DOE/EA-1915D

Draft Environmental Assessment

Proposed Conveyance of Land at the Hanford Site, Richland, Washington
July 2015

U.S. Department of Energy
Richland Operations Office
Richland, Washington 99352

S. SUMMARY

S.1 Introduction

The *Draft Environmental Assessment for the Proposed Conveyance of Land at the Hanford Site, Richland, Washington* (EA) analyzes the potential environmental impacts of conveying Hanford Site land to the Tri-Cities Development Council (TRIDEC) for the purpose of economic development. The EA is prepared in accordance with the Council on Environmental Quality and the U.S. Department of Energy (DOE) regulations implementing the *National Environmental Policy Act* (NEPA), and the Council on Environmental Quality (CEQ) and the Advisory Council on Historic Preservation guidance on integrating NEPA and Section 106 of the *National Historic Preservation Act* (NHPA).

A cultural resources report has been prepared to comply with NHPA Section 106 requirements. The NHPA Section 106 process is integrated with the implementation of the NEPA process (CEQ and ACHP 2013). The cultural resources report is not available to the public because of the sensitive nature of its content but the evaluation is summarized in the EA.

S.2 Purpose and Need

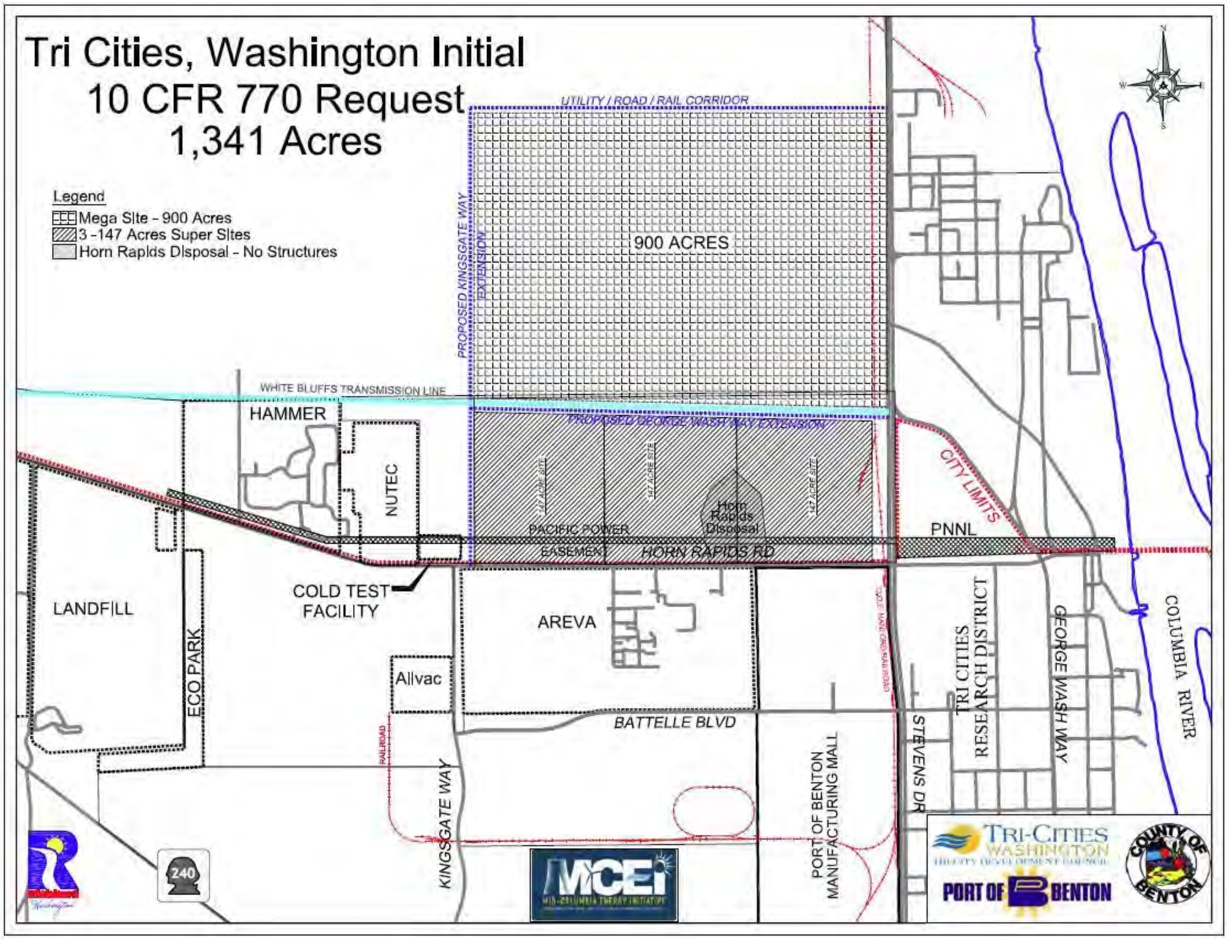
This EA has been prepared to evaluate potential environmental impacts regarding TRIDEC's land request under 10 CFR 770 and a mandate established by the *National Defense Authorization Act of 2015* (NDAA; Public Law 113-291), Section 3013, directing:

> Not later than September 30, 2015, the Secretary of Energy shall convey to the Community Reuse Organization of the Hanford Site (in this section referred to as the 'Organization') all right, title, and interest of the United States in and to two parcels of real property, including any improvements thereon, consisting of approximately 1,341 acres and 300 acres, respectively, of the Hanford Reservation, as requested by the Organization on May 31, 2011, and October 13, 2011, and as depicted within the proposed boundaries on the map titled ''Attachment 2–Revised Map'' included in the October 13, 2011, letter.

S.3 Proposed Action

The Proposed Action is to convey the lands requested by TRIDEC, or approximately equivalent acreage, in response to their land request (under 10 CFR 770) for community economic development (TRIDEC 2011a). **Figure S-1**, "TRIDEC's request map "Attachment 2–Revised Map" included in the October 13, 2011, letter and referred to in NDAA," is the map cited in the NDAA (TRIDEC 2011b).

Figure S-1. TRIDEC's request map "Attachment 2–Revised Map'' included in the October 13, 2011, letter and referred to in NDAA.



Source: TRIDEC 2011b.

S.4 No Action Alternative

Under the No Action Alternative, DOE would not convey land in response to TRIDEC's land request (TRIDEC 2011a, 2011b). DOE would then not meet the NDAA Section 3013 requirement to transfer land to the Hanford Site Community Reuse Organization not later than September 30, 2015. The No Action Alternative would not meet the purpose and need for action, but is analyzed as required by DOE's NEPA-implementing procedures (10 CFR 1021.321).

S.5 Scoping Process

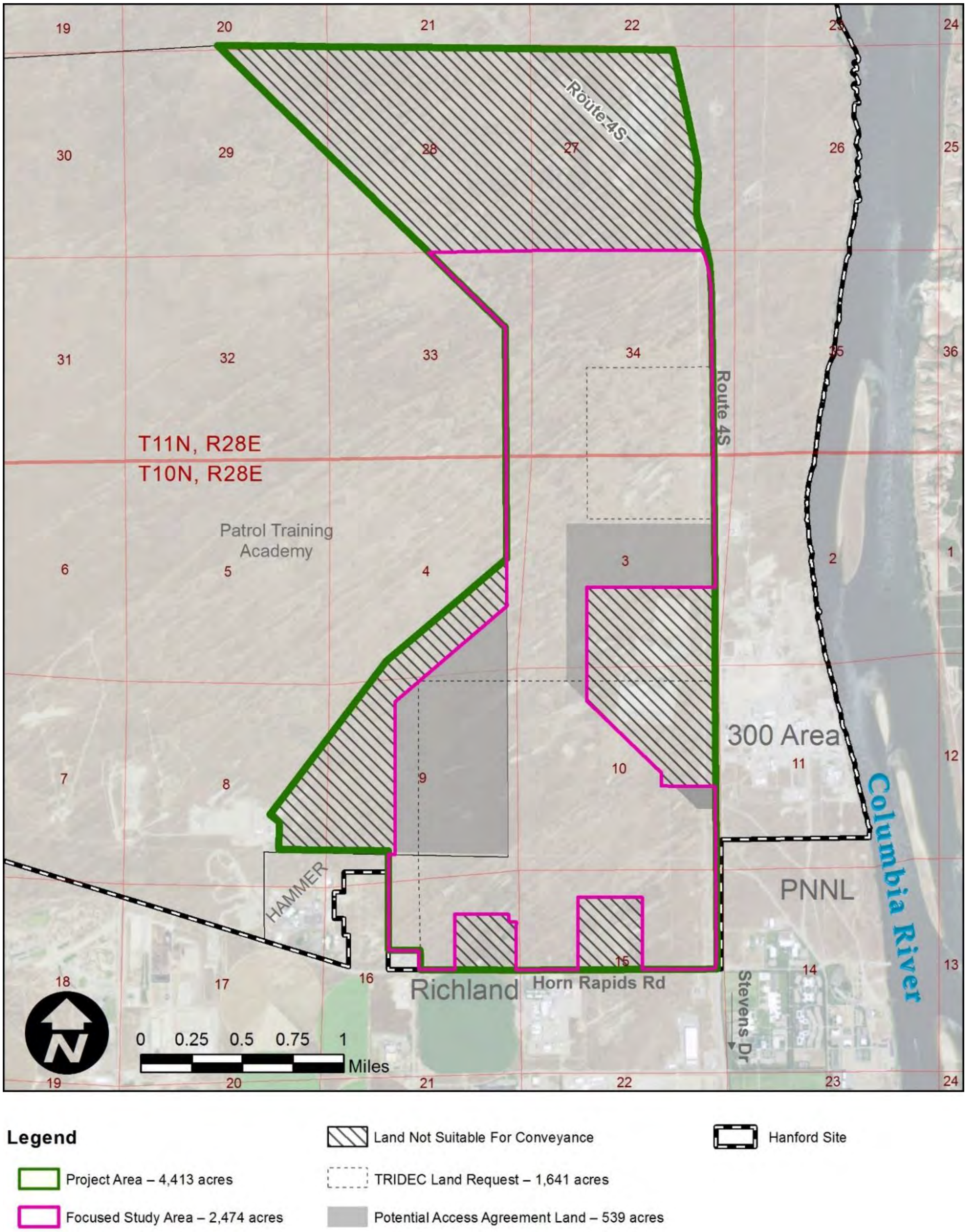
DOE published a Notice of Intent (NOI) in the *Federal Register* on September 19, 2012, that announced its intention to prepare an EA to assess the potential environmental effects of conveying approximately 1,641 acres of Hanford Site land to the local community reuse organization (DOE 2012c). Following the NOI, DOE held a public scoping meeting for the EA on October 10, 2012, for which notification was published in the Tri-City Herald on October 5, 7, and 10, 2012. During the scoping period, DOE received comments from members of the public, agencies, and tribes. The majority of the comments addressed the biological environment, the NEPA process, water resources, socioeconomics, tribal concerns, and cultural resources.

S.6 Land Suitable for Transfer

DOE recognized that there were continuing mission needs on some of the requested lands, such as an active borrow area and a safety buffer zone, making them unsuitable for conveyance. Therefore, DOE conducted a land suitability review process (see **Appendix A**) that started with the 4,413-acre Initial Hanford Site Land Conveyance Project Area (PA) identified in the NOI. Through this review process DOE identified and documented continuing mission or operational needs on the PA. **Figure S-2**, "Project Area, Focused Study Area, Potential Access Agreement Land, and Land Not Suitable for Conveyance," shows the PA and 2,474 acres of land referred to as the Focused Study Area (FSA) lands that have the least encumbrances. The FSA is made up of a 1,635-acre "main" FSA, a 300-acre "solar farm" FSA, and a 539-acre Potential Access Agreement Land (PAAL).

The approximately 1,641 acres of land that DOE would convey as required by the NDAA would be selected from the 1,935 acres (the acreage of the FSA minus the acreage of the PAAL [see **Figure S-2**]) that make up the main and solar farm FSAs. The 1,341 acres TRIDEC requested would be selected from the main FSA, and the 300 acres TRIDEC requested would be the 300-acre solar farm FSA land. Portions of the 539-acre PAAL could be conveyed but only for utilities required for other transferred FSA lands. PAAL acreage would only be conveyed, if necessary, by a realty instrument other than a deed and would stay under the institutional control and ownership of DOE.

Figure S-2. Project Area, Focused Study Area, Potential Access Agreement Land, and Land Not Suitable for Conveyance.



S.7 Environmental Consequences

This EA analyzes the potential environmental effects associated with the reasonably foreseeable future uses of FSA land, based on industry targets described in TRIDEC's proposal (TRIDEC 2011a) and target marketing industries (TMI) (TRIDEC 2014a), including warehousing and distribution, research and development, technology manufacturing, food processing and agriculture, ‘‘back office’’ (i.e., business services), and energy. In addition to information in the TRIDEC proposal and marketing studies, DOE used assumptions in the EA for its analysis based on full development of representative facilities (examples of the TMI) that would tend to maximize estimates (over estimates impacts) of potential environmental impacts associated with footprint, infrastructure, utilities, emissions, construction of buildings, projected workforce and traffic, water usage, and similar requirements.

This EA addresses the environmental consequences to geology; water resources; air quality; ecological resources; wetlands and floodplains; cultural resources; land use; visual resources; noise, vibration, and electromagnetic fields (EMF); utilities and infrastructure; transportation; waste management; socioeconomics and environmental justice; and human health and safety.

The analysis identifies the potential environmental consequences to the local region and ongoing federal missions and activities at the Hanford Site. This EA also discusses potential mitigation measures, including potential deed restrictions aimed at precluding or minimizing environmental consequences.

Construction and operation of the representative facilities are evaluated on all 1,635 acres of the main FSA; however, only about 1,341 acres would be transferred and developed. Two solar technologies were evaluated on the 300-acre solar farm FSA, but only one technology would likely be built. It is assumed that about 10 percent of the PAAL would be used for utility corridors. The most likely location for the utility corridor would be on PAAL just south of the solar farm FSA, which is an area of about 100 acres. Ten percent over all of the PAAL was assumed (a conservative estimate) to be the acreage required for the utility corridor. DOE would retain ownership of the PAAL.

Common No Action Alternative assumptions:

For the No Action Alternative (i.e., no conveyance of lands), existing activities would continue (including the two borrow pits, Navy Storage Area and Load Test [SALT] Facility, well monitoring, and others). Assumptions for these include:

- Lands stay under the federal government's institutional control and ownership, including restricted access and oversight of activities
- Lands remain largely undeveloped and undisturbed as described in the affected environment sections for ambient noise, air quality, vibration, and minimal artificial light
- Minimal changes to the natural and cultural resources except those caused by nature (e.g., weather and burrowing animals).

Important assumptions for the 1,635-acre main FSA environmental consequence analysis:

- The 1,341-acre parcel of land requested by the Tri-City Development Council (TRIDEC) would be selected, to the extent possible, from the 1,635-acre main FSA.
- Future landowners would construct and operate facilities within the target marketing industry (TMI) categories and subareas identified by TRIDEC (see **Figure 2-3**).

- Construction and operation characteristics for each selected facility example are indicative of the TMI category and subareas they represent.
- To evaluate location-specific environmental sensitivities, the multi-phase and single-phase representative industry examples could be built anywhere on the main FSA.
- To evaluate short-term construction impacts, the first phase of the multi-phased development and all the single-phase development representative examples would begin construction simultaneously for up to 18 months (although some could take a few months longer to complete than others).
- To evaluate the impacts associated with longer-term construction, the multi-phased development would be constructed and developed in phases over a 20-year period.
- Future landowners would construct and operate their facilities in compliance with applicable federal, state (e.g., the *State Environmental Policy Act* [SEPA][1]), and local laws, regulations, and other legal requirements.
- Future landowners would comply with any deed restrictions and covenants accompanying the land transfer action.
- Any development of these lands would be in accordance with local comprehensive land use plans, zoning and ordinances.

Important assumptions for the 300-acre solar farm FSA environmental consequence analysis:

- The 300-acre parcel requested by TRIDEC is the solar farm FSA analyzed in this chapter.
- Only the single-axis photovoltaic (PV) and parabolic thermal electric dish solar technology types were considered for construction and operation on the solar farm FSA because they are most likely to represent the range of construction and operation characteristics for the solar technologies identified by TRIDEC.
- The solar technology example facilities are much larger than the 300 acres proposed for transfer in the Proposed Action; therefore, their construction characteristics were linearly proportioned to the 300 acres of land.
- Two scenarios were analyzed for the solar farm, with each scenario using only a single solar technology type (i.e., PV or thermal electric) for the entire solar farm FSA.
- The entire solar farm FSA would be populated with PV arrays or dishes to a maximum reasonable density, avoiding the “infrastructure corridor” so as not to interfere with the operation, repair, or maintenance of the railroad, power lines, and similar systems.
- Future landowners would comply with any deed restrictions and covenants accompanying the land transfer action.

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[1] *State Environmental Policy Act* (SEPA) (RCW 43.21C) is implemented by the SEPA rules (WAC 197-11-704) and applies to state agencies, municipal and public corporations, and counties. Much like NEPA, after which SEPA is patterned, the SEPA process includes evaluation of a proposed action’s potential effects on the environment, mitigation measures, consideration of alternatives, documentation, and public notification. For further information about the SEPA process, please see http://www.ecy.wa.gov/programs/sea/sepa/e-review.html. If the FSA lands were transferred from federal ownership, SEPA responsibilities could be carried out by, for example, the City of Richland, Benton County, or the Port of Benton, depending on which organization is determined to be the lead agency for a proposed action.

- Future landowners would construct and operate their facilities in compliance with the federal, state, and local laws, regulations, and other legal requirements.
- Any development of these lands would be in accordance with local comprehensive land use plans, zoning and ordinances.

Important assumptions for the 539-acre PAAL environmental consequence analysis:

- These 539 acres would remain under DOE ownership.
- The PAAL includes two separate areas described in **Appendix A** (see **Figure A-6**).
  - The Patrol Training Academy Range 10 and related lands.
  - A DOE-controlled area.
- Access to PAAL would only be for the purpose of construction or maintenance of utilities on these lands.
- No public access would be allowed onto or across these lands.
- Use of this land would be subject to applicable federal laws and DOE orders, regulations, and oversight.

Construction assumptions:

Construction of the representative facilities on the main and solar farm FSAs would involve extensive land disturbing activities necessary for buildings, equipment, roads, parking areas, and utilities and infrastructure. These activities would include site clearing, grading, land contouring, adding aggregate fill, soil compacting, and excavating for footings and trenches or pilings. These activities would remove vegetation, surface soil, natural and manmade surface features, and any associated objects and materials changing the landscape from one sculptured by wind and weather to industrial development.

The use of heavy machinery to effect these changes would introduce machine noise and vibration. Noise and vibration levels would be within *Richland Municipal Code* (RMC) requirements at the representative facility site boundary[2]. Odors associated with diesel engines, lubricants, and other sources could also be noticeable but are expected to be within the RMC limits (the regulatory compliance point for odor is at the industrial use district boundary, RMC 23.26.020). The sight of large construction equipment moving across the landscape would be readily discernable. During the part of the year with fewer daylight hours, temporary lighting would flood the construction sites so that operations could be conducted safely. Lighting would be visible from the construction sites but within the "uplight" shielding requirements of the RMC (RMC 23.58.030).

After site clearing activities have concluded, construction materials would be brought onsite by heavy trucks driving across unimproved surfaces. Cranes and boom-trucks would be brought onsite for building erection, sized to the task for "tilt-up" warehouses or multistory buildings. Utility services could be extended from existing lines at Horn Rapids Road before or in sequence with these activities requiring erection of power poles or buried cable, water and sewer lines, and gas lines. During construction, pneumatic tools using air compressors are often used that create higher noise levels but must still be within the RMC at the site boundary.

[2] RMC Chapter 23.22, "Commercial Zoning Districts," Section 23.22.020, "Performance standards and special requirements"; and Chapter 9.16, "Public Nuisance Noise – Prohibited."

Facility operation assumptions:

- Future landowners would operate their facilities in accordance with all applicable federal, state, and local laws, regulations, and ordinances.
- Future landowners or parties to a PAAL agreement would comply with any restrictions and covenants or requirements in other realty instruments that would be conveyed to them.

Table 3-30 provides a summary of environmental consequences that are common to all representative facilities and their location; unique to certain representative facilities or their location; and specific to the photovoltaic solar technology, the solar-concentrating solar power dish technology, and utilities on the PAAL.

Potential mitigation measures for environmental consequences are listed at the end of each resource area discussion in **Chapter 3.0**. Many of the potential environmental consequences would be reduced by compliance with federal, state, and local laws and regulations (e.g., dust generation, lighting at night), although additional mitigation could be warranted depending on the circumstances. DOE is also developing deed restrictions and covenants as mitigation measures. As described in the land suitability discussion (see **Section 2.2.3** and **Appendix A**), Some PA lands were removed from consideration for transfer to avoid potential environmental consequences to cultural resources and ongoing federal missions.

Environmental consequences ecological resources; noise, vibration, and EMF; utilities and infrastructure; and transportation differ depending on certain representative facilities or their location.

- For ecological resources, no species are known to occur within the FSA or the larger PA that are listed as threatened or endangered under the *Endangered Species Act* (see **Appendix H**). Development within the FSA would result in habitat loss and wildlife displacement on 1,641 acres of shrub-steppe habitat. The environmental consequences can differ depending on the amount of land disturbed and whether a representative facility operates at night. Larger facilities disturb more land and nighttime operations (noise and light) can cause greater disturbance to wildlife. Of the representative facilities, warehousing facilities have both of these characteristics. The FSA, however, makes up less than one percent of lands with similar habitats on the surrounding Hanford Site, including the Hanford Reach National Monument. Mitigation approaches that could be considered by future landowners and local jurisdictions include avoiding a potential impact (location), limiting the degree of an action (the intensity of the facility operation), and compensating for a potential impact (protecting the same resource at another location in lieu of this location). Mitigation that could be undertaken by DOE could involve compensating for the loss of habitat within the FSA by making habitat improvements or enhancing habitat protection on the Hanford Site.
- For cultural resources, cultural studies identified 28 sites and 9 isolated finds within the FSA. Two of these sites (Richland Irrigation Canal and Hanford Site Plant Railroad) had been previously found eligible for the National Register of Historic Places. **Section 3.6.1.2**, “Identification of Cultural Resources and Historic Properties” describes the process used for identifying cultural resources and historic properties including archival research, literature research, and field investigations. DOE funded four tribes – the Confederated Tribes of the Umatilla Indian Reservation, Confederated Tribes and Bands of the Yakama Nation, the Nez Perce Tribe, and the Wanapum – to provide traditional cultural property studies – the summaries of which are included in **Appendix G**.
- The tribal summaries contain information about areas of religious and cultural significance (see **Appendix G**) to the tribes. With few exceptions, specific locations were not identified

in the tribal summaries. These exceptions include three properties that DOE had previously determined to be eligible for listing in the NRHP. The tribal summaries described potential effects that would occur from the Proposed Action to these three properties: Laliik, Wanawish, and Gable Mountain. All three properties are outside of the FSA and this EA describes effects to these properties in **Section 3.8,** "Visual Resources." The tribal summaries also contain information about other named and unnamed places and traditional resources (e.g., plants) of importance to the tribes. Additional information about areas of importance has been provided, and DOE is continuing to consult with tribes and will consider the information it receives. DOE will continue the NHPA process until complete.

NRHP-eligible properties discussed in this EA are the Hanford Site Plant Railroad, the Richland Irrigation Canal, and a historic homestead.

- The Hanford Site Plant Railroad was previously identified and determined eligible. Mitigation measures were completed in compliance with the Hanford Built Environment Programmatic Agreement (DOE 1996b) and included a Historic Property Inventory Form and documentation in the Hanford Site Manhattan Project and Cold War Era Historic District (DOE 1997b). The railroad would be adversely affected under NHPA if transferred out of federal ownership, and any appropriate additional mitigation measures will be addressed as part of the Section 106 process.
- The Richland Irrigation Canal is present on FSA land that could be transferred, FSA land that could be conveyed by other realty instrument other than a deed (PAAL), and Hanford Site lands not considered for conveyance. The canal would be adversely affected under NHPA if transferred out of federal ownership. The adverse effect determination reached in accordance with the NHPA implementing regulations and any appropriate mitigation measures will be addressed as part of the Section 106 process. Physical segments of the canal could be demolished in part or whole by industrial development on the FSA.
- The NRHP-eligible historic homestead located on the PA is not within the FSA and is not being considered for conveyance, and therefore is not directly adversely affected under NHPA Section 106.

Land disturbance from construction has the potential to destroy archeological sites or affect cultural resources located on the FSA. Heavy machinery used during construction is known to generate noise and vibration well above the current ambient background levels. Since construction activities include the removal of surface vegetation, the change in the surface characteristics would also mean that traditional plant species that could be used by the tribes would be removed and no longer available. The Hanford Site, however, includes large tracts of lands with similar plant communities.

- For noise, vibration, and EMF, environmental consequences can differ depending on location and type of facilities. For construction, the closer to Pacific Northwest National Laboratory (PNNL) and Laser Interferometer Gravitational-wave Observatory (LIGO), the greater the impact. The representative facilities with the most potential to impact the sensitive receptors at PNNL and LIGO are industrial facilities (biofuels manufacturing and the rail distribution center with trains and trucks). DOE is preparing deed restriction language to prohibit certain levels of noise, vibration, and EMFs on parts of the FSA nearest to PNNL and, to limit vibrations that could impact LIGO.
- For utilities and infrastructure, construction of the representative facilities would require the phased introduction of new infrastructure (e.g., water lines, sewer lines, and natural gas pipelines) to service the FSA where these utilities do not currently exist. Certain

representative facilities, specifically the biofuels manufacturing facility, the multi-phase commerce center, and the wine warehouse, would have higher utility demands. The City of Richland has long-range plans to improve the electrical infrastructure to service the area that could include the construction of one or more additional electrical substations. The Proposed Action would result in new, long-term demand for utility services. New infrastructure and services would be provided and maintained by the City of Richland, BPA, and Cascade Natural Gas, as applicable. Environmental consequences for constructing infrastructure are addressed in **Chapter 3.0** for each applicable resource area.

- For transportation, the construction of the representative facilities would result in an increase in traffic on local roads and highways for the duration of construction. Operation of the representative facilities would also increase traffic and congestion on local roadways particularly during peak commuting times. The amount of traffic and degree of congestion would vary depending on the type and number of facilities. The warehouse representative facility that involves a rail-based receiving and distribution facility could result in trains blocking Horn Rapids Road and potentially cause road blockage and vehicle delays. Mitigation measures identified by the applicable local jurisdiction could require the developer to conduct a project- and site-specific traffic impact analysis for planned developments and identify access and capacity improvements that would be required. Although not obligatory or within the control of DOE, commuter traffic could be mitigated by using mass transit, car-pooling, and other ride-sharing measures.

For the other resource areas, there are no appreciable differences in the types of impacts due to the construction of any representative facility. The environmental consequences for the other resource areas discussed in this EA are summarized below:

- For geology, partial or complete removal, redistribution, mixing of soil horizons, and soil compaction would affect soil permeability and porosity. Exposed surface areas are susceptible to soil erosion from wind and precipitation. Topography would be altered by grading land for building, roads, and parking lots. Disturbance of 1 acre or more requires a National Pollutant Discharge Elimination Permit, which requires erosion, sediment, and stormwater management controls to minimize the potential for soil removal.
- For water resources, construction of buildings and parking lots would create impervious surfaces that would lead to increased stormwater runoff during precipitation (rain or snow) events, which could result in increased soil erosion. Development plans would include stormwater retention features required by state stormwater pollution control regulations to provide the appropriate controls for mitigating any water quality and quantity impacts.
- For air quality, construction activities would generate particulate emissions as fugitive dust from ground-disturbing activities and from the combustion of fuels in construction equipment. Fugitive dust can be mitigated by application of water to areas of disturbance. Although not obligatory or within the control of DOE, during operation of built facilities, potential mitigation measures could be undertaken by future landowners. Air emissions by commuter vehicles could be mitigated by using mass transit or car-pooling. Air emissions by commercial haul trucks could be mitigated by encouraging facility owners to minimize truck idling, using yard-trucks (efficient slow-speed vehicles) to move trailers around a facility, and designing roads and traffic patterns to minimize truck idling situations (e.g., having few stop signs and maximizing one-way truck movement). Long-term, moderate effects on air quality would result from the operation of the various representative facilities that could be on the main FSA.

- There would be no effects on wetlands or floodplains from construction or operation of the representative facilities because neither of these resources has been identified within the PA nor within close enough proximity to the PA to experience effects.
- For land use, the construction of any of the representative facilities would be in accordance with local comprehensive land use plans zoning, and ordinances. The land conveyance would result in a change in current land use from essentially undeveloped to industrial land uses. The proposed uses would be consistent with land use plans; however, opportunities for other future land uses would be foreclosed.
- For visual resources, development of the FSA would result in a change in the visual resource management classification of the conveyed lands from Class III to Class IV, as defined by the Bureau of Land Management. The buildings and infrastructure on the built-out site would be consistent with the existing development in the 300 Area to the east of the analysis area and the City of Richland development to the south. However, in the western and northern areas of the PA, where the existing setting is primarily undeveloped, construction of the representative facilities would change the landscape setting to industrial. If a concentrating solar power system were installed on the solar farm FSA, a detailed light and glare analysis may be required to identify mitigation measures.
- For waste management, solid nonhazardous waste generated during construction and operation of the representative facilities would most likely be recycled or transported to the Horn Rapids Sanitary Landfill for disposal. The projected waste volumes represent less than 15 percent of the current disposal rate at the landfill. Although not obligatory or within the control of DOE, potential mitigation measures could be undertaken by a future landowner and local jurisdictions such as providing public recognition or economic development incentives to design, construct, and operate their facilities to minimize waste production and maximize waste recycling, and, thereby reduce demand on city and county waste management facilities. The Proposed Action would generate solid and liquid wastes that would add to existing waste streams. The amount of wastes that would be generated is not expected to exceed the capabilities of existing waste management systems.
- For socioeconomics, development of the FSA would result in a long-term economic benefit to the Tri-Cities area by the creation of new jobs within the local labor force. For Environmental Justice, U.S. Census Bureau data were used to identify minority populations in the Tri-Cities area. The closest census block group had a minority population relatively greater (over 29 percent) than that of the PA and the immediately surrounding area. The majority of this block group, however, does not include residences. The nearest residences (minority or not) are located within the southern part of the census tract, almost 2 miles southeast of the PA. There would not be disproportionately high and adverse human health or environmental effects to minority or low-income populations as a result of the Proposed Action.
- For human health and safety, soil sampling, gamma scanning surveys, land feature surveys, and ALARA assessment were completed in compliance with the requirements in DOE O 458.1 for the control, clearance, and release of DOE property containing potential residual radioactivity. These activities have demonstrated that there are no radiological sources within the property. Radiological dose consequences from accidents for facilities (Buildings 324 and 325) determined to have potential accident risks to the FSA were calculated. These facilities are located approximately 587 meters to the east of the FSA. The dose consequences within the FSA would not require any unique mitigation measures to ensure the adequate protection of the public health, safety, and environment. Following land conveyance DOE and the local and state agencies responsible for performing the function of

emergency management would apply the same emergency planning and response actions to members of the public in the transferred lands as applied to the population at large.

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Abbreviations and Acronyms

μT	microtesla
AC	alternating current
ACGIH	American Conference of Governmental Industrial Hygienists
ACS	American Community Survey
ALARA	as low as reasonably achievable
AMSL	above mean sea level
ANSI	American National Standards Institute
APE	area of potential effect
BLM	Bureau of Land Management
BMP	best management practice
BPA	Bonneville Power Administration
Bq	becquerel
BRMP	Biological Resources Management Plan
CA/T	Central Artery/Tunnel Project
CEQ	Council on Environmental Quality
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act*
CFR	Code of Federal Regulations
Ci	curie
CLUP	comprehensive land-use plan
CO	carbon monoxide
CO_2	carbon dioxide
CSP	concentrating solar power
D&D	decontamination and decommissioning
DAHP	Washington State Department of Archeology and Historic Preservation
dB	decibel
dBA	A-weighted decibel
dBAI	A-weighted impulse decibel
DC	direct current
DOE	U.S. Department of Energy
DOE/RL	DOE Richland, WA
EA	environmental assessment
EDNA	environmental designation for noise abatement
EIS	environmental impact statement
ELF	extremely low frequency
EMA	elevated measurement area
EMF	electromagnetic field
EMI	electomagnetic interference
EMSL	Environmental Molecular Sciences Laboratory
EPA	U.S. Environmental Protection Agency
EPZ	Emergency planning zone
FHWA	U.S. Federal Highway Administration
FRA	Federal Railroad Administration
FSA	Focused Study Area

ft	foot
ft^3/sec	cubic feet per second
FTA	Federal Transit Administration
g	gram
G	gauss
gal	gallon
GHG	greenhouse gas
GHz	gigahertz
GIS	geographic information system
H-3E	tritium equivalence
HAMMER	Hazardous Materials Management and Emergency Response
HCP	Hanford Comprehensive Land-Use Plan
HEIS	Hanford Environmental Information System
HEMP	*Hanford Emergency Management Plan*
HFB	heterogeneous feed biorefinery
HRD	Horn Rapids Disposal
HRNM	Hanford Reach National Monument
HST	high speed train
HVAC	heating, ventilation, and air conditioning
Hz	Hertz
ICNIRP	International Commission on Non-Ionizing Radiation Protection
in	inch
ISO	International Standards Organization
JDES	John Deere Electronics Solutions Inc.
kg	kilogram
kHz	kilohertz
km	kilometer
KOP	key observation point
kV	kilovolt
kVA	kilo volt-ampere
kW	kilowatt
lb	pound
LCF	latent cancer fatality
LEED	Leadership in Energy and Environmental Design
LIGO	Laser Interferometer Gravitational-wave Observatory
LLW	low-level radioactive waste
L_{max}	maximum sound pressure level
m	meter
m^3	cubic meter
m^3/sec	cubic meter per second
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MBTA	*Migratory Bird Treaty Act*
MEI	maximally exposed individual
mG	milligauss
mgd	million gallons per day

MHz	megahertz
mm	millimeter
MRF	Materials Recovery Facility
MSA	metropolitan statistical area
MW	megawatt
NAAQS	National Ambient Air Quality Standard
NCRP	National Council on Radiation Protection and Measurements
NDAA	*National Defense Authorization Act of 2015*
NEPA	*National Environmental Policy Act*
NHPA	*National Historic Preservation Act*
NO_x	nitrogen oxides
NPDES	National Pollutant Discharge Elimination System
NREL	National Renewable Energy Laboratory
NRHP	National Register of Historic Places
nT	nanotesla
OSHA	Occupational Safety and Health Administration
PA	project area
PAAL	Potential Access Agreement Land
pCi	picocurie
PM_{10}	particulate matter less than 10 micrometers in diameter
$PM_{2.5}$	particulate matter less than 2.5 micrometers in diameter
PNNL	Pacific Northwest National Laboratory
PNSO	Pacific Northwest Site Office
PPV	peak particle velocity
PSD	prevention of significant deterioration
PSF	Physical Sciences Facility
PTA	Patrol Training Academy
Pu-239E	plutonium equivalence
PV	photovoltaic
Q-Wing	Quiet Wing
R&D	research and development
RC	reactor compartment
RCRA	*Resource Conservation and Recovery Act*
RCW	Revised Code of Washington
RESRAD	Residual Radioactivity
RMC	Richland Municipal Code
RMS	root mean square
ROI	region of influence
ROW	right-of-way
RPL	Radiochemical Processing Laboratory
rpm	revolutions per minute
RQ	reportable quantity
RSF	Research Support Facility
RTI	Rainsville Technology Inc.
SALT	Storage Area and Load Test

sec	second
SEPA	*State Environmental Policy Act*
SHPO	State Historic Preservation Officer
SO_2	sulfur dioxide
SPL	sound pressure level
T	tesla
TCP	traditional cultural property
TLV	threshold limit value
TMI	target marketing industry
TNM	Traffic Noise Model
TRIDEC	Tri-City Development Council
U.S.C.	United States Code
ULF	ultra low frequency
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service
V	volt
VdB	vibration velocity decibel
VLF	very low frequency
VRM	Visual Resource Management
WAC	Washington Administrative Code
WDFW	Washington Department of Fish and Wildlife
WIDS	Waste Information Data System

1.0 INTRODUCTION

The U.S. Department of Energy (DOE) Hanford Site encompasses 586 square miles in southeastern Washington State just north of Richland (see **Figure 1-1**, "Hanford Site Location Map"). Over half of the 586 square miles is included within the Hanford Reach National Monument created by Presidential Proclamation 7319 on June 9, 2000, under the authority of the *Antiquities Act of 1906* (16 USC 432). Plutonium was produced at Hanford from 1943 to 1987, when its last reactor ceased operation. Over the years, activities shifted from plutonium production to nuclear power generation, advanced reactor design, basic scientific research, and research related to the development of nuclear weapons. Waste management and environmental remediation are now the largest part of the remaining Hanford Site's activities.

The acreage being considered in this environmental assessment (EA) is part of approximately 59 square miles of Hanford Site lands previously designated by DOE for industrial uses under the Hanford Comprehensive Land-Use Plan, based on analyses presented in the *Final Hanford Comprehensive Land-Use Plan Environmental Impact Statement* (DOE 1999a) and its Record of Decision (DOE 1999b).

In accordance with 10 CFR 770, "Transfer of Real Property at Defense Nuclear Facilities for Economic Development," the Tri-City Development Council (TRIDEC), a DOE designated Community Reuse Organization for the Hanford Site and 501(c)(6) nonprofit corporation, submitted a proposal to DOE in May 2011 (amended October 2011)[3] requesting the transfer of approximately 1,641 acres of land located in the southeastern corner of the Hanford Site near the City of Richland in Benton County, Washington, for economic development purposes.[4] This proposal, *10 CFR 770 Proposal to Transfer Tract 1 at Department of Energy Hanford Site to the Community Reuse Organization Tri-City Development Council (TRIDEC) for Economic Development* (TRIDEC 2011a), was submitted by TRIDEC in cooperation with the City of Richland, Port of Benton, and Benton County. The proposal states that after transfer of lands to TRIDEC, they will subsequently transfer ownership either to a private user or to one of its public agency partners, such as the City of Richland. On August 24, 2011, DOE responded to TRIDEC's request notifying TRIDEC that the proposal was complete and that DOE would begin the necessary regulatory reviews and actions related to transfer of property (see **Chapter 5.0**). **Figure 1-2**, "TRIDEC Land Transfer Request Parcels," shows the 1,341-acre parcel ("main parcel") request and two additional 300-acre parcel ("small parcel") locations. After making the initial land request, TRIDEC modified that request to include a 300-acre parcel (the "Original TRIDEC Land Transfer Request 300 Acres" in **Figure 1-2**). Subsequently, TRIDEC determined that a better location for the parcel that was farther south (the "Revised TRIDEC Land Transfer Request 300 Acres" [Howard 2014]) as shown on **Figure 1-2**.

[3] TRIDEC's original proposal submitted in May 2011 (TRIDEC 2011a) included a request for approximately 1,341 acres. The proposal was amended on October 13, 2011 (TRIDEC 2011b), to include an additional 300 acres (approximately 0.47 square miles) bringing the total requested acreage to approximately 1,641 acres.
[4] "Economic development" means the use of transferred DOE real property in a way that enhances the production, distribution, or consumption of goods and services in the surrounding region(s) and furthers the public policy objectives of the laws governing the downsizing of DOE's defense nuclear facilities" (65 FR 10689).

Figure 1-1. Hanford Site Location Map.

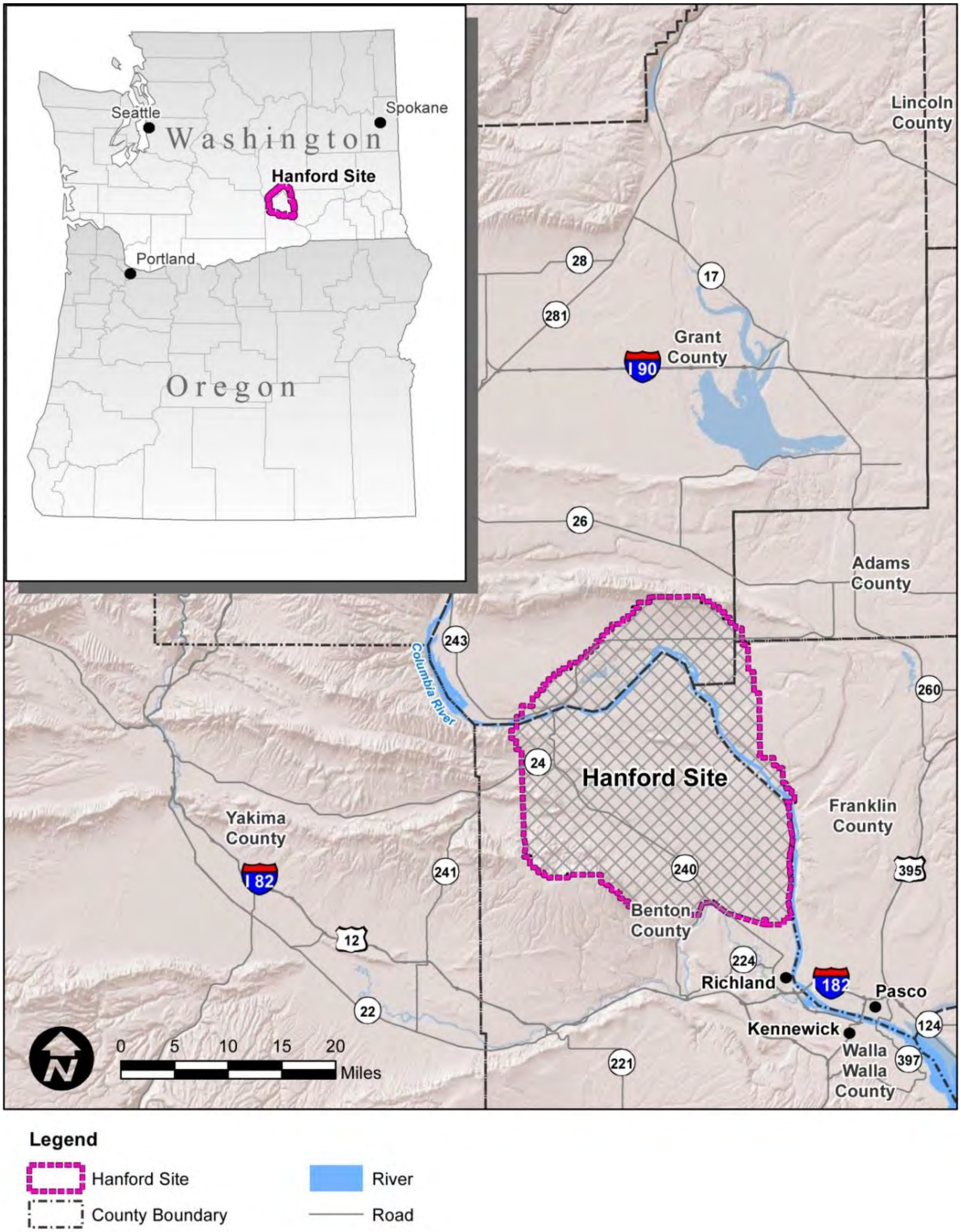
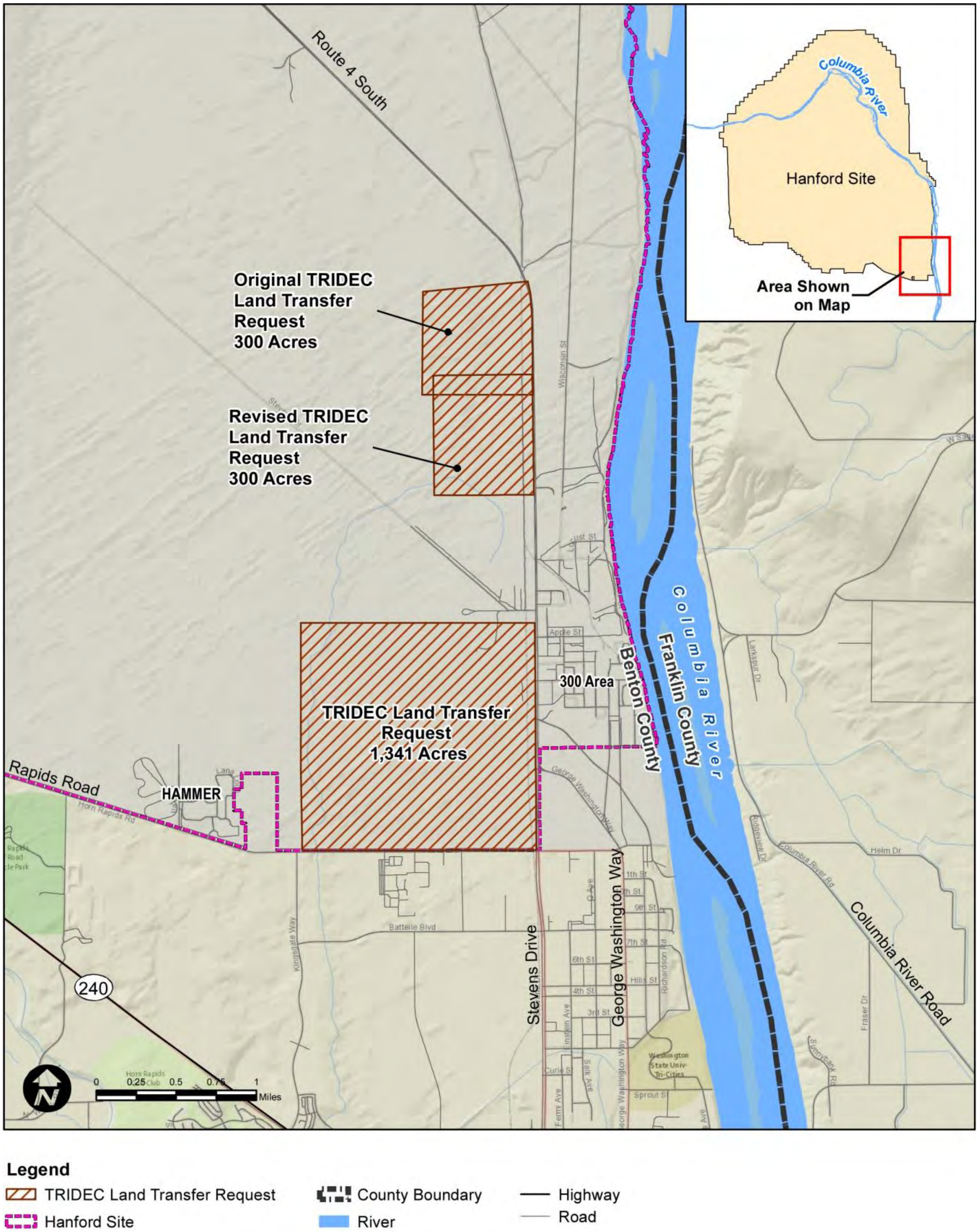


Figure 1-2. TRIDEC Land Transfer Request Parcels.



1.1 Background

The *Atomic Energy Community Act of 1955* (42 USC 2301 et seq.) provided the authority for the federal government to support municipalities that had been established as wholly government-owned communities while these communities transitioned to self-sufficiency. Under the Act, national policies were established regarding the obligations of the United States to the three "Atomic Energy Communities," of which Hanford is one. These policies were directed at terminating federal government ownership and management of the communities by facilitating the establishment of local self-government, providing for the orderly transfer to local entities of municipal functions, and providing for the orderly sale to private purchasers of property within these communities with a minimum of dislocation. The establishment of self-government and transfer of infrastructure and land were intended to encourage self-sufficiency of the communities like those in the Hanford Site area through the establishment of a broad base for economic development.

The primary mission at Hanford for more than 40 years was associated with the production of nuclear materials for national defense. Land management and development practices at the Hanford Site were driven by resource needs for nuclear production, chemical processing, waste management, and research and development activities. DOE developed infrastructure and facility complexes to accomplish this work, but large tracts of land used as protective buffer zones for safety and security purposes remained largely undisturbed. These buffer zones now contain biological and cultural resource settings that are unique in the Columbia Basin region, and much of the area is now part of the Hanford Reach National Monument.

In the late 1980s, the primary DOE mission for the Hanford Site changed from defense materials production to environmental remediation. In 1989, DOE entered into the *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) with the U.S. Environmental Protection Agency and the Washington State Department of Ecology (Ecology et al. 2015). Accordingly extensive efforts are underway at Hanford to cleanup contamination resulting from past nuclear defense research and development activities dating back to World War II.

With remediation and cleanup progress in recent years, the local community is focusing on the need to transition from an economy focused largely on DOE and Hanford Site activities to one based on private sector or other non-DOE federal agencies. TRIDEC, as the DOE-designated Community Reuse Organization for the Hanford Site, is chartered with establishing and promoting economic development in the community to effect this transition.

Beginning in 1996 and continuing through 2014 (TRIDEC 2004, 2005a, 2005b, 2005c, 2006, 2014a), TRIDEC commissioned private firms and consultants to conduct economic development studies with the intent to develop business development marketing strategies and identify target industries for future economic development. TRIDEC engaged in marketing and business recruitment activities to identify development opportunities. Through these approaches, "clusters" of general industries were identified as "target market areas." The studies did not use the same terminology or group their targeted areas into the same "cluster" categories, but they can be grouped generally as follows:

- Warehousing and distribution (manufactured parts and materials distribution, food and agriculture, refrigerated warehousing and storage, material handling, packaging and crating, and logistics)
- Research and development (scientific research, software, data security, computation, energy technology, environmental, and biotechnology)

- Technology manufacturing (defense manufacturing, sensor manufacturing, medical device manufacturing, food processing, machinery manufacturing, advanced materials manufacturing, and carbon fiber manufacturing)
- Food processing and agriculture (wine processing, food processing, agricultural products, and craft beer production)
- Back office (call centers, administrative processing, data processing, information technology, remote sensing, professional services, and training).

The more recent TRIDEC marketing studies (TRIDEC 2014a) also included the energy sector (i.e., solar energy production, smart grid, and biofuels manufacturing). DOE considers these areas of business the reasonably foreseeable land uses that this EA should evaluate for potential environmental consequences. There is no development plan or specific projects to analyze, therefore representative examples of each of these land use business development types are presented in **Chapter 2.0**, and described in more detail in **Appendix E**, "Representative Facilities."

1.2 Purpose of and Need for Agency Action

The purpose of and need for DOE action is to consider the TRIDEC land request under 10 CFR 770 (TRIDEC 2011a, 2011b).

Moreover, conveyance of land to TRIDEC is mandated by the *National Defense Authorization Act of FY 2015* (Public Law 113-291). Section 3013 of the Act is entitled "Land Conveyance, Hanford Site, Washington," and states that:

> …not later than September 30, 2015, the Secretary of Energy shall convey to the Community Reuse Organization of the Hanford Site (in this section referred to as the 'Organization') all right, title, and interest of the United States in and to two parcels of real property, including any improvements thereon, consisting of approximately 1,341 acres and 300 acres, respectively, of the Hanford Reservation, as requested by the Organization on May 31, 2011 and October 13, 2011, and as depicted within the proposed boundaries on the map titled 'Attachment 2-Revised Map' included in the October 13, 2011, letter.

1.3 U.S. Department of Energy Decisions to be Made

Under the laws and regulations giving DOE the authority to dispose of property (including the *Atomic Energy Act of 1955*, Section 161; regulations for "Transfer of Real Property at Defense Nuclear Facilities for Economic Development" [10 CFR 770]), and the *National Defense Authorization Act for FY 2015*), DOE must decide on the acreage determined to be suitable by DOE for conveyance for the intended use, and by TRIDEC for economic development. To be suitable for conveyance, DOE must (1) determine whether there are any continuing mission needs, such as security and safety buffer zones on some of the requested lands; (2) determine whether property easements, deed restrictions, or institutional controls[5] will be required; and (3) ensure that any requirements for remediation of the property for conveyance has been identified and completed where required prior to conveyance.

[5] Institutional controls are those methods that can be used to "…appropriately limit access to, or uses of, land, facilities and other real and personal properties; protect the environment (including cultural and natural resources); maintain the physical safety and security of DOE facilities; and prevent or limit inadvertent human and environmental exposure to residual contaminants and other hazards." (DOE 2003a).

1.4 Scoping Process and Comments Received

DOE published a Notice of Intent in the *Federal Register* on September 19, 2012, that an EA would be prepared to assess the potential environmental impacts of conveying certain land tracts located at the Hanford Site in Benton, County, Washington (77 FR 58112).

DOE held a public scoping meeting for the EA on October 10, 2012, for which notification was published in the *Tri-City Herald*. See **Chapter 6.0** for a description of public scoping for this EA.

1.5 Environmental Assessment Scope

DOE has prepared this EA to assess the reasonably foreseeable environmental effects associated with the Proposed Action and No Action Alternative in accordance with the Council on Environmental Quality (CEQ) *National Environmental Policy Act* (NEPA) regulations and DOE's NEPA-implementing regulations (40 CFR 1500-1508 and 10 CFR 1021, respectively). This EA describes the affected (i.e., existing) environment of the Initial Hanford Site Land Conveyance Project Area (4,413 acres) as a baseline for evaluating impacts from the alternatives.

This EA analyzes the reasonably foreseeable environmental effects associated with the probable future uses of lands within an area referred to in this EA as the Focused Study Area (FSA)[6], based upon industry targets described in the TRIDEC proposal, including warehousing and distribution, research and development, technology manufacturing, food processing and agriculture, and back office. A recent TRIDEC marketing study (TRIDEC 2014a) added another reasonably foreseeable category, energy, which included biofuels manufacturing. TRIDEC's amended request (TRIDEC 2011b) for the 300-acre parcel added solar energy to the analysis. In addition to data and information available in the TRIDEC proposal and marketing studies, DOE used analytical assumptions in this EA based upon representative facilities that would tend to maximize estimates of reasonably foreseeable environmental impacts associated with footprint, infrastructure, utilities, emissions, construction of buildings, projected workforce and traffic, water usage, and similar requirements.

Environmental effects addressed in the analysis in this EA include the reasonably foreseeable effects associated with geology and soils, water resources, air quality, ecological resources, wetlands and floodplains, cultural and historic resources, land use, visual resources, noise, utilities and infrastructure, transportation, waste management, socioeconomics and Environmental Justice, and human health and safety.

The analyses identify the environmental effects that are reasonably foreseeable to the local region as well as to ongoing DOE missions and activities at the Hanford Site. This EA explores mitigation measures, as appropriate, including potential deed restrictions aimed at precluding or minimizing environmental consequences. Mitigation measures are presented at the end of each resource area analysis in **Chapter 3.0**.

Other regulatory compliance actions and information needed for the land conveyance process include:

- Completion of consultation requirements under Section 106 of the *National Historic Preservation Act* (NHPA) (16 USC 470 et seq.) and its implementing regulations (36 CFR 800). The NEPA process associated with this EA is being coordinated with NHPA Section

[6] For simplicity, throughout this EA, the 1,341-acre and 300-acre lands (or their equivalent acreage) are referred to as the "main FSA" and the "solar farm FSA," respectively.

106 requirements to the greatest extent possible and a summary of the NHPA studies is included.

- Completion of requirements for "Compliance with Floodplains/Wetlands Environmental Review Requirements" (10 CFR 1022). No floodplains or wetlands are located on the FSA or surrounding area, therefore there would be no effect to floodplains and wetlands by the Proposed Action.

1.5.1 Uncertainties and Limitations in the Environmental Assessment Analysis

At this time, no specific end users or development proposals have been identified or proposed. This uncertainty, as well as those related to the suitability of the originally requested lands, affect the EA analysis. The suitability limitations have the effect of both reducing the amount of land that can be considered for conveyance, and determining the specific location(s) of the land that could be available for conveyance – see further discussion at the end of this section.

This EA uses a "sliding-scale" approach to analysis. The CEQ regulations require agencies to "focus on significant environmental issues and alternatives" (40 CFR 1502.1) and discuss impacts "in proportion to their significance" (40 CFR 1502.2(b)). CEQ and DOE refer to this as the "sliding-scale" approach so that those actions with greater potential effect can be discussed in greater detail in NEPA documents than those that have little potential for impact.

The assessment approach for the lands considered for the main FSA includes a bounding analysis approach. Neither the CEQ NEPA-implementing regulations (40 CFR 1500-1508) nor the DOE NEPA regulations (10 CFR 1021) specifically address bounding analyses in NEPA documents. However, DOE provides guidance on when a bounding approach is useful (DOE 2005a). Such an approach is useful to simplify assumptions and address uncertainty because needed information on the activities to be evaluated is unknown. A bounding analysis is designed to identify a range of potential impacts. As a practical matter, a bounding analysis provides conservatism (i.e., over estimates impacts) because of the uncertainty in the available data. The probable future uses were provided in the TRIDEC proposal and are used in the EA as the basis for the bounding analysis.

Two important aspects of the land considered potentially suitable for the "main parcel" are known or can be reasonably assumed. First, the total land area requested by TRIDEC for development is given. Second, the business development categories listed in **Section 1.1**, "Background" cited by TRIDEC, can reasonably be assumed to represent the types of development for this land. This EA requires bounding analysis for this land largely because of uncertainties that affect the ability to evaluate environmental consequences. These include, for example:

- Whether any or all of the parcel would be developed
- The ultimate land uses of the parcel once conveyed
- Which areas of the parcel would be developed and when
- The order of development for the different parts of the parcel
- Where on this parcel any specific land use would be located.

The assessment of the "small parcel" (solar farm) does not need a bounding analysis approach because the uncertainties mentioned above do not apply. The total land area requested by TRIDEC for this development of the small parcel is provided along with the specific land use. TRIDEC in their 10 CFR 770 request, designated this land specifically for solar technology development and in their request they identified the solar technology types they would consider. Some uncertainties still exist for this parcel but they can be addressed based on a set of reasonable assumptions without a bounding approach. The key assumptions are explained in **Chapter 3.0**.

The other uncertainty, land suitability limitations, was the reason for identifying a 4,413-acre project area as the total EA analysis area from which DOE could convey approximately 1,641 acres of suitable land. The suitability limitations are for reasons such as safety, security, and potential interference from or to existing federal and non-federal facility operations, as well as the need to avoid potential cultural and ecological impacts. The land suitability limitations are discussed in **Chapter 2.0** and described in detail in **Appendix A**, “The Hanford Site Land Suitability Review.”

The lands being considered for conveyance in the FSA are comprised of land that was in non-federal ownership prior to acquisition by the federal government for the Hanford nuclear facility.

2.0 ALTERNATIVES CONSIDERED IN THIS ENVIRONMENTAL ASSESSMENT

This chapter evaluates two alternatives, the Proposed Action and the No Action Alternative. The No Action Alternative provides a baseline for comparison with the environmental impacts that could result from development after the land is conveyed. Under the No Action Alternative, the U.S. Department of Energy (DOE) would retain all right, title, and interest to the lands within the analysis area and no property conveyance would occur.

The Proposed Action is to convey the lands requested by Tri-City Development Council (TRIDEC), or approximately equivalent acreage, in response to their land request (under 10 CFR Part 770) for community economic development (see **Figure 2-1**, "Project Location," and **Sections 2.2.1** and **2.2.2**). Relevant to the Proposed Action, DOE's statutory mission and responsibilities are:

- Responding to TRIDEC's land request under the procedural/implementing DOE regulations in 10 CFR 770.7. The regulatory requirements of paragraph 770.7(d)(2) require that the DOE Field Office Manager "Ensures that any required environmental reviews have been completed."
- Conveying lands to TRIDEC as required by the *National Defense Authorization Act* (NDAA) (Public Law 113-291). Section 3013 of this Act addresses the Proposed Action: "Land Conveyance, Hanford Site, Washington." The Act states that "not later than September 30, 2015, the Secretary of Energy shall convey to the Community Reuse Organization of the Hanford Site … all right, title, and interest of the United States in and to two parcels of real property, including any improvements thereon, consisting of approximately 1,341 acres and 300 acres, respectively, of the Hanford Reservation, as requested by the Organization on May 31, 2011 and October 13, 2011…"

TRIDEC requested specific tracts of land that are close to existing community infrastructure; however, the suitability of this land for transfer had not been determined at the time of the request. DOE decided to establish a larger study area that encompassed the requested lands and additional surrounding areas, referred to as the project area (PA). **Section 2.2.3** explains the process that was undertaken to determine which of these lands would be suitable for conveyance. Of the 4,413 acres initially considered, there are 2,474 acres potentially suitable for conveyance and 1,935 of those acres could be transferred by deed. Any alternative based on the transfer of 1,641-acres of land would therefore differ only by 294 acres (i.e., 1,935 acres minus 1,641 acres), which is not an appreciable enough difference to identify additional alternatives. DOE is not aware of any other alternatives to the proposed action that would reasonably meet the Proposed Action purpose and need described in **Chapter 1.0**.

2.1 No Action Alternative

Under the No Action Alternative, DOE would not convey any land in response to TRIDEC's land request (TRIDEC 2011a, 2011b). DOE would then not meet the intent of the NDAA, Section 3013 requirement to transfer approximately 1,641 acres of land to TRIDEC not later than September 30, 2015.

The No Action Alternative would not meet the stated purpose and need for action, but is still analyzed as required by the Council on Environmental Quality regulations and DOE *National Environmental Policy Act* (NEPA)-implementing procedures[7] (10 CFR 1021.321). In this alternative, the federal

[7] "…DOE shall assess the no action alternative in an EA, even when the proposed action is specifically required by legislation or a court order." (10 CFR 1021.321).

government would retain ownership of the requested lands and there would be no change in land use caused by the Proposed Action. Existing activities, such as environmental remediation, utility corridors, and other administrative purposes would continue.

2.2 Proposed Action

The Proposed Action is for DOE to convey approximately 1,641 acres of land to TRIDEC. TRIDEC would subsequently convey these lands, in whole or part, to a public entity partner (e.g., City of Richland) or private ownership for purposes of economic development (Section 770.7(a)(1)(ii) [TRIDEC 2011a]).

DOE may convey the specific land requested by TRIDEC or adjust boundaries upon agreement between DOE and TRIDEC in accordance with the NDAA (see **Section 5.3**). As stated in the Notice of Intent, DOE recognized that there were continuing mission needs on some of the requested lands, such as an active borrow area and a safety buffer zone, making them unsuitable for conveyance. Therefore, DOE conducted a land suitability review process (see **Appendix A**, "The Hanford Site Land Suitability Review") that started with the 4,413-acre Initial Hanford Site Land Conveyance Project Area (PA) identified in the NOI. Through this review process DOE identified and documented continuing mission or operational needs on the PA. **Figure 2-2**, "Project Area, Focused Study Area, Potential Access Agreement Land, and Land Not Suitable for Conveyance," shows the PA and 2,474 acres of land referred to as the Focused Study Area (FSA) lands that have the least encumbrances. The FSA is made up of a 1,635-acre "main" FSA, a 300-acre "solar farm" FSA, and a 539-acre Potential Access Agreement Land (PAAL).

The approximately 1,641 acres of land that DOE would convey as required by the NDAA would be selected from the 1,935 acres (the acreage of the FSA minus the acreage of the PAAL [see **Figure 2-2**]) that make up the main and solar farm FSAs. The 1,341 acres TRIDEC requested would be selected from the main FSA, and the 300 acres TRIDEC requested would be the 300-acre solar farm FSA land. Portions of the 539-acre PAAL could be conveyed but only for utilities and infrastructure required for other transferred FSA lands. PAAL acreage would only be conveyed, if necessary, by a realty instrument other than a deed and would stay under the institutional control and ownership of DOE.

TRIDEC plans to use, market, lease, sell, or otherwise develop the land to conduct industrial development and commercial activities that are consistent with local zoning and comprehensive land use plans. DOE assumes for this EA that once conveyed to an end user, the land will be used for one or more of the "target marketing industries" (TMI) that TRIDEC envisioned in its proposal to DOE (TRIDEC 2011a, 2011b).

This EA analyzes the potential environmental effects associated with the reasonably foreseeable future uses of Focused Study Area (FSA) land, based on industry targets described in TRIDEC's proposal (TRIDEC 2004, 2005a, 2005b, 2005c, 2006, 2011a, 2011b, 2014a, 2014b) and TMI (TRIDEC 2014a), including warehousing and distribution, research and development, technology manufacturing, food processing and agriculture, ''back office'' (i.e., business services), and energy. The TMI categories and subareas identified are shown in **Figure 2-3**, "TRIDEC's General Current and Projected Target Marketing Industries." In addition to information in the TRIDEC proposal and marketing studies, DOE used assumptions in the EA for its analysis based on full development of representative facilities (examples of the TMI) that would tend to maximize estimates (over estimates impacts) of potential environmental impacts associated with footprint, infrastructure, utilities, emissions, construction of buildings, projected workforce and traffic, water usage, and similar requirements.

This EA uses representative solar farm examples for the 300-acre parcel on which to base analysis of the types and intensity of impacts associated with solar technologies.

Figure 2-1. Project Location.

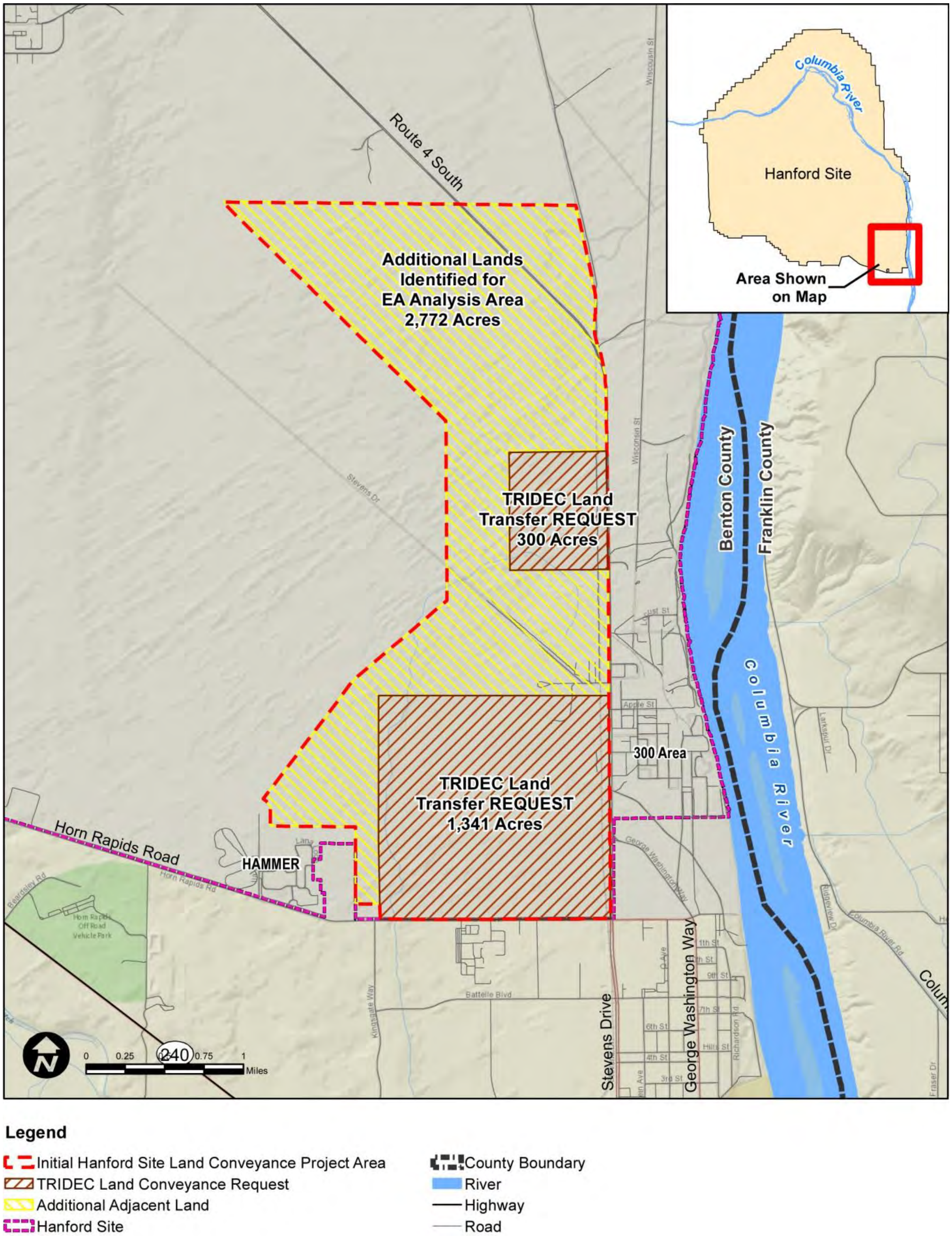


Figure 2-2. Project Area, Focused Study Area, Potential Access Agreement Land, and Land Not Suitable for Conveyance.

