPCPURPLE									
Total/NA	Analysis	Ra226_Ra228		1			695373	12/26/24 09:30	FLC	EET SL
	Instrument ID: NOEQUIP									

Client Sample ID: CCR-AP-2

Date Collected: 11/14/24 08:05
Date Received: 11/16/24 09:30

Lab Sample ID: 180-182961-2

Matrix: Water

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	EPA 9056A		1	1 mL	1 mL	484985	11/21/24 15:51	SJM	EET PIT
	Instrument ID: CHICS2100B									
Total/NA	Analysis	EPA 9056A		10	1 mL	1 mL	484985	11/21/24 16:06	SJM	EET PIT
	Instrument ID: CHICS2100B									
Total Recoverable	Prep	3005A			50 mL	50 mL	636038	11/20/24 14:00	S4FJ	EET CLE
Total Recoverable	Analysis	EPA 6010D		1			636493	11/22/24 21:39	KLC	EET CLE
	Instrument ID: I12									
Total Recoverable	Prep	3005A			50 mL	50 mL	636038	11/20/24 14:00	S4FJ	EET CLE
Total Recoverable	Analysis	EPA 6020B		1			636305	11/21/24 19:55	AJC	EET CLE
	Instrument ID: I14									
Total/NA	Prep	7470A			50 mL	50 mL	636040	11/20/24 14:00	S4FJ	EET CLE
Total/NA	Analysis	EPA 7470A		1			636245	11/21/24 12:10	TQ6W	EET CLE
	Instrument ID: H11									
Total/NA	Analysis	EPA 9040C		1			485167	11/23/24 09:44	BAB	EET PIT
	Instrument ID: NOEQUIP									

Lab Chronicle

Client: Haley & Aldrich, Inc.
Project/Site: CCR Groundwater Monitoring FB Culley East

Job ID: 180-182961-1
SDG: FB Culley East

Client Sample ID: CCR-AP-2

Date Collected: 11/14/24 08:05
Date Received: 11/16/24 09:30

Lab Sample ID: 180-182961-2

Matrix: Water

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	SM 2540C		1	100 mL	100 mL	484659	11/18/24 11:34	EBA	EET PIT
Total/NA	Prep	PrecSep-21			507.75 mL	1.0 g	689970	11/22/24 09:22	BCE	EET SL
Total/NA	Analysis	9315		1			693993	12/16/24 20:57	SCB	EET SL
	Instrument ID: GFPCPURPLE									
Total/NA	Prep	PrecSep_0			507.75 mL	1.0 g	689999	11/22/24 12:14	BCE	EET SL
Total/NA	Analysis	9320		1			693093	12/11/24 12:45	SCB	EET SL
	Instrument ID: GFPCPURPLE									
Total/NA	Analysis	Ra226_Ra228		1			695373	12/26/24 09:30	FLC	EET SL
	Instrument ID: NOEQUIP									

Client Sample ID: CCR-AP-4

Date Collected: 11/14/24 13:20
Date Received: 11/16/24 09:30

Lab Sample ID: 180-182961-3

Matrix: Water

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	EPA 9056A		1	1 mL	1 mL	484985	11/21/24 16:23	SJM	EET PIT
	Instrument ID: CHICS2100B									
Total Recoverable	Prep	3005A			50 mL	50 mL	636038	11/20/24 14:00	S4FJ	EET CLE
Total Recoverable	Analysis	EPA 6010D		1			636493	11/22/24 21:43	KLC	EET CLE
	Instrument ID: I12									
Total Recoverable	Prep	3005A			50 mL	50 mL	636038	11/20/24 14:00	S4FJ	EET CLE
Total Recoverable	Analysis	EPA 6020B		1			636305	11/21/24 20:03	AJC	EET CLE
	Instrument ID: I14									
Total Recoverable	Prep	3005A			50 mL	50 mL	636038	11/20/24 14:00	S4FJ	EET CLE
Total Recoverable	Analysis	EPA 6020B		1			636748	11/26/24 02:46	AJC	EET CLE
	Instrument ID: I14									
Total/NA	Prep	7470A			50 mL	50 mL	636040	11/20/24 14:00	S4FJ	EET CLE
Total/NA	Analysis	EPA 7470A		1			636245	11/21/24 12:11	TQ6W	EET CLE
	Instrument ID: H11									
Total/NA	Analysis	EPA 9040C		1			485167	11/23/24 09:44	BAB	EET PIT
	Instrument ID: NOEQUIP									
Total/NA	Analysis	SM 2540C		1	50 mL	100 mL	484667	11/18/24 11:43	EBA	EET PIT
	Instrument ID: NOEQUIP									
Total/NA	Prep	PrecSep-21			479.14 mL	1.0 g	689970	11/22/24 09:22	BCE	EET SL
Total/NA	Analysis	9315		1			693993	12/16/24 20:58	SCB	EET SL
	Instrument ID: GFPCPURPLE									
Total/NA	Prep	PrecSep_0			479.14 mL	1.0 g	689999	11/22/24 12:14	BCE	EET SL
Total/NA	Analysis	9320		1	1.0 mL	1.0 mL	693093	12/11/24 12:45	SCB	EET SL
	Instrument ID: GFPCPURPLE									
Total/NA	Analysis	Ra226_Ra228		1			695373	12/26/24 09:30	FLC	EET SL
	Instrument ID: NOEQUIP									

Lab Chronicle

Client: Haley & Aldrich, Inc.
Project/Site: CCR Groundwater Monitoring FB Culley East

Job ID: 180-182961-1
SDG: FB Culley East

Client Sample ID: CCR-AP-5

Date Collected: 11/14/24 15:45
Date Received: 11/16/24 09:30

Lab Sample ID: 180-182961-4

Matrix: Water

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	EPA 9056A		1	1 mL	1 mL	484985	11/21/24 16:53	SJM	EET PIT
	Instrument ID: CHICS2100B									
Total/NA	Analysis	EPA 9056A		5	1 mL	1 mL	484985	11/21/24 17:07	SJM	EET PIT
	Instrument ID: CHICS2100B									
Total Recoverable	Prep	3005A			50 mL	50 mL	636038	11/20/24 14:00	S4FJ	EET CLE
Total Recoverable	Analysis	EPA 6010D		5			636691	11/26/24 05:36	RKT	EET CLE
	Instrument ID: I9									
Total Recoverable	Prep	3005A			50 mL	50 mL	636038	11/20/24 14:00	S4FJ	EET CLE
Total Recoverable	Analysis	EPA 6020B		1			636305	11/21/24 20:06	AJC	EET CLE
	Instrument ID: I14									
Total Recoverable	Prep	3005A			50 mL	50 mL	636038	11/20/24 14:00	S4FJ	EET CLE
Total Recoverable	Analysis	EPA 6020B		1			636748	11/26/24 02:49	AJC	EET CLE
	Instrument ID: I14									
Total/NA	Prep	7470A			50 mL	50 mL	636040	11/20/24 14:00	S4FJ	EET CLE
Total/NA	Analysis	EPA 7470A		1			636245	11/21/24 12:13	TQ6W	EET CLE
	Instrument ID: H11									
Total/NA	Analysis	EPA 9040C		1			485028	11/21/24 14:10	BAB	EET PIT
	Instrument ID: OZ									
Total/NA	Analysis	SM 2540C		1	100 mL	100 mL	484737	11/19/24 09:41	EBA	EET PIT
	Instrument ID: NOEQUIP									
Total/NA	Prep	PrecSep-21			1007.13 mL	1.0 g	690430	11/25/24 09:43	BCE	EET SL
Total/NA	Analysis	9315		1			694357	12/18/24 18:10	SCB	EET SL
	Instrument ID: GFPCBLUE									
Total/NA	Prep	PrecSep_0			1007.13 mL	1.0 g	690431	11/25/24 09:46	BCE	EET SL
Total/NA	Analysis	9320		1			693477	12/13/24 11:28	FLC	EET SL
	Instrument ID: GFPCRED									
Total/NA	Analysis	Ra226_Ra228		1			695373	12/26/24 09:30	FLC	EET SL
	Instrument ID: NOEQUIP									

Client Sample ID: CCR-AP-6I

Date Collected: 11/13/24 08:41
Date Received: 11/16/24 09:30

Lab Sample ID: 180-182961-5

Matrix: Water

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	EPA 9056A		1	1 mL	1 mL	484985	11/21/24 17:25	SJM	EET PIT
	Instrument ID: CHICS2100B									
Total Recoverable	Prep	3005A			50 mL	50 mL	636038	11/20/24 14:00	S4FJ	EET CLE
Total Recoverable	Analysis	EPA 6010D		1			636493	11/22/24 21:52	KLC	EET CLE
	Instrument ID: I12									
Total Recoverable	Prep	3005A			50 mL	50 mL	636038	11/20/24 14:00	S4FJ	EET CLE
Total Recoverable	Analysis	EPA 6020B		1			636305	11/21/24 20:09	AJC	EET CLE
	Instrument ID: I14									
Total Recoverable	Prep	3005A			50 mL	50 mL	636038	11/20/24 14:00	S4FJ	EET CLE
Total Recoverable	Analysis	EPA 6020B		1			636748	11/26/24 02:57	AJC	EET CLE
	Instrument ID: I14									

Lab Chronicle

Client: Haley & Aldrich, Inc.
Project/Site: CCR Groundwater Monitoring FB Culley East

Job ID: 180-182961-1
SDG: FB Culley East

Client Sample ID: CCR-AP-6I

Date Collected: 11/13/24 08:41
Date Received: 11/16/24 09:30

Lab Sample ID: 180-182961-5

Matrix: Water

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	7470A			50 mL	50 mL	636040	11/20/24 14:00	S4FJ	EET CLE
Total/NA	Analysis	EPA 7470A		1			636245	11/21/24 12:15	TQ6W	EET CLE
	Instrument ID: H11									
Total/NA	Analysis	EPA 9040C		1			485028	11/21/24 14:05	BAB	EET PIT
	Instrument ID: OZ									
Total/NA	Analysis	SM 2540C		1	100 mL	100 mL	484667	11/18/24 11:43	EBA	EET PIT
	Instrument ID: NOEQUIP									
Total/NA	Prep	PrecSep-21			989.18 mL	1.0 g	690430	11/25/24 09:43	BCE	EET SL
Total/NA	Analysis	9315		1			694357	12/18/24 18:10	SCB	EET SL
	Instrument ID: GFPCBLUE									
Total/NA	Prep	PrecSep_0			989.18 mL	1.0 g	690431	11/25/24 09:46	BCE	EET SL
Total/NA	Analysis	9320		1			693477	12/13/24 11:28	FLC	EET SL
	Instrument ID: GFPCRED									
Total/NA	Analysis	Ra226_Ra228		1			695373	12/26/24 09:30	FLC	EET SL
	Instrument ID: NOEQUIP									

Client Sample ID: CCR-AP-9

Date Collected: 11/14/24 10:50
Date Received: 11/16/24 09:30

Lab Sample ID: 180-182961-6

Matrix: Water

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	EPA 9056A		2.5	1 mL	1 mL	484985	11/21/24 18:10	SJM	EET PIT
	Instrument ID: CHICS2100B									
Total Recoverable	Prep	3005A			50 mL	50 mL	636038	11/20/24 14:00	S4FJ	EET CLE
Total Recoverable	Analysis	EPA 6010D		1			636493	11/22/24 21:56	KLC	EET CLE
	Instrument ID: I12									
Total Recoverable	Prep	3005A			50 mL	50 mL	636038	11/20/24 14:00	S4FJ	EET CLE
Total Recoverable	Analysis	EPA 6020B		1			636305	11/21/24 20:12	AJC	EET CLE
	Instrument ID: I14									
Total Recoverable	Prep	3005A			50 mL	50 mL	636038	11/20/24 14:00	S4FJ	EET CLE
Total Recoverable	Analysis	EPA 6020B		1			636748	11/26/24 02:59	AJC	EET CLE
	Instrument ID: I14									
Total/NA	Prep	7470A			50 mL	50 mL	636040	11/20/24 14:00	S4FJ	EET CLE
Total/NA	Analysis	EPA 7470A		1			636245	11/21/24 12:20	TQ6W	EET CLE
	Instrument ID: H11									
Total/NA	Analysis	EPA 9040C		1			485167	11/23/24 09:44	BAB	EET PIT
	Instrument ID: NOEQUIP									
Total/NA	Analysis	SM 2540C		1	50 mL	100 mL	484667	11/18/24 11:43	EBA	EET PIT
	Instrument ID: NOEQUIP									
Total/NA	Prep	PrecSep-21			525.00 mL	1.0 g	690430	11/25/24 09:43	BCE	EET SL
Total/NA	Analysis	9315		1			694357	12/18/24 18:10	SCB	EET SL
	Instrument ID: GFPCBLUE									
Total/NA	Prep	PrecSep_0			525.00 mL	1.0 g	690431	11/25/24 09:46	BCE	EET SL
Total/NA	Analysis	9320		1			693477	12/13/24 11:28	FLC	EET SL
	Instrument ID: GFPCRED									

Client Sample ID: CCR-AP-9
Lab Sample ID: 180-182961-6
Date Collected: 11/14/24 10:50
Matrix: Water
Date Received: 11/16/24 09:30

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	Ra226_Ra228		1			695373	12/26/24 09:30	FLC	EET SL

Client Sample ID: CCR-AP-11
Lab Sample ID: 180-182961-7
Date Collected: 11/15/24 08:58
Matrix: Water
Date Received: 11/16/24 09:30

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	EPA 9056A		1	1 mL	1 mL	484985	11/21/24 18:24	SJM	EET PIT
	Instrument ID: CHICS2100B									
Total/NA	Analysis	EPA 9056A		5	1 mL	1 mL	484985	11/21/24 18:39	SJM	EET PIT
	Instrument ID: CHICS2100B									
Total Recoverable	Prep	3005A			50 mL	50 mL	636038	11/20/24 14:00	S4FJ	EET CLE
Total Recoverable	Analysis	EPA 6010D		1			636493	11/22/24 22:01	KLC	EET CLE
	Instrument ID: I12									
Total Recoverable	Prep	3005A			50 mL	50 mL	636038	11/20/24 14:00	S4FJ	EET CLE
Total Recoverable	Analysis	EPA 6020B		1			636305	11/21/24 20:15	AJC	EET CLE
	Instrument ID: I14									
Total Recoverable	Prep	3005A			50 mL	50 mL	636038	11/20/24 14:00	S4FJ	EET CLE
Total Recoverable	Analysis	EPA 6020B		1			636748	11/26/24 03:02	AJC	EET CLE
	Instrument ID: I14									
Total/NA	Prep	7470A			50 mL	50 mL	636040	11/20/24 14:00	S4FJ	EET CLE
Total/NA	Analysis	EPA 7470A		1			636245	11/21/24 12:22	TQ6W	EET CLE
	Instrument ID: H11									
Total/NA	Analysis	EPA 9040C		1			485167	11/23/24 09:44	BAB	EET PIT
	Instrument ID: NOEQUIP									
Total/NA	Analysis	SM 2540C		1	100 mL	100 mL	484659	11/18/24 11:34	EBA	EET PIT
	Instrument ID: NOEQUIP									
Total/NA	Prep	PrecSep-21			741.62 mL	1.0 g	690430	11/25/24 09:43	BCE	EET SL
Total/NA	Analysis	9315		1			694358	12/18/24 18:09	SCB	EET SL
	Instrument ID: GFPCPURPLE									
Total/NA	Prep	PrecSep_0			741.62 mL	1.0 g	690431	11/25/24 09:46	BCE	EET SL
Total/NA	Analysis	9320		1			693477	12/13/24 11:28	FLC	EET SL
	Instrument ID: GFPCRED									
Total/NA	Analysis	Ra226_Ra228		1			695373	12/26/24 09:30	FLC	EET SL
	Instrument ID: NOEQUIP									

Client Sample ID: DUP-1
Lab Sample ID: 180-182961-8
Date Collected: 11/14/24 00:00
Matrix: Water
Date Received: 11/16/24 09:30

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	EPA 9056A		1	1 mL	1 mL	484985	11/21/24 18:54	SJM	EET PIT
	Instrument ID: CHICS2100B									
Total/NA	Analysis	EPA 9056A		5	1 mL	1 mL	484985	11/21/24 19:09	SJM	EET PIT
	Instrument ID: CHICS2100B									

Lab Chronicle

Client: Haley & Aldrich, Inc.
Project/Site: CCR Groundwater Monitoring FB Culley East