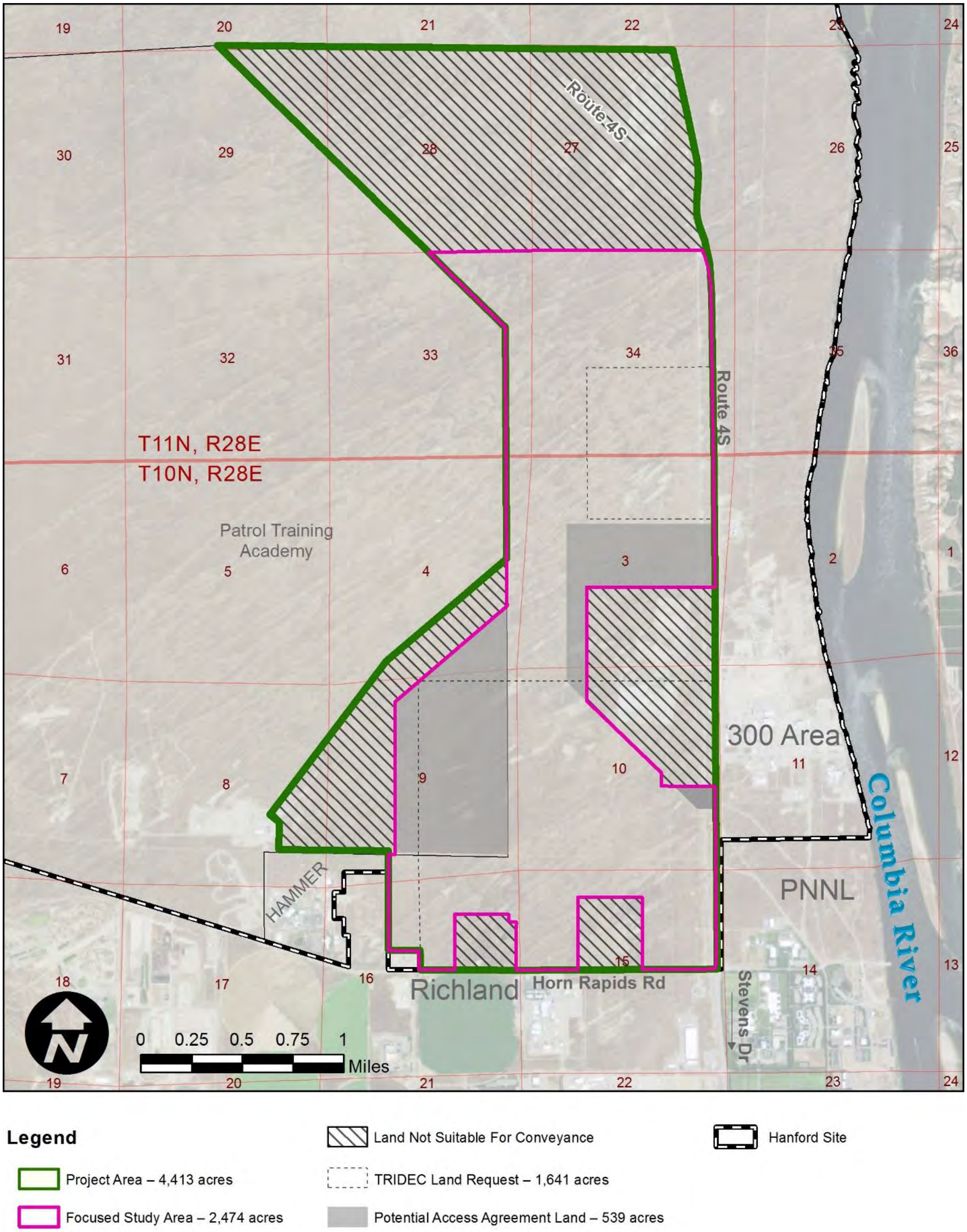
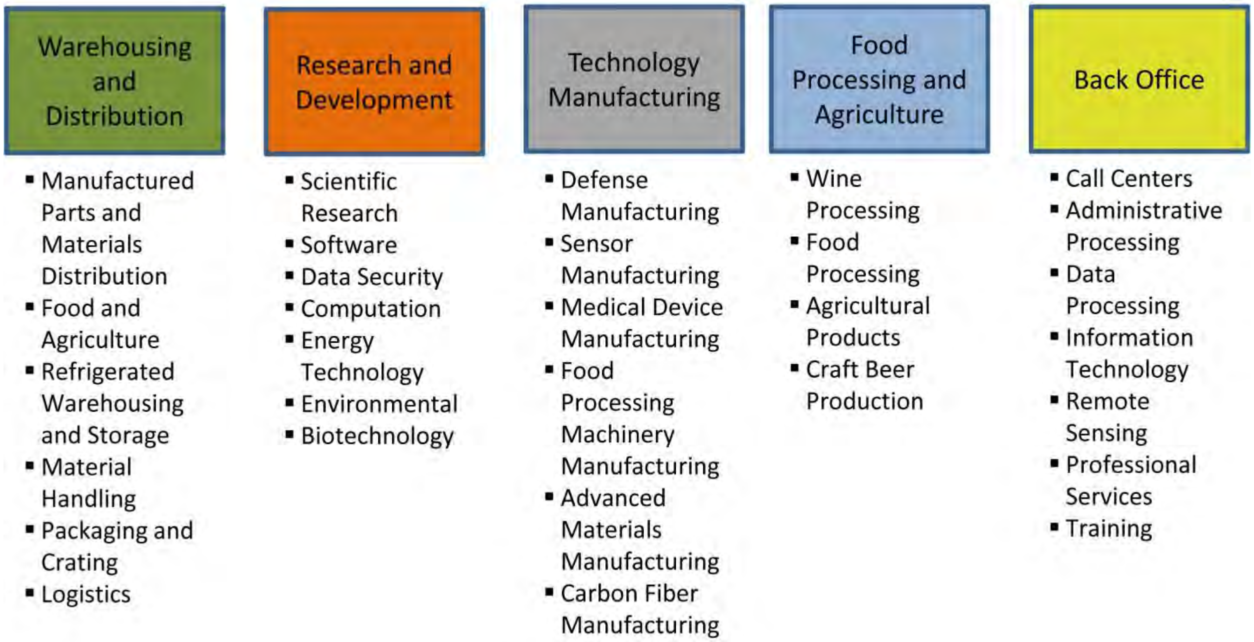


Figure 2-3. TRIDEC's General Current and Projected Target Marketing Industries.



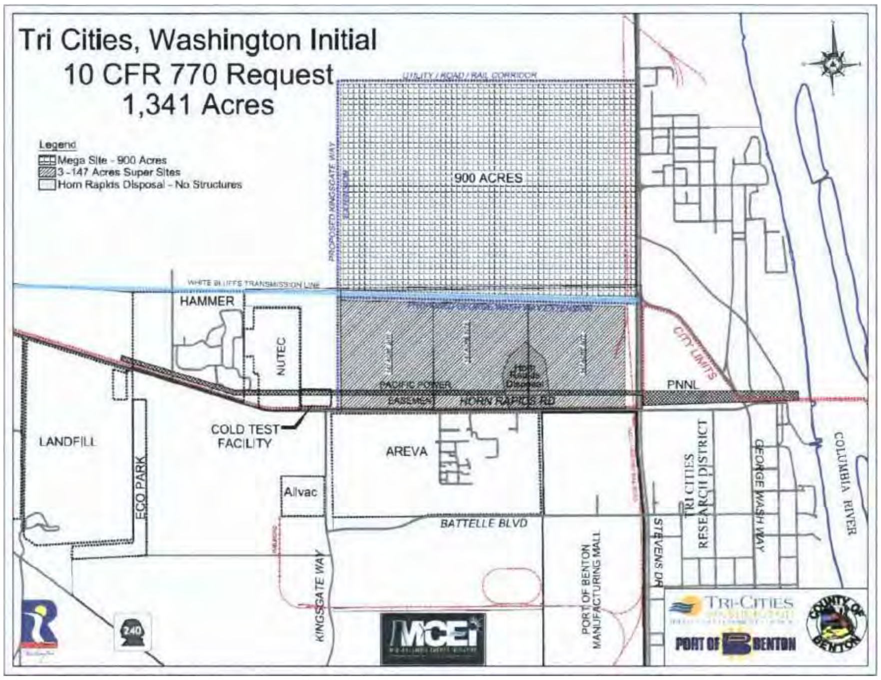
Source: TRIDEC 2004, 2005a, 2005b, 2005c, 2006, 2011a, 2014a.

This analysis approach and these representative land use examples for both the main FSA and the solar farm FSA are presented and discussed in **Section 2.2.4**. Details of the representative examples are provided in **Appendix E**, "Representative Facilities."

2.2.1 Tri-City Development Council's Land Transfer Proposal

TRIDEC's May 2011 land transfer proposal is for a 1,341-acre tract (see **Figure 2-4**, "TRIDEC's Proposed Use for the 1,341 Acres"), close to the intersection of Horn Rapids Road and Stevens Drive. TRIDEC indicated that they would potentially extend Kingsgate Way into the conveyed land. On the north side of the 1,341-acre parcel, TRIDEC indicated that a utility road/rail corridor would also potentially be constructed that would connect with the northern extension of Kingsgate Way.

Figure 2-4. TRIDEC's Proposed Use for the 1,341 Acres.



Source: TRIDEC 2011a.

2.2.2 Tri-City Development Council's Addendum to Their Land Transfer Proposal

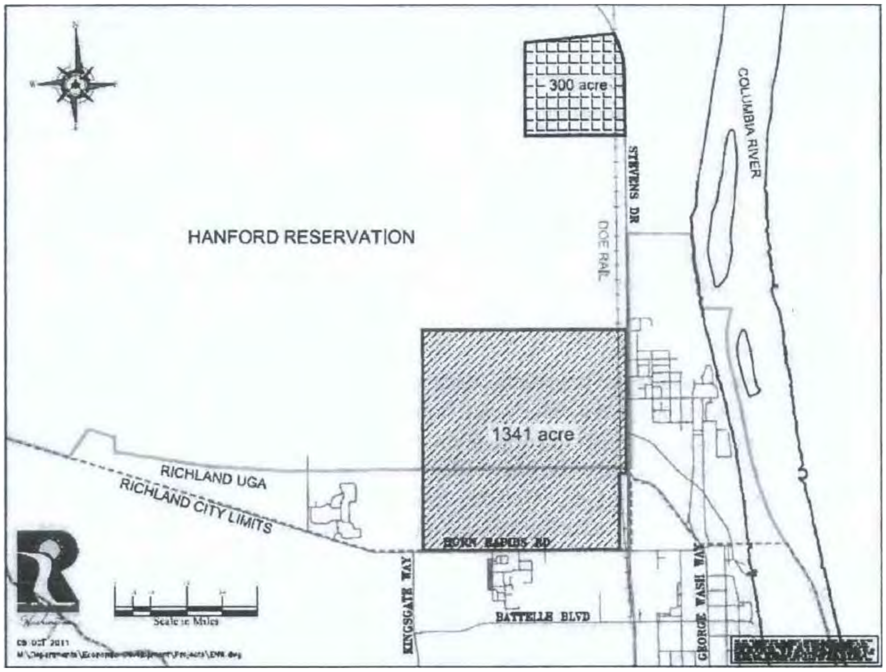
TRIDEC submitted an addendum (TRIDEC 2011b) to their original proposal in October 2011 – adding a 300-acre parcel for an energy park. TRIDEC identified this acreage as an initial step toward creation of the Mid-Columbia Energy Initiative Energy Park for uses "specific to solar powered applications." TRIDEC described this addendum as an "envelope because it sets some overall parameters for how the land could be utilized, while not being overly specific to one particular application." The addendum identified three specific solar technology applications:

1. Fixed tilt photovoltaic (PV)
2. Single axis tracking PV
3. Two-axis tracking PV or thermal electric ("dish" style)

The third technology application represents two very different types of two-axis tracking. The first uses PV panels and the second thermal electric parabolic dishes. Therefore there are a total of four solar technologies to consider. The first three types are PVs that rely directly on the conversion of light (photons) from the sun into electricity using flat-panel arrays. They are designed to absorb rather than reflect light. The difference among them is that one is set in a fixed position, the second rotates on one axis to generally follow the sun's travel, and the third rotates on two axes to directly follow the sun's travel. The two-axis tracking thermal electric parabolic dish depends entirely upon the reflectivity of mirrors to concentrate as much light as possible and focus it on a receiver, and is known as a concentrating solar power system. The dish's receiver contains a fluid or gas that expands upon heating, thus driving a turbine converting its motion into electricity. In addition to its operational differences, the parabolic dish looks very different from the three technologies that are based on PV panels.

Figure 2-5, "TRIDEC's Addendum "Attachment 2 – Revised Map" Showing the Original 300-Acre Solar Energy Park Request," is TRIDEC's map from their proposal addendum (TRIDEC 2011b) showing the proposed location of the proposed "solar farm." Subsequently TRIDEC determined that a better location for the 300-acre parcel was farther south to the location shown on **Figure 2-1**. **Figure 2-5** is the map referenced in Section 3013 of the NDAA.

Figure 2-5. TRIDEC's Addendum "Attachment 2 – Revised Map" Showing the Original 300-Acre Solar Energy Park Request.

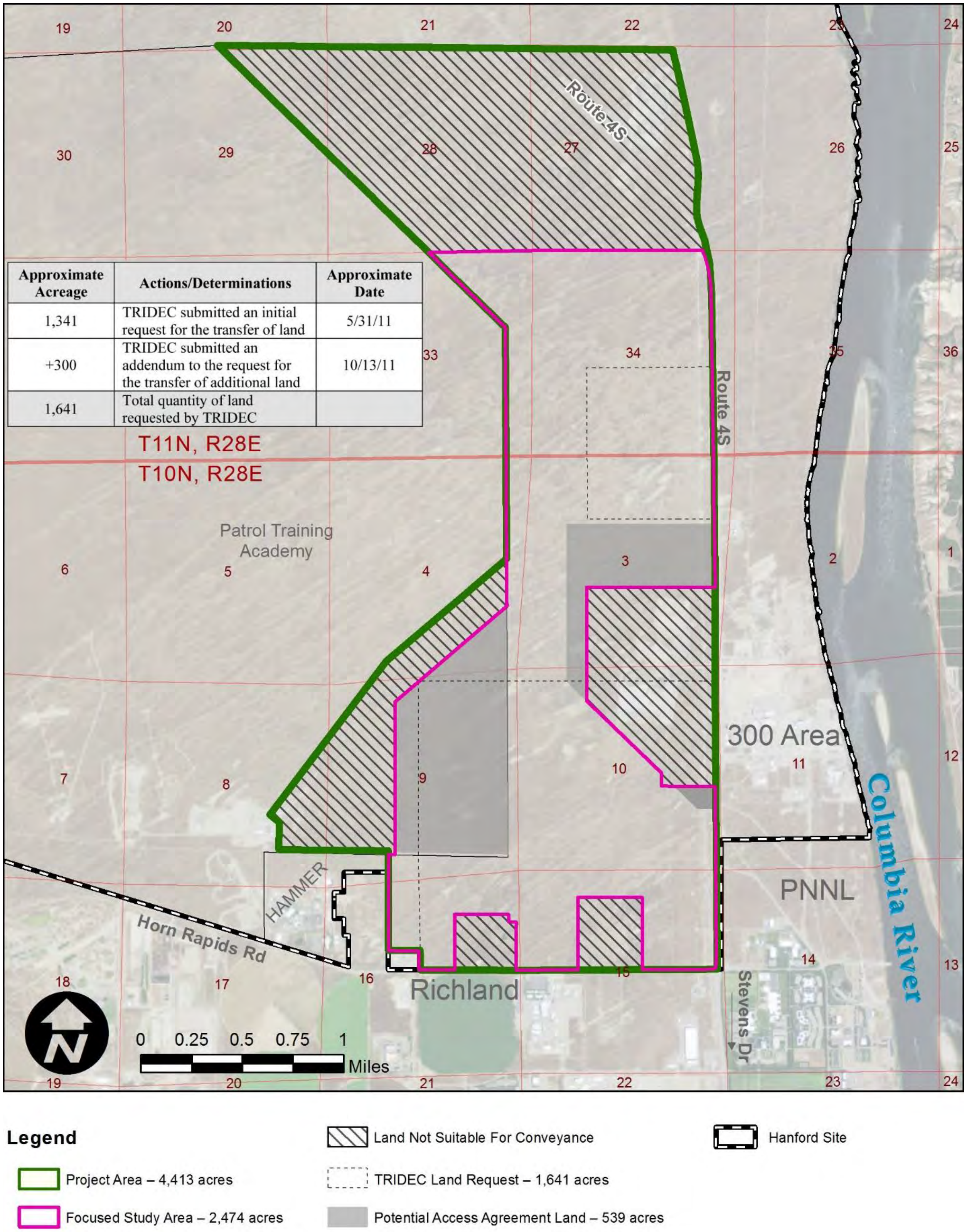


Source: TRIDEC 2011b.

2.2.3 Lands Considered for Conveyance

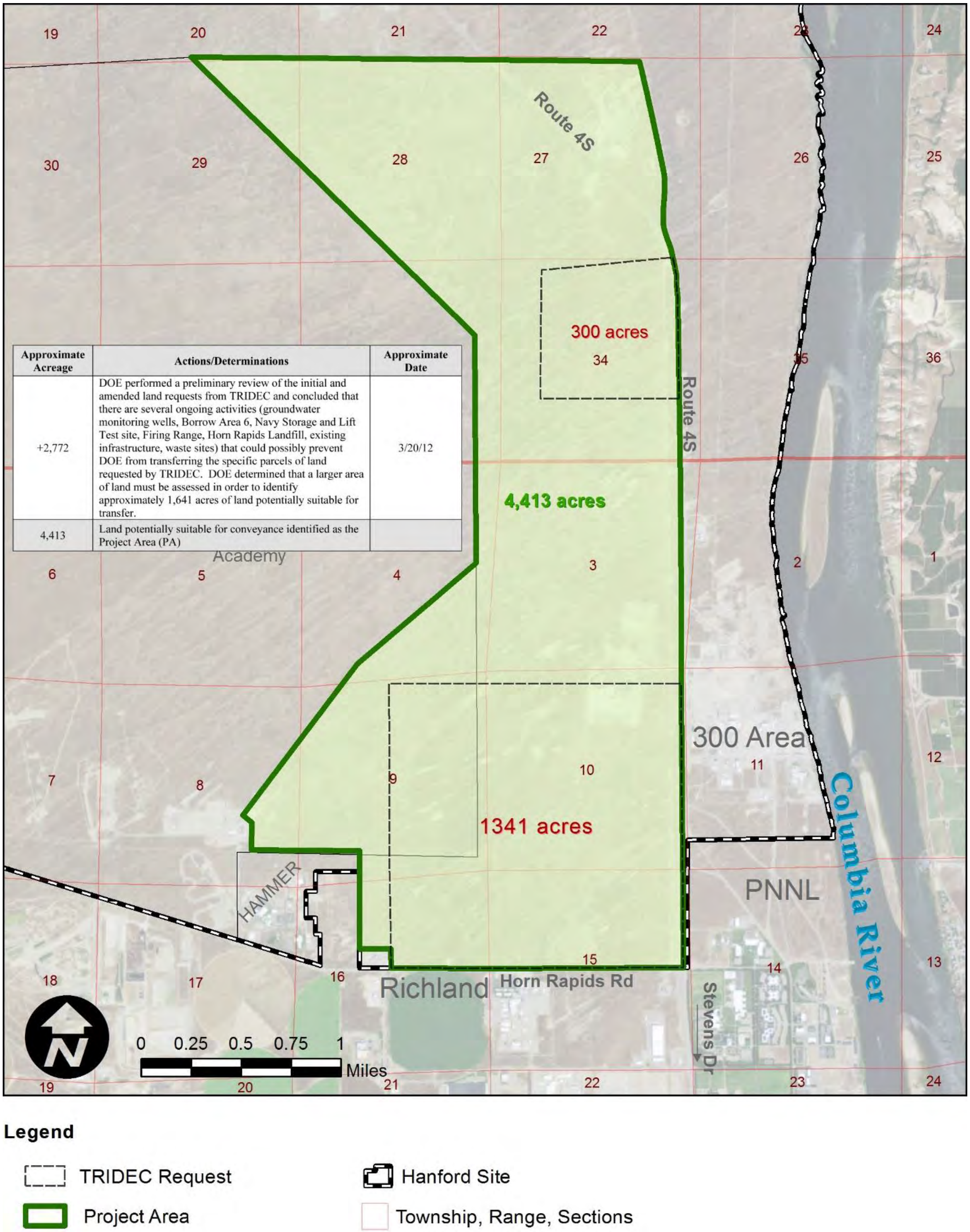
DOE identified 4,413 acres from which 1,641 acres could be identified for conveyance to TRIDEC. The 4,413 acres are referred to as the PA. Since the project began, DOE has conducted research and evaluations on these lands to determine their potential suitability for conveyance. The chronology of the suitability review process to identify land potentially suitable for conveyance is shown on **Figure 2-6** through **Figure 2-12**. The reduction in potentially suitable land from the initial 4,413 acres begins with **Figure 2-7** and proceeds sequentially. Each map includes a small table that identifies the approximate acreage, the actions or determinations and approximate dates, and the potentially suitable land acreage after the action or determination. The TRIDEC-requested acreages (i.e., 1,341- and 300-acres) are shown on each map for context. The acreage value shown in bold at the center of each figure is the remaining potentially suitable land after the action or determination was taken.

Figure 2-6. TRIDEC's Initial Land Request Areas Total 1,641 Acres.



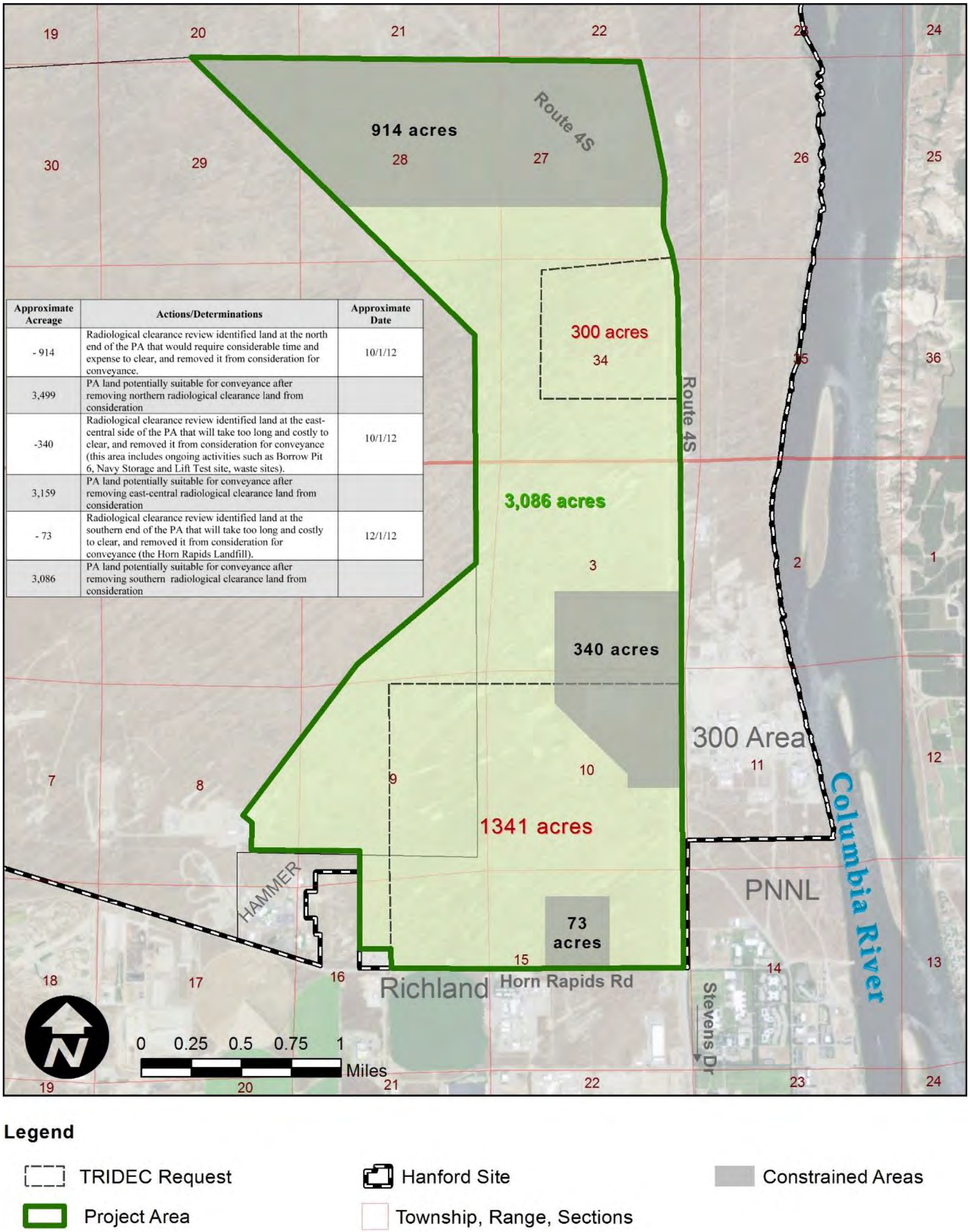
Approximate Acreage	Actions/Determinations	Approximate Date
1,341	TRIDEC submitted an initial request for the transfer of land	5/31/11
+300	TRIDEC submitted an addendum to the request for the transfer of additional land	10/13/11
1,641	Total quantity of land requested by TRIDEC	

Figure 2-7. DOE Identified 4,413 Acres as the PA.



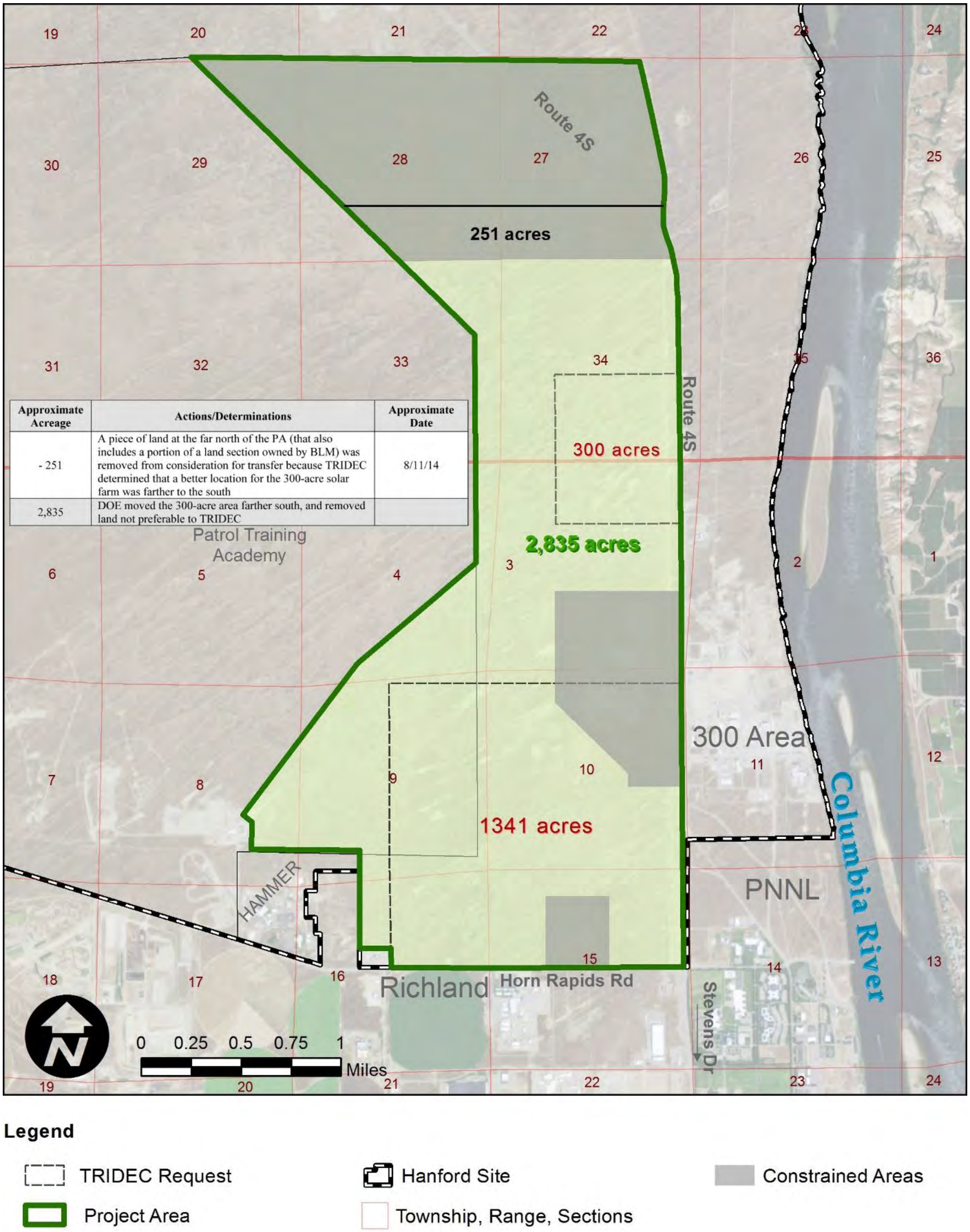
Approximate Acreage	Actions/Determinations	Approximate Date
+2,772	DOE performed a preliminary review of the initial and amended land requests from TRIDEC and concluded that there are several ongoing activities (groundwater monitoring wells, Borrow Area 6, Navy Storage and Lift Test site, Firing Range, Horn Rapids Landfill, existing infrastructure, waste sites) that could possibly prevent DOE from transferring the specific parcels of land requested by TRIDEC. DOE determined that a larger area of land must be assessed in order to identify approximately 1,641 acres of land potentially suitable for transfer.	3/20/12
4,413	Land potentially suitable for conveyance identified as the Project Area (PA)	

Figure 2-8. DOE Removed 1,327 Acres Needing Radiological Clearance Leaving 3,086 Acres of the PA Potentially Suitable for Transfer.



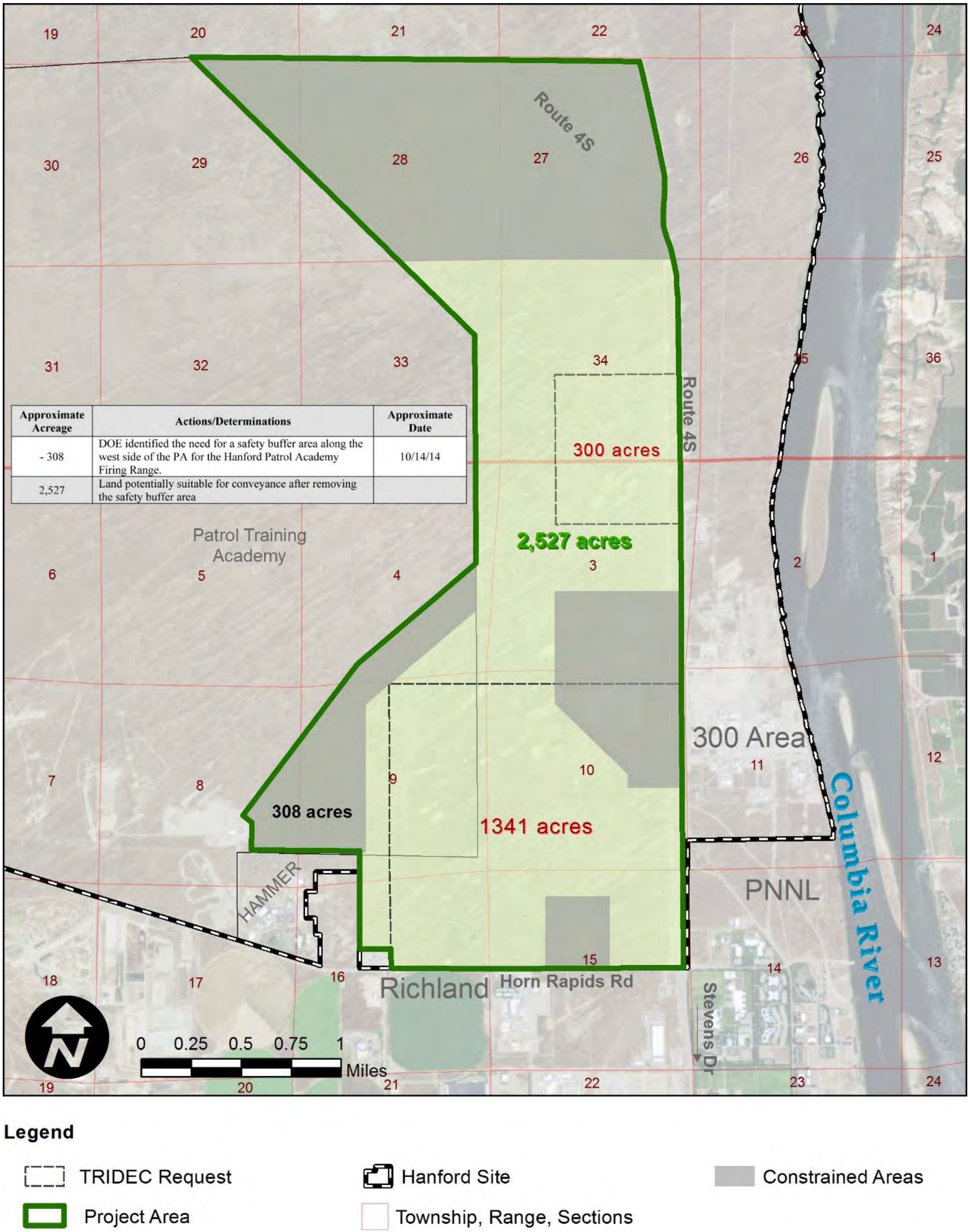
Approximate Acreage	Actions/Determinations	Approximate Date
- 914	Radiological clearance review identified land at the north end of the PA that would require considerable time and expense to clear, and removed it from consideration for conveyance.	10/1/12
3,499	PA land potentially suitable for conveyance after removing northern radiological clearance land from consideration	
-340	Radiological clearance review identified land at the east-central side of the PA that will take too long and costly to clear, and removed it from consideration for conveyance (this area includes ongoing activities such as Borrow Pit 6, Navy Storage and Lift Test site, waste sites).	10/1/12
3,159	PA land potentially suitable for conveyance after removing east-central radiological clearance land from consideration	
- 73	Radiological clearance review identified land at the southern end of the PA that will take too long and costly to clear, and removed it from consideration for conveyance (the Horn Rapids Landfill).	12/1/12
3,086	PA land potentially suitable for conveyance after removing southern radiological clearance land from consideration	

Figure 2-9. TRIDEC Moves 300-Acre Request Location South, and DOE Removes 251 Acres Not Preferred by TRIDEC Leaving 2,835 Acres of the PA Potentially Suitable for Transfer.



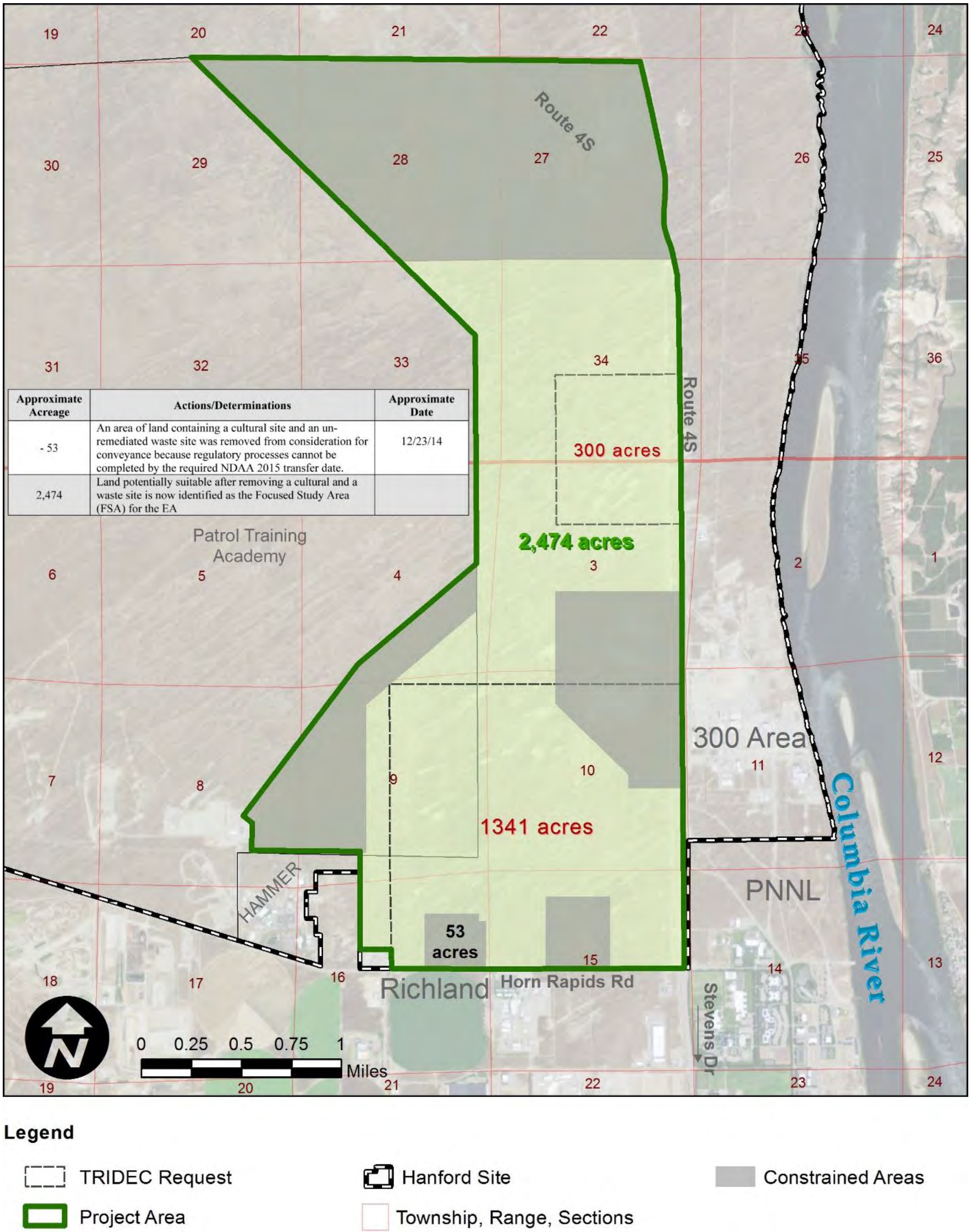
Approximate Acreage	Actions/Determinations	Approximate Date
- 251	A piece of land at the far north of the PA (that also includes a portion of a land section owned by BLM) was removed from consideration for transfer because TRIDEC determined that a better location for the 300-acre solar farm was farther to the south	8/11/14
2,835	DOE moved the 300-acre area farther south, and removed land not preferable to TRIDEC	

Figure 2-10. DOE Removed 308-Acre Buffer Zone for Hanford Patrol Firing Range Leaving 2,527 Acres of the PA Potentially Suitable for Transfer.



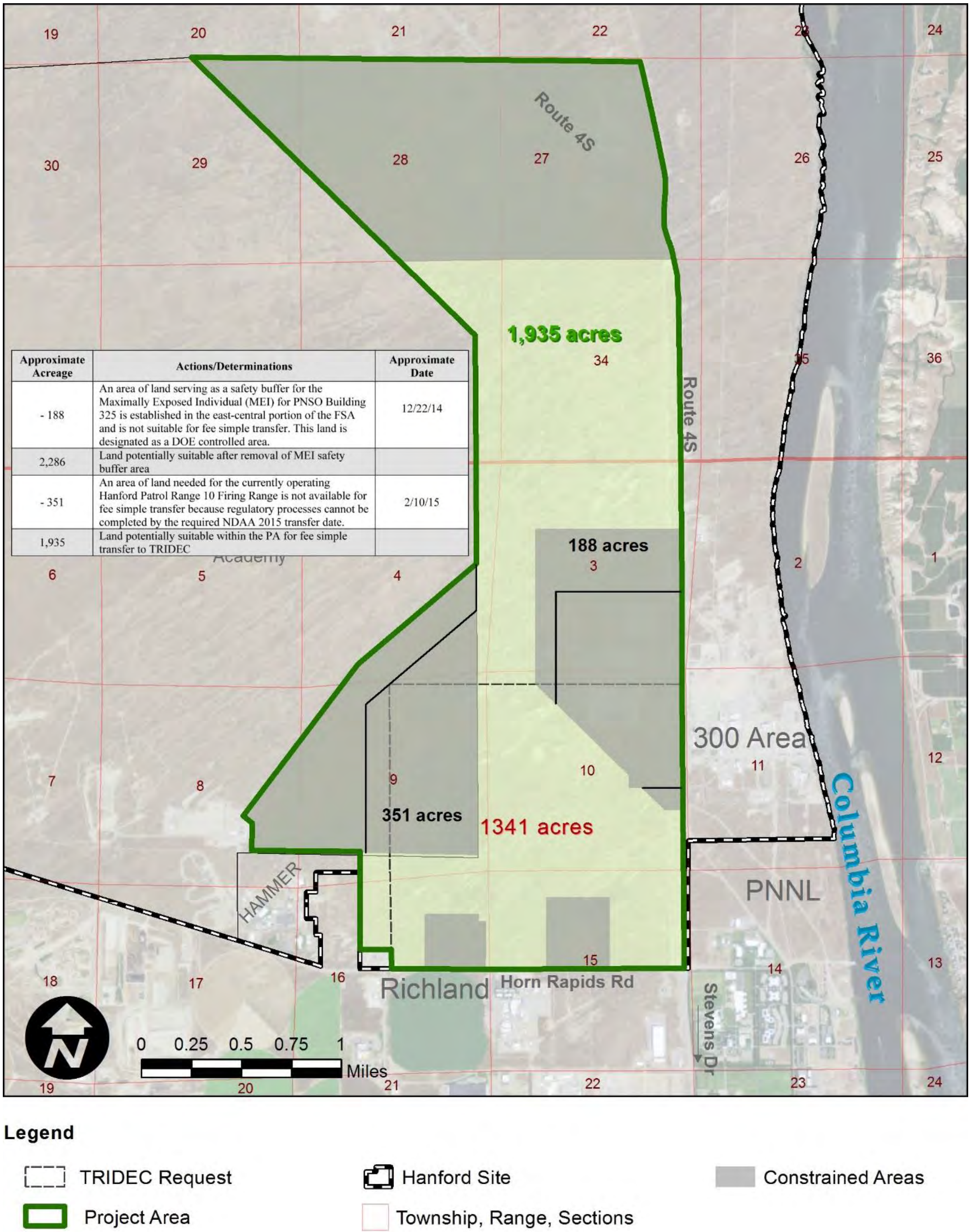
Approximate Acreage	Actions/Determinations	Approximate Date
- 308	DOE identified the need for a safety buffer area along the west side of the PA for the Hanford Patrol Academy Firing Range.	10/14/14
2,527	Land potentially suitable for conveyance after removing the safety buffer area	

Figure 2-11. DOE Removed 53 Acres for Containing Unremediated Waste and a Cultural Site Leaving 2,474 Acres of the PA Potentially Suitable for Transfer.



Approximate Acreage	Actions/Determinations	Approximate Date
- 53	An area of land containing a cultural site and an un-remediated waste site was removed from consideration for conveyance because regulatory processes cannot be completed by the required NDAA 2015 transfer date.	12/23/14
2,474	Land potentially suitable after removing a cultural and a waste site is now identified as the Focused Study Area (FSA) for the EA	

Figure 2-12. DOE Removed 188 Acres for a Radiological Safety Buffer, and 351 Acres of the Patrol Firing Range that for Regulatory Reasons Could Not Be Available in Time for Transfer Leaving 1,935 Acres of the PA Potentially Suitable for Transfer.



Approximate Acreage	Actions/Determinations	Approximate Date
- 188	An area of land serving as a safety buffer for the Maximally Exposed Individual (MEI) for PNSO Building 325 is established in the east-central portion of the FSA and is not suitable for fee simple transfer. This land is designated as a DOE controlled area.	12/22/14
2,286	Land potentially suitable after removal of MEI safety buffer area	
- 351	An area of land needed for the currently operating Hanford Patrol Range 10 Firing Range is not available for fee simple transfer because regulatory processes cannot be completed by the required NDAA 2015 transfer date.	2/10/15
1,935	Land potentially suitable within the PA for fee simple transfer to TRIDEC	

Following this review process (see **Appendix A**), DOE identified 2,474 acres of land that is potentially suitable for conveyance. The 2,474 acres of land is referred to as the FSA in this EA. DOE may convey approximately 1,641 acres from the FSA. Lands in the FSA are further distinguished by their suitability for transfer from federal ownership. The FSA contains 1,935 acres potentially suitable for transfer from federal ownership, and 539 acres that could be conveyed (e.g., leases and easements), but must remain under federal ownership.

This EA assumes that the 1,341 acres that TRIDEC requested would come from the main FSA and that the 300 acres requested would be the solar farm FSA. The 539 acres of lands removed from consideration for transfer in **Figure 2-12** are the two Potential Access Agreement Land (PAAL) areas (i.e., 188 and 351 acres). The diagonally cross-hatched areas on **Figure 2-6** are those determined unsuitable for transfer. To provide a comprehensive impact analysis, the affected environment and environmental consequences (see **Chapter 3.0**) addresses the 4,413-acre PA and surrounding lands, as applicable (the maximum amount of land to be conveyed is approximately 1,641 acres).

2.2.4 Probable Intended Uses

Section 2.2 presents TRIDEC's TMI categories. DOE assumes that these would be the most probable intended uses for the conveyance lands and therefore can consider them the most reasonably foreseeable to use in the EA's analysis.

For the main FSA lands, the analysis in this EA uses representative example industry facilities for each of the TMI categories within a given subarea. Existing environmental analyses were used to obtain information about facility characteristics that are necessary for environmental consequence analysis (e.g., footprint, infrastructure, utilities, emissions, construction of buildings, projected workforce and traffic, water usage, and similar requirements). These were available for most of the representative types (see **Table 2-1**, "Representative Target Marketing Industry and Solar Technology Example Facilities"). Some of these facilities are constructed and operated by commercial private-sector enterprises and details of their construction or operation are not readily publicly available.

> **Important Note**: By identifying these facilities as representative for this EA, DOE in no way recommends or endorses these companies or their products.

Table 2-1 identifies the representative TMI facility examples. An energy category was added to TRIDEC's original TMI proposal categories in order to address the proposed solar development and a biofuels manufacturing facility that appear in a more recent TRIDEC marketing study (TRIDEC 2014a). More detailed information on these representative facilities is provided in **Appendix E**. One facility is a "multi-phased development" and the others are all "single-phase developments." Phases refers to the facilities being constructed all at once (single phase) or spread out in time (multi-phase). All facilities were identified and information was obtained using online searches using key words from TRIDEC's TMI analyses.

Table 2-1. Representative Target Marketing Industry and Solar Technology Example Facilities.

Target Marketing Industry Category	Subarea(s)	Type of Operation/Facility	Supporting Environmental Analysis[8]
Multi-Phase Development			
Warehousing and Distribution, Food Processing and Agriculture, and Back Office	Food and Agriculture, Refrigerated Warehousing and Storage, Packaging and Crating, Wine Processing, Food Processing, Administrative Processing, and Information Technology	Commerce Center – Phased Development Light Multi-Use Industrial Business Park	Yes
Single-Phase Developments			
Warehousing and Distribution – A	Manufactured Parts and Materials Distribution, Material Handling, Packaging and Crating, and Logistics	Manufactured Parts Distribution Center	No
Warehousing and Distribution – B	Food and Agriculture, Refrigerated Warehousing and Storage, Material Handling, and Logistics	Storage and Rail Distribution Center	No
Research and Development – A	Scientific Research, Computation, and Biotechnology	Biological Research and Development Center	No
Research and Development – B	Scientific Research, Software, Computation, and Energy	Energy Research and Development Center	No
Technology Manufacturing – A	Defense Manufacturing, Sensor, and Medical Device Manufacturing	Electronics Equipment Manufacturing	No
Technology Manufacturing – B	Advanced Materials Manufacturing	Light Industrial	No
Food Processing and Agriculture – A	Food Processing and Agricultural Products	Vegetable Food Processing	No
Food Processing and Agriculture – B	Wine Processing and Agricultural Products	Wine/Spirits Processing	Yes
Back Office – A	Call Center, Data Processing, and Training	National Call Center	No
Back Office – B	Administrative Processing, Data Processing, Information Technology, Professional Services, and Training	Automatic Data Processing Center	No
Energy	Biofuel Manufacturing	Biofuels Manufacturing	Yes
Energy	Photovoltaic Energy Production	Electrical Production Facility	Yes
Energy	Thermal Electric Dish Energy Production	Electrical Production Facility	Yes

[8] Supporting Environmental Analysis refers to an environmental study like an EA or environmental impact statement. Where there is a "Yes" it means the information is taken from a study. If there is a "No" it means that study was not found for the representative facility. References for all these facilities are in Appendix E.

General and resource-area specific assumptions were made to provide for a consistent analysis. These assumptions are provided at the beginning of **Chapter 3.0**. Assumptions specific to analysis of impacts for any particular resource are presented in the respective resource area subsections in **Chapter 3.0**.

2.2.5 The Bounding-Case Analysis for the Main Focused Study Area

To account for uncertainties associated with the actual development of the FSA, this EA provides a bounding-case analysis. DOE NEPA guidance (DOE 2005a) states that:

> A bounding analysis is an analysis designed to identify the **range** of potential impacts or risks, both upper and lower. Such an approach might be used in an EA or environmental impact statement, for example, to simplify assumptions, address uncertainty, or because expected values are unknown. As a practical matter, a bounding analysis most often is used to provide conservatism in the face of uncertainty.

A bounding-case analysis is not needed for the 300-acre solar farm FSA since the specific use of the land was identified by TRIDEC (2011b). The lower bound is represented by the No Action Alternative. The upper bound is represented by the development of these lands. This EA environmental consequence analysis becomes bounding in that it addresses a “range” of:

- Reasonable Land Uses – There are two examples for each of the TRIDEC TMI representative facilities in development of the main FSA plus the multi-phase development facility.
- Locations – This EA assumes each of the example representative facilities would be constructed and operated anywhere within the main FSA to identify potential location-specific impacts.
- Construction Durations – All TMI representative facilities would begin and end construction at about the same time to address the collective short-term construction impacts. Longer-term impacts are associated with the multi-phase development.
- Individual and Collective Impacts – The environmental consequences for any representative facility were assessed by each resource area for those that are general (the same regardless of location) and those that are location-specific.

DOE’s NEPA-implementing regulations address mitigation (10 CFR 1021.322 (b) (1)) and mitigation action plans (10 CFR 1021.331). The types of mitigation measures that could be applied for a proposed action include the following:

- Avoiding an impact by not taking an action or parts of an action
- Minimizing impacts by limiting the degree or magnitude of an action and its implementation
- Rectifying an impact by repairing, rehabilitating, or restoring the affected environment
- Reducing or eliminating the impact by preservation and maintenance operations during the life of the action
- Compensating for the impact by replacing or providing substitute resources or environments (40 CFR 1508.20).

While DOE may use any of these mitigation measure approaches, and will proactively mitigate potential impacts by avoiding a potential impact, limiting the degree of an action, and by compensating for a potential impact.

In **Chapter 3.0**, each resource area analysis has a section on potential mitigation measures that could be performed by DOE or future land owners. DOE would perform any mitigation measures necessary on the PAAL since these lands stay under DOE ownership. DOE will prepare a mitigation action plan utilizing the mitigation measures described in **Chapter 3.0** that are within DOE's control.

DOE has avoided lands that would have resulted in additional potential impacts to the affected environment that may have required additional mitigation measures. By avoiding areas with certain potential environmental or other impact, an advance mitigation measure or impact reduction effect has been built into the Proposed Action.

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3.0 AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES

This chapter presents the affected environment and environmental consequences analyses for geology; water resources; air quality; ecological resources; wetlands and floodplains; cultural resources; land use; visual resources; noise, vibration, and electromagnetic fields (EMF); utilities and infrastructure; transportation; waste management; socioeconomics and environmental justice; and human health and safety.

The affected environment analysis covers the Proposed Action lands considered for conveyance (see **Section 2.2.3**) identified as the 4,413-acre Project Area (PA). For many of the resource areas, this PA constitutes the study area or region of influence (ROI), although for some, like socioeconomics, the study area includes surrounding areas where there may be effects. The lands initially considered to be potentially suitable for conveyance are shown on **Figure 2-6**.

The environmental consequences analysis addresses those lands determined to be potentially suitable for conveyance after conducting a land suitability review for the PA (see **Appendix A**, "The Hanford Site Land Suitability Review," and **Figure 2-6**). These lands are the 2,474-acre Focused Study Area (FSA) discussed in **Section 2.2.3** that consists of a 1,635-acre main FSA, a 300-acre solar farm FSA, and 539 acres of Potential Access Agreement Land (PAAL) (see **Figure 2-6**). The FSA lands are those that could be transferred by deed with the exception of the PAAL that could only be conveyed by realty instruments other than a deed. The U.S. Department of Energy (DOE) intends to convey approximately 1,641 acres of FSA land, which may include some PAAL conveyed (e.g., via lease or easement) for utilities and infrastructure. This analysis is based upon the proposed construction and operation of all the representative example facilities (including the solar farm) identified in **Section 2.2.1** and **Section 2.2.2** and described in **Appendix E**, "Representative Facilities." In this chapter, impacts to adjacent land or facilities are also addressed to the extent necessary for some resource areas, such as, noise, vibration, and EMF. General assumptions for construction and operation are provided in the following sections.

Common No Action Alternative assumptions:

For the No Action Alternative (i.e., no conveyance of lands), existing activities would continue (including the two borrow pits, Navy Storage Area and Load Test [SALT] Facility, well monitoring, and others). Assumptions for these include:

- Lands stay under the federal government's institutional control and ownership, including restricted access and oversight of activities
- Lands remain largely undeveloped and undisturbed as described in the affected environment sections for ambient noise, air quality, vibration, and minimal artificial light
- Minimal changes to the natural and cultural resources except those caused by nature (e.g., weather and burrowing animals).

Important assumptions for the 1,635-acre main FSA environmental consequence analysis:

- The 1,341-acre parcel of land requested by the Tri-City Development Council (TRIDEC) would be selected, to the extent possible, from the 1,635-acre main FSA.
- Future landowners would construct and operate facilities within the target marketing industry (TMI) categories and subareas identified by TRIDEC (see **Figure 2-3**).

- Construction and operation characteristics for each selected facility example are indicative of the TMI category and subareas they represent.
- To evaluate location-specific environmental sensitivities, the multi-phase and single-phase representative industry examples could be built anywhere on the main FSA.
- To evaluate short-term construction impacts, the first phase of the multi-phased development and all the single-phase development representative examples would begin construction simultaneously for up to 18 months (although some could take a few months longer to complete than others).
- To evaluate the impacts associated with longer-term construction, the multi-phased development would be constructed and developed in phases over a 20-year period.
- Future landowners would construct and operate their facilities in compliance with applicable federal, state (e.g., the *State Environmental Policy Act* [SEPA][9]), and local laws, regulations, and other legal requirements.
- Future landowners would comply with any deed restrictions and covenants accompanying the land transfer action.
- Any development of these lands would be in accordance with local comprehensive land use plans, zoning, and ordinances.

Important assumptions for the 300-acre solar farm FSA environmental consequence analysis:

- The 300-acre parcel requested by TRIDEC is the solar farm FSA analyzed in this chapter.
- Only the single-axis photovoltaic (PV) and parabolic thermal electric dish solar technology types were considered for construction and operation on the solar farm FSA because they are most likely to represent the range of construction and operation characteristics for the solar technologies identified by TRIDEC.
- The solar technology example facilities are much larger than the 300 acres proposed for transfer in the Proposed Action; therefore, their construction characteristics were linearly proportioned to the 300 acres of land.
- Two scenarios were analyzed for the solar farm, with each scenario using only a single solar technology type (i.e., PV or thermal electric) for the solar farm FSA.
- The solar farm FSA would be populated with PV arrays or dishes to a maximum reasonable density, avoiding the "infrastructure corridor" so as not to interfere with the operation, repair, or maintenance of the railroad, power lines, and similar systems.
- Future landowners would comply with any deed restrictions and covenants accompanying the land transfer action.

[9] *State Environmental Policy Act* (SEPA) (RCW 43.21C) is implemented by the SEPA rules (WAC 197-11-704) and applies to state agencies, municipal and public corporations, and counties. Much like NEPA, after which SEPA is patterned, the SEPA process includes evaluation of a proposed action's potential effects on the environment, mitigation measures, consideration of alternatives, documentation, and public notification. For further information about the SEPA process, please see http://www.ecy.wa.gov/programs/sea/sepa/e-review.html. If the FSA lands were transferred from federal ownership, SEPA responsibilities could be carried out by, for example, the City of Richland, Benton County, or the Port of Benton, depending on which organization is determined to be the lead agency for a proposed action.

- Future landowners would construct and operate their facilities in compliance with the federal, state, and local laws, regulations, and other legal requirements.
- Any development of these lands would be in accordance with local comprehensive land use plans, zoning, and ordinances.

Important assumptions for the 539-acre PAAL environmental consequence analysis:

- These 539 acres would remain under DOE ownership.
- The PAAL includes two separate areas described in **Appendix A** (see **Figure A-6**).
  - Patrol Training Academy Range 10 and related lands.
  - A DOE-controlled area.
- Access to PAAL would only be for the purpose of construction or maintenance of utilities on these lands.
- No public access would be allowed onto or across these lands.
- Use of this land would be subject to applicable federal laws and DOE orders, regulations, and oversight.

Construction assumptions:

Construction of the representative facilities on the main and solar farm FSAs would involve extensive land disturbing activities necessary for buildings, equipment, roads, parking areas, and utilities and infrastructure. These activities would include site clearing, grading, land contouring, adding aggregate fill, soil compacting, and excavating for footings and trenches or pilings. These activities would remove vegetation, surface soil, natural and manmade surface features, and any associated objects and materials changing the landscape from one sculptured by wind and weather to industrial development.

The use of heavy machinery to effect these changes would introduce machine noise and vibration. Noise and vibration levels would be within *Richland Municipal Code* (RMC) requirements at the representative facility site boundary[10]. Odors associated with diesel engines, lubricants, and other sources could also be noticeable but are expected to be within the RMC limits (the regulatory compliance point for odor is at the industrial use district boundary, RMC 23.26.020). The sight of large construction equipment moving across the landscape would be readily discernable. During the part of the year with fewer daylight hours, temporary lighting would flood the construction sites so that operations could be conducted safely. Lighting would be visible from the construction sites but within the "uplight" shielding requirements of the RMC (RMC 23.58.030).

After site clearing activities have concluded, construction materials would be brought onsite by heavy trucks driving across unimproved surfaces. Cranes and boom-trucks would be brought onsite for building erection, sized to the task for "tilt-up" warehouses or multistory buildings. Utility services could be extended from existing lines at Horn Rapids Road before or in sequence with these activities requiring erection of power poles or buried cable, water and sewer lines, and gas lines. During construction, pneumatic tools using air compressors are often used that create higher noise levels but must still be within the RMC at the site boundary.

[10] RMC Chapter 23.22, "Commercial Zoning Districts," Section 23.22.020, "Performance standards and special requirements"; and Chapter 9.16, "Public Nuisance Noise – Prohibited."

Facility operation assumptions:

- Future landowners would operate their facilities in accordance with all applicable federal, state, and local laws, regulations, and ordinances.
- Future landowners or parties to a PAAL agreement would comply with any deed restrictions, and covenants or requirements in other realty instruments that would be conveyed to them.

3.1 Geology

The geologic conditions important to the potential development of the PA include soils or near surface geologic strata, mineral (gravel) deposits, topography, and the Hanford Site environmental remediation, which is discussed in **Section 3.7**. Soils lie above bedrock and usually consist of weathered bedrock fragments or material deposited by wind, often with decomposed organic matter from plants, bacteria, fungi, and other living things. Mineral resources in this area are earth materials that can be extracted for a useful purpose, such as gravel that can be used for road beds or backfill. Topography refers to the elevation, slope, aspect, and surface features found within a given area. The ROI for these geologic resources is the PA and immediately adjacent lands.

The principal geologic hazards that could affect man-made structures or the use of conveyed property are soil and slope stability (e.g., landslide potential or soils that shrink and swell and could crack foundations), seismic activity (earthquakes), and volcanic activity. This environmental assessment (EA) assumes that these geologic hazards to structures on the conveyed lands would be addressed by the applicable commercial building codes and engineering design.

This geologic resource area section focuses on soils, gravel deposits, and topography.

3.1.1 Affected Environment

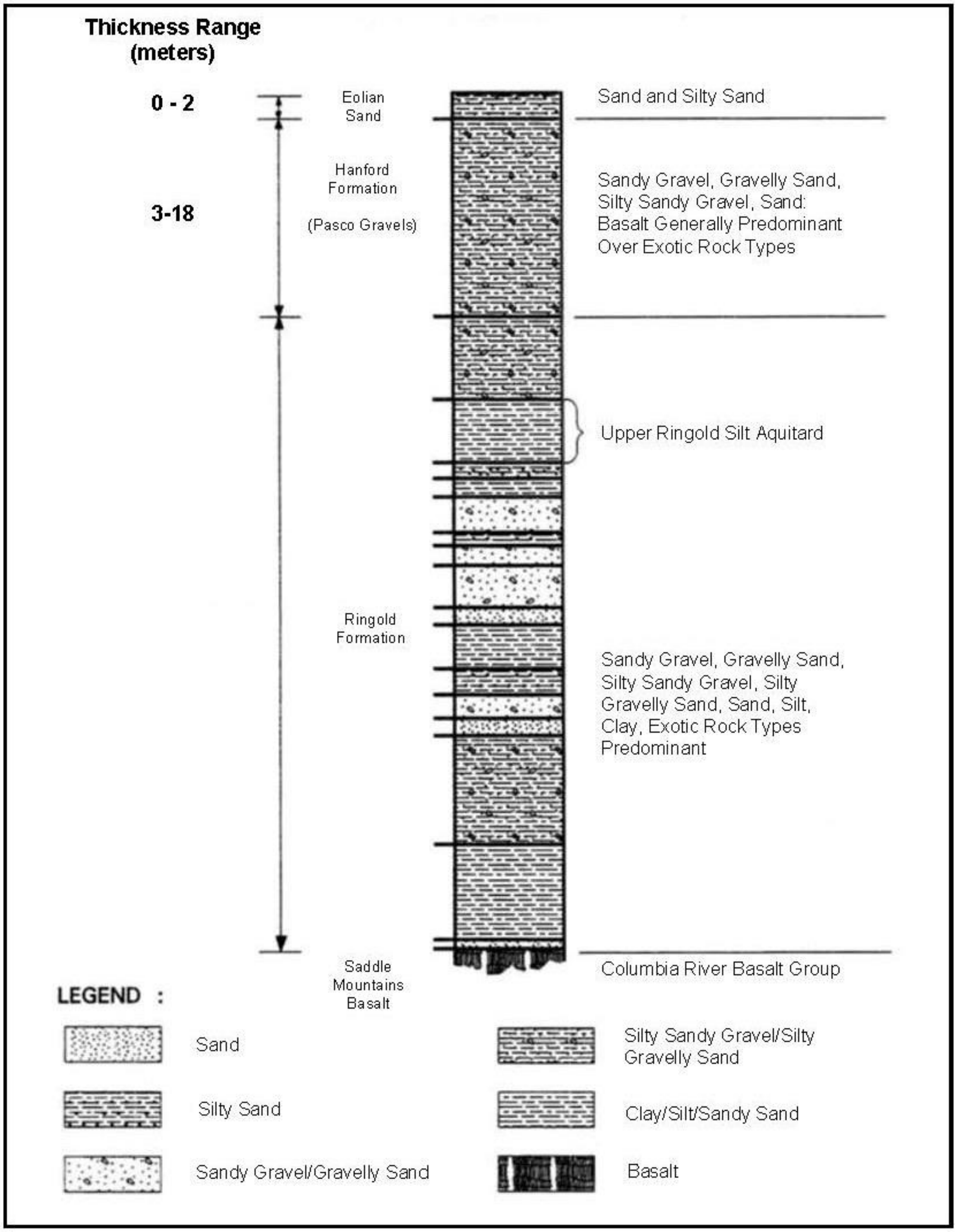
3.1.1.1 Geology and Mineral Resources

The affected environment includes the- PA and immediately adjacent offsite land. The Hanford Site lies within the Columbia Basin, which comprises the northern part of the Columbia Plateau physiographic province and the Columbia River flood-basalt geologic province (Duncan 2007; Reidel et al. 1993). The extent of the Columbia Basin is generally defined as that area underlain by the Columbia River Basalt Group.

The physiographic setting of the Hanford Site is relatively low relief resulting from river and stream sedimentation filling the valleys and basins between the ridges. The surface rocks of the proposed land conveyance area include the Hanford formation and surficial sediments. Sediments deposited by the cataclysmic flood waters between about 1.8 million and 15,000 years ago have been informally called the Hanford formation (see **Figure 3-1**, "General Lithology of the Local Area"). Three major types of flood deposits are recognized: coarse sand- and gravel-dominated, sand-dominated, and interbedded sand- and silt-dominated (DOE 2002). The gravel- and sand-dominated sediments make up most of the vadose zone (water unsaturated soils above the shallow groundwater) beneath the Hanford Site. Gravel from these deposits is mined at Borrow Pits 9 and 6 within the PA (see **Appendix A**, **Figure A-1**). The Hanford formation in the vicinity of the 300 Area (between the Columbia River and Route 4S, north of the Pacific Northwest National Laboratory [PNNL]) is about 15 meters (49 feet) thick and consists of both gravel-dominated and sand-dominated sediment (Duncan 2007). Wind has been the dominant process that has locally reworked the flood sediments, depositing Holocene (approximately 12,000 years ago to present) dune sands in the lower elevations and windblown silt around the margins of the Pasco Basin. Many of the sand dunes have been stabilized by vegetation. Active dunes exist north of the 300 Area in the Hanford Reach National

Monument (HRNM). Some dunes elsewhere on the Hanford Site were temporarily reactivated by removal of vegetation resulting from a range fire in July 2000 (Duncan 2007).

Figure 3-1. General Lithology of the Local Area.



Source: DOE 2014a.

3.1.1.2 Soils

The Soil Survey Hanford Project in Benton County Washington (PNL 1966) describes 15 different soil types on the Hanford Site, varying from sand to silty and sandy loam. The soil classifications have not been updated to reflect current reinterpretations of soil classifications. Soils identified within the evaluated area include Rupert sand, Ephrata sandy loam, and Burbank loamy sand associated with the Quincy sand (Duncan 2007; Rasmussen 1971).

Rupert sand, brown to grayish-brown coarse sand grading to dark grayish-brown at a depth of 90 centimeters (35 inches), is one of the most extensive soil types on the Hanford Site. Rupert sand developed under grass, sagebrush, and hopsage in coarse sandy alluvial deposits that were mantled by wind-blown sand and formed hummocky terraces and dune-like ridges (Duncan 2007).

Ephrata sandy loam is found on level topography on the Hanford Site. Its surface is darkly colored and its subsoil is dark grayish-brown medium-textured soil underlain by gravelly material that may continue for many feet (Duncan 2007).

Burbank loamy sand is a dark-colored, coarse-textured soil underlain by gravel. Its surface soil is usually about 40 centimeters (16 inches) thick but may be as much as 75 centimeters (30 inches) thick. The gravel content of its subsoil ranges from 20 to 80 percent (Duncan 2007). Burbank soils are geographically associated with Quincy soils that are excessively drained, coarse-textured soils on hummocky, or dune-like terraces (Rasmussen 1971).

The sandy nature of these soils contributes to very high permeability, with most or all precipitation and snowmelt infiltrating into the soil column before generating any surface runoff. The potential for water erosion is expected to be low, but the sandy soils are susceptible to wind erosion if disturbed or left unvegetated. Fertility is low, making the soils poorly suited for crop production without significant inputs of both water and nutrients (Rasmussen 1971).

3.1.1.3 Topography

The Hanford Site lies in the Pasco Basin bounded on the north by the Saddle Mountains, on the west by Hog Ranch–Naneum Ridge and the eastern extension of Umtanum and Yakima Ridges, on the south by Rattlesnake Mountain (*Laliik*) and the Rattlesnake Hills, and on the east by the Palouse Slope. Two east-west trending ridges, Gable Butte and Gable Mountain, lie in the central portion of Hanford northwest of the PA. Rattlesnake Mountain, the highest of the Rattlesnake Hills, reaches an elevation of 1,060 meters (3,480 feet) above mean sea level, the highest elevation in the vicinity. The Pasco Basin is a structural and topographic depression of generally lower-relief plains and ridges (Duncan 2007). Elevations across the central portion of the basin and Hanford Site range from about 119 meters (390 feet) above mean sea level at the Columbia River to 229 meters (750 feet) above mean sea level in the part of the Hanford Site that is the highest in elevation several miles to the northwest of the PA.

The landscape of the Hanford Site is dominated by the low-relief plains of the Central Plains and the ridges of the Yakima Folds physiographic regions. The surface topography has been modified within the past several million years by several geomorphic processes: cataclysmic flooding, wind activity, and landsliding. Cataclysmic flooding occurred when ice dams in western Montana and northern Idaho were breached and allowed large volumes of water to spill across eastern and central Washington. This flooding formed the channeled scablands and deposited sediments in the Pasco Basin. The last major flood occurred about 13,000 years ago. Braiding flood channels, giant current ripples, and giant flood bars are among the landforms created by the floods. Winds have locally reworked the flood sediments and have deposited dune sands in the lower elevations and loess (windblown silt) around the margins of the Pasco Basin. Many sand dunes have been stabilized by anchoring vegetation, except where they have been reactivated by human activity disturbing the vegetation. A series of bluffs occurs for a distance of approximately 56 kilometers (35 miles) along the eastern and northern shores of the Columbia River. In the northern portion of the Hanford Site, these bluffs are known as the White Bluffs (DOE 1999a).

3.1.2 Environmental Consequences

The following sections address environmental consequences related to geological and mineral resources, soils, and topography that could occur on the FSA.

3.1.2.1 No Action Alternative

Under the No Action Alternative, existing activities would continue on the PA and some of the FSA lands (including Borrow Pits 6 and 9, SALT Facility, well monitoring, and others). Vehicles for these operations driving on unimproved roads would continue to disturb surface soils. Some deeper geologic units would continue to be disturbed by the gravel mining at the borrow pits. These activities are small in area and short in duration. No additional impacts on geology would occur from taking no action.

3.1.2.2 Proposed Action

Construction

Development of the FSA lands for the purpose of constructing any of the representative facilities (see **Table 2-1**) would involve site clearing, grading, and contouring that would alter the topography of the property in the areas developed. Soils and bedrock materials would be removed from some locations and moved to other locations in order to construct building footings and foundations, dig trenches for utilities and infrastructure, and level the land for roads and parking areas. Excess excavated materials (sand and gravel) could be transported offsite for disposal, but it is more likely that these materials would be stockpiled and used on other construction sites.

The geology and minerals resources, soils, and topography impacts are:

- Partial or complete removal, redistribution, mixing of soil horizons, and soil compaction affecting soil permeability and porosity
- Minimal to substantial changes in topographic relief resulting from grading lands for building, roads, and parking lot construction.

For geology, there are no appreciable differences in the types of impacts due to the construction of any representative facility. However, these impacts differ in degree and extent. Facilities with a larger footprint and that require larger acreage would have a greater extent of impact on soils and topography than a smaller footprint facility. For geologic resources, there is no specific location within the FSA that is more sensitive to construction than another. These impacts would be of relatively short duration. The first phase of the multi-phased development and all the single-phase development representative examples would begin construction simultaneously for up to 18 months (although some could take a few months longer to complete than others). Impacts would be of longer duration for the multi-phased development because the construction activities would be spread out over many years (on the order of 20 years).

Operation

There would be no additional impacts on geology and mineral resources, soils, and topography once the representative facilities (see **Table 2-1**) have been constructed. With time, as landscaping matures and the vegetation establishes or re-establishes itself, the soils would become more stabilized and less vulnerable to erosion. There are no specific locations that are more sensitive to geologic impacts from operations than any others on the FSA. There are no differences in impacts for this resource area among the representative facilities for operations.

3.1.3 Potential Mitigation Measures

Potential impacts would be mitigated by future landowners following state and local construction regulations. Construction projects that disturb 1 acre or more of land would require a stormwater permit under the National Pollutant Discharge Elimination System (NPDES) program (Ecology 2004). The permit process also requires a stormwater pollution prevention plan for the site. This plan would include erosion, sediment, and stormwater management controls to minimize the potential for soil removal. Examples include silt fences, sediment basins, erosion control mats and blankets, and other measures.

3.1.4 Unavoidable Adverse Impacts

Changes in topography would occur with soils being reworked for site construction. Some mineral resources (gravel) would be removed but the effect on geology over the FSA is minor relative to the surrounding areas (i.e., the rest of the PA and the ROI) that would remain largely undisturbed.

3.2 Water Resources

Water resources include surface water, the vadose zone, and groundwater. No perennial (i.e., continuously existing during years of normal rainfall) surface water exists on the PA. The vadose zone or unsaturated zone is a subsurface zone of soil or rock between the ground surface and the deeper saturated zone. Water in the vadose zone is called soil moisture. Groundwater refers to water within the saturated zone. Permeable saturated units in the subsurface are called aquifers. The ROI for water resources includes the PA and the hydraulically downgradient (in the direction of water flow) lands adjacent to the PA.

3.2.1 Affected Environment

3.2.1.1 Surface Water

The PA and adjacent areas do not have perennial surface water, streams, or ponds, and no wetlands have been identified (see **Section 3.5**). The nearest perennial surface water is the Columbia River, which is approximately 0.8 kilometers (0.5 miles) east of the PA at its closest point. It is possible that very localized areas have a limited amount of standing surface water after a heavy precipitation or snowmelt event, and these surface waters may flow limited distances before infiltrating into the highly permeable soils found on the PA.

3.2.1.2 Flooding

Large Columbia River floods have occurred in the past (DOE 1987), but the likelihood of recurrence of large-scale flooding has been reduced by the construction of several flood control/water-storage dams upstream of the Hanford Site. Major floods on the Columbia River are typically the result of rapid melting of the winter snowpack over a wide area augmented by above-normal precipitation.

The U.S. Army Corps of Engineers (USACE) has derived the Standard Project Flood with both regulated and unregulated peak discharges given for the Columbia River downstream of Priest Rapids Dam (USACE 1989). Frequency curves for both unregulated and regulated peak discharges are also given for the same portion of the Columbia River. The regulated Standard Project Flood for this part of the river is given as 15,200 cubic meters per second (m^3/sec) (54,000 cubic feet per second [ft^3/sec]) and the 100-year regulated flood as 12,400 m^3/sec (440,000 ft^3/sec) (DOE 1998a). Impacts to the Hanford Site, including the PA, would be less than the probable maximum flood (Duncan 2007). The maximum historical flood on record occurred June 7, 1894, with a peak discharge at the Hanford Site of 21,000 m^3/sec (742,000 ft^3/sec). The flood area on the Hanford Site was computer modeled using the topographic cross sections of the river, which showed that flooding did not go as far west from the river as the 300 Area (Duncan 2007). Since the flooding did not reach the 300 Area, it can be assumed that it did not reach the PA lands.

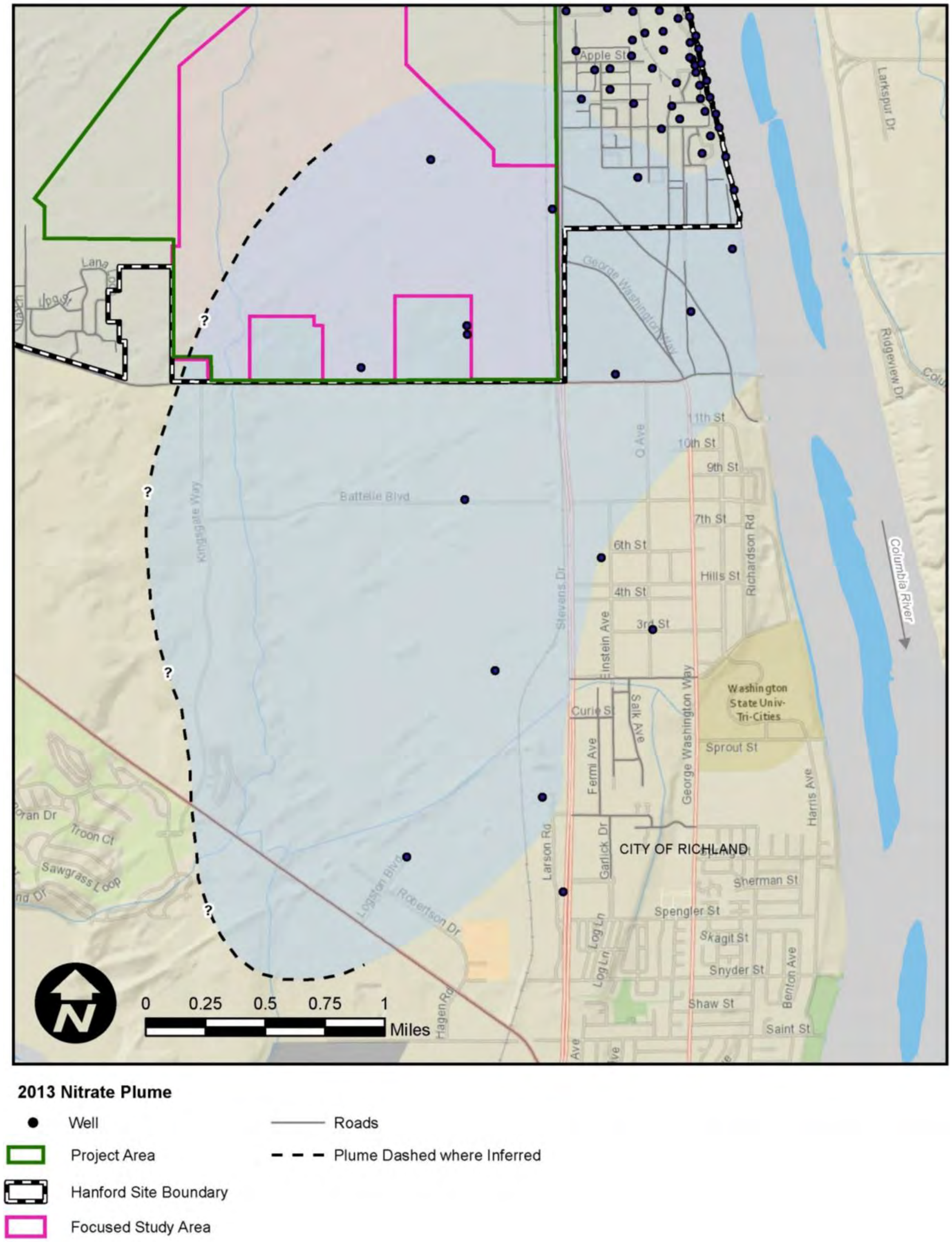
3.2.1.3 Groundwater

Groundwater at the Hanford Site originated as either recharge from rain and snowmelt, or from irrigation, canal seepage, and wastewater disposal. Most of this groundwater will eventually discharge to the Columbia River. Some will be brought to the surface through wells or excavations, or through evaporation or transpiration in shallow water table areas. Groundwater beneath the Hanford Site is found in both an upper unconfined aquifer system and deeper basalt-confined aquifers (see **Figure 3-1**). The unconfined aquifer system is also referred to as the suprabasalt aquifer system because it is within the sediments that overlie the basalt bedrock. Portions of the suprabasalt aquifer system are locally confined. However, because the entire suprabasalt aquifer system is interconnected on a sitewide scale, it is referred to in this document as the Hanford unconfined aquifer system (Duncan 2007).

Relatively permeable sedimentary interbeds and the more porous tops and bottoms of basalt flows provide the confined aquifers within the Columbia River Basalts. The horizontal hydraulic conductivities of most of these aquifers fall in the range of 10^{-10} to 10^{-4} m/sec (3×10^{-10} to 3×10^{-4} ft/sec). Hydraulic head information indicates that groundwater in the basalt-confined aquifers generally flows toward the Columbia River and, in some places, toward areas of enhanced vertical interaquifer flow within the unconfined aquifer system (Hartman et al. 2007; DOE 1988; Spane 1987). The basalt-confined aquifer system is important because there is a potential for significant groundwater movement between the two systems (Duncan 2007).

The unconfined aquifer water table in the 300 Area, adjacent to the PA on the east side, is found in both the Hanford formation and the Ringold Formation (see **Figure 3-1**). It is 0 to 62 feet below ground surface depending on location. Groundwater flows from the northwest, west, and even the southwest to discharge into the Columbia River near the 300 Area (Duncan 2007). The Hanford Site environmental monitoring program has a number of wells on the PA (see **Appendix A**, **Figure A-1**). These wells monitor nitrate contamination found in the north Richland area in this aquifer. This is the result of industrial and agricultural offsite sources. The nitrate plume is migrating eastward and entering the Columbia River. Concentrations above the 45 milligram per liter maximum contaminant level are found over most of the north Richland area (Hartman et al. 2007). The plume shown in blue on **Figure 3-2**, "Nitrate Plume in Richland North and the 300 Area," extends under the southeastern corner of the PA (DOE 2014b).

Figure 3-2. Nitrate Plume in Richland North and the 300 Area.



Source: DOE 2014b.

The unconfined aquifer system consists primarily of the Ringold Formation and overlying Hanford formation (see **Figure 3-1**). In some areas, the coarse-grained multilithic facies of the Cold Creek unit (pre-Missoula gravels) lie between these formations and below the water table. The other subunits of the Cold Creek unit are generally above the water table (Duncan 2007).

Water table elevations show that groundwater in the unconfined aquifer at Hanford generally flows from recharge areas in the elevated region near the western boundary of the Hanford Site toward the Columbia River on the eastern and northern boundaries. The Columbia River is the primary discharge area for the unconfined aquifer. The Yakima River borders the Hanford Site on the southwest and is generally regarded as a source of recharge (Duncan 2007).

Recharge is variable both spatially and temporally. It is greatest for coarse-textured soils bare of deep-rooted vegetation and in years with rapid snowmelt events and precipitation during cool months. The magnitude of recharge at a particular location is influenced by five main factors: climate, soils, vegetation, topography, and springs and streams.

3.2.1.4 Vadose Zone

The vadose zone is that part of the geologic media that extends from the earth's surface to the water table. At the Hanford Site, the thickness of the vadose zone ranges from 0 feet near the Columbia River to greater than 330 feet beneath parts of the central plateau (Hartman 2000). Unconsolidated glacio-fluvial sands and gravels of the Hanford formation make up most of the vadose zone (see **Figure 3-1**). Currently, the major source of moisture to the vadose zone in the PA is derived from precipitation that has infiltrated through the soil zone (Duncan 2007).

3.2.2 Environmental Consequences

Impacts on water resources are typically defined by degradation of the quality of surface water or groundwater. Impacts could also include changes in quantities of surface water, changes in stormwater runoff volumes or locations, decreases or increases in groundwater levels, or changes to groundwater aquifer recharge. This section describes potential environmental consequences related to the subsurface waters that could occur on the FSA and the hydraulically downgradient offsite adjacent areas.

3.2.2.1 No Action Alternative

Under the No Action Alternative, existing activities would continue on the PA (including Borrow Pits 6 and 9, SALT Facility, well monitoring, and others). Of these operations, the borrow pits have the potential to affect water resources since they excavate in what would be the vadose zone. During rainfall events they could allow rainfall directly into the vadose zone and during dryer periods they could allow soil moisture to be lost. The effect would be minor in area and short in duration. No additional impacts on water resources would occur from taking no action.

3.2.2.2 Proposed Action

For the Proposed Action, groundwater wells would not be permitted on any transferred or conveyed lands, and would be restricted through deed or other realty instrument language.

Construction

The *Stormwater Management Manual for Eastern Washington* (Ecology 2004) specifies requirements for bioinfiltration swales. Swales are excavations in the ground designed to capture rainfall runoff and are often referred to as stormwater retention ponds. Bioinfiltration swales use the grass and soil to naturally filter the water that infiltrates the ground. The sizing is based upon the area of impervious surface needed to capture surface runoff. Approximately 20,000 ft^3 of soil and rock would be excavated for the swales when all the representative facilities are constructed (see **Table 3-1**, "Calculated Impervious Land Area, Bioinfiltration Swale Sizing, and Paved Areas"). Bioinfiltration swales use vegetation in strips or channels to capture and biologically reduce pollutants carried by stormwater. Stormwater runoff captured by the swales would either infiltrate or evaporate. Swale construction would be required for the construction of representative facilities. The solar farm activities are not expected to create sufficient impervious surfaces to require swales.

Table 3-1. Calculated Impervious Land Area, Bioinfiltration Swale Sizing, and Paved Areas.

Representative Facility	Type of Operation or Facility	Total Land Area (acres)[a]	Impervious Land Area[b] (acres)	Bioinfiltration Swale Sizing[c] (cubic feet)	Paved Area[d] (acres)
Commerce center	Phased development light multi-use industrial business park	180	117	4,404	108
Warehousing and distribution – A	Manufactured parts distribution center	10	8	304	6
Warehousing and distribution – B	Storage and rail distribution center	30	24	906	18
Research and development – A	Biological R&D center	17	14	516	10
Research and development – B	Energy R&D center	29	24	894	18
Technology and manufacturing – A	Electronics equipment manufacturing	30	24	911	18
Technology and manufacturing – B	Light industrial	50	41	1,519	30
Food and agriculture – A	Vegetable food processing	83	67	2,521	50
Food and agriculture – B	Wine/spirits processing	218	177	6,622	131
Back office – A	National call center	5	4	152	3
Back office – B	Automatic data processing center	6	5	182	4
Biofuels manufacturing facility	Biorefinery and feedstock processing facility	31	16	617	19
	Totals	**689**	**521**	**19,548**	**415**

[a] Acreage used is the actual acreage of the representative example facilities
[b] Calculated using impervious surface coefficients (California Environmental Protection Agency 2010).
[c] Calculated based upon the impervious surface area (Ecology 2004).
[d] Such as parking lots and roads. Calculated as 60 percent of total land area for the development (City of Olympia and Ecology 1995).
Key: R&D = research and development.

Construction activities also involve earthmoving activities that have the potential to generate dust. In order to control dust emissions, the standard procedure is to spray water on areas likely to produce dust as required by the State of Washington (WAC 173-400-040(9)(a)) and the Benton Clean Air Agency Urban Fugitive Dust Policy (BCAA 1996). The quantities of water applied would be minimal, sufficient to limit dust generation. This water is not likely to penetrate measureable quantities into the subsurface. Construction activities would be required to follow the appropriate regulatory process, including obtaining an NPDES stormwater permit. There are no specific site locations that are more sensitive to water resources impacts from construction than any others on the FSA. For the representative example facility construction, there is no difference in water resource issues except that larger footprint facilities would have larger impervious surfaces, more surface water runoff, and consequently larger bioinfiltration swales.

Operation

Surface water runoff from impervious surfaces such as buildings, parking lots, and roads would be much higher since the land currently has little impervious surface area. Design of the development would need to include stormwater retention and treatment as required by state and local regulations. Water for operation of the facilities and landscape irrigation would be needed, the amount of which would vary depending on the type of facility (see **Section 3.10**). There are no specific site locations or representative example facilities that are more sensitive to water resources impacts from operations than others on the FSA.

3.2.3 Potential Mitigation Measures

During construction, exposed ground would be susceptible to erosion during precipitation events. Best management practices (BMP) would be used to minimize or eliminate these effects (EPA 2014a). NPDES permits are required for construction sites disturbing one or more acres.

Increases in surface water runoff resulting from the creation of impervious surfaces would be attenuated by meeting the requirements of Core Elements established by the State of Washington (Ecology 2004) through the application of technology and water quality-based BMPs. Applicable standards that require the implementation of BMPs for stormwater are found in WAC 173-200, "Water Quality Standards for Ground Waters of the State of Washington"; WAC 173-201A, "Water Quality Standards for Surface Waters of the State of Washington"; and WAC 173-204, "Sediment Management Standards." Bioinfiltration swales are one of the methods (Ecology 2004).

3.2.4 Unavoidable Adverse Impacts

Future landowners would follow state and local regulations, and use BMPs and stormwater retention and control methods to minimize potential impacts to water. Thus, unavoidable adverse impacts are not expected to occur.

3.3 Air Quality

The ROI for air quality includes the PA and surrounding areas. Regional air quality is measured by the U.S. Environmental Protection Agency (EPA) in terms of the concentrations of criteria pollutants in the atmosphere. Under the *Clean Air Act*, EPA developed numerical concentration-based standards, or National Ambient Air Quality Standards (NAAQS), for six criteria pollutants that have been determined to affect human health and the environment (EPA 2014b). The NAAQS represent the maximum allowable concentrations for ozone, carbon monoxide (CO), nitrogen dioxide, sulfur dioxide (SO_2), lead, and respirable particulate matter (including particulate matter [PM] equal to or less than 10 micrometers in diameter [PM_{10}] and particulate matter equal to or less than 2.5 micrometers in diameter [$PM_{2.5}$]) (40 CFR 50).

EPA classifies the air quality in a region according to whether the concentrations of criteria pollutants in ambient air exceed the NAAQS. Areas are designated as either "attainment," "nonattainment," "maintenance," or "unclassified" for each of the six criteria pollutants. Attainment means that the air quality is better than (i.e., pollutant levels are lower than) the NAAQS, nonattainment indicates that criteria pollutant levels exceed the NAAQS, maintenance indicates that an area was previously designated nonattainment but is now attainment, and an unclassified air quality designation by EPA means that there is not enough information to appropriately classify an area, so the area is treated as if it is attainment.

Greenhouse gases (GHG) in the atmosphere are also considered in an evaluation of air quality impacts. GHGs are gaseous emissions that trap heat in the atmosphere. These emissions occur from natural processes and human activities. The most common GHGs emitted from human activities are carbon dioxide (CO_2), methane, and nitrous oxide. Human-caused GHG releases are produced primarily by burning fossil fuels and through industrial and biological processes. Because CO_2 emissions account for approximately 92 percent of all energy-related GHG emissions in the United States, they are used for analyses of GHG emissions in this EA.

3.3.1 Affected Environment

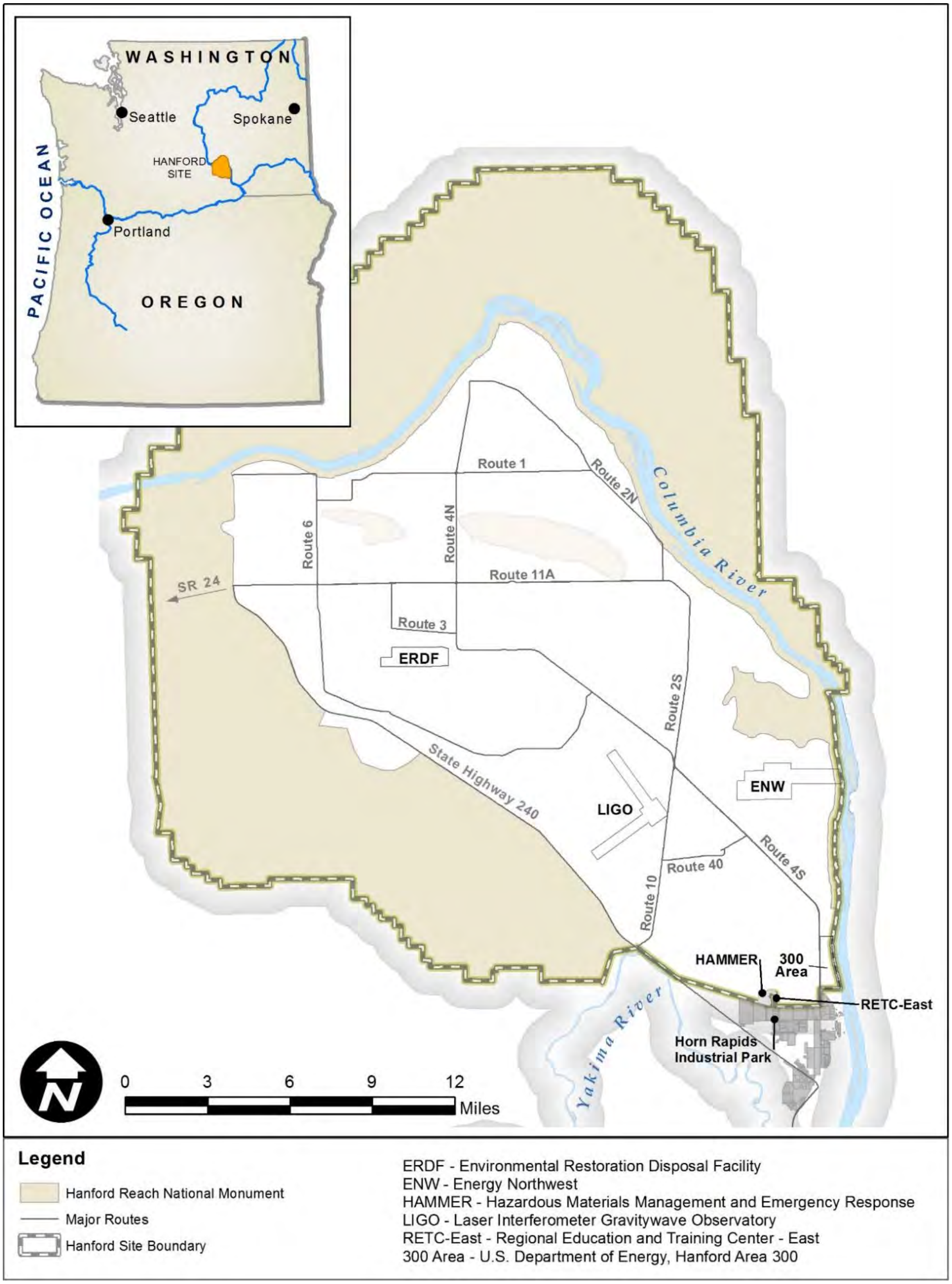
The PA is located in Benton County, Washington, where the air quality is considered to be good, and EPA has designated the county as unclassified/attainment for all criteria pollutants (DOE 2012a). Elevated particulate matter (dust) concentrations are of greatest concern and result from the typically windy and arid weather conditions. Aside from dust generation, the existing air quality emissions are all from offsite locations.

DOE activities at Hanford in the 200 Area generate fugitive dust emissions and equipment emissions from various borrow area and construction sites; dust and equipment emissions from ongoing construction and operation of the Environmental Restoration Disposal Facility (ERDF); emissions from canyon disposition (221-U B-Plant or PUREX closure); emissions from facility demolition and remediation, including excavation, backfill, and capping; and emissions from above-grade structure removal of the Plutonium Finishing Plant (see **Figure 3-3**, "Facilities on the Hanford Site Adjacent to the Project Area"). In the 300 Area, there would be fugitive dust emissions and other emissions from closure and future uses of surplus facilities (DOE 2012b).

Existing and reasonably foreseeable non-DOE activities that emit fugitive dust and other pollutants include commercial operations on Horn Rapids Road such as AREVA facility operation, which emit nitrogen oxide; and Perma-Fix non-thermal and thermal treatment of mixed low-level radioactive waste (LLW), which produces combustion emissions. The operation of the US Ecology commercial LLW disposal site located near the center of the Hanford Site, produces fugitive dust emissions (DOE 2012b).

The Wanapa Energy Center, if built by the Confederated Tribes of the Umatilla Indian Reservation, could be a major source of air pollutant emissions, but would not substantially deteriorate the quality of the air surrounding the proposed site or lead to deterioration of air quality in nearby pristine areas (DOE 2012b). The Wanapa Energy Center would be located on about 20 acres of land east of the city of Umatilla, along the Columbia River. The Plymouth Generating Facility, if built by Plymouth Energy, LLC, would not substantially deteriorate the quality of the air surrounding the proposed site based on the analysis in the *Final Environmental Impact Statement for the Plymouth Generating Facility, Plymouth, Washington* (Benton County and BPA 2003). The Plymouth Generating Facility would be located on a 44.5-acre site, 2 miles west of the rural community of Plymouth in southern Benton County. The Wanapa Energy Center and Plymouth Generating Facility projects are currently on hold by the project proponents (DOE 2012b).

Figure 3-3. Facilities on the Hanford Site Adjacent to the Project Area.



Mobile source emissions in Benton County account for about 68 percent of county annual emissions of CO, 52 percent of nitrogen oxides, 69 percent of sulfur oxides, and 39 percent of volatile organic compounds (DOE 2012b). In addition to the industrial sources of air pollutants discussed above, there are industries that produce asphalt paving material and block, nitrogen fertilizer, crushed stone, canned fruits and vegetables, frozen foods, and nonferrous metal sheets, as well as grain storage facilities and natural gas transmission facilities (DOE 2012b).

Other development in the region could result in increases in air pollutant emissions from construction activities, vehicle traffic, and other sources related to new housing, businesses, and industries. In addition, increased mining activity and reclamation of mined areas could lead to increases in air pollutant emissions.

The majority of the PA is currently unused and there are no continuously emitting air pollution sources except for DOE gravel pit operations at Borrow Pits 9 and 6 (DOE 2012a), which operate intermittently. A discussion of radiological air emissions from outside of the PA is provided in **Section 3.14** and **Appendix F**, “Radiological Accidents.”

3.3.2 Environmental Consequences

The environmental consequences analysis addresses potential impacts to air quality from the construction and operation on the FSA from the representative facilities and the solar farm.

3.3.2.1 No Action Alternative

Under the No Action Alternative, there would be no change from existing conditions on air quality. Air emissions from DOE gravel removal activities would continue at Borrow Pits 9 and 6.

3.3.2.2 Proposed Action

Construction

Temporary effects on air quality would result from constructing the representative facilities including roadways, parking lots, sidewalks, solar array, utility lines, and landscaping. These construction activities would generate criteria pollutant and GHG air emissions from site-disturbing activities such as grading, filling, compacting, and trenching and operation of construction equipment. Construction activities would also generate particulate emissions as fugitive dust from ground-disturbing activities and from the combustion of fuels in construction equipment. Fugitive dust emissions would be greatest during the initial site preparation activities and would vary depending on the work phase, level of activity, and prevailing weather conditions. The quantity of uncontrolled fugitive dust emissions from a work site is proportional to the area of land being worked and the level of activity. Construction workers (2,500 daily workers for the main FSA, 100 daily workers for solar farm, and 200 daily workers for the PAAL) commuting daily to and from the work site in their personal vehicles would also result in criteria and GHG pollutant emissions. Emissions from construction activities would be produced for the duration of construction activities, nominally during daylight hours and weekdays. The numbers of construction workers here differs from those given in the Socioeconomics and Environmental Justice analysis (see **Section 3.13.1.1**) because these are conservative numbers that are based upon construction acreage, number of daily construction commuters, and vary depending on the type of facility.

The construction activities associated with each target industry would entail similar levels of ground disturbance requiring similar amounts of material, staffing, and equipment. Therefore, construction for each possible facility would result in similar air quality impacts, and the sequencing of such activities would not affect air quality differently. There are no locations on the FSA that are particularly sensitive to air quality; therefore, impacts to air quality would be the same regardless of the location of facilities. **Table 3-2**, "Estimated Annual Air Emissions from Hypothetical Construction on the Main FSA," contains a quantitative estimate of the air emissions from construction on the main FSA; **Table 3-3**, "Estimated Annual Air Emissions from Constructing the Solar Farm FSA," contains a quantitative estimate of the air emissions from constructing a single solar technology on the solar farm FSA; and **Table 3-4**, **"**Estimated Air Emissions from Constructing Utilities and Infrastructure on the PAAL," contains a quantitative estimate of the air emissions from constructing utilities and infrastructure on the PAAL. All of these construction activities are assumed to occur in the same (one) year. Because the exact footprint and design of each building to be constructed is not known, assumptions were made to establish parameters for the air emissions analysis. The intent of these assumptions was to bracket the potential air impacts to show the upper bounding scenario, which over estimates the results.

Table 3-2. Estimated Annual Air Emissions from Hypothetical Construction on the Main FSA.

Activity	Emissions (tons per year)						
	NO_x	Volatile Organic Compounds	CO	SO_2	PM_{10}	$PM_{2.5}$	CO_2
Combustion	500.716	43.983	218.694	39.910	35.442	34.379	57,175.102
Fugitive dust	-	-	-	-	1,991.385	199.139	-
Haul truck, on-road	67.972	6.328	36.332	0.218	2.182	2.073	17,622.489
Construction commuter	9.310	9.555	91.857	0.129	1.077	0.690	13,218.305
Total Yearly Construction Emissions	**577.997**	**59.867**	**346.883**	**40.257**	**2,030.087**	**236.281**	**88,015.896**

Table 3-3. Estimated Annual Air Emissions from Constructing the Solar Farm FSA.

Activity	Emissions (tons per year)						
	NO_x	Volatile Organic Compounds	CO	SO_2	PM_{10}	$PM_{2.5}$	CO_2
Combustion	3.748	0.232	1.414	0.310	0.229	0.222	444.737
Fugitive dust	-	-	-	-	85.500	8.550	-
Construction commuter	0.372	0.382	3.674	0.005	0.043	0.028	528.732
Total Yearly Construction Emissions	**4.120**	**0.614**	**5.088**	**0.316**	**85.772**	**8.800**	**973.470**

Table 3-4. Estimated Air Emissions from Constructing Utilities and Infrastructure on the PAAL.

Activity	Emissions (tons per year)						
	NO_x	Volatile Organic Compounds	CO	SO_2	PM_{10}	$PM_{2.5}$	CO_2
Combustion	0.625	0.039	0.236	0.052	0.038	0.037	74.123
Fugitive dust	-	-	-	-	61.446	6.145	-
Haul truck, on-road	1.792	0.167	0.958	0.006	0.058	0.055	464.470
Construction commuter	0.745	0.764	7.349	0.010	0.086	0.055	1,057.464
Total Construction Emissions	**3.161**	**0.970**	**8.542**	**0.068**	**61.628**	**6.291**	**1,596.057**

Assumptions specific to air quality include the following:

- The 1,341 acres would be disturbed by construction in 1 year (this is the size of the main FSA).
- The proposed buildings would occupy 70 percent (939 acres); roadways, parking, and pavement, 25 percent (335 acres); and landscaping and open space, 5 percent (67 acres) of the 1,341-acre parcel. These are standard modeling parameters for air emissions analysis.
- Each building would be one story in height. Even though some representative facilities are shown to be multi-story, this simplification does not appreciably affect the air quality estimates because the amount of ground disturbance would not change based on the number of floors in each building.
- For the solar farm FSA grading activities would take 3 months and construction would take 1 year.
- Ten percent of the PAAL would be disturbed from construction of utilities and infrastructure.

Appendix J, "Air Emissions Estimates," contains a detailed summary of the quantitative air emissions estimates and a list of assumptions used during its development.

Air emissions from construction activities would be entirely from mobile sources, which are not subject to most permitting requirements such as prevention of significant deterioration (PSD), Title V, or State of Washington air operating permits. Site operators would obtain any applicable construction permits for stationary sources to be constructed (e.g., boilers, emergency electrical generators, and industry-specific manufacturing equipment).

For a PSD major source, regulatory thresholds are 250 tons per year of any criteria pollutant or 100,000 metric tons per year of CO_2. These thresholds provide a reference point for evaluating potential impacts. Based on these thresholds, air emissions from construction activities would exceed the significance thresholds for nitrogen oxides (NO_x), CO, PM_{10}, and $PM_{2.5}$. However, these emissions were calculated as though they were coming from a single PSD major source, when they would actually come from 12 independent construction sites. Each construction site would be subject to its own applicable air permitting requirements. Individually, each of these construction sites would not exceed the thresholds for NO_x, CO, $PM_{10,}$ and $PM_{2.5}$.

There are no specific site locations that are more sensitive to air quality impacts from construction than any others. The emissions analysis for construction does not discriminate on the basis of the representative facility type only building size. Larger buildings would contribute more emissions than smaller buildings because of the amount of time and materials it takes to construct larger facilities.

Operation

Long-term, moderate effects on air quality would result from the operation of the various representative facilities that could be on the main FSA. Operation of these facilities would generate criteria pollutant and GHG air emissions from building heating equipment, emergency electrical generators, industry-specific manufacturing equipment, truck traffic, and employees commuting daily to and from the proposed buildings. **Table 3-5**, "Estimated Annual Air Emissions from Operational Activities," contains a quantitative estimate of these emissions.

Table 3-5. Estimated Annual Air Emissions from Operational Activities.

Activity	Emissions (tons per year)						
	NO_x	Volatile Organic Compounds	CO	SO_2	PM_{10}	$PM_{2.5}$	CO_2
Boiler (40,902,840 ft^2)	71.580	3.937	60.127	0.429	5.440	5.440	85,895.964
Diesel generator (50 generators)	94.110	7.682	20.273	6.189	6.615	6.615	3,499.787
Truck traffic	41.204	3.836	22.024	0.132	1.323	1.257	10,682.540
Employee commuter (4,000 new employees)	11.172	11.466	110.228	0.154	1.293	0.828	15,861.966
Total	**218.066**	**26.922**	**212.652**	**6.905**	**14.671**	**14.140**	**115,940.256**

Source: BCAA 2015.

The estimated air emissions in **Table 3-5** would be produced after the proposed construction period is complete. Lesser quantities of operational air emissions would be produced during the construction period and would progressively increase as more buildings become operational. **Appendix J** contains a detailed summary of the quantitative air emissions estimates and a complete list of assumptions used during its development.

Air emissions from the boilers, emergency electrical generators, and industry-specific manufacturing equipment assumed to be used in future development of the FSA would be from stationary sources and would be subject to applicable operational air permit requirements. Such permits could include PSD, Title V, or State of Washington air operating permits. In Benton County, the Benton Clean Air Agency would issue any applicable state-level air operating permits. Air emissions from new employees commuting to and from work and from truck traffic hauling goods and other materials would be from mobile sources, which are not subject to permitting requirements.

For a PSD major source, regulatory thresholds are 250 tons per year of any criteria pollutant or 100,000 metric tons per year of CO_2. These thresholds provide a reference point for evaluating potential impacts. The rationale for these levels is that they are consistent with the threshold for a PSD major source. Based on these significance thresholds, none of the criteria pollutant emissions would exceed the 250-ton-per-year threshold; however, NO_x and CO air emissions would be near the threshold. Emissions of CO_2 would slightly exceed the 100,000-metric tons-per-year threshold, mostly from the natural gas-fired boiler emissions.

There are no specific site locations that are more sensitive to air quality impacts from operations than any others. The emissions analysis for operations does not discriminate on the basis of the representative facility type only building size. Larger buildings would contribute more emissions than smaller buildings simply because of the energy demands of larger facilities.

3.3.3 Potential Mitigation Measures by Future Landowners

Although not obligatory or within the control of DOE, the following section describes potential mitigation measures, which could be undertaken by a future landowner.

Impacts from fugitive dust can be mitigated by applying water to areas of disturbance and by minimizing the amount of land disturbed at a given time by staging phases of the construction. Additionally, construction vehicles could use diesel particle filters to reduce emissions.

Possible mitigation of emissions from mobile sources could be accomplished through the institution of mass transit, car-pooling, and other ride-sharing approaches by the City of Richland, local transit authority, and future landowners. Possible mitigation measures for mobile air emissions from commercial truck hauling could be accomplished by encouraging facility owners to minimize truck idling while at a facility, using yard-trucks (efficient slow-speed vehicles) to move trailers around a facility, and designing roads and traffic patterns to minimize truck idling situations (e.g., having few stop signs and maximizing one-way truck movement).

3.3.4 Unavoidable Adverse Impacts

Construction and operation of new facilities would create new air emissions of criteria and GHG air pollutants that would not be created under the No Action Alternative or existing condition. These emissions cannot be completely mitigated and, therefore, represent an unavoidable adverse impact.

3.4 Ecological Resources

The ROI for ecological resources includes the PA and adjacent Hanford Site lands. The following section addresses vegetation, wildlife, and habitat for the PA and adjacent Hanford Site lands.

3.4.1 Affected Environment

The 375,000-acre Hanford Site represents one of the largest remaining blocks of relatively undisturbed shrub-steppe habitat in the Columbia Basin Ecoregion (DOE 2012c; Poston et al. 2009). Shrub-steppe habitats in the region and throughout western North America have declined from agriculture, grazing, and human development activities (Poston et al. 2009). Studies show that eastern Washington’s shrub-steppe habitats, which once covered 15 million acres, have decreased by 50 percent since the arrival of settlers in the 1840s (DOE 2012c). Hanford Site lands are important because they add to habitat value and facilitate landscape connectivity with other regional shrub-steppe habitat areas, such as the Yakima Training Center to the west and Columbia National Wildlife Refuge to the north (DOE 2013a). More than half (52 percent) of the site was included in the 2000 HRNM designation. The HRNM was established, in part, to permanently protect its shrub-steppe vegetation communities and wildlife habitats (Proclamation 7319 of June 9, 2000, “Establishment of the Hanford Reach National Monument”).

Prior to federal acquisition of the Hanford Site (see **Section 3.6.1.1**), vegetation and wildlife habitat in the PA were subject to human disturbance from irrigation system development, homesteading, and agricultural activities. Following federal acquisition, PA lands functioned as a buffer area for Hanford Site defense-related production and waste management activities, with human disturbance primarily concentrated in transportation and utility corridors, borrow areas, the Horn Rapids landfill, and groundwater monitoring well sites. In addition, a number of wildfires have burned over the PA (PNNL 2011), and most of the lands have been sprayed with herbicide to control weeds (see **Appendix I**, “Salstrom and Easterly, Vegetation Survey of the Proposed Land Conveyance, Central Hanford, Washington”).

While vegetation and wildlife habitat in parts of the PA has been disturbed by ongoing Hanford Site activities as described above, most of the PA has remained relatively undisturbed for more than 70 years.

This analysis considers the results of wildlife and plant surveys conducted for this EA (see **Appendix H**, “Wildlife Survey,” and **Appendix I**) and other existing ecological studies of the Hanford Site. Survey results are considered in context of the Hanford Site Biological Resources Management Plan (BRMP) (DOE 2013a), which is used to address vegetation and wildlife habitat concerns for Hanford Site projects. The BRMP identifies six levels of resource concern (Levels 0 through 5), with Level 0 representing the lowest and 5 the highest, each with corresponding management guidance. For example, Level 5 resources include species listed on the *Endangered Species Act*, Level 4 includes candidate and state listed species and high quality habitats, and Levels 3 through 1 include migratory birds, state monitor species, and common native and plant species, respectively. Guidance for Level 5 and 4 resources is avoidance, and if that is not possible, compensatory mitigation measures are recommended. Guidance for Levels 3 through 1 resources includes avoidance, conservation actions, and some mitigation measures (DOE 2013a).

3.4.1.1 Vegetation

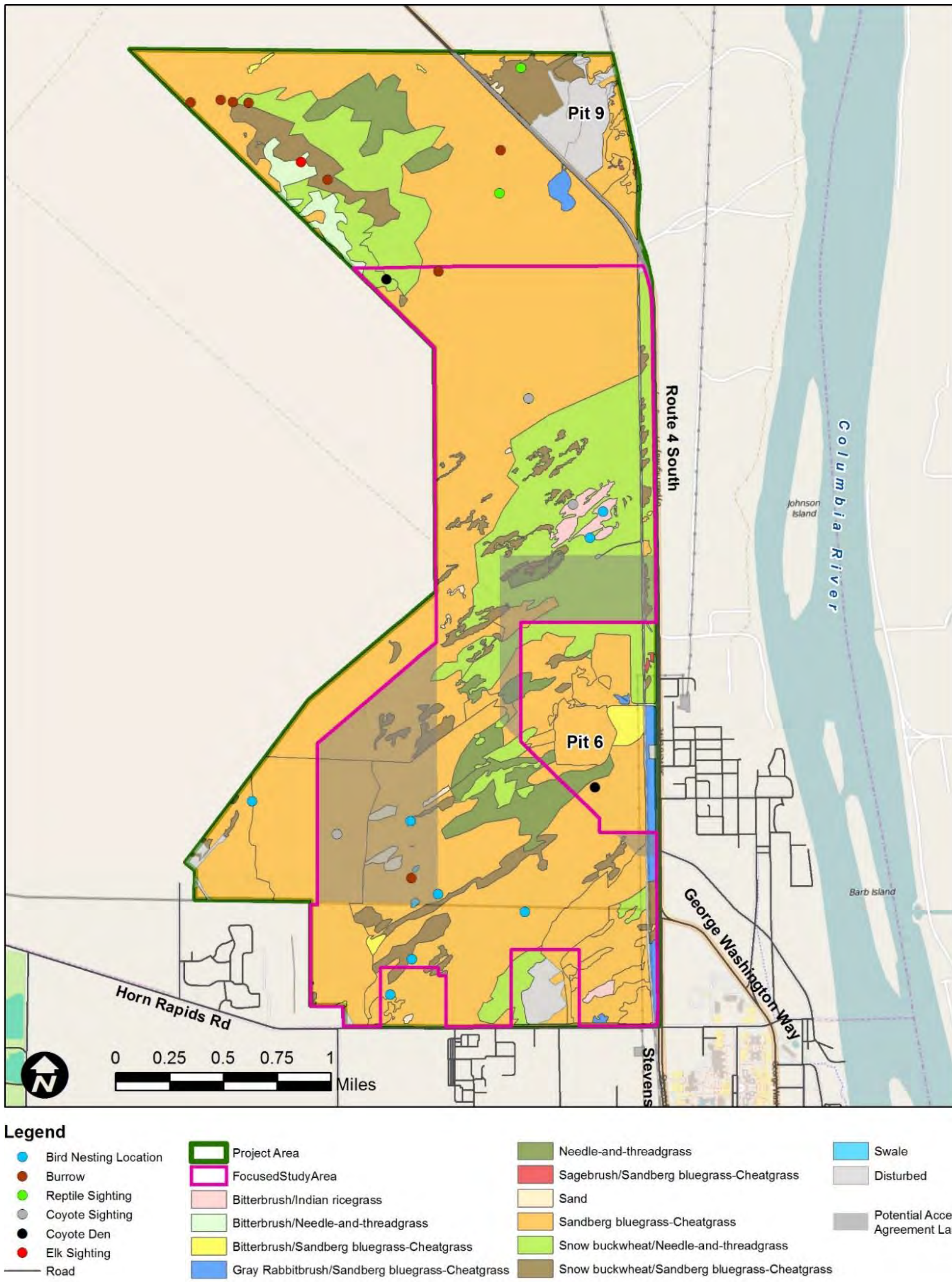
The PA landscape has been shaped by the Pleistocene cataclysmic floods, with most of the area consisting of a flood terrace where fine-textured sediments were deposited (see **Appendix I**). Flood sediments are capped by layers of wind-blown sand, and dunes have formed in some areas. The dunes are stabilized by vegetation with some blowouts caused by wind. Most of the PA has been burned by wildfire during recent decades, and the shrub component of PA vegetation communities was burned off by a large wildfire in 2000 (PNNL 2011). While sagebrush is mostly absent, snow buckwheat (*Eriogonum niveum*) and green (*Chrysothamnus viscidiflorus*) and grey rabbitbrush (*Ericameria nauseosus*), have reestablished in some areas.

A detailed list of plant species observed within the PA during the 2013 field survey is included in **Appendix I**. There are no known species currently considered to be rare in the PA. Since some annual species likely did not have their environmental conditions met during 2013, the lack of their detection does not rule out that they are present, just that the conditions were not conducive for them to be growing in 2013. Areas with the highest potential for those species are associated with the open sands on the stabilized dunes, which are limited in the PA (see **Appendix I**).

Beardless wildrye (*Leymus triticoides*), a species not recently collected in Washington, was identified during 2013 field surveys. This species is currently identified by the state as a species of potential concern, with insufficient information available to determine if a different conservation status rating is appropriate (WHNP 2015). The species' distribution within the PA was limited to an area within the FSA with three swales, or areas lower in elevation than surrounding terrain. The swales include plants not known to occur elsewhere on the Hanford Site, or away from riparian areas at the Hanford Site, including hairy crabgrass (*Digitaria sanguinalis*), mountain rush (*Juncus arcticus*), salt heliotrope (*Heliotropium curassavicum*), Douglas' sedge (*Carex douglasii*), yellow bee plant (*Cleome lutea*), and coyote willow (*Salix exigua*). An abundance of insect activity was noted in this area during the 2013 field surveys (see **Appendix I**).

Table 3-6, "Vegetation Community Types and Cover in the PA and FSA," lists current vegetation communities in the PA and FSA. Most of the FSA (66 percent) consists of a BRMP Level 2 sandberg bluegrass-cheatgrass vegetation community (*Poa secunda, Bromus tectorum*). BRMP Level 3 snow buckwheat and needle-and-threadgrass communities make up about 21 percent of the FSA, and Level 4 bitterbrush/Indian ricegrass and bitterbrush/needle and threadgrass communities make up about 2 percent of the FSA (see **Figure 3-4**, "Vegetation and Wildlife Survey Map Showing the Location of the FSA," and **Table 3-6**).

Figure 3-4. Vegetation and Wildlife Survey Map Showing the Location of the FSA.



Source: See Appendices H and I.

Table 3-6. Vegetation Community Types and Cover in the PA and FSA.

Dominant Vegetation Type	PA Cover (rounded percent)	PA Cover (approximate acres)	FSA Cover including the PAAL (rounded percent)	FSA Cover including the PAAL (approximate acres)
Bitterbrush/Indian ricegrass	0.7	31	1.3	32
Bitterbrush/needle-and-threadgrass	0.9	40	0.0	1
Bitterbrush/Sandberg bluegrass-cheatgrass	0.5	22	0.2	4
Gray rabbitbrush/Sandberg bluegrass-cheatgrass	0.9	40	0.5	13
Needle-and-threadgrass	4.4	194	4.5	110
Sagebrush/Sandberg bluegrass-cheatgrass	0.1	4	0.0	0
Sandberg bluegrass-cheatgrass	64.9	2864	65.5	1613
Snow buckwheat/needle-and-threadgrass	17.3	763	20.7	509
Snow buckwheat/Sandberg bluegrass-cheatgrass	6.2	274	5.8	143
Swale	0.03	1	0.0	1
Sand	0.4	18	0.6	14
Disturbed	3.7	163	0.9	22
Total Cover	100	4414	100.0	2461

Source: See Appendix I.

3.4.1.2 Wildlife

Wildlife resources that inhabit the PA primarily consist of native wildlife, invertebrate, and plant species and include several species of concern, state monitor species, and species protected under the *Migratory Bird Treaty Act* (MBTA). All species observed during the wildlife surveys conducted in 2013 are included in BRMP Levels 1, 2, or 3, with most included in Level 2. Habitats within the PA are categorized by the BRMP as Levels 2 and 3 (see **Appendix H**; DOE 2013a).

A detailed account of wildlife species observed within the PA during the 2013 field survey is included in **Appendix H**.

3.4.1.3 Birds

Bird species in the PA include common native species found in shrub-steppe habitats throughout the Hanford Site, including the western meadowlark, horned lark, and western kingbird (see **Table 3-7**, "Bird Species Observed during Surveys of the Hanford Land Conveyance Property in late May and early June 2013"). Based upon the 2013 field survey, these species are likely to nest throughout much of the property (see **Appendix H**). In addition, the Swainson's hawk, nighthawk, and long-billed curlew nest in the PA. The long-billed curlew, a U.S. Fish and Wildlife Service (USFWS) Bird of Conservation Concern and Washington State Monitor Species, was observed throughout the PA during the 2013 field survey.

Neither ferruginous hawks nor burrowing owls nest within the PA, but are known to nest on Hanford Site lands west of the PA, and may use PA lands for foraging habitat.

Table 3-7. Bird Species Observed During Surveys of the Hanford Land Conveyance Property in late May and early June 2013.

Common Name/Scientific Name	Status[1, 2]	Occurrence During Surveys[3]
Western Meadowlark (*Sturnella neglecta*)	MBTA	C
Horned Lark (*Eremophila alpestris*)	MBTA	C
Western Kingbird (*Tyrannus verticalis*)	MBTA	FC
Long-billed Curlew (*Numenius americanus*)	MBTA; State Monitored	FC
Mourning Dove	MBTA	FC
Common Nighthawk (*Chordeiles minor*)	MBTA	FC
Black-billed Magpie (*Pica hudsonia*)	MBTA	U
Common Raven (*Corvus corax*)	MBTA	FC
Barn swallow (*Hirundo rustica*)	MBTA	U
Grasshopper sparrow (*Ammodramus savannarum)*	State Monitored; MBTA	R
Lark sparrow (*Chondestes grammacus*)	MBTA	R
European Starling (*Sturnus vulgaris*)		U
Chukar (*Alectoris chukar*)		R
American kestrel (*Falco sparverius*)	MBTA	U
Swainsons Hawk	State Monitored	U
Ferruginous Hawk (*Buteo regalis*)	Federal Species of Concern State Threatened; MBTA	R
Red Tailed Hawk (*Buteo jamaicensis*)	MBTA	U

[1]MBTA = Species is listed under the *Migratory Bird Treaty Act.*
[2]Source: USFWS 2013
[3]C = Common, FC = Fairly Common, U = Uncommon, R = Rare

3.4.1.4 Mammals

Table 3-8, "Mammal Species Observed during Surveys of the Hanford Land Conveyance Property in late May and early June 2013," shows mammal species observed in the PA during 2013. Burrows found throughout the PA indicated that the PA is likely inhabited by badgers, ground squirrels, mice, voles, and shrews. Evidence of jackrabbits has not been documented on the PA lands in recent years. While bat roosts are not likely to occur in the PA, bats may use the area for foraging.

Table 3-8. Mammal Species Observed during Surveys of the Hanford Land Conveyance Property in late May and early June 2013.

Species	Status	Occurrence During Surveys[1]
Coyote (*Canis latrans*)	None	U
Mule Deer (*Odocoileus hemionus*)	None	R
Elk (*Cervus elaphus*)	None	R

[1]C = Common, FC = Fairly Common, U = Uncommon, R = Rare

3.4.1.5 Reptiles and Amphibians

Table 3-9, "Reptile Species Observed during surveys of the Hanford Land Conveyance Property in late May and early June 2013," shows reptile species observed in the PA during 2013. Due to lack of surface water, the PA does not have suitable habitat for amphibian species. Reptiles known or likely to occur on the PA include the western yellow-bellied racer (*Coluber constrictor*), the Great Basin gopher snake (*Pituophis catenifer*), pygmy short-horned lizard (*Phrynosoma douglasii*), and the common side-blotched lizard (*Uta stansburiana*). In addition, sagebrush lizards (*Sceloporus graciosus*) could be expected to occur in the portions of the PA with some shrub cover (DOE 2013a).

Table 3-9. Reptile Species Observed during surveys of the Hanford Land Conveyance Property in late May and early June 2013.

Species	Status	Occurrence during Surveys[1]
Gopher Snake (Bull Snake) (*Pituophis catenifer*)	None	U
Short-horned lizard (*Phrynosoma douglassii*)	State Monitored	R

[1]C = Common, FC = Farily Common, U = Uncommon, R = Rare

3.4.1.6 Threatened and Endangered Species

Federally listed threatened and endangered species that have the potential to occur in Benton County were identified from available data on websites maintained by the USFWS, National Marine Fisheries Service, and the Washington Department of Fish and Wildlife (WDFW). Priority habitat and species data were also reviewed from WDFW's online resources. USFWS lists for Benton County include 11 species, distinct population segments, or evolutionarily significant units listed as threatened or endangered, 2 candidate species, and 22 species of concern under the *Endangered Species Act*. None of the threatened, endangered, or candidate species listed for the county is documented to occur within the FSA or PA (see **Appendix H**; WDFW 2013) and none of these species were observed during the wildlife surveys conducted in May and June 2013. Based on agency data and the 2013 surveys, there are no listed species or any that are currently proposed for listing in the PA (see **Appendix H**).

The Greater sage grouse is a Washington state listed threatened species and a candidate for federal protection under the *Endangered Species Act*. This species was historically known to occur throughout the Columbia Basin, including on the Hanford Site. There have been sporadic sightings of sage grouse on the Hanford Site, but no known breeding populations currently exist on the site (Duncan 2007; DOE 2013a).

The bald eagle (*Haliaeetus leucocephalus*) was removed from the federal threatened and endangered species list in July 2007 and its status was changed from threatened to sensitive in Washington State in January 2008. Federal and state protection is still applied to bald eagles through the *Bald and Golden Eagle Protection Act*, the MBTA (USFWS 2012), and the Washington Administrative Code. Bald eagles are reported to occur during the winter months along the Yakima River and the Columbia River. They are known to use riparian trees for perching and nesting (USFWS 2008); however, they are not known to use the PA.

The WDFW (2013) also lists the black-tailed jackrabbit (*Lepus californicus*) and white–tailed jackrabbit (*Lepus townsendii*) as state candidate species. Field personnel conducting surveys in 2011, including night spotlight surveys throughout the Hanford Site, yielded no jackrabbit sightings (DOE 2012a). Field personnel conducting surveys in 2013 demonstrated the occurrence of black-tailed jackrabbits in the northern areas of Hanford, with the closest sighting approximately two miles to the north of the PA (Lindsey et al. 2014). No rabbits or rabbit presence indicators were observed during the wildlife surveys for this project (see **Appendix H**).

3.4.2 Environmental Consequences

The following sections describe the effects from construction and operational activities in the FSA.

3.4.2.1 No Action Alternative

Under the No Action Alternative, current human activities occurring within the FSA would continue and new development is not anticipated. Currently documented wildlife species would continue to use the area, and new species may move into the area if native vegetation communities continue to recover from past disturbance.

3.4.2.2 Proposed Action

Land conveyance and subsequent development would result in wildlife disturbance and habitat loss. Regardless of which representative facilities are constructed, the general effects to wildlife and existing habitat would be similar, but would vary by degree and intensity related to the amount of land area that is affected and whether a representative facility operates at night.

Construction

For the purpose of this analysis, construction activities for the various proposed single-phase developments are assumed to take roughly one to two years to complete, depending on the facility. The multi-phased development would be constructed over a 20-year period.

Vegetation and Wildlife

Of the representative facilities for the FSA, the back offices would result in the least amount of habitat loss, while the much larger footprints for the food and agriculture processing, biofuels manufacturing facility, and warehouse facilities would have the greatest amount of impact on vegetation and wildlife resources.

Construction activities would remove vegetation and level the land for development. In addition, these activities would introduce noise, traffic, lighting, and human presence in the FSA. Most wildlife species with adequate mobility (birds, larger mammals) would leave the area and seek replacement habitat. If construction occurs during bird nesting, birds may abandon nests. Some bird species tolerant to human activity may continue to reside in the area or use structures as roosts or nesting areas. However, many of the current bird species nesting in the area would lose their habitat. Areas in the surrounding Hanford Site, including the HRNM, contain habitats of similar ecological value and would potentially allow displaced birds to relocate to these areas. If these birds encounter competition by birds that already occupy these adjacent habitats, this forced displacement may result in mortality. Some small mammals and reptiles may be unable to escape construction activities and injury or mortality may occur.

For the solar farm, permanent loss of vegetation and wildlife habitat is anticipated with vegetation clearing, grading, and construction of solar arrays.

Much of the shrub-steppe habitat has been lost in the Columbia Basin Ecoregion and some of the last remaining large tracts of this habitat occur on the Hanford Site. Construction activities would further reduce the amount of this habitat that remains available to its endemic species. Consequently, this loss of habitat may place further pressure on populations of some of these species that are already experiencing habitat loss in other parts of their range. The FSA encompasses less than 1 percent of the Hanford Site, including the HRNM, which contains large areas of similar habitat.

Threatened and Endangered Species

Construction of the representative facilities within the FSA would eliminate much of the existing vegetation and habitat. No species are known to occur on the PA that are listed under the *Endangered Species Act* (see Appendices H and I). As a result, construction activities on the FSA would be unlikely to have an effect on any federally listed species.

Operation

Once construction activities are complete, the FSA would function as an industrial landscape with little habitat value for wildlife. Operation of the representative facilities would be similar to those from construction for the different proposed facilities, but vary by degree and intensity depending on the type of facility and its location.

Vegetation and Wildlife

During operations in the main FSA, vegetation would likely include native or ornamental species in landscaped areas around developed facilities and bio-infiltration swales. For the solar farm FSA, vegetated areas would be minimal due to maintenance activities such as mowing, mirror washing, and weed management, and the large areas of perennial shade created by the solar facility.

Wildlife species that were not displaced during construction; such as birds and small mammals; would be exposed to dangers from traffic (vehicle strikes), buildings (flight collision), power lines (electrocution). Some warehousing facilities with noise, lighting, and activity occurring all day and night; would be a continual source of disturbance to birds, bats, and other wildlife in the area. Noise and lighting impacts would extend beyond the footprint of the development and could also affect wildlife on adjacent lands. For example, birds must be able to discriminate between songs of their own and other species, apart from any background noise. Calls are important in the isolation of species, pair bond formation, courtship display, territorial defense, danger, advertisement of food sources, and flock cohesion (FHWA 2004). The warehouse and distribution facility involves trains that would create acoustic noise and ground vibration. While some wildlife may habituate to these disturbances many mobile species would likely leave the area.

Operations of multiple development sites would serve to fragment any remaining habitats in the FSA and degrade or eliminate connectivity between adjacent habitats.

Motion of the single-axis PV panels at the solar facility (see **Appendix E**) is sufficiently slow as to not be noticeable to wildlife (Power Engineers Inc. 2014). While movement of the dishes for the concentrating solar power (CSP) solar facility is similarly slow, the dish surfaces are mirrored and elevated 40 feet (see **Appendix E**). Birds could be blinded or die from the concentrated heat or by collision with the mirrors. The humming sound of the CSP Stirling engine could disturb wildlife (see **Appendix C**, "Acoustic Noise and Vibration from Facility Operations").

Threatened and Endangered Species

No species are known to occur on the PA that are listed under the *Endangered Species Act* (see Appendices H and I). As a result, operation of facilities on the FSA would be unlikely to have an effect on any federally listed species.

3.4.3 Potential Mitigation Measures by Future Landowners or U.S. Department of Energy

Development locations within the FSA have not been determined at this time; however, it is possible that facilities may not completely cover FSA lands. Mitigation measures that could be considered by future landowners include avoiding a potential impact (location), limiting the degree of an action (the intensity of the facility operation), and compensating for a potential impact (protecting the same resource at another location). Mitigation measures that could be undertaken by DOE could involve compensating for the loss of habitat within the FSA by making habitat improvements or enhancing habitat protection in surrounding areas. Potential DOE mitigation measures are summarized below in **Table 3-10**, "Potential DOE Mitigation Measures for Impacts to Ecological Resources."

Table 3-10. Potential DOE Mitigation Measures for Impacts to Ecological Resources.

Environmental Consequence	Type of Mitigation Measure (Avoid/Prevent, Reduce, or Remedy/Offset)	Mitigation Measure Effectiveness		
		Mitigation Measure	Residual Environmental Consequence with Mitigation	Environmental Consequence without Mitigation
Loss of shrub-steppe habitat and bird nesting habitat; displacement of wildlife species; facilities and roads will fragment habitat and impair movement through area; power lines and increased vehicles increase mortality/collision risk.	Remedy/Offset	Habitat improvements or enhanced habitat protection could be made to surrounding areas consistent with BRMP Levels 2–4 resources.	Specific development type and locations within the FSA have not been determined at this time; however, impacts to migratory bird nesting and shrub-steppe habitats used by wildlife would occur within the FSA. Habitat improvements would be made on surrounding lands to the benefit of migratory bird nesting and shrub-steppe resources.	Any or all environmentally sensitive areas in the FSA including MBTA bird nesting sites such as curlews on the FSA lands conveyed would be eliminated; shrub-steppe habitat would be lost, and wildlife would be displaced.

3.4.4 Unavoidable Adverse Impacts

Some shrub-steppe habitats categorized as BRMP Levels 2 through 4 would be eliminated by development within the FSA. The quality and quantity of wildlife habitat over the entire FSA will be greatly reduced for many species and eliminated for others.

3.5 Wetlands and Floodplains

3.5.1 Affected Environment

3.5.1.1 Wetlands

Wetlands often perform important hydrologic support, water quality treatment, and habitat functions, including groundwater recharge and discharge, stormwater attenuation and storage, erosion protection pollution mitigation, nutrient cycling, sediment detention, and wildlife habitat.

A preliminary field survey of the PA was conducted in June 2012. Five small areas were identified as potential wetland areas in the southwestern part of the PA. Potential wetland areas within the PA were assessed in 2013 through a two-step process to verify the need for delineation. First, a botanical survey was conducted in May 2013 (see **Appendix I**). The botanical survey identified specific locations where plant species that are common within wetlands occur. A wetland reconnaissance was then conducted within those areas on May 15 and 16, 2013, to document the existing conditions of these potential wetland areas.

Field observations for wetland indicators were conducted in accordance with the *Corps of Engineers Wetland Delineation Manual* (USACE 1987) and the *Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Arid West Region* (USACE 2008). The 1987 manual and its supplement provide technical guidance and procedures for identifying and delineating wetlands potentially subject to Section 404 of the *Clean Water Act* or Section 10 of the *Rivers and Harbors Act*. Environmental conditions can differ regionally; therefore, supplemental manuals (e.g., that for the Arid West Region) were prepared by USACE to accommodate regional characteristics.

USACE's wetland delineation process is a three-parameter approach. Areas must meet all three of the mandatory criteria of (1) dominance of hydrophytic vegetation (plants tolerant of wet soil conditions), (2) presence of wetland hydrology, and (3) presence of hydric soils (saturated for sufficient time to develop anaerobic conditions). National Wetland Inventory Maps do not indicate wetlands are present on the Hanford Site.

Specific areas evaluated during the wetland reconnaissance are located within several shallow depressions totaling approximately 0.11 acres. These areas contain cheatgrass (*Bromus tectorum*), yellow spiderflower (*Cleome lutea*), seaside heliotrope (*Heliotropium curassavicum*), Douglas's sedge (*Carex douglasii*), arctic rush (*Juncus arcticus*), beardless wildrye (*Leymus triticoides*), coastal fiddleneck (*Amsinckia lycopsoides*), and hairy crabgrass (*Digitaria sanguinalis*), as well as a few saplings of coyote willow (*Salix exigua*). These depressional areas contain plant species that often are found in wetlands (e.g., Douglas's sedge, arctic rush, beardless wildrye, narrow-leaf willow), but the dominant cover consists of upland species.

For the first three weeks of May 2013, the Hanford Meteorological Station recorded a trace of precipitation, whereas the average precipitation recorded from 1947 to 2012 is 0.53 inches of precipitation for the month of May (DOE 2013b). This indicates that the Hanford Site was experiencing drier conditions than average during the site reconnaissance. However, precipitation recorded during the prior months of March and April 2013 was within the normal range when compared to the WETS table, a tool to determine the normal range for monthly precipitation (DOE 2013b; NRCS 2013). As a result, the period between March and May 2013 was considered to be a normal rainfall season in the region. Surface water was not observed in any of the subject areas and no evidence of recent inundation typical to arid regions such as surface soil cracks, salt crust, biotic crust, water marks, sediment deposits, drift deposits, or drainage patterns was observed in the subject areas. Aerial imagery of the site also did not show signs of inundation.

Surface soil maps show the PA as largely made up of Quincy sand. According to the Natural Resources Conservation Service soil survey (NRCS 2013), Quincy soils consist of very deep, excessively drained soils formed in sands on dunes and terraces and have rapid or rapid permeability. Based on the description from the soil survey and field observations of soil conditions, the areas with hydrophytic vegetation are unlikely to contain hydric soils

Based on the field observations and soils data for the Hanford Site, the areas that contain hydrophytic vegetation do not meet the federal definition of what constitutes a wetland (USACE 1987; USACE 2008). The three wetland criteria as applied to these areas are summarized below:

1. Hydrophytic Vegetation – These areas do not have a "predominance of wetland vegetation." The plant species growing in these areas are species often found in wet conditions, but these species are not dominant. Instead, upland plant species dominate these depression areas.
2. Wetland Hydrology – There is no visible source or evidence of wetland hydrology (e.g., surface ponding, soil cracks, drainage patterns, saturation).
3. Hydric Soils – The soil survey indicates the soils in these areas are excessively drained, and sandy soils were observed in the areas during the site reconnaissance. In addition, there were no visible signs of hydrology that would indicate the potential for hydric soil conditions (USACE 1987; USACE 2008).

3.5.1.2 Floodplains

A floodplain is defined as "the lowlands adjoining inland and coastal waters and relatively flat areas and flood prone areas of offshore islands" (10 CFR 1022.4), including at a minimum, that area subject to a 1 percent or greater chance of occurrence in any given year. The frequency of flooding typically results in a complex ecosystem containing diverse habitats serving a variety of riparian functions.

There are no naturally occurring surface water bodies or designated floodplains within the PA (Conrads 1998). The PA is located approximately 0.5 mile west of the Columbia River and 2 miles north of the Yakima River. The PA is outside of the 100-year and 500-year floodplains of the Columbia and Yakima rivers (Conrads 1998). The Columbia River is bounded by uplands and levees in the reach to the east and south of the PA. The Yakima River 100-year floodplain extends east of the river channel and is located approximately 1.75 miles southwest of the PA. The closest area to the project where the Columbia River 100-year floodplain extends landward is at the confluence of the Yakima and Columbia rivers approximately 7 miles to the south based on the Federal Emergency Management Agency flood insurance rate map.

3.5.2 Environmental Consequences

3.5.2.1 No Action Alternative

There would be no effects on wetlands or floodplains from the No Action Alternative because neither is present on the PA.

3.5.2.2 Proposed Action

There would be no effects on wetlands or floodplains from construction or operation of the Proposed Action because neither is present in the PA nor within close enough proximity to the PA to experience effects. Therefore, there are no specific site locations that are more sensitive to wetland and floodplain impacts from construction or operations than any others on the FSA.

3.5.3 Potential Mitigation Measures

No wetlands or floodplains are located within the PA, and therefore no mitigation measures are required.

3.5.4 Unavoidable Adverse Impacts

There would be no unavoidable adverse impacts to wetlands or floodplains from the proposed project because neither is present in the PA.