Job ID: 180-182961-1
SDG: FB Culley East

Client Sample ID: DUP-1

Lab Sample ID: 180-182961-8

Date Collected: 11/14/24 00:00

Matrix: Water

Date Received: 11/16/24 09:30

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total Recoverable	Prep	3005A			50 mL	50 mL	636038	11/20/24 14:00	S4FJ	EET CLE
Total Recoverable	Analysis	EPA 6010D		1			636493	11/22/24 22:13	KLC	EET CLE
	Instrument ID: I12									
Total Recoverable	Prep	3005A			50 mL	50 mL	636038	11/20/24 14:00	S4FJ	EET CLE
Total Recoverable	Analysis	EPA 6020B		1			636305	11/21/24 20:17	AJC	EET CLE
	Instrument ID: I14									
Total Recoverable	Prep	3005A			50 mL	50 mL	636038	11/20/24 14:00	S4FJ	EET CLE
Total Recoverable	Analysis	EPA 6020B		1			636748	11/26/24 03:05	AJC	EET CLE
	Instrument ID: I14									
Total/NA	Prep	7470A			50 mL	50 mL	636040	11/20/24 14:00	S4FJ	EET CLE
Total/NA	Analysis	EPA 7470A		1			636245	11/21/24 12:23	TQ6W	EET CLE
	Instrument ID: H11									
Total/NA	Analysis	EPA 9040C		1			485028	11/21/24 14:19	BAB	EET PIT
	Instrument ID: OZ									
Total/NA	Analysis	SM 2540C		1	100 mL	100 mL	484645	11/18/24 10:34	EBA	EET PIT
	Instrument ID: NOEQUIP									
Total/NA	Prep	PrecSep-21			985.52 mL	1.0 g	690430	11/25/24 09:43	BCE	EET SL
Total/NA	Analysis	9315		1			694358	12/18/24 18:10	SCB	EET SL
	Instrument ID: GFPCPURPLE									
Total/NA	Prep	PrecSep_0			985.52 mL	1.0 g	690431	11/25/24 09:46	BCE	EET SL
Total/NA	Analysis	9320		1			693477	12/13/24 11:28	FLC	EET SL
	Instrument ID: GFPCRED									
Total/NA	Analysis	Ra226_Ra228		1			695373	12/26/24 09:30	FLC	EET SL
	Instrument ID: NOEQUIP									

Client Sample ID: FIELD BLANK 1

Lab Sample ID: 180-182961-9

Date Collected: 11/15/24 11:55

Matrix: Water

Date Received: 11/16/24 09:30

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	EPA 9056A		1	1 mL	1 mL	484985	11/21/24 19:27	SJM	EET PIT
	Instrument ID: CHICS2100B									
Total Recoverable	Prep	3005A			50 mL	50 mL	636038	11/20/24 14:00	S4FJ	EET CLE
Total Recoverable	Analysis	EPA 6010D		1			636493	11/22/24 22:18	KLC	EET CLE
	Instrument ID: I12									
Total Recoverable	Prep	3005A			50 mL	50 mL	636038	11/20/24 14:00	S4FJ	EET CLE
Total Recoverable	Analysis	EPA 6020B		1			636305	11/21/24 20:20	AJC	EET CLE
	Instrument ID: I14									
Total Recoverable	Prep	3005A			50 mL	50 mL	636038	11/20/24 14:00	S4FJ	EET CLE
Total Recoverable	Analysis	EPA 6020B		1			636748	11/26/24 03:08	AJC	EET CLE
	Instrument ID: I14									
Total/NA	Prep	7470A			50 mL	50 mL	636040	11/20/24 14:00	S4FJ	EET CLE
Total/NA	Analysis	EPA 7470A		1			636245	11/21/24 12:25	TQ6W	EET CLE
	Instrument ID: H11									

Lab Chronicle

Client: Haley & Aldrich, Inc.
Project/Site: CCR Groundwater Monitoring FB Culley East

Job ID: 180-182961-1
SDG: FB Culley East

Client Sample ID: FIELD BLANK 1

Date Collected: 11/15/24 11:55
Date Received: 11/16/24 09:30

Lab Sample ID: 180-182961-9

Matrix: Water

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	EPA 9040C		1			485167	11/23/24 09:44	BAB	EET PIT
Total/NA	Analysis	SM 2540C		1	100 mL	100 mL	484667	11/18/24 11:43	EBA	EET PIT
	Instrument ID: NOEQUIP									
Total/NA	Prep	PrecSep-21			996.81 mL	1.0 g	690430	11/25/24 09:43	BCE	EET SL
Total/NA	Analysis	9315		1			694324	12/18/24 18:12	SCB	EET SL
	Instrument ID: GFPCRED									
Total/NA	Prep	PrecSep_0			996.81 mL	1.0 g	690431	11/25/24 09:46	BCE	EET SL
Total/NA	Analysis	9320		1			693477	12/13/24 11:29	FLC	EET SL
	Instrument ID: GFPCRED									
Total/NA	Analysis	Ra226_Ra228		1			695373	12/26/24 18:01	FLC	EET SL
	Instrument ID: NOEQUIP									

Laboratory References:

EET SL = Eurofins St. Louis, 13715 Rider Trail North, Earth City, MO 63045, TEL (314)298-8566

Analyst References:

Lab: EET CLE
- Batch Type: Prep
  - S4FJ = Katherine Wise
- Batch Type: Analysis
  - AJC = Alexander Colosi
  - KLC = Karen Counts
  - RKT = Roger Toth
  - TQ6W = Bryan Pere ka

Lab: EET PIT
- Batch Type: Analysis
  - BAB = Brooke Batyi
  - EBA = Elizabeth Arbster
  - SJM = Shannon Mueller

Lab: EET SL
- Batch Type: Prep
  - BCE = Benjamin Celeslie
- Batch Type: Analysis
  - FLC = Fernando Cruz
  - SCB = Sarah Bernsen

Client Sample ID: CCR-AP-1R
Lab Sample ID: 180-182961-1

Date Collected: 11/14/24 06:45
Matrix: Water
Date Received: 11/16/24 09:30

Method: SW846 EPA 9056A - Anions, Ion Chromatography

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Chloride	28		1.0	0.71	mg/L			11/21/24 15:21	1
Fluoride	0.40		0.10	0.026	mg/L			11/21/24 15:21	1
Sulfate	160		1.0	0.76	mg/L			11/21/24 15:21	1

Method: SW846 EPA 6010D - Metals (ICP) - Total Recoverable

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Boron	0.79		0.10	0.057	mg/L		11/20/24 14:00	11/22/24 21:35	1

Method: SW846 EPA 6020B - Metals (ICP/MS) - Total Recoverable

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Antimony	0.0010	J	0.0020	0.00057	mg/L		11/20/24 14:00	11/21/24 19:52	1
Arsenic	0.011		0.0050	0.00075	mg/L		11/20/24 14:00	11/21/24 19:52	1
Barium	0.20		0.0050	0.00077	mg/L		11/20/24 14:00	11/21/24 19:52	1
Beryllium	0.0015		0.0010	0.00027	mg/L		11/20/24 14:00	11/21/24 19:52	1
Cadmium	0.00034	J	0.0010	0.000077	mg/L		11/20/24 14:00	11/21/24 19:52	1
Calcium	55		1.0	0.25	mg/L		11/20/24 14:00	11/21/24 19:52	1
Chromium	0.034		0.0050	0.0012	mg/L		11/20/24 14:00	11/21/24 19:52	1
Cobalt	0.018		0.0010	0.000086	mg/L		11/20/24 14:00	11/21/24 19:52	1
Lead	0.018		0.0010	0.00045	mg/L		11/20/24 14:00	11/21/24 19:52	1
Lithium	0.067		0.0080	0.0034	mg/L		11/20/24 14:00	11/21/24 19:52	1
Molybdenum	0.0056		0.0050	0.0011	mg/L		11/20/24 14:00	11/21/24 19:52	1
Selenium	0.0013	J	0.0050	0.00089	mg/L		11/20/24 14:00	11/21/24 19:52	1
Thallium	0.00092	J *+	0.0010	0.00051	mg/L		11/20/24 14:00	11/21/24 19:52	1

Method: SW846 EPA 7470A - Mercury (CVAA)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	ND		0.00020	0.00013	mg/L		11/20/24 14:00	11/21/24 12:08	1

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Dissolved Solids (SM 2540C)	700		20	20	mg/L			11/18/24 11:43	1

Analyte	Result	Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
pH (SW846 EPA 9040C)	7.4	HF	0.1	0.1	SU			11/23/24 09:44	1

Method: SW846 9315 - Radium-226 (GFPC)

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Radium-226	1.10		0.384	0.397	1.00	0.417	pCi/L	11/22/24 09:22	12/16/24 20:57	1

Carrier	*%Yield*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Ba Carrier	*60.2*		*30 - 110*	*11/22/24 09:22*	*12/16/24 20:57*	*1*

Method: SW846 9320 - Radium-228 (GFPC)

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Radium-228	2.28	U G	1.74	1.75	1.00	2.68	pCi/L	11/22/24 12:14	12/11/24 12:45	1

Carrier	*%Yield*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Ba Carrier	*60.2*		*30 - 110*	*11/22/24 12:14*	*12/11/24 12:45*	*1*

Client Sample ID: CCR-AP-1R
Lab Sample ID: 180-182961-1

Date Collected: 11/14/24 06:45
Matrix: Water
Date Received: 11/16/24 09:30

Method: SW846 9320 - Radium-228 (GFPC) (Continued)

Carrier	*%Yield*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Y Carrier	*60.9*		*30 - 110*	*11/22/24 12:14*	*12/11/24 12:45*	*1*

Method: TAL-STL Ra226_Ra228 - Combined Radium-226 and Radium-228

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Combined Radium 226 + 228	**3.38**		1.78	1.79	5.00	2.68	pCi/L		12/26/24 09:30	1

Client Sample ID: CCR-AP-2

Date Collected: 11/14/24 08:05
Date Received: 11/16/24 09:30

Lab Sample ID: 180-182961-2

Matrix: Water

Method: SW846 EPA 9056A - Anions, Ion Chromatography

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Chloride	**190**		1.0	0.71	mg/L			11/21/24 15:51	1
Fluoride	**0.24**		0.10	0.026	mg/L			11/21/24 15:51	1
Sulfate	**420**		10	7.6	mg/L			11/21/24 16:06	10

Method: SW846 EPA 6010D - Metals (ICP) - Total Recoverable

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Boron	**9.2**		0.10	0.057	mg/L		11/20/24 14:00	11/22/24 21:39	1

Method: SW846 EPA 6020B - Metals (ICP/MS) - Total Recoverable

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Antimony	ND		0.0020	0.00057	mg/L		11/20/24 14:00	11/21/24 19:55	1
Arsenic	**0.0021**	**J**	0.0050	0.00075	mg/L		11/20/24 14:00	11/21/24 19:55	1
Barium	**0.045**		0.0050	0.00077	mg/L		11/20/24 14:00	11/21/24 19:55	1
Beryllium	ND		0.0010	0.00027	mg/L		11/20/24 14:00	11/21/24 19:55	1
Cadmium	**0.00011**	**J**	0.0010	0.000077	mg/L		11/20/24 14:00	11/21/24 19:55	1
Calcium	**230**		1.0	0.25	mg/L		11/20/24 14:00	11/21/24 19:55	1
Chromium	**0.0024**	**J**	0.0050	0.0012	mg/L		11/20/24 14:00	11/21/24 19:55	1
Cobalt	**0.0080**		0.0010	0.000086	mg/L		11/20/24 14:00	11/21/24 19:55	1
Lead	**0.0013**		0.0010	0.00045	mg/L		11/20/24 14:00	11/21/24 19:55	1
Lithium	**0.0038**	**J**	0.0080	0.0034	mg/L		11/20/24 14:00	11/21/24 19:55	1
Molybdenum	ND		0.0050	0.0011	mg/L		11/20/24 14:00	11/21/24 19:55	1
Selenium	ND		0.0050	0.00089	mg/L		11/20/24 14:00	11/21/24 19:55	1
Thallium	ND	*+	0.0010	0.00051	mg/L		11/20/24 14:00	11/21/24 19:55	1

Method: SW846 EPA 7470A - Mercury (CVAA)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	ND		0.00020	0.00013	mg/L		11/20/24 14:00	11/21/24 12:10	1

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Dissolved Solids (SM 2540C)	**1500**		10	10	mg/L			11/18/24 11:34	1

Analyte	Result	Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
pH (SW846 EPA 9040C)	**6.8**	**HF**	0.1	0.1	SU			11/23/24 09:44	1

Method: SW846 9315 - Radium-226 (GFPC)

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Radium-226	0.401	U	0.304	0.306	1.00	0.450	pCi/L	11/22/24 09:22	12/16/24 20:57	1

Carrier	*%Yield*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Ba Carrier	*55.6*		*30 - 110*	*11/22/24 09:22*	*12/16/24 20:57*	*1*

Method: SW846 9320 - Radium-228 (GFPC)

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Radium-228	1.42	U G	1.50	1.51	1.00	2.44	pCi/L	11/22/24 12:14	12/11/24 12:45	1

Carrier	*%Yield*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Ba Carrier	*55.6*		*30 - 110*	*11/22/24 12:14*	*12/11/24 12:45*	*1*

Client Sample ID: CCR-AP-2
Date Collected: 11/14/24 08:05
Date Received: 11/16/24 09:30

Lab Sample ID: 180-182961-2
Matrix: Water

Method: SW846 9320 - Radium-228 (GFPC) (Continued)

Carrier	*%Yield*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Y Carrier	*66.9*		*30 - 110*	*11/22/24 12:14*	*12/11/24 12:45*	*1*

Method: TAL-STL Ra226_Ra228 - Combined Radium-226 and Radium-228

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Combined Radium 226 + 228	1.82	U	1.53	1.54	5.00	2.44	pCi/L		12/26/24 09:30	1

Client Sample ID: CCR-AP-4

Date Collected: 11/14/24 13:20
Date Received: 11/16/24 09:30

Lab Sample ID: 180-182961-3

Matrix: Water

Method: SW846 EPA 9056A - Anions, Ion Chromatography

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Chloride	26		1.0	0.71	mg/L			11/21/24 16:23	1
Fluoride	0.89		0.10	0.026	mg/L			11/21/24 16:23	1
Sulfate	12		1.0	0.76	mg/L			11/21/24 16:23	1

Method: SW846 EPA 6010D - Metals (ICP) - Total Recoverable

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Boron	0.58		0.10	0.057	mg/L		11/20/24 14:00	11/22/24 21:43	1

Method: SW846 EPA 6020B - Metals (ICP/MS) - Total Recoverable

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Antimony	0.00096	J	0.0020	0.00057	mg/L		11/20/24 14:00	11/21/24 20:03	1
Arsenic	0.089		0.0050	0.00075	mg/L		11/20/24 14:00	11/21/24 20:03	1
Barium	0.52		0.0050	0.00077	mg/L		11/20/24 14:00	11/26/24 02:46	1
Beryllium	0.00099	J	0.0010	0.00027	mg/L		11/20/24 14:00	11/21/24 20:03	1
Cadmium	0.00045	J	0.0010	0.000077	mg/L		11/20/24 14:00	11/21/24 20:03	1
Calcium	140		1.0	0.25	mg/L		11/20/24 14:00	11/21/24 20:03	1
Chromium	0.027		0.0050	0.0012	mg/L		11/20/24 14:00	11/21/24 20:03	1
Cobalt	0.014		0.0010	0.000086	mg/L		11/20/24 14:00	11/21/24 20:03	1
Lead	0.019		0.0010	0.00045	mg/L		11/20/24 14:00	11/21/24 20:03	1
Lithium	0.020		0.0080	0.0034	mg/L		11/20/24 14:00	11/21/24 20:03	1
Molybdenum	0.0073		0.0050	0.0011	mg/L		11/20/24 14:00	11/21/24 20:03	1
Selenium	0.0018	J	0.0050	0.00089	mg/L		11/20/24 14:00	11/21/24 20:03	1
Thallium	ND	*+	0.0010	0.00051	mg/L		11/20/24 14:00	11/21/24 20:03	1

Method: SW846 EPA 7470A - Mercury (CVAA)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	ND		0.00020	0.00013	mg/L		11/20/24 14:00	11/21/24 12:11	1

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Dissolved Solids (SM 2540C)	740		20	20	mg/L			11/18/24 11:43	1

Analyte	Result	Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
pH (SW846 EPA 9040C)	6.9	HF	0.1	0.1	SU			11/23/24 09:44	1

Method: SW846 9315 - Radium-226 (GFPC)

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Radium-226	0.852		0.371	0.379	1.00	0.441	pCi/L	11/22/24 09:22	12/16/24 20:58	1

Carrier	*%Yield*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Ba Carrier	*57.6*		*30 - 110*	*11/22/24 09:22*	*12/16/24 20:58*	*1*

Method: SW846 9320 - Radium-228 (GFPC)

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Radium-228	0.598	U G	1.24	1.24	1.00	2.17	pCi/L	11/22/24 12:14	12/11/24 12:45	1

Carrier	*%Yield*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Ba Carrier	*57.6*		*30 - 110*	*11/22/24 12:14*	*12/11/24 12:45*	*1*

Client Sample ID: CCR-AP-4
Lab Sample ID: 180-182961-3

Date Collected: 11/14/24 13:20
Matrix: Water
Date Received: 11/16/24 09:30

Method: SW846 9320 - Radium-228 (GFPC) (Continued)

Carrier	*%Yield*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Y Carrier	*69.9*		*30 - 110*	*11/22/24 12:14*	*12/11/24 12:45*	*1*

Method: TAL-STL Ra226_Ra228 - Combined Radium-226 and Radium-228

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Combined Radium 226 + 228	1.45	U	1.29	1.30	5.00	2.17	pCi/L		12/26/24 09:30	1

Client Sample ID: CCR-AP-5

Date Collected: 11/14/24 15:45
Date Received: 11/16/24 09:30

Lab Sample ID: 180-182961-4

Matrix: Water

Method: SW846 EPA 9056A - Anions, Ion Chromatography

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Chloride	**51**		1.0	0.71	mg/L			11/21/24 16:53	1
Fluoride	**1.7**		0.10	0.026	mg/L			11/21/24 16:53	1
Sulfate	**450**		5.0	3.8	mg/L			11/21/24 17:07	5

Method: SW846 EPA 6010D - Metals (ICP) - Total Recoverable

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Boron	**11**		0.50	0.29	mg/L		11/20/24 14:00	11/26/24 05:36	5

Method: SW846 EPA 6020B - Metals (ICP/MS) - Total Recoverable

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Antimony	ND		0.0020	0.00057	mg/L		11/20/24 14:00	11/21/24 20:06	1
Arsenic	**0.0013**	**J**	0.0050	0.00075	mg/L		11/20/24 14:00	11/21/24 20:06	1
Barium	**0.053**		0.0050	0.00077	mg/L		11/20/24 14:00	11/26/24 02:49	1
Beryllium	ND		0.0010	0.00027	mg/L		11/20/24 14:00	11/21/24 20:06	1
Cadmium	**0.00010**	**J**	0.0010	0.000077	mg/L		11/20/24 14:00	11/21/24 20:06	1
Calcium	**200**		1.0	0.25	mg/L		11/20/24 14:00	11/21/24 20:06	1
Chromium	ND		0.0050	0.0012	mg/L		11/20/24 14:00	11/21/24 20:06	1
Cobalt	**0.0023**		0.0010	0.000086	mg/L		11/20/24 14:00	11/21/24 20:06	1
Lead	ND		0.0010	0.00045	mg/L		11/20/24 14:00	11/21/24 20:06	1
Lithium	**0.080**		0.0080	0.0034	mg/L		11/20/24 14:00	11/21/24 20:06	1
Molybdenum	**0.34**		0.0050	0.0011	mg/L		11/20/24 14:00	11/21/24 20:06	1
Selenium	ND		0.0050	0.00089	mg/L		11/20/24 14:00	11/21/24 20:06	1
Thallium	ND	*+	0.0010	0.00051	mg/L		11/20/24 14:00	11/21/24 20:06	1

Method: SW846 EPA 7470A - Mercury (CVAA)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	ND		0.00020	0.00013	mg/L		11/20/24 14:00	11/21/24 12:13	1

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Dissolved Solids (SM 2540C)	**1200**		10	10	mg/L			11/19/24 09:41	1

Analyte	Result	Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
pH (SW846 EPA 9040C)	**7.7**	**HF**	0.1	0.1	SU			11/21/24 14:10	1

Method: SW846 9315 - Radium-226 (GFPC)

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Radium-226	**0.158**		0.102	0.103	1.00	0.136	pCi/L	11/25/24 09:43	12/18/24 18:10	1

Carrier	*%Yield*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Ba Carrier	*82.7*		*30 - 110*	*11/25/24 09:43*	*12/18/24 18:10*	*1*

Method: SW846 9320 - Radium-228 (GFPC)

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Radium-228	-0.153	U	0.355	0.355	1.00	0.701	pCi/L	11/25/24 09:46	12/13/24 11:28	1

Carrier	*%Yield*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Ba Carrier	*82.7*		*30 - 110*	*11/25/24 09:46*	*12/13/24 11:28*	*1*

Client Sample ID: CCR-AP-5
Lab Sample ID: 180-182961-4

Date Collected: 11/14/24 15:45
Matrix: Water
Date Received: 11/16/24 09:30

Method: SW846 9320 - Radium-228 (GFPC) (Continued)

Carrier	*%Yield*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Y Carrier	*74.4*		*30 - 110*	*11/25/24 09:46*	*12/13/24 11:28*	*1*

Method: TAL-STL Ra226_Ra228 - Combined Radium-226 and Radium-228

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Combined Radium 226 + 228	0.00506	U	0.369	0.370	5.00	0.701	pCi/L		12/26/24 09:30	1

Client Sample ID: CCR-AP-6I

Date Collected: 11/13/24 08:41
Date Received: 11/16/24 09:30

Lab Sample ID: 180-182961-5

Matrix: Water

Method: SW846 EPA 9056A - Anions, Ion Chromatography

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Chloride	**31**		1.0	0.71	mg/L			11/21/24 17:25	1
Fluoride	**0.20**		0.10	0.026	mg/L			11/21/24 17:25	1
Sulfate	**140**		1.0	0.76	mg/L			11/21/24 17:25	1

Method: SW846 EPA 6010D - Metals (ICP) - Total Recoverable

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Boron	**0.14**		0.10	0.057	mg/L		11/20/24 14:00	11/22/24 21:52	1

Method: SW846 EPA 6020B - Metals (ICP/MS) - Total Recoverable

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Antimony	ND		0.0020	0.00057	mg/L		11/20/24 14:00	11/21/24 20:09	1
Arsenic	ND		0.0050	0.00075	mg/L		11/20/24 14:00	11/21/24 20:09	1
Barium	**0.21**		0.0050	0.00077	mg/L		11/20/24 14:00	11/26/24 02:57	1
Beryllium	ND		0.0010	0.00027	mg/L		11/20/24 14:00	11/21/24 20:09	1
Cadmium	ND		0.0010	0.000077	mg/L		11/20/24 14:00	11/21/24 20:09	1
Calcium	**46**		1.0	0.25	mg/L		11/20/24 14:00	11/21/24 20:09	1
Chromium	ND		0.0050	0.0012	mg/L		11/20/24 14:00	11/21/24 20:09	1
Cobalt	**0.00085**	**J**	0.0010	0.000086	mg/L		11/20/24 14:00	11/21/24 20:09	1
Lead	ND		0.0010	0.00045	mg/L		11/20/24 14:00	11/21/24 20:09	1
Lithium	**0.0049**	**J**	0.0080	0.0034	mg/L		11/20/24 14:00	11/21/24 20:09	1
Molybdenum	**0.020**		0.0050	0.0011	mg/L		11/20/24 14:00	11/21/24 20:09	1
Selenium	ND		0.0050	0.00089	mg/L		11/20/24 14:00	11/21/24 20:09	1
Thallium	ND	*+	0.0010	0.00051	mg/L		11/20/24 14:00	11/21/24 20:09	1

Method: SW846 EPA 7470A - Mercury (CVAA)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	ND		0.00020	0.00013	mg/L		11/20/24 14:00	11/21/24 12:15	1

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Dissolved Solids (SM 2540C)	**350**		10	10	mg/L			11/18/24 11:43	1

Analyte	Result	Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
pH (SW846 EPA 9040C)	**7.6**	**HF**	0.1	0.1	SU			11/21/24 14:05	1

Method: SW846 9315 - Radium-226 (GFPC)

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Radium-226	0.0927	U	0.105	0.106	1.00	0.171	pCi/L	11/25/24 09:43	12/18/24 18:10	1

Carrier	*%Yield*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Ba Carrier	*76.6*		*30 - 110*	*11/25/24 09:43*	*12/18/24 18:10*	*1*

Method: SW846 9320 - Radium-228 (GFPC)

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Radium-228	**0.844**		0.458	0.465	1.00	0.637	pCi/L	11/25/24 09:46	12/13/24 11:28	1

Carrier	*%Yield*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Ba Carrier	*76.6*		*30 - 110*	*11/25/24 09:46*	*12/13/24 11:28*	*1*

Client Sample ID: CCR-AP-6I
Lab Sample ID: 180-182961-5

Date Collected: 11/13/24 08:41
Matrix: Water
Date Received: 11/16/24 09:30

Method: SW846 9320 - Radium-228 (GFPC) (Continued)

Carrier	*%Yield*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Y Carrier	*76.3*		*30 - 110*	*11/25/24 09:46*	*12/13/24 11:28*	*1*

Method: TAL-STL Ra226_Ra228 - Combined Radium-226 and Radium-228

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Combined Radium 226 + 228	**0.937**		0.470	0.477	5.00	0.637	pCi/L		12/26/24 09:30	1

Client Sample ID: CCR-AP-9

Date Collected: 11/14/24 10:50
Date Received: 11/16/24 09:30

Lab Sample ID: 180-182961-6

Matrix: Water

Method: SW846 EPA 9056A - Anions, Ion Chromatography

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Chloride	2.5		2.5	1.8	mg/L			11/21/24 18:10	2.5
Fluoride	0.15	J	0.25	0.065	mg/L			11/21/24 18:10	2.5
Sulfate	ND		2.5	1.9	mg/L			11/21/24 18:10	2.5

Method: SW846 EPA 6010D - Metals (ICP) - Total Recoverable

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Boron	0.41		0.10	0.057	mg/L		11/20/24 14:00	11/22/24 21:56	1

Method: SW846 EPA 6020B - Metals (ICP/MS) - Total Recoverable

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Antimony	ND		0.0020	0.00057	mg/L		11/20/24 14:00	11/21/24 20:12	1
Arsenic	0.0022	J	0.0050	0.00075	mg/L		11/20/24 14:00	11/21/24 20:12	1
Barium	0.16		0.0050	0.00077	mg/L		11/20/24 14:00	11/26/24 02:59	1
Beryllium	ND		0.0010	0.00027	mg/L		11/20/24 14:00	11/21/24 20:12	1
Cadmium	0.000077	J	0.0010	0.000077	mg/L		11/20/24 14:00	11/21/24 20:12	1
Calcium	120		1.0	0.25	mg/L		11/20/24 14:00	11/21/24 20:12	1
Chromium	0.0065		0.0050	0.0012	mg/L		11/20/24 14:00	11/21/24 20:12	1
Cobalt	0.0025		0.0010	0.000086	mg/L		11/20/24 14:00	11/21/24 20:12	1
Lead	0.0024		0.0010	0.00045	mg/L		11/20/24 14:00	11/21/24 20:12	1
Lithium	0.035		0.0080	0.0034	mg/L		11/20/24 14:00	11/21/24 20:12	1
Molybdenum	0.0017	J	0.0050	0.0011	mg/L		11/20/24 14:00	11/21/24 20:12	1
Selenium	ND		0.0050	0.00089	mg/L		11/20/24 14:00	11/21/24 20:12	1
Thallium	ND	*+	0.0010	0.00051	mg/L		11/20/24 14:00	11/21/24 20:12	1

Method: SW846 EPA 7470A - Mercury (CVAA)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	ND		0.00020	0.00013	mg/L		11/20/24 14:00	11/21/24 12:20	1

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Dissolved Solids (SM 2540C)	710		20	20	mg/L			11/18/24 11:43	1

Analyte	Result	Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
pH (SW846 EPA 9040C)	7.2	HF	0.1	0.1	SU			11/23/24 09:44	1

Method: SW846 9315 - Radium-226 (GFPC)

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Radium-226	2.63		0.589	0.635	1.00	0.522	pCi/L	11/25/24 09:43	12/18/24 18:10	1

Carrier	*%Yield*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Ba Carrier	*55.6*		*30 - 110*	*11/25/24 09:43*	*12/18/24 18:10*	*1*

Method: SW846 9320 - Radium-228 (GFPC)

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Radium-228	3.70	G	1.51	1.55	1.00	2.00	pCi/L	11/25/24 09:46	12/13/24 11:28	1

Carrier	*%Yield*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Ba Carrier	*55.6*		*30 - 110*	*11/25/24 09:46*	*12/13/24 11:28*	*1*

Client Sample ID: CCR-AP-9
Lab Sample ID: 180-182961-6

Date Collected: 11/14/24 10:50
Matrix: Water
Date Received: 11/16/24 09:30

Method: SW846 9320 - Radium-228 (GFPC) (Continued)

Carrier	*%Yield*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Y Carrier	*75.1*		*30 - 110*	*11/25/24 09:46*	*12/13/24 11:28*	*1*

Method: TAL-STL Ra226_Ra228 - Combined Radium-226 and Radium-228

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Combined Radium 226 + 228	**6.33**		1.62	1.68	5.00	2.00	pCi/L		12/26/24 09:30	1

Client Sample ID: CCR-AP-11

Date Collected: 11/15/24 08:58
Date Received: 11/16/24 09:30

Lab Sample ID: 180-182961-7

Matrix: Water

Method: SW846 EPA 9056A - Anions, Ion Chromatography

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Chloride	**29**		1.0	0.71	mg/L			11/21/24 18:24	1
Fluoride	**0.34**		0.10	0.026	mg/L			11/21/24 18:24	1
Sulfate	**610**		5.0	3.8	mg/L			11/21/24 18:39	5

Method: SW846 EPA 6010D - Metals (ICP) - Total Recoverable

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Boron	**0.45**		0.10	0.057	mg/L		11/20/24 14:00	11/22/24 22:01	1

Method: SW846 EPA 6020B - Metals (ICP/MS) - Total Recoverable

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Antimony	ND		0.0020	0.00057	mg/L		11/20/24 14:00	11/21/24 20:15	1
Arsenic	**0.051**		0.0050	0.00075	mg/L		11/20/24 14:00	11/21/24 20:15	1
Barium	**0.23**		0.0050	0.00077	mg/L		11/20/24 14:00	11/26/24 03:02	1
Beryllium	ND		0.0010	0.00027	mg/L		11/20/24 14:00	11/21/24 20:15	1
Cadmium	ND		0.0010	0.000077	mg/L		11/20/24 14:00	11/21/24 20:15	1
Calcium	**140**		1.0	0.25	mg/L		11/20/24 14:00	11/21/24 20:15	1
Chromium	**0.0021**	**J**	0.0050	0.0012	mg/L		11/20/24 14:00	11/21/24 20:15	1
Cobalt	**0.065**		0.0010	0.000086	mg/L		11/20/24 14:00	11/21/24 20:15	1
Lead	**0.00051**	**J**	0.0010	0.00045	mg/L		11/20/24 14:00	11/21/24 20:15	1
Lithium	**0.0043**	**J**	0.0080	0.0034	mg/L		11/20/24 14:00	11/21/24 20:15	1
Molybdenum	ND		0.0050	0.0011	mg/L		11/20/24 14:00	11/21/24 20:15	1
Selenium	ND		0.0050	0.00089	mg/L		11/20/24 14:00	11/21/24 20:15	1
Thallium	ND	*+	0.0010	0.00051	mg/L		11/20/24 14:00	11/21/24 20:15	1

Method: SW846 EPA 7470A - Mercury (CVAA)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	ND		0.00020	0.00013	mg/L		11/20/24 14:00	11/21/24 12:22	1

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Dissolved Solids (SM 2540C)	**1200**		10	10	mg/L			11/18/24 11:34	1

Analyte	Result	Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
pH (SW846 EPA 9040C)	**6.2**	**HF**	0.1	0.1	SU			11/23/24 09:44	1

Method: SW846 9315 - Radium-226 (GFPC)

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Radium-226	**0.243**		0.161	0.163	1.00	0.229	pCi/L	11/25/24 09:43	12/18/24 18:09	1

Carrier	*%Yield*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Ba Carrier	*78.7*		*30 - 110*	*11/25/24 09:43*	*12/18/24 18:09*	*1*

Method: SW846 9320 - Radium-228 (GFPC)

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Radium-228	0.965	U	0.650	0.656	1.00	0.980	pCi/L	11/25/24 09:46	12/13/24 11:28	1

Carrier	*%Yield*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Ba Carrier	*78.7*		*30 - 110*	*11/25/24 09:46*	*12/13/24 11:28*	*1*

Client Sample ID: CCR-AP-11
Lab Sample ID: 180-182961-7

Date Collected: 11/15/24 08:58
Matrix: Water
Date Received: 11/16/24 09:30

Method: SW846 9320 - Radium-228 (GFPC) (Continued)

Carrier	%Yield	Qualifier	Limits	Prepared	Analyzed	Dil Fac
Y Carrier	77.4		30 - 110	11/25/24 09:46	12/13/24 11:28	1

Method: TAL-STL Ra226_Ra228 - Combined Radium-226 and Radium-228

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Combined Radium 226 + 228	1.21		0.670	0.676	5.00	0.980	pCi/L		12/26/24 09:30	1