3.6 Cultural Resources

For cultural resources, the ROI is the PA. The PA and initial Area of Potential Effects (APE; described below) originally comprised 4,413 acres. Through the land suitability evaluation process, the PA was reduced to become the FSA and the final APE (2,474 acres) (see **Section 2.2.3**). Although the FSA and APE are equivalent, the term "APE" is retained because it has a regulatory meaning.

Cultural resources and historic properties must be evaluated for federal actions through *National Environmental Policy Act* (NEPA) and the *National Historic Preservation Act* (NHPA). As explained in *NEPA and NHPA, A Handbook for Integrating NEPA and Section 106* (CEQ and ACHP 2013), cultural resource effects assessed under NEPA (40 CFR 1508.8) consider both cultural resources and historic properties. The NEPA term "cultural resources" covers a wider range of resources than the NHPA term "historic properties." Under NEPA, "cultural resources" may include sacred sites and archeological sites not eligible for listing in the National Register of Historic Places (NRHP). Sacred sites are also considered under the multi-agency sacred sites MOU[11].

The process for compliance with Section 106 of the NHPA is outlined in the regulations at 36 CFR 800. This includes defining the APE, identifying historic properties, evaluating effects, and resolving any potential adverse effects. This process is ongoing and is being conducted in consultation with the State Historic Preservation Officer (SHPO), Indian tribes, Advisory Council on Historic Preservation (ACHP), representatives of local government, applicants (project proponents), and certain individuals and organizations with a demonstrated interest in the undertaking (see "consulting parties" as defined in 36 CFR 800.2(c)).

The APE is defined as "…the geographic area or areas within which an undertaking may directly or indirectly cause alterations in the character or use of historic properties, if any such properties exist…" (36 CFR 800.16(d)). The Washington SHPO concurred with the APE in September 2012.

Section 106 requires agencies to identify historic properties within the APE for the proposed undertaking. Under NHPA, "historic property" means any prehistoric or historic district, site, building, structure, or object included in, or eligible for inclusion in, the NRHP maintained by the Secretary of the Interior. Section 106 of the NHPA requires federal agencies to take into account the effect of proposed undertakings on any historic properties (16 USC 470f).

An "adverse effect" is found when an undertaking may alter, directly or indirectly, any of the characteristics of a historic property that qualify the property for inclusion in the NRHP. Adverse effects may include reasonably foreseeable effects caused by the undertaking that may occur later in time, be farther removed in distance, or be cumulative (36 CFR 800.5(a)(1)).

[11] http://www.bia.gov/cs/groups/xnifc/documents/text/idc-037385.pdf.

Under NEPA and NHPA, the meaning of "effects" is different. The comparison of defined terms in **Table 3-11**, "Meaning of "Effects" Under NEPA and NHPA," are taken from the NEPA and NHPA guidance for integration (CEQ and ACHP 2013).

Table 3-11. Meaning of "Effects" Under NEPA and NHPA.

	NEPA	NHPA
Type of Effects or Impacts	Effects and impacts are synonymous terms under NEPA. The magnitude, duration, and timing of the effect to different aspects of the human environment are evaluated in the impact section of an EA or an environmental impact statement for their significance. Effects can be beneficial or adverse, and direct, indirect, or cumulative (40 CFR 1508.8).	An "effect" means alteration to the characteristics of a historic property qualifying it for inclusion in or eligibility for the NRHP (36 CFR 800.16(i)).
Direct Effects	An impact that occurs as a result of the proposal or alternative in the same place and at the same time as the action. Direct effects include actual changes to cultural or historic resources (40 CFR 1508.8).	A direct effect to a historic property would include demolition of a historic building, major disturbance of an archeological site, or any other actions that occur to the property itself.
Indirect Effects	Reasonably foreseeable impacts that occur later in time or are further removed in distance from the proposed action (40 CFR 1508.8).	Indirect effects may change the character of the property's use or physical features within the property's setting that contribute to its historic significance; are often audible, atmospheric, and visual effects; and may relate to viewshed issues.

Source: Adapted from CEQ and ACHP 2013.

Cultural resource protection for lands in DOE ownership is governed by the *Hanford Cultural Resources Management Plan* (DOE 2003b). Privately owned lands are subject to Washington State laws and requirements protecting archeological sites, Native American graves, and abandoned, historic pioneer cemeteries and graves. These laws and requirements include the *Indian Graves and Records Act* (RCW 27.44), the *Archaeological Sites and Resources Act* (RCW 27.53), the *Abandoned and Historic Cemeteries and Historic Graves Act* (RCW 68.60), and the Archaeological Excavation and Removal Permit process (WAC 25-48). In addition, the SEPA review process and the Washington State's Executive Order 05-05 requires consideration of archeological and cultural resources during capital improvement project planning and implementation. The FSA lands are not currently within the state's jurisdiction, but would be following a transfer of lands by deed to TRIDEC.

3.6.1 Affected Environment

3.6.1.1 Background

The Hanford Site has been a focus of human activity for more than 10,000 years. Proximity to the Columbia River influenced pre-contact and historic settlement in the region. This discussion of pre-contact history and historical development is from the historical and cultural review of the region completed for the *National Register of Historic Places Multiple Property Documentation Form-Historic, Archaeological, and Traditional Cultural Properties of the Hanford Site* (DOE 1997a), *Hanford Site National Environmental Policy Act Characterization* (Duncan 2007) and previous archeological investigations in the area. For this reason, this EA uses the terms "pre-contact" and "historic" to describe these periods when appropriate.

Pre-contact occupation of the area is characterized by Paleo-Indian groups relying upon hunting wild game and gathering wild plant foods. These groups became increasingly sedentary around the Frenchman Springs Period (4500–2500 BP [years before present]) during the Mid-Holocene with the emergence of semi-subterranean house-dwellings. Groups still remained mobile however as environmental changes fluctuated. During the Upper Mid-Holocene, specifically the Cascade and Vantage phases, reduced large mammal hunting occurred due to decreased large mammal populations from gradual drought in the area (DOE 1997a). When Europeans first arrived in the Northwest, the descendants of ancient Native peoples were still living a traditional lifestyle. Native peoples that lived and used the area and its resources included the Chamnapum, the Wanapum, the Walla Walla, Yakama, the Umatilla, the Nez Perce, the Palouse, and others. When the Treaties of 1855 were signed, many of these peoples and their descendants moved to reservations, while some, such as the Wanapum, did not (Walker 1998). The descendants of these groups continue to live in the region and still highly value the Hanford Site lands and resources.

The first Euro-Americans to enter the Columbia Plateau region were with the Lewis and Clark expedition between 1804 and 1806. Shortly after the Lewis and Clark expedition, other exploration parties and, eventually, settlers came into the region. Like many territories or states surrounding the region, the discovery of gold brought an influx of non-Indian people into the area by the 1860s (Rodman 2001). Concurrently, the end of the Civil War and the passage of the *Homestead Act* in 1862 further contributed to large movements of Euro-American settlers across the American West that included the Mid-Columbia River Basin and Priest Rapids Valley.

In 1902, the *Newlands Reclamation Act* made possible large-scale irrigation projects and the establishment of irrigation districts with federal funding. As a result, irrigation infrastructure improvements took place in the Columbia and Yakima River valleys leading to the founding of towns such as Richland, Hanford, White Bluffs, and, within the PA, a small, short-lived community known as Fruitvale. Much of the land making up Fruitvale was owned by the Richland Irrigation District (Sharpe 1999; Metsker 1934; U.S. War Department 1943). People purchased land from the irrigation district and the new community of Fruitvale was born. However, the community waned through the Great Depression and was subsumed by the federal government in 1942 under the *Second War Powers Act* for the location of the Hanford Engineer Works subsequently known as the Hanford Site (Marceau et al. 2003; PNNL 2003).

The war-time Hanford Site acquisition was one of the largest in the nation. The federal government redeveloped the land into several production districts, some with multiple areas (Harvey 2003). One area was a broad expanse that contained transportation networks, such as roads and rail systems between production areas. Between 1950 and 1961, expansion included the construction of anti-aircraft artillery batteries and Nike missile systems used for air defense (Harvey 2003).

3.6.1.2 Identification of Cultural Resources and Historic Properties

The following approach was used to identify cultural resources and historic properties in the PA. A literature review and archeological surveys were conducted to identify previously recorded archeological sites and architectural/historic resources, conduct field investigations, and evaluate the eligibility of resources located within the PA.

This work began with archival research at several locations. Archival sources such as photographs, manuscripts, land records, and property records were examined at the following institutions:

- DOE Hanford, Cultural Resource Records Library (Richland, Washington)
- Benton County Courthouse
- Richland and Kennewick Public Libraries
- East Benton County Historical Society and Museum
- University of Washington, University Libraries, Special Collections
- Bureau of Land Management (BLM), General Land Office, Records Automation website
- Ancestry.com.

Document searches pertaining to previous archeological investigations took place at the DOE Hanford Cultural Resource Records Library, Mission Support Alliance, LLC Cultural and Historic Resources Program GIS proprietary database, and the Department of Archaeological and Historic Preservation's Washington Information System for Architectural and Archaeological Records Data.

After the document searches, field (pedestrian) surveys were conducted throughout the entire PA, focusing special attention on those areas where the document search showed sites identified by previous investigations. Additional field and archival document studies were then conducted to complete determinations of NRHP eligibility of sites for which additional archeological information was needed. Description of surveys conducted and resources encountered were provided in the NHPA cultural resource report (Morton et al. 2015)[12].

In May 2013, a field survey was conducted by walking 171 transects spaced 20 meters (approximately 65 feet) apart. About 170 acres of the PA's 4,413 acres were not surveyed as they contained a high traffic road, Stevens Drive; the Horn Rapids landfill; Borrow Pit 6 (and its expansion); and Borrow Pit 9. Portions of the project's survey area had been disturbed from existing gravel roads, proximity to high traffic roads, construction activities, and maintenance work related to the borrow pits and transmission power lines.

The purpose of the field surveys were to identify and document historic properties in the PA and to evaluate the presence and condition of previously documented sites revealed by the archival document search. While a site can range in size and complexity (e.g., small single-use hunting camps to big permanent villages), archeological isolates are single artifacts not associated geographically with a larger archeological site. Archeological isolates were not evaluated for eligibility as these resources do not have the potential to be significant.

Archeological subsurface investigations (shovel testing) were also conducted in November 2013 using a 10 meters (approximately 32 feet) grid spacing centered on surface features. The objective was to determine the nature and extent of any buried archeological materials associated with surface features. Sites that appeared to have moderate to good integrity (characteristics to determine eligibility) and potential to yield buried deposits were selected for subsurface testing. A testing plan was developed in order to determine which archeological sites were to be shovel tested. This plan

[12] NHPA analysis of the historic properties has been separately prepared as an "Official Use Only" cultural resources report to address the potential effects to NRHP-eligible and NRHP listed historic properties on the lands that could be transferred out of federal control in accordance with the NHPA directives (Morton et al. 2015). That report was provided to the SHPO and the tribes in June 2015. Official Use Only or OUO is a category of sensitive unclassified information whose release to an unauthorized person could damage Governmental, commercial, or private interest and falls under an exemption in the Freedom of Information Act.

outlined research questions that would enable identification of those sites with the greatest potential to meet the aforementioned NRHP eligibility criteria.

Field Survey Results

The field work identified a number of archeological sites on the PA including 38 pre-contact and historical period archeological sites and 20 archeological isolates. A brief description of these is provided in **Table 3-12**¸ "Archeological Sites and Isolates Identified on the PA." Of the 16 pre-contact archeological resources, 5 are sites and 11 are isolates. Of the 44 historic archeological resources, 35 are sites and 9 are isolates. Two of the archeological sites are multi-component, meaning they have both pre-contact and historic components, making the total number of sites 38 and not 40.

Table 3-12. Archeological Sites and Isolates Identified on the PA.

Archeological Resource Type	Resource Date		General Description
	Pre-Contact	Historic	
Site	X		Faunal materials and charcoal
Isolate	X		Lithic flake
Site		X	Hanford Site Plant Railroad
Site		X	Debris concentration
Site		X	Refuse scatter
Site		X	Artifact scatter
Site		X	Farmstead
Site		X	Debris scatter
Site		X	Richland Irrigation Canal
Isolate	X		Cobble chopper - bifacially flaked
Isolate		X	Steel beer can - Heidelberg
Isolate	X		Projectile point
Isolate		X	Base fragment of clear bottle
Site		X	Debris scatter
Site		X	Debris scatter and debris concentration
Site		X	Tin can scatter
Site		X	Refuse scatter
Site		X	Debris scatter
Site		X	Debris scatter
Site		X	Debris scatter
Site		X	Can dump
Site		X	Military property and objects
Site		X	Debris scatter
Site	X	X	Debris and lithic scatter
Site		X	Homestead
Site		X	Debris scatter
Site		X	Debris scatter

Table 3-12. Archeological Sites and Isolates Identified on the PA. *(continued)*

Archeological Resource Type	Resource Date		General Description
	Pre-Contact	Historic	
Site		X	Debris scatter
Site	X	X	Debris and lithic scatter
Site		X	Debris scatter
Site		X	Debris scatter
Site		X	Debris scatter
Site		X	Debris scatter
Site		X	Debris scatter
Site		X	Debris scatter
Site		X	Debris scatter
Site	X		Lithic scatter
Isolate		X	12-Gauge shotgun shell casing – Western Cartridge Company
Isolate		X	12-Gauge shotgun shell casing – Peters Cartridge Company
Isolate		X	Glass insulator – clear, short-domed
Isolate		X	SCA liquor flask – embossed bottle reading “FULL PINT”
Isolate		X	Glass insulator – embossed, colorless, with attached guide wire, pole bracket, and anchors
Isolate		X	12-Gauge shotgun shell casing – Clinton Cartridge Company
Isolate	X		Fragmented projectile point – Quilomene Bar, basal-notched, Type A
Isolate	X		Primary lithic flake – petrified wood
Isolate	X		Secondary lithic flake, fine-grained, translucent, greenish-brown chert
Isolate	X		Projectile point – probable Columbia Stemmed, Type C – brown Jasper with a matrix
Isolate	X		Projectile point – Columbia corner-notched, Type B – caramel-colored, semi-translucent chert
Isolate	X		Primary lithic flake – buff/tan colored, fine-grained chert
Isolate	X		Projectile point – Columbia corner-notched, Type B, tan and pink-colored, banded chert
Isolate	X		Broken projectile point - whitish-pink chert
Isolate		X	License plate
Site		X	Debris scatter
Site		X	Debris scatter
Site		X	Debris scatter

Table 3-12. Archeological Sites and Isolates Identified on the PA *(continued)*

Archeological Resource Type	Resource Date		General Description
	Pre-Contact	Historic	
Site	X		Lithic scatter
Site		X	Debris scatter
Site		X	Debris scatter

The artifacts identified are consistent with the types of artifacts found at other locations surrounding the PA such as pre-contact lithic or artifact scatters (a scattering of chipped stone artifacts, shell, faunal bone, fire cracked rock, grinding stones and debris), and materials associated with historic period farms, fishing and hunting.

A total of 12 of the archeological sites were tested to determine the nature and extent of any buried and associated archeological materials. Two isolated finds associated with the pre-contact period were also tested. A total of 77 shovel tests were shovel excavated for these 12 sites and 2 pre-contact isolated finds. One previously identified homestead was determined eligible for listing on the NRHP as a result of this study. The remainder of the archeological sites and isolated finds identified and recorded during the surveys are considered by DOE to be not eligible for listing on the NRHP.

Tribal Traditional Cultural Property Studies

DOE acknowledges the special expertise of area tribes in identifying properties that may possess religious and cultural significance to them. DOE funded four tribes – the Confederated Tribes of the Umatilla Indian Reservation, Confederated Tribes and Bands of the Yakama Nation, the Nez Perce Tribe, and the Wanapum – to each complete a study[13] for this purpose. Each tribe provided a summary of its study to DOE and these summaries are included in **Appendix G**, "Tribal Studies Executive Summaries." As requested by the tribes, these summaries have not been modified in any way.

3.6.2 Environmental Consequences

The cultural resources environmental consequences analysis considers those impacts that could occur on main and solar farm FSA lands, and the PAAL.

3.6.2.1 No Action Alternative

Under the No Action Alternative, there would be no additional environmental consequences to cultural resources, beyond those occurring currently as part of DOE's mission.

3.6.2.2 Proposed Action

The Proposed Action is for all the representative facilities and a single solar technology to be built on 1,641 acres of land out of the 1,935 acres potentially suitable within the FSA. Development assumptions relevant to the proposed action were provided at the beginning of this chapter.

[13] The National Park Service introduced the concept of the traditional cultural property (TCP) as a means to identify and protect cultural landscapes, places, and objects that have special cultural significance to American Indians and other ethnic groups. A TCP that is eligible for the NRHP is associated with the cultural practices or beliefs of a living community that are rooted in that community's history and are important in maintaining the continuing cultural identity of the community.

From previous cultural studies and the current cultural resources survey it was estimated that:

- About 5 percent or 127 of the 2,474 acres of the FSA have archeological sites on them.
- About 6 percent or 118 of the 1,935 acres of the FSA that could be potentially suitable for transfer by deed have archeological sites on them.
- About 2 percent or 9 of the 539 acres within the FSA (PAAL) that could be conveyed by a realty instrument other than a deed and remaining in federal control also contained archeological sites.

These percentages are a rough approximation that was calculated using ArcGIS mapping tools. The reasons the percentages are approximations are provided at the end of **Section 3.6.1.2**. These percentages do not include archeological sites that were previously identified but not found (located again) by this survey.

Of the 38 archeological sites and 20 isolated artifact sites identified on the PA in the cultural resource surveys, 28 sites and 9 isolated finds are located within the FSA. Of these 28 archeological sites, two are determined to be eligible NRHP sites that are located on the 1,935 acres of the FSA lands that could be transferred. These include the Hanford Site Plant Railroad and the Richland Irrigation Canal segments. The NRHP-eligible historic period homestead is not within the FSA, but is adjacent to it. These properties are discussed in more detail in **Section 3.6.3**. DOE determined the remaining archeological sites and isolated finds are not eligible for listing in the NRHP and therefore require no special treatment or protection under NHPA. These determinations were provided in the NHPA cultural resource report (Morton et al. 2015).

The tribal summaries contain information about areas of religious and cultural significance to the tribes (see **Appendix G**). With few exceptions, specific locations were not identified in the tribal summaries. These exceptions include three properties that DOE had previously determined to be eligible for listing in the NRHP. The tribal summaries described potential effects that would occur from the Proposed Action to these three properties: Laliik, Wanawish, and Gable Mountain. All three properties are outside of the FSA and this EA describes effects to these properties in **Section 3.8**. The tribal summaries also contain information about other named and unnamed places and traditional resources (e.g., plants) of importance to the tribes. Additional information about areas of importance has been provided, and DOE is continuing to consult with tribes and will consider the information it receives. DOE will continue the NHPA process until complete.

Construction

Construction of the previously described representative facilities on the larger part of the main FSA and the single solar technology on the solar farm FSA would involve extensive land disturbing activities necessary for buildings, equipment, roads, parking areas, utilities, and infrastructure improvement such as those described in the introduction to this chapter. For the bounding case analysis the EA assumes that these activities could occur at any and all locations of the main FSA lands that can be transferred by deed. These activities would remove vegetation, surface soil, natural and manmade surface features, and any associated objects and materials changing the landscape from one sculptured by wind and weather to industrial development. These development activities may result in the destruction of archeological sites and may affect other cultural resources in the PA.

Construction activities on the PAAL would not include buildings, but could include utilities to provide services to the land that is transferred. Development could include construction of buried sanitary and storm sewers, natural gas distribution lines, electrical cables, or above ground electrical transmission and distribution lines. These activities would have more limited areas of land disturbance than the main FSA because of the lesser acreages involved. Any archeological sites potentially impacted by these activities would be addressed through implementation of the *Hanford Cultural Resources Management Plan* (DOE 2003b) since these lands would remain in DOE ownership.

Land disturbances such as those described above have the potential to destroy archeological sites or affect cultural resources located on the FSA and affect other cultural resources in the PA. For example, cultural resources can be affected by normal construction site noise, vibration, artificial light, and odors. The heavy fossil-fueled machinery used during construction is known to generate noise and vibration well above the current ambient background levels (see **Section 3.9**). This equipment also produces diesel exhaust, although construction sites are expected to comply with the limits in the Richland Municipal Codes. In the western and northern areas of the FSA away from other existing industrial activities, construction activities could have a greater effect on the landscape, changing it from a previously disturbed area that has, by lack of intrusion, returned to a more natural landscape to one that more closely resembles the current Horn Rapids Industrial Park to the south where warehousing and manufacturing facilities have and are being built.

Since construction activities include the removal of surface vegetation, the change in the surface characteristics would also mean that traditional plant species that could be used by the tribes would be removed and no longer available. The Hanford Site, however, includes large tracts of lands with similar plant communities. **Appendix I** details the vegetation survey performed in May and July of 2013.

For construction, the environmental consequences do not vary to a meaningful extent as a result of the specific representative facility or type of facility except that those facilities that require greater acreage have more potential to affect one of these properties due to the amount of land needed. All representative facilities require roads and parking lots or paved areas. Those that require larger amounts of paved areas also have a greater potential to impact cultural resources because of the need to level ground and thereby disturb a greater span of the surface (see **Section 3.8** for discussion of visual impacts from construction).

Operation

Once the representative facilities are constructed and operational on the main FSA and the single solar technology is operational within the solar farm FSA, the surface disturbance is largely completed. However, some activities like landscaping (including tilling, terrain shaping, and planting) could create some additional surface disturbance. There is potential for glare and glint from reflectivity characteristics of, one of the two proposed solar technologies, the solar dish (see **Section 3.8**).

Buildings, traffic, sound, light, and smells that differ from the pre-existing ambient condition have the potential to affect cultural resources. The degree to which these effects would occur would vary depending on the facilities. Warehousing and distribution centers are likely to have more commercial vehicle traffic with more associated sounds, headlights, parking area lights, and similar effects. Agricultural food processing facilities are likely to produce odors that are not currently present in the existing environment.

Cultural resources located nearest to Horn Rapids Road and Stevens Drive would be less affected since industrial development already exists on the Hanford Site east of Stevens Drive, and other commercial facilities are present on the south side of Horn Rapids Road in the Horn Rapids Industrial Park. Cultural resources farther from these roads would be more affected by industrial development since the change would be from a more natural setting to an industrial one.

3.6.3 Potential Mitigation Measures

The identification and consultation efforts for this project are ongoing with the SHPO, tribes, and the ACHP, and have resulted in the identification of three NRHP-eligible properties within the PA. DOE has made its NHPA finding that the land conveyance will have an adverse effect on the two historic properties within the FSA as described below. The SHPO concurred with DOE's finding and provided comments on June 18, 2015.

The three NRHP-eligible properties were the Hanford Site Plant Railroad, the Richland Irrigation Canal, and a historic homestead.

- The Hanford Site Plant Railroad was previously identified and determined eligible. Mitigation measures were completed in compliance with the Hanford Built Environment Programmatic Agreement (DOE 1996a) and included a Historic Property Inventory Form and documentation in the Hanford Site Manhattan Project and Cold War Era Historic District (DOE 1997b). The railroad would be adversely affected under NHPA if transferred out of federal ownership, and any appropriate additional mitigation measures will be addressed as part of the Section 106 process.
- The Richland Irrigation Canal is present on FSA land that could be transferred, FSA land that could be conveyed by other realty instrument other than a deed (PAAL), and Hanford Site lands outside the PA. The canal would be adversely affected under NHPA if transferred out of federal ownership. The adverse effect determination and any appropriate mitigation measures will be addressed as part of the Section 106 process.
- The NRHP-eligible historic homestead located on the PA is not within the FSA and is not being considered for conveyance. Development of the adjacent FSA lands would change the existing views from this location. The potential change and existing views would not alter any of the NRHP qualifying characteristics of the historic homestead in a manner that would diminish its integrity.

Potential mitigation measures for impacts to cultural resources related to the conveyance of FSA lands can be implemented by DOE or by other parties including agencies of a federal, state, or local government (see **Table 3-13**, "Potential Mitigation Measures for Impacts to Cultural Resources").

3.6.4 Unavoidable Adverse Impacts

Construction and operations of new facilities would likely result in destruction or indirect impacts to some archeological and cultural resources.

Table 3-13. Potential Mitigation Measures for Impacts to Cultural Resources.

Environmental Consequence	Type of Mitigation Measure (Avoid/Prevent; Reduce; or Remedy/Offset)	Mitigation Measure Effectiveness		
		Mitigation Measure	**Residual Environmental Consequence with Mitigation**	**Environmental Consequence without Mitigation**
Ground disturbance could result in adverse impacts to the Richland Irrigation Canal segments by potentially removing the physical site segments.	Avoid/Prevent or Remedy/Offset	DOE is discussing mitigation measures with consulting parties through the NHPA process.	While the physical segments could be demolished in part or whole, documentation would preserve the information.	The physical segments could be demolished in part or whole.
Development of the adjacent FSA lands would change the existing views from the historic homestead location.	Avoid/Prevent or Reduce	DOE has already performed mitigation by removing this site from becoming part of the FSA. DOE will continue to manage the property in accordance with DOE's *Hanford Cultural Resources Management Plan*.	The potential change and existing views would not alter any of the NRHP qualifying characteristics of the historic homestead in a manner that would diminish its integrity.	The potential change and existing views would not alter any of the NRHP qualifying characteristics of the historic homestead in a manner that would diminish its integrity.
Ground disturbing activities could destroy archeological sites.	Avoid/Prevent or Reduce	DOE conducted an extensive survey to identify cultural resources as described in **Section 3.6.1.2**. DOE could include provisions in realty instruments such as those that reaffirm compliance with state and local laws relating to archeological resources.	Once transferred, Washington regulations (RCW 27.53 and others) would provide for protection of archeological sites. Additional mitigations may be identified during ongoing consultations.	Once transferred, Washington regulations (RCW 27.53 and others) would provide for protection of archeological sites.

Table 3-13. Potential Mitigation Measures for Impacts to Cultural Resources. *(continued)*

Environmental Consequence	Type of Mitigation Measure (Avoid/Prevent; Reduce; or Remedy/Offset)	Mitigation Measure Effectiveness		
		Mitigation Measure	Residual Environmental Consequence with Mitigation	Environmental Consequence without Mitigation
Industrial development could have potential impacts to the three NRHP-eligible properties located outside the PA and described by the tribes in their summaries.	Avoid/Prevent or Reduce or Remedy/Offset	DOE is continuing tribal consultation.	To be determined	To be determined
Development activities have potential to result in impact (e.g., plants and viewshed) associated with tribal places of traditional religious and cultural importance and other named and unnamed resources identified in the summaries.	Avoid/Prevent or Reduce or Remedy/Offset	Additional information about areas of importance to the tribes has been provided by the tribes. DOE is continuing tribal consultation and will consider the information it receives to identify mitigation measures.	To be determined	To be determined

3.7 Land Use

Land use is defined as the way land is developed and used in terms of the kinds of human activities that occur (e.g., agriculture, residential, and industrial areas). Cities and counties typically identify land uses and zoning for specific areas in which they want to encourage a particular kind of growth with the idea that compatible land uses would be grouped together.

The area analyzed for potential effects in this land use analysis includes the PA, as well as DOE-owned Hanford Site lands in and around the FSA, and the adjacent City of Richland lands (see **Figure 3-5**, "Land Use: Hanford Site and Richland"). For this resource area, the ROI includes the PA and the surrounding urban and rural areas.

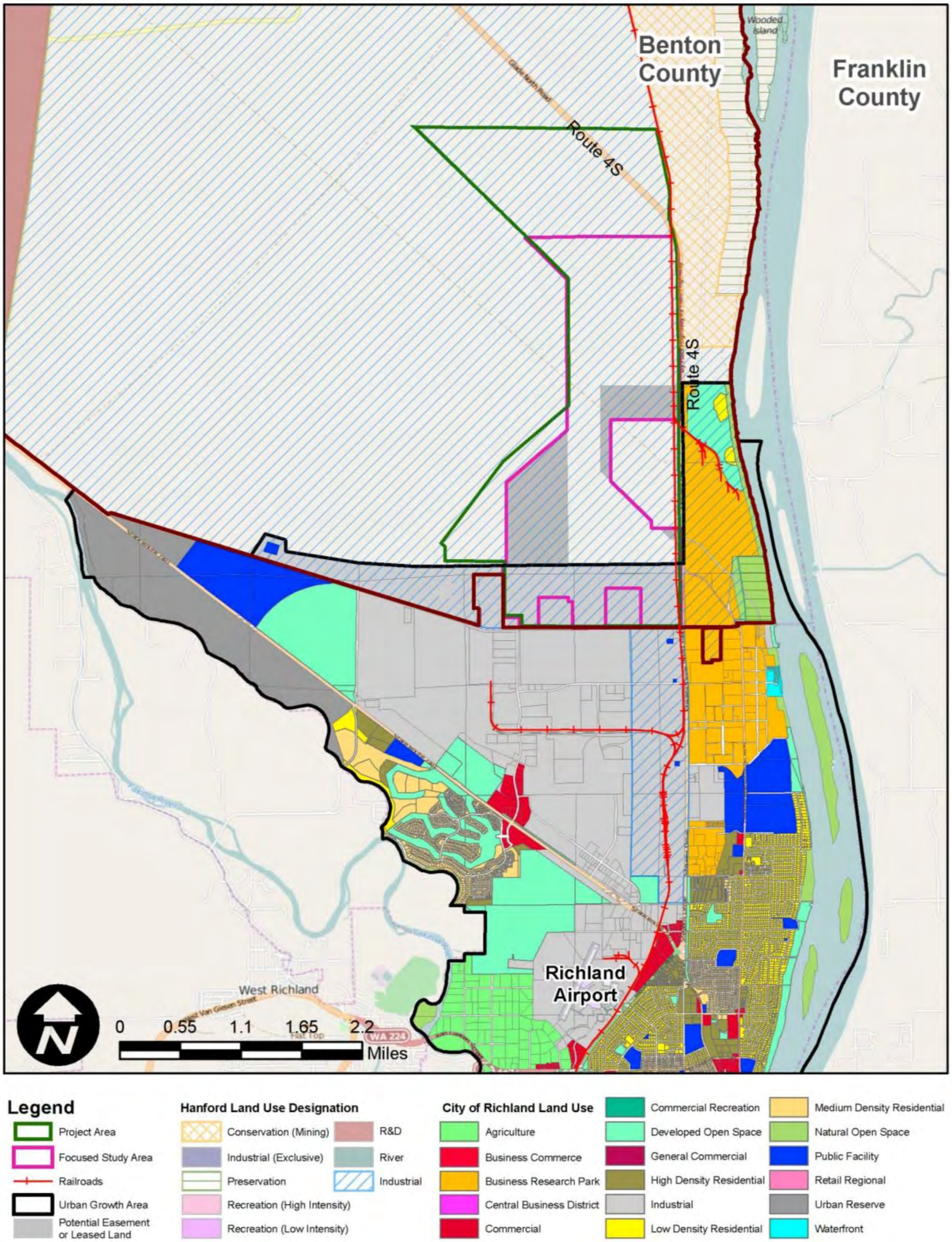
3.7.1 Affected Environment

3.7.1.1 Hanford Site

Land use at the Hanford Site is guided by the comprehensive land-use plan (CLUP; DOE 1999a). Land use designations in the CLUP include areas envisioned for industrial, conservation, preservation, recreation, and research and development uses (DOE 1999a). The area that includes the PA is designated in the CLUP for industrial uses (see **Figure 3-5**).

Some of the land within the PA is used for borrow pits, roads, utility corridor, train tracks, firing range buffer zones, and the inactive Horn Rapids landfill. These are described in **Appendix A**. Also located in the PA is the SALT Facility. The SALT Facility is used to load test transporters that transport decommissioned defueled Navy reactor compartment disposal packages and to store equipment associated with the disposal program. A number of groundwater monitoring wells are in the southeast corner of the PA (see **Appendix A**, **Figure A-1**).

Figure 3-5. Land Use: Hanford Site and Richland.



The PA contains Waste Information Data System sites (DOE 2014c), shown on **Figure A-2**. These sites are not within the FSA and will remain under the institutional control of DOE. There are no Waste Information Data System sites on FSA land that require further action.

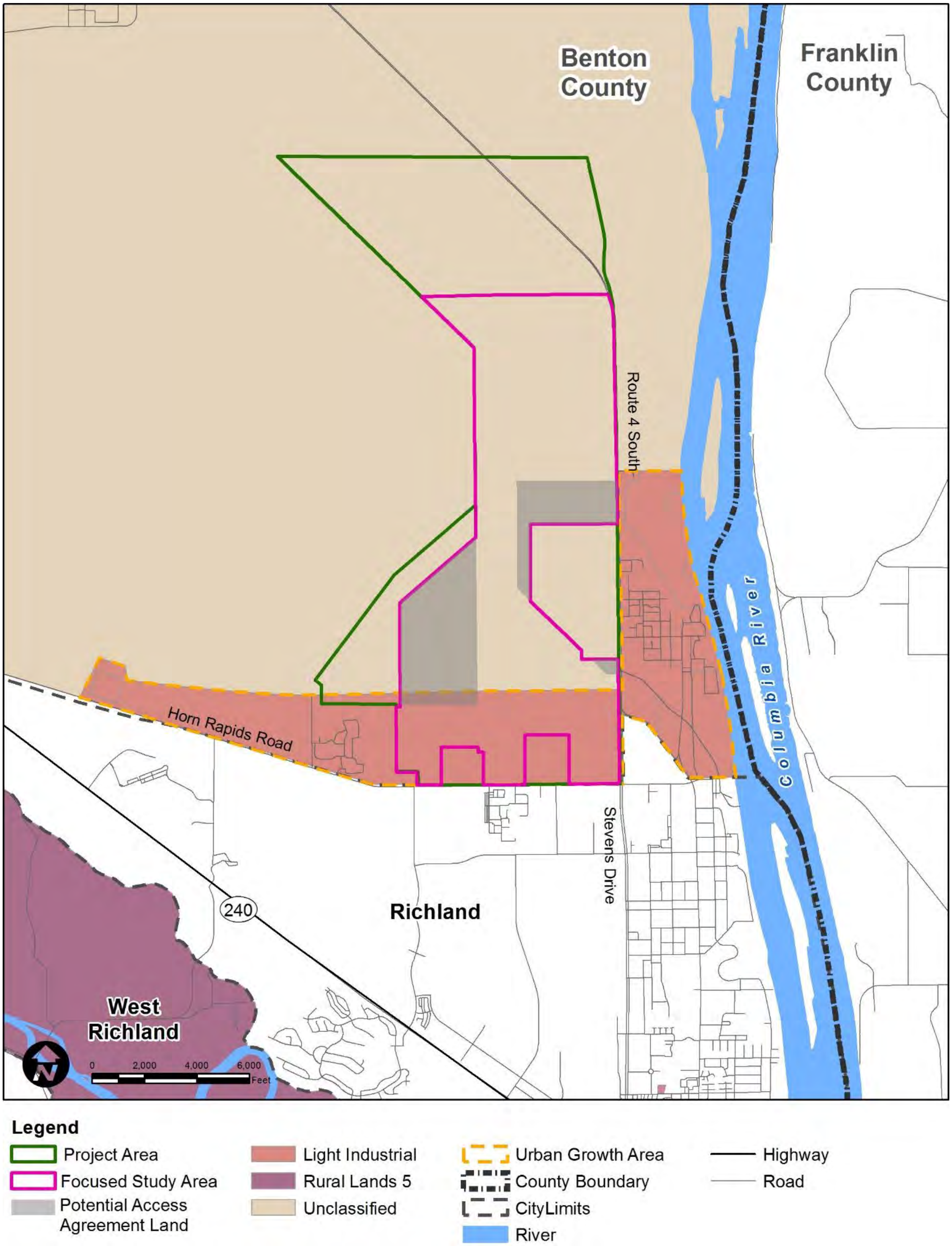
Most land within the Hanford Site adjacent to the PA is designated for industrial uses by the CLUP (DOE 1999a). The Hanford Site Patrol Training Academy ranges are to the west of the PA. Adjacent to the PA within the Hanford Site are a number of facilities (see **Figure 3-3**), including:

- **Hazardous Materials Management and Emergency Response (HAMMER) Federal Training Center.** Located adjacent to the southwest corner of the PA, the HAMMER Federal Training Center is a training campus for local and federal law enforcement (within the Patrol Training Academy) and hazardous materials response personnel and includes classrooms, training courses, and a live fire ranges.
- **Hanford Site 300 Area.** Located east of the PA this was used for fuel manufacturing operations and experimental and laboratory facilities. Remedial activities have removed many of the buildings; however, a few are still used by PNNL. This area includes the radiological sources cited in **Appendix F**.
- **ERDF.** Built in 1996, this facility accepts LLW, hazardous waste, and mixed waste that are generated during cleanup activities at the Hanford Site. This facility is several miles northwest of the PA.
- **Laser Interferometer Gravitational-Wave Observatory (LIGO).** Located several miles from the northwest corner of the PA, the LIGO research facility's mission is to observe gravitational waves of cosmic origin using a laser beam that bounces off mirrors very distant from one another.
- **Regional Education and Training Center-East.** Located adjacent to the HAMMER Facility and adjacent to the southwest corner of the PA, this training facility is used to train workers on high rise power structures (formerly known as the Northwest Utility Training and Education Center).
- **Energy Northwest (formerly known as Washington Public Power Supply System).** North of the PA is the Energy Northwest facility, which is a nuclear power generation facility providing power to Washington State residents.
- **AREVA and Perma-Fix.** Facilities south of the PA along Horn Rapids Road include AREVA, a nuclear fuels production facility, and Perma-Fix, which manages and treats both low-level and mixed LLWs.

3.7.1.2 Benton County

The PA is located in Benton County, Washington. Growth in Benton County is guided by the *Benton County Comprehensive Plan Update* (Benton County 2006). The land use element of the comprehensive plan provides the framework for future growth and development and guidance for ensuring that growth is consistent with the plan's objectives. The southern portion of the area immediately to the east of the PA was designated in the 1999 *Benton County Comprehensive Plan* as an urban growth area for the City of Richland (see **Figure 3-6**, "Land Use: Benton County"). Under the Washington State *Growth Management Act* (WAC 173-95A-610), an urban growth area is an area "within which urban growth shall be encouraged and outside of which growth can occur only if it is not urban in nature" (Benton County 2006). As defined in the Act, urban growth areas should include enough land to accommodate population growth and provide adequate land for industrial activities, open space, and public facilities.

1797 **Figure 3-6. Land Use: Benton County.**



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The *Growth Management Act* requires that counties and cities adopt zoning that is consistent with local comprehensive land use plans, zoning, and ordinances. Benton County zoning designations are provided in the county zoning code (Benton County 2012). The city's northern urban growth area identified in the county's comprehensive plan is zoned as predominantly light industrial with areas of park district, growth area residential, and general commercial (see **Figure 3-6**). Light industrial is "designed to provide an area for the establishment of manufacturing facilities that generally do not involve significant pollution issues, such as research and development, computer component manufacturing businesses, and other businesses of a similar nature" (Benton County 2012). Reactor operations are prohibited in these areas.

3.7.1.3 City of Richland

The City of Richland is located immediately south of the PA (see **Figure 3-5**). The *City of Richland Comprehensive Plan* designates land uses within the city limits such as agriculture, commercial, industrial, open space, business research park, and residential (City of Richland 2008). The PA borders areas designated by the city for industrial and business research park uses (see **Figure 3-5**). The city's industrial designation includes a variety of light and heavy manufacturing, assembly, warehousing, and distribution uses. The business research park designation provides for a variety of office and research and development facilities in a planned business park setting (City of Richland 2008). The *Growth Management Act* requires that counties and cities adopt local comprehensive land use plans, zoning, and ordinances. The land uses as designated in the city's comprehensive plan are also used as the city's zoning designations (City of Richland 2008).

3.7.1.4 Pacific Northwest National Laboratory

The PNNL campus is adjacent to the southeast corner of the main FSA. The PNNL campus consists of a mix of public and private lands to the east of Stevens Drive. The majority of the campus is within Richland city limits, with a small portion of DOE-owned campus lands within the urban growth area in Benton County (PNNL 2012). PNNL consists of a series of research facilities, including the Environmental Molecular Sciences Laboratory, the Atmospheric Radiation Measurement Climate Research Facility, the Systems Engineering Laboratory, the Physical Sciences Laboratory, and the Radiochemical Processing Laboratory.

3.7.2 Environmental Consequences

A proposed action could have a potential effect to land use if the action would be inconsistent or in noncompliance with existing land use plans or policies, preclude the continued use or occupation of an area, or be incompatible with adjacent land uses.

The environmental consequences analysis addresses the impacts related to the Proposed Action on the FSA lands and adjacent offsite locations. The Proposed Action assumes that the conveyed property would be used for economic development purposes, as described by TRIDEC (see **Chapter 2.0**).

3.7.2.1 No Action Alternative

Under the No Action Alternative, the existing land uses described above would continue and there would be no change as a result of the Proposed Action.

3.7.2.2 Proposed Action

Construction

One of the construction assumptions regarding the representative facilities (see **Table 2-1**) is that development would be in accordance with local comprehensive land use plans, zoning, and ordinances. Facilities and necessary infrastructure include parking areas, roads, public services (e.g., emergency response), and utilities (e.g., gas, electric, water).

The land conveyance would result in a change in current land use from undeveloped to industrial. The development would be consistent with the other industrial uses within the ROI.

The *City of Richland Comprehensive Plan* (City of Richland 2008) and the *Benton County Comprehensive Plan Update* (Benton County 2006) would guide development of the FSA. Although the PA is federal land and outside of county jurisdiction, the city and county plans designate the southern portion of the PA as light industrial within an urban growth area. It is assumed that following conveyance, the urban growth area would be expanded to include the PA, annexed by the City of Richland, and subject to the city's zoning code.

Operation

Land use would change from undeveloped to industrial. The development of the FSA with representative facilities would be consistent with the local comprehensive land use plans, zoning, and ordinances.

3.7.3 Potential Mitigation Measures

No mitigation measures for the change in land use would be required.

3.7.4 Unavoidable Adverse Impacts

The FSA lands in the existing condition are largely an undeveloped area. The change in land use from undeveloped to developed would foreclose opportunities for these lands to be considered for other future uses.

3.8 Visual Resources

The ROI includes the PA and surrounding areas from which the PA can be viewed, as illustrated by the brown-shaded terrain in **Figure 3-7**, "Viewshed as seen from the Approximate Center of the PA from a 5-Foot Elevation." The viewshed is based upon an elevation of five feet in the approximate middle of the PA, which represents the average eye-sight height above the ground. The PA terrain is uneven with some higher and lower elevations so this height is an approximation.

This section addresses visual resources, which include the natural and man-made physical features that give a particular landscape its character. Features that form the overall visual impression a viewer receives include landforms, vegetation, water, color, adjacent scenery, scarcity, and man-made modifications. Evaluating the aesthetic qualities of an area is a subjective process because the value that an observer places on a specific feature varies depending on their perspective and judgment. In general, a feature observed within a landscape can be considered as "characteristic" (or character-defining) if it is inherent to the composition and function of the landscape. Landscapes can change over time, so the assessment of the environmental effects of a proposed action on a given landscape or area must be made relative to the "characteristic" features currently composing the landscape or area.

Figure 3-7. Viewshed as Seen from the Approximate Center of the PA from a 5-Foot Elevation.

The analysis of visual effects of the proposed action consists of a qualitative description of the visual characteristics of the PA and an assessment of potential changes from implementing the Proposed Action. DOE does not have a standardized approach to management of visual resources; therefore, the visual resources assessment in this EA uses the BLM's Visual Resource Management (VRM) classification system, as summarized below (BLM 2014). The BLM VRM classification system was chosen as representative of a federal agency methodology and the vistas at the Hanford Site are similar to the types of lands the BLM manages. A qualitative visual resource analysis was conducted to determine whether disturbances associated with project activities would alter the visual environment. Classifications were derived from an inventory of scenic qualities, sensitivity levels, and distance zones for particular areas:

- Class I: Very limited management activity; natural ecological change.
- Class II: Management activities related to solitary small buildings and dirt roads may be seen, but should not attract the attention of the casual observer.
- Class III: Management activities may attract attention, but should not dominate the view of the casual observer; the natural landscape still dominates buildings, utility lines, and secondary roads.
- Class IV: Management activities related to clusters of two-story buildings, large industrial/office complexes, and primary roads, as well as limited clearing for utility lines or ground disturbances, may dominate the view and be the major focus of viewer attention.

The *Visual Resource Inventory Manual* (BLM 1986) identifies three mapping distance zones that qualitatively describe how landscapes are observed under good viewing conditions. These are:

- Foreground-Middleground Zone: Areas seen from highways, rivers, or other viewing locations less than 3 to 5 miles away. This is the point where the texture and form of individual plants are no longer apparent in the landscape.
- Background Zone: Areas seen from beyond the foreground-middleground zone but less than 15 miles away. Vegetation in this zone is visible just as patterns of light and dark.
- Seldom-Seen Zone: Areas that are hidden from view or not distinguishable and more than 15 miles away.

3.8.1 Affected Environment

DOE selected a number of key observation points (KOP), which include viewpoints along commonly traveled routes or other likely observation points. The KOPs selected do not represent all the potential sensitive viewer locations but rather a range of locations that could be important to a good portion of the viewers. Some of the KOPs are identified in the tribal summaries (see **Appendix G**) as being of importance to local tribes, including the Confederated Tribes of the Umatilla Indian Reservation, Confederated Tribes and Bands of the Yakama Nation, the Nez Perce Tribe, and Wanapum. These include Gable Mountain, Rattlesnake Mountain, and Saddle Mountain.

The mapping distance zones and the KOPs for the affected environment description and for the environmental consequences analysis are shown on viewshed maps (see **Figure 3-7**, and **Figure 3-8**, "Viewshed as seen from the Approximate Center of the FSA from a 115-Foot Elevation") and described in the following sections.

Figure 3-8. Viewshed as Seen from the Approximate Center of the FSA from a 115-Foot Elevation.

The 13 KOPs used in the viewshed analysis are:

- Foreground-Middleground Zone
  - Horn Rapids Road
  - Port of Benton
  - Ridgeview Drive
  - Sagemoor Road
  - Gemini Drive
- Background Zone
  - Rattlesnake Mountain
  - Badger Mountain
  - Sand Dunes
  - Horn Rapids Dam
  - Harrington Road
- Seldom-Seen Zone
  - Saddle Mountain
  - Gable Mountain.

The analysis also takes into account whether development following the land conveyance would be consistent with the visual resources goals of the *City of Richland Comprehensive Land Use Plan* (City of Richland 2008) or the *Benton County Comprehensive Land Use Plan* (Benton County 2006), as applicable.

The land on and in the vicinity of the Hanford Site is generally flat with little relief. Rattlesnake Mountain, rising to 1,060 meters (3,480 feet) above mean sea level, forms the southwestern boundary of the Hanford Site. Gable Mountain and Gable Butte are the highest land forms within the central Hanford Site. The Columbia River flows through the site. The Hanford Site is characterized by shrub-steppe vegetation communities, with widely spaced clusters of industrial buildings along the southern banks of the Columbia River and at several interior locations. The landscape adjacent to the Hanford Site consists primarily of rural rangeland and farms. The City of Richland and PNNL are adjacent to the Hanford Site to the south.

Within the Hanford Site, developed areas in the Foreground-Middleground Zone are consistent with a VRM Class IV rating. However, the majority of the Hanford Site is consistent with a VRM Class II or III rating, as the site consists mostly of undeveloped areas that have some ongoing management activity. The lands within the PA are consistent with a VRM Class III rating. The natural landscape dominates; however, some roads and minor development are present in the area. The PA is most visible from Horn Rapids Road to the south, and within the Hanford Site from Stevens Drive and Hanford Route 10. The primary landscape features in the Background Zone visible from the analysis area include Badger Mountain to the south and Rattlesnake Mountain to the west. Saddle Mountain and Gable Mountain to the northwest are in the Seldom-Seen Zone (see **Figure 3-7**).

From **Figure 3-7** for the affected environment, the following sites that the tribes identified as important in their summaries (see **Appendix G**) would or would not be visible (land highlighted or not highlighted in dark brown, respectively):

- Gable Mountain – not visible from the PA because it is in the Seldom-Seen Zone and not discernible (too far away).

- Rattlesnake Mountain – a portion is visible from the PA but at the farthest edge of the Background zone where objects are not readily discernible in the landscape.

- Saddle Mountain – could potentially be visible from the far eastern mountain heights but because of being in the Seldom-Seen Zone the PA is not discernible.

The Hanford Site 300 Area, the PNNL complex and the Horn Rapids Industrial Park provide an existing industrial development backdrop to the FSA.

3.8.2 Environmental Consequences

The visual resource analysis focuses on the degree of contrast between the Proposed Action and the surrounding landscape, the sensitivity levels of KOPs, and the visibility of the Proposed Action from those KOPs (see **Figure 3-8**) with regard to the FSA. The distance from a KOP to the affected area was also considered, as distance can diminish the degree of contrast and visibility. To determine the range of the potential visual effects, the viewshed analysis considered the potential effects in light of the aesthetic quality of surrounding areas, as well as the visibility of possible activities and facilities from vantage points.

3.8.2.1 No Action Alternative

Under the No Action Alternative, the appearance of the existing PA landscape would not change and the existing visual resource classifications would remain.

3.8.2.2 Proposed Action

Construction

The overall effects to visual resources from construction of the representative facilities would be the same. During construction, equipment and activities would be visible within the FSA, but the visibility would diminish the farther a viewer is from the construction sites. Construction activities would be similar to activities occurring in the 300 Area to the east and the city of Richland to the south. To the west of the PA, the site is primarily undeveloped and construction activities would change the visual environment. The FSA would be partially visible from Stevens Drive and Hanford Route 10. These vantage points do not offer unique views or serve as viewpoints for sensitive viewers. The developed Hanford Site 300 Area lies between much of the river and the FSA; however, depending on the location and characteristics such as topography the FSA may or may not be visible.

Operation

The visual impacts from the representative facilities would vary slightly depending on the height of the buildings. For example, a 115-foot-tall tower associated with the biofuels manufacturing facility would be more visible than a 20-foot-tall food and agricultural facility. As depicted in **Figure 3-8**, the tower could be visible from more than 30 miles away at Saddle Mountain although, since it lies in the Seldom-Seen Zone, it would be difficult to distinguish from the urban landscape behind it in the city of Richland.

Regardless of the representative facilities, development would result in a change in the VRM classification of the conveyed lands from Class III to Class IV, as the buildings and infrastructure on the built-out site would become the primary focus for viewers. This development would be consistent with development in the 300 Area to the east and in the city of Richland to the south. In both areas, the existing buildings and structures are similar in height to the potential representative facilities. To the west of the PA, the site is primarily undeveloped and new development would change the visual environment. The FSA would be partially visible from Stevens Drive and Hanford Route 10. These vantage points do not offer unique views or would serve as viewpoints for sensitive viewers. The developed Hanford Site 300 Area lies between much of the river and the FSA; however, depending on the location characteristics such as topography the FSA may or may not be visible.

Development would be consistent with the visual resources goals of the *City of Richland Comprehensive Land Use Plan* (City of Richland 2008). The plan states as a goal that development should recognize and preserve established major vistas, as well as protect natural features such as rivers, ridgelines, steep slopes, major drainage corridors, and archeological and historic resources.

Once the FSA is developed, the following KOPs that the tribes identified as important in their summaries (see **Appendix G**) would, or would not be visible (land highlighted or not highlighted in dark brown, respectively) (see **Figure 3-8**):

- Gable Mountain – not visible from the PA because it is in the Seldom-Seen Zone and not discernable (too far away).
- Rattlesnake Mountain – a portion is visible from the PA, but at the farthest edge of the Background Zone where objects are not readily discernable in the landscape.
- Saddle Mountain – the far eastern mountain heights could potentially be visible from the PA, but because is in the Seldom-Seen Zone, it would be difficult to discern.

The views from these KOPs would not change to any extent from the affected environment perspective.

Glint and Glare during Operation of the Solar Farm Focused Study Area

The solar farm FSA would operate 7 days a week and approximately 10 hours per day (i.e., when sunlight is available). One of the potential issues associated with operation of solar facilities is the generation of glint and glare. Glint is defined as a momentary flash of light, while glare is defined as a more continuous source of excessive brightness relative to the ambient lighting. Generally, PV systems have not been found to be a source of glint and glare hazards; however, CSP dish systems, which use mirrors to focus the light at a single focal point, can be a source of glint and glare (Ho et al. 2009). The CSP system, a SunCatcher ™, would be about 40 feet tall with a dish diameter of 38 feet. Representative photographs of these types of dishes (see **Appendix E**, **Figures E-15** and **E-16**) show some of the glint from the reflecting mirror. Glare from these systems is seen on the dish side of the Stirling engine mounted on the arm extending out from the dish where the light is focused.

Glint and glare from the CSP could be visible by motorists on Route 4 South or viewers to the east of the solar farm FSA. At a distance of thousands of feet or more, glint would last only a fraction of a second. For a few minutes in the morning, the dish elevation would be low to the horizon, pointed over Stevens Drive, but the CSP dish would be oriented to a higher elevation while awaiting adequate sunlight. From the west, glint and glare would not be visible as the dishes pan westward because the higher topography would block the sun at a much higher angle relative to the ground.

The Federal Aviation Administration published guidance for evaluating solar technologies near airports (FAA 2010). This report is concerned about solar facilities near airports because the planes are flying slow and low to the ground. Distance from solar facilities to pilots is short and the duration of a glint could be longer. Glint and glare could be a concern for low-flying aircraft operations in the vicinity of the solar FSA. Such operations occur routinely during training exercises at the HAMMER and the Regional Education Training Center (RETC). In addition, DOE and other federal agencies conduct routine flights over the PA and surrounding Hanford Site for monitoring and operational purposes. Pilots and crew could be temporarily blinded by the glint from the CSP dishes due to their low altitude flying and slow or hovering speed.

Of the two solar technologies, the solar dish because of its mirrored surface could be seen on sunny days. At the winter solstice (the shortest day of the year) the maximum elevation of the sun is about

20 degrees above the horizon at noon (USNO 2015a). In the summer the maximum is about 67 degrees above the horizon at 1:00 p.m. (USNO 2015b). The lower the angle of the dish, the more likely it would be visible to an observer on the ground, but the lower angle would mean the sun would be blocked by topography and the dish would not be operating. In the summer months over the middle part of the day, the dishes would be aiming at higher elevations and glint would be less likely. Glint could be visible during summer months at the beginning and end of each day. One of the KOPs that was identified as being important to the tribes from which glint might be observed is from a portion of Rattlesnake Mountain in the waning hours of the day during the summer months. Rattlesnake Mountain is about 15 miles from the solar site. At that distance, the point at which the mirror's reflection is visible would move at a rate of about 6 feet per second. Thus, the glint observed at that distance would only last a fraction of a second. The observer would have to be looking in that direction to catch a glimpse.

In addition to the potential hazards associated with CSP glint and glare, there could be a potential nuisance issue for some residents in Franklin County and in the City of Richland and viewers from nearby KOPs. Glare and glint would be visible from the solar farm for reduce periods throughout the day; however, the distance from the solar farm to residents would limit this potential effect.

It is assumed that a SEPA environmental review would be completed by the local lead agency when a developer submits an application for construction of the solar farm. The local agency may require analysis of potential glint and glare issues, including a detailed analysis of the potential hazards and need for mitigation measures.

3.8.3 Potential Mitigation Measures by DOE

Because of the potential to blind helicopter pilots and crews using the RETC Facility for training DOE may use deed language to disallow CSP dishes or similar highly reflective concentrating solar technologies such as a parabolic trough or power tower (NREL 2011). Other PV-based systems are substantially less reflective and do not concentrate the suns energy as do CSP systems. PV-based systems do not require mitigation.

If CSP technology were to be allowed potential mitigation measures include the following mitigation measures. Although not obligatory or within the control of DOE, potential mitigation measures could be undertaken by a future landowner.

Visual resource mitigation measures may be identified by local jurisdictions at the time a project is proposed. If a CSP system is proposed a detailed glint and glare analysis may be required to identify specific mitigation measures. Examples of mitigation measures for a CSP system include (Power Engineers 2010; Ho et al. 2009):

- Track Repositioning – Offset tracking is where the CSP dish is oriented to a higher elevation while awaiting adequate sunlight to eliminate or substantially reduce glint.
- Morning Stow to Tracking Transitions – Consider positioning CSP dish in the higher offset tracking position several minutes before sunup. This will eliminate the chance of glint effects created by a moving CSP dish after the sun is up.
- Night Stow – Consider positioning CSP dish into a night stow position after sundown. This will eliminate the chance of glint effects created by a moving CSP dish from the position at the end of the day back to the morning position.
- Develop an Emergency Glint Response Plan – Consider developing an emergency response plan for when an immobile malfunctioning CSP is aiming in a direction generating

substantial glint. The plan should include procedures to quickly reduce potential glint impacts to offsite viewers.

- Installation of privacy slats in the perimeter fencing along the roadway. Privacy slats would reduce potential glint and glare to drivers and pedestrians. Because of the high latitude at Richland, the dish elevation would be at a low angle when aimed at the sun (USNO 2015a, 2015b), which could increase the need for this as a mitigation measure.

3.8.4 Unavoidable Adverse Impacts

Views from the PA and surrounding areas from which the PA can be viewed would be changed with buildings and infrastructure becoming the primary focus.

3.9 Noise, Vibration, and Electromagnetic Fields

The ROI for acoustic noise, vibration, and EMFs includes the PA and the surrounding area, including the PNNL and LIGO facilities. These facilities contain receptors that are sensitive to vibration (LIGO) and acoustic noise, vibration, and EMF (PNNL). The receptors have threshold levels much lower than those regulated for the protection of human health. Appendices B, C, and D provide information on acoustic noise, vibration and EMF and how they are generated from construction activities and facility operations.

3.9.1 Affected Environment

Acoustic noise and vibration from DOE activities within the ROI occurs primarily from vehicle traffic, operation of the borrow pits, and heavy equipment operating at remediation and waste sites. Noise and vibration from non-DOE activities at Hanford; such as workers commuting to and from the Columbia Generating Station; vibration from regional dams; and operational noise from the AREVA facility, the Perma-Fix facility, and the US Ecology commercial LLW disposal site; are also part of the existing background (ambient) sound and vibration environment near the PA.

Future development in the area, such as new industry, agriculture, offices, schools, residential areas, roads and other infrastructure, could result in variations in the levels of traffic noise from local roads and increased noise levels near these developments. In May 2015, the Port of Benton sold 128 acres west of Stevens Drive and south of Battelle Boulevard for mining purposes to supply material for concrete and other construction projects in the Tri-Cities Area (Beaver 2015). This new facility, when it begins operation, would use heavy machinery to excavate gravel and sand and haul it to a batch plant at the Horn Rapids Industrial Park. Heavy equipment traveling down unimproved roads and excavation of coarse material would be a major source of vibration (see **Appendix B**). Other proposed developments in the area that are expected to result in increased vibration levels include development of the 750-acre Horn Rapids Industrial Park including the 313,000 square-foot, 10-story Preferred Freezer Services facility currently under construction, and expansion of activities on the PNNL site.

3.9.1.1 Acoustic Noise

Acoustic noise is generally understood as unwanted sound. Sound propagates through air as well as solid media such as geologic materials, or wood and even liquids such as water. Through air, sound propagates as a compression wave and travels as fluctuations of air pressure above and below atmospheric pressure. Sound can also be described in terms of a “wave” of vibrating air particles where, at certain points along the wave, air particles are compressed and, at other points, the air particles are spread out. The human ear perceives sound as tones or frequencies. Shorter wavelengths are higher tones/frequencies and longer wavelengths are lower tones/frequencies. The sound pressure level (SPL) is related to the amplitude of the wave, which is perceived as loudness. Noise may consist of a single or range of frequencies. A frequency-dependent sound pressure rating scale was developed with values given in decibels[14] (dB) to reflect the variations in human sensitivity known as the A-weighting scale and values given in dBA. The threshold of audibility is generally within the range of 10 to 25 dBA for normal hearing. **Appendix B** provides more general information on acoustic noise.

Sound is measured on an exponential scale, thus, two sources of sound are not necessarily twice the amount of noise. The frequency and SPL are factors. Sounds can cancel each other or combine to form new frequencies and sound levels depending on whether the peaks line up – **Appendix B** graphically illustrates this phenomena. For the effect to be measurable, the two sounds must not only be of the same frequency but of nearly the same SPL– within about 3 dB of each other. For example, two pieces of the same type/manufacture of construction equipment could add or subtract noise.

The State of Washington defines noise as the "…intensity, duration and character of sounds from any and all sources" (RCW 70.107.020). RCW 70.107 and its implementing regulations (WAC 173-60 to 173-70) define the management of environmental noise levels. Maximum noise levels are defined for the zoning of the area in accord with the environmental designation for noise abatement (EDNA). The Hanford Site is classified as a Class C EDNA on the basis of industrial activities. Unoccupied areas are also classified as Class C areas by default because they are neither Class A (residential) nor Class B (commercial). Maximum noise levels are established based on the EDNA classification of the receiving area and the source area. The Class C industrial receptor EDNA is 70 dBA for daytime hours (between 7:00 a.m. and 10:00 p.m.).

The Hanford Site is within Benton County Washington. Chapter 6A.15 of the Benton County Code of Ordinances states that the policy of the county is to "minimize the exposure of its citizens to the adverse effects of excessive unwanted public nuisance noise and to protect, promote, and preserve the public health, safety and welfare." However, a number of exemptions, such as sounds created by the temporary use of construction equipment, are allowed. PNNL is designated Business Research Park by the City of Richland (see **Figure 3-5**). The compliance point for the city would be at the boundary of the industrial zone at Stevens Drive (the receiving area). Therefore 70 dBA would be permitted at that point from 7:00 a.m. until 10:00 p.m.

Ambient Noise Levels on the PA

Wind is a primary contributor to background noise levels at Hanford. The entire Hanford Site experiences average wind speeds exceeding 12 miles per hour. In addition to noise from wind, routine DOE field activities contribute to the existing noise environment. Background noise levels in undeveloped areas on the Hanford Site were measured to range between 24 and 36 dBA (Coleman 1988).

The National Park Service Natural Sounds and Night Skies Division performed sound modeling for the PA (Lynch 2014). **Table 3-14**, "Predicted Natural Ambient Sound Levels within the PA and Two Offsite Locations," shows the output of that background noise modeling (November 10, 2014) using the methodology published in "A Geospatial Model of Ambient Sound Pressure Levels in the Contiguous United States" (Mennitt et al. 2014). These levels are consistent with those reported by Duncan (2007). **Figure 3-9**, "Location of the PA, Johnson Island, and Horn Rapids Dam," shows Johnson Island, Horn Rapids Dam, and the PA background modeled locations.

[14] Decibel is a unit used to express the intensity of a sound wave, equal to 20 times the common logarithm of the ratio of the pressure produced by the sound wave to a reference pressure, usually 0.0002 microbar.

Table 3-14. Predicted Natural Ambient Sound Levels within the PA and Two Offsite Locations.

Site Name	Metric	Predicted sound levels (dBA)					
		Min.	First Quartile	Median	Mean	Third Quartile	Max
PA	Predicted natural ambient	26.6	26.8	27.0	27.0	27.3	27.6
Johnson Island	Predicted natural ambient	28.8	28.8	28.8	28.8	28.8	28.8
Horn Rapids Dam	Predicted natural ambient	28.6	28.6	28.6	28.6	28.6	28.6

Source: Lynch 2014.

3.9.1.2 Vibration

Vibration is an oscillatory motion that can be described in terms of displacement, velocity, or acceleration. Ground-borne vibration can cause building floors to shake, windows to rattle, hanging pictures to fall off walls, and in some cases damage buildings. Like acoustic noise, vibration from a single source may consist of a range of frequencies. **Appendix B** provides more information on vibration. There are no state or local government regulations for vibration. Occupational Safety and Health Administration enforces vibration standards to protect workers and the only environmental standards are from the Federal Transit Administration for trains and mass transit to protect nearby structures, not for sensitive receptors such as LIGO.

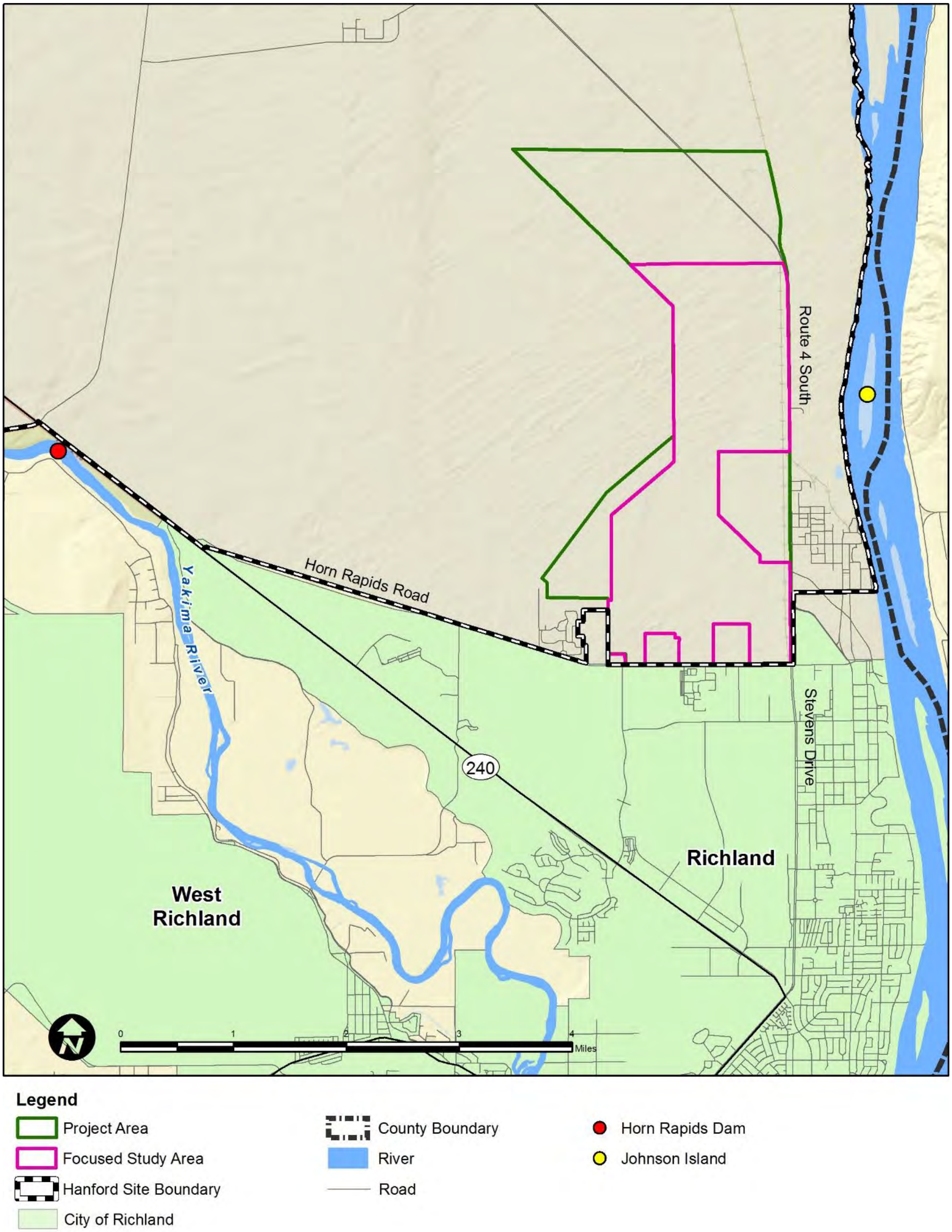
Ambient Vibration Levels on the PA

Normal background levels of vibration in an urban environment are in the low 50 vibration decibels (VdB) range (FTA 2006).

"In contrast to airborne noise, ground-borne vibration is not a phenomenon that most people experience every day. The background vibration velocity level in residential areas is usually 50 VdB or lower, well below the threshold of perception for humans which is around 65 VdB. Most perceptible indoor vibration is caused by sources within buildings such as operation of mechanical equipment, movement of people or slamming of doors. Typical outdoor sources of perceptible ground-borne vibration are construction equipment, steel-wheeled trains, and traffic on rough roads. If the roadway is smooth, the vibration from traffic is rarely perceptible" (FTA 2006). Background vibration levels were measured by LIGO to determine impacts on their operations (Rohay 1996).

Background vibration levels at the LIGO are normally below the LIGO standard spectrum between 1 and 10 Hertz (Rohay 1996). Assumptions about this spectrum, and LIGO's recent operating experience, can be used to establish design criteria necessary for LIGO's seismic isolation needs. The frequency ranges identified in **Appendix A, Section A.4.2** represent key points on the LIGO standard spectrum. Vibration levels that exceed the LIGO standard spectrum could severely disrupt LIGO operations.

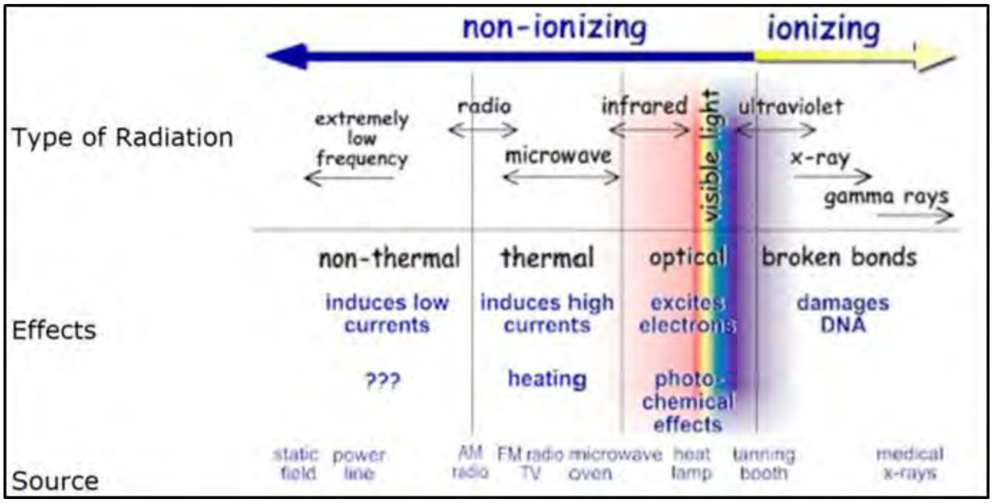
Figure 3-9. Location of the PA, Johnson Island, and Horn Rapids Dam.



3.9.1.3 Electromagnetic Fields

EMFs are created as a result of radiation in the electromagnetic spectrum (see **Figure 3-10**, "Types of Radiation in the Electromagnetic Spectrum"). EMF is produced through the generation, transmission, and use of electric power.

Figure 3-10. Types of Radiation in the Electromagnetic Spectrum.



Source: EPA 2013.

Magnetic fields associated with electrical power are measured in units of gauss[15] or tesla[16] (T), where 1 T = 10,000 gauss. The magnetic field levels of concern to PNNL are in units of nanoteslas (nT). For reference, 1,000 nT equals 1 microtesla or 10 mG. The earth's static magnetic field is about 500 mG. **Appendix D** provides more information on electric and magnetic fields. There are no state or local government regulations for EMF. Occupational Safety and Health Administration enforces EMF standards established to protect workers, but not other receptors such as PNNL.

Ambient Electromagnetic Field Levels on the PA

The existing EMF sources on the PA come from electric transmission and distribution lines, electrical substations, and power transformers. These include the White Bluffs and the Sandhill Crane substations. White Bluffs is west of the FSA on the north side of Horn Rapids Road. The Sandhill Crane Substation is southwest of the corner of Horn Rapids Road and Stevens Drive. In general, EMF levels produced by electric power transmission are reduced with distance from the source. This characteristic is explained in detail in **Appendix D**.

3.9.2 Environmental Consequences

The environmental consequences related to acoustic noise, vibration, and EMFs result from construction and operation of the representative facilities on the FSA. This section addresses impacts to LIGO for vibration and to PNNL for all three technical issues.

[15] A gauss is a unit of magnetic induction wherein 1 gauss corresponds to the magnetic flux density that will induce an electromotive force of 1 abvolt (10^{-8} volts) in a linear centimeter of wire moving laterally at 1 centimeter per second.
[16] A tesla is also a unit of magnetic flux density and is equal to 10^{-4} gauss.

3.9.2.1 No Action Alternative

Under the No Action Alternative, acoustic noise, vibration, and EMFs would remain at their ambient levels and there would be no environmental consequences to LIGO or PNNL other than what currently occurs. For noise and vibration, this would be due to construction at and around PNNL and from Horn Rapids Industrial Park, operation of the new aggregate materials mine, and truck traffic along local roads. For EMFs at PNNL, this would be from existing sources on and around PNNL including power transmission lines and electrical substations such as the nearby Sandhill Crane Substation.

3.9.2.2 Proposed Action

Acoustic Noise

Construction Acoustic Noise and Vibration

For this EA it is assumed that all construction activities would comply with the federal, state, and local laws and ordinances for noise and therefore there would be no human health-related impacts. It is also assumed that construction would last up to 18 months depending upon the specific representative facility.

Noise levels upwards of 90 dBA would be produced from construction heavy equipment, compressors, and generators (see **Appendix B**) but their SPLs are normally reduced dramatically as the square of the distance (see **Figure B-2**). This means that a 100 dB source measured at 10 feet would diminish to 66 dB at a distance of 500 feet from the source. Noise reduces approximately 6 dB for every doubling of the distance. PNNL's closest future sensitive facility would not be closer than 500 feet from the west side of Stevens Drive right-of-way (referred to as the PNNL 500-foot setback) (see **Figure A-8**). Since these construction activities would be at least 500 feet away from any sensitive receptor, the SPLs would be reduced to about 66 dB by the time they reached the PNNL 500-foot setback. If measured at the Physical Sciences Facility about 5,100 feet away, the noise level would be 46 dB, and at the Environmental Molecular Science Laboratory about 7,000 feet away it would be 43 dB. These are the distances from the PNNL facilities to the closest point on the FSA. There are some characteristics of sound propagation (ground, atmospheric, and wind effects) that could allow some frequencies to transmit longer distances with less attenuation (see **Appendix B**). These conditions, if occurred however, would likely be of short duration.

Main sources of acoustic noise and vibration from construction activities would include operation of heavy equipment, pile drivers, compressors, generators, pumps, and haul trucks. Much of this results from their movement on non-paved surfaces and the gear-shifting from forward and backward movements. Whenever wheels or tracks go over rough surfaces they generate both noise and vibration. Blasting activities are not anticipated during construction because the site geology is unconsolidated sediments and sand.

Noise from construction would result in temporary, minor, changes to the ambient noise environment. Construction noise would not likely exceed 100 dBA (i.e., at the source of the noise) even for a short time and most construction equipment would not exceed 90 dBA measured at a distance of 50 feet from the source (see **Table B-3** and **Figure B-7** in **Appendix B**). Equipment such as pile drivers and rock hammers generate higher SPLs but would not likely be necessary on the FSA since soils and rocks are relatively soft. Ambient noise levels (discussed in the affected environment) are 24 to 36 dBA. At times the SPLs could increase as much as 50 dBA during construction activity, but at the end of the work day, noise would return to near ambient levels. Increases above ambient for non-construction activities might be elevated if generators are used for something like security lighting. It is assumed that each construction site would operate within the City of Richland 70 dBA Class C EDNA at the industrial zone boundary.

The nearest residential area is approximately 1,700 feet from the edge of the FSA. Noise generation would last for the duration of construction activities. It is likely that the distance from the PA would have a dampening effect on noise that could heard from the nearest residences, however depending on the type of construction activity, the level and intensity would vary.

Vibration sources for construction would primarily be heavy truck traffic crossing over unimproved roads (see **Appendix B** and **Appendix C**, **Section C.3**). Measured values for construction equipment at 25 feet from the source would generally be less than 90 dB and would continue to decrease at greater distances. LIGO would likely be able to detect this truck traffic since it would be greater in intensity (i.e., the number of trucks, their weight, and the surface roughness) than commuter traffic driving on smoother pavement. Increased periods of vibration would be intermittent and of short duration during construction. As construction proceeds towards completion, fewer trucks would be crossing unimproved roads and the effect would diminish. For both LIGO and PNNL, the degree of effect would be related to the proximity of the vibration source. Disturbance to LIGO and PNNL from vibration caused by construction activities cannot be determined at this time because the necessary information needed to model the potential impacts is unavailable. Given advance notice, both PNNL and LIGO may be able to accommodate some level of impacts if the source activities are temporary or short-term in nature.

Operation Acoustic Noise and Vibration

Operation of the representative facilities that consist mostly of warehouses or office buildings are not likely to produce appreciable amounts of acoustic noise or vibration with the exception of truck traffic. The transport and loading and unloading of semi tractor-trailers onsite would generate acoustic noise and vibration. Vibration could result from trucks backing into loading docks and going over speed bumps or other traffic calming devices (see **Appendix C**). Duration would be intermittent. The most significant generators of acoustic noise and vibration would be the industrial facilities (the biofuels manufacturing facility and the rail distribution center). Noise and vibration would be generated at the biofuels manufacturing facility from heavy trucks, scrapers, and excavators moving and separating waste and placing it into shredders and onto conveyors. At the rail distribution center, noise and vibration would be generated by train locomotives and a 55-car train and delivery trucks moving across Horn Rapids Road to and from the facility. These activities produce vibration levels like those discussed in **Appendix C**, **Sections C.3.1** and **C.3.2**. Slower and lighter cars and train cars generate lower energy vibration. For road traffic at a distance of about 100 meters (330 feet) from the source, vibration levels decrease dramatically (see **Figure C-19**). At the current distance between PNNL facilities and the FSA, vibration from these sources would be measureable (see **Appendix C**, **Table C-13**) but appreciably reduced because of the geologic conditions (sandy unconsolidated soils and bedrock. The direct vibration impacts to LIGO and PNNL from these operations cannot be determined at this time because the necessary information needed to model the potential impacts are unavailable.

Operation of proposed industrial facilities would result in an increase in traffic volumes on the local roadway network, and consequently, an intermittent increase in noise levels from traffic sources along affected roadway segments. It is anticipated that noise levels from traffic would remain within industrial noise ordnance levels.

Construction Electromagnetic Field

Generation of EMF from construction activities can include mobile generators, misfiring combustion engines, and temporary electrical connections. Resulting EMF levels are low, infrequent, and not of long duration.

Operations Electromagnetic Field

Most of the EMF produced by the Proposed Action would result from the infrastructure upgrades and not the representative facilities themselves. Exception are the solar farm inverters, transformers, electrical substations, and power lines. Resulting EMF levels are not expected to affect the PNNL sensitive receptors due to the distance between PNNL and the solar farm FSA. Another exception is the food and agricultural processing facility, which may use industrial microwave heating devices and magnetic induction furnaces for injection molding. Impacts to PNNL from the food and agricultural processing facility cannot be determined at this time because the necessary information needed to model the potential impacts is unavailable.

3.9.3 Potential Mitigation Measures

A basic assumption of the proposed action is that TRIDEC or the future landowners or public entity partners would comply with all federal, state, and local laws and regulations for worker and public health and safety applicable to acoustic noise, vibration, and EMFs. In addition, DOE is preparing deed restriction language to prohibit certain levels of noise, vibration, and EMFs on parts of the FSA nearest to PNNL and, to limit vibrations that could impact LIGO. This may involve prohibiting certain types of operations or activities such as heavy equipment or trucks traveling on unimproved roads or lots, prohibiting traffic calming devices that cause trucks to bounce (see **Appendix C**, **Section C.3.1**) and establishing threshold criteria for noise, vibration and EMF.

Although not obligatory or within the control of DOE, additional mitigation measures described below could be undertaken by a future landowner and a local jurisdiction. For example, development plans could incorporate distance and shielding measures to reduce noise, vibration, and EMF levels. The farther from a sensitive location, the less likely there would be an impact since all of these types of energy would be reduced with distance. Shielding is effective for acoustic noise and electric fields but less so for vibration and magnetic fields. Technological mitigation measures are possible for acoustic noise, vibration, and EMFs if the sources are within a building or facility and less effective if the sources are outdoors.

In addition, operational activities that create substantial acoustic noise and vibration (e.g., the biofuels manufacturing facility and the rail distribution center) could be located as far away as possible from PNNL and LIGO because these characteristics (e.g., heavy equipment movement and train locomotives) are largely outdoor sources and difficult to shield or mitigate. Likewise, to reduce impacts from vibration and noise, heavy truck traffic could be directed along streets and highways farther from PNNL and LIGO. Noise and vibration are greatest for trucks that are starting from a stop or at higher speeds (see **Appendix C**), therefore, traffic flows could be designed to limit these conditions.

EMF is produced largely by electrical substations and power lines. The effects from power lines are a function of the voltage magnitude and voltage fluctuation. Lower voltage lines do not create corona effects (see **Appendix D**) so electromagnetic interference from that should be minimal if lines are 230 kilovolt (kV) or less. Impacts from power lines or substations would be mitigated by the 500 foot PNNL setback (see **Figure A-8**). The other two operations that could produce EMF would be magnetic induction furnaces that could be used for injection molding and industrial microwave heating devices used in food and agriculture processing. The furnaces would likely be shielded to protect workers and additional shielding could ensure a reduction in EMFs below levels of concern if these facilities were located near PNNL (see **Appendix A**).

3.9.4 Unavoidable Adverse Impacts

Depending upon the types and locations of facilities that are developed, the Proposed Action would result in increased levels of noise, vibration and EMF within the ROI. The level of disturbance cannot be determined at this time because the necessary information needed to model the potential impacts is unavailable. Assuming future development implements necessary mitigation measures and complies with deed covenants and restrictions regarding these issues, disturbance should not affect PNNL and LIGO mission capabilities.

3.10 Utilities and Infrastructure

The ROI for utilities and infrastructure is the PA and the surrounding urban environment. Infrastructure consists of the systems and physical structures that enable a population in a specified area to function. Infrastructure is wholly human-made, with a high correlation between the type and extent of infrastructure and the degree to which an area is characterized as "urban" or developed. The availability of infrastructure and its capacity to support growth are generally regarded as essential to the economic growth of an area. Utilities and infrastructure include electric power supply, gas supply, water supply, and sewer and wastewater systems. The analysis to determine potential effects on infrastructure and infrastructure systems considers primarily whether a proposed action would exceed capacity or place unreasonable demand on a specific utility.

3.10.1 Affected Environment

3.10.1.1 Hanford Site

Electric power for the Hanford Site is provided primarily by the Bonneville Power Administration (BPA) and the City of Richland. The BPA provides approximately 90 percent of the electricity consumed onsite; the City of Richland provides the majority of the remaining power (DOE 2012c). The Benton Public Utility District provides electrical power to the LIGO via a 13.8-kV distribution line from a DOE-owned electrical substation in the 400 Area. There is limited electrical infrastructure within the area that is proposed for conveyance. The White Bluffs-Benton transmission line is a 115-kV power line from BPA White Bluffs Substation to the BPA Benton Substation that crosses the proposed conveyance area (DOE 2012c). The nearest substations are the White Bluffs substation operated by BPA located approximately 1.5 miles west of the HAMMER Facility and the Sandhill Crane substation operated by the City of Richland on the southwest corner of Stevens Drive and Horn Rapids Road (City of Richland 2008). Electricity usage for the Hanford Site has been approximately 173,000 megawatt-hours per year. Hanford is a priority customer of BPA and has historically had surplus transmission line capacity (DOE 2012c).

DOE has replaced centralized coal-fired steam plants in the 200 Area and 300 Area with smaller boilers at specific facilities to supply heat and process steam. Oil-fired package boilers are used in the 200 Area, while steam in the 300 Area is produced by natural gas-fired boilers. A pipeline operated by Cascade Natural Gas runs from South Richland to the 300 Area to supply natural gas to the 300 Area package boilers (DOE 1999a). Natural gas usage at the Hanford Site has been approximately 978,000 cubic meters per year. No natural gas is currently delivered to the PA.

Water is supplied to the Hanford Site from a Hanford Site-operated water system that draws water from the Columbia River, the City of Richland water supply system, and water wells located onsite. In the 100 Area and 200 Area, water is supplied by a DOE operated water system that draws water from the Columbia River. In the 300 Area, water is supplied by the City of Richland water supply system. In the 400 Area, water is obtained from groundwater supply wells. Water usage at the

Hanford Site has been approximately 215 million gallons per year, which is less than 5 percent of the capacity of the Hanford Export Water System (DOE 2012c).

3.10.1.2 City of Richland

Following land conveyance and annexation, the City of Richland would provide electricity, water, wastewater, and solid waste management services to the FSA. In the city of Richland, the BPA and the city own and operate eight substations with a summer capacity of 302,000 kV amperes. In 2013, the summer peak demand was approximately 218,000 kilowatt (kW). The City of Richland has recently updated their long range plan for electrical power delivery and plans to update their distribution system to meet future growth (RGW Enterprises 2015).

The Richland Department of Public Works provides water, wastewater, and solid waste management services to the City of Richland. The City of Richland obtains about 82 percent of its water directly from the Columbia River, with the remaining water coming from groundwater wells and from a well field north of the city. Prior to consumption, water is stored in 15 reservoirs with a total capacity of about 25 million gallons. The city maintains approximately 1.7 million feet of pipe. In 2013, the average daily use of water across the entire service area was 14.7 million gallons and the peak daily use was 34 million gallons (TRIDEC 2014b). Water drawn from the Columbia River is treated at the city's water treatment facility. The treatment facility has a capacity of up to 36 million gallons per day (City of Richland 2004). According to the City of Richland Comprehensive Plan, the city has water rights totaling 58 million gallons per day, which is considered adequate to support any future growth of the city (City of Richland 2008). Existing water mains extend to the Horn Rapids Sanitary landfill southwest of the FSA. A 24-inch main extends north and south along Stevens Drive, connecting to a 30-inch main that serves the Horn Rapids area (City of Richland 2008); however, additional distribution mains would be required to serve the PA, as well as improvements to existing water mains to provide increased capacity.

Richland's sewer collection system consists of gravity sewers, pump stations, and force mains that convey wastewater to the Richland Wastewater Treatment Facility. The treatment facility has a capacity of 11.4 million gallons per day, and an average daily usage of about 5.5 million gallons per day (TRIDEC 2014b). Treated wastewater is discharged to the Columbia River. The city maintains about 1.2 million feet of sewer pipe throughout the service area (City of Richland 2004). Because the city is relatively flat and cannot rely completely on gravity to encourage flow, the city owns and operates 15 pump stations to help move sewage in the direction of the treatment facility. Existing sewer mains serve the City of Richland's Horn Rapids Sanitary landfill approximately 1 mile west of the southwest corner of the FSA; however, no distribution mains exist north of Horn Rapids Road (City of Richland 2008).

Cascade Natural Gas Corporation provides natural gas service to the city of Richland. Natural gas pipelines are owned and maintained by Cascade Natural Gas Corporation. No natural gas pipelines exist north of Horn Rapids Road that could service the FSA; however, an 8-inch main is located along Kingsgate Way south of Horn Rapids Road that provides service to the Horn Rapids Industrial Park (City of Richland 2011). Gas service would likely be extended north along the proposed extension of Kingsgate Way to the FSA. In 2010, the City of Richland updated its comprehensive water system plan in order to forecast future water demands and water supply for 20 years. The plan concluded that current supplies within the City of Richland can support projected future usage (City of Richland 2010).

Richland Fire and Emergency Services provides fire, emergency medical services and transport, as well as hazard mitigation services for approximately 46,000 citizens of Richland, and emergency medical transport services for approximately 18,000 citizens within Benton County Fire District 4. In addition, all services are extended to neighboring agencies through extensive automatic aid agreements in the region. The department is made up of 56 uniformed officers and firefighters, of whom 26 are paramedics and 27 are emergency medical technicians. Richland Fire and Emergency Services shares borders with Kennewick, Pasco, Benton County Fire District 4, and the Hanford Fire Department (Huntington 2010). It is assumed that these agreements and services would be extended to cover the FSA.

3.10.2 Environmental Consequences

The assessment of potential effects to infrastructure relies on identifying the current levels of service for existing infrastructure and comparing that to the expected infrastructure requirements from the construction and operation of the proposed facilities on the FSA. Spatially, the analysis extends to the broader infrastructure systems that would be required for the new facilities. Temporally, the analysis considers those effects that would occur in the short term (construction of facilities) and those that would occur in the long term (operation of the facilities). See the individual resource topics in this EA for discussion of anticipated impacts from construction, including utilities and infrastructure.

3.10.2.1 No Action Alternative

Under the No Action Alternative, no additional demands would be placed on infrastructure and no effects would be anticipated.

3.10.2.2 Proposed Action

Construction

Under the Proposed Action, the FSA would be developed for industrial purposes. The majority of the FSA is currently undeveloped and does not have existing infrastructure; therefore, infrastructure would have to be constructed. Existing water, sanitary sewer, and electrical lines are located at the corner of Horn Rapids Road and Stevens Drive at the southeast corner of the FSA. Electricity is provided by the City of Richland and natural gas provided by the Cascade Natural Gas Corporation. Construction assumptions are discussed at the beginning of this chapter. Land disturbance for all construction activities is described in **Section 3.1.2.2**.

A single water line exists in Horn Rapids Road. Initially, water service would be extended north of Horn Rapids Road to serve the first phase of the multi-phased industrial development. Heavy water users like the wine/spirits and biofuels manufacturing representative facilities (see **Table 3-15**) may require the construction of additional water supply infrastructure, which would be identified, planned, and overseen by the applicable local jurisdiction.

There is currently no sanitary sewer service within the PA. An existing 12-inch sewer line is located at the corner of Horn Rapids Road and Kingsgate Way, but an additional trunk line would be extended north across Horn Rapids Road to service the FSA. It is unlikely that the entire FSA could be served by gravity flow; therefore, as the FSA is developed, new sewer lift stations, and associated forced mains would also be required. A fiber optic data communication network serves the city of Richland; the network would be extended to the FSA along existing and newly constructed access roads (RGW Enterprises 2015).

The city's Sandhill Crane Distribution Substation receives power from BPA's 115-kV transmission line that runs between the BPA's White Bluffs Transmission Substation and Richland's First Street Distribution Substation. The Sandhill Crane Substation is currently at capacity and City of Richland plans to construct a new substation in the future on Kingsgate Way west of the Battelle Road intersection (RGW Enterprises 2015). Depending on the rate of development within the FSA, a second substation may be required at a future date. BPA would provide electrical transmission lines that would be needed for any new substation. The City of Richland would construct new distribution lines from the substations to serve the FSA. An estimated 3 miles of 115-kV transmission line and approximately 18 miles of additional feeder lines would be constructed along existing and planned roadways in the FSA. Power would also be extended to the north to serve the solar facility (RGW Enterprises 2015).

The City of Richland would provide solid waste disposal and recycling services to the FSA. Although the Horn Rapids Sanitary landfill is anticipated to reach capacity by 2018, the city is exploring alternative options for waste disposal and no effects on its ability to provide these services are anticipated (see **Section 3.12.1**).

The City of Richland would work with Cascade Natural Gas Corporation to bring natural gas service to the conveyance area, as needed.

When the City of Richland or other local jurisdiction considers a future need for additional infrastructure, such as gas lines to serve the area, it would conduct SEPA reviews for those actions.

Operations

Table 3-15, "Rough Estimate of the Projected Utility Usage by Representative Facility," presents a rough estimate of the projected annual utility usage for each of the representative facilities on the main FSA lands listed in **Chapter 2.0**. The methodology for identifying representative facilities is described in **Appendix E**. Specific references for deriving estimated utility usage for the representative facilities are found in the footnotes to **Table 3-15**.

Following construction, the demand for these utilities would increase, but would not exceed existing service capabilities. For example, the projected water use at full build out would be approximately 2.3 million gallons per day, which is about 16 percent of the current average daily water use and 6 percent of the City of Richland water treatment capacity. The quantity of wastewater generated would be approximately 1.4 million gallons per day, or about 12 percent of the design capacity of the City of Richland Wastewater Treatment Facility. Similarly, electrical demand for all proposed facilities would be approximately 16,000 kW, or about 7 percent of the peak power demands in 2013. Construction of the new substations to the north and south of Horn Rapids Road, when needed, would ensure that adequate load capacity exists for future demands on the power system in that area of the city.

As explained in the bounding case assumptions in **Section 2.2.5**, all of the representative facilities, including the multi-phased development, would begin and end construction at the same time to address the collective short-term construction impacts. In actuality, economic development would proceed in phases over a period of several years, and the utility providers would improve the building infrastructure over several years, as needed.

The Proposed Action would result in new, long-term demand for utility services. New infrastructure and services would be provided and maintained by the City of Richland, BPA, and Cascade Natural Gas, as applicable.

Table 3-15. Rough Estimate of the Projected Utility Usage by Representative Facility.

TMI Category	Type of Facility	Electrical	Natural Gas	Fuel Oil	All Major Fuels	Water	Wastewater	Solid Waste Generation	Electrical Generation	Energy Production
	Units	kW	BTUs/year (x 1,000)	BTUs/year (x 1,000)	BTUs/year (x 1,000)	Gallons/day	Gallons/day	Tons/year	kW	Gallons/year
Commerce Center	Multi-Use	4,500	81,000,000	21,000,000	261,000,000	106,849	360,000	4,000	N/A	N/A
Warehousing and Distribution – A	Manufactured Parts Distribution Center	200	7,000,000	20,000	13,000,000	8,219	20,000	1,000	N/A	N/A
Warehousing and Distribution – B	Storage and Rail Distribution Center	700	25,000,000	80,000	46,000,000	30,137	59,646	200	N/A	N/A
Research and Development – A	Biological R&D Center	400	5,000,000	550,000	20,000,000	27,397	34,000	900	N/A	N/A
Research and Development – B	Energy R&D Center	0	0	0	0	2,192	58,880	500	450	N/A
Technology and Manufacturing – A	Electronics Equipment Manufacturing	200	3,000,000	740,000	10,000,000	30,137	60,000	100	N/A	N/A
Technology and Manufacturing – B	Light Industrial	400	7,000,000	2,000,000	20,000,000	10,959	100,000	600	N/A	N/A
Food and Agriculture – A	Vegetable Food Processing	100	2,000,000	400,000	6,000,000	202,740	166,000	100	N/A	N/A
Food and Agriculture – B	Wine/Spirits Processing	2,600	46,000,000	12,000,000	148,000,000	1,197,260	436,000	2,000	N/A	N/A
Back Office – A	National Call Center	100	2,000,000	150,000	6,000,000	104,110	10,000	300	N/A	N/A
Back Office – B	Automatic Data Processing Ctr.	200	3,000,000	250,000	9,000,000	82,192	12,000	300	N/A	N/A
Biorefinery and Feedstock Processing	Biofuels Manufacturing Facility	6,500	3,000,000	Minimal	Minimal	457,534	61,400	800	N/A	10,000,000
	TOTAL	**15,900**	**184,000,000**	**37,190,000**	**539,000,000**	**2,260,000**	**1,380,000**	**10,800**	**450**	**10,000,000**

[a] Energy usage derived from DOE (2012e), *Energy Efficiency & Renewable Energy, Buildings Energy Data Book, Index for Commercial Buildings*, found at: http://buildingsdatabook.eren.doe.gov/docs%5CDataBooks%5C2011_BEDB.pdf.

[b] Industrial water use derived from water use coefficients by SIC code (gallons per employee per day), Pacific Institute (2003), *Waste Not, Want Not: The Potential for Urban Water Conservation in California, Appendix C*, found at: http://www.pacinst.org/wp-content/uploads/sites/21/2013/02/waste_not_want_not_full_report3.pdf.

[c] Industrial wastewater generation derived from City of Richland (2004), *General Sewer Plan Update*, industrial wastewater flow planning criteria of 2,000 gallons per acre per day, found at: http://www.ci.richland.wa.us/DocumentCenter/View/6215.

Key: BTU = British thermal unit; kW = kilowatt; N/A = not applicable; R&D = research and development; TMI = target marketing industry.

Table 3-16, "Projected Utility Usage for Solar Facilities within the 300-Acre Parcel," presents the projected utility usage for the solar farm FSA for two possible solar applications: (1) a single-axis PV solar panel installation designed to produce 42 mW of energy, and (2) CSP parabolic dishes coupled with the Stirling engine thermal technology designed to produce 41 mW of energy. The CSP design utilizes more water than the PV installation because of water requirements for cooling, or an estimated 170,000 gallons per day. The PV panels require water periodically when they become coated with dust or dirt or when the energy generation for the panels drops off below some efficiency threshold, or 44,000 gallons per washing (NREL 2011). The projected water use of 170,000 gallons per day is less than 5 percent of the City of Richland water treatment capacity.

Table 3-16. Projected Utility Usage for Solar Facilities within the Solar Farm FSA.

Solar Facility Type	Electrical (kW)	Natural Gas (BTUs/ year x 1,000)	Fuel Oil (BTUs/ year x 1,000)	All Major Fuels (BTUs/ year x 1,000)	Water [a] (gallons/ year)	Waste Water (gallons/ year)	Solid Waste Generation (tons/year)	Electrical Generation (kW)
Photo-voltaic	110	2,462,000	0	5,761,000	8,800,000	0	Minimal	42,000
Parabolic dish	166	10,700,000	0	15,700,000	176,000	96,000	Minimal	41,000

[a] The water use is prorated based upon the usage of the representative facility.

3.10.3 Potential Mitigation Measures by Future Landowners

Although not obligatory or within the control of DOE, future landowners could be encouraged by TRIDEC and local jurisdictions through public recognition and/or economic development incentives to design, construct, and operate their facilities in a manner that further reduces or eliminates some potential environmental impacts.

3.10.4 Unavoidable Adverse Impacts

Although not necessarily an adverse impact, the Proposed Action would result in new, long-term demand for utility services from the City of Richland, BPA, and Cascade Natural Gas.

3.11 Transportation

The ROI for transportation includes the PA and surrounding urban areas and perimeter roads.

3.11.1 Affected Environment

The PA is located in the Tri-Cities area, a regional transportation and distribution hub with air, rail, highway, and river connections.

The road network in the vicinity of the PA (see **Figure 3-11**, "Transportation") consists of several main roads, including:

- State Route 240 (to the southwest of the PA) a six-lane highway that connects to Stevens Drive in Richland. State Route 240 is a designated freight route in the Regional Transportation Plan for the Tri-Cities (DKS Associates 2005).
- Route 4 South, a four-lane, north-south principal arterial that runs along the eastern border of the PA, and then turns to the northwest in the northeastern portion of the PA.

- Stevens Drive, a four-lane, north-south principal arterial that adjoins Route 4 South at the Horn Rapids Road intersection.
- George Washington Way, a principal four-lane north-south arterial through Richland that intersects Stevens Drive east of the PA.
- Horn Rapids Road, an east-west minor arterial on the southern border of the PA.
- Kingsgate Way, a north-south minor arterial that ends at Horn Rapids Road about 1.5 miles west of Stevens Drive.

The roads that provide direct access to the PA are Stevens Drive, George Washington Way (which terminates at Stevens Drive immediately to the east of the PA), and Horn Rapids Road (immediately south of PA). These roads are in turn connected to the regional transportation system that serves the Tri-Cities.

Average daily traffic volumes for nearby intersections are shown in **Table 3-17**, “2010–2011 Average Daily Traffic at Principal Access Route Intersections.” **Table 3-18**, “Average Daily and Peak Hour Traffic for Principal Access Roads,” presents traffic volumes, including peak hour counts, for the roads around the PA. While collection dates vary, the data demonstrate the dominant flows of traffic during the peak morning and afternoon commute times when traffic is heaviest.

The Benton-Franklin Council of Governments’ *2011-2032 Regional Transportation Plan* modeling predicted in the 2020 “build” scenario[17] that peak hour traffic volumes would be well below the capacity (i.e., peak hour volumes would be less than 50 percent of the capacity of the roadway) of Stevens Drive, George Washington Way, and Horn Rapids Road around the PA (Benton-Franklin Council of Governments 2012).

The Tri-City Railroad Company maintains and operates about 12 miles of rail formerly owned by DOE. In 1998 the Port of Benton received 750 acres of land and numerous buildings from DOE for economic development purposes, and the railroad serves this area and the City of Richland’s Horn Rapids Industrial Site (via a spur line built by the city in 1997) (DKS Associates 2005). The rail line runs west of Stevens Drive south of and within the PA, and crosses Horn Rapids Road at grade just west of Stevens Drive. The crossing is equipped with gates and signals.

[17] As part of the regional transportation planning, future transportation conditions were modeled based on planned land use and transportation projects and projected changes in regional population and employment.

Figure 3-11. Transportation.

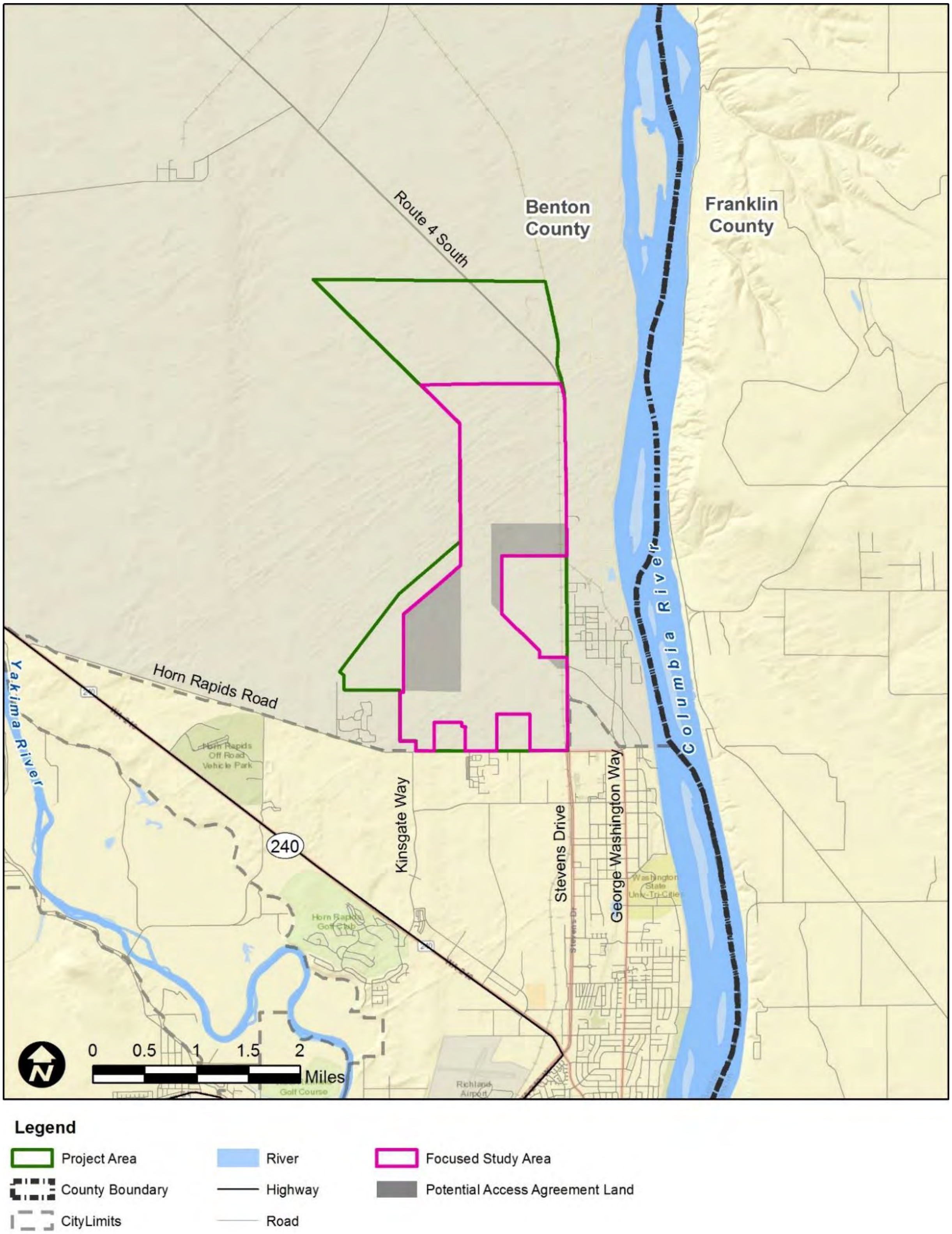


Table 3-17. 2010–2011 Average Daily Traffic at Principal Access Route Intersections.

Access Routes Intersection	Eastbound (daily number of vehicles)	Westbound (daily number of vehicles)
Horn Rapids Road and Stevens Drive	481	403
Horn Rapids Road and George Washington Way	1,190	1,210

Source: DOE 2013b.

Table 3-18. Average Daily and Peak Hour Traffic for Principal Access Roads.

Street Location	Direction	Year	Average Daily Traffic	AM Peak Hour Traffic	PM Peak Hour Traffic
Horn Rapids west of Stevens Drive	eastbound	2010	1,210	319	95
	westbound	2010	1,190	134	255
Route 4 South north of Horn Rapids	southbound	2001	4,325	248	1,464
	northbound	2001	4,108	1,542	168
Horn Rapids east of Stevens Drive	westbound	2001	532	46	149
	eastbound	2001	620	144	58
George Washington east of Stevens Drive	westbound	2001	474	187	41
	eastbound	2001	454	34	119
George Washington north of Horn Rapids	southbound	2001	994	189	265
	northbound	2001	1,157	321	209
Horn Rapids west of George Washington	westbound	2010	403	53	66
	eastbound	2010	481	92	65

Source: City of Richland 2015.

3.11.2 Environmental Consequences

The environmental consequences analysis of the construction and operation of the representative facilities on FSA land was conducted by estimating transportation demands of land uses and comparing them to current and anticipated future transportation conditions. Trip generation estimates for potential land uses in the FSA were developed using the Institute of Transportation Engineers common trip generation rates (ITE 2012) for the afternoon peak use period (PM peak hour) and comparing those trips to current and projected future traffic volumes. It should be noted that this is a qualitative assessment and traffic estimates for potential land uses in the FSA serve as an indicator of the magnitude of expected change. Trip generation is subject to many variables and uncertainties that would make actual trips generated by specific representative facilities higher or lower than those estimated in this analysis. As part of the development in the FSA, an approximately 2-mile new interior roadway is assumed for this analysis and it was assumed that access to developed land uses would be via that interior roadway with trips being evenly distributed to Horn Rapids Road and Stevens Drive.

3.11.2.1 No Action Alternative

Under the No Action Alternative, the FSA lands would not be conveyed and land use would not change. As such, there would be no impacts to the transportation system from the No Action Alternative.

3.11.2.2 Proposed Action

Construction

Construction of representative industries on the main and the solar farm FSAs would result in increases in car and truck traffic on Horn Rapids Road, Stevens Drive, and other surrounding roadways during construction.

The construction of new interior roadway and access to and from Stevens Drive and Horn Rapids Road could cause temporary disruption from construction activities, delivery of material and equipment, and construction workers traveling to and from the FSA. The number of construction workers for each representative facility would vary depending on the size and scope, phase of development, and other factors. Multiple construction projects occurring simultaneously would result in traffic congestion on Horn Rapids Road, Stevens Drive, and George Washington Way for the duration of construction activities.

Operation

Upon full operation, the representative industries assessed would be expected to each contribute from about 37 PM peak hour trips (for "Food and Agriculture A") to about 1,095 PM peak hour trips (for "Food and Agriculture B"). If all the representative facilities were developed (with the exception of phase II of the Multi-Phase Development Site), about 3,000 new peak hour trips would be generated. This volume of trips representing all industries would constitute a new load on the internal roadway as well as on Stevens Drive and Horn Rapids Road, the primary arterials providing access to the FSA. For illustrative purposes, if about half of the new trips were allocated to Stevens Drive (entering north of Horn Rapids Road), it would more than double the PM peak hour volume (based on the City of Richland's 2001 traffic count), and would be more than five times the PM peak hour volume on Horn Rapids Road west of Stevens Drive (based on the 2010 traffic count). While both roadways are anticipated to have substantial peak hour capacity in the future, the addition of a large number of peak hour trips not accounted for in the Regional Transportation Plan's modeled 2020 build scenario would likely affect operations on those and other roadways, including congestion and delays at intersections (reduced level of service) and safety issues related to congestion.

The multi-phased development is estimated to generate about 3,200 PM peak hour trips (for both phase I and phase II). Effects of the multi-phased development on internal circulation and main arterials would be similar to that described above for the development of all other potential industries and land uses.

The rail distribution center would receive two 55-car unit trains each week via the Tri-City Railroad line in the PA. This would represent additional traffic on the rail line, and four additional crossings of Horn Rapids Road by the unit trains each week. Vehicle delays at the crossings would depend on the speed of the train and time of the crossings, as well as the influence of potential additional train traffic serving the Horn Rapids Industrial Park.

The solar farm would generate a few trips for operations and maintenance activities; these would not noticeably contribute to the existing and projected future traffic volumes or affect traffic operations.

3.11.3 Potential Mitigation Measures by Future Landowners

Although not obligatory or within the control of DOE, this section describes certain potential mitigation measures, which could be undertaken by a future landowner and local jurisdictions.

The assumed simultaneous development of representative facilities of the scope and type as those assessed would cause increased traffic and congestion on Horn Rapids Road, Stevens Drive, State Route 240, and other surrounding roadways that serve as the primary access routes to the PA. Prior to approving specific developments, the applicable local agency would conduct a SEPA review. A local agency could require the developer to conduct a project- and site-specific traffic impact analysis and identify access and capacity improvements as mitigation measures to lessen or avoid transportation impacts.

3.11.4 Unavoidable Adverse Impacts

Current development on the adjacent Horn Rapids Industrial Park and PNNL campus generates vehicle and truck traffic on roads adjacent to the FSA. The industrial development of the FSA lands would result in increased traffic and congestion during both construction and operations, the severity of which would vary depending on the rate and extent of development.

3.12 Waste Management

The ROI for waste management is the PA and the waste management facilities and operations in the city of Richland.

3.12.1 Affected Environment

The PA is currently largely undeveloped and there are no active waste generation or disposal facilities. Solid waste management in the city of Richland is guided by the 2011 City of Richland Solid Waste Management Plan (City of Richland 2011) and the 2006 Benton County Comprehensive Solid Waste Management Plan (Benton County 2007). In 2013, the City of Richland generated 69,274 tons of solid waste. Of this total, 15,125 tons (approximately 22 percent) were recycled and 54,149 tons were landfilled at the City of Richland-owned and -operated Horn Rapids Sanitary landfill (City of Richland 2014). Projections made in the 2011 solid waste management plan predicted that the current permitted space of the landfill would be filled by 2018. The city is exploring options for future growth, including expanding the Horn Rapids Sanitary landfill or closing the landfill and long-hauling the waste out of the city (City of Richland 2011). Recycling in the city is collected from voluntary curbside collection and from seven recycling drop-off centers throughout the city. The city delivers all recycled materials to Clayton Ward Recycling in Richland, where the materials are sent to recycling centers in Western Washington or Oregon (City of Richland 2011).

Sanitary wastewater at the Hanford Site is discharged to onsite treatment facilities such as septic tanks, subsurface soil absorption systems, and wastewater treatment plants, which treat on average about 158,000 gallons per day of sewage. Hanford's sewer system in the 300 Area is connected to the City of Richland's sewage treatment plant.

Nonhazardous solid waste from the Hanford Site is disposed at the Roosevelt Regional Landfill near Glendale, Washington (DOE 2012a). The Hanford Site has established target objectives for solid waste reduction by reuse and recycling of 10 percent per year, based on a fiscal year 2010 baseline. In fiscal year 2013, approximately 600 metric tons were generated and disposed of at the Roosevelt Regional Landfill, while more than 1,300 metric tons of solid waste were recycled (DOE 2014c).

Section 3.10 describes current municipal solid waste handling practices for other areas of the Hanford Site and the city of Richland.

The FSA is currently undeveloped and there are no associated waste generation or disposition activities.

3.12.2 Environmental Consequences

3.12.2.1 No Action Alternative

In the No Action Alternative, no construction or operations waste would be generated.

3.12.2.2 Proposed Action

Construction

Solid nonhazardous waste generated by the Proposed Action during construction would most likely be recycled or transported to the Horn Rapids Sanitary landfill for disposal. Nonhazardous construction wastes would likely consist of solid waste such as packaging material, including wooden crates, cardboard, and plastic; scrap material such as electrical wire, insulation, gypsum drywall, floor tiles, carpet, scrap metal, and empty adhesive and paint containers; concrete rubble; and land-clearing debris. These wastes would be recycled through agreement with local contractors or collected in roll-off bins located onsite and transported to the Horn Rapids Sanitary landfill, as appropriate.

Operation

Specific detail about the wastes that may be generated by the representative facilities is not available; however, the types of anticipated uses would produce waste typical of other industrial, research, and office park operations in the region. Wastes would be disposed at the Horn Rapids Sanitary landfill. **Table 3-15** includes an estimate of solid waste generation for each representative facility for each TMI category. An estimated total of 10,800 tons would be generated per year; however, at the current diversion rate of 22 percent, about 8,400 tons per year would be disposed. This represents about 15 percent of the current disposal rate at the landfill.

The City of Richland notes that the 46-hectare (114-acre) Horn Rapids Sanitary landfill could potentially be at capacity in 2018 and is evaluating the options of expanding the permitted space or using long-haul services to a regional landfill. Initial studies indicate the landfill could be expanded to accommodate 7 million tons, or approximately 65,000 tons per year for 66 years, depending on the quantity of material disposed per year. The landfill would be expanded in compliance with *Resource Conservation and Recovery Act* Subtitle D regulations for sanitary landfills, and would accept municipal solid waste for disposal.

Petroleum, oils, lubricants, and chemicals would be managed in accordance with applicable State of Washington regulations. If required by state or federal law, facilities would have a spill prevention, control, and countermeasures plan and an emergency response plan to address the potential release of hazardous materials.

Liquid wastes from representative facilities would consist of waste process water and sanitary sewage. Both of these wastewaters would be sent to the City of Richland's publicly owned treatment works for processing. Process water generated from facility operations would be monitored to verify compliance with permitted pollutant concentrations in accordance with the City of Richland pretreatment program (City of Richland Code 17.30). Process wastewater from the representative facilities is anticipated to be similar in composition to other industrial, research, and office park operations in the region.

3.12.3 Potential Mitigation Measures by Future Landowners

Although not obligatory or within the control of DOE, the following section describes certain potential mitigation measures, which could be undertaken by a future landowner and the local jurisdiction.

The future landowners could be encouraged by TRIDEC and local and state government through public recognition and/or economic development incentives to design, construct, and operate their facilities in a manner that further reduces or eliminates some potential environmental impacts by designing industrial facilities and operations that minimize waste production and maximize waste recycling to reduce demand on the city and county's waste management facilities. It is expected that companies who practice the mitigation measures of waste minimization, source reduction, recycling, and other BMPs would reduce the quantities of waste generated and the impact on the existing disposal facilities.

3.12.4 Unavoidable Adverse Impacts

The Proposed Action would generate solid and liquid wastes that would add to existing waste streams. The amount of wastes that would be generated is not expected to exceed the capabilities of existing waste management systems.

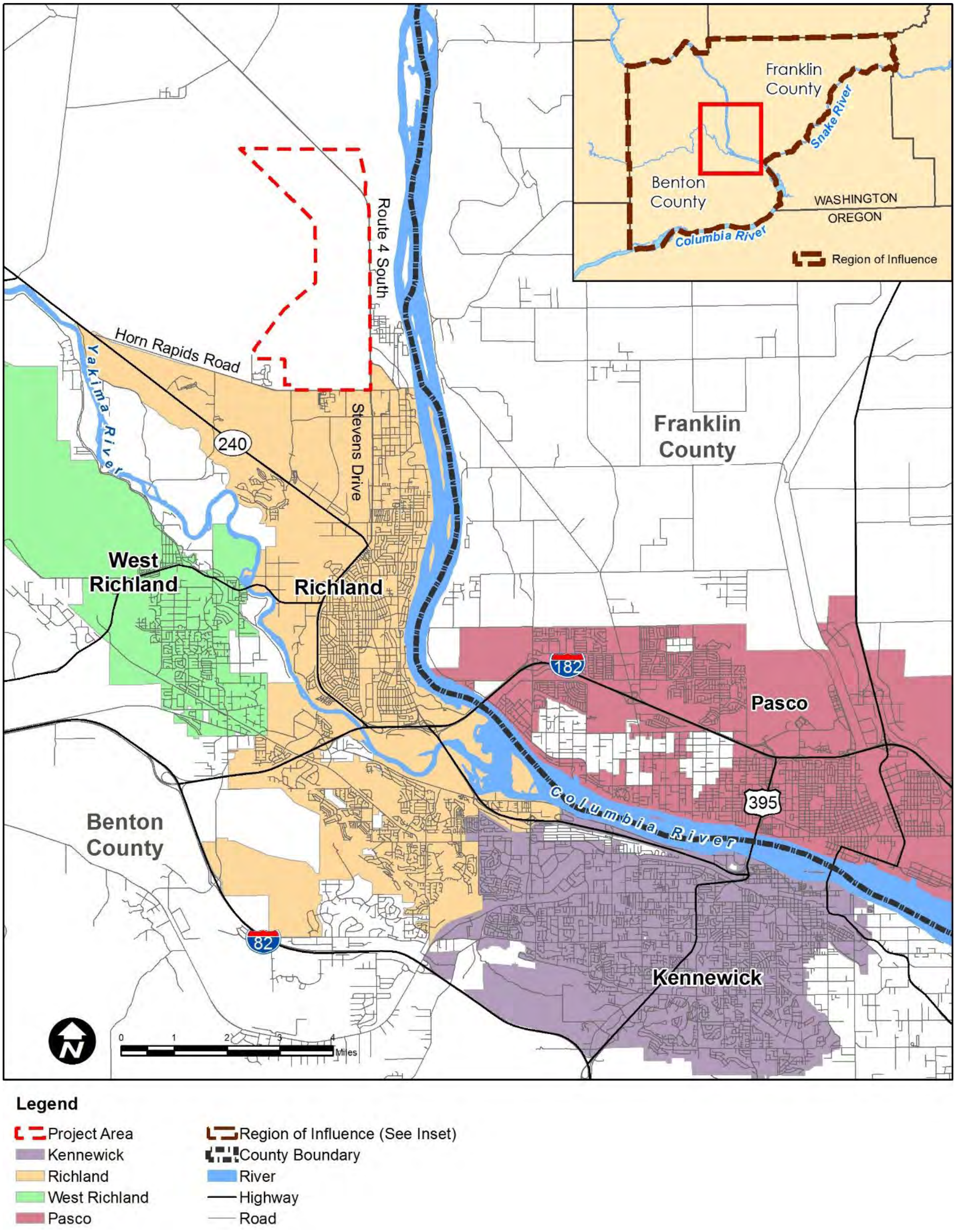
3.13 Socioeconomics and Environmental Justice

The ROI for socioeconomics and environmental justice comprises Benton and Franklin counties. The socioeconomic environment includes regional economic, demographic, housing, and community service characteristics that could potentially be affected by the Proposed Action.

The ROI, as shown in **Figure 3-12**, "Socioeconomics and Environmental Justice Region of Influence," coincides with the statistical boundaries of the Tri-Cities (Kennewick, Richland, and Pasco) metropolitan statistical area (MSA). The Tri-Cities area includes Kennewick, Richland, Pasco, West Richland, and unincorporated communities within Benton and Franklin counties. Therefore, the Tri-Cities area is the same as Benton and Franklin counties combined. The socioeconomic ROI is defined by the areas in which people reside, work, spend their incomes, and use their benefits, thereby affecting the social and economic conditions of the region.

Foreseeable future activities analyzed include construction activities that have temporary impacts, including expansion of facilities or construction of new facilities at PNNL, and ongoing activities (e.g., fuel storage at the K Basins). Other non-DOE activities in the ROI could have longer-term impacts. The non-DOE activities analyzed include management of the HRNM and increased operations at the Perma-Fix facility. The total projected workers required for these future activities would be approximately 3,290 (see **Appendix E**).

2791 **Figure 3-12. Socioeconomics and Environmental Justice Region of Influence.**



2792

3.13.1 Affected Environment

Activities on the Hanford Site influence the socioeconomics of the Tri-Cities area. The communities surrounding the PA provide the people, goods, and services required by businesses and industries at the Hanford Site. These businesses and industries in turn create the demand for employees, goods, and services and acquire these resources in the form of wages, benefits, and purchases of goods and services.

3.13.1.1 Employment and Income

Based on the 2007–2011 American Community Survey (ACS) data, the Tri-Cities civilian labor force was 118,017 and unemployment rate was 6.6 percent (USCB 2011). In comparison, the 2008–2012 ACS data presented in **Table 3-19**, "Employment and Income," show that the Tri-Cities civilian labor force (122,263) and unemployment rate (7.2 percent) have increased. **Table 3-19** also shows that the Tri-Cities unemployment rate is slightly higher than Benton County (6.7 percent), but lower than Franklin County (8.4 percent) and Washington State (8.9 percent) (USCB 2012). The Tri-Cities has a lower per capita income ($25,354) than Benton County ($28,171) and the state ($30,661), but higher than Franklin County ($19,073). In comparison, the average salary of a Hanford Site employee hired by the *American Recovery and Reinvestment Act of 2009* (from 2009 to 2011) was approximately $77,000, not including the cost of benefits provided to the employee (DOE 2013a).

Table 3-19. Employment and Income.

Area	Civilian Labor Force	Unemployment Rate	Per Capita Income
Benton County	86,369	6.7%	$28,171
Kennewick	36,010	6.2%	$24,088
Richland	24,727	5.9%	$35,119
West Richland	5,835	3.9%	$31,310
Franklin County	35,894	8.4%	$19,073
Pasco	27,461	8.7%	$17,353
Tri-Cities MSA	122,263	7.2%	$25,354
Washington	3,459,542	8.9%	$30,661

Source: USCB 2012.

The 2008–2012 ACS data presented in **Table 3-20**, "Tri-Cities Area Employment by Industry," show employment by industry for the Tri-Cities area. As shown in **Table 3-20**, the Tri-Cities workforce is diverse and would be capable of supporting the TMI categories being considered for future development in the FSA. The top three industry sector groups in the Tri-Cities area are (1) educational services, and health care and social assistance; (2) professional, scientific, and management, and administrative and waste management services; and (3) retail trade (USCB 2012). With the exception of the city of Pasco, where agriculture and manufacturing are the second and third top industry sector groups, respectively, these are also the top three industry sector groups in the cities of Richland, West Richland, and Kennewick (USCB 2012). Relative to other cities, Richland and West Richland contain a high percentage of people employed by the professional, scientific, management and administrative, and waste management services industry sector group.

Table 3-20. Tri-Cities Area Employment by Industry.

Industry	Estimated Labor Force	Percentage of Total Labor Force
Agriculture, forestry, fishing and hunting, and mining	8,996	7.9%
Construction	9,874	8.7%
Manufacturing	9,004	7.9%
Wholesale trade	3,500	3.1%
Retail trade	12,741	11.2%
Transportation and warehousing, and utilities	7,146	6.3%
Information	1,379	1.2%
Finance and insurance, and real estate and rental and leasing	4,339	3.8%
Professional, scientific, and management, and administrative and waste management services	16,831	14.8%
Educational services, and health care and social assistance	21,563	19.0%
Arts, entertainment, and recreation, and accommodation and food services	8,082	7.1%
Other services, except public administration	4,731	4.2%
Public administration	5,263	4.6%

Source: USCB 2012.

Since the 1970s, DOE and its contractors have been one of three primary contributors to the local economy (the other two are Energy Northwest and the agricultural community) (DOE 2013c). According to employee residence records from April 2007, over 90 percent of DOE contract employees of the Hanford Site lived in Benton and Franklin counties (DOE 2012b). Approximately 73 percent resided in Kennewick, 36 percent in Richland, and 11 percent in Pasco. Residents of other areas of Benton and Franklin counties, including West Richland, Benton City, and Prosser, account for about 17 percent of total DOE contractor employment (DOE 2012b).

Increasingly, technology-based businesses, many originating due to Hanford Site associations, have a role in expanding and diversifying the local private business sector. Some of the major technology-based businesses in the Tri-Cities area include PNNL, a research and development laboratory, and various food processing businesses including ConAgra Foods and Tyson Foods (TRIDEC 2014a).

In 2012 the Hanford Site employed 14,900 workers (DOE 2013c). In 2013, PNNL and DOE Pacific Northwest Site Office employed an additional 4,380 workers (DOE 2013c).

3.13.1.2 Population

As shown in **Table 3-21**, “Population,” the 2012 population estimates for the Benton County and Franklin County were 182,398 and 78,163, respectively, which is equal to the population of the Tri-Cities MSA (USCB 2012). From 2010 to 2012, the Tri-Cities grew at a faster rate than Washington State as a whole.

As of July 2013, approximately 22.6 percent of the Tri-Cities area population had attended college, with 8.5 percent of the population holding an associate’s degree, 13.5 percent holding a bachelor’s degree, and 7.7 percent holding graduate degrees (TRIDEC 2014b).

Table 3-21. Population.

Area	2010	2012	Change
Benton County	175,177	182,398	4.0%
Kennewick	73,917	75,971	2.7%
Richland	48,058	51,440	6.6%
West Richland	11,811	12,663	6.7%
Franklin County	78,163	85,845	8.9%
Pasco	59,781	65,398	8.6%
Tri-Cities MSA	253,340	268,243	5.6%
Washington	6,724,543	6,897,012	2.5%

Source: USCB 2012.

3.13.1.3 Environmental Justice

Executive Order 12898, "Federal Action to Address Environmental Justice in Minority and Low-Income Populations," directs federal agencies to identify and address human health or environmental effects of federal actions, which might have disproportionately high and effects on minority populations and low-income populations. U.S. Census Bureau data were used to identify minority populations as Black or African American, American Indian and Alaska Native, Asian, Native Hawaiian and other Pacific Islander, other races, two or more races, and Hispanic or Latino.

Based on the 2008–2012 ACS minority population data presented in **Table 3-22**, "Minority Population," the population within the Tri-Cities includes approximately 35 percent minority persons, which is less than Franklin County (57 percent), but greater than Benton County and Washington State (25 and 28 percent, respectively) (USCB 2012). The majority of the minority population in the ROI consists of Hispanic and Latino, with other minority populations being relatively low. The Tri-Cities Hispanic and Latino population is 29 percent, which is greater than the statewide population (11 percent) and that of Benton County (19 percent), but lower than in Franklin County (57 percent). The minority population of the Tri-Cities area is most concentrated in the cities of Pasco and Kennewick. As shown on **Figure 3-13**, "Minority Population," a block group (census tract 53005010202, block group 1) with a minority population that is relatively greater (over 29 percent) than that of the PA and the immediately surrounding area, is located adjacent to the southeast corner of the PA. However, the majority of this block group does not include residences. The nearest residences (minority or not) are located within the southern part of census tract 53005010202, block group 1, and almost 2 miles southeast of the PA.

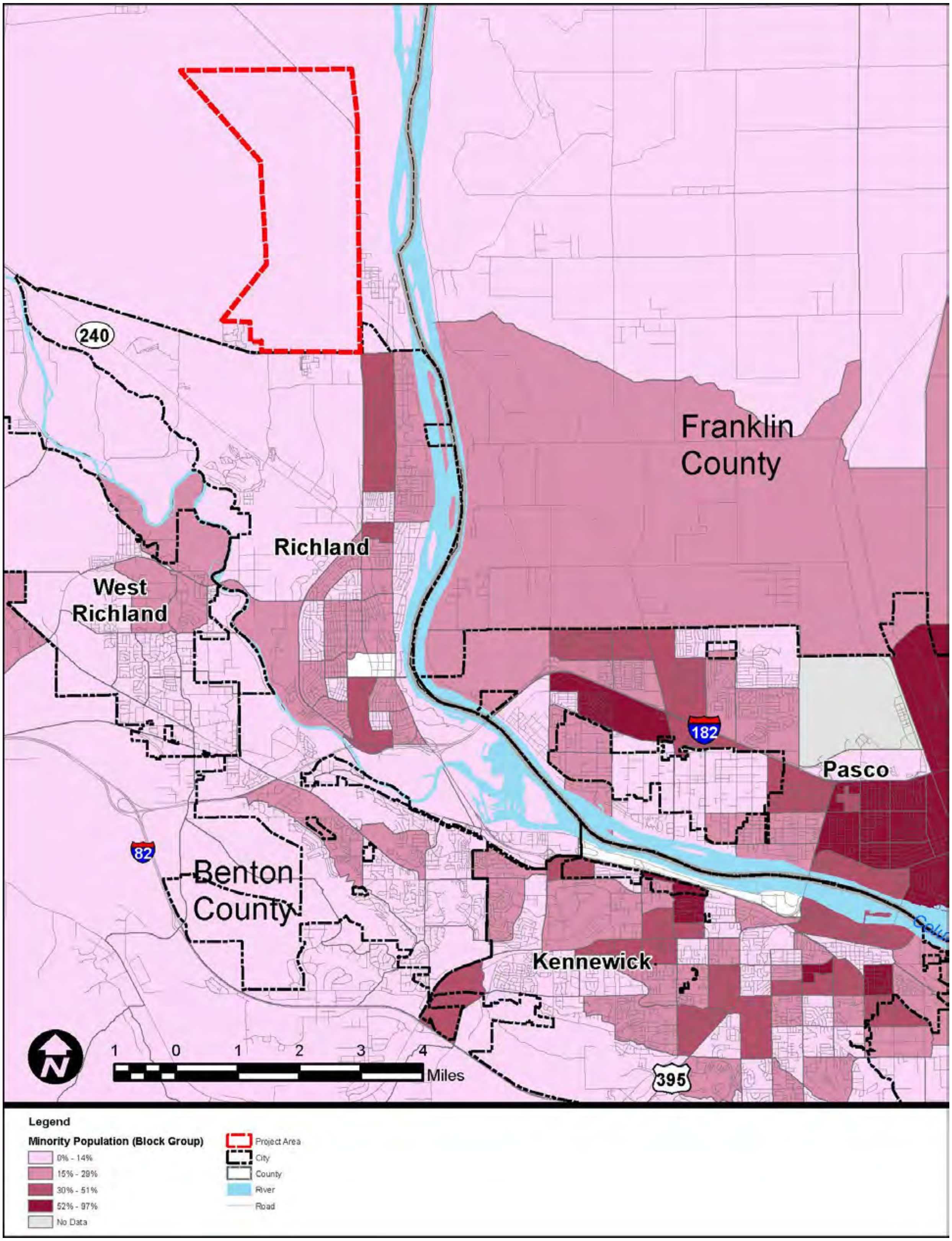
The Council on Environmental Quality recommends that poverty thresholds be used to identify low-income individuals (CEQ 1997). Poverty status is the number of persons with income below the poverty level, defined by the U.S. Census Bureau as $11,720 annual income or less for an individual in 2012.

Table 3-22. Minority Population.

Area	Total Population	White	Black or African American	American Indian and Alaska Native	Asian	Native Hawaiian and Other Pacific Islander	Some Other Race	Two or More Races	Hispanic or Latino	Total Minority
Benton County	175,424	75%	1%	1%	3%	0%	0%	2%	19%	25%
Kennewick	73,640	68%	2%	1%	3%	0%	0%	2%	25%	32%
Richland	48,556	82%	2%	1%	5%	0%	0%	3%	7%	18%
West Richland	11,904	88%	0%	1%	0%	0%	0%	2%	8%	12%
Franklin County	78,680	43%	2%	1%	2%	0%	0%	1%	51%	57%
Pasco	60,024	38%	2%	0%	2%	0%	0%	1%	57%	62%
Tri-Cities MSA	254,104	65%	1%	1%	2%	0%	0%	2%	29%	35%
Washington	6,738,714	72%	3%	1%	7%	1%	0%	4%	11%	28%

Source: USCB 2012.

Figure 3-13. Minority Population.



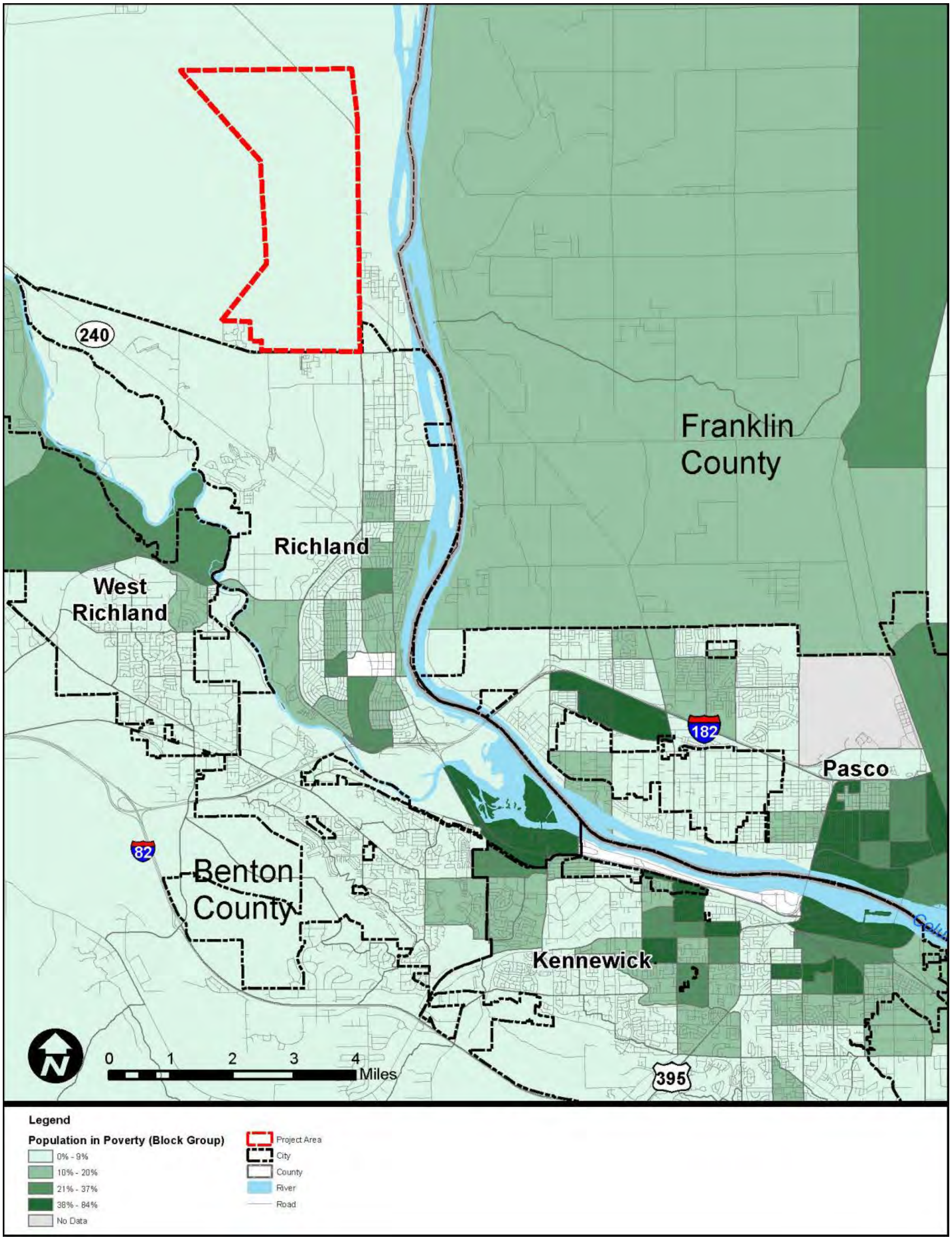
Based on the 2008–2012 ACS poverty population data presented in **Table 3-23**, "Population Below Poverty Level," approximately 16 percent of individuals within the Tri-Cities MSA are below poverty level (USCB 2012). By comparison, Benton County and Washington State have fewer individuals below the poverty level, with 13 percent. In Franklin County, 22 percent of individuals are below the poverty level. The low-income population of the Tri-Cities MSA is most concentrated in the cities of Pasco and Kennewick with some additional rural concentrations in unincorporated Franklin County. As shown on **Figure 3-14**, "Populations Living at or Below Poverty Level" block groups with populations with relatively greater concentrations of poverty (over 20 percent) than that of the PA and surrounding area, are located over 2 miles from the PA.

Table 3-23. Population Below Poverty Level.

Area	**Population Below Poverty Level**
Benton County	13%
Kennewick	18%
Richland	9%
West Richland	10%
Franklin County	22%
Pasco	23%
Tri-Cities MSA	16%
Washington	13%

Source: USCB 2012.

Figure 3-14. Populations Living at or Below Poverty Level.



3.13.1.4 Housing

Table 3-24, "Housing," shows that there are 5,974 vacant housing units in the Tri-Cities, with a vacancy rate of 6.4 percent.

Table 3-24. Housing.

Area	Total Housing Units	Vacant Housing Units	Vacancy Rate
Benton County	68,896	4,236	6.1%
Kennewick	28,760	1,860	6.5%
Richland	20,860	1,421	6.8%
West Richland	4,282	155	3.6%
Franklin County	24,585	1,738	7.1%
Pasco	18,574	1,189	6.4%
Tri-Cities MSA	93,481	5,974	6.4%
Washington	2,884,186	264,191	9.2%

Source: USCB 2012.

3.13.1.5 Community Services

Community services in the Tri-Cities include public schools and medical and emergency services. There are three public school districts (Kennewick, Richland, and Pasco). The Kennewick School District has 14 elementary schools, 4 middle schools, and 3 high schools. During the 2013–2014 school year, the school district had a total student enrollment of 16,772 and a teacher-to-student ratio of 1 to 19 (OSPI 2015). The Richland School District has nine elementary schools, three middle schools, and two high schools. During the 2013–2014 school year, the school district had a total student enrollment of 12,136 and a teacher-to-student ratio of 1 to 21 (OSPI 2015). The Pasco School District has 12 elementary schools, 3 middle schools, and 4 high schools. During the 2013–2014 school year, the school district had a total student enrollment of 16,582 and a teacher-to-student ratio of 1 to 16 (OSPI 2015).