Client Sample ID: DUP-1

Date Collected: 11/14/24 00:00
Date Received: 11/16/24 09:30

Lab Sample ID: 180-182961-8

Matrix: Water

Method: SW846 EPA 9056A - Anions, Ion Chromatography

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Chloride	54		1.0	0.71	mg/L			11/21/24 18:54	1
Fluoride	1.8		0.10	0.026	mg/L			11/21/24 18:54	1
Sulfate	450		5.0	3.8	mg/L			11/21/24 19:09	5

Method: SW846 EPA 6010D - Metals (ICP) - Total Recoverable

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Boron	12		0.10	0.057	mg/L		11/20/24 14:00	11/22/24 22:13	1

Method: SW846 EPA 6020B - Metals (ICP/MS) - Total Recoverable

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Antimony	ND		0.0020	0.00057	mg/L		11/20/24 14:00	11/21/24 20:17	1
Arsenic	0.0015	J	0.0050	0.00075	mg/L		11/20/24 14:00	11/21/24 20:17	1
Barium	0.051		0.0050	0.00077	mg/L		11/20/24 14:00	11/26/24 03:05	1
Beryllium	ND		0.0010	0.00027	mg/L		11/20/24 14:00	11/21/24 20:17	1
Cadmium	0.000088	J	0.0010	0.000077	mg/L		11/20/24 14:00	11/21/24 20:17	1
Calcium	200		1.0	0.25	mg/L		11/20/24 14:00	11/21/24 20:17	1
Chromium	ND		0.0050	0.0012	mg/L		11/20/24 14:00	11/21/24 20:17	1
Cobalt	0.0023		0.0010	0.000086	mg/L		11/20/24 14:00	11/21/24 20:17	1
Lead	ND		0.0010	0.00045	mg/L		11/20/24 14:00	11/21/24 20:17	1
Lithium	0.083		0.0080	0.0034	mg/L		11/20/24 14:00	11/21/24 20:17	1
Molybdenum	0.34		0.0050	0.0011	mg/L		11/20/24 14:00	11/21/24 20:17	1
Selenium	ND		0.0050	0.00089	mg/L		11/20/24 14:00	11/21/24 20:17	1
Thallium	ND	*+	0.0010	0.00051	mg/L		11/20/24 14:00	11/21/24 20:17	1

Method: SW846 EPA 7470A - Mercury (CVAA)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	ND		0.00020	0.00013	mg/L		11/20/24 14:00	11/21/24 12:23	1

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Dissolved Solids (SM 2540C)	1200		10	10	mg/L			11/18/24 10:34	1

Analyte	Result	Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
pH (SW846 EPA 9040C)	7.6	HF	0.1	0.1	SU			11/21/24 14:19	1

Method: SW846 9315 - Radium-226 (GFPC)

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Radium-226	0.212		0.124	0.125	1.00	0.165	pCi/L	11/25/24 09:43	12/18/24 18:10	1

Carrier	*%Yield*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Ba Carrier	*76.9*		*30 - 110*	*11/25/24 09:43*	*12/18/24 18:10*	*1*

Method: SW846 9320 - Radium-228 (GFPC)

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Radium-228	0.460	U	0.451	0.453	1.00	0.725	pCi/L	11/25/24 09:46	12/13/24 11:28	1

Carrier	*%Yield*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Ba Carrier	*76.9*		*30 - 110*	*11/25/24 09:46*	*12/13/24 11:28*	*1*

Client: Haley & Aldrich, Inc.
Project/Site: CCR Groundwater Monitoring FB Culley East

Job ID: 180-182961-1
SDG: FB Culley East

Client Sample ID: DUP-1
Date Collected: 11/14/24 00:00
Date Received: 11/16/24 09:30

Lab Sample ID: 180-182961-8
Matrix: Water

Method: SW846 9320 - Radium-228 (GFPC) (Continued)

Carrier	%Yield	Qualifier	Limits	Prepared	Analyzed	Dil Fac
Y Carrier	*75.9*		*30 - 110*	*11/25/24 09:46*	*12/13/24 11:28*	*1*

Method: TAL-STL Ra226_Ra228 - Combined Radium-226 and Radium-228

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Combined Radium 226 + 228	0.673	U	0.468	0.470	5.00	0.725	pCi/L		12/26/24 09:30	1

Client Sample ID: FIELD BLANK 1

Date Collected: 11/15/24 11:55
Date Received: 11/16/24 09:30

Lab Sample ID: 180-182961-9

Matrix: Water

Method: SW846 EPA 9056A - Anions, Ion Chromatography

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Chloride	ND		1.0	0.71	mg/L			11/21/24 19:27	1
Fluoride	ND		0.10	0.026	mg/L			11/21/24 19:27	1
Sulfate	ND		1.0	0.76	mg/L			11/21/24 19:27	1

Method: SW846 EPA 6010D - Metals (ICP) - Total Recoverable

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Boron	ND		0.10	0.057	mg/L		11/20/24 14:00	11/22/24 22:18	1

Method: SW846 EPA 6020B - Metals (ICP/MS) - Total Recoverable

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Antimony	ND		0.0020	0.00057	mg/L		11/20/24 14:00	11/21/24 20:20	1
Arsenic	ND		0.0050	0.00075	mg/L		11/20/24 14:00	11/21/24 20:20	1
Barium	ND		0.0050	0.00077	mg/L		11/20/24 14:00	11/26/24 03:08	1
Beryllium	ND		0.0010	0.00027	mg/L		11/20/24 14:00	11/21/24 20:20	1
Cadmium	ND		0.0010	0.000077	mg/L		11/20/24 14:00	11/21/24 20:20	1
Calcium	ND		1.0	0.25	mg/L		11/20/24 14:00	11/21/24 20:20	1
Chromium	ND		0.0050	0.0012	mg/L		11/20/24 14:00	11/21/24 20:20	1
Cobalt	ND		0.0010	0.000086	mg/L		11/20/24 14:00	11/21/24 20:20	1
Lead	ND		0.0010	0.00045	mg/L		11/20/24 14:00	11/21/24 20:20	1
Lithium	ND		0.0080	0.0034	mg/L		11/20/24 14:00	11/21/24 20:20	1
Molybdenum	ND		0.0050	0.0011	mg/L		11/20/24 14:00	11/21/24 20:20	1
Selenium	ND		0.0050	0.00089	mg/L		11/20/24 14:00	11/21/24 20:20	1
Thallium	ND	*+	0.0010	0.00051	mg/L		11/20/24 14:00	11/21/24 20:20	1

Method: SW846 EPA 7470A - Mercury (CVAA)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	ND		0.00020	0.00013	mg/L		11/20/24 14:00	11/21/24 12:25	1

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Dissolved Solids (SM 2540C)	ND		10	10	mg/L			11/18/24 11:43	1

Analyte	Result	Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
pH (SW846 EPA 9040C)	**5.6**	**HF**	0.1	0.1	SU			11/23/24 09:44	1

Method: SW846 9315 - Radium-226 (GFPC)

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Radium-226	**0.166**		0.108	0.109	1.00	0.144	pCi/L	11/25/24 09:43	12/18/24 18:12	1

Carrier	*%Yield*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Ba Carrier	*77.2*		*30 - 110*	*11/25/24 09:43*	*12/18/24 18:12*	*1*

Method: SW846 9320 - Radium-228 (GFPC)

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Radium-228	**0.630**		0.396	0.400	1.00	0.573	pCi/L	11/25/24 09:46	12/13/24 11:29	1

Carrier	*%Yield*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Ba Carrier	*77.2*		*30 - 110*	*11/25/24 09:46*	*12/13/24 11:29*	*1*

Client Sample ID: FIELD BLANK 1
Lab Sample ID: 180-182961-9

Date Collected: 11/15/24 11:55
Matrix: Water
Date Received: 11/16/24 09:30

Method: SW846 9320 - Radium-228 (GFPC) (Continued)

Carrier	*%Yield*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Y Carrier	*82.6*		*30 - 110*	*11/25/24 09:46*	*12/13/24 11:29*	*1*

Method: TAL-STL Ra226_Ra228 - Combined Radium-226 and Radium-228

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Combined Radium 226 + 228	**0.796**		0.410	0.415	5.00	0.573	pCi/L		12/26/24 18:01	1

Method: EPA 9056A - Anions, Ion Chromatography

Lab Sample ID: MB 180-484985/6
Matrix: Water
Analysis Batch: 484985

Client Sample ID: Method Blank
Prep Type: Total/NA

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Chloride	ND		1.0	0.71	mg/L			11/21/24 11:58	1
Fluoride	ND		0.10	0.026	mg/L			11/21/24 11:58	1
Sulfate	ND		1.0	0.76	mg/L			11/21/24 11:58	1

Lab Sample ID: LCS 180-484985/7
Matrix: Water
Analysis Batch: 484985

Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec Limits
Chloride	50.0	48.9		mg/L		98	80 - 120
Fluoride	2.50	2.57		mg/L		103	80 - 120
Sulfate	50.0	50.8		mg/L		102	80 - 120

Method: EPA 6010D - Metals (ICP)

Lab Sample ID: MB 240-636038/1-A
Matrix: Water
Analysis Batch: 636493

Client Sample ID: Method Blank
Prep Type: Total Recoverable
Prep Batch: 636038

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Boron	ND		0.10	0.057	mg/L		11/20/24 14:00	11/22/24 20:55	1

Lab Sample ID: LCS 240-636038/2-A
Matrix: Water
Analysis Batch: 636493

Client Sample ID: Lab Control Sample
Prep Type: Total Recoverable
Prep Batch: 636038

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec Limits
Boron	1.00	1.07		mg/L		107	80 - 120

Method: EPA 6020B - Metals (ICP/MS)

Lab Sample ID: MB 240-636038/1-A
Matrix: Water
Analysis Batch: 636305

Client Sample ID: Method Blank
Prep Type: Total Recoverable
Prep Batch: 636038

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Antimony	ND		0.0020	0.00057	mg/L		11/20/24 14:00	11/21/24 19:32	1
Arsenic	ND		0.0050	0.00075	mg/L		11/20/24 14:00	11/21/24 19:32	1
Barium	ND		0.0050	0.00077	mg/L		11/20/24 14:00	11/21/24 19:32	1
Beryllium	ND		0.0010	0.00027	mg/L		11/20/24 14:00	11/21/24 19:32	1
Cadmium	ND		0.0010	0.000077	mg/L		11/20/24 14:00	11/21/24 19:32	1
Calcium	ND		1.0	0.25	mg/L		11/20/24 14:00	11/21/24 19:32	1
Chromium	ND		0.0050	0.0012	mg/L		11/20/24 14:00	11/21/24 19:32	1
Cobalt	ND		0.0010	0.000086	mg/L		11/20/24 14:00	11/21/24 19:32	1
Lead	ND		0.0010	0.00045	mg/L		11/20/24 14:00	11/21/24 19:32	1
Lithium	ND		0.0080	0.0034	mg/L		11/20/24 14:00	11/21/24 19:32	1
Molybdenum	ND		0.0050	0.0011	mg/L		11/20/24 14:00	11/21/24 19:32	1
Selenium	ND		0.0050	0.00089	mg/L		11/20/24 14:00	11/21/24 19:32	1
Thallium	ND		0.0010	0.00051	mg/L		11/20/24 14:00	11/21/24 19:32	1

Method: EPA 6020B - Metals (ICP/MS) (Continued)

Lab Sample ID: MB 240-636038/1-A
Matrix: Water
Analysis Batch: 636748

Client Sample ID: Method Blank
Prep Type: Total Recoverable
Prep Batch: 636038

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Barium	ND		0.0050	0.00077	mg/L		11/20/24 14:00	11/26/24 02:25	1

Lab Sample ID: LCS 240-636038/3-A
Matrix: Water
Analysis Batch: 636305

Client Sample ID: Lab Control Sample
Prep Type: Total Recoverable
Prep Batch: 636038

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec Limits
Antimony	0.100	0.102		mg/L		102	80 - 120
Arsenic	1.00	0.969		mg/L		97	80 - 120
Barium	1.00	0.983		mg/L		98	80 - 120
Beryllium	0.500	0.503		mg/L		101	80 - 120
Cadmium	0.500	0.482		mg/L		96	80 - 120
Calcium	25.0	25.0		mg/L		100	80 - 120
Chromium	0.500	0.497		mg/L		99	80 - 120
Cobalt	0.500	0.505		mg/L		101	80 - 120
Lead	0.500	0.497		mg/L		99	80 - 120
Lithium	0.500	0.509		mg/L		102	80 - 120
Molybdenum	0.500	0.481		mg/L		96	80 - 120
Selenium	1.00	0.966		mg/L		97	80 - 120
Thallium	1.00	1.38	*+	mg/L		138	80 - 120

Lab Sample ID: LCS 240-636038/3-A
Matrix: Water
Analysis Batch: 636748

Client Sample ID: Lab Control Sample
Prep Type: Total Recoverable
Prep Batch: 636038

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec Limits
Barium	1.00	0.996		mg/L		100	80 - 120

Method: EPA 7470A - Mercury (CVAA)

Lab Sample ID: MB 240-636040/1-A
Matrix: Water
Analysis Batch: 636245

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 636040

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	ND		0.00020	0.00013	mg/L		11/20/24 14:00	11/21/24 11:59	1

Lab Sample ID: LCS 240-636040/2-A
Matrix: Water
Analysis Batch: 636245

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 636040

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec Limits
Mercury	0.00500	0.00475		mg/L		95	80 - 120

Method: EPA 9040C - pH

Lab Sample ID: LCS 180-485028/24
Matrix: Water
Analysis Batch: 485028

Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec Limits
pH	7.00	7.0		SU		100	99 - 101

Lab Sample ID: LCS 180-485167/24
Matrix: Water
Analysis Batch: 485167

Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec Limits
pH	7.00	7.0		SU		100	99 - 101

Method: SM 2540C - Solids, Total Dissolved (TDS)

Lab Sample ID: MB 180-484645/2
Matrix: Water
Analysis Batch: 484645

Client Sample ID: Method Blank
Prep Type: Total/NA

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Dissolved Solids	ND		10	10	mg/L			11/18/24 10:34	1

Lab Sample ID: LCS 180-484645/1
Matrix: Water
Analysis Batch: 484645

Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec Limits
Total Dissolved Solids	417	394		mg/L		94	85 - 115

Lab Sample ID: 180-182961-8 DU
Matrix: Water
Analysis Batch: 484645

Client Sample ID: DUP-1
Prep Type: Total/NA

Analyte	Sample Result	Sample Qualifier	DU Result	DU Qualifier	Unit	D	RPD	RPD Limit
Total Dissolved Solids	1200		1180		mg/L		0.2	10

Lab Sample ID: MB 180-484659/1
Matrix: Water
Analysis Batch: 484659

Client Sample ID: Method Blank
Prep Type: Total/NA

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Dissolved Solids	ND		10	10	mg/L			11/18/24 11:34	1

Lab Sample ID: LCS 180-484659/2
Matrix: Water
Analysis Batch: 484659

Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec Limits
Total Dissolved Solids	417	402		mg/L		96	85 - 115

Method: SM 2540C - Solids, Total Dissolved (TDS) (Continued)

Lab Sample ID: MB 180-484667/1
Matrix: Water
Analysis Batch: 484667

Client Sample ID: Method Blank
Prep Type: Total/NA

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Dissolved Solids	ND		10	10	mg/L			11/18/24 11:43	1

Lab Sample ID: LCS 180-484667/2
Matrix: Water
Analysis Batch: 484667

Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec Limits
Total Dissolved Solids	417	386		mg/L		93	85 - 115

Lab Sample ID: 180-182961-9 DU
Matrix: Water
Analysis Batch: 484667

Client Sample ID: FIELD BLANK 1
Prep Type: Total/NA

Analyte	Sample Result	Sample Qualifier	DU Result	DU Qualifier	Unit	D	RPD	RPD Limit
Total Dissolved Solids	ND		ND		mg/L		NC	10

Lab Sample ID: MB 180-484737/1
Matrix: Water
Analysis Batch: 484737

Client Sample ID: Method Blank
Prep Type: Total/NA

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Dissolved Solids	ND		10	10	mg/L			11/19/24 09:41	1

Lab Sample ID: LCS 180-484737/2
Matrix: Water
Analysis Batch: 484737

Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec Limits
Total Dissolved Solids	417	398		mg/L		95	85 - 115

Lab Sample ID: 180-182961-4 DU
Matrix: Water
Analysis Batch: 484737

Client Sample ID: CCR-AP-5
Prep Type: Total/NA

Analyte	Sample Result	Sample Qualifier	DU Result	DU Qualifier	Unit	D	RPD	RPD Limit
Total Dissolved Solids	1200		1220		mg/L		0.2	10

Method: 9315 - Radium-226 (GFPC)