There are four hospitals located in the Tri-Cities, which have a total of 431 beds and 829 staff physicians (TRIDEC 2014b). Emergency services within Benton County include Kennewick Police and Fire; Richland Police and Fire; West Richland Police; Benton County Sheriff's Office; and Benton County Fire Protection Districts 1, 2, and 4. Emergency services within Franklin County include Franklin County Sheriff's Office; City of Pasco police, fire, and emergency medical service; Franklin County Fire Districts 1, 2, 3, 4, and 5; and City of Connell Police and Fire.

3.13.2 Environmental Consequences

3.13.2.1 No Action Alternative

Under the No Action Alternative, there would be no construction- or operation-related employment. As no new jobs would be created, there would be no related increase in annual per capita income and the local tax base of the Tri-Cities area. There would be no impacts to population, housing availability, or community services. As there would be no impacts to members of the public in general, there would be no disproportionately high effects on human health or environmental impacts to minority or low-income populations.

3.13.2.2 Proposed Action

Construction

Construction of all the single-phase representative facilities (see **Table 2-1**) in the FSA simultaneously would employ approximately 150 to 350 construction workers over an 18-month construction period. Construction of the multi-phased development would employ fewer construction workers (6 to 75 in total) but those positions would last much longer due to the long-term, 20-year planning horizon. Construction of the solar farm (either PV or dish) would employ between 25 and 166 construction workers per month over a 12-month construction period. More construction workers would be required for the PV solar farm (166 workers) than the solar dish solar farm (25 to 134 workers). Construction would likely result in indirect and induced economic benefits through construction-related and employee spending on regional goods and services. The number of workers for this analysis are rounded and derived from the identified or estimated numbers for the representative facilities (see **Appendix E, Table E-2**). The corresponding construction worker numbers for the air quality analysis is different because of the modeling calculation assumptions (see **Section 3.3**).

Most construction jobs would likely be filled from within the Tri-Cities labor force, resulting in a short-term economic benefit. In addition, construction of the new facilities would likely result in indirect and induced employment through increased business and construction worker spending on regional goods and services. Some workers may be hired from outside of the Tri-Cities to fill more specialized positions.

As the majority of the work force would likely already reside in the Tri-Cities area, there would be limited influx of people during construction, and short-term impacts to population, housing, or community services. Infrastructure improvements (e.g., new utilities and fire/ambulance services) required for the new facilities would be provided incrementally and maintained by the City of Richland. The ability of existing utilities and public services to accommodate public needs would not be affected.

Operations

Industry development within the FSA is estimated to result in 2,530 new jobs for the single phase and 50 to 1,500 new jobs for the multi-phase, increasing the annual per capita income and the local tax base of the Tri-Cities area. Solar farm development is estimated to result in six or seven new jobs that would also provide annual incomes and contribute to the local tax base (see **Appendix E**, **Table E-2**). Additionally, developing the FSA would likely result in indirect and induced employment through increased business and employee spending on regional goods and services.

Jobs would primarily be filled from within the Tri-Cities labor force, resulting in a long-term economic benefit to the Tri-Cities area. There may be a small number of specialized workers that move into the area, resulting in minor increases in population levels. Based on 2008–2012 ACS employment estimates, the total impact of direct employment could increase the Tri-Cities current employment level by 2 to 4 percent. Indirect and induced employment would further increase employment in the Tri-Cities.

As there are 5,974 vacant housing units in the Tri-Cities (USCB 2012; see **Table 3-24**), there would be adequate housing to accommodate a minor influx of new workers moving into the area. Community services, including schools and emergency services, are also adequate to accommodate the small population increase.

Environmental Justice

This EA has not identified any potential human health or environmental effects or minority or low-income populations that would be affected by the Proposed Action. The Proposed Action would not result in disproportionately high and adverse effects on minority or low-income populations.

3.13.3 Potential Mitigation Measures

Because there would be no impacts, mitigation measures would not be required for the socioeconomics and environmental justice topics.

3.13.4 Unavoidable Adverse Impacts

There are no unavoidable adverse impacts for socioeconomics and environmental justice.

3.14 Human Health and Safety

3.14.1 Affected Environment

The ROI for human health and safety is the PA and surrounding areas.

The Hanford Site is undergoing a large scale cleanup effort to reduce the risk of impacts on the health of public and the environment. During this cleanup effort, hazardous and radioactive materials will either be placed in a stabilized condition or removed from the site.

3.14.1.1 Radiological

United States Background Radiation

Major sources and average levels of exposure to natural background radiation and other non-site related sources to individuals are shown in **Table 3-25**, "Natural Background and Other Radiological Doses Unrelated to Hanford Operations."[18] The average annual dose from these sources is approximately 620 millirem. The annual dose from natural background sources is approximately 310 millirem. This dose can vary depending on geographic location, individual buildings in the geographic area, or age, but is essentially all from cosmic or terrestrial sources. Another source of annual public exposure to radiation is from medical exposure (approximately 300 millirem), including computed tomography, fluoroscopy, X-rays, and nuclear medicine for diagnosis and treatment. An additional source of exposures to the public is approximately 15 millirem from consumer products and other sources (e.g., nuclear power, security, and research) (NCRP 2009). All doses identified in **Table 3-25** are unrelated to Hanford Site operations.

Table 3-25. Natural Background and Other Radiological Doses Unrelated to Hanford Operations.

Source	Effective Dose Equivalent (millirem/yr)[a]
Natural background radiation	310
Medical exposure	300
Consumer, industrial, and other	15
Total (rounded)	**620**

Source: NCRP 2009 [a]Averages for the United States.

[18] Average doses from background radiation in the Hanford vicinity are assumed to approximate the average dose to an individual in the United States population.

Hanford Site Radiation Sources and Background Levels

Background Radiation Levels in the Hanford Area

The report *Hanford Site Background: Part 2, Soil Background for Radionuclides* (DOE 1996b) documents radioactivity levels found in various soils, as well as the vadose zone, from other worldwide activities.[19] Over the years, manmade (anthropogenic) background activity associated with other worldwide activities (fallout from weapons testing) has been mostly limited to measureable amounts of strontium-90, cesium-137, plutonium-239, and plutonium-240 in soils. Other manmade nuclides, such as cobalt-60 and europium-154 were considered in establishing background levels, but were found to be below measureable levels. The nuclides (manmade and naturally occurring) evaluated, along with their associated concentrations and statistical confidence of their presence, are shown in **Table 3-26**, "Background Soil Activity Concentrations."

Table 3-26. Background Soil Activity Concentrations.

Analyte	Background Soil Activity (pCi/g)	
	Mean	Standard Deviation
Potassium-40	13.1	2.71
Cobalt-60	0.00132	0.00591
Strontium-90	0.0806	0.0688
Cesium-137	0.417	0.338
Europium-154	0.000826	0.0250
Europium-155	0.0234	0.0184
Radium-226	0.561	0.202
Thorium-232	0.945	0.260
Uranium-234	0.793	0.233
Uranium-235	0.0515	0.0373
Uranium-238	0.763	0.216
Plutonium-238	0.00158	0.00332
Plutonium-239/240	0.00935	0.00782
Total	**19.8**	**2.40**

Key: pCi/g = picocuries (of radioactivity) per gram (of soil).
Source: DOE 1996b.

Vadose zone activity levels proximal to the FSA have likewise been characterized in terms of the presence of nuclides found in soils across the site. As with the case of the soils, a combination exists of manmade, and naturally occurring nuclides within the vadose zone. Subject isotopes, along with their associated concentrations, are shown in **Table 3-27**, "Background Vadose Zone Activity Concentrations."

[19] The vadose zone is the unsaturated zone of the subsurface soils, where the spaces are not consistently and completely filled with groundwater.

Table 3-27. Background Vadose Zone Activity Concentrations[a]

Analyte	Background Vadose Zone Activity (pCi/g)	
	Mean	Standard Deviation
Potassium-40	16.1	1.87
Cesium-137	-0.00130	0.0204
Europium-152	0.0194	0.0529
Europium-154	-0.0340	0.0861
Europium-155	0.0730	0.0700
Radium-226	0.653	0.102
Thorium-232	0.912	0.164
Thorium-238	1.27	0.210
Uranium-234	0.741	0.240
Uranium-235	0.0383	0.0473
Uranium-238	0.794	0.251

[a] Based on measurements taken at sampling location HEIS #BOC2W8.
Key: pCi/g = picocuries (of radioactivity) per gram (of soil).
Source: DOE 1996b.

Doses associated with these background activity concentrations were estimated using the RESRAD dose modeling program (DOE 1996b; ANL 2001). A conservative calculation of background dose from radionuclide data requires a detailed set of assumptions concerning exposure pathways, potential biological damage (i.e., quality factors), and other aspects of exposure for each radionuclide. The doses are evaluated based on a conservative, hypothetical residential scenario (versus proposed industrial use), which includes external exposure; inhalation of fugitive dust; inhalation of radon; ingestion of plants, meat, and milk produced on typical Hanford soil; and incidental ingestion of the soil itself. Such a residential exposure scenario (excluding ingestion of groundwater and fish) was used to generate associated dose estimates, resulting in a conservative sitewide total background dose of 97 millirem/year, as presented in **Table 3-28**, "RESRAD-Modeled Doses Derived from Background Concentrations," with only nuclides of discernible dose contribution included (DOE 1996b). In summary, the greatest contributor to dose from background radionuclides was from the naturally occurring radon pathway, with only background levels of cesium-137 and strontium-90 noticeably contributing to dose from the domain of potential sources. It should be noted for consistency that this value is comparable to the 85 and 83 millirem/year background levels recently measured at the southern 600 Area and 618-10 burial grounds, respectively, via the Hanford Site environmental surveillance program (MSA 2015a; DOE 2014b; DOE 1996b).

Table 3-28. RESRAD-Modeled Doses Derived from Background Concentrations.

Analyte	Mean (millirem/yr)	Standard Deviation (millirem/yr)
Potassium-40	27.0	5.6
Strontium-90	0.49	0.42
Cesium-137	1.45	1.21
Radium-226 + daughter nuclides	45.5	16.4
Thorium-232 + daughter nuclides	22.0	6.04
Uranium-234	0.19	0.056
Uranium-235	0.045	0.032
Uranium-238	0.26	0.073
Total	**96.9**	**29.8**

Source: DOE 1996b.

Sitewide Operations

Releases of radionuclides to the environment from Hanford operations provide a source of radiological exposure to members of the public in the vicinity of Hanford. A hypothetical maximally exposed individual (MEI) is a person whose place of residence and lifestyle make it unlikely that any other member of the public would receive a higher radiation dose from Hanford operational releases. This person is assumed to be exposed to radionuclides in the air and on the ground from Hanford emissions, ingestion of food grown downwind from Hanford and irrigated with water from the Columbia River downstream from Hanford, ingestion of fish from the Columbia River, and exposure to radionuclides in the river and on the shoreline during recreation. The annual dose to this MEI has ranged from about 0.1 to 0.2 millirem over the last 5 years, with this individual typically being located at the PNNL Physical Sciences Facility on Horn Rapids Road along the Hanford Site's southeastern boundary (DOE 2014b). Individuals within the FSA would be expected to receive in the same range of dose as the MEI, or less. Historically, there have been no distinct emissions generated within the FSA that have discernibly contributed to offsite public doses.

In summary, doses to the public from the greater Hanford Site operations fall well within the limits established in 40 CFR 61, Subpart H (10 millirem/year from airborne sources) and DOE O 458.1 (100 millirem/year from all sources), and are much lower than those due to natural background radiation. In general, airborne emissions of tritium and radon-220 from the 300 Area, along with uranium-234 and uranium-238 effluents via the Columbia River, account for the vast majority of calculated dose to the MEI for the greater Hanford Site (DOE 2014b).

Radiological Clearance of Land

Per DOE O 458.1, DOE's maximum allowable administrative (or "authorized") limit for permitting radiological clearance of lands (i.e., "real" property) to the proposed industrial workforces is 25 millirem/year. This dose limit would principally be applicable to upcoming construction and operational workforces within the FSA. Although the intended use of the FSA is industrial, DOE O 458.1 was developed to address three separate potential receptor scenarios: the intended industrial use, the low-probability use of land by a resident farmer, and the potential dose to biota (vegetation and wildlife). Soil concentration limits (authorized limits) were developed to meet the requirements of DOE O 458.1. The soil concentration values were also derived to ensure that individual doses are less than 25 millirem/year. As such, associated activity concentration administrative limits for each nuclide have been constructed to maintain compliance with the dose limiting criteria of DOE O 458.1; these are provided in **Table 3-29**, "Administrative (Authorized) Activity Concentration Limits to Assure Compliance with DOE O 458.1." These values, as determined in the *Final Report on the Radiological Clearance of Land in the Southern 600 Area of the Hanford Site* (MSA 2015b), are the highest activity concentrations permissible for each radionuclide for maintaining associated dose compliance with the limits discussed above.

Table 3-29. Administrative (Authorized) Activity Concentration Limits to Assure Compliance with DOE O 458.1.

Nuclide	Administrative Limit (pCi/g soil)
Americium-241	1,400
Cobalt-60	11
Cesium-137	21
Plutonium-239/240	1,600
Strontium-90	23
Uranium-234	690
Uranium-235	200
Uranium-238	690

Key: pCi/g = picocuries (of radioactivity) per gram (of soil).
Source: MSA 2015b.

3.14.1.2 Chemical

Administrative and design controls are regularly implemented at the Hanford Site to reduce hazardous chemical releases to the environment and to help achieve compliance with permit requirements (e.g., air emission permits). Baseline studies are also regularly performed to estimate the highest existing onsite and offsite concentrations, as well as the highest concentrations to which nearby workforces and members of the public could potentially be exposed. Hazardous chemical concentrations routinely remain in compliance with applicable regulatory guidelines.

3.14.2 Environmental Consequences

3.14.2.1 No Action Alternative

Under the No Action Alternative, no associated changes to human health impacts would be expected compared to the baseline public health impacts that are regularly assessed and provided in the Hanford Site annual environmental reports. The estimated total annual dose to an MEI would be expected to remain within the range seen in recent years (approximately 0.1 to 0.2 millirem) from all Hanford Site and surrounding vicinity sources, with the likely location of this individual remaining at the PNNL Physical Sciences Facility along Horn Rapids Road. Similarly, as discussed in further detail in **Section 3.14.2.2**, the dose to a member of the public within the FSA, from any potential Hanford residual radioactive material, would be less than 1 millirem/year. This conclusion is supported by the results of recent soil sampling and the gamma scanning described in the *Final Report on the Radiological Clearance of Land in the Southern 600 Area of the Hanford Site* (MSA 2015b).

These determinations are further substantiated by the conclusions drawn in *Historical Site Assessment (HSA) – Hanford Southern 600 Area* (MSA 2015a), which projected that because the Hanford Site has long since ceased plutonium production activities, the primary sources for potential future airborne radioactivity at the southern 600 Area will be limited to: (1) remediation, or other activities such as construction and excavation; (2) the Columbia Generating Station, although as previously discussed, the potential source term would be low (both due to the facility's location [to the northeast]); and (3) low emissions from the nearby AREVA and Perma-Fix facilities (MSA 2015a).

3.14.2.2 Proposed Action

Radiological Clearance Survey

Under DOE O 458.1, in order for DOE lands to be transferred to the public domain for commercial development, a series of radiological clearance surveys must first be performed to measure the radiological conditions of such lands in order to determine whether they qualify for release to the public. The *Final Report on the Radiological Clearance of Land in the Southern 600 Area of the Hanford Site* (MSA 2015b) was prepared to comply with DOE O 458.1. Emphasis and evaluation was placed primarily upon the FSA. The survey process consisted of performing radiological measurements, analyzing the data in regards to the administrative limits, and drawing conclusions based on the results.

The clearance survey report (MSA 2015b), has four distinct components: soil sampling, gamma-scanning surveys, land feature surveys, and an as low as reasonably achievable (ALARA) assessment. A summary of the results for each component is provided below.

Soil Sampling. Overall, the soil sampling results indicated only a small fraction of the administrative limit (approximately 1 percent of the limit). A value of 1 percent is deemed equivalent to an estimated dose of 0.25 millirem/year (a value of “1” equates to the 25 millirem/year administrative limit). It is concluded that radionuclide concentrations in southern 600 Area soils (e.g., the FSA) are at or near natural background levels (MSA 2015b).

Gamma-Scanning Surveys. Six areas within the FSA were chosen to perform a direct gamma scan. The scans focused on the principal nuclides cesium-137, cobalt-60, americium-241, and protactinium-234m. Results of the direct gamma scans were near background and a small fraction of the authorized limits.

Land Feature Surveys. During site reconnaissance of the PA, many features were observed, such as old trash piles, holes in the ground, pipe protruding from the ground, buckets, and cans. Almost all of these features found within the three separate survey units were benign. Although none showed an obvious risk of potential radioactive contamination, a few were considered to have a higher contamination risk than others. In the interest of prudence, a set of 12 features was chosen for a confirmatory radiological survey using hand-held instruments and normal survey methods. The results showed no indication of man-made radioactivity in or on any of these land features (MSA 2015b).

ALARA Assessment. An ALARA assessment was made to determine if the clearance of land with current levels of potential contamination (however small) meets the ALARA principle. The assessment concluded that, since the radioactivity levels in the soil have been found to be at or near background levels, the radiological clearance of the land meets the ALARA principle (MSA 2015b).

Clearance Survey Summary

The clearance survey resulted in the following overarching conclusions:

- Man-made radioactivity levels in the soil in the three survey units are below 1 percent of the authorized limits.
- There are no elevated areas found from the gamma scans.
- There is little chance of any radioactivity above background on any artifacts or other land features found in the three survey units.
- The man-made radioactivity level in the soil in the three survey units is at or near background levels.
- The dose to an industrial worker on this land from Hanford residual radioactivity will be less than 1 millirem/year.

Other Potentially Contributing Sources

Potential dose contributions to members of the public (e.g., FSA industrial workers) may be exposed from non-Hanford sources (e.g., facility emissions). Non-Hanford-related potential sources of radiological exposure include the US Ecology commercial LLW disposal site; AREVA, a nuclear fuel fabrication plant; Perma-Fix, a commercial LLW treatment and a commercial decontamination facility, and Columbia Generating Station operated by Energy Northwest, a commercial nuclear power plant. The radiation dose to a member of the public on the FSA would not be expected to exceed 0.004 millirem per year from all but Energy Northwest (DOE 2012b). In addition, an individual would not be expected to incur a dose greater than 0.0054 millirem from operations at the nearby Columbia Generating Station. These contributory doses would remain well within the limits established in 40 CFR 61, Subpart H and DOE O 458.1.

Chemical

As stated in **Section 3.14.1.2**, administrative and design controls will continue to be regularly implemented at the Hanford Site to reduce hazardous chemical releases to the environment and to help achieve compliance with permit requirements (e.g., air emission permits). Baseline studies would continue to be regularly performed to estimate the highest existing onsite and offsite concentrations, as well as the highest concentrations to which nearby workforces and members of the public could potentially be exposed.

Accident Impacts

The following discussion provides a summary of the accident impacts described in more detail in **Appendix F**.

DOE evaluated its facilities to determine potential accident risks to the FSA. Buildings 324 and 325 were determined to be the facilities with the highest risk potential to the FSA. Buildings 324 and 325 are located approximately 600 meters east of the FSA, and both buildings contain radioactive material that could be released under certain accident scenarios.

Building 324, a three-story building that covers approximately 102,000 square feet, was used between 1965 and 1996 to support research and development activities associated with material and chemical processing. DOE has been preparing for the demolition of Building 324 by stabilizing and preparing for the removal of five highly contaminated hot cells. The cells were built to allow Hanford personnel to work with highly radioactive materials without being exposed to significant levels of radiation. The greatest level of contamination is beneath a two-story hot cell.

The bounding accident scenario evaluated for Building 324 is an elevated spill of contaminated powder in a hot cell (WCH 2014). This accident could only occur during future remediation of the Building 324. The building's structure and filtration system would reduce releases from the accident. Based on a series of conservative assumptions, the estimated dose from this accident at the eastern edge of the FSA (approximately 600 meters west of Building 324) is 0.18 rem (180 millirem). Factoring in the estimated frequency of a spill (0.1 per year), the dose equivalent risk associated with this accident is 0.018 rem per year (18 millirem per year). DOE expects that any actual exposure from the accident would result in a lower dose and risk.

Building 325, a two-story building that covers approximately 65,000 square feet, also known as the Radiochemical Processing Laboratory (RPL), was originally designed to provide space for radiochemical research to support Hanford projects and programs. Today, the RPL remains a fully operational facility of the PNNL where scientists and engineers conduct research related to national missions in environmental management, nuclear energy, nuclear nonproliferation, homeland-security, and science. RPL's underlying mission is to create and implement innovative processes in support of national priority areas. Some of the work taking place at the RPL involves advancements in the cleanup of radiological and hazardous wastes, processing and disposal of nuclear fuels, detection and forensics of nuclear material, and production and delivery of medical isotopes.

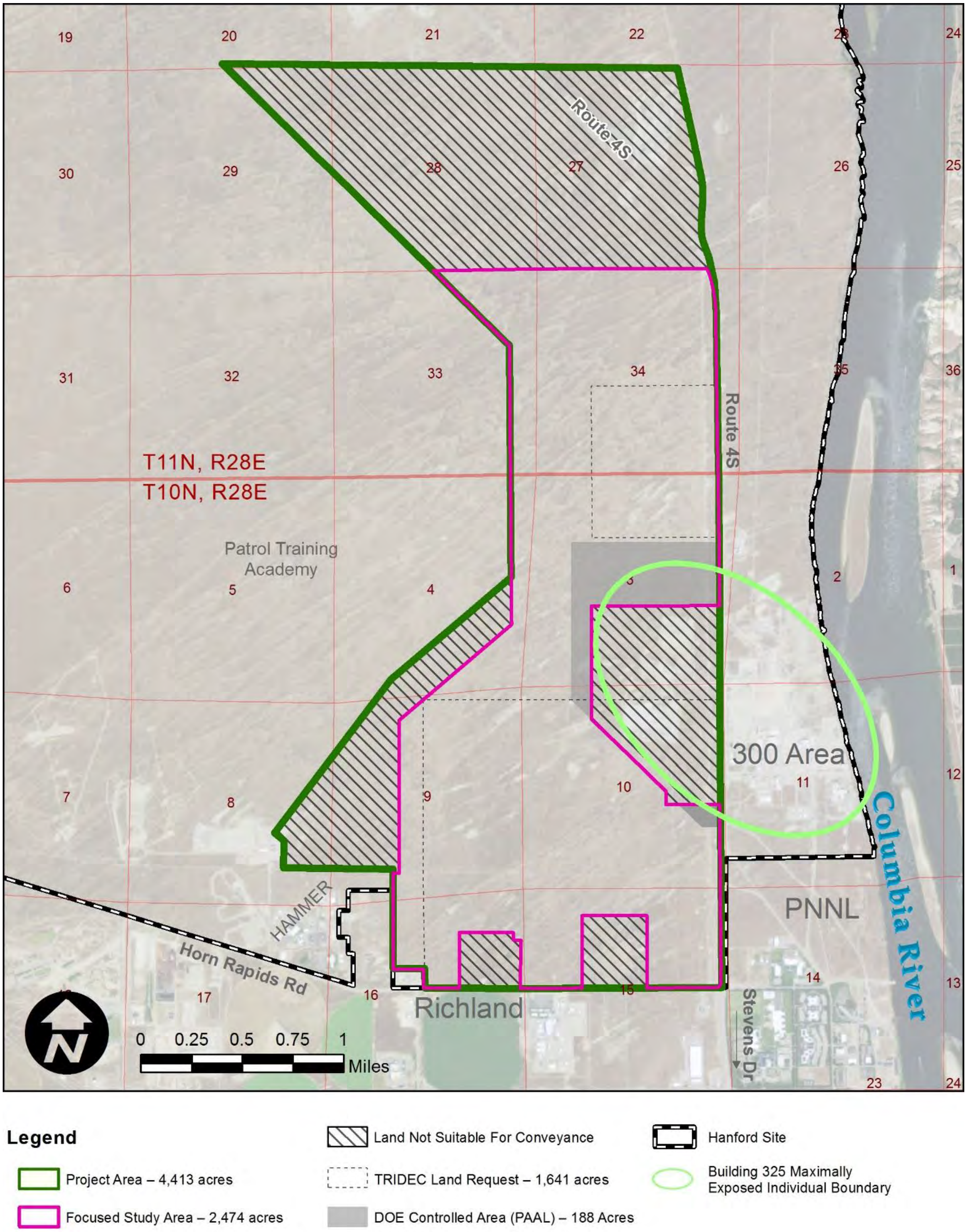
The bounding accident scenario for Building 325 is an unfiltered, ground-level seismic event, which, based on conservative assumptions, could result in an estimated dose near the eastern edge of the FSA (approximately 587 meters northwest of Building 325) of 11.1 rem (1,100 millirem). This has an estimated probability of 0.01 per year or lower, resulting in an annual dose equivalent risk of 0.11 rem (110 millirem) (PNNL 2014). DOE expects that actual exposure from the postulated accident would result in a lower dose and risk.

The analysis of this seismic event also identifies the area over which exposures could exceed 5 rem. A portion of this area overlaps the FSA and cannot be conveyed as unrestricted public access. As discussed in **Appendix F**, DOE would designate this portion of the land a controlled area and maintain it within the PAAL to ensure protection of the public. The subject controlled area would be comprised of a total of 188 acres (see **Figure 3-15**, "DOE-Controlled Area and the Maximally Exposed Individual Boundary").

A discussion of nominal latent cancer fatality (LCF) probabilities for postulated accidents at the Buildings 324 and 325 is presented in **Appendix F** at **Section F.3**. The LCF probabilities assume location of an individual in the DOE-controlled area, which would not be transferred from federal ownership. The calculated LCFs range from 1.1×10^{-4} to 6.7×10^{-3} for the various postulated accidents considered. The LCF probabilities for individuals within the FSA would be smaller due to distance from the Buildings 324 and 325, increased atmospheric dispersion of any release, and application of emergency response procedures such as evacuation or shelter in place. See **Appendix F** at **Section F.3** for more details.

As the accident doses are within the DOE-controlled areas and meet applicable nuclear safety protocols, no explicit calculation of potential dose was calculated spanning across the FSA. However, calculated doses from both 324 and 325 Buildings will diminish across the FSA due to atmospheric dispersion.

Figure 3-15. DOE-Controlled Area and the Maximally Exposed Individual Boundary.



3.14.3 Emergency Preparedness

As required by law, DOE orders and policies, Hanford has established a comprehensive emergency management program that provides detailed, hazard-specific planning and preparedness measures to protect worker and public health and safety, and the environment in the event of an emergency at the Hanford Site. Following implementation of the proposed action to transfer FSA lands to TRIDEC, DOE and the local and state agencies responsible for performing the function of emergency management would apply the same emergency planning and response actions to members of the public in the transferred lands as applied to the population at large.

DOE maintains the *Hanford Emergency Management Plan* (HEMP; DOE 2010), which addresses the full scope of emergencies that may occur at the Hanford Site. These potential emergencies include building and range fires, earthquakes, accidental releases of radiological and toxicological materials from Hanford contractor-operated facilities and transportation incidents, and other external events.

Predetermined protective actions are developed in accordance with the HEMP (DOE 2010). Protective actions are taken to preclude or reduce the exposure of individuals following an accidental release at the Hanford Site. Emergencies at site facilities may require actions only on the Hanford Site or may also affect offsite areas. Emergency Planning Zones (EPZ) are designated areas, based on hazards assessments, in which predetermined protective actions may be required. DOE develops EPZs, as determined necessary by hazard assessments, and submits them to affected states and counties for their use in emergency planning.

The predetermined protective actions include the following:

- Methods for providing timely protective action recommendations, such as sheltering, evacuation, and relocation, to appropriate offsite agencies
- Plans for timely sheltering and/or evacuation
- Methods for controlling access to contaminated areas and for decontaminating personnel or equipment exiting the area
- Protective action criteria prepared in accordance with DOE-approved guidance applicable to actual or potential releases of hazardous materials to the environment for use in protective action decision making.

Evacuation routes for the Hanford Site are provided in the HEMP (DOE 2010). Specific routes are determined at the time of an event based on event magnitude, location, and meteorological conditions.

DOE and adjacent counties have predetermined initial offsite protective action recommendations for the members of the public. These initial, preplanned protective action recommendations, as indicated by the event classification and location, are included on the initial notification of offsite agencies. The determination of need for additional protective action recommendations are based on consequence assessments.

DOE maintains the Hanford emergency plan and implementing procedures in coordination with state and local authorities. DOE also provides technical assistance to other federal agencies and to state and local governments. Hanford contractors are responsible for maintaining emergency plans and response procedures for all facilities, operations, and activities under their jurisdiction and for implementing those plans and procedures during emergencies. The DOE, DOE contractors, state, and local government plans are fully coordinated and integrated. Emergency control centers have been established by DOE, local, and state authorities to allow for proper response to emergency conditions.

3.14.4 Potential Mitigation Measures

Based on the description of the impacts associated with the Human Health and Safety resource area, no mitigation measures are required.

3.14.5 Unavoidable Adverse Impacts

No unavoidable adverse impacts would be expected from the proposed conveyance of land at the Hanford Site in regard to human health. Radiological dose consequences from accidents (Buildings 324 and 325) are determined to have minimal potential accident risks to the FSA. These facilities are located approximately 600 meters to the east of the FSA. The dose consequences within the FSA would not require any unique mitigation measures to ensure the adequate protection of the public health, safety, and environment.

3.15 Summary of Environmental Consequences

This is a summary of the environmental consequences of the Proposed Action of transferring approximately 1,641 acres of land to TRIDEC and constructing and operating the representative facilities, a single solar technology, and potentially providing utility corridor access through the PAAL. Construction and operation of the representative facilities were evaluated on the main FSA, but only about 1,341 acres would be transferred to TRIDEC and potentially have facilities on them. The 294 acres of the main FSA that are not transferred would stay undeveloped. Both solar technologies were evaluated on the entire solar farm FSA, but just one technology would be built. It was assumed that about 10 percent of the PAAL would be used for utility corridors and associated maintenance roads. DOE would retain ownership of the PAAL and convey lands if needed for utility corridors. The approximately 485 acres of the PAAL that are not conveyed would stay undeveloped.

Important assumptions for construction and operation are listed at the beginning of this chapter along with the common No Action Alternative impacts. Environmental consequences of the Proposed Action are addressed separately for the 14 resource areas, not in any priority order.

Table 3-30, “Summary of Environmental Consequences,” provides a resource-by-resource summary of environmental consequences that are common to all representative facilities and locations, unique to certain representative facilities or locations, the PV solar technology, the solar CSP dish technology, and utilities and infrastructure on the PAAL.

Table 3-30. Summary of Environmental Consequences.

	No Action Alternative	Proposed Action[1]
Resource Area		Main FSA (1,635 acres), Solar FSA (300 acres) and PAAL (539 acres) = FSA (2,474 acres)
Geology	Mining at the borrow pits would continue. Impacts to geology or soils from the Proposed Action would not occur.	Construction Site clearing, grading, and contouring would alter the topography in the areas developed. Soil compaction would reduce permeability and porosity. Operations No impacts after construction
Water Resources	Surface water does not exist on the project area (PA). Groundwater is not used or affected by activities on the PA. Existing groundwater monitoring (via wells) would continue. Impacts to water from the Proposed Action would not occur.	Construction Construction activities on the FSA would expose soil to wind and precipitation resulting in potential erosion and sedimentation from stormwater runoff. An NPDES permit would be required. Operations Development would create large areas of impervious surface (e.g., buildings and pavement) resulting in stormwater runoff. Development plans would likely include stormwater retention/detention ponds to manage the quantity and quality of stormwater per state regulations. For the solar FSA, less impervious surfaces would be created than for the main FSA. Water used to wash solar dishes and panels could introduce water to the vadose zone. Permits may be required depending on the amount of water and whether it is contained or discharged.
Air Quality	Fugitive dust and GHG emissions from mining at the borrow pits would continue. Impacts to air quality from the Proposed Action would not occur.	Construction Construction activities on the FSA would result in temporary effects by generating criteria pollutants, fugitive dust, and GHG air emissions from operation of mobile construction equipment and excavation activities. Facilities with a larger footprint would have a greater impact than a smaller facility. Operations Operation of all representative facilities would generate criteria pollutants and GHG emissions from operation of stationary and mobile equipment. Operations on the solar farm FSA would generate small amounts of fugitive dust and GHG emissions during maintenance activities.
Ecological Resources	Existing shrub-steppe habitat in one of the largest remaining shrub-steppe areas in the ecoregion would remain. Wildlife species would continue to use the area, and new species may move into the area if native vegetation communities continue to recover from past disturbance. Impacts to ecological resources from the Proposed Action would not occur.	Construction Construction on the FSA would remove vegetation and existing habitat. Wildlife would be disturbed by noise, lighting, and human activity. Wildlife with adequate mobility would leave the area and seek replacement habitat which may or may not be available. Forced displacement may result in mortality. Shrub-steppe habitat loss may place further pressure on populations of some species that are already experiencing habitat loss in other parts of their range. Operations Wildlife would be subject to continued disturbances such as noise, traffic and lighting, and mortality from vehicle collisions could occur. Facilities, infrastructure, and roads would fragment habitat and impair movement through the area for some species. Facilities with nighttime operations would disturb nocturnal wildlife.
Wetlands and Floodplains	There are no wetlands or floodplains on the PA or within close proximity.	N/A

Table 3-30. Summary of Environmental Consequences *(continued)*

	No Action Alternative	**Proposed Action**[1]
Resource Area		Main FSA (1,635 acres), Solar FSA (300 acres) and PAAL (539 acres) = FSA (2,474 acres)
Cultural Resources	Cultural resources would remain in federal ownership. Impacts to cultural resources from the Proposed Action would not occur.	Construction Development and land-disturbing activities on the FSA such as removal of vegetation, surface soil, natural and manmade surface features, and any associated objects and materials may result in the destruction of archeological sites and may affect other cultural resources in the PA. Cultural resources may also be affected by construction noise, vibration, artificial light, and odors. Removal of vegetation would result in loss of traditional plant species. Impacts to the Hanford Site Plant Railroad and the Richland Irrigation Canal are being addressed as part of the NHPA Section 106 process. Operations Buildings, traffic, sound, light, and odors that differ from the pre-existing ambient condition have the potential to impact cultural resources. The Visual Resources section includes an analysis of the effect on views to some locations identified as being of importance in the tribal summaries.
Land Use	Ongoing uses such as mining, Navy Storage Area and Load Test facility, and well monitoring would continue. Impacts to land use from the Proposed Action would not occur.	Construction The main and solar FSA land use would change from essentially undeveloped to industrial. Operations Development would be consistent with local comprehensive land use plans, zoning, and ordinances. Development would foreclose opportunities for these lands to be considered for other future uses.
Visual Resources	The natural landscape would continue to dominate. Impacts to visual resources from the Proposed Action would not occur.	Construction During construction in the FSA, equipment and activities would be visible, but visibility would diminish the farther a viewer is from the construction sites. Operations Development in the FSA of primarily undeveloped area would change the visual environment and result in a change in the visual resource classification of the conveyed lands, as the buildings and infrastructure would become a primary focus for viewers. Development in the main FSA would be consistent with existing development to the east and south. To the north and west the adjacent land is primarily undeveloped and would change the visual environment. Views to some locations identified as being of importance in the tribal summaries (Gable Mountain, Rattlesnake Mountain, Saddle Mountain) would not change to any extent as objects would not be readily discernable because of the distance. Operation of a concentrating solar power (CSP) solar farm may result in the generation of glint and glare, which could temporarily blind pilots and crew due to their low altitude and slow or hovering speed while training at HAMMER and RETC. Glint and glare would diminish the farther a viewer is from the sites.

Table 3-30. Summary of Environmental Consequences *(continued)*

	No Action Alternative	**Proposed Action[1]**
Resource Area		Main FSA (1,635 acres), Solar FSA (300 acres) and PAAL (539 acres) = FSA (2,474 acres)
Noise, Vibration and EMF	*Continued development in the area surrounding the PA would result in new sources of vibration and noise, and possibly EMF from new substations. Impacts to noise, vibration, and EMF from the Proposed Action would not occur.*	Construction Construction activities in the FSA such as the use of heavy equipment, pile drivers, compressors, generators, pumps, and haul trucks would result in temporary, minor changes to the ambient environment for acoustic noise and vibration. Distance from the developed areas would have a dampening effect on noise and vibration impacts. Generation of EMF from construction activities can include mobile generators, misfiring combustion engines, and temporary electrical connections. Resulting EMF levels are low, infrequent, and not of long duration. The level and intensity of noise, vibration and EMF would vary depending on factors such as the type of construction activity, timing, and location. Construction closer to Stevens Drive and Horn Rapids Road would have greater potential for vibration and noise to affect PNNL's sensitive facilities. Similarly, construction in the northwest part of the FSA, closer to LIGO, would have a greater likelihood of disturbance to its operations. Operations Certain industrial facilities, such as the rail distribution center, would generate the most noise and vibration, including from truck traffic. The biofuels manufacturing facility would also generate higher levels of noise and vibration from heavy equipment moving waste, shredding materials, and other activities. The degree of effect to PNNL and LIGO would be related to the proximity of the vibration source. EMF would be generated by electrical substations or magnetic induction furnaces and may need to be shielded or require other mitigation. Solar farms would generate little noise or vibration. Solar farm inverters, transformers, electrical substations, and power lines would generate EMF. Resulting EMF levels are not expected to affect the PNNL sensitive receptors due to the distance between PNNL and the solar FSA.
Utilities and Infrastructure	Additional demand for utilities and infrastructure from the Proposed Action would not occur.	Construction See the individual resource topics for discussion of anticipated environmental impacts from construction, including utilities and infrastructure. Operations The Proposed Action would result in new, long-term demand for utility services. New infrastructure and services would be provided and maintained by the City of Richland, BPA, and Cascade Natural Gas, as applicable. A solar farm would have little requirement for sewer, natural gas, and waste utilities but would require 8.8 million gallons/year of water to wash panels for a PV technology and 176,000/year for a CSP solar farm. Estimated utility usage by representative facility is shown in Table 3-15. The food/agriculture and biofuels manufacturing facilities would likely use more electricity and water than the other facilities. Estimated utility usage for solar facilities is shown in Table 3-16. See the individual resource topics for discussion of anticipated impacts from operation, including utilities and infrastructure.

Table 3-30. Summary of Environmental Consequences *(continued)*

	No Action Alternative	Proposed Action[1]
Resource Area		Main FSA (1,635 acres), Solar FSA (300 acres) and PAAL (539 acres) = FSA (2,474 acres)
Transportation	Impacts to transportation from the Proposed Action would not occur.	<u>Construction</u> Construction activities in the FSA would result in increased car and truck traffic on Horn Rapids Road, Stevens Drive, and other surrounding roadways, which could result in temporary disruptions or increases in traffic from activities such as delivery of material and equipment, and construction workers commuting to and from work areas. The number of construction workers for each representative facility would vary depending on the size and scope, phase of development, and other factors. <u>Operations</u> Industrial development in the FSA would generate a new load on primary transportation roadways such as Stevens Drive and Horn Rapids Road. Increased traffic would likely affect operations on those and other roadways, including congestion and delays at intersections (reduced level of service) and safety issues related to congestion. The rail-based facility would increase traffic on the regional rail line and potentially contribute to additional vehicle delays at the Horn Rapids Road crossing. A solar farm would not result in a noticeable increase in commuter traffic.
Waste Management	Impacts to waste management from the Proposed Action would not occur.	<u>Construction</u> Solid non-hazardous waste generated during construction in the FSA, such as packaging material, scrap material, concrete rubble, and land-clearing debris would likely be recycled or transported to the Horn Rapids Sanitary Landfill for disposal. <u>Operations</u> Operation of all of the representative facilities would produce solid and liquid waste typical of other industrial, research, and office park operations in the region. Generated solid waste would likely represent about 15 percent of the current disposal rate at the landfill. Waste generation from operation of a solar farm is expected to be minimal.
Socioeconomics and Environmental Justice (EJ)	Impacts to socioeconomics and EJ from the Proposed Action would not occur.	<u>Construction</u> Single-phase development would employ approximately 150 to 350 workers over an 18-month period. Multi-phased development would likely employ fewer workers but for a longer period of time. Construction would contribute to the economy through construction-related and employee spending on regional goods and services for the main and solar FSAs. More construction workers would be required for the PV solar farm (166 workers) than the solar dish solar farm (25 to 134 workers). <u>Operations</u> Estimated to result in ~2,530 new jobs for the single phase and ~50 to 1,500 new jobs for the multi-phase, increasing the annual per capita income and the local tax base of the Tri-Cities area. Development would likely contribute to the economy through increased business and employee spending on regional goods and services. Housing and services are adequate to accommodate employment influxes. Six or seven new jobs would be created for operation of a solar farm. The Proposed Action would not result in disproportionately high and adverse effects on minority or low-income populations.

Table 3-30. Summary of Environmental Consequences *(continued)*

	No Action Alternative	**Proposed Action**[1]
Resource Area		Main FSA (1,635 acres), Solar FSA (300 acres) and PAAL (539 acres) = FSA (2,474 acres)
Human Health and Safety	No associated changes to human health impacts would be expected compared to the baseline public health impacts that are regularly assessed and provided in the Hanford Site annual environmental reports. Estimated total annual dose to an MEI would be expected to remain within the range seen in recent years (~ 0.1 to 0.2 millirem) from all Hanford Site and surrounding vicinity sources. Similarly, the dose to a member of the public within the FSA, from any potential Hanford residual radioactive material, would be less than 1 millirem/year. Impacts to human health and safety from the Proposed Action would not occur.	Construction and Operation Any localized residual sources and other Hanford-area facility emission sources would be expected to result in a total annual dose of less than 1 mrem within the FSA. Radiological dose consequences from accident for facility (Buildings 324 and 325) were calculated and dose consequences within the FSA would not require any unique mitigation measures to ensure adequate protection of public health, safety, and environment.

4.0 CUMULATIVE EFFECTS

Past, present, and reasonably foreseeable future actions that occur within the region of influence (ROI) that is defined in each resource area may contribute to cumulative impacts. Examples of past U.S. Department of Energy (DOE) activities include operation of the fuel fabrication plants, production reactors, Plutonium-Uranium Extraction Plant, other fuel reprocessing facilities, Plutonium Finishing Plant, and research facilities, as well as waste treatment and disposal activities. Current DOE activities include environmental cleanup, waste disposal, tank waste stabilization, and construction of the Waste Treatment and Immobilization Plant in the 200 East Area, laboratory operations in the 300 Area and on the Pacific Northwest National Laboratory (PNNL) Site, and management of portions of the Hanford Reach National Monument. The Bonneville Power Administration (a part of DOE) operates and maintains five electrical substations and electrical transmission lines across the Hanford Site. Non-DOE activities at Hanford include the following:

- U.S. Navy shipment of reactor compartments on Stevens Drive for transport to Burial Ground 218-E-12B Trench 94 in the 200 East Area, and operation of the Navy Storage Area and Load Test (SALT) Facility
- Energy Northwest operation of the Columbia Generating Station
- US Ecology, Inc. operation of the commercial low-level radioactive waste (LLW) disposal site
- U.S. Fish and Wildlife Service management of portions of the Hanford Reach National Monument
- Laser Interferometer Gravitational-Wave Observatory (LIGO).

Past, present, and reasonably foreseeable future actions at the Hanford Site and in and around Benton County that occur in the ROIs considered in this analysis may also contribute to cumulative impacts; examples of such offsite activities include clearing land for urban development, waste management, industrial and commercial development, mining, and power generation. Activities at the Hanford Site and in the region surrounding the Hanford Site could include the following (DOE 2012b):

- Future regional land use as described in local city and county comprehensive land use plans
- Cleanup of toxic, hazardous, and dangerous waste disposal sites
- Columbia River and Yakima River water management
- Electric power generation and transmission line projects
- Transportation projects
- Future construction and operation of additional facilities and associated infrastructure on the PNNL Site and the rest of the Tri-Cities Research District
- Establishment of the Manhattan Project National Historical Park (Public Law 113-291)
- Build out of the 750-acre Horn Rapids Industrial Park including the 313,000 square-foot, 10-story Preferred Freezer Services Facility currently under construction (Foster 2014)
- Development of a 128-acre parcel on the northeast side of the Horn Rapids Industrial Park for a gravel mine (Beaver 2015) by American Rock Products.

4.1 Potential Cumulative Impacts

For each resource analyzed in **Chapter 3.0**, this cumulative impacts analysis identifies (1) the ROI; (2) the potential incremental impacts associated with the Proposed Action; (3) the potential impacts of past, present, and reasonably foreseeable future actions that may contribute to cumulative impacts within the ROI; and (4) the potential cumulative impacts of the Proposed Action with past, present, and reasonably foreseeable future actions. The affected environment is described in **Chapter 3.0** and defines the environmental baseline considered for this cumulative impacts analysis. Thus, the environmental baseline already reflects past actions that have affected a resource area.

4.1.1 Geology

The ROI for geologic resources includes the Project Area (PA) and immediately adjacent lands.

There are no active landfills, mines, or other special use areas at the Hanford Site within the PA except for two gravel pits (6 and 9), and the SALT Facility in Constrained Area 2 (see **Appendix A**, "Hanford Site Land Suitability Review"). There are other gravel pits on the Hanford Site (Pits F, H, N, 18, 21, 23, 24, 30, and 34) that are described in this EA for *Expansion of Borrow Areas on the Hanford Site* (DOE 2012d). Gravel from the DOE gravel pits are used for Hanford Site projects. The Proposed Action would require sand and gravel and result in an incremental addition to the use of geologic mineral resources but the material would come from four existing commercial sand and gravel quarries in the Tri-Cities area with one at the southern end of the Horn Rapids Industrial Park. All are owned and operated by American Rock Products that recently purchased 128 acres of land from the Port of Benton for a new gravel mine across Stevens Drive from PNNL. The Tri-Cities area has abundant sand and gravel, and although there would be a cumulative effect on these mineral resources above the existing condition, the incremental effect of the Proposed Action is minor.

At Hanford, projected cumulative impacts on geologic resources mainly reflect demands for sitewide cleanup and closure actions and facility decontamination and decommissioning (D&D). Future closure actions, including cleanup and restoration of closed disposal facilities and final capping of closed disposal facilities or facilities that have undergone D&D, but contain residual waste, represent the largest activity demands for geologic resources (DOE 2012b). DOE has analyzed expansion of borrow areas on the Hanford Site for sitewide cleanup, closure, and D&D operations (DOE 2012c). The closest location on the Hanford Site where soil remediation activities are ongoing is at the 618-10 Burial Ground (see **Appendix A**).

Implementation of the *Hanford Reach National Monument, Comprehensive Conservation Plan and Environmental Impact Statement* (USFWS 2008) would entail construction and maintenance of new facilities and other improvements such as interpretive sites, parking and boat access areas, trails, and a possible visitor center. These proposed activities would require geologic resources. However, these needs, as well as the ongoing demand for maintenance of existing assets, are not known at this time (DOE 2012b).

As discussed in **Section 3.1.1.2**, the Proposed Action's incremental impact on soils and topography would be temporary disturbance of soils on approximately 1,641 acres and long-term disturbance on a smaller acreage related to a facility's actual footprint, parking areas, and roads. Site development effects include soil removal, soil erosion, and loss of soil productivity through soil compaction, and mixing of soil horizons. Successful revegetation is expected following construction on the land not covered by buildings, parking areas, and roads. To provide protection and restoration of topsoil, it is assumed future landowners would implement best management practices during site development in accordance with local and state regulations.

After construction when the facilities are operating, no additional incremental impacts are expected to geologic and soil resources on the main Focused Study Area (FSA). Some long-term impacts to soil would continue on the solar farm FSA from maintenance of unimproved roads between the rows of solar arrays or concentrating solar power dishes.

4.1.2 Water Resources

The ROI for water resources includes the PA and the immediately adjacent offsite land. This section addresses the potential cumulative impacts of past, present, and reasonably foreseeable future actions on water resources, including surface water, vadose zone, and the groundwater system.

The cessation of liquid waste discharges to ponds, ditches, and cribs in the early 1990s at Hanford has a beneficial impact on groundwater quality. This has slowed the migration of contaminants through the vadose zone and into the groundwater and eliminated a large source of artificial recharges with resultant declines in groundwater mounds beneath the waste sites and adjacent areas. The Hanford environmental baseline already reflects past DOE and non-DOE actions that have affected existing surface waters, such as alteration of Columbia River hydrology from past construction of dams, as well as historical contaminant releases from DOE or other facilities that have affected surface water and groundwater quality.

Other projects at Hanford include future cleanup and facility disposition activities, and D&D actions. Ongoing and future actions to clean up the Central Plateau, as well as individual facility D&D actions, are not expected to affect water resources. This is because, other than the Columbia River, surface water resources are not present at Hanford; surface-water drainage patterns are poorly developed to convey potentially contaminated stormwater or other effluents; the depth to groundwater across much of the site is such that any effluents would be unlikely to affect groundwater; and the most intensive cleanup and D&D activities (on the Central Plateau) are some distance from the Columbia River.

Future non-DOE activities near Hanford, for example, new industries, agriculture, residential development, new road construction, and other infrastructure improvements are likely to be the larger contributors to cumulative impacts on surface water and groundwater over the timeframe considered in this analysis. Water use by communities that utilize the Columbia River as a water source is expected to rise commensurate with land use development and general population increases in the region, and contemplated actions at Hanford (e.g., closure of facilities) would reduce the overall cumulative impact on surface water and groundwater availability and quality (DOE 2012b).

As discussed in **Section 3.2**, construction of the representative facilities would involve land disturbance, which would increase the potential for soil erosion and increased stormwater runoff. There are no perennial sources of surface water on the PA, but ponding likely occurs during heavy rainfall events. Construction activities could result in soil removal, compaction, reduced porosity, and decreased infiltration rates. Stormwater runoff, however, would be minimized by the relatively high porosity of the undisturbed surrounding sandy soils along with high evaporation and plant transpiration rates in the shrub-steppe semiarid desert climate that is characteristic of the area. Because of distance and topography, it is unlikely that stormwater would carry sediments or other potential contaminants away from the construction areas and to the Yakima or Columbia rivers. To prevent disturbance to area hydrologic conditions that might affect transport of existing contaminants in the groundwater, groundwater wells would not be permitted, and would be restricted through deed or other realty instrument language. The Proposed Action is not expected to contribute cumulative impact on surface water or groundwater.

4.1.3 Air Quality

ROI for air quality includes the PA and surrounding urban and rural environments.

DOE activities at Hanford in the 200 Area would generate fugitive dust emissions and equipment emissions from various borrow area and construction sites; dust and equipment emissions from ongoing construction and operation of the Environmental Restoration Disposal Facility (ERDF); emissions from canyon disposition (221-U B-Plant or PUREX closure); emissions from facility demolition and remediation, including excavation, backfill, and capping; and emissions from above-grade structure removal of the Plutonium Finishing Plant (see **Figure 3-3**). In the 300 Area, there would be fugitive dust emissions and other emissions from closure and future uses of surplus facilities (DOE 2012b).

Existing and reasonably foreseeable non-DOE activities that would emit fugitive dust and other pollutants include commercial operations on Horn Rapids Road such as AREVA facility operation, which would have nitrogen oxide emissions; Perma-Fix non-thermal and thermal treatment of mixed LLW, which could have some combustion emissions; and Hazardous Materials Management and Emergency Response (HAMMER) activities, which would have negligible emissions, except for vehicular emissions. The operation of the US Ecology commercial LLW disposal site located near the center of the Hanford Site would have fugitive dust emissions (DOE 2012b).

The Wanapa Energy Center, if built by the Confederated Tribes of the Umatilla Indian Reservation, could be a major source of air pollutant emissions, but would not significantly deteriorate the quality of the air surrounding the proposed site or lead to deterioration of air quality in nearby areas (DOE 2012c). The Wanapa Energy Center would be located on about 20 acres of land east of the city of Umatilla, along the Columbia River. The Plymouth Generating Facility, if built by Plymouth Energy, LLC, would not significantly deteriorate the quality of the air surrounding the proposed site based on the analysis in the *Final Environmental Impact Statement, Plymouth Generating Facility, Plymouth, Washington* (Benton County and BPA 2003). The Plymouth Generating Facility would be located on a 44.5-acre site, 2 miles west of the rural community of Plymouth in southern Benton County. The Wanapa Energy Center and Plymouth Generating Facility projects are currently on hold by the project proponents (DOE 2012b).

Mobile source emissions in Benton County account for about 68 percent of county annual emissions of carbon monoxide, 52 percent of nitrogen oxides, 69 percent of sulfur oxides, and 39 percent of volatile organic compounds (DOE 2012b). In addition to the industrial sources of air pollutants discussed above, there are industries that produce asphalt paving material and block, nitrogen fertilizer, crushed stone, canned fruits and vegetables, frozen foods, and nonferrous metal sheet, as well as grain storage facilities and natural gas transmission facilities (DOE 2012b).

Other development in the region could result in increases in air pollutant emissions from construction activities, vehicle traffic, and other sources related to new housing, businesses, and industries in the Tri-Cities area. In addition, increased mining activity and reclamation of mined areas could lead to increases in air pollutant emissions.

4.1.3.1 Emissions of Greenhouse Gases

Greenhouse gas emissions in the Hanford Site region include carbon dioxide from multiple sources, including the burning of natural gas and fuel oil for home and commercial heating and the use of gasoline and diesel fuel to power automobiles, trucks, construction equipment, and other vehicles. Generation of electricity also results in carbon dioxide emissions in parts of Washington State. In the region near Hanford, most of the electricity (97 percent) is supplied by a combination of hydroelectric dams, nuclear power plants, and wind turbines (DOE 2012b). These types of power production generate little carbon dioxide. The state has implemented regulations to mitigate emissions of carbon dioxide from certain fossil-fueled, thermal-electricity-generating facilities larger than the station-generating capability of 25 megawatts of electricity. Recently adopted amendments to these regulations are intended to establish goals for statewide reduction of greenhouse gas emissions and immediately reduce greenhouse gas emissions from electric power generation. Participation of Washington State in the Western Climate Initiative's proposed Cap-and-Trade Program may also result in a reduction in greenhouse gas emissions (DOE 2012b).

There also are emissions of chlorofluorocarbons and hydrofluorocarbons, which are used locally in the Hanford region in refrigeration and air conditioning units at residential, commercial, industrial, and government facilities. Opportunities for reductions in greenhouse gas emissions at Hanford have been pursued, including the reduction and phase-out of chlorofluorocarbon use and the reduction of carbon dioxide emissions and other trace gases through energy conservation. Other potential mitigation technologies that are currently available and could be applicable at Hanford include alternative fuels and renewable heat and power sources, carbon capture and storage, fuel-efficient vehicles, cleaner diesel vehicles, hybrid vehicles, biofuels, efficient lighting and daylighting, more-efficient electrical equipment, improved insulation, passive and active solar design for heating and cooling, and use of alternative refrigeration fluids (DOE 2012b).

During construction of the representative facilities, the Proposed Action would generate fugitive dust (airborne particulate matter generated from a source other than a stack or chimney), and fossil-fueled construction equipment.

Air emissions from the Proposed Action construction activities are described in **Section 3.3**. Because of the uncertainties in knowing which facilities would be constructed at a particular location, emissions for nitrogen oxides, carbon monoxide, and particulate matter were calculated as though they were generated by a single "prevention of significant deterioration" major source. When constructed, emissions would be generated and be permitted by each of the independent commercial sites. Calculations show that if all emissions were from a single source, they would slightly exceed their prevention of significant deterioration thresholds, but as individual permittees, they would not. There are no regulatory significance thresholds for stationary or mobile source air emissions in air quality attainment areas like this. None of the criteria pollutant emissions would exceed the 250-ton-per-year significance threshold. Collective emissions from all the facilities for carbon dioxide would minimally exceed the 100,000-metric tons-per-year significance threshold and lead to an incremental impact. Based on this information, operation of the facilities would contribute emissions in the ROI, the amount of which depends on the type, size, and number of industries.

4.1.4 Ecological Resources

The ROI for ecological resources includes the PA and the adjacent Hanford Site lands.

Studies have estimated that 15 million acres of shrub-steppe habitat (60 percent of the landscape) existed in eastern Washington before land conversion began with the arrival of settlers. Recent studies have estimated that only about 30 percent of the landscape now consists of this habitat type. Thus, there has been a 50 percent decrease in the historical occurrence of shrub-steppe habitat in eastern Washington since the 1840s (DOE 2012a). The Hanford Site represents one of the largest remaining blocks of relatively undisturbed shrub-steppe habitat in the Columbia Basin ecoregion (DOE 2012c; Poston et al. 2009).

As described in **Section 3.4**, existing habitat within the PA has been disturbed in the past and is currently subject to disturbance from human activities. Electrical transmission power lines, roads, gravel pit quarries, train tracks, a firing range buffer zone, the SALT Facility, and an inactive asbestos disposal landfill are present within the PA (see **Appendix A**). Much of the area was burned by wildfire in 1984 and 2000 (PNNL 2011) and affected by other smaller fires before and after those years. The majority of the PA has also been sprayed with herbicide to control weedy species in 2003, 2004, and 2006 (see **Appendix I**, "Salstrom and Easterly, Vegetation Survey of the Proposed Land Conveyance, Central Hanford, Washington"). The entire PA consists of upland habitat, and consequently species diversity is lower compared to the riparian areas alongside the Columbia River to the east. None of the threatened, endangered, or candidate species listed for the county are documented to occur within the FSA or PA (WDFW 2013; see **Appendix H**, "Wildlife Survey").

As discussed in **Section 3.4.2**, the Proposed Action would result in disturbance and loss of existing vegetation communities and wildlife habitat on approximately 1,641 acres of land. Construction of the representative facilities would permanently convert much of the acreage from undeveloped land to large areas of pavement, buildings, and associated infrastructure. Operation of the facilities would result in disturbance from noise, traffic, lighting, and human activity. Many existing wildlife species currently using the lands would be displaced to adjacent areas and be subject to competition from same or other species that occupy the adjacent habitat. Some individual animals would not survive; however, effects at a population level from the Proposed Action are not likely. Habitat loss from the Proposed Action makes up less than one percent of surrounding Hanford Site lands, including the Hanford Reach National Monument. Impacts to ecological resources from the Proposed Action would represent an additive adverse impact to similar impacts occurring from regional development activities such as transportation and transmission line projects and conversion of undeveloped land for industrial and residential purposes.

4.1.5 Wetlands and Floodplains

For floodplains and wetlands, the ROI includes the PA and the adjacent lands. Because the ROI does not contain any floodplains or wetlands (see **Section 3.5.2**), the Proposed Action would not contribute to cumulative impacts on floodplains and wetlands in the ROI.

4.1.6 Cultural Resources

For cultural resources, the ROI for cumulative effects includes the PA and adjacent lands, which is a larger area than the Area of Potential Effect.

The protection and preservation of cultural resources is governed by a number of federal laws, statutes, and executive orders. Cultural resource protection for lands in DOE ownership is governed by the *Hanford Cultural Resources Management Plan* (DOE 2003b). Once transferred, Washington regulations (RCW 27.53 and others) would provide for protection of archeological sites.

In this EA, **Section 3.6.1.2** describes the process used for identifying cultural resources and historic properties including archival research, literature research, and field investigations. DOE funded four tribes – the Confederated Tribes of the Umatilla Indian Reservation, Confederated Tribes and Bands of the Yakama Nation, the Nez Perce Tribe, and the Wanapum to provide traditional cultural property studies – the summaries of which are included in **Appendix G**. The tribal summaries contain information about areas of religious and cultural significance to the tribes. With few exceptions, specific locations were not identified in the tribal summaries. These exceptions include three properties that DOE had previously determined to be eligible for listing in the NRHP. The tribal summaries described potential effects that would occur from the Proposed Action to these three properties: Laliik, Wanawish, and Gable Mountain. All three properties are outside of the FSA and this EA describes effects to these properties in **Section 3.8**. The tribal summaries also contain information about other named and unnamed places and traditional resources (e.g., plants) of importance to the tribes. Additional information about areas of importance has been provided, and DOE is continuing to consult with tribes and will consider the information it receives. DOE will continue the NHPA process until complete.

NRHP-eligible properties discussed in this EA are the Hanford Site Plant Railroad, the Richland Irrigation Canal, and a historic homestead.

- The Hanford Site Plant Railroad was previously identified and determined eligible. Mitigation measures were completed in compliance with the Hanford Built Environment Programmatic Agreement (DOE 1996a) and included a Historic Property Inventory Form and documentation in the Hanford Site Manhattan Project and Cold War Era Historic District (DOE 1997b).
- The Richland Irrigation Canal is present on FSA land that could be transferred, FSA land that could be conveyed by other realty instrument other than a deed (Potential Access Agreement Land), and Hanford Site lands not considered for conveyance. The canal would be adversely affected under *National Historic Preservation Act* (NHPA) if transferred out of federal ownership. The adverse effect determination reached in accordance with the NHPA implementing regulations and any appropriate mitigation measures will be addressed as part of the Section 106 process. Physical segments of the canal could be demolished in part or whole by industrial development on the FSA.
- The NRHP-eligible historic homestead located on the PA is not within the FSA and is not being considered for conveyance, and therefore is not directly adversely affected under NHPA Section 106. Development of the adjacent FSA lands could change the existing views from this location.

The non-DOE activities identified in the introduction to this Cumulative Effects chapter are subject to Washington State laws and requirements protecting archeological sites, Native American graves, and abandoned, historic pioneer cemeteries and graves. Not all segments of the Richland Irrigation Canal are on DOE property as some are located south of Horn Rapids Road and potentially on the Horn Rapids Industrial Park or the Tri-Cities Research District. In addition to the Proposed Action causing segments of the canal to be removed, development at the Horn Rapids Industrial Park and Tri-Cities Research District could result in additional removal of segments of the Richland Irrigation Canal. The homestead is on DOE property but adjacent to these same two non-DOE developments. Views from the homestead location could change as a result of private industrial development across Horn Rapids Road. The Proposed Action would contribute incrementally to cumulative effects on the views from this location.

Cultural resources could be affected by the presence of buildings, traffic, sound, light, and smell that differs from the pre-existing ambient condition. Land disturbances from construction activities have the potential to destroy archeological sites or affect cultural resources located on the FSA. Heavy machinery used during construction would generate noise and vibration well above the current ambient background levels (see **Section 3.9**). Since construction activities include the removal of surface vegetation, the change in the surface characteristics would also mean traditional plant species that could be used by the tribes would be removed and no longer available. The Hanford Site, however, includes large tracts of lands with similar plant communities.

The Proposed Action would incrementally contribute to the cumulative effects of noise, vibration, artificial light, and odors in the ROI, the degree to which depends on the type and location of the representative facilities.

4.1.7 Land Use

The ROI includes the PA and the surrounding urban and rural areas. Some activities on the Hanford Site and within the ROI may have beneficial effects. For example, remediation efforts at Hanford could facilitate potential reuse or restoration of land. Restoration of remediated sites would return some land to more natural conditions (e.g., shrub-steppe habitat). The PA is largely undeveloped with a few exceptions (e.g., borrow pits, SALT Facility, and others) and is bounded on the east by DOE's 300 Area and PNNL facilities and on the southwest by HAMMER, Patrol Training Academy, and Regional Education Training Center. Areas to the north and northwest are less developed.

DOE is planning the construction and operation of additional facilities and associated infrastructure on the PNNL Site for expanded chemical, physical, biological, nuclear, process, and material science; instrumentation; and imaging and computational capabilities for PNNL's core capabilities and meet DOE's research and development mission. Construction could include expansion of existing facilities and construction of new facilities as well as infrastructure upgrades needed for the operations of the planned facilities, including installation of new roads and utilities (e.g., water, natural gas, electric, sewer, and communications) (DOE 2013d). Adjacent areas are under development, including the Horn Rapids Industrial Park south of Horn Rapids Road. DOE's Hanford Comprehensive Land-Use Plan (DOE 1999a) identifies the PA as industrial development. The recent purchase of lands located off the Hanford Site and west of Stevens Drive across from PNNL for use as a gravel quarry shows continuing industrialization of the area. Tri-City Development Council's target marketing categories are also consistent with development of the area for industrial development.

The Proposed Action would incrementally contribute (1,641 acres) to cumulative change in land uses from largely undeveloped to industrial in the ROI.

4.1.8 Visual Resources

Cumulative impacts related to visual resources were evaluated in an ROI that includes the PA and offsite areas visible with the naked eye. Visual resources include the natural and man-made physical features that give a particular landscape its character. Features that form the overall visual impression include landforms, vegetation, water, color, adjacent scenery, scarcity, and man-made modifications. Evaluating the aesthetic qualities of an area is a subjective process because the value that an observer places on a specific feature varies depending on their perspective and judgment. In general, a feature observed within a landscape can be considered as "characteristic" (or character-defining) if it is inherent to the composition and function of the landscape.

The land on and in the vicinity of the Hanford Site is generally flat with little relief. Rattlesnake Mountain (*Laliik*), rising to 1,060 meters (3,480 feet) above mean sea level, forms the southwestern boundary of the Hanford Site. Gable Mountain and Gable Butte are the highest land forms within the central Hanford Site. The Columbia River flows through the Hanford Site. Typical of the regional shrub-steppe desert, the site is dominated by widely spaced, low-brush grasslands. The Hanford Site is characterized by mostly undeveloped land, with widely spaced clusters of industrial buildings along the southern banks of the Columbia River and at several interior locations.

Completion of remediation and revegetation activities at Hanford has beneficial impact on the visual environment. These activities would include, for example, decommissioning of the reactors in the 100 Area, closure of the canyon facilities in the 200 Area, and revegetation of the borrow areas following completion of mining activities. In most cases, activities within the ROI would not change the Bureau of Land Management visual resource management classifications because projects would be located in or adjacent to areas that are already developed.

The visual resource analysis performed focuses on the degree of contrast between the Proposed Action and the surrounding landscape, the sensitivity levels of key observation points (KOP), and the visibility of the Proposed Action from KOPs with regard to the FSA. The distance from a KOP to the affected area was also considered, as distance can diminish the degree of contrast and visibility. To determine the range of the potential visual effects, the viewshed analysis considered the potential effects in light of the aesthetic quality of surrounding areas, as well as the visibility of possible activities and facilities from vantage points. When viewed from a distance to the north or northwest, most of the Proposed Action facilities would not be discernable against the backdrop of the existing industrial development. None of the sensitive viewer locations provide unique views of the development area and some are blocked by topography or other obstructions. Some glint and glare effects from the concentrated solar power dishes could occur for low flying aircraft and several KOPs.

The landscape would change from largely undeveloped to industrial. The facilities and the single solar technology, however, would likely not be discernable against the backdrop of the existing industrial development when viewed from KOPs (see **Section 3.8**). None of the sensitive viewer locations provide unique views of the development area and some are blocked by topography or other obstructions.

The Proposed Action would contribute incrementally to the ongoing visual effects from industrial development of the area, the degree to which depends on the type and location of facilities.

4.1.9 Noise, Vibration, and Electromagnetic Fields

Cumulative impacts related to noise were evaluated with an ROI that includes the PA and surrounding area, including PNNL and LIGO.

Noise, vibration, and electromagnetic field (EMF) impacts of activities under the Proposed Action would result from a variety of sources from the construction and operation of the representative facilities. Heavy equipment, pile drivers, generators, compressors, and pumps from construction all create noticeable acoustic noise and vibration. Facilities such as the biofuels manufacturing facility use heavy equipment like bulldozers, excavators, and front end loaders to move municipal and cellulosic waste materials and feed it into a shredder. There are no common sensitive receptors (e.g., schools, libraries, hospitals, or churches) near the proposed representative facilities. PNNL's sensitive facilities are concerned with all three. LIGO is only concerned with vibration.

4.1.9.1 Background Environment

Based on available information, potential noise, and vibration impacts to the public from other DOE activities are related primarily to vehicle traffic and some heavy equipment operating at remediation and waste sites. Cumulative noise and vibration impacts also considered non-DOE construction and operations activities. Noise impacts from existing non-DOE activities at Hanford (e.g., traffic noise and vibration from workers commuting to and from the Columbia Generating Station; vibration from regional dams; and operation noises from the AREVA facility, the Perma-Fix facility, and the US Ecology commercial LLW disposal site) are part of the existing background sound environment near the PA. Existing electromagnetic sources come from electric transmission and distribution lines, electrical substations, and power transformers. These include the White Bluffs and the Sandhill Crane substations. White Bluffs is west of the FSA on the north side of Horn Rapids Road. The Sandhill Crane substation is southwest of the corner of Horn Rapids Road and Stevens Drive.

4.1.9.2 Future Sources

Future sources near the Hanford Site, such as new industries, agriculture, offices, schools, residential development, new roads, and other infrastructure improvements could result in variations in the levels of traffic noise along access roads and increased noise levels near these developments. In May 2015, the Port of Benton sold 128 acres west of Stevens Drive and south of Battelle Boulevard to a regional aggregate company to supply materials (i.e., gravel) for concrete and other construction projects in the Tri-Cities Area (Beaver 2015). This new facility, when it begins operation, would use heavy machinery to excavate gravel and sand, then haul it to the batch plant on the Horn Rapids Industrial Park. Heavy equipment traveling down unimproved roads, and excavation of coarse material would be a major source of noise and vibration (see **Appendix B**, "Acoustic Noise and Vibration from Construction"). Other proposed developments in the area that are expected to result in increased noise and vibration levels include build out of the 750-acre Horn Rapids Industrial Park including the 313,000 square-foot, 10-story Preferred Freezer Services facility currently under construction, and expansion of activities on the PNNL Site.