Lab Sample ID: MB 160-689970/1-A
Matrix: Water
Analysis Batch: 693993

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 689970

Analyte	MB Result	MB Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Radium-226	0.02322	U	0.0781	0.0781	1.00	0.146	pCi/L	11/22/24 09:22	12/16/24 18:01	1

Carrier	*MB %Yield*	*MB Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Ba Carrier	*91.4*		*30 - 110*	*11/22/24 09:22*	*12/16/24 18:01*	*1*

Method: 9315 - Radium-226 (GFPC) (Continued)

Lab Sample ID: LCS 160-689970/2-A
Matrix: Water
Analysis Batch: 693993

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 689970

Analyte			Spike Added	LCS Result	LCS Qual	Total Uncert. (2σ+/-)	RL	MDC	Unit	%Rec	%Rec Limits		
Radium-226			9.58	9.841		1.06	1.00	0.138	pCi/L	103	75 - 125		

Carrier	*LCS %Yield*	*LCS Qualifier*	*Limits*
Ba Carrier	*91.1*		*30 - 110*

Lab Sample ID: MB 160-690430/1-A
Matrix: Water
Analysis Batch: 694357

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 690430

Analyte	MB Result	MB Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Radium-226	0.02793	U	0.0747	0.0747	1.00	0.140	pCi/L	11/25/24 09:43	12/18/24 18:09	1

Carrier	*MB %Yield*	*MB Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Ba Carrier	*81.5*		*30 - 110*	*11/25/24 09:43*	*12/18/24 18:09*	*1*

Lab Sample ID: LCS 160-690430/2-A
Matrix: Water
Analysis Batch: 694357

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 690430

Analyte			Spike Added	LCS Result	LCS Qual	Total Uncert. (2σ+/-)	RL	MDC	Unit	%Rec	%Rec Limits		
Radium-226			9.58	9.247		1.02	1.00	0.121	pCi/L	97	75 - 125		

Carrier	*LCS %Yield*	*LCS Qualifier*	*Limits*
Ba Carrier	*87.6*		*30 - 110*

Method: 9320 - Radium-228 (GFPC)

Lab Sample ID: MB 160-689999/1-A
Matrix: Water
Analysis Batch: 693092

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 689999

Analyte	MB Result	MB Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Radium-228	0.2740	U	0.476	0.477	1.00	0.816	pCi/L	11/22/24 12:14	12/11/24 12:43	1

Carrier	*MB %Yield*	*MB Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Ba Carrier	*91.4*		*30 - 110*	*11/22/24 12:14*	*12/11/24 12:43*	*1*
Y Carrier	*65.4*		*30 - 110*	*11/22/24 12:14*	*12/11/24 12:43*	*1*

Method: 9320 - Radium-228 (GFPC) (Continued)

Lab Sample ID: LCS 160-689999/2-A
Matrix: Water
Analysis Batch: 693092

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 689999

Analyte			Spike Added	LCS Result	LCS Qual	Total Uncert. (2σ+/-)	RL	MDC	Unit	%Rec	%Rec Limits		
Radium-228			8.27	9.882		1.46	1.00	0.746	pCi/L	119	75 - 125		

Carrier	*LCS %Yield*	*LCS Qualifier*	*Limits*
Ba Carrier	*91.1*		*30 - 110*
Y Carrier	*73.6*		*30 - 110*

Lab Sample ID: MB 160-690431/1-A
Matrix: Water
Analysis Batch: 693477

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 690431

Analyte	MB Result	MB Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Radium-228	0.2666	U	0.347	0.348	1.00	0.578	pCi/L	11/25/24 09:46	12/13/24 11:27	1

Carrier	*MB %Yield*	*MB Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Ba Carrier	*81.5*		*30 - 110*	*11/25/24 09:46*	*12/13/24 11:27*	*1*
Y Carrier	*82.2*		*30 - 110*	*11/25/24 09:46*	*12/13/24 11:27*	*1*

Lab Sample ID: LCS 160-690431/2-A
Matrix: Water
Analysis Batch: 693477

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 690431

Analyte			Spike Added	LCS Result	LCS Qual	Total Uncert. (2σ+/-)	RL	MDC	Unit	%Rec	%Rec Limits		
Radium-228			8.27	9.885		1.37	1.00	0.548	pCi/L	120	75 - 125		

Carrier	*LCS %Yield*	*LCS Qualifier*	*Limits*
Ba Carrier	*87.6*		*30 - 110*
Y Carrier	*79.3*		*30 - 110*

HPLC/IC

Analysis Batch: 484985

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-182961-1	CCR-AP-1R	Total/NA	Water	EPA 9056A	
180-182961-2	CCR-AP-2	Total/NA	Water	EPA 9056A	
180-182961-2	CCR-AP-2	Total/NA	Water	EPA 9056A	
180-182961-3	CCR-AP-4	Total/NA	Water	EPA 9056A	
180-182961-4	CCR-AP-5	Total/NA	Water	EPA 9056A	
180-182961-4	CCR-AP-5	Total/NA	Water	EPA 9056A	
180-182961-5	CCR-AP-6I	Total/NA	Water	EPA 9056A	
180-182961-6	CCR-AP-9	Total/NA	Water	EPA 9056A	
180-182961-7	CCR-AP-11	Total/NA	Water	EPA 9056A	
180-182961-7	CCR-AP-11	Total/NA	Water	EPA 9056A	
180-182961-8	DUP-1	Total/NA	Water	EPA 9056A	
180-182961-8	DUP-1	Total/NA	Water	EPA 9056A	
180-182961-9	FIELD BLANK 1	Total/NA	Water	EPA 9056A	
MB 180-484985/6	Method Blank	Total/NA	Water	EPA 9056A	
LCS 180-484985/7	Lab Control Sample	Total/NA	Water	EPA 9056A	

Metals

Prep Batch: 636038

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-182961-1	CCR-AP-1R	Total Recoverable	Water	3005A	
180-182961-2	CCR-AP-2	Total Recoverable	Water	3005A	
180-182961-3	CCR-AP-4	Total Recoverable	Water	3005A	
180-182961-4	CCR-AP-5	Total Recoverable	Water	3005A	
180-182961-5	CCR-AP-6I	Total Recoverable	Water	3005A	
180-182961-6	CCR-AP-9	Total Recoverable	Water	3005A	
180-182961-7	CCR-AP-11	Total Recoverable	Water	3005A	
180-182961-8	DUP-1	Total Recoverable	Water	3005A	
180-182961-9	FIELD BLANK 1	Total Recoverable	Water	3005A	
MB 240-636038/1-A	Method Blank	Total Recoverable	Water	3005A	
LCS 240-636038/2-A	Lab Control Sample	Total Recoverable	Water	3005A	
LCS 240-636038/3-A	Lab Control Sample	Total Recoverable	Water	3005A	

Prep Batch: 636040

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-182961-1	CCR-AP-1R	Total/NA	Water	7470A	
180-182961-2	CCR-AP-2	Total/NA	Water	7470A	
180-182961-3	CCR-AP-4	Total/NA	Water	7470A	
180-182961-4	CCR-AP-5	Total/NA	Water	7470A	
180-182961-5	CCR-AP-6I	Total/NA	Water	7470A	
180-182961-6	CCR-AP-9	Total/NA	Water	7470A	
180-182961-7	CCR-AP-11	Total/NA	Water	7470A	
180-182961-8	DUP-1	Total/NA	Water	7470A	
180-182961-9	FIELD BLANK 1	Total/NA	Water	7470A	
MB 240-636040/1-A	Method Blank	Total/NA	Water	7470A	
LCS 240-636040/2-A	Lab Control Sample	Total/NA	Water	7470A	

Analysis Batch: 636245

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-182961-1	CCR-AP-1R	Total/NA	Water	EPA 7470A	636040
180-182961-2	CCR-AP-2	Total/NA	Water	EPA 7470A	636040

Metals (Continued)

Analysis Batch: 636245 (Continued)

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-182961-3	CCR-AP-4	Total/NA	Water	EPA 7470A	636040
180-182961-4	CCR-AP-5	Total/NA	Water	EPA 7470A	636040
180-182961-5	CCR-AP-6I	Total/NA	Water	EPA 7470A	636040
180-182961-6	CCR-AP-9	Total/NA	Water	EPA 7470A	636040
180-182961-7	CCR-AP-11	Total/NA	Water	EPA 7470A	636040
180-182961-8	DUP-1	Total/NA	Water	EPA 7470A	636040
180-182961-9	FIELD BLANK 1	Total/NA	Water	EPA 7470A	636040
MB 240-636040/1-A	Method Blank	Total/NA	Water	EPA 7470A	636040
LCS 240-636040/2-A	Lab Control Sample	Total/NA	Water	EPA 7470A	636040

Analysis Batch: 636305

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-182961-1	CCR-AP-1R	Total Recoverable	Water	EPA 6020B	636038
180-182961-2	CCR-AP-2	Total Recoverable	Water	EPA 6020B	636038
180-182961-3	CCR-AP-4	Total Recoverable	Water	EPA 6020B	636038
180-182961-4	CCR-AP-5	Total Recoverable	Water	EPA 6020B	636038
180-182961-5	CCR-AP-6I	Total Recoverable	Water	EPA 6020B	636038
180-182961-6	CCR-AP-9	Total Recoverable	Water	EPA 6020B	636038
180-182961-7	CCR-AP-11	Total Recoverable	Water	EPA 6020B	636038
180-182961-8	DUP-1	Total Recoverable	Water	EPA 6020B	636038
180-182961-9	FIELD BLANK 1	Total Recoverable	Water	EPA 6020B	636038
MB 240-636038/1-A	Method Blank	Total Recoverable	Water	EPA 6020B	636038
LCS 240-636038/3-A	Lab Control Sample	Total Recoverable	Water	EPA 6020B	636038

Analysis Batch: 636493

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-182961-1	CCR-AP-1R	Total Recoverable	Water	EPA 6010D	636038
180-182961-2	CCR-AP-2	Total Recoverable	Water	EPA 6010D	636038
180-182961-3	CCR-AP-4	Total Recoverable	Water	EPA 6010D	636038
180-182961-5	CCR-AP-6I	Total Recoverable	Water	EPA 6010D	636038
180-182961-6	CCR-AP-9	Total Recoverable	Water	EPA 6010D	636038
180-182961-7	CCR-AP-11	Total Recoverable	Water	EPA 6010D	636038
180-182961-8	DUP-1	Total Recoverable	Water	EPA 6010D	636038
180-182961-9	FIELD BLANK 1	Total Recoverable	Water	EPA 6010D	636038
MB 240-636038/1-A	Method Blank	Total Recoverable	Water	EPA 6010D	636038
LCS 240-636038/2-A	Lab Control Sample	Total Recoverable	Water	EPA 6010D	636038

Analysis Batch: 636691

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-182961-4	CCR-AP-5	Total Recoverable	Water	EPA 6010D	636038

Analysis Batch: 636748

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-182961-3	CCR-AP-4	Total Recoverable	Water	EPA 6020B	636038
180-182961-4	CCR-AP-5	Total Recoverable	Water	EPA 6020B	636038
180-182961-5	CCR-AP-6I	Total Recoverable	Water	EPA 6020B	636038
180-182961-6	CCR-AP-9	Total Recoverable	Water	EPA 6020B	636038
180-182961-7	CCR-AP-11	Total Recoverable	Water	EPA 6020B	636038
180-182961-8	DUP-1	Total Recoverable	Water	EPA 6020B	636038
180-182961-9	FIELD BLANK 1	Total Recoverable	Water	EPA 6020B	636038
MB 240-636038/1-A	Method Blank	Total Recoverable	Water	EPA 6020B	636038

Metals (Continued)

Analysis Batch: 636748 (Continued)

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
LCS 240-636038/3-A	Lab Control Sample	Total Recoverable	Water	EPA 6020B	636038

General Chemistry

Analysis Batch: 484645

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-182961-8	DUP-1	Total/NA	Water	SM 2540C	
MB 180-484645/2	Method Blank	Total/NA	Water	SM 2540C	
LCS 180-484645/1	Lab Control Sample	Total/NA	Water	SM 2540C	
180-182961-8 DU	DUP-1	Total/NA	Water	SM 2540C	

Analysis Batch: 484659

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-182961-2	CCR-AP-2	Total/NA	Water	SM 2540C	
180-182961-7	CCR-AP-11	Total/NA	Water	SM 2540C	
MB 180-484659/1	Method Blank	Total/NA	Water	SM 2540C	
LCS 180-484659/2	Lab Control Sample	Total/NA	Water	SM 2540C	

Analysis Batch: 484667

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-182961-1	CCR-AP-1R	Total/NA	Water	SM 2540C	
180-182961-3	CCR-AP-4	Total/NA	Water	SM 2540C	
180-182961-5	CCR-AP-6I	Total/NA	Water	SM 2540C	
180-182961-6	CCR-AP-9	Total/NA	Water	SM 2540C	
180-182961-9	FIELD BLANK 1	Total/NA	Water	SM 2540C	
MB 180-484667/1	Method Blank	Total/NA	Water	SM 2540C	
LCS 180-484667/2	Lab Control Sample	Total/NA	Water	SM 2540C	
180-182961-9 DU	FIELD BLANK 1	Total/NA	Water	SM 2540C	

Analysis Batch: 484737

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-182961-4	CCR-AP-5	Total/NA	Water	SM 2540C	
MB 180-484737/1	Method Blank	Total/NA	Water	SM 2540C	
LCS 180-484737/2	Lab Control Sample	Total/NA	Water	SM 2540C	
180-182961-4 DU	CCR-AP-5	Total/NA	Water	SM 2540C	

Analysis Batch: 485028

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-182961-4	CCR-AP-5	Total/NA	Water	EPA 9040C	
180-182961-5	CCR-AP-6I	Total/NA	Water	EPA 9040C	
180-182961-8	DUP-1	Total/NA	Water	EPA 9040C	
LCS 180-485028/24	Lab Control Sample	Total/NA	Water	EPA 9040C	

Analysis Batch: 485167

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-182961-1	CCR-AP-1R	Total/NA	Water	EPA 9040C	
180-182961-2	CCR-AP-2	Total/NA	Water	EPA 9040C	
180-182961-3	CCR-AP-4	Total/NA	Water	EPA 9040C	
180-182961-6	CCR-AP-9	Total/NA	Water	EPA 9040C	
180-182961-7	CCR-AP-11	Total/NA	Water	EPA 9040C	
180-182961-9	FIELD BLANK 1	Total/NA	Water	EPA 9040C	

General Chemistry (Continued)

Analysis Batch: 485167 (Continued)

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
LCS 180-485167/24	Lab Control Sample	Total/NA	Water	EPA 9040C	

Rad

Prep Batch: 689970

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-182961-1	CCR-AP-1R	Total/NA	Water	PrecSep-21	
180-182961-2	CCR-AP-2	Total/NA	Water	PrecSep-21	
180-182961-3	CCR-AP-4	Total/NA	Water	PrecSep-21	
MB 160-689970/1-A	Method Blank	Total/NA	Water	PrecSep-21	
LCS 160-689970/2-A	Lab Control Sample	Total/NA	Water	PrecSep-21	

Prep Batch: 689999

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-182961-1	CCR-AP-1R	Total/NA	Water	PrecSep_0	
180-182961-2	CCR-AP-2	Total/NA	Water	PrecSep_0	
180-182961-3	CCR-AP-4	Total/NA	Water	PrecSep_0	
MB 160-689999/1-A	Method Blank	Total/NA	Water	PrecSep_0	
LCS 160-689999/2-A	Lab Control Sample	Total/NA	Water	PrecSep_0	

Prep Batch: 690430

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-182961-4	CCR-AP-5	Total/NA	Water	PrecSep-21	
180-182961-5	CCR-AP-6I	Total/NA	Water	PrecSep-21	
180-182961-6	CCR-AP-9	Total/NA	Water	PrecSep-21	
180-182961-7	CCR-AP-11	Total/NA	Water	PrecSep-21	
180-182961-8	DUP-1	Total/NA	Water	PrecSep-21	
180-182961-9	FIELD BLANK 1	Total/NA	Water	PrecSep-21	
MB 160-690430/1-A	Method Blank	Total/NA	Water	PrecSep-21	
LCS 160-690430/2-A	Lab Control Sample	Total/NA	Water	PrecSep-21	

Prep Batch: 690431

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-182961-4	CCR-AP-5	Total/NA	Water	PrecSep_0	
180-182961-5	CCR-AP-6I	Total/NA	Water	PrecSep_0	
180-182961-6	CCR-AP-9	Total/NA	Water	PrecSep_0	
180-182961-7	CCR-AP-11	Total/NA	Water	PrecSep_0	
180-182961-8	DUP-1	Total/NA	Water	PrecSep_0	
180-182961-9	FIELD BLANK 1	Total/NA	Water	PrecSep_0	
MB 160-690431/1-A	Method Blank	Total/NA	Water	PrecSep_0	
LCS 160-690431/2-A	Lab Control Sample	Total/NA	Water	PrecSep_0	