The Proposed Action's initial noise and vibration impact in the region and, in particular, the effect on PNNL and LIGO would be, for the most part, temporary for the duration of construction activities. Impacts from the single-phased development representative facilities are assumed to conclude within a year or so, whereas the multi-phased development could last several years, but would not be continuous.

After construction, operation of the representative facilities could generate vibration and noise with the potential to disturb PNNL and LIGO operations, predominantly from haul trucks and heavy equipment operation. Representative facilities with the most potential to cause this effect would be the biofuels manufacturing and the rail distribution center facilities, although any of the representative facilities that use heavily laden trucks would contribute to cumulative impacts on PNNL and LIGO. Similar activities on Horn Rapids Road or the industrial park would have a cumulative effect, including the future development of the newly-purchased rock quarry on Stevens Drive across from PNNL.

The Proposed Action would contribute incrementally to cumulative impacts in the ROI; however, noise is less of a cumulative issue than vibration because it dissipates more readily with distance and is regulated by the City of Richland at each facility's site boundary whereas vibration is not.

Electromagnetic Field

EMF levels for the Proposed Action would be less than the EMF generated by the Sandhill Crane substation just southwest of the corner of Stevens Drive and Horn Rapids Road and adjacent to PNNL. Because of being farther away, EMF from the representative facilities is not expected to affect PNNL's identified sensitive receptors. Therefore, the Proposed Action is not expected to contribute to cumulative effects in the ROI.

4.1.10 Utilities and Infrastructure

Current levels and patterns of use of the utilities and infrastructure are an effect of the past and present actions that have occurred within the PA and surrounding urban environment. The Proposed Action would generate increased demand on utilities (e.g., electricity, natural gas, water, and sewer). Potable water usage at the Hanford Site has been approximately 215 million gallons per year, which is less than 5 percent of the capacity of the Hanford Export Water System (DOE 2012b). According to the *City of Richland Comprehensive Land Use Plan* (City of Richland 2008), the city has water rights to 58 million gallons per day (mgd) with an average daily water use of 14.7 mgd and a peak use of 34 mgd (see **Section 3.10.2.2**). The rough estimate of water use for the Proposed Action at build out is 2.3 mgd (see **Table 3-15**).

The Proposed Action would not require significant amounts of electrical power or water during construction. Once operational, the Proposed Action would contribute to cumulative demands in the ROI on electricity and water.

4.1.11 Transportation

Current levels and patterns of use of the transportation system are an effect of the past and present actions that have occurred within the Hanford ROI. The bulk of daily traffic comes from commuters (DOE 2012b). Traffic levels would increase following implementation of the Proposed Action and future development of the land. The Benton-Franklin Council of Governments' 2011-2032 Regional Transportation Plan modeling predicted in the 2020 "build" scenario[20] that peak hour traffic volumes would be well below the capacity (i.e., peak hour volumes would be less than 50 percent of the capacity of the roadway) of Stevens Drive, George Washington Way, and Horn Rapids Road around the PA (Benton-Franklin Council of Governments 2012).

The regional road network in the vicinity of the PA consists of several main roads, including:

- State Route 240 (to the southwest of the PA) is a six-lane highway that connects to Stevens Drive in Richland. State Route 240 is a designated freight route in the *Citywide Transportation Plan* for the Tri-Cities (DKS Associates 2005).
- Route 4 South, a four-lane, north-south principal arterial that runs along the eastern border of the PA, and then turns to the northwest in the northeastern portion of the PA.
- Stevens Drive, a four-lane, north-south principal arterial that adjoins Route 4 South at the Horns Rapid Road intersection.
- George Washington Way, a principal four-lane north-south arterial through Richland that intersects Stevens Drive east of the PA.
- Horn Rapids Road, an east-west minor arterial on the southern border of the PA.
- Kingsgate Way is a north-south minor arterial that ends at Horn Rapids Road about 1.5 miles west of Stevens Drive.

The Tri-City Railroad Company maintains and operates about 12 miles of rail formerly owned by DOE. In 1998 the Port of Benton received 750 acres of land and numerous buildings from DOE for economic development purposes, and the railroad serves this area and the City of Richland's Horn Rapids Industrial Site (via a spur line built by the city in 1997) (DKS Associates 2005). The rail line runs west of Stevens Drive south of and within the PA, and crosses Horn Rapids Road at grade just west of Stevens Drive. The crossing is equipped with gates and signals.

The Proposed Action incremental impacts to transportation from construction and operation of the representative facilities would depend on the types of facilities and when they are constructed. Other reasonably foreseeable future actions, such as continued development and operation of the Horn Rapids Industrial Park, would also affect the primary roads serving the PA. Assessment of project-specific impacts and improvements to the surrounding roadways that serve as the primary access routes to the PA may be required and adverse impacts would be addressed by the local agency (e.g.,

[20] As part of the regional transportation planning, future transportation conditions were modeled based on planned land use and transportation projects and projected changes in regional population and employment.

City of Richland). The construction of a rail distribution center would require a substantial increase in the use of the tracks near Stevens Drive and has the potential to cause traffic delays when 55-car trains are pulling onto the FSA lands several times per week.

The roadways around the conveyance lands currently support commuter traffic to DOE, PNNL, Energy Northwest, ERDF, and other Hanford Site project locations to the north. The same roadways also support AREVA, Perma-Fix, and other facilities on the Horn Rapids Industrial Park that produce both commuter and truck transportation traffic. The recently purchased rock quarry on Stevens Drive may produce additional haul truck traffic to these same roads once it is operational. The Proposed Action would have a substantial incremental impact on these primary roads due to the increase in traffic levels above the current levels if all the representative facilities were constructed.

4.1.12 Waste Management

There are currently no waste generating or disposal activities on the FSA. Solid waste management in the City of Richland is guided by the *City of Richland Solid Waste Management Plan* (City of Richland 2011) and the *2006 Solid Waste Management Plan* (Benton County 2007). In 2013, the City of Richland generated 69,274 tons of solid waste. Of this total, 15,125 tons (approximately 22 percent) were recycled and 54,149 tons were landfilled at the City of Richland-owned and -operated Horn Rapids Sanitary Landfill (City of Richland 2014). Projections made in the 2011 solid waste management plan predicted that the current permitted space of the landfill would be filled by 2018. The city is exploring options for future growth, including expanding the Horn Rapids Sanitary Landfill or closing the landfill and long-hauling the waste out of the city (City of Richland 2011). Recycling in the city is collected from voluntary curbside collection and from seven recycling drop-off centers throughout the city. The city delivers all recycled materials to Clayton Ward Recycling in Richland, where the materials are sent to recycling centers in Western Washington or Oregon (City of Richland 2011).

Nonhazardous solid waste from the Hanford Site is disposed of at the Roosevelt Regional Landfill near Glendale, Washington (DOE 2012a). The Hanford Site has established target objectives for solid waste reduction by reuse and recycling of 10 percent per year, based on a fiscal year 2010 baseline. In fiscal year 2013, approximately 600 metric tons were generated and disposed of at the Roosevelt Regional Landfill, while more than 1,300 metric tons of solid waste were recycled (DOE 2014c).

Construction activities associated with the Proposed Action would generate nonhazardous waste of all types (see **Section 3.12**). The increased demand would not exceed the capacity of the existing waste management system. Local waste disposal transporters and landfills would be used where appropriate. However, it is anticipated that solid waste would be recycled and reclaimed to the maximum extent possible. The minimal number of workers needed for operation and maintenance would not impact solid waste management facility use.

The Proposed Action would incrementally contribute to cumulative demands in the ROI on waste management facilities built in the FSA.

4.1.13 Socioeconomics and Environmental Justice

The ROI for the cumulative socioeconomic analysis comprises Benton and Franklin counties. Activities on the Hanford Site play a substantial role in the socioeconomics of the Tri-Cities area. The communities surrounding the PA provide the people, goods, and services required by businesses and industries at the Hanford Site. These businesses and industries in turn create the demand for employees, goods, and services and acquire these resources in the form of wages, benefits, and purchases of goods and services. Since the 1970s, DOE and its contractors have been one of three primary contributors to the local economy (the other two are Energy Northwest and the agricultural community) (DOE 2013c). According to employee residence records from April 2007, over 90 percent of DOE contract employees of the Hanford Site lived in Benton and Franklin counties (DOE 2012b). Approximately 73 percent resided in Kennewick, 36 percent in Richland, and 11 percent in Pasco. Residents of other areas of Benton and Franklin counties, including West Richland, Benton City, and Prosser account for about 17 percent of total DOE contractor employment (DOE 2012).

As discussed in **Section 3.13.1.3**, there are no low-income or minority populations that would be affected by the Proposed Action and, therefore, there would be no disproportionately high and adverse impacts to any low-income or minority populations from the Proposed Action.

4.1.14 Human Health and Safety

Major sources and average levels of exposure to natural background radiation and other non-site-related sources to individuals in the Hanford vicinity are shown in **Table 3-22**.[21] The average annual dose from these sources is approximately 620 millirem. About half of the annual dose is from natural background sources (311 millirem) that can vary depending on geographic location, individual buildings in the geographic area, or age, but is essentially all from space or naturally occurring minerals in rock and soil. Approximately the remaining half of the dose is from medical exposure to radiation (300 millirem), including computed tomography, fluoroscopy, x-rays, and nuclear medicine (use of unsealed radionuclides for diagnosis and treatment). Another approximately 14 millirem are from consumer products and other sources (e.g., nuclear power, security, research, and occupational exposure) (NCRP 2009). All doses identified in **Table 3-25** are unrelated to Hanford site operations, and are provided as a context for subsequent comparison (and perspective) to the *de minimis* doses typically associated with the latter.

In summary, doses to the public from greater Hanford Site operations fall well within the limits established in 40 CFR 61, Subpart H (10 millirem per year from airborne sources) and DOE O 458.1 (100 millirem per year from all sources), and are much lower than those due to natural background radiation. In general, airborne emissions of tritium and radon-220 from the 300 Area, along with uranium-234 and uranium-238 effluents via the Columbia River, account for the vast majority of calculated dose to the maximally exposed individual for the greater Hanford Site (DOE 2014b).

Compliance with the requirements in DOE O 458.1 for the control, clearance, and release of DOE property containing potential residual radioactivity will ensure that potential radiological sources within such property are mitigated or altogether eliminated prior to completion of the land conveyance process. The human health and safety effects from the Proposed Action would not contribute to cumulative impacts on human health and safety in the ROI.

[21] Average doses from background radiation in the Hanford vicinity are assumed to approximate the average dose to an individual in the United States population.

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5.0 APPLICABLE LAWS, REGULATIONS, AND OTHER REQUIREMENTS

This chapter addresses the major laws, regulations, and other requirements required for implementing the Proposed Action to convey lands. Most of these laws and regulations are identified and described in the *Cross-Cut Guidance on Environmental Requirements for DOE Real Property Transfers (Update)* (DOE 2005b). This guidance provides information on the environmental requirements associated with the conveyance of real property out of the U.S. Department of Energy's (DOE) custody and control. Other guidance is provided in the *DOE Real Estate Desk Guide* (DOE 2014d).

It is assumed that the Tri-City Development Council (TRIDEC) or future landowners would comply with all federal, state, and local statutory requirements applicable to the construction and operation of their respective facilities.

Section 5.1 provides a description of the DOE's 10 CFR 770 implementing regulation for "Transfer of Real Property at Defense Nuclear Facilities for Economic Development." **Section 5.2** addresses the *National Defense Authorization Act for FY 2015* (NDAA) (Public Law 113-291). **Section 5.3** addresses DOE's real property disposal authority. **Section 5.4** discusses the environmental and health and safety requirements for real property conveyance. **Section 5.5** discusses the realty instruments relative to the Hanford Site land conveyance.

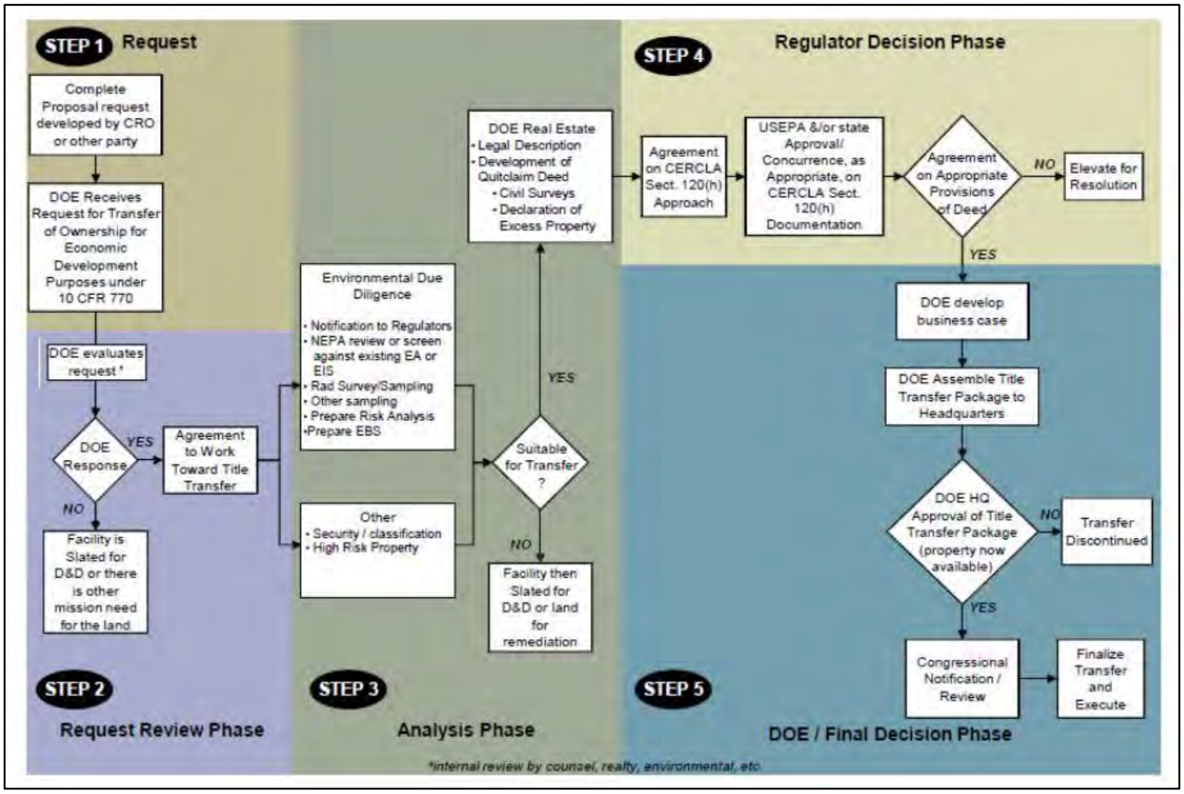
5.1 10 CFR 770, "Transfer of Real Property at Defense Nuclear Facilities for Economic Development"

TRIDEC's request for 1,641 acres was made in accordance with DOE's 10 CFR 770 implementing regulation. 10 CFR 770 establishes how DOE will transfer, by sale or lease, real property at closed or downsized defense nuclear facilities for economic development purposes. Section 3158 of the NDAA directed DOE to prescribe regulations that describe procedures for the transfer by sale or lease of real property at such defense nuclear facilities. Transfers of real property under these regulations are intended to offset negative impacts on communities caused by unemployment from related DOE downsizing, facility closeouts, and work force restructuring at these facilities. Section 3158 also provides discretionary authority to the Secretary of Energy to indemnify transferees of real property at DOE defense nuclear facilities. 10 CFR 770 sets forth the indemnification process.

The overall 10 CFR 770 process can be generally described as a series of steps: request, request review, analysis, regulator decision, and DOE final decision. **Figure 5-1**, "Overview of the 10 CFR 770 Process," is a flowchart showing these steps of the process.

This environmental assessment (EA) is part of the "Environmental Due Diligence" under Step 3, the Analysis Phase (see **Figure 5-1**).

Figure 5-1. Overview of the 10 CFR 770 Process.



Source: Modified from Cooke 2012.

5.2 National Defense Authorization Act for Fiscal Year 2015

Section 3013 of the NDAA pertains specifically to the land conveyance action, requiring that two parcels of approximately 1,341 acres and 300 acres be transferred by DOE to TRIDEC by September 30, 2015. The following is Section 3013 in its entirety as taken from the congressional website (https://www.congress.gov/bill/113th-congress/house-bill/3979/text).

> SEC. 3013. LAND CONVEYANCE, HANFORD SITE, WASHINGTON.
>
> (a) Conveyance Required.--
>
> (1) In general.--Not later than September 30, 2015, the Secretary of Energy shall convey to the Community Reuse Organization of the Hanford Site (in this section referred to as the "Organization") all right, title, and interest of the United States in and to two parcels of real property, including any improvements thereon, consisting of approximately 1,341 acres and 300 acres, respectively, of the Hanford Reservation, as requested by the Organization on May 31, 2011, and October 13, 2011, and as depicted within the proposed boundaries on the map titled "Attachment 2-Revised Map" included in the October 13, 2011, letter.
>
> (2) Modification of conveyance.--Upon the agreement of the Secretary and the Organization, the Secretary may adjust the boundaries of one or both of the parcels specified for conveyance under paragraph (1).
>
> (b) Consideration.--As consideration for the conveyance under subsection (a), the Organization shall pay to the United States an amount equal to the estimated fair market value of the conveyed real property, as determined by the Secretary of Energy, except that the Secretary may convey the property without consideration or

> for consideration below the estimated fair market value of the property if the Organization--
>
> (1) agrees that the net proceeds from any sale or lease of the property (or any portion thereof) received by the Organization during at least the seven-year period beginning on the date of such conveyance will be used to support the economic redevelopment of, or related to, the Hanford Site; and
>
> (2) executes the agreement for such conveyance and accepts control of the real property within a reasonable time.
>
> (c) Expedited Notification to Congress.--Except as provided in subsection (d)(2), the enactment of this section shall be construed to satisfy any notice to Congress otherwise required for the land conveyance required by this section.
>
> (d) Additional Terms and Conditions.--
>
> (1) In general.--The Secretary of Energy may require such additional terms and conditions in connection with the conveyance under subsection (a) as the Secretary deems necessary to protect the interests of the United States.
>
> (2) Congressional notification.--If the Secretary uses the authority provided by paragraph (1) to impose a term or condition on the conveyance, the Secretary shall submit to Congress written notice of the term or condition and the reason for imposing the term or condition.

The "Attachment 2 – Revised Map" referred to in Section 3013 is **Figure 2-5** included in **Chapter 2.0** of this EA.

5.3 U.S. Department Of Energy Real Property Conveyance Authority

Although not necessarily applicable to the transfer of lands in accordance with the NDAA, DOE has real property conveyance authority under several laws. Some of these may also be relevant to those lands identified within the Potential Access Agreement Land. The primary authorities for DOE to convey real property are:

- The *Atomic Energy Act* (42 USC 2201(g)), Section 161(g) – authorizes DOE to sell, lease, grant, and dispose of such real property as provided in the Act. Section 161(q) allows for easements for rights-of-way.
- *Atomic Energy Community Act* (42 USC 2301) – authorizes DOE to dispose of real property within the atomic energy communities of Oak Ridge, Tennessee; Richland, Washington; and Los Alamos, New Mexico.
- *DOE Organization Act* (42 USC 7256), Sections 646(c)-(f)) (together these sections are known as the "Hall Amendment") – authorizes DOE to lease property.
- *DOE Organization Act* (42 USC 7259), Section 649 – authorizes DOE to lease facilities.

5.4 Environmental and Health and Safety Requirements for Real Property Conveyance

The mechanics of real property conveyance for DOE involve a complex array of regulations promulgated by federal agencies, many of which are addressed in DOEs guidance document (DOE 2005b). As the guidance describes, the procedures required when real property is conveyed differ depending on how the property came under DOE's control (e.g., acquired or withdrawn from another federal agency). The lands being considered for conveyance in the Focused Study Area (FSA) are comprised entirely of land that was in non-federal ownership prior to acquisition by the federal government for the formation of the Hanford nuclear facility.

Certain provisions of the *Comprehensive Environmental Response, Compensation, and Liability Act* (CERCLA) (42 USC 9601 et seq.) are relevant to this proposed conveyance. Specifically, CERCLA §120(h) requires information on the type and quantity of any hazardous substance that was stored for 1 year or more, known to have been released, or disposed of on the property and the time at which the substance was stored, released, or disposed. These CERCLA reporting requirements, and the amounts that trigger reporting, are codified at 40 CFR 373. CERCLA Section 120(h) also requires identification of areas on the real property "on which no hazardous substances and no petroleum products or their derivatives were known to have been released or disposed of." This identification is required when the United States intends to terminate Federal government operations on property it owns.

Table 5-1, "Comparison of the CERCLA Requirements for Sections 120(h)(1), (3), (4), and (5)," compares and summarizes CERCLA Sections 120(h)(1), (3), (4), and (5) requirements (DOE 1998a).

The Hanford Site is considered a single facility for purposes of the *Resource Conservation and Recovery Act* (42 USC 6901, as amended) and the *Washington State Hazardous Waste Management Act* (RCW 70.105). In accordance with these acts and their implementing regulations at 40 CFR 264, 40 CFR 265, and WAC 173-303, owners and operators of dangerous waste facilities must obtain a permit. Although no hazardous or dangerous waste facilities are on the PA, it is currently contiguous property under the control of DOE. Pursuant to WAC 173-303-830(4) the DOE will propose a modification to change the Legal Description and Operating Boundary of the *Dangerous Waste Portion of the Resource Conservation and Recovery Act Permit for the Treatment, Storage, and Disposal of Dangerous Waste, WA7890008967, Revision 8C* (Permit) to remove land transferred out of DOE ownership. Until completion of the Permit modification, the DOE will continue to be responsible for fulfilling any corrective action requirements imposed by the Permit on this land. Upon successful completion of the modification, the land transferred out of DOE ownership will no longer be subject to the Permit requirements.

The *National Historic Preservation Act* (NHPA), as amended (54 USC 300101 et seq.), governs the consideration of historic properties in real property conveyance. The regulations implementing Section 106 of this act are located in "Protection of Historic Properties" (36 CFR 800). DOE's compliance with the requirements of the NHPA are discussed in **Section 3.6**.

DOE O 458.1, *Radiation Protection of the Public and the Environment*, Change 3, establishes requirements to protect the public and the environment against undue risk from radiation associated with radiological activities conducted under the control of DOE, pursuant to the *Atomic Energy Act*, as amended. DOE's compliance with this order and other applicable federal, state, or local regulations relative to protection of the public from residual radioactive material and other hazardous substances is discussed in **Section 3.14**.

DOE's responsibilities to protect floodplains and wetlands in real property dispositions are described in 10 CFR 1022 (see **Section 3.5**).

Table 5-1. Comparison of the CERCLA Requirements for Sections 120(h)(1), (3), (4), and (5).

Requirement	Section 120(h)(1)	Section 120(h)(3)	Section 120(h)(4)	Section 120(h)(5)
Brief Description	Include in the contract for sale or transfer a notice of the types and quantities of hazardous substances stored ≥ 1 year, disposed of, or released on the property and the time at which these activities took place.	Report on the deed the types and quantities of hazardous substances stored for ≥ 1 year, disposed of, or released on the property, and the time at which these activities took place.	Identify uncontaminated parcels of land (i.e., land on which no contaminants were stored ≥ 1 year, disposed of, or released).	Notify states of sites that are being closed and that are encumbered by a lease beyond the closure date and are contaminated (i.e., land on which contaminants were stored ≥ 1 year, disposed of, or released).
Contaminants Covered	Hazardous substances as found at 40 CFR 302.4 only.	Hazardous substances as found at 40 CFR 302.4 only.	Hazardous substances or any petroleum product or its derivatives.	Hazardous substances or any petroleum product or its derivatives.
Threshold Quantities	As specified by 40 CFR 373: the greater of 1,000 kg or the RCRA RQ for storage of ≥ 1 year; the RQ for release or disposal; and 1 kg for acutely hazardous waste.	As specified by 40 CFR 373: the greater of 1,000 kg or the RQ for storage of ≥ 1 year; the RQ for release or disposal; and 1 kg for acutely hazardous waste.	Not specified; the same thresholds specified by Sections 120(h)(1) and (3) are suggested.	Not specified; the same thresholds specified by Sections 120(h)(1) and (3) are suggested.
Information Source	Departmental files only; however, it is a best management practice to follow the most stringent data gathering requirements [found at Section 120(h)(4)].	Departmental files only; however, it is a best management practice to follow the most stringent data gathering requirements [found at Section 120(h)(4)].	Reasonably obtainable federal, state, and local government records and other sources (e.g., interviews, physical inspection, sampling, and aerial photographs).	Not specified, however, it is a best management practice to follow the most stringent data gathering requirements Section 120(h)(4)].
Types of Real Property Transfers Covered	All real property transfers regardless of whether ownership changes, including transfers between federal agencies.	All real property transfers in which ownership changes, and transfers between federal agencies.	Not specified.	Leases of real property after operations cease.

Key: kg = kilogram; RCRA = *Resource Conservation and Recovery Act*; RQ = reportable quantity.
Source: DOE 1998a.

5.5 Realty Instruments for Hanford Site Land Conveyance

Generally, DOE may convey land as a transfer of deed or other realty instruments (e.g., lease, permit, or easement). DOE can use real estate (realty) instrument language as one potential mechanism to preclude or minimize environmental consequences. DOE would use deed restrictions (private agreements that restrict the use of the real estate in some way, and are listed in the deed), covenants (a promise in a written contract to agree to something), or other forms of conditional language in the conveyance realty instrument(s) to allow DOE to mitigate potential environmental consequences, meet regulatory obligations, and protect mission and operational needs.

5.5.1 Conveyance as a Transfer of Deed

It is DOE's intent to convey FSA lands primarily by transfer of deed, and the property once transferred, would no longer be under DOE regulatory oversight. However, as stated previously, DOE assumes that TRIDEC or future landowners would comply with all applicable federal, state, and local statutory requirements applicable to the construction and operation of their respective facilities. Moreover, DOE assumes that future uses would be developed in accordance with local zoning and current comprehensive land use plans (City of Richland 2008, Benton County 2006).

The specific language could be different depending upon the realty instrument used to convey land. The following items are representative of the type of language that could, for example, be included in a transfer of deed for the purpose of protecting the interests of the government and protection of the environment:

- WATER USE RESTRICTIONS – The GRANTEE, for itself and its successors and assigns, covenants and agrees that GRANTEE shall not extract, consume, or permit to be extracted any water from the aquifer below the surface of the ground. The purpose is to prevent disturbance to area hydrologic conditions that might affect transport of contaminants in the groundwater.
- EXCAVATION LIMITATION – The GRANTEE, for itself and its successors and assigns, covenants and agrees that GRANTEE shall not disturb by drilling or other excavation any portion of the land located below a depth of 20 feet below the ground surface, except upon the express written permission of the DOE or its successor. The purpose is to prevent disturbance to area hydrologic conditions that might affect transport of contaminants in the groundwater.
- RESERVING TO the Agency and its assigns all coal, oil, gas, geothermal steam and associated geothermal resources, and other minerals on said Property, together with the right to prospect for and remove the same under applicable laws, rules, and regulations prescribed by the Secretary of the Department of the Interior.
- RESERVING TO the United States easements for ingress/egress and utility purposes located in the …quarter of Section…, Township…, Range…, Benton County, Washington…

5.5.2 Conveyance by Realty Instrument Other Than a Deed

If DOE uses any other realty instrument for conveyance wherein DOE retains institutional control, like a lease or easement, DOE could include language in non-deed realty instruments to protect the government's interest since it retains ownership. Some examples of protective language include:

- Access to and in some cases "reserved use" of the premises for such things as maintenance, repair, removal, installation and replacement of infrastructure, or ingress and egress to and from abutting government-owned lands and roads
- Termination agreement for such things as nonuse, abandonment, or interference with DOE operations and programs
- Indemnification from the user for any claims, costs, or liabilities arising from the user's activities including but not limited to environmental indemnity
- Compensation for destruction of government property
- Requirement to obtain all necessary permits, licenses, certifications, and authorizations required for construction, occupancy, and operations while using government land
- Requirement to pay for all federal, state, and local taxes levied for use of the government premises
- Requirement to obtain a Hanford excavation permit, preserve and protect historic properties and cultural resources by watching for them, and when found stop work until DOE has assessed the significance of the find, and, if necessary, arranged for mitigation of the impacts to the find.

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6.0 CONSULTATION AND COORDINATION

U.S. Department of Energy (DOE) published a notice of intent in the *Federal Register* on September 19, 2012 (DOE 2012f) that announced its intention to prepare this environmental assessment (EA) for the proposed conveyance of Hanford Site land. The notice of intent briefly summarized the project, identified preliminary environmental issues, and identified the time of the public scoping meeting, the time period for public comment, and a point of contact for questions and comment submittal.

6.1 Scoping

The DOE held a 30-day scoping period from September 19 to October 19, 2012, during which federal agencies; state, tribal, and local governments; special interest groups; concerned citizens; and any other interested parties were invited to comment on the scope of this EA, including specific issues that should be addressed in the EA. A public scoping meeting was held (October 10, 2012) at the Richland Public Library in Richland, Washington. At the public meeting, DOE provided an overview of the Proposed Action, an informal question-and-answer period to clarify the information presented, and an opportunity for individuals to provide formal written or oral statements. A court reporter recorded individual comments during the meeting (Bridges Reporting & Legal Video 2012). Fifty-three individuals registered for attendance at the public meeting.

The following documents were made available on the DOE Hanford *National Environmental Policy Act* (NEPA) – EAs website (http://www.hanford.gov/page.cfm/EnvironmentalAssessments) (DOE 2012f). Those shown in bold below were provided at the scoping meeting:

- September 12, 2012, *Federal Register* "Notice of Intent To Prepare an Environmental Assessment (EA) for the Proposed Conveyance" (http://www.hanford.gov/files.cfm/Hanford_NOI.pdf)
- Tri-City Development Council (TRIDEC) proposal (the DOE website points to the TRIDEC website) (http://tridec.org/images/uploads/MCEI-Hanford%20Land%20Request%20Updated%209_20_12.pdf)
- Draft Land Conveyance EA Analysis Area (http://www.hanford.gov/files.cfm/HanfordDraftLCEAArea.pdf)
- **Land Conveyance EA Scoping Fact Sheet** (http://www.hanford.gov/files.cfm/ConveyanceEAScopingFact%20Sheet.pdf)
- **Public Scoping Meeting Agenda** (http://www.hanford.gov/files.cfm/Public_Scoping_Agenda101012.pdf)
- **Public Scoping Meeting Presentation** (http://www.hanford.gov/files.cfm/Public_Scoping_projectoverview.pdf)
- **Key Requirements Poster** (http://www.hanford.gov/files.cfm/KeyRequirementsPoster.pdf)
- Public Comments (http://www.hanford.gov/files.cfm/ScopingMeeting101012.pdf)
- Letters Received (http://www.hanford.gov/files.cfm/Scopingletters.pdf).

Displays available at the public meeting included a large map of the Hanford Site EA analysis area, and a "key requirements" poster of the four regulatory processes that must be completed for land conveyance: the NEPA; the *National Historic Preservation Act* (NHPA) Section 106; the

Comprehensive Environmental Response, Compensation, and Liability Act; and DOE O 458.1, *Radiation Protection of the Public and the Environment* (DOE 2011).

During the scoping period, DOE received comments from members of the public, public agencies, and tribes. Overall, the comments focused on topics that can be grouped into the general categories of ecological resources, Hanford site cleanup, the human environment, the NEPA process, the physical environment, real estate actions, and tribal concerns and cultural resources. A general comment asked how the land transfer could be affected by or cause effects to natural resources due to potential existing contamination or cleanup activities at the Hanford Site.

General comment topics and specific concerns:

- **Ecological resources** – threatened and endangered species, migratory birds, or fish; mitigation plan for the entire analysis area; vegetation management plan; biological assessment and *Endangered Species Act* Section 7 consultation (USFWS 2013); critical habitat; wetlands.
- **Hanford Site cleanup** – chemical or nuclear materials associated with land use, existing waste materials and locations, and their potential to affect land use development.
- **Human environment** – public health and safety from new industry or accidental release of pollutants, economic viability of the transaction/should be conveyed at fair market value, improved economic vitality to the area, burden on taxpayers for future uses, effects on roads and traffic, compatibility with Pacific Northwest National Laboratories activities, assessment of future mission needs, pollution depositories near or on tribal lands, environmental justice populations within the analysis area.
- **NEPA process** – regulation by the Washington State Department of Ecology should be required under separate process; NEPA document should be an environmental impact statement; confirm land uses as part of project description; include analysis of new nuclear facilities; should not depend on or tier off of the *Final Hanford Comprehensive Land-Use Plan Environmental Impact Statement* (DOE 1999a); a finding of no significant impact is unacceptable.
- **Physical environment** – air quality protection and greenhouse gases, existing radiological and chemical contamination and potential of spread to the project area, industrial development on uranium plume and known contaminant areas, plan for long-term storage of nuclear material, spill prevention/mitigation, mobilization of contaminants in soil, and discharges to water resources.
- **Real estate actions** – *Hanford Site Biological Resources Management Plan* (DOE 2013f) requirements for lease/deed of property, funds from lease or sale to help with cleanup, and liability associated with existing contaminants.
- **Tribal concerns and cultural resources** – leases follow the *Hanford Site Cultural Resources Management Plan* (DOE 2003b); tribes not offered right of first refusal; effects on sacred sites, sites listed on or eligible for the National Register of Historic Places (30 CFR 60), and Hanford Site-specific cultural resources; conduct traditional use survey; disproportionate burden of loss to Confederated Tribes of the Umatilla Indian Reservation; loss of ability to exercise treaty rights; request for government-to-government consultation; purchase of tribal electricity or natural gas; and a site planning advisory board consisting of DOE, cooperating agencies, and Comprehensive Land-Use Plan site planning advisory board was not created (DOE 1999a).

DOE considered comments received during public scoping in preparing the draft EA.

6.2 Agencies and Persons Consulted

DOE sent letters to the following individuals on May 1, 2012, providing "Upcoming Notice of Intent to Prepare an Environmental Assessment for the Proposed Transfer of Land at the Hanford Site, Washington, and Notice of National Historic Preservation Act Integration":

Brooklyn Baptiste, Chairman
Nez Perce Tribe

Harry Smiskin
Confederated Tribes and Bands of the Yakama Nation

Les Minthorn
Confederated Tribes of the Umatilla Indian Reservation

Allyson Brooks
State Historic Preservation Office
Washington State Department of Archaeology and Historic Preservation

J. Fowler, Executive Director
Advisory Council on Historic Preservation

Rex Buck
Grant County PUD – Wanapum.

On September 19, 2012, DOE sent a "Notice of Public Scoping Period for Environmental Assessment (EA) for the Proposed Conveyance of Land at the Hanford Site, Washington, and National Historic Preservation Act (NHPA) Integration" to the following individuals:

Jack Bell
Nez Perce Tribe
Chairman, Hanford Site Natural Resource Trustee Council

Gerald Pollet
Heart of America Northwest

Tracy Bier
Washington Physicians for Social Responsibility

Tom Carpenter
Hanford Challenge

Perry Harvester, Regional Habitat Program Manager
Washington State Department of Fish and Wildlife

Dennis Faulk, Program Manager
Hanford Project Office
U.S. Environmental Protection Agency

Jane A. Hedges, Program Manager
Nuclear Waste Program
Washington State Department of Ecology

Steve Hudson, Chair
Hanford Advisory Board

Ken Niles, Assistant Director
Nuclear Safety Division
Oregon Department of Energy

Dan Haas, NEPA Coordinator
U.S. Fish and Wildlife Service
Mid-Columbia River National Wildlife Refuge Complex

Rick Leaumont
Lower Columbia Basin Audubon Society

Sandy Swope
Washington State Department of Natural Resources.

The NHPA process was initiated simultaneously with the NEPA process through a September 19, 2012 notification from DOE to the Washington State Department of Archeology and Historic Preservation (DAHP), the consulting tribes, and local historical societies identifying an Area of Potential Effect (APE) following the process detailed in 36 CFR 800.4(a)(1). On September 24, 2012, DAHP concurred with the project's APE (Whitlam 2012).

Cultural resources field studies and tribal coordination were conducted concurrently with development of this EA. The four tribes with interest in the proposed land conveyance were identified and invited to participate in NHPA Section 106 consultation and the NEPA process. DOE acknowledges the special expertise of area tribes in identifying properties that may possess religious and cultural significance to them. DOE funded each of the four tribes to complete a traditional cultural property study for this purpose. Each tribe provided a summary of its study to DOE and these summaries are included in **Appendix G**, "Tribal Studies Executive Summaries." As requested by the tribes, these summaries have not been modified in any way. The following tribes provided an executive summary:

- Confederated Tribes of the Umatilla Indian Reservation
- Confederated Tribes and Bands of the Yakama Nation
- Nez Perce
- Wanapum

Between 2012 and 2015, DOE provided regular presentations and discussed the status and progress of the NHPA and NEPA processes for this project with Tribal and DAHP staff during Hanford's monthly cultural resource meetings. The tribes were invited to participate in project field investigations in accordance with DOE's Tribal Notification Matrix. In addition, DOE has consulted with the Confederated Tribes of the Umatilla Indian Reservation Council, the Nez Perce Council, and Wanapum elders. DOE has requested consultation and is awaiting confirmation dates from the Confederated Tribes and Bands of the Yakama Nation Council.

Between 2012 and 2015, meetings were also held with:

- Hanford Site Tribal Working Group
- Pacific Northwest Site Office
- U.S. Environmental Protection Agency
- Washington State Department of Ecology
- Washington State Department of Health
- Hanford Advisory Board
- Tri-Cities Development Council

- City of Richland, Washington
- Port of Benton, Washington
- Benton County, Washington
- Laser Interferometer Gravitational-Wave Observatory.

A 30-day public review and comment period for the Draft EA is being conducted from July 13, 2015, through August 12, 2015. The Draft EA is available in the DOE reading room (Consolidated Information Center at Washington State University Tri-Cities), the Richland Public Library, and on the Hanford Site website at http://www.hanford.gov/docs/ea/ea1915.html and the DOE NEPA website at http://www.energy.gov/nepa.

The Draft EA is also available in the following places:

Portland State University
Government Information
Branford Price Millar Library
1875 SW Park Avenue
Portland, Oregon

University of Washington
Suzzallo Library
Government Publications Department
Seattle, Washington

U.S. Department of Energy
Public Reading Room
Washington State University
Consolidated Information Center,
Room 101-L
2770 University Drive
Richland, Washington 99352

Gonzaga University
Foley Center Library
East 502 Boone Avenue
Spokane, Washington

Administrative Record and Public Information Repository
Address: 2440 Stevens Center Place, Room 1101
Richland, Washington.

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APPENDIX A – THE HANFORD SITE LAND SUITABILITY REVIEW

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Abbreviations, Acronyms, and Initialisms

DOE	U.S. Department of Energy
IPT	Integrated Project Team
FSA	Focused Study Area
Hz	hertz
LIGO	Laser Interferometer Gravitational-wave Observatory
PA	project area
PNNL	Pacific Northwest National Laboratory
PTA	Patrol Training Academy
RC	reactor compartment
RCRA	*Resource Conservation and Recovery Act of 1976*
RMS	root mean square
SALT	Storage Area and Load Test
TRIDEC	Tri-City Development Council
WIDS	Waste Information Data System

A. APPENDIX A – THE HANFORD SITE LAND SUITABILITY REVIEW

A.1 INTRODUCTION

The U.S. Department of Energy (DOE) first mentioned "suitability" in the Notice of Intent for this environmental assessment (77 FR 58112): "DOE anticipates that there may be continuing mission needs, such as security and safety buffer zones on some of the requested lands, making them less suitable for conveyance." As discussed in **Chapter 2.0**, these continuing mission needs guided DOE's evaluation of the potentially suitable lands and provide explanation to any adjustment to the boundaries of the specific lands proposed for conveyance from those originally requested by the Tri-City Development Council (TRIDEC; 2011a, 2011b).

To identify the lands that could be conveyed, DOE established an Integrated Project Team (IPT) consisting of real estate, legal, and environmental professionals to review mission- and operation-related needs both on and off the 4,413-acre Initial Hanford Site Land Conveyance Project Area (PA) lands. The process focused on identifying PA lands that may not be presently suitable for DOE to convey. The IPT determined that "suitable" in this context had generally three distinct but important evaluation aspects: mission need or impact, environmental condition, and health and safety. These categories are also generally discussed in the *Cross-Cut Guidance on Environmental Requirements for DOE Real Property Transfers (Update)* (DOE 2005).

The suitability evaluation for safety included the results of DOE's Radiological Clearance Process as required by DOE O 458.1 (DOE 2011). The IPT's review addressed this order's requirement that releases of property be consistent with the as low as reasonably achievable process as explained in **Section 3.14**. Release or clearance of property with the potential to contain residual radioactive material must be conducted in accordance with the requirements of DOE O 458.1. Property control and clearance processes must be developed and implemented in accordance with dose limits under any plausible use of the property, and as low as reasonably achievable process requirements in DOE O 458.1 must be met before property is cleared.

Unless alternative dose constraints are approved by issuance of a directive or memorandum by the DOE Chief Health, Safety, and Security Officer, the following dose constraints for DOE residual radioactive material must be applied to each specific clearance of property. For any actual or likely future use of the property a total effective dose[1] of 25 millirem (0.25 millisieverts) above background in any calendar year.

Property potentially containing residual radioactive material must not be cleared from DOE control unless either the property is demonstrated not to contain residual radioactive material based on process and historical knowledge, radiological monitoring or surveys, or a combination of these; or the property is evaluated and appropriately monitored or surveyed. Real property under evaluation for clearance from DOE radiological controls must be evaluated against the need for maintaining institutional controls or impacting long-term stewardship of adjacent DOE real property. Lands not meeting these requirements would, by definition, not be suitable for conveyance. These issues are discussed in **Section 3.14** and **Appendix F**, "Radiological Accidents."

Suitability also relates to the environmental condition of the property as mentioned in the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980*, Section 120(h)

[1] The total effective dose is the sum of the effective dose from external exposures and the committed effective dose equivalent from internal exposures (10 CFR 835).

(42 USC 9620, Sections 120(h)(3) to 120(h)(5)). DOE must document the environmental condition of a property and "Provide a basis for determining if property is suitable for transfer, lease or assignment" (DOE 2005) The IPT determined that some lands considered for conveyance for some uses may not be suitable based on the environmental condition.

Although not specifically a suitability issue, the IPT also determined that two Public Land Survey System sections, Section 28 in the northwest part of the PA and Section 8 in the southwest part, are part of Bureau of Land Management withdrawn lands. These two sections are removed from consideration for conveyance since the Bureau of Land Management has jurisdiction over transfers involving property that was acquired by DOE through withdrawal from the public domain as stated in the *Federal Land Policy and Management Act of 1976* (Public Law 94-579, as amended). These two Public Land Survey System sections are shown on **Figure A-1**, "Facilities and Operations that Present Suitability Concerns."

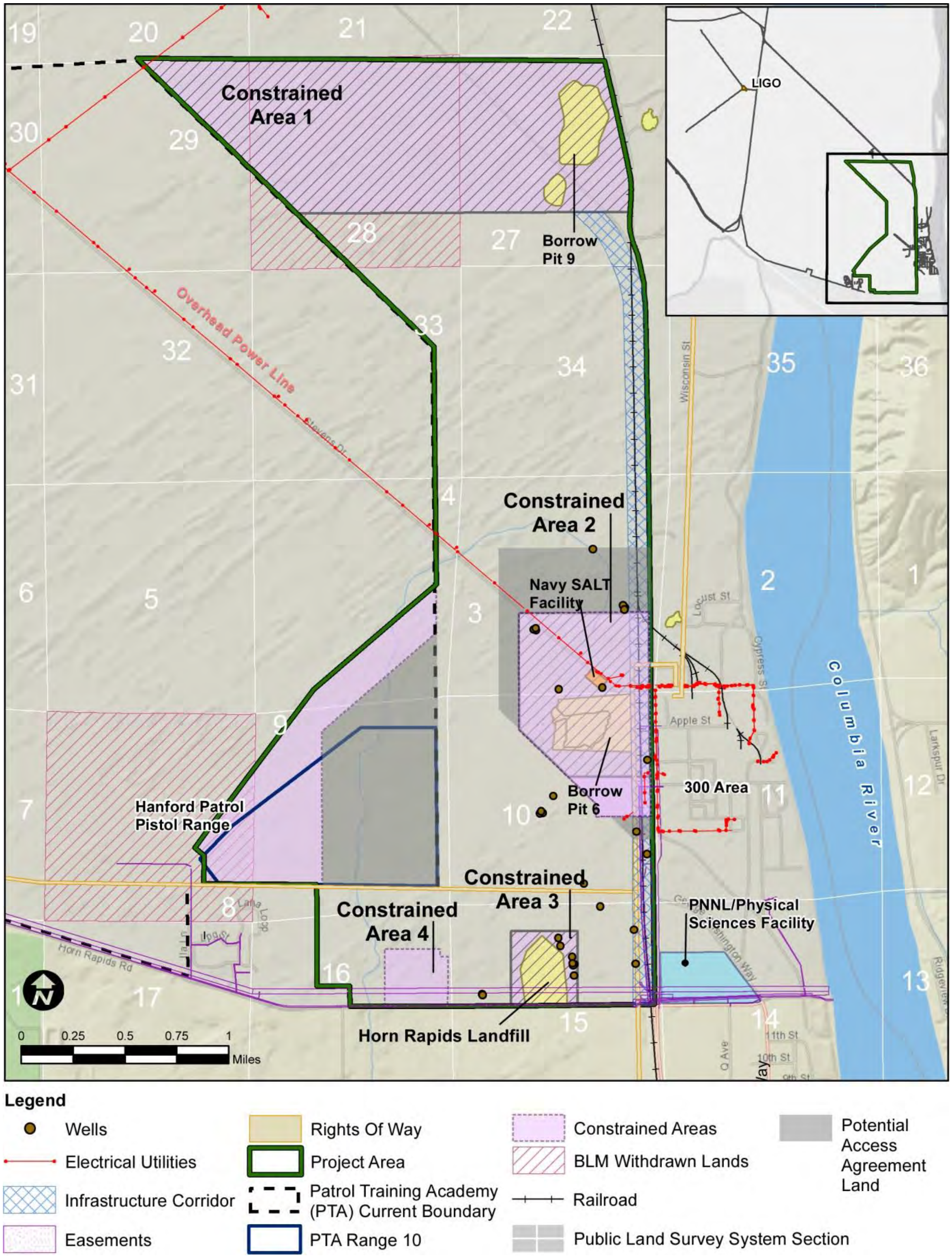
Also not specifically a suitability issue, the IPT identified the presence of various existing easements, rights-of-way, and an "infrastructure corridor" within the PA lands (see Figure A-1). DOE will retain ownership of, and require easements and the associated right-of-ways from TRIDEC for:

- Railroad line (i.e., the rails, ties, and all associated equipment) with a 100-feet easement width
- A 13.8 kilovolt electrical distribution line and parallel access road with a 185-feet easement width extending northwest from Pit 6
- A 115 kilovolt electrical transmission lines (owned by Bonneville Power Administration) with a 100-feet easement width running north-south along Stevens Drive on the west side, and going west from Pit 6
- Telecommunications lines paralleling Horn Rapids Road on the north side with an easement width of 50 feet adjacent to the road
- A 70-feet wide shoulder easement measured from 30 feet of the west side of the Stevens Drive pavement starting at the intersection with Horn Rapids Road and extending to the northern end of the Focused Study Area (FSA).

DOE is reserving the right to access and operate/maintain a 10-foot wide access route and a 20 foot radius around each groundwater well site for monitoring operations and maintenance.

Easements may be required for other things for which requirements have not been established at this time.

Figure A-1. Facilities and Operations that Present Suitability Concerns.



For the purpose of this environmental assessment, the IPT identified suitability concerns resulting from the three aspects of suitability constraints: (1) operating facility mission; (2) environmental concerns such as cultural or ecological resource protection; and (3) health, safety, and security. The four types of suitability constraints (restrictions on the conveyance of the requested or additional lands) identified by the IPT are as follows (not in any priority order):

- **Type I** – where DOE must retain full institutional control for use by ongoing operations and related safety on lands located within the PA.
- **Type II** – where DOE must retain full institutional control by having a defined safety or security distance (buffer) from ongoing DOE operations located outside of the PA. This is where DOE and Pacific Northwest National Laboratory (PNNL) operations have a potential to affect users of the conveyed lands.
- **Type III** – where conveyed land activities could affect DOE, PNNL or the Laser Interferometer Gravitational-wave Observatory (LIGO) facility operations located outside the PA.
- **Type IV** – where the Proposed Action could affect cultural, ecological, or floodplain areas located within the PA suitable lands that must be protected under federal, state, or local law. These are not discussed in this appendix but are evaluated in **Chapter 3.0** to the extent reasonable in order to protect the respective resource.

A.2 TYPE I SUITABILITY CONSTRAINTS

The **Type I suitability constraints** are shown on **Figure A-1** and described below. These "operationally" constrained areas account for 1,309 acres within the PA. Constrained Area 2 overlaps the northeast part of the 1,341-acre main TRIDEC land request area. Constrained Areas 3 and 4 lie entirely within the main TRIDEC request area. Many of these sites are related to Waste Information Data Systems (WIDS) sites that are shown on **Figure A-2**, "Waste Information Data Systems Site Locations."

A.2.1 Constrained Area 1

This 914-acre area is used as a safety buffer zone for Burial Ground 618-10 (WIDS 618-10), and Borrow Pit 9 (WIDS 600-246) activities in the northernmost part of the PA (see Figure A-2 and Figure A-3, "Burial Ground 618-10 just North of the Project Area in Section 21") (DOE 2014a). The burial ground is located offsite but adjacent to the northern border of the PA in Section 21, southwest of Route 4S. This site contains a broad spectrum of low- to high-level dry wastes, primarily fission products and some transuranic waste from the 300 Area. Low-level radioactive wastes are buried in trenches, and medium- to high-level beta/gamma wastes are mostly in the vertical pipe units. Some higher activity wastes were placed in concrete shielded drums and disposed in the trenches (DOE 2014a). Borrow Pit 9 has also been referred to as Gravel Pit 9, a large depression where gravel is extracted. The gravel pit is also used as an inert landfill for nondangerous and nonradioactive wastes. The waste includes concrete, wood, and asphalt. Soil was removed from around fuel oil day tanks and placed in Gravel Pit 9. Soil sample results showed a plutonium spike, so the bioremediation pad was posted as a Soil Contamination Area (DOE 2014a).

Figure A-2. Waste Information Data Systems Site Locations.

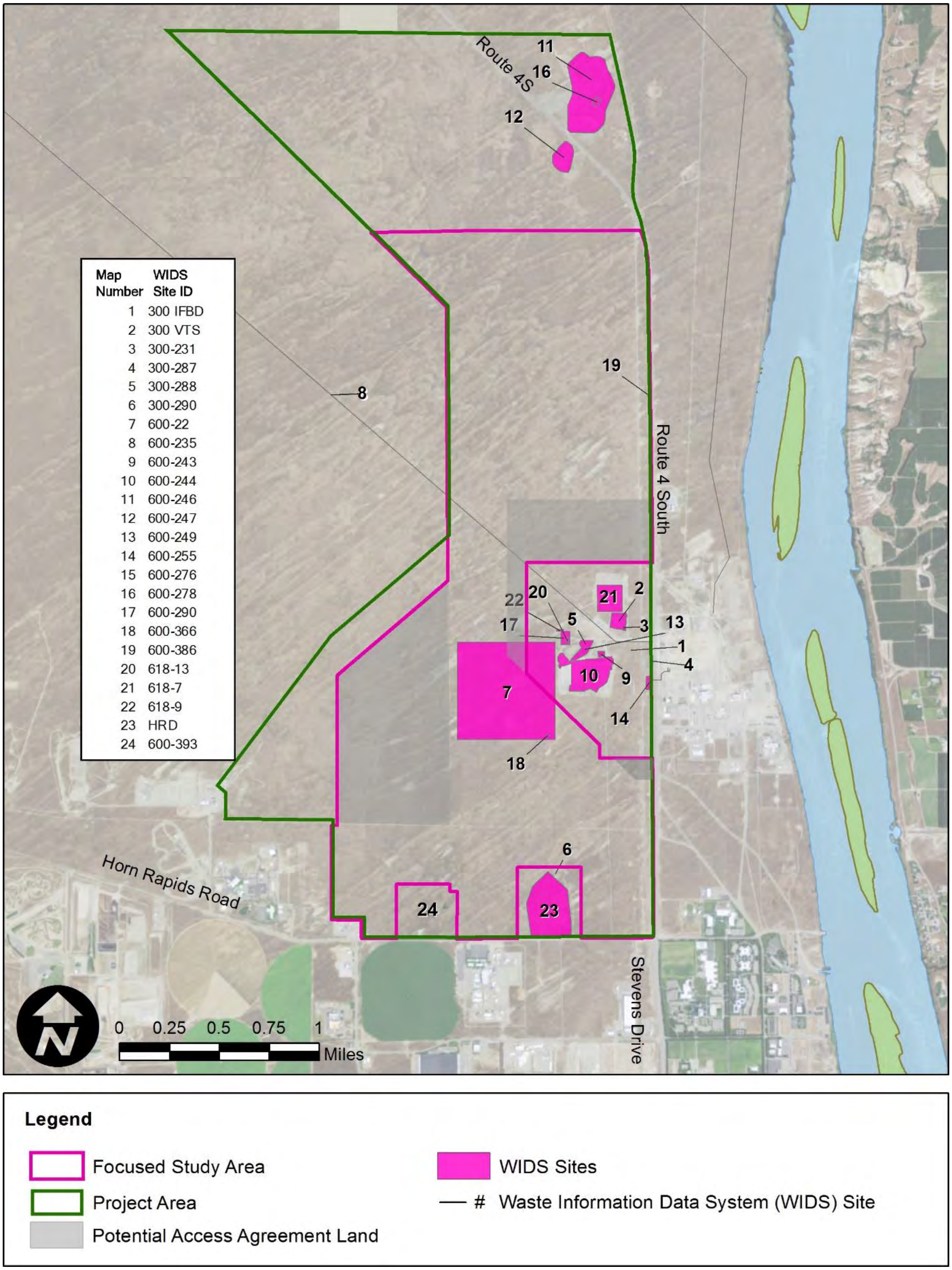


Figure A-3. Burial Ground 618-10 just North of the Project Area in Section 21.

A.2.2 Constrained Area 2

This 320-acre constrained area borders Stevens Drive directly across from the 300 Area (see Figure A-2 and Figure A-4, "Features in Constrained Area 2"). This area serves as a safety and security buffer for DOE Borrow Pit 6 (WIDS 600-244) operation and the Navy's Storage Area and Load Test (SALT) Facility. Borrow Pit 6, also referred to as Gravel Pit 6, is a source for gravel used for bedding and backfill material. A gravel road leads into a large irregularly shaped pit area. The physical boundaries of the site are larger than the area where gravel is currently being excavated. The four corners of the pit's largest extents are marked with posts (railroad ties installed vertically). Stock piles of gravel and excavation equipment are present, indicating active gravel pit operations. A chain link fenced equipment storage area is located in the northwest corner of Borrow Pit 6 (DOE 2014a).

The SALT area is used to load test transporters that transport decommissioned defueled Navy reactor compartment (RC) disposal packages and to store equipment associated with the RC disposal program. The SALT Facility consists of a 2.6-acre load test area and an adjacent 4.0-acre storage area. The load test area is fenced and has a large metal load frame placed on top of concrete walls. Concrete test weights are stacked on top of the load frame to simulate the weight of an RC disposal package. The load test site allows a transporter to drive underneath the elevated load frame and lift up the frame and concrete test weights. This allows the transporter to be load-tested prior to transporting an RC disposal package. The storage area is used to store materials and equipment associated with the handling and transport of RC disposal packages. It is fenced and has an 8-foot by 30-foot mobile office. Both areas are equipped with electrical service (Arnold 2014). Transport of the RC disposal packages requires road closures on Stevens Drive.

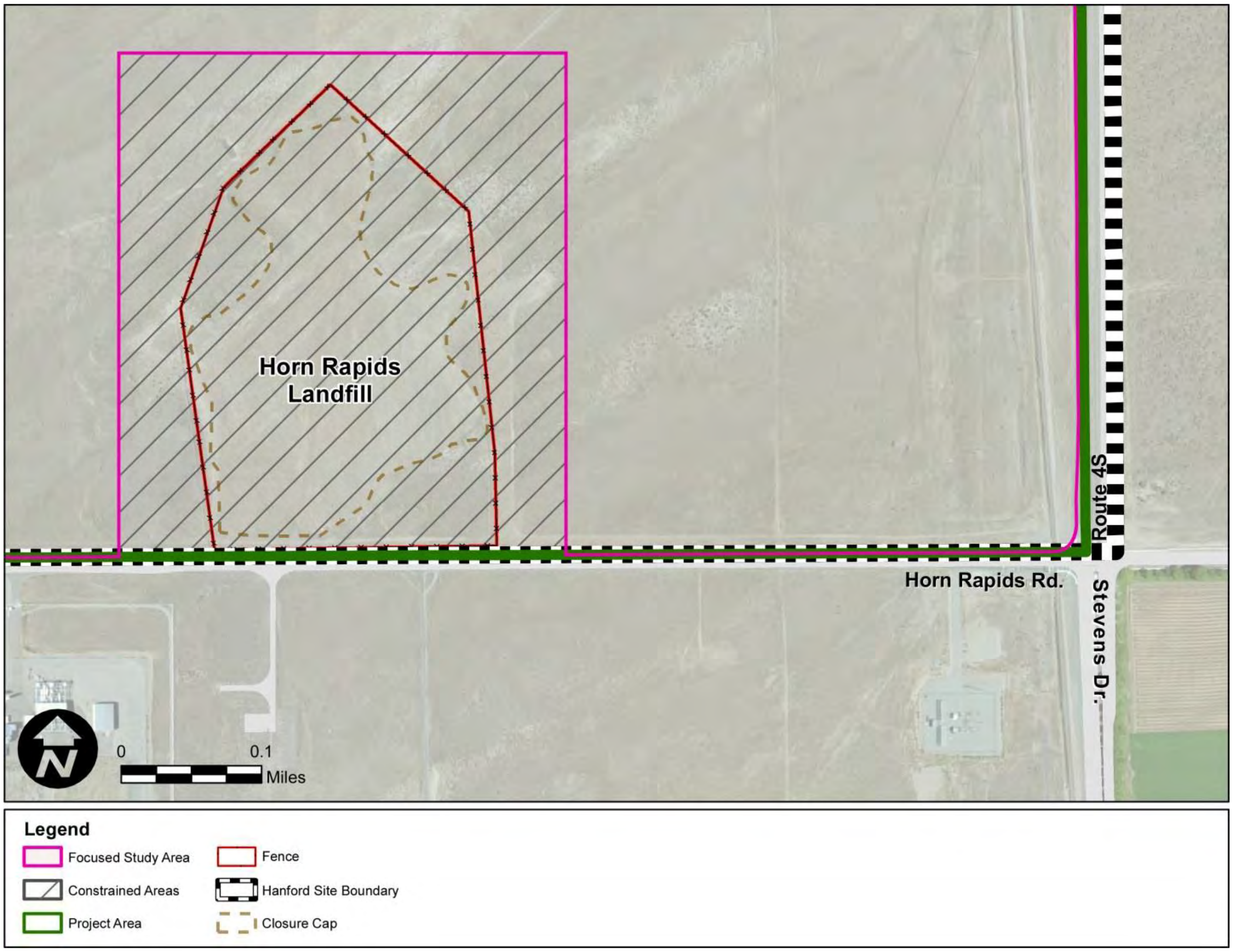
Figure A-4. Features in Constrained Area 2.

Source: PNNL 2011.

A.2.3 Constrained Area 3

This 75-acre area includes the inactive DOE Horn Rapids Landfill and surrounding area as a designated safety buffer zone (see Figure A-2 and Figure A-5, "Horn Rapids Landfill Location"). Originally a borrow pit for sand and gravel, the landfill was used from the late 1940s to the 1970s for disposal of office and construction waste, asbestos, sewage sludge, fly ash, and reportedly numerous drums of unidentified organic liquids (DOE 2012). The landfill is identified in WIDS as "HRD" (Horn Rapids Disposal) and designated as an inactive sanitary landfill (DOE 2014a). The constrained area also includes WIDS 300-290, designated as "Radiological Debris Area East of Horn Rapids Disposal Landfill" (DOE 2014a). This is a posted Radiological Materials Area classified in WIDS as an inactive dumping area (DOE 2014a).

Figure A-5. Horn Rapids Landfill Location.



A.2.4 Constrained Area 4

This area includes 53 acres of land along Horn Rapids Road east of the Hazardous Materials Management and Emergency Response Facility and west of Constrained Area 3 (see Figure A-2). This location encompasses WIDS 600-393, designated as a "Potential Battery Components Debris Area" (DOE 2014a) and a National Register of Historic Places-recommended eligible historic property. This area is a "waste disposal unit or unplanned release unit where radioactive or dangerous waste is present or possibly present" (DOE 2013). In January 2014, a "Notification of Newly Identified Solid Waste Management Units and Areas of Concern at the Hanford Facility for Calendar Year 2013" was sent to the Washington State Department of Ecology, informing them of this site's designation (DOE 2014b). The letter was submitted to ensure compliance with *Resource Conservation and Recovery Act of 1976* (RCRA) Permit Condition II.Y.3.b in advance of the Tri-Party Agreement commitment among DOE, the U.S. Environmental Protection Agency, and the Washington State Department of Ecology (Ecology et al. 2015). The site is a debris area from decomposed battery components resembling battery pads. It is classified in WIDS as an inactive dumping area (DOE 2014a).

A.2.5 Other Noncontiguous Operationally Constrained Areas

The other operationally constrained areas pertain to the Hanford Site groundwater monitoring wells (DOE 2014c) and are shown at their approximate location on **Figure A-1**. Groundwater monitoring requirements for the Hanford Site's RCRA units fall into one of two broad categories: interim status or final status. The Hanford Site's permitted RCRA units require final status monitoring, as specified in Washington State's dangerous waste regulations, "Releases from regulated units" (WAC 173-303-645). RCRA units not currently incorporated into a permit require interim status monitoring (DOE 2014c). The monitoring well locations shown on **Figure A-1** will need to be retained for monitoring in accordance with the Hanford groundwater monitoring program until no longer needed.

A.3 TYPE II SUITABILITY CONSTRAINTS

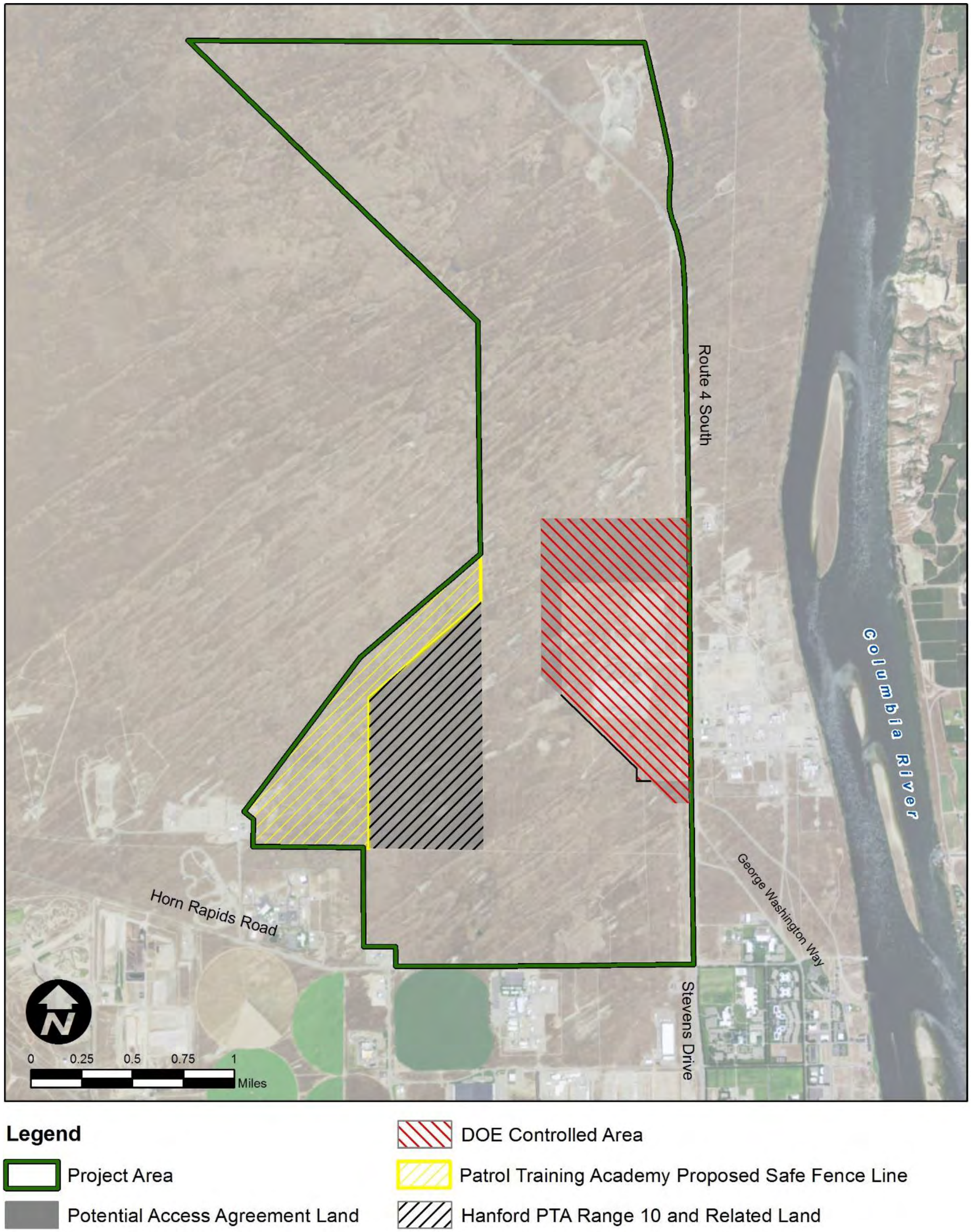
The Type II suitability constraints are shown on **Figure A-6**, "Type II Suitability Constrained Areas." These constrained areas are "mission-related" and are due to operations that are not physically located on potential conveyance lands but whose operational needs require a buffer zone that extends into them. These reflect operational needs from DOE and PNNL toward the lands to be conveyed. These include:

- A safety buffer zone for the Hanford Patrol Training Academy (PTA) Live Fire Range
- An open-space operational area of Hanford PTA Range 10
- A DOE-controlled area for Hanford Site Area 300 and PNNL.

A.3.1 Safety Buffer Zone for the Hanford Site Patrol Training Academy Live Fire Range

The Hanford PTA Live Fire Range is used by DOE security personnel; other federal personnel, military personnel; and state and local law enforcement personnel. The range is situated on Hanford PTA's campus, which occupies over 8,000 acres on the southern border of the Hanford Site (HAMMER 2015). The range, which is outside the PA, is used for target practice and includes a rifle range, a machine gun range, and a range for firing rifle-grenades. **Figure A-6** shows a proposed safe fence line for the PTA Live Fire Range. About 308 acres of buffer zone associated with the range are within the PA boundary, as indicated by the yellow hatched area on **Figure A-6**.

Figure A-6. Type II Suitability Constrained Areas.



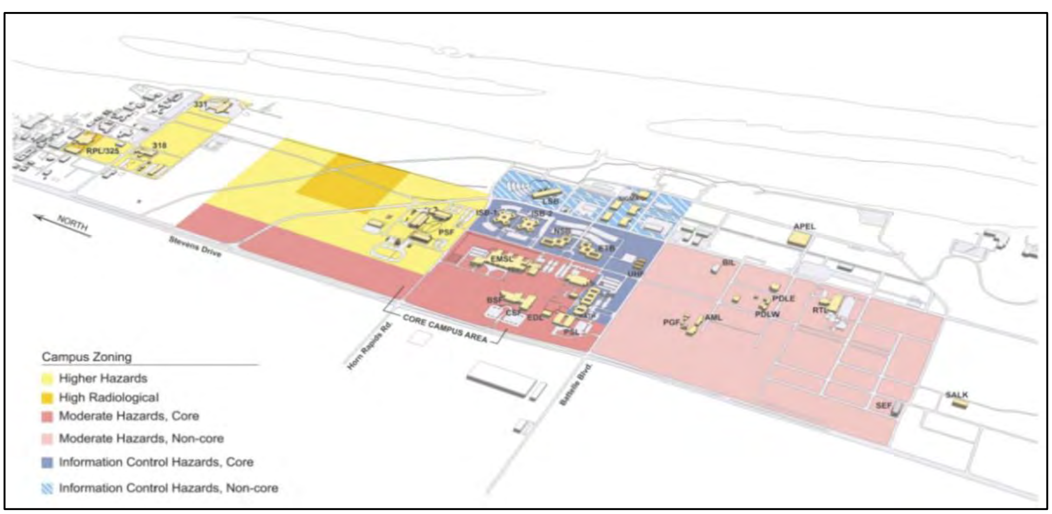
A.3.2 Patrol Training Academy Range 10 Operational Area

Hanford PTA Range 10 covers about 397 acres almost entirely within the PA (see Figure A-1); however, the operational portion of Range 10, about 140 acres, lies within the PTA proposed safe fence line safety buffer zone for the Hanford PTA Live Fire Range (see Figure A-5). Range 10 is a tactical training and firearms qualification area for nonlethal training and Multiple Integrated Laser Engagement System exercises (HAMMER 2015) and does not use live fire. The 275 acres of Range 10 to the east of the safety buffer zone represent an operational portion of the range that exists largely as an extra laser safety buffer zone (see Figure A-1). Because this area is still operational, conveyance of the 275-acre portion of PTA Range 10 could not occur by the *National Defense Authorization Act of 2015* mandated deadline of September 30, 2015, and must be retained by DOE. This is the gray-shaded area on the west side shown in **Figure A-6**.