18

NOT FOIL
RAD

	CCR-AP-1R	11/14/24	0645	500mL
1	CCR-AP-2	11/14/24	0805	650mL
1	CCR-AP-4	11/14/24	1320	450mL
2	CCR-AP-5	11/14/24	1545	—
2	CCR-AP-6I	11/13/24	0841	—
1	CCR-AP-9	11/14/24	1050	600mL
2	CCR-AP-11	11/15/24	0858	—
2	DUP-1	11/14/24	—	—
2	Field Blank	1	11/15/24	1155

180-182961 Chain of Custody

NO COC
[illegible] 11/16/24 0930

2 MW3 0364 | | 250 ORP ILF 0104303

Eurofins Pittsburgh
301 Alpha Drive RIDC Park
Pittsburgh, PA 15238
Phone: 412-963-7058 Fax: 412-963-2468

Chain of Custody Record

eurofins | Environment Testing

Client Information	Sampler: MARK BRETING	Lab PM: Johnson, Andy	Carrier Tracking No(s):	COC No: 180-106631-14505.2
Client Contact: Mark Breting	Phone: 317 313 8306	E-Mail: Andy.Johnson@et.eurofinsus.com	State of Origin: IN	Page: Page 2 of 2
Company: Atlas Technical Consultants LLC	PWSID:	Analysis Requested		Job #:
Address: 7988 Centerpoint Drive Suite 100	Due Date Requested:			Preservation Codes: N None D HNO3
City: Indianapolis	TAT Requested (days):			
State, Zip: IN, 46256	Compliance Project: Δ Yes Δ No			
Phone:	PO #: 0129420-032-001-01			Other:
Email: mark.breting@atcassociates.com	WO #: See Chain			
Project Name: CCR GW Monitoring FB Culley East	Project #: 18016014			
Site:	SSOW#:			

Sample Identification	Sample Date	Sample Time	Sample Type (C=Comp, G=grab)	Matrix (W=water, S=solid, O=waste/oil, BT=Tissue, A=Air)	Field Filtered Sample (Yes or No)	Perform MS/MSD (Yes or No)	9060C, 9056A_ORGFM_28D	2540C_Calcd TDS by 2540C	9315_Ra226, 9320_Ra228	6020B Metals by 6020B	7470A Hg by 7470A	6010D Boron by 6010D	Total Number of Containers	Special Instructions/Note:
			Preservation Code:				N	N	D	D	D	D		
CCR-AP-6I	11/13/24	08:41	G	W	N	N	X	X	X	X	X	X		
CCR-AP-1R	11/14/24	06 45	G	W	N	N	X	X	X	X	X	X		Only 1 Radium Filtered
CCR-AP-2		08:05	G	W	N	N	X	X	X	X	X	X		" " "
CCR-AP-9		10 50	G	W	N	N	X	X	X	X	X	X		" " "
CCR-AP-4R		13 20	G	W	N	N	X	X	X	X	X	X		" " "
CCR-AP-5		15 45	G	W	N	N	X	X	X	X	X	X		
DUP-1		0000	G	W	N	N	X	X	X	X	X	X		
CCR-AP-11	11/15/24	0858	G	W	N	N	X	X	X	X	X	X		
Field Blank 1	11/15/24	1155	G	W	N	N	X	X	X	X	X	X		

180-182961-02 Chain of Custody

Possible Hazard Identification
☐ Non-Hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☑ Unknown ☐ Radiological

Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)
☐ Return To Client ☑ Disposal By Lab ☐ Archive For _____ Months

Deliverable Requested: I, II, III, IV Other (specify)

Special Instructions/QC Requirements:

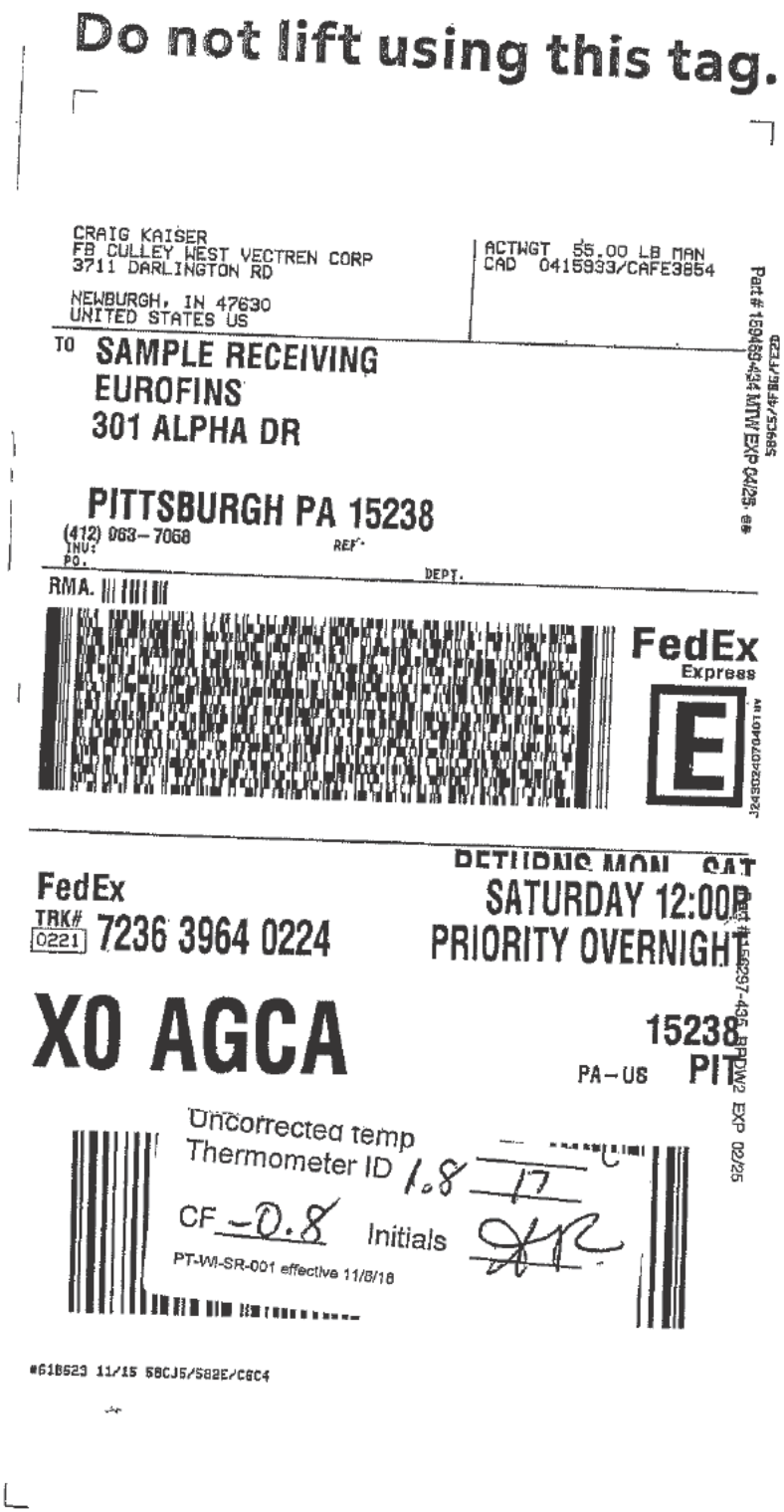
Empty Kit Relinquished by:	Date:	Time:	Method of Shipment:

Relinquished by:	Date/Time:	Company	Received by:	Date/Time:	Company
Mark Breting	11/15/24 1340	Atlas	FedEx	11/15/24 1340	
Relinquished by:	Date/Time:	Company	Received by:	Date/Time:	Company
				11/16/24 0930	ETHV
Relinquished by:	Date/Time:	Company	Received by:	Date/Time:	Company

Custody Seals Intact: Δ Yes Δ No	Custody Seal No.	Cooler Temperature(s) °C and Other Remarks:

Ver: 05/06/2024


Do Not Lift Using This Tag
Ref
Dep
Date 17Oct24
Wgt 55 00 LBS
DV:
SHIPPING 0 00
SPECIAL 0 00
HANDLING 0 00
0 00 TOTAL
Svcs: PRIORITY OVERNIGHT Master 7236 3963 9470
TRCK 7236 3963 9481
ORIGIN ID:ORFA (317) 579-4082
CRAIG KAISER
FB CULLEY VECTREN CORP
3711 DARLINGTON RD
NEWBURGH, IN 47630
UNITED STATES US
SHIP DATE 17OCT24
ACTWGT 55.00 LB MAN
CAD 0416933/CAFE3854
180-182981 Waybill
TO SAMPLE RECEIVING
EUROFINS
301 ALPHA DR
PITTSBURGH PA 15238
(412) 963-7058
REF
INV:
PO:
DEPT.
RMA.
FedEx
Express
Uncorrected temp
Thermometer ID 4.1
CF -0.1
Initials
PT-WI-SR-001 effective 11/8/18
FedEx
TRK# 0221 7236 3963 9481
XO AGCA
SATURDAY 12:00P
PRIORITY OVERNIGH
15238
PA-US
#6190970 11/15 58CJS/582E/C8C4
CRAIG KAISER
FB CULLEY WEST/VECTREN CORP
3711 DARLINGTON RD.
NEWBURGH, IN 47630
UNITED STATES US
ACTWGT 55 00 LB MAN
CAD 0416933/CAFE3854
TO SAMPLE RECEIVING
EUROFINS
301 ALPHA DR
PITTSBURGH PA 15238
(412) 963-7058
REF:
PO:
DEPT.
RMA.
FedEx
Express
Uncorrected temp
Thermometer ID 1.7
CF -0.1
Initials
PT-WI-SR-001 effective 11/8/18
FedEx
TRK# 0221 7236 3964 0280
XO AGCA
SATURDAY 12:00P
PRIORITY OVERNIGH
15238
PA-US
FedEx
Express
SDR
Saturday Delivery



Do not lift using this tag.

CRAIG KAISER
FB CULLEY WEST VECTREN CORP
3711 DARLINGTON RD

NEWBURGH, IN 47630
UNITED STATES US

ACTWGT 55.00 LB MAN
CAD 0415933/CAFE3854

TO SAMPLE RECEIVING
EUROFINS
301 ALPHA DR

PITTSBURGH PA 15238
(412) 963-7058
INV:
PO:
REF:
DEPT:

RMA.

FedEx Express

FedEx
TRK# 0221 7236 3964 0224

SATURDAY 12:00P
PRIORITY OVERNIGHT

XO AGCA

15238
PA-US PIT

Uncorrected temp
Thermometer ID 1.8 17
CF -0.8 Initials
PT-WI-SR-001 effective 11/8/18

#618523 11/15 58CJ5/582E/C8C4

Part # 158469-494 MTW EXP 04/25 ee

Part # 156297-435 BRDW2 EXP 02/25



CRAIG KAISER
FB CULLEY VECTREN CORP
3711 DARLINGTON RD

NEWBURGH, IN 47630
UNITED STATES US

ACTWGT 55.00 LB MAN
CAD 0415933/CAFE3854

TO SAMPLE RECEIVING
EUROFINS
301 ALPHA DR

PITTSBURGH PA 15238
(412) 963-7058
INV:
PO:
REF:
DEPT:

RMA.

FedEx Express

FedEx
TRK# 0221 7236 3963 9492

SATURDAY 12:00
PRIORITY OVERNIGH

XO AGCA

15238
PA-US PIT

Uncorrected temp
Thermometer ID 36 17
CF -0.1 Initials
PT-WI-SR-001 effective 11/8/18

#6190970 11/15 58CJ

Part # 158469-494 MTW EXP 04/25 ee

Part # 156297-435 BRDW2 EXP 08/26

CRAIG KAISER
FB CULLEY VECTREN CORP
3711 DARLINGTON RD

NEWBURGH, IN 47630
UNITED STATES US

CAD 0415933/CAFE3654

TO SAMPLE RECEIVING
EUROFINS
301 ALPHA DR

PITTSBURGH PA 15238
(412) 963-7058 REF:
INV:
PO: DEPT:

RMA.

FedEx Express

FedEx
TRK# 0221 7236 3963 9518

SATURDAY 12:00
PRIORITY OVERNIGH

15238
PA-US PIT

XO AGCA

Uncorrected temp °C
Thermometer ID 24 17
CF -0.1 Initials SR
PT-WI-SR-001 effective 11/8/18

EXP 08/25

#6190970 11/15 58CJ5/582E/C6C4

Ref
Dep

Date 17Oct24
Wgt 35 00 LBS

DV

SHIPPING 0 00
SPECIAL 0 00
0 00
0 00

Svcs PRIORITY OVERNIGHT Master 7236 3963 9470
TRCK 7236 3963 9470

ORIGIN ID ORFA (317) 579-4082
CRAIG KAISER
FB CULLEY VECTREN CORP
3711 DARLINGTON RD

NEWBURGH, IN 47630
UNITED STATES US

9470 11 16
A 12 00
1
639
RT
FZ

TO SAMPLE RECEIVING
EUROFINS
301 ALPHA DR

PITTSBURGH PA 15238
(412) 963-7058 REF
INV:
PO: DEPT:

RMA.

FedEx Express

FedEx
TRK# 0221 7236 3963 9470

SATURDAY 12:00
PRIORITY OVERNIGH

15238
PA-US PIT

XO AGCA

Uncorrected temp °C
Thermometer ID 25 17
CF -0.1 Initials SR
PT-WI-SR-001 effective 11/8/18

EXP 08/25

#6190970 11/15 58CJ5/582E/C6C4

Eurofins Pittsburgh
301 Alpha Drive RIDC Park
Pittsburgh, PA 15238
Phone: 412-963-7058 Fax: 412-963-2468

Chain of Custody Record

eurofins

Client Information (Sub Contract Lab)	Sampler: N/A	Lab PM: Johnson, Andy	Carrier Tracking No(s): N/A	COC No: 180-528237.1
Client Contact: Shipping/Receiving	Phone: N/A	E-Mail: Andy.Johnson@et.eurofinsus.com	State of Origin: Indiana	Page: Page 1 of 1
Company: TestAmerica Laboratories, Inc.		Accreditations Required (See note): N/A		Job #: 180-182961-1
Address: 13715 Rider Trail North,	Due Date Requested: 12/26/2024			Preservation Codes: -
City: Earth City	TAT Requested (days): N/A			
State, Zip: MO, 63045				
Phone: 314-298-8566(Tel) 314-298-8757(Fax)	PO #: N/A			
Email: N/A	WO #: N/A			
Project Name: CCR Groundwater Monitoring FB Culley East	Project #: 18016014			
Site: N/A	SSOW#: N/A			Other: N/A

Analysis Requested

Sample Identification - Client ID (Lab ID)	Sample Date	Sample Time	Sample Type (C=Comp, G=grab)	Matrix (W=water, S=solid, O=waste/oil, BT=Tissue, A=Air)	Field Filtered Sample (Yes or No)	Perform MS/MSD (Yes or No)	9315_Ra226/PrecSep_21 Radium-226 (GFPC) by 9315 (21-day decay)	9320_Ra228/PrecSep_0 Radium-228 (GFPC) by 9320	Ra226Ra228_GFPC/ Combined Radium-226 and Radium-228	Total Number of containers	Special Instructions/Note:
			Preservation Code:								
CCR-AP-1R (180-182961-1)	11/14/24	06:45 Eastern	G	Water			X	X	X	1	
CCR-AP-2 (180-182961-2)	11/14/24	08:05 Eastern	G	Water			X	X	X	1	
CCR-AP-4R (180-182961-3)	11/14/24	13:20 Eastern	G	Water			X	X	X	1	
CCR-AP-5 (180-182961-4)	11/14/24	15:45 Eastern	G	Water			X	X	X	2	
CCR-AP-6I (180-182961-5)	11/13/24	08:41 Eastern	G	Water			X	X	X	2	
CCR-AP-9 (180-182961-6)	11/14/24	10:50 Eastern	G	Water			X	X	X	1	
CCR-AP-11 (180-182961-7)	11/15/24	08:58 Eastern	G	Water			X	X	X	2	
DUP-1 (180-182961-8)	11/14/24	Eastern	G	Water			X	X	X	2	
FIELD BLANK 1 (180-182961-9)	11/15/24	11:55 Eastern	G	Water			X	X	X	2	

Note: Since laboratory accreditations are subject to change, Eurofins Pittsburgh places the ownership of method, analyte & accreditation compliance upon our subcontract laboratories. This sample shipment is forwarded under chain-of-custody. If the laboratory does not currently maintain accreditation in the State of Origin listed above for analysis/tests/matrix being analyzed, the samples must be shipped back to the Eurofins Pittsburgh laboratory or other instructions will be provided. Any changes to accreditation status should be brought to Eurofins Pittsburgh attention immediately. If all requested accreditations are current to date, return the signed Chain of Custody attesting to said compliance to Eurofins Pittsburgh.

Possible Hazard Identification	Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)
Unconfirmed	☐ Return To Client ☐ Disposal By Lab ☐ Archive For ____ Months
Deliverable Requested: I, II, III, IV, Other (specify) Primary Deliverable Rank: 2	Special Instructions/QC Requirements:

Empty Kit Relinquished by:	Date:	Time:	Method of Shipment:		
Relinquished by:	Date/Time: 11/27/1900	Company: EUHT	Received by: M. Pinette	Date/Time: NOV 19 2024 0910	Company
Relinquished by:	Date/Time:	Company	Received by: Meadow Pinette	Date/Time:	Company
Relinquished by:	Date/Time:	Company	Received by:	Date/Time:	Company

Custody Seals Intact: Δ Yes Δ No	Custody Seal No.:	Cooler Temperature(s) °C and Other Remarks:

Login Sample Receipt Checklist

Client: Haley & Aldrich, Inc.

Job Number: 180-182961-1
SDG Number: FB Culley East

Login Number: 182961
List Number: 1
Creator: Ryan, Shannon G

List Source: Eurofins Pittsburgh

Question	Answer	Comment
Radioactivity wasn't checked or is </= background as measured by a survey meter.	N/A	
The cooler's custody seal, if present, is intact.	True	
Sample custody seals, if present, are intact.	True	
The cooler or samples do not appear to have been compromised or tampered with.	True	
Samples were received on ice.	True	
Cooler Temperature is acceptable.	True	
Cooler Temperature is recorded.	True	
COC is present.	False	
COC is filled out in ink and legible.	True	
COC is filled out with all pertinent information.	True	
Is the Field Sampler's name present on COC?	True	
There are no discrepancies between the containers received and the COC.	True	
Samples are received within Holding Time (excluding tests with immediate HTs)	True	
Sample containers have legible labels.	True	
Containers are not broken or leaking.	True	
Sample collection date/times are provided.	True	
Appropriate sample containers are used.	True	
Sample bottles are completely filled.	False	
Sample Preservation Verified.	True	
There is sufficient vol. for all requested analyses, incl. any requested MS/MSDs	True	
Containers requiring zero headspace have no headspace or bubble is <6mm (1/4").	True	
Multiphasic samples are not present.	True	
Samples do not require splitting or compositing.	True	
Residual Chlorine Checked.	N/A	

This receipt checklist is generated for all samples received in this Login. It may not be applicable to all Jobs associated with this Login.

Login Sample Receipt Checklist

Client: Haley & Aldrich, Inc.

Job Number: 180-182961-1
SDG Number: FB Culley East

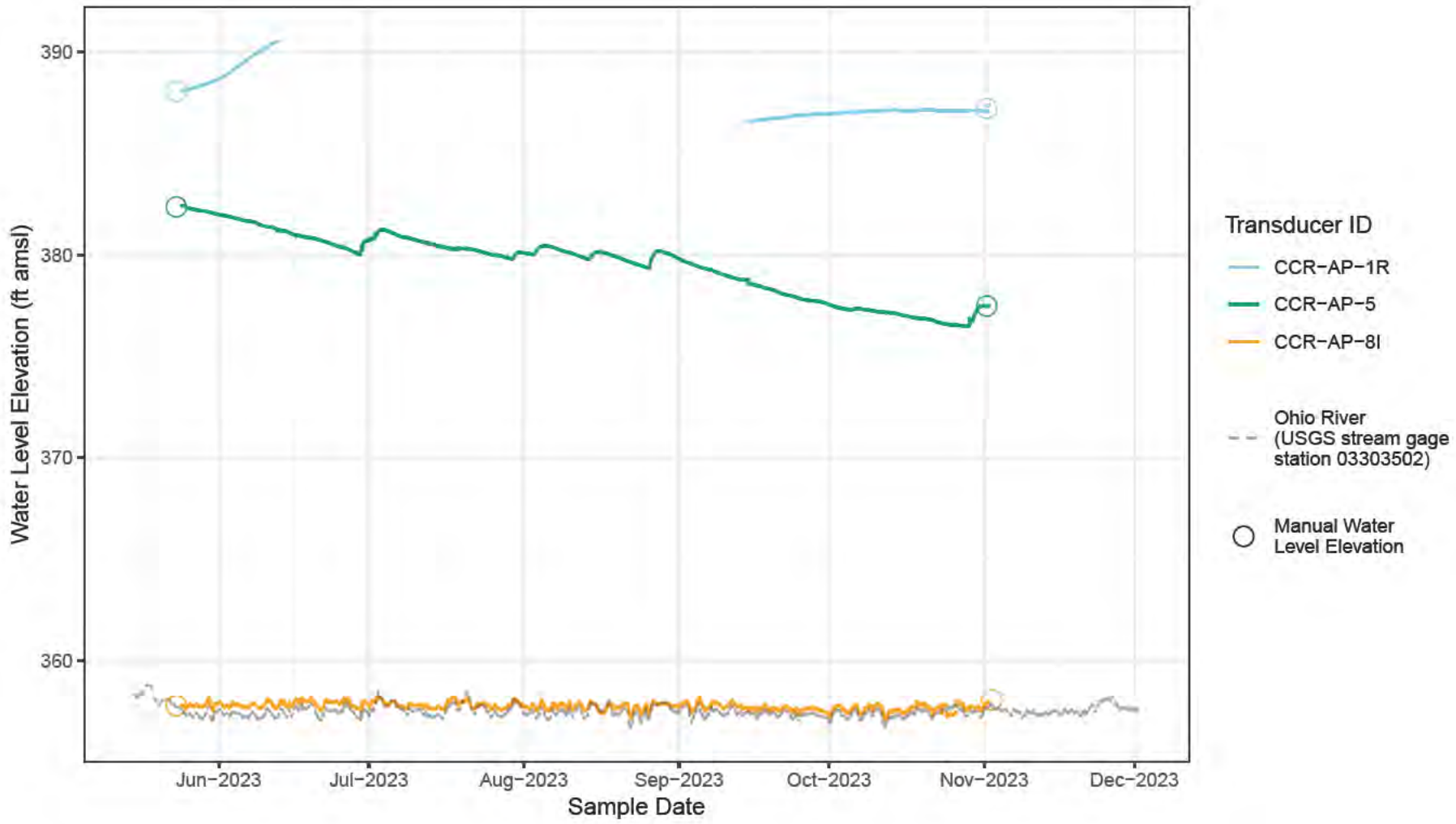
Login Number: 182961
List Number: 3
Creator: Pinette, Meadow L

List Source: Eurofins St. Louis
List Creation: 11/19/24 01:45 PM

Question	Answer	Comment
Radioactivity wasn't checked or is </= background as measured by a survey meter.	True	
The cooler's custody seal, if present, is intact.	True	
Sample custody seals, if present, are intact.	True	
The cooler or samples do not appear to have been compromised or tampered with.	True	
Samples were received on ice.	True	
Cooler Temperature is acceptable.	True	
Cooler Temperature is recorded.	True	
COC is present.	True	
COC is filled out in ink and legible.	True	
COC is filled out with all pertinent information.	True	
Is the Field Sampler's name present on COC?	N/A	
There are no discrepancies between the containers received and the COC.	True	
Samples are received within Holding Time (excluding tests with immediate HTs)	True	
Sample containers have legible labels.	True	
Containers are not broken or leaking.	True	
Sample collection date/times are provided.	True	
Appropriate sample containers are used.	True	
Sample bottles are completely filled.	True	
Sample Preservation Verified.	True	
There is sufficient vol. for all requested analyses, incl. any requested MS/MSDs	True	
Containers requiring zero headspace have no headspace or bubble is <6mm (1/4").	N/A	
Multiphasic samples are not present.	True	
Samples do not require splitting or compositing.	True	
Residual Chlorine Checked.	N/A	

This receipt checklist is generated for all samples received in this Login. It may not be applicable to all Jobs associated with this Login.

APPENDIX D
Hydrographs



Notes:

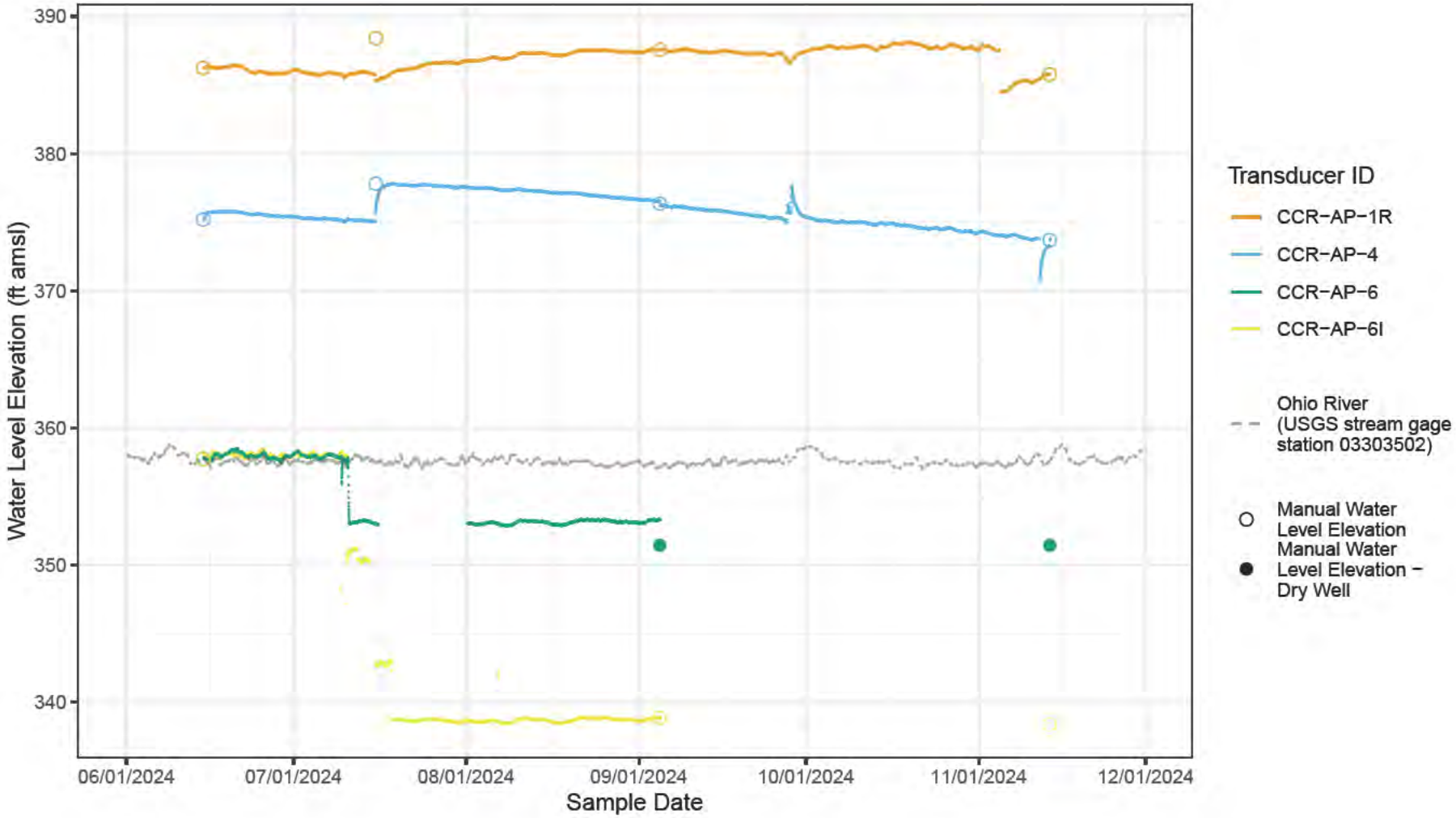
- Water Level Elevation (ft amsl) = top of riser (ft amsl) − adjusted trasducer water level (ft), where adjusted transducer water level = −(manual water level elevation − transducer water level).
- USGS stream gage station 03303502 is located on the Ohio River at Riverport, Owensboro, KY, USA.

APPENDIX D-1

EAST ASH POND HYDROGRAPHS OVER OHIO RIVER AT RIVERPORT GAGE HEIGHT

HALEY ALDRICH

JANUARY 2025



Notes:

- ft NAVD88 = feet relative to the NAVD88 datum
- USGS stream gage station 03303502 is located on the Ohio River at Riverport, Owensboro, KY, USA.

APPENDIX D-2

EAST ASH POND HYDROGRAPHS OVER OHIO RIVER AT RIVERPORT GAGE HEIGHT

HALEY ALDRICH

JANUARY 2025

BEFORE THE UNITED STATES DEPARTMENT OF ENERGY

Federal Power Act Section 202(c) Emergency Order: Midcontinent Independent System Operator and Northern Indiana Public Service Company LLC	)))))	Order No. 202-26-19
Federal Power Act Section 202(c) Emergency Order: Midcontinent Independent System Operator and CenterPoint Energy Indiana South	))))	Order No. 202-26-20

Exhibit to
Motion to Intervene and Request for Rehearing and Stay of
Public Interest Organizations

Exhibit 149
New York Times Article on Trump's Coal Plant Policy

Trump Wants to Halt Almost All Coal Plant Shutdowns. It Could Get Messy.

Even as administration officials vowed this week to head off scheduled retirements, some aging plants are now breaking, and costs could run to the billions.

Listen to this article · 11:35 min Learn more




By Claire Brown and Brad Plumer

Jan. 16, 2026

Over the past eight months, the Energy Department has taken the extraordinary step of ordering that generators at five coal-burning power plants that had been headed for retirement stay open and keep running.

That's just the beginning, officials say.

At a White House event on Thursday, Trump administration officials said they planned to keep open as many coal plants as they could and prevent any further retirements over the next three years.

"The goal is to stop the political closure of coal plants," Chris Wright, the energy secretary, said during the first meeting of the National Coal Council, which had lapsed under the Biden administration but which President Trump has revived. Dozens of representatives from the coal industry were present.

The moves are part of a sweeping plan by Mr. Trump to revive America's coal industry, which has been declining for years. Mr. Trump has expressed a certain affection for the fuel, calling it "beautiful clean coal" to goad environmentalists, who note that coal is the dirtiest of fossil fuels and a major driver of global warming.

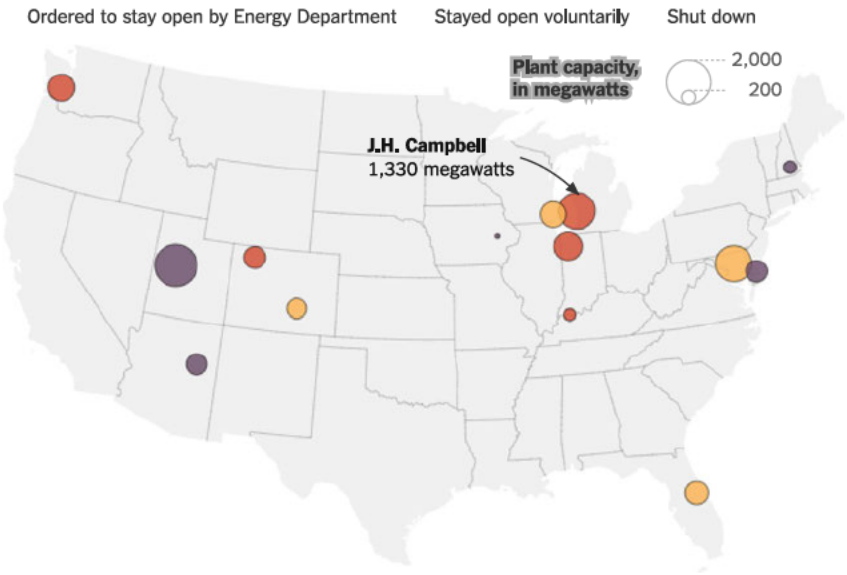
Administration officials say that keeping coal plants open is necessary to avoid blackouts and meet rising energy needs.

On the ground, however, efforts to halt coal retirements are already causing complications. Two of the coal units that the Energy Department ordered to stay online in December are broken, and it's unclear when they might be repaired.

Some plants that were ordered to keep running had already shuttered their coal mines and stopped maintaining old equipment. Now, utilities and operators are straining to revive them. The costs of extending coal-burning plants are significant, and federal and state regulators are embroiled in disputes over who will ultimately pay.

"These are old plants, and they are expensive to refurbish and keep open," said Ari Peskoe, director of Harvard Law School's Electricity Law Initiative. "The costs are going to fall on somebody. The question is whether it's the plant owners or the public."

Most coal units expected to close in 2025 were kept open



Source: U.S. Energy Information Administration. Brad Plumer/The New York Times

The debate over whether to keep aging coal plants open comes amid an astonishing turnaround in the coal industry's political fortunes.

Since 2005, the number of operating coal plants in the United States had been declining precipitously as utilities switched to cheaper and cleaner natural gas, wind and solar power. Even Mr. Trump in his first term couldn't stop the slide; more than 150 coal-burning units shut down between 2017 and 2020.

This time around, the Trump administration has gone much further to rescue coal, with more success. Last year, the amount of electricity produced by coal increased 13 percent, and retirements have slowed.

The administration has been aided by a surge in electricity demand nationwide driven by a boom in data centers, which has led some utilities to postpone coal plant closures. Federal agencies have also rolled back environmental regulations on coal, which produces more air pollution than other sources like natural gas. Burning coal also emits mercury, a powerful neurotoxin, and other heavy metals.



A surge in electricity demand has been driven by a boom in data centers. Scott Ball for The New York Times

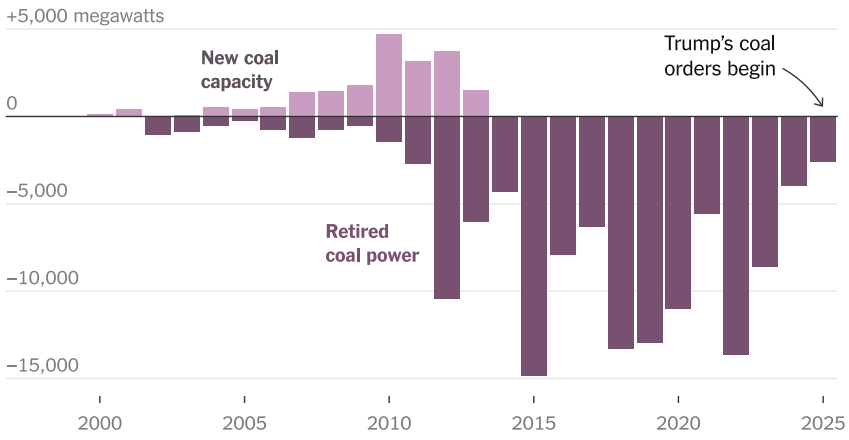
Even more drastic, however, has been the Energy Department's use of emergency orders to mandate that coal plants that had been set to retire keep operating, as the agency has invoked Section 202(c) of the Federal Power Act.

Historically, this provision has been used to keep plants online during temporary emergencies such as hurricanes or heat waves. But the Trump administration has claimed that the emergency this time is an expected shortage of reliable power over the next decade, and officials are trying to avert as many closures as they can.

The impact is already visible: At the start of last year, utilities were expected to close roughly 8.5 gigawatts of coal capacity in 2025, according to federal data. But they ended up retiring only 2.7 gigawatts, the lowest amount since 2011.

Coal retirements slowed in 2025

Changes in annual U.S. coal power capacity



Source: Energy Information Administration. Brad Plumer/The New York Times

At the White House event on Thursday, Mr. Wright said that many states were closing their coal plants for environmental reasons and that the administration would do everything it could to stop that. More than 20 gigawatts of coal capacity is currently scheduled to retire by 2028.

"I think you will not see those plants close during this administration," Mr. Wright said, adding that there might be a few exceptions for the very oldest plants.

Mr. Wright said he hoped other actions by the administration to support coal would eventually make emergency orders "unnecessary." But, he claimed, many utilities were quietly welcoming the orders to save coal plants at imminent risk of closure. "We get a lot of inbound calls now saying, 'Can you 202(c) this plant?'"

Those orders are also facing a backlash. Environmental groups and states like Michigan and Washington are mounting legal challenges. The grid operator in the Midwest and state officials in Colorado have said their regions already have adequate electrical capacity, even with coal retirements.



Mr. Wright, second from the right, said that many states were closing their coal plants for environmental reasons and that the administration would do everything it could to stop that. Tierney L. Cross/The New York Times

Even analysts who agree that the country needs more power plants that can run at all hours say that forcing aging coal units to stay online can be counterproductive, because they can distort energy markets and make it harder for states and companies to plan to bring new power plants online.

“Using a blunt instrument like this to keep the legacy coal fleet online could backfire,” said Devin Hartman, director of energy and environmental policy at the R Street Institute. “There are a ton of risks.”

Broken plants, busy railroads

Reviving a geriatric coal fleet isn’t easy: Many plants are more than 50 years old and need major repairs.

On the shores of Lake Michigan, the J.H. Campbell coal plant was set to retire last May under a plan backed by the state and the electric utility that operates it, Consumers Energy. But, at the last minute, the Energy Department ordered that the plant’s three coal units stay open for 90 days during the summer. The agency has since twice renewed the order and is widely expected to order that the plant remain open indefinitely.

That created headaches for the operator, which had canceled roughly $161 million in maintenance for the plant in the years leading up to the scheduled retirement, according to one engineer’s testimony. The plant has struggled to generate reliable power: One unit faced extended outages in June and produced electricity for only a handful of days, according to legal filings by environmental groups.

Other plants may be in rougher shape.

In December, the Energy Department ordered that the R.M. Schahfer plant in northern Indiana keep two coal units operating past their planned retirement. Yet one of those units has been offline since the summer because of a turbine failure.

Repairing the unit could ultimately take “six months or longer,” Vince Parisi, the chief operating officer of the Northern Indiana Public Service Company, which owns the plant, told regulators last month. “It’s just the reality of that unit being close to retirement.”

In Colorado, a rural electric cooperative had been planning since 2016 to close a coal-burning unit at the Craig Generating Station. Last month, the Energy Department ordered that the unit stay open. Yet the coal unit is offline because of a broken valve, and it is unclear how long it will take to fix it.

There's also the question of where to get fuel.

Until recently, the Craig unit in Colorado obtained some of its coal from a local mine operated by its part owner, the Tri-State Generation and Transmission Association. But that mine closed last year, laying off all its workers.

"This makes no economic sense or functional sense, to extend the life of an effectively broken coal plant," said Gov. Jared Polis, Democrat of Colorado, who opposes the order and says the federal government had done little to consult with the state.

Last month, when Bob Guenther drove past the coal-burning power plant in Centralia, Wash., where he worked for 34 years before retirement, there wasn't much coal in sight. The power plant had been winding down for years and was scheduled to close by Dec. 31 until the Energy Department ordered that it stay open. Coal piles that once filled acres had dwindled.

"It's going to cost a lot of money to put that plant back in shape," Mr. Guenther said.



The coal-burning power plant in Centralia, Wash. Reviving a geriatric coal fleet isn't easy. Evan McGlinn for The New York Times

Some local officials and unions have cheered the lifeline for coal plants, which are often an engine of local economic activity. But environmental groups have pointed to the hazards from air pollution and coal-ash waste.

"Northwest Indiana has long borne the brunt of industrial pollution," said Ashley Williams, the executive director of Just Transition Northwest Indiana, a nonprofit group, criticizing the order to keep the R.M. Schahfer plant open. "We will continue to suffer."

Mounting costs, legal threats

The cost to keep coal plants open could prove especially divisive.

In Michigan, Consumers Energy spent $164 million from May to September to keep its coal plant running, according to regulatory filings. During that time, the plant earned only $84 million in revenue.

It remains to be seen who will ultimately pay for the rest. Consumers Energy has proposed that the costs be shared by ratepayers in multiple states in the Midwestern regional grid, rather than paid for by its customers alone. But other groups have challenged this proposal.

In Colorado, Tri-State has said that its ratepayers may have to bear the full cost of repairing and operating the Craig plant — which state officials say could cost $80 million per year or more. In Washington, state law now forbids utilities to buy electricity from coal plants, raising legal complications.

Preventing the nation's coal plants from retiring over the next three years could cost consumers at least $3 billion per year, according to a report from Grid Strategies, a consulting firm.

"A lot of these plants were retiring because they're no longer economic to operate," said Michael Goggin, an executive vice president at Grid Strategies. "It's expensive to keep them going."

Opponents have challenged the coal orders in court, arguing that Congress intended for emergency powers to be used only in rare, temporary cases. If the orders are struck down, it is unclear who would bear the cost of spending millions of dollars to repair run-down plants.

While federal forecasts still expect coal generation to decline next year, the Trump administration is trying to prevent that from occurring.

The Environmental Protection Agency is rolling back numerous air pollution and climate rules that have made coal plants more costly to operate. It has also given electric utilities more time to clean up contamination from toxic coal ash landfills.

At the same time, the Energy Department has offered up to $350 million to try to bring back to life coal plants that have already closed.

Michelle Bloodworth, chief executive of America's Power, a coal trade group, estimates that at least 29 coal units with roughly 13 gigawatts of capacity have recently closed but are not yet demolished and could be candidates for restarting. She added that more utilities were voluntarily postponing coal retirements and that the future for the industry is looking brighter under the Trump administration.

"There's a huge opportunity for the coal fleet," Ms. Bloodworth said. "It's a big change after years and years of punitive environmental regulations."

Claire Brown covers climate change for The Times and writes for the Climate Forward newsletter.

Brad Plumer is a Times reporter who covers technology and policy efforts to address global warming.

A version of this article appears in print on , Section A, Page 1 of the New York edition with the headline: Trump Pushes To Retain Coal On Power Grid

BEFORE THE UNITED STATES DEPARTMENT OF ENERGY

Federal Power Act Section 202(c) Emergency Order: Midcontinent Independent System Operator and Northern Indiana Public Service Company LLC	)))))	Order No. 202-26-19
Federal Power Act Section 202(c) Emergency Order: Midcontinent Independent System Operator and CenterPoint Energy Indiana South	))))	Order No. 202-26-20

Exhibit to
Motion to Intervene and Request for Rehearing and Stay of
Public Interest Organizations

Exhibit 150
May Campbell Order

Order No. 202-25-3

Pursuant to the authority vested in the Secretary of Energy by section 202(c) of the Federal Power Act (FPA), 16 U.S.C. § 824a(c), and section 301(b) of the Department of Energy Organization Act, 42 U.S.C. § 7151(b), and for the reasons set forth below, I hereby determine that an emergency exists in portions of the Midwest region of the United States due to a shortage of electric energy, a shortage of facilities for the generation of electric energy, and other causes, and that issuance of this Order will meet the emergency and serve the public interest.

Emergency Situation

The Midcontinent Independent System Operator (MISO) faces potential tight reserve margins during the summer 2025 period, particularly during periods of high demand or low generation resource output. The North American Electric Reliability Corporation (NERC) released its 2025 Summer Reliability Assessment on May 14, 2025. In its assessment, NERC indicated that "[d]emand forecasts and resource data indicate that MISO is at elevated risk of operating reserve shortfalls during periods of high demand or low resource output."[1] In particular, the retirement of thermal generation capacity creates the potential for electricity supply shortfalls. NERC anticipates that the near-term period of highest capacity shortfall for MISO will occur in August.[2]

Multiple generation facilities in Michigan have retired in recent years. According to the U.S. Energy Information Administration (EIA), "[s]ince 2020, about 2,700 megawatts of coal-fired generating capacity have been retired and no new coal-fired facilities are planned."[3] Additionally EIA stated, "[t]ypically Michigan's nuclear power plants have supplied about 30% of in-state electricity, but the amount of electricity generated by nuclear power plants in Michigan has declined as plants have been decommissioned."[4] The state's Big Rock Point nuclear power plant shut down in 1997 and the Palisades nuclear power plant closed in 2022. While the Palisades nuclear power plant may reopen in 2025, it will not be available during the peak demand period this summer.

The 1,560 MW J.H. Campbell coal-fired power plant in West Olive, MI, is scheduled to cease operations on May 31, 2025. Its retirement would further decrease available dispatchable generation within MISO's service territory, removing additional such generation along with the other 1,575 MW of natural gas and coal-fired generation that has retired since the summer of 2024. In 2021, Consumers announced that it planned to "speed closure" of Campbell in 2025, several years before the end of its scheduled design life.[5] Although MISO and Consumers have

[1] 2025 summer reliability assessment. (May 14, 2025). https://www.nerc.com/pa/RAPA/ra/Reliability%20Assessments%20DL/NERC_SRA_2025.pdf
[2] *Id*.
[3] U.S. Energy Information Administration, Michigan State Energy Profile, Oct. 17, 2024, *available at*: https://www.eia.gov/state/print.php?sid=mi.
[4] *Id.*
[5] https://www.consumersenergy.com/news-releases/news-release-details/2021/06/23/consumers-energy-announces-plan-to-end-coal-use-by-2025-lead-michigans-clean-energy-transformation

incorporated the planned retirement into their supply forecasts and acquired a 1,200 MW natural gas power plant in Covert, MI, the NERC Assessment still anticipates "elevated risk of operating reserve shortfalls."

MISO's Planning Resource Auction Results for Planning Year 2025-26, released in April 2025, note that for the northern and central zones, which includes Michigan, "new capacity additions were insufficient to offset the negative impacts of decreased accreditation, suspensions/retirements and external resources." While the results "demonstrated sufficient capacity," the summer months reflected the "highest risk and a tighter supply-demand balance" and the results "reinforce the need to increase capacity."[6]

ORDER

Given the determination that an emergency exists as discussed above, the responsibility of MISO to ensure reliability of its system, and the ability of MISO to identify and dispatch generation necessary to meet load requirements, I have determined that, under the conditions specified below, additional dispatch of the Campbell Plant is necessary to best meet the emergency and serve the public interest for purposes of FPA section 202(c). This determination is based on the insufficiency of dispatchable capacity and anticipated demand during the summer months, and the potential loss of power to homes and local businesses in the areas that may be affected by curtailments or outages, presenting a risk to public health and safety.

This Order is limited in duration to align with the emergency circumstances. Because the additional generation may result in a conflict with environmental standards and requirements, I am authorizing only the necessary additional generation on the conditions contained in this Order, with reporting requirements as described below.

FPA section 202(c) requires the Secretary of Energy to ensure that any 202(c) order that may result in a conflict with a requirement of any environmental law be limited to the "hours necessary to meet the emergency and serve the public interest, and, to the maximum extent practicable," be consistent with any applicable environmental law and minimize any adverse environmental impacts.

Based on my determination of an emergency set forth above, I hereby order:

A. From the time this Order is issued on May 23, 2025, MISO and Consumers Energy shall take all measures necessary to ensure that the Campbell Plant is available to operate. For the duration of this order, MISO is directed to take every step to employ economic dispatch of the Campbell Plant to minimize cost to ratepayers. Following conclusion of this Order, sufficient time for orderly ramp down is permitted, consistent with industry practices. Consumers Energy is directed to comply with all orders from MISO related to the availability and dispatch of the Campbell Plant.

[6] https://cdn misoenergy.org/2025%20PRA%20Results%20Posting%2020250428694160.pdf

B. To minimize adverse environmental impacts, this Order limits operation of dispatched units through the expiration of the Order. MISO shall provide a daily notification to the Department (via AskCR@hq.doe.gov) reporting whether the Campbell Plant has operated in compliance with the allowances contained in this Order.

C. All operation of the Campbell Plant must comply with applicable environmental requirements, including but not limited to monitoring, reporting, and recordkeeping requirements, to the maximum extent feasible while operating consistent with the emergency conditions. This Order does not provide relief from any obligation to pay fees or purchase offsets or allowances for emissions that occur during the emergency condition or to use other geographic or temporal flexibilities available to generators.

D. By June 15, 2025, MISO is directed to provide the Department of Energy (via AskCR@hq.doe.gov) with information concerning the measures it has taken and is planning to take to ensure the operational availability and economic dispatch of the Campbell Plant consistent with the public interest. MISO shall also provide such additional information regarding the environmental impacts of this Order and its compliance with the conditions of this Order, in each case as requested by the Department of Energy from time to time.

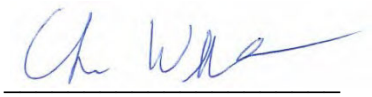
E. The extent to which MISO's current Tariff provisions are inapposite to effectuate the dispatch and operation of the units for the reasons specified herein, the relevant governmental authorities are directed to take such action and make accommodations as may be necessary to do so.

F. Consumers is directed to file with the Federal Energy Regulatory Commission Tariff revisions or waivers necessary to effectuate this order. Rate recovery is available pursuant to 16 U.S.C. § 824a(c).

G. This Order shall not preclude the need for the Campbell Plant to comply with applicable state, local, or Federal law or regulations following the expiration of this Order.

H. This Order shall be effective upon its issuance, and shall expire at 00:00 EDT on August 21, 2025, with the exception of the reporting requirements in paragraph D and applicable compliance obligations in paragraph E.

I. Issued in Washington, D.C. at 3:15:pm Eastern Daylight Time on this 23rd day of May 2025.



Chris Wright
Secretary of Energy

cc: **FERC Commissioners**
Chairman Mark Christie
Commissioner David Rosner
Commissioner Lindsay S. See
Commissioner Judy W. Chang

Michigan Public Service Commissioners
Chairman Dan Cripps
Commissioner Katherine Peretick
Commissioner Alessandra Carreon