A.3.3 U.S. Department of Energy Controlled Area

A DOE controlled area (see Figure A-6) has been established as a radiation operational buffer between the 300 Area and PNNL operations, and future users of the conveyed lands. Potential radiation sources include accident releases from Building 325 (Radiochemical Processing Laboratory), the remediation of Building 324, the operation of a future potential PNNL Hazard Category 3 facility (with a potential for only significant localized consequences) in the High Radiological Zone within the PNNL Site, and other future and current PNNL operations (Snyder 2013; PNNL 2012). Potential Access Agreement Lands that are within this controlled area would be restricted for only utilities corridors and controlled road access. Realty instrument language would, for example, limit public access to construction and maintenance activities only. While **Figure A-7**, "PNNL Campus Zoning Showing Hazard Areas Adjacent to the Project Area," is for planning purposes, the areas shown in light and dark yellow, indicating "radiological, nuclear, and other higher hazards (Higher Hazards, High Radiological)," are geographic zones where "typical operations within these laboratory facilities require special hazard considerations and/or geographic isolation for public safety. Within this zone, there is also a sub-zone of even higher risk functions requiring a significant stand-off from any public way" (PNNL 2012). The DOE controlled area is the red cross-hatched area on the east side of the PA and is shown on **Figure A-6**. This area incorporates the maximally exposed individual area of potential impact discussed in **Appendix F** and **Section 3.14**.

Figure A-7. PNNL Campus Zoning Showing Hazard Areas Adjacent to the Project Area.



Source: PNNL 2012.

A.4 TYPE III SUITABILITY CONSTRAINTS

The **Type III suitability constraints** are operational constraints that cannot be shown like the others as a geographic demarcation or location. These address how operations on the conveyed lands could affect existing operations. This type of constraint comes from acoustic, vibration, and electromagnetic noise production associated with construction or operational activities on the conveyed land and their effects on PNNL and the LIGO facility operations (see Figure A-1 for the LIGO location).

A.4.1 Type III Suitability Constraints Associated with Pacific Northwest National Laboratory

These constraints are given as acoustic, vibration, electromagnetic energy, and radionuclide emissions threshold or tolerance levels measurable at PNNL located on the PNNL site, near Horn Rapids Road and east of Stevens Drive. PNNL contains laboratories for materials science and technology, radiological detection, and ultra-trace analysis. These buildings include, for example, a radiation portal monitoring test track with accompanying large detector laboratory, a deep underground laboratory, and a central utility plant (PNNL 2012). The energy and radionuclide sensitivity threshold levels associated with two of these PNNL facilities (the Physical Sciences Facility and the Environmental Molecular Sciences Laboratory – Quiet Wing) were provided in a memorandum from the Pacific Northwest Site Office (Snyder 2013). These levels are:

- Acoustic[2] (dependent on frequency) noise generation must be less than 35 to 50 decibels[3] per 1/3 octave[4].
- Vibration (dependent on frequency) must be:
  - Less than 2 micrometers per second per 1/3 octave (approximately) in the horizontal direction.
  - Less than 1 micrometer per second per 1/3 octave (approximately) in the vertical direction.
- Magnetic interference in the nonionizing spectrum from direct current through the highest microwave frequencies must be less than 20 nanoteslas[5] in the horizontal direction, and less than 75 nanoteslas in the vertical direction.
- Electric field interference in the nonionizing spectrum from direct current through the highest microwave frequencies must be less than 300 millivolts per meter.
- Radionuclide emissions from any industrial process should not cumulatively exceed 1×10^6 becquerels per day.[6]

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[2] Acoustic refers to sound or the sense of hearing.

[3] Decibel is a unit used to express the intensity of a sound wave, equal to 20 times the common logarithm of the ratio of the pressure produced by the sound wave to a reference pressure, usually 0.0002 microbar.

[4] Any two sounds whose frequencies make a 2:1 ratio are said to be separated by an octave.

[5] A tesla is a unit of magnetic field strength or magnetic flux density. A nanotesla is one billionth of a tesla.

[6] Becquerel is the activity of a quantity of radioactive material in which one nucleus radioactively decays per second.

PNNL also stated that:

> …it should be noted that construction activities associated with facilities that would be located on the conveyed land parcel will need to be closely coordinated with PNNL to assure ongoing experiments are not disrupted. In particular, excavation, ground compacting, and operation of heavy equipment may impact R&D operations. PNNL's ultra-trace capabilities would be impacted by locating radiological-type activities in proximity to the PNNL Physical Sciences Facility. In particular, medical isotope production using fission-based methods, accelerator production activities, nuclear reactor (even a small modular reactor), or a reprocessing operation would present significant challenges to PNNL. Maximum radionuclide emissions of any industrial process should not exceed $1x10^6$ Bq/day. It is highly recommended that accommodations are made to ensure these types of activities are reviewed during the permitting to determine full range of impacts. Current and planned facilities have nuclear sources excluded from hazard categorization and analysis in their safety basis documentation, which depends on being isolated from sources of energetic hazards. Limiting aircraft operations (fixed wing and rotor impacts) would minimize impacts. (Snyder 2013).

Figure A-8, "Schematic of the Planned Potential Development of PNNL Campus Showing a 500-foot Sensitive Facility Setback from the West Side of Stevens Drive," is a schematic map of the PNNL campus plan for development (Snyder 2015). The figure shows two vertical black lines that indicate the closest that any of the PNNL future sensitive facilities would be constructed in reference to the west side of Stevens Drive. The setback is 500 feet measured from the west side of Stevens Drive to the nearest sensitive building location on PNNL (the "west side" is defined as 30 feet west of the pavement edge). The figure shows the location of the two existing PNNL operational sensitive facilities, Physical Sciences Facility and Environmental Molecular Sciences Laboratory – Quiet Wing. PNNL does not intend to construct any sensitive facilities any closer than 500 feet from the west side of Stevens Drive.

A.4.2 Type III Suitability Constraints associated with Laser Interferometer Gravitational-Wave Observatory

The LIGO facility (see Figure A-9, "Aerial View Looking West from the PA toward LIGO with Route 10 in Foreground") is about 10 miles northwest of the intersection of Horn Rapids Road and Stevens Drive (see the inset in Figure A-1). It is west-northwest of the northernmost part of the PA. This facility is designed to measure gravitational waves generated by cosmic events and is ultra-sensitive to vibration.

Figure A-8. Schematic of the Planned Potential Development of PNNL Campus Showing a 500-foot Sensitive Facility Setback from the West Side of Stevens Drive.

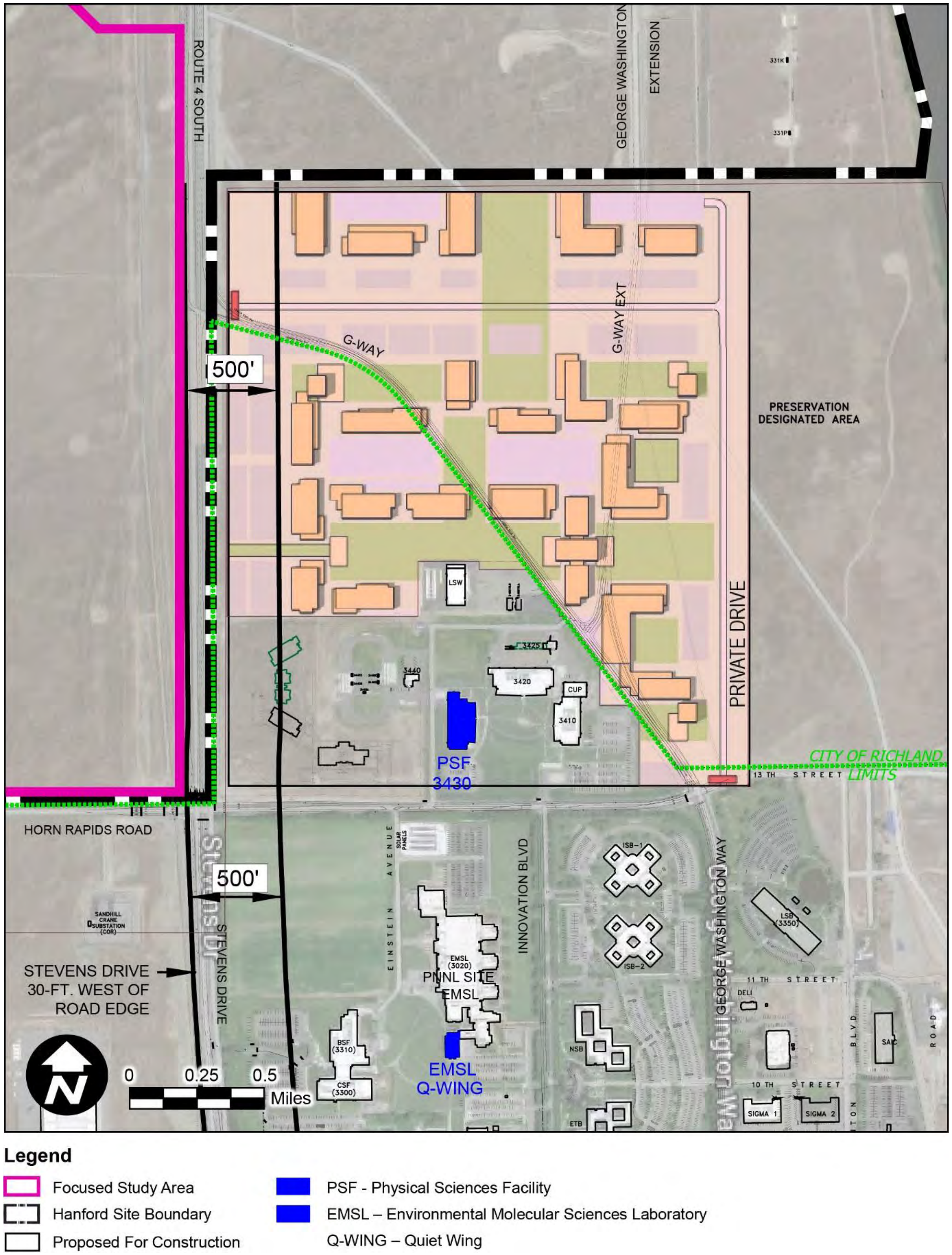


Figure A-9. Aerial View Looking West from the PA toward LIGO with Route 10 in Foreground.

The LIGO Type III constraints were provided by Dr. Fred Raab from the LIGO Facility. In his email to DOE (Raab 2014), Dr. Raab stated that the specifications he provides are for the western edge of the PA. The following was provided by Dr. Raab with added footnote:

Maximum Allowable Vibration Specification:

For the proposed conveyance property, with distances from LIGO instrumentation in the range of 7 kilometers (4.3 miles) to 15 kilometers (9.3 miles), the constraints on vibration levels to avoid significant impacts on LIGO are:

- In the frequency range from 0.3 Hz to 1.5 Hz, ground vibration levels as measured 100 meters from the source should not exceed 0.3 micrometers/seconds/root (Hz). For example, in the frequency band from 0.5 Hz to 1.5 Hz this would be equivalent to a vibration level of 0.3 micrometers/seconds root mean square (RMS).
- In the frequency range from 1.5 Hz to 2.5 Hz, ground vibration levels as measured 100 meters from the source should not exceed 0.3 micrometers/seconds/root (Hz). For example, in the frequency band from 1.5 Hz to 2.5 Hz this would be equivalent to a vibration level of 0.3 micrometers/seconds RMS.
- In the frequency range from 2.5 Hz to 3.5 Hz, ground vibration levels as measured 100 meters from the source should not exceed 0.5 micrometers/second/root (Hz). For example, in the frequency band from 2.5 Hz to 3.5 Hz this would be equivalent to a vibration level of 0.5 micrometers/second RMS.
- In the frequency range from 3.5 Hz to 5 Hz, ground vibration levels as measured 100 meters from the source should not exceed 2.5 micrometers/seconds/root (Hz). For example, in the frequency band from 3.5 Hz to 5 Hz this would be equivalent to a vibration level of 3 micrometers/seconds RMS.
- Ground vibration levels above 5 Hz are unrestricted.

A.5 TYPE IV SUITABILITY CONSTRAINTS

The **Type IV suitability constraints** are those associated with the Proposed Action that require protection of the human and ecological environment. These are most commonly related to cultural, ecological, and hydrological resources that require protection under federal, state, or local laws. Some of these constraints could result in the need for DOE to include deed restrictions in the event of a title transfer, or covenants in the case of a lease, to protect these resources to the extent practical.

In support of determining Type IV constraints in this land conveyance process, cultural surveys including those for traditional cultural properties and historic properties were conducted by the Confederated Tribes and Bands of the Yakama Nation, the Confederated Tribes of the Umatilla Indian Reservation, the Nez Perce Tribe, the Wanapum Band of Priest Rapids, and the Fort Walla Walla Museum. These were conducted in coordination with and to support the *National Historic Preservation Act* Section 106 process. Executive summaries of the Native American conducted surveys are provided in **Appendix G**, "Tribal Studies Executive Summaries." Ecological surveys and floodplains assessments have also been conducted (see Appendices H through J) and the results of these are included in the respective sections in **Chapter 3.0**.

A.6 HANFORD SITE LAND POTENTIALLY SUITABLE FOR CONVEYANCE

The land suitability review process takes into consideration each of the four suitability constraint types described above with the intent to identify lands that:

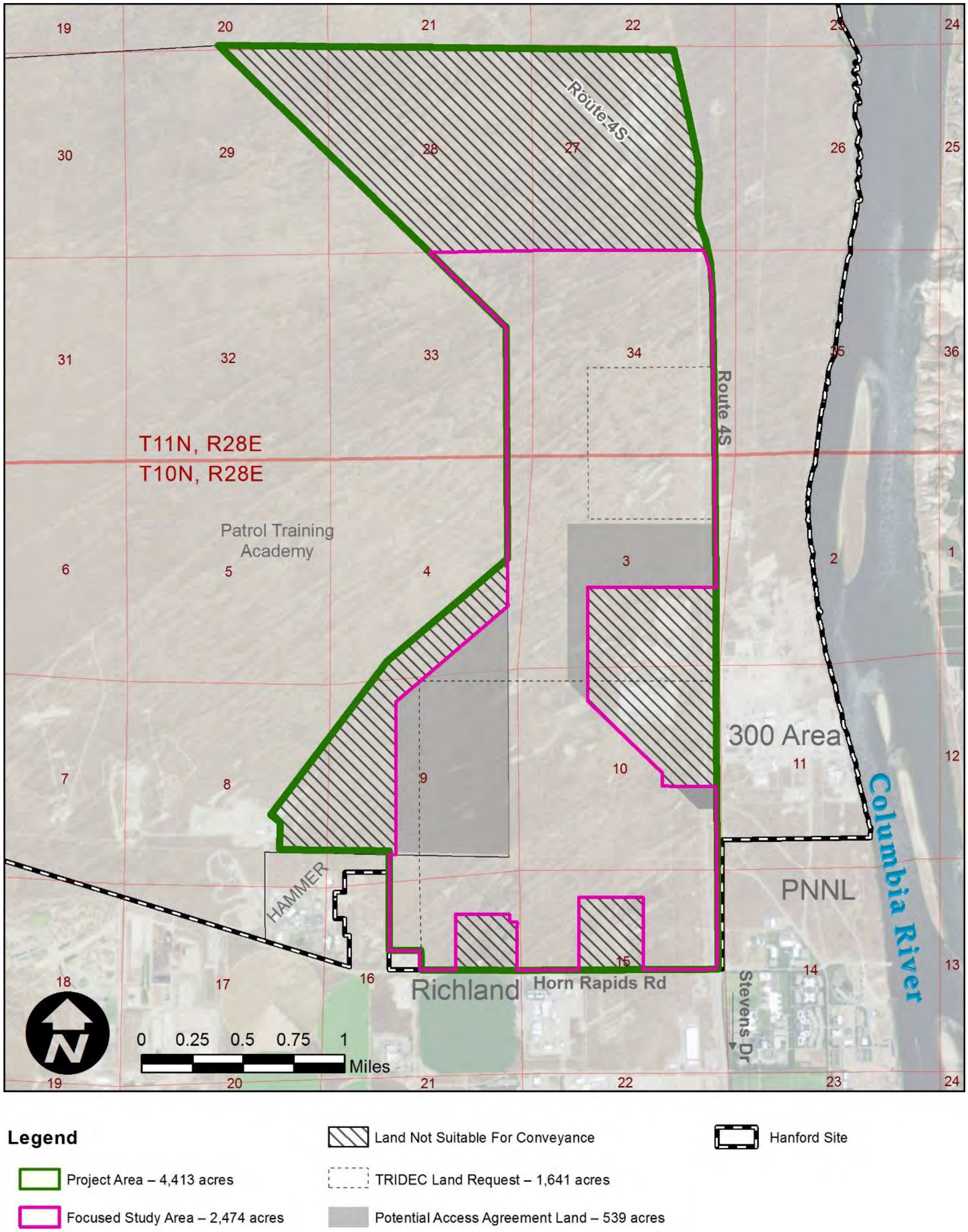
- Most suitable for conveyance by DOE
- Most useful to TRIDEC for marketing and business development
- Fewest potential operational or environmental issues that would require some type of mitigation.

Following the suitability review, the IPT prepared a map showing the Hanford Site lands that have the best potential suitability for conveyance that are defined as the FSA (2,474 acres) (see Figure A-10, "FSA Resulting from the Suitability Review Process"). The subareas within the FSA are identified as the main FSA (1,635 acres), the solar farm FSA (300 acres), and Potential Access Agreement Land. This map was prepared after concluding the following:

- **Type I** – None of these Constrained Areas are suitable for conveyance at this time because they must remain under institutional control for operational, safety, security, and regulatory reasons.
- **Type II** – The Hanford PTA Live Fire Range safety buffer zone is not suitable for conveyance at this time for safety reasons. The Hanford PTA Live Fire Range 10 operational area is not suitable for transfer. The DOE controlled area is evaluated in **Section 3.14** and **Appendix F** for impacts and mitigation and does not result in removal of any lands for suitability but may require mitigation. These lands are identified as Potential Access Agreement Lands that cannot be transferred but could be conveyed by other realty instruments remaining in DOE ownership.
- **Type III** – These constraints associated with the Proposed Action's effect on PNNL and LIGO are evaluated in **Section 3.9** and do not result in removal of any lands for suitability but certain types of usage by future owners may require mitigation.

- **Type IV** – These constraints must be identified individually for each resource area according to the TRIDEC-proposed land uses. These do not result in removal of any lands for suitability but may require mitigation.

Figure A-10. FSA Resulting from the Suitability Review Process.



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APPENDIX B – ACOUSTIC NOISE AND VIBRATION FROM CONSTRUCTION

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B. APPENDIX B – ACOUSTIC NOISE AND VIBRATION FROM CONSTRUCTION

B.1 INTRODUCTION

An analysis of environmental noise (acoustic and vibration) is based upon a source-path-receiver concept (FTA 2006). A source generates a noise. Then, along the propagation path between the source and receiver, noise levels are generally reduced (attenuated) by distance, intervening obstacles, and other factors. By the time sound reaches the receiver, noise combines from all surrounding sources and can be compounded or reduced depending upon a number of factors explained in **Section B.2**, Characteristics of Acoustic Noise.

It is expected that there will be many "sources" from construction and related equipment operation as the Focused Study Area lands are developed. There are and will be many "receivers" including the people, equipment, and buildings in the surrounding government, commercial, and industrial sites, residential and tribal members of the public, and the users of the conveyed lands. It is assumed that all construction-related activities would comply with the Washington Administrative Code (WAC) for the residential, commercial, and industrial Maximum Permissible Environmental Noise Levels (WAC 173-060-040) and the associated durations and times of day. **Section 3.9** of this environmental assessment (EA) discusses compliance with the WAC. However, as mentioned in **Appendix A**, the Pacific Northwest National Laboratory (PNNL) and the Laser Interferometer Gravitational-Wave Observatory identified scientific equipment sensitivity to acoustic noise and vibration at levels that are not protected by the WAC regulations as their threshold levels of concern are, for the most part, not generally perceptible to humans.

B.2 CHARACTERISTICS OF ACOUSTIC NOISE

"Noise" is generally understood as unwanted sound. Normally we think of sound propagating through air but it also propagates through solid media such as geologic materials, or wood and even liquids such as water. Through air, sound propagates as a compression wave and travels as fluctuations of air pressure above and below atmospheric pressure. Sound can also be described in terms of a "wave" of vibrating air particles where, at certain points along the wave, air particles are compressed and, at other points, the air particles are spread out. The height of the wave is its amplitude and the distance between two peaks of the wave is the wavelength. The human ear perceives sound as tones or frequencies. Shorter wavelengths are higher tones/frequencies and longer wavelengths are lower tones/frequencies. The sound pressure level is related to the amplitude of the wave, which we perceive as loudness. Noise may consist of a single or range of frequencies.

B.2.1 The Characteristics of Sound and Human Sensitivity

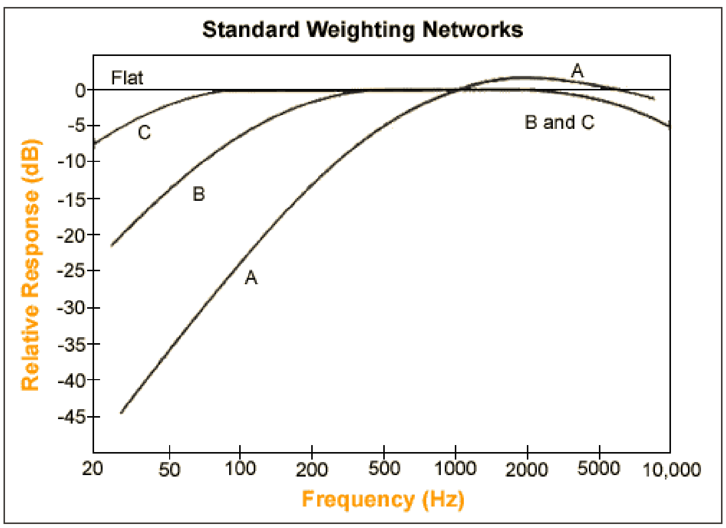
Human hearing is not equally sensitive to sound at all frequencies within the audible frequency range. At best, that frequency range is 20 to 20,000 hertz (one hertz (Hz) is one cycle or wavelength per second) for young adults with good hearing. A frequency-dependent sound pressure rating scale was developed with values given in decibels[1] (dB) to reflect the variations in human sensitivity. This is

[1] Decibel is a unit used to express the intensity of a sound wave, equal to 20 times the common logarithm of the ratio of the pressure produced by the sound wave to a reference pressure, usually 0.0002 microbar. The logarithm of a number is how many times a number, called a base, must be multiplied by itself to get that number. In the case of the "common logarithm," as specified in this definition, the base is 10. An example is10×10×10=1,000, so the common logarithm of 1,000 is 3.

referred to as the A-weighted dB (dBA) scale (a curve relating relative response to frequency shown in Figure B-1) and developed to compensate by approximating human hearing sensitivities. The lower threshold of human hearing is 0 dBA at 1,000 Hz and the human threshold of pain is somewhere around 130 dBA (DOL 2015).

Therefore, A-weighted dBA values are appropriate to use when the receiver is a human, but as shown on the figure, un-weighted dB values (the flat line on Figure B-1) are appropriate when the receiver is, for example, sensitive scientific equipment. The figure shows that A-weighted values underestimate the sound pressure levels at frequencies less than about 1,000 and more than about 7,000 Hz and overestimate them at the frequencies in between. Any two sounds whose frequencies make a two to one ratio are said to be separated by an octave. An octave band is named for its center frequency[2]. Each octave band can be broken into three smaller bands called the 1/3 octave bands (upper, center, and lower). The 1/3 octave bands are important to addressing the potential acoustic noise impact to sensitive equipment at PNNL's Physical Sciences Facility. **Table B-1** shows the 1/3 octave-band correction factors for the A-weighting (FHWA 2011a).

Figure B-1. Diagram of the standard sound weighting networks.



Source: DOL 2015.

[2] The center frequency is the geometric mean calculated as $f_c = (f_1 f_2)^{1/2}$, where f_c is the center frequency, and f_1 and f_2 are the lower and upper frequency limits, respectively.

Table B-1 Octave-band correction factors for A-weighted sound pressure levels.

One-Third Octave-Band Center Frequency (Hz)	Correction Factor, relative to 1,000 Hz	One-Third Octave-Band Center Frequency (Hz)	Correction Factor, relative to 1000 Hz
20	-50.5	800	-0.8
25	-44.7	1,000	0
31.5	-39.4	1,250	0.6
40	-34.6	1,600	1
50	-30.2	2,000	1.2
63	-26.2	2,500	1.3
80	-22.5	3,150	1.2
100	-19.1	4,000	1
125	-16.1	5,000	0.5
160	-13.4	6,300	-0.1
200	-10.9	8,000	-1.1
250	-8.6	10,000	-2.5
315	-6.6	12,500	-4.3
400	-4.8	16,000	-6.6
500	-3.2	20,000	-9.3
630	-1.9	—	—

Source: FHWA 2011a**.**

B.2.2 The Environmental Factors Affecting Sound Propagation

This EA addresses acoustic noise (sound pressure level in dBs and the associated frequencies) that is propagated or transmitted in the outdoor environment. This is significantly complicated by the sound-absorbing and sound-reflecting characteristics of the natural and man-made environment. Major studies have been performed to address sound propagation outdoors by the U.S. Department of Transportation's Federal Transit Administration (FTA) (FTA 2006) and Federal Highway Administration (FHWA 2011a). The following general discussion relies on these studies.

The environmental factors that affect noise propagation are:

1. Type of source (point or line source)
2. Distance to be traveled from the source (the receiver location)
3. Ground surface characteristics (natural or man-made)
4. Atmospheric conditions (temperature, humidity, wind, precipitation)
5. Obstructions (natural or man-made).

These factors can be described as divergence effects, ground effects, atmospheric or meteorological effects, shielding effects (FHWA 2011a), and one other effect that relates to the interaction of different sources of sound, sound interference.

Divergence is the spreading of the sound waves over distance and is either spherical (point source) or cylindrical (line source) (FHWA 2011a). In a free field, which is a location with no obstructions, sound radiates uniformly in all directions and the sound level is reduced by what is called the inverse-square law. The sound pressure intensity level (in dB) at equal spherical distances from a point source is the same. The sound level decreases by 6 dB for every doubling of the distance from a stationary point source. For a line or mobile source such as traffic noise, the decrease is less and varies between 3 and 4 dB with the doubling distance (FHWA 2011a). The divergence effect is one of the most important to consider as it results in an attenuation of sound as the receiver is farther and farther away from the source. Some construction noise would be considered a point source (stationary) while others would be a line source (mobile equipment).

To calculate a sound pressure level in a field with no obstructions (free field) for a point source the equation is (DOL 2015):

$$Lp_2 = Lp_1 - 20 \log_{10}(r_2/r_1)$$

where Lp_1 is the sound level pressure (in dBs) at distance r_1 (in feet) from the point source and Lp_2 is the sound level pressure (in dBs) at a different distance, r_2 (in feet), from the source.

An example is for a point source with a measured sound pressure level of 100 dB at a distance of 10 feet away. The calculated sound pressure level in dBs at the doubling distance of 20 feet from the same source would be: 100 – 20 log (20/10) or 94 dB (see Figure B-2).

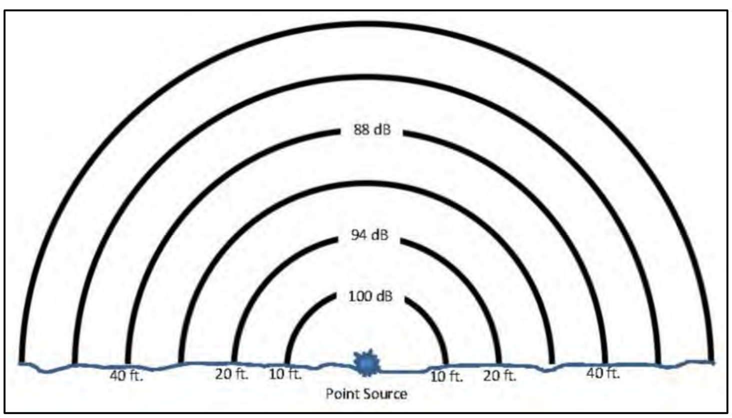
To calculate the same sound pressure level for a line source with no obstructions (free field), the equation is (FHWA 2011a):

$$Lp_2 = Lp_1 - 10 \log_{10}(r_2/r_1)$$

where Lp_1 is the sound level pressure (in dBs) at distance r_1 (in feet) from the point source and Lp_2 is the sound level pressure (in dBs) at a different distance, r_2 (in feet), from the source.

An example is for a line source with a measured sound pressure level of 100 dB at a distance of 10 feet away. The calculated sound pressure level in dBs at the doubling distance of 20 feet from the same source would be: 100 – 10 log (20/10) or 97 dB.

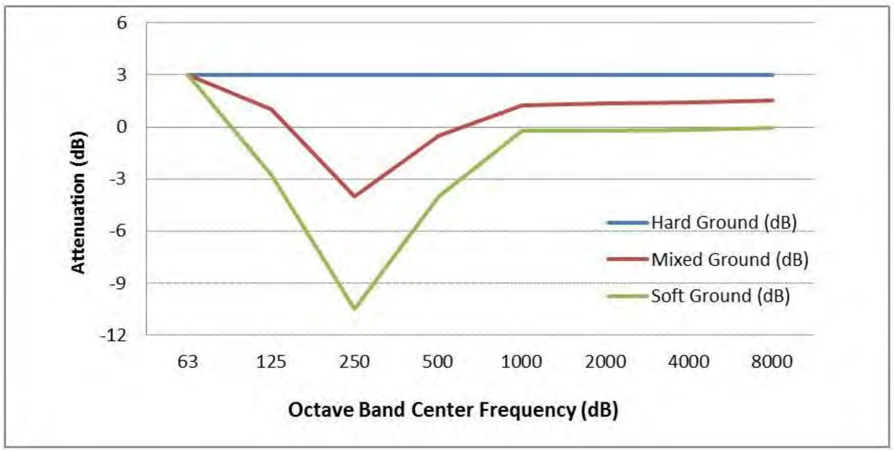
Figure B-2. Diagram of the divergence effect for a point source in a free field (no obstructions).



Ground effects refer to the change in sound level due to the ground between the source and the receiver. It is a very complex acoustic phenomenon and a function of the ground characteristics, geometry between the source and receiver, and the frequency spectrum of the source. Hard ground refers to any highly reflective surface such as water, asphalt, and concrete that preserves or increases sound energy. Soft ground refers to any absorptive surface in which the sound energy is diminished due to, for example, dense vegetation or freshly fallen snow (FHWA 2011a). Absorption is less significant at lower frequencies. Mixed surfaces are a combination of hard and soft. See **Figure B-3** for a graphic example of these effects.

> A commonly used rule-of-thumb is that: (1) for propagation over hard ground, the ground effect is neglected; and (2) for propagation over acoustically soft ground, for each doubling of distance the soft ground effect attenuates the sound pressure level at the receiver by an additional 1.5 dB(A). This extra attenuation applies to only incident angles of 20 degrees or less. For greater angles, the ground becomes a good reflector and can be considered acoustically hard. Keep in mind that these relationships are quite empirical but tend to break down for distances greater than about 30.5 to 61 m [meters] (100 to 200 ft [feet]). (FHWA 2011a).

Figure B-3. Example of the influence of ground surface effects between a source and receiver.[a]

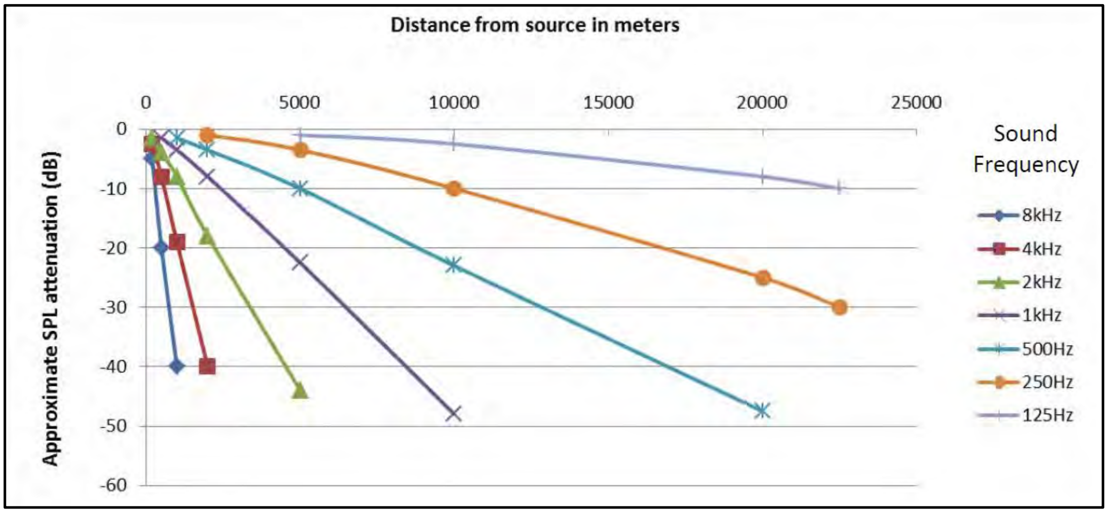


[a] Using data from BKSV 2001.

Meteorological effects result from three different atmospheric conditions (FHWA 2011a). These include (1) atmospheric absorption by air and water vapor, (2) atmospheric refraction caused by temperature and wind gradients, and (3) air turbulence.

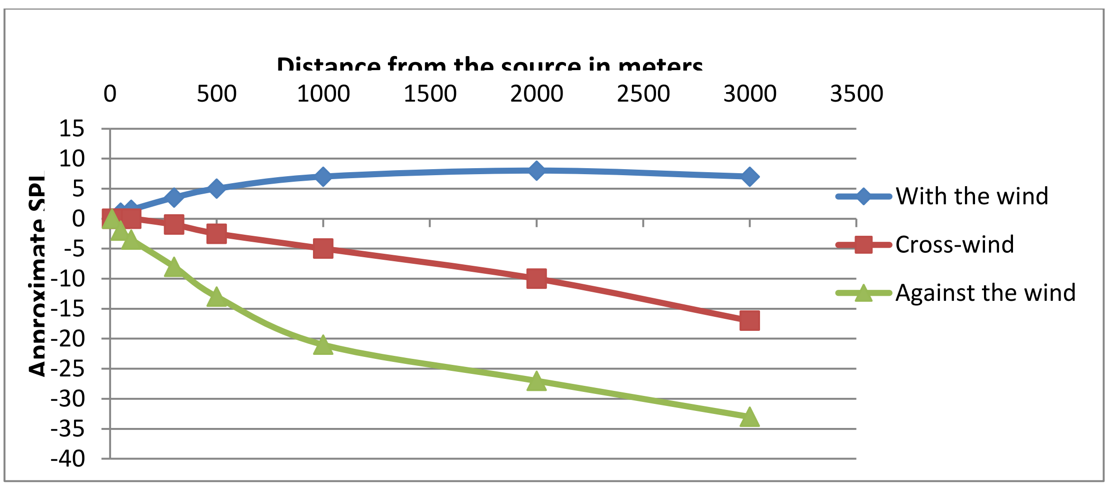
- Atmospheric **absorption by air and water vapor** over distances greater than 100 feet can substantially reduce sound levels especially at high frequencies. The effect of atmospheric absorption does not appreciably attenuate lower frequencies (see Figure B-4) (BKSV 2001).
- Atmospheric **refraction** is the bending of sound waves due largely to **near-ground wind effects** (see Figure B-5). Sound propagation against the direction of the wind (upwind) refracts sound waves upward reducing sound levels. Sound propagation in the direction of the wind (downwind) refracts sound towards the ground resulting in an increase in sound levels at the receiver. Side winds also affect noise propagation.
- **Temperature** effects on sound propagation show that when the air **near the ground** is warm it results in sound refracting upward away from the ground and decreasing sound levels at the receiver. Conversely, sound propagation when the air near the ground is cold (e.g., nighttime conditions) results in sound refracting downward and an increase in sound levels at the receiver. Refraction effects due to temperature do not substantially influence sound levels within 200 feet of the source.
- Effects on sound propagation due to air **turbulence** are largely unpredictable but can be significant within 400 feet of the source.

Figure B-4. The atmospheric effect of frequency on sound pressure level attenuation with distance



Source: Using data from BKSV 2001.

Figure B-5. Wind effects on sound pressure levels with distance.



Source: Using data from BKSV 2001.

Shielding effects from natural and man-made structures such as trees and buildings attenuate or reduce sound levels as a function of the object's size, shape, density, and the frequency of the sound source (FHWA 2011a). For example, for transportation sound sources, the FHWA found that vegetation over 15 feet high and 100 feet wide and dense enough to completely obstruct line-of-sight between the source and receiver could provide up to 5 dBA of noise reduction, and that the maximum reduction could be as much as 10 dBA. They found for buildings grouped in a row with small gaps between them could result in a 3 dBA reduction with additional rows behind them resulting in an added decrease of about 1.5 dBA for each row. For longer buildings or buildings spaced closer together, the effect could be more like a noise barrier.

Sound wave interference results in constructive, destructive (reduction), or complete cancellation when sound waves are either in or out of phase with each other (as shown in Figure B-6**)**. One of the most noticeable effects is **constructive interference** when sound waves are in phase and they add together. This results in **sound addition**. When sound waves are completely out of phase (that is, 180 degrees) they can cancel each other out resulting in no sound or **sound cancellation**. When different sound waves interact that are not completely in-phase or out-of-phase they result in **destructive interference**. The result is a sound that is intermittently louder or softer giving us the impression of pulses or beats in the sound. The new sound wave combines by both addition and subtraction to result in a new sound wave of different frequency and sound pressure level from the initial waves.

Where multiple sources of sound in the same frequency range have sound pressure levels within nine dBs of each other, there is generally a noticeable increase in sound pressure levels due to **sound addition** (DOL 2015) (see Table B-2). To accurately add sound values it would be necessary to convert the sound pressure level in dBs (a logarithmic value) back into the energy values they represent, perform the addition (or subtraction) as appropriate, and then convert the energy values back to dBs. However noise analysts have found a straightforward method to add or subtract dBs that closely approximate the longer process. This is shown in **Table B-2**. So when two sounds within, for example, one dB of each other interact they produce a sound that is 3 dBs higher than the highest sound pressure level of the two. An increase of 1 dB is just noticeable, to 3 dBs is noticeable, 3 to 6 dBs is obvious, and 6 to 10 dBs or more is significant (BKSV 2001).

Figure B-6. Sound wave interference.

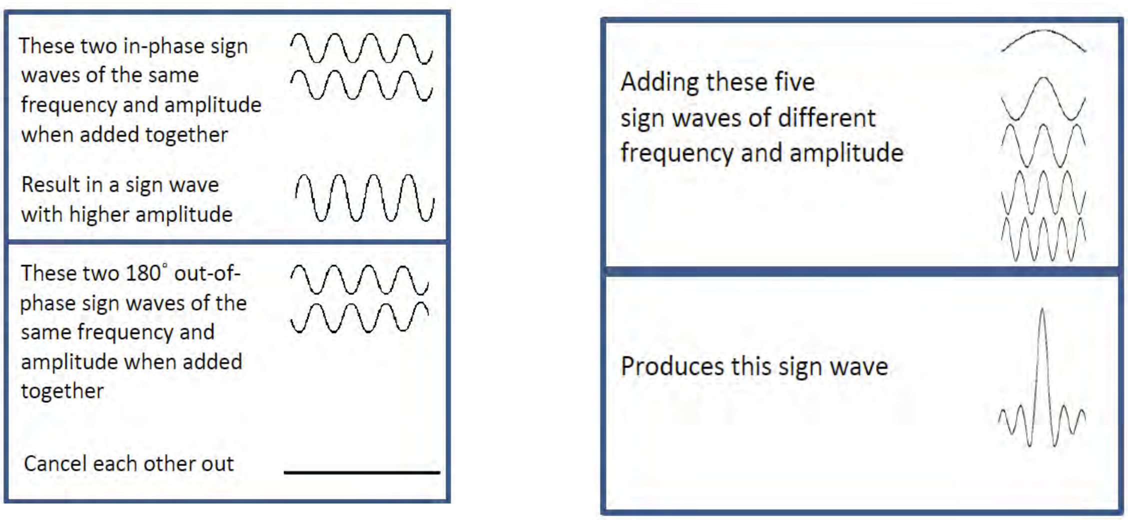


Table B-2. Table of approximations for the addition of sound pressure levels.

When two dB values differ by (dB)	Add to the higher value (dB)	Example
0 to 1	3	50 + 51 = 54
2 to 3	2	62 + 65 = 67
4 to 9	1	65 + 71 = 72
10 or more	0	55 + 65 = 65

Source: FHWA 2011a..

B.3 CONSTRUCTION EQUIPMENT ACOUSTIC NOISE SOUND PRESSURE LEVELS

Noise levels created by construction equipment vary greatly depending on such factors as the type of equipment, the power source (engines), the operation being performed, the age and condition of the equipment, and whether it is stationary or mobile. In addition, the proximity of the equipment to noise-and vibration-sensitive locations like PNNL and the Laser Interferometer Gravitational-Wave Observatory, duration of the activity (months or years), the days of the week, and time of day will influence the effects of construction noise.

Stationary equipment consists of equipment that generates noise at mainly one location, although some can be moved around a site as they are needed at different locations. These include items such as pumps, generators, and compressors. They operate at a more-or-less constant noise level (sound pressure) under normal operation and are classified as non-impact equipment. Other types of stationary equipment such as pile drivers, jackhammers, pavement breakers, blasting operations, produce variable and intermittent noise levels and produce what we perceive as hammering or impact-type noises. Impact equipment generates impulse noise. Impulse noise is defined as noise of short duration (generally less than one second), high loudness or intensity (sound pressure level), with an abrupt onset and rapid decay, often quickly changing frequency composition. The noise produced by “impact” equipment results from the striking of a heavy mass on a surface, typically repeating cyclically over time.

Mobile equipment naturally moves around a construction site. This equipment (often called “heavy” equipment) includes dozers, scrapers, excavators, and graders that may operate in a cyclic fashion in which a period of full power is followed by a period of reduced power. These are generally very large and heavy, often creating considerable acoustic noise and ground vibration as they move.

As discussed in *Construction Noise and Vibration Impact on Sensitive Premises* (Roberts 2009), “An additional factor of great importance is the presence of low frequency noise (< 200 Hz) in the source sound spectra of many items of equipment for which the ‘true’ annoyance capability at sensitive receptors is not reflected either in the measurement or prediction using the overall A-weighted sound pressure level, or dB(A).”

Table B-3 provides example values of noise (sound pressure level) measured in A-weighted dBs associated with the operation of stationary and mobile construction equipment measured at a distance of 50 feet from the source of the equipment. These data come from the Central Artery/Tunnel Project (CA/T) known as the “Big Dig” in Boston, MA (FHWA 2011b). The reason for presenting these data is to show both reasonable sound levels associated with various types of construction equipment from the regulatory and actual use perspective.

The Permissible Limit was developed for the CA/T project to be consistent with the local noise code and is based upon manufacturer information and actual measurement to ensure that equipment could meet those specifications. L_{max} represents the maximum sound pressure level. The sound pressure noise values in this table are considered reasonable and characteristic for construction equipment for this EA. Where no "actual measured" values are shown, the "Permissible Limit" value should be considered a representative maximum.

Table B-3. Construction Equipment Noise Emission Reference Levels and Usage Factors. (2 pages)

Equipment Description	Impact Device?	Permissible Limit L_{max} at 50 feet	Actual Measured L_{max} at 50 feet (averaged value from multiple samples)
All other equipment >5 horsepower	No	85	N/A
Auger drill rig	No	85	84
Backhoe	No	80	78
Bar bender	No	80	N/A
Blasting	Yes	94	N/A
Boring jack power unit	No	80	83
Chain saw	No	85	84
Clam shovel (dropping)	Yes	93	87
Compactor (ground)	No	80	83
Compressor (air)	No	80	78
Concrete batch plant	No	83	N/A
Concrete mixer truck	No	85	79
Concrete pump truck	No	82	81
Concrete saw	No	90	90
Crane	No	85	81
Dozer	No	85	82
Drill rig truck	No	84	79
Drum mixer	No	80	80
Dump truck	No	84	76
Excavator	No	85	81
Flat bed truck	No	84	74
Front end loader	No	80	79
Generator	No	82	81
Generator (<25 KVA, VMS signs)	No	70	73
Gradall	No	85	83
Grader	No	85	N/A
Grapple (on backhoe)	No	85	87
Horizontal boring hydraulic jack	No	80	82
Hydra break ram	Yes	90	N/A
Impact pile driver	Yes	95	101
Jackhammer	Yes	85	89
Man lift	No	85	75
Mounted impact hammer (hoe ram)	Yes	90	90
Pavement scarifier	No	85	90
Paver	No	85	77

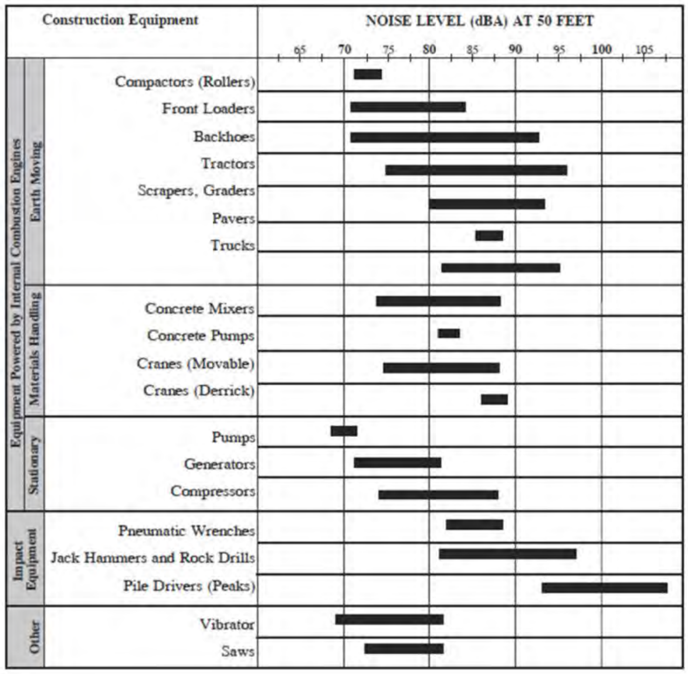
Table B-3. Construction Equipment Noise Emission Reference Levels and Usage Factors. (2 pages)

Equipment Description	Impact Device?	Permissible Limit L_{max} at 50 feet	Actual Measured L_{max} at 50 feet (averaged value from multiple samples)
Pickup truck	No	55	75
Pneumatic tools	No	85	85
Pumps	No	77	81
Refrigerator unit	No	82	73
Rivit [sic] buster/chipping gun	Yes	85	79
Rock drill	No	85	81
Roller	No	85	80
Sandblasting (single nozzle)	No	85	96
Scraper	No	85	84
Sheers (on backhoe)	No	85	96
Slurry plant	No	78	78
Slurry trenching machine	No	82	80
Soil mix drill rig	No	80	N/A
Tractor	No	84	N/A
Vacuum excavator (vac-truck)	No	85	85
Vacuum street sweeper	No	80	82
Ventilation fan	No	85	79
Vibrating hopper	No	85	87
Vibratory concrete mixer	No	80	80
Vibratory pile driver	No	95	101
Warning horn	No	85	83
Welder/torch	No	73	74

Source: FHWA 2011b.

Figure B-7 is taken from a literature study done by the U.S. Environmental Protection Agency (EPA) (EPA 1971) published in 1971, *Noise from Construction Equipment and Operations, Building Equipment, and Home Appliances* (December 31). The figure provides some similar sound pressure levels in dBA at 50 feet from construction equipment.

Figure B-7. Construction equipment noise ranges.



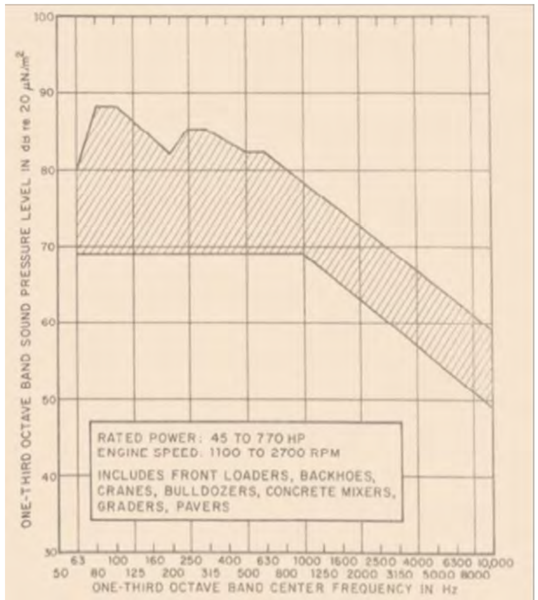
Source: EPA 1971, Figure 1.

B.4 CONSTRUCTION EQUIPMENT ACOUSTIC NOISE FREQUENCIES

Acoustic noise maximum permissible environmental noise levels such as those from the State of Washington (WAC 173-060-040) are based upon sound pressure levels in dBA and are designed to be protective of humans. However, equally important to this EA is the impact of noise to sensitive scientific equipment. For this sensitive equipment the frequency of the noise and, in particular, the one-third octave band frequencies, are an important consideration (see Appendix A, Section A.4.1). To demonstrate the frequency range and associated sound pressure levels, this section includes figures and tables or data taken from recognized authoritative sources on this subject.

Figure B-8 from the EPA construction equipment treatise (EPA 1971) shows the envelope of one-third octave band center frequency sound pressure levels for 23 different pieces of diesel-powered equipment. EPA acknowledged in that report that the diesel engine equipment “constitute the predominant noise sources.” The diesel-powered equipment in this figure was rated between 45 and 770 horsepower and was operating between 1,100 and 2,700 revolutions per minute. The noise data were obtained by making measurements of this equipment at various peripheral locations and demonstrate various degrees of loading (power utilization), ranging from none (engine idling) to heavy use. The equipment also varied in the degree of exhaust muffling.

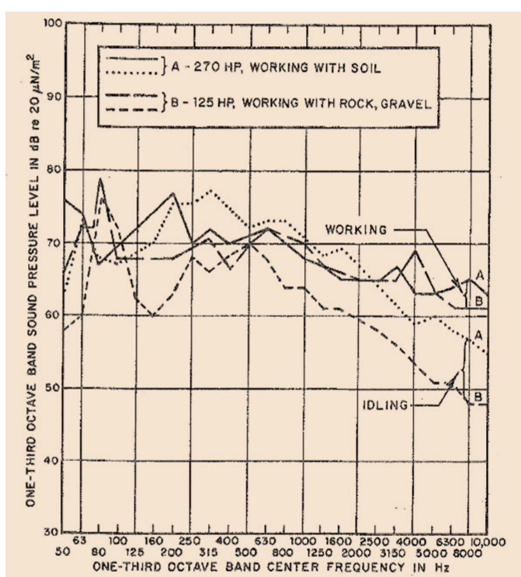
Figure B-8. Envelope of sound pressure levels from 23 diesel-powered items of construction equipment measured at 50 feet from the source.



Source: EPA 1971, Figure A.1.

Figure B-9 illustrates the sound noise frequency spectra for two "continuous track"[3] diesel-engine bulldozers. These spectra reflect not just the engine noise but also some noise due to the metal track tread, gears, and scraping of metal against rock. Gasoline engine vehicles exhibit similar spectra (EPA 1971).

Figure B-9. Sound pressure levels from two bulldozers under various conditions measured at 50 feet from the source.

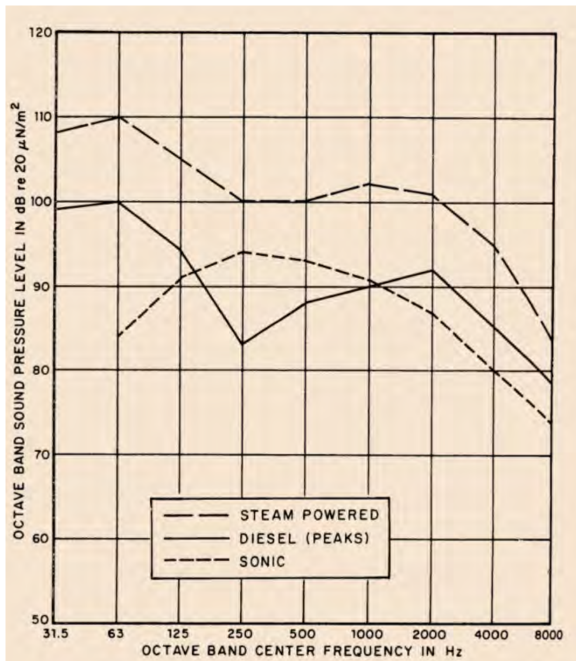


Source: EPA 1971.

[3] Continuous track refers to the vehicle's tread propulsion system. Typically, a track is a long band of joined modular steel plates that distribute the vehicle's weight and make it easier to traverse soft ground.

Figure B-10 shows pressure levels from impact equipment producing impulse sound. This example shows the "peak sound pressure"[4] levels from pile drivers driving a 14-inch diameter pipe pile into the ground, measured at 50 feet from the source (see Figure B-10). The noise from conventional pile drivers is characterized by intense peaks (the steam and diesel drivers in the figure) associated with the impacts of the hammer against the pile. The noise from the sonic pile driver is non-impact/non-impulse and, because it is driven by sonic vibration, it generates a lower level of acoustic noise sound pressure.

Figure B-10. Peak sound pressure levels from pile drivers, driving 14-inch diameter pipe piles, measured at 50 feet from the source.



Source: EPA 1971, Figure A.8.

Table B-4 shows source frequency spectra and overall noise levels for three pieces of construction equipment from Construction Noise and Vibration Impact on Sensitive Premises (Roberts 2009). The table shows one-third octave band frequencies between 31.5 and 250 Hz in the first 10 rows of the table, then shows the overall sound pressure levels in Z-weighted[5] decibels (dBZ) and A-weighted decibels (dBA) in the bottom two rows. The overall sound pressures were measured or derived from the full audio frequency range from 31.5 to 10 kilohertz.

[4] The peak sound pressure is the maximum value reached and is the true peak of the sound pressure wave and is usually either C-weighted or unweighted (that is, measured dB not dBA).
[5] Z-weighting stands for zero-weighting or no-weighting and is a measurement with equal emphasis of all frequencies.

Table B-4. Source Spectra and Overall Noise Levels

One-Third Octave Band Frequency (Hz)	Measured in Decibels at:		
	10 meters	10 meters	15 meters
	Excavator on Dirt Pile	Front-End Loader Driving	Caterpillar-Scraper - Unsilenced
31.5	89	95	86
40	93	101	83
50	96	100	76
63	96	106	83
80	104	108	103
100	104	108	87
125	97	115	82
160	100	106	81
200	100	107	82
250	100	108	75
Overall - 31.5 to 10,000 (dBZ)	112	120	103
Overall - 31.5 to 10,000 (dBA)	106	114	90

Source: Roberts 2009, Table 4.

B.5 CONSTRUCTION EQUIPMENT GENERATION OF VIBRATION

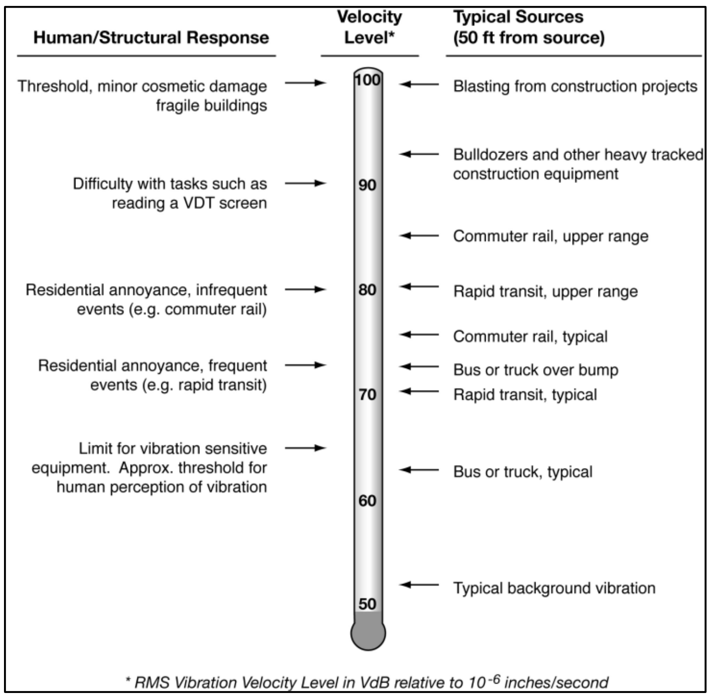
Vibration is an oscillatory motion which can be described in terms of displacement, velocity, or acceleration. Ground-borne vibration can cause building floors to shake, windows to rattle, hanging pictures to fall off walls, and in some cases damage buildings. Like noise, vibration from a single source may consist of a range of frequencies. The magnitude of vibration is commonly expressed as the peak particle velocity (PPV) in the unit of inches per second (in/sec). The PPV is the maximum instantaneous vibration velocity experienced by any point in a structure during a vibration event and indicates the magnitude of energy transmitted through vibration. PPV is an indicator often used in determining potential damage to buildings from vibration associated with blasting and other construction activities.

Because the net average of a vibration signal is zero (it goes positive and negative), the root mean square (RMS) amplitude is used to describe the "smoothed" vibration amplitude. The root mean square of a signal is the square root of the average of the squared amplitude of the signal. The average is typically calculated over a one-second period. The vibration velocity, like noise, is given in decibels but with the abbreviation of “VdB.” In the United States all vibration levels are referenced to 1×10^{-6} in/sec.

Vibration from construction projects is caused by general equipment operations, and is usually highest during pile-driving, soil compacting, jack hammering, demolition, and blasting activities. Although it is conceivable for ground-borne vibration from construction projects to cause building damage, the vibration from construction activities is almost never of sufficient amplitude to cause even minor cosmetic damage to buildings. According to the FTA in *Transit Noise and Vibration Impact Assessment* (FTA 2006), “It is unusual for vibration from sources such as buses and trucks to be perceptible, even in locations close to major roads. Some common sources of ground-borne vibration are trains, buses on rough roads, and construction activities such as blasting, pile-driving and operating heavy earth-moving equipment.”

As stated by the FTA (2006), “In contrast to airborne noise, ground-borne vibration is not a phenomenon that most people experience every day. The background vibration velocity level in residential areas is usually 50 VdB or lower, well below the threshold of perception for humans which is around 65 VdB. Most perceptible indoor vibration is caused by sources within buildings such as operation of mechanical equipment, movement of people or slamming of doors. Typical outdoor sources of perceptible ground-borne vibration are construction equipment, steel-wheeled trains, and traffic on rough roads. If the roadway is smooth, the vibration from traffic is rarely perceptible.” **Figure B-11** illustrates common sources of vibration and the human/structural responses to it. Note that the human threshold of perception to vibration is about 65 VdB.

Figure B-11. Typical levels of ground-borne vibration.



Source: FTA 2006, Figure 7-3

Various types of construction equipment were measured for the FTA (2006) analysis under a wide variety of construction activities with an average of source levels reported in terms of velocity as shown in **Table B-5**. The FTA notes that, although the table gives one level for each piece of equipment, there is a considerable variation in reported ground vibration levels from construction activities. The data provide a reasonable estimate for a wide range of soil conditions.

Like acoustic noise, vibration is attenuated as it traverses media such as ground. The mechanics of this are very complicated and beyond the scope of this analysis.

Table B-5. Vibration source levels for construction equipment.

Table 12-2. Vibration Source Levels for Construction Equipment (From measured data.[7,8,9,10])

Equipment		**PPV at 25 ft (in/sec)**	**Approximate L_v[†] at 25 ft**
Pile Driver (impact)	upper range	1.518	112
	typical	0.644	104
Pile Driver (sonic)	upper range	0.734	105
	typical	0.170	93
Clam shovel drop (slurry wall)		0.202	94
Hydromill (slurry wall)	in soil	0.008	66
	in rock	0.017	75
Vibratory Roller		0.210	94
Hoe Ram		0.089	87
Large bulldozer		0.089	87
Caisson drilling		0.089	87
Loaded trucks		0.076	86
Jackhammer		0.035	79
Small bulldozer		0.003	58

[†] RMS velocity in decibels (VdB) re 1 micro-inch/second

Note: L_v is the velocity level in decibels. RMS is the "root mean square" which is the square root of the average of the squared amplitudes. A micro-inch is 10^{-6} inches.
Source: FTA 2006, Table 12-2.

The California Department of Transportation, in Chapter 7 of their *Transportation- and Construction-Induced Vibration Guidance Manual* (Caltrans 2004), provides equations to calculate the vibration amplitudes for various construction equipment at a given distance. Below are the equation and an example problem for a pile-driver provided by Caltrans (2004):

$$PPV_{\text{Vibratory Pile Driver}} = PPV_{\text{Ref}}(25/D)^n \text{ (in/sec)}$$

where:

PPV_{Ref} = 0.65 in/sec for a reference pile driver at 25 feet
D = distance from pile driver to the receiver in feet
n = 1.1 (the value related to the attenuation rate through ground)

Example: An 80,000 foot-pound pile driver will be operated at 100 feet from a new office building and 100 feet from a historic building known to be fragile. Evaluate the potential for damage to the buildings and annoyance to the building occupants. No information on the soil conditions is known. In the absence of soil information, use n = 1.1 (see Table B-6).

$$PPV = 0.65\ (25/100)^{1.1} \times (80{,}000/36{,}000)^{0.5} = 0.21 \text{ in/sec}$$

Table B-6. Measured and suggested "n" values based on soil class.

Soil Class	Description of Soil Material	Value of "n" measured by Woods and Jedele	Suggested Value of "n"
I	Weak or soft soils: loose soils, dry or partially saturated peat and muck, mud, loose beach sand, and dune sand, recently plowed ground, soft spongy forest or jungle floor, organic soils, top soil. (shovel penetrates easily)	Data not available	1.4
II	Competent soils: most sands, sandy clays, silty clays, gravel, silts, weathered rock. (can dig with shovel)	1.5	1.3
III	Hard soils: dense compacted sand, dry consolidated clay, consolidated glacial till, some exposed rock. (cannot dig with shovel, need pick to break up)	1.1	1.1
IV	Hard, competent rock: bedrock, freshly exposed hard rock. (difficult to break with hammer)	Data not available	1.0

Source: Caltrans 2004.

The U.S. Bureau of Reclamation, in *Klamath Facilities Removal Environmental Impact Statement/Environmental Impact Review* (BOR 2012), used this methodology to calculate the effects of construction vibration at different receptor locations.

B.6 REFERENCES

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APPENDIX C – ACOUSTIC NOISE AND VIBRATION FROM FACILITY OPERATIONS

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C. APPENDIX C – ACOUSTIC NOISE AND VIBRATION FROM FACILITY OPERATIONS

C.1 INTRODUCTION

The Tri-City Development Council (TRIDEC) target marketing industry (TMI) category facility types described in this environmental assessment (EA) (Chapter 2) are commercial operations and they must follow federal, state, and local laws and regulations governing worker and public safety as well as protection of the environment. The facilities that could be constructed would, of necessity, be designed and built to comply with these regulations and building codes so as not to incur fines, penalties, or other potential costs associated with civil actions against them. Therefore, both the regulators and the regulated are interested in knowing what if anything about the facility operations could exceed limits for noise or vibration. This, it is not uncommon for facilities that are likely to have environmental noise issues to prepare a noise impact analysis, report, or mitigation plan. They may even be required to prepare one by a local city or county ordinance for facilities similar to those evaluated in this EA. Some examples of these noise plans are:

- *LRI and BioFuels Energy Landfill Gas to Energy Facilities, Noise Mitigation Plan,* Tacoma, WA (SCS 2012)
- *Noise Impact Analysis, Cott Beverage Facility*, San Bernardino County, CA (LSA 2012)
- *Noise Impact Feasibility Study Canadian Tire Distribution Centre, Bolton, Ontario, Canada* (HGC 2013)
- *Noise Impact Analysis, California State University Long Beach, Foundation Retail Project, City of Long Beach, Los Angeles County, CA* (LSA 2013a)
- *Noise Impact Analysis, Bloomington Truck Terminal,* Long Beach, CA (LSA 2013b)
- *Noise Assessment for Proposed Dartmouth Street Zone Substation, Queensland, Australia* (EEC 2011)
- *Noise Assessment: Borrego 1 Solar Project,* Borrego Springs, CA (LDN 2011).

Once these noise impact analyses raise the important issues, architects and industrial design engineers incorporate appropriate environmental noise control and mitigation strategies into facility planning. Understandably it is not in the best interest of a company to use equipment that emits a lot of acoustic noise or vibration because of the related health and safety and equipment maintenance costs. But when they must, it is most likely they would locate as much of the potentially noise-offending equipment as possible within acoustical noise and vibration-dampened rooms or enclosures to comply with federal and state occupational safety and environmental regulations. The equipment in these buildings are primarily of concern for worker health and safety, but it is the stationary and mobile equipment located outside (on top of and around buildings) that are of most concern in this EA since noise from these sources would be the most likely to propagate to potential receivers on- and off-site.

As explained in Chapter 2, facility operations relevant to this EA are those associated with the TRIDEC TMI categories. The categories include warehousing and distribution, research and development, technology manufacturing, food and agriculture, back office, and energy. The operations within these categories include such things as manufacturing, food processing, and material handling (see Figure 2-2 in Chapter 2, *TRIDEC's General Current and Projected Target Marketing Industries*), but it is the equipment used by these facilities and operations that generate the environmental noise (acoustic and vibration).

Facility equipment and operations that generate environmental noise can generally be classified into three categories. These are:

1. **Stationary equipment** that may include a very wide range of equipment including generators, pumps, compressors, crushers (of plastics, stone or metal), grinders, screens, conveyers, storage bins, and electrical equipment
2. **Mobile equipment** that may include drilling, haulage, pug mills, mobile treatment units, and service operations
3. **Transportation equipment** for movement of products, raw material, or waste that may include truck traffic on the operating facility grounds, loading and unloading trucks, and movement in and out of a facility

In general, the most environmental noise from facility operations comes from equipment such as heating, ventilation, and air conditioning systems (HVAC); generators; compressors; transformers; and trucks. The equipment associated with the representative facility types overlap one another, and some equipment is common to all facility types. For example, all facility types have buildings and parking lots for their employees or customers. Therefore, these all have environmental noise from building mechanical equipment (for example, HVAC and emergency generators) and automotive vehicles. It should be noted that the Commerce Center is not a facility type unto itself but is a mixture of warehouse and distribution, food and agriculture, and back office-related type facilities.

The major environmental noise sources for TRIDEC TMI facility types have been described as follows:

- **Warehouse distribution centers –** these facilities require arriving/departing hauling trucks, shunter trucks[1], exhaust fans and HVAC systems, and testing of emergency generators (HGC 2013).
- **Research and development** – these facilities could use equipment found in any of the other five industry types shown here, although in much lesser quantities, because the purpose of research and development is innovation not production.
- **Technology and manufacturing –** these facilities have general industrial noise classified as impact (punch presses, stamping machines, and hammers), mechanical (machinery unbalance, resonant structures, gears and bearings), fluid flow (fans, blowers, compressors, turbines, and control valves), and combustion (furnaces and flare stacks) (EPA 1971).
- **Food and agriculture** – these are primarily food/agriculture processing facilities with some warehousing and distribution operations and equipment such as conveyor belts, vibrating tables, pneumatic systems, and trucks (WDOLI 2001).
- **Back office –** these facilities have general building noise (HVAC and emergency generators) and automotive vehicles.

Energy was added as a category to the original five listed above because of TRIDEC's amended request and interest. In these facilities, the equipment used and the noise generated are specific to a particular operation, such as:

- **Solar energy operations** – these facilities utilize equipment such as solar dish engines, pumps, solar tracking devices (electric motors), electrical substations (transformers and switchgears) and

[1] A shunter truck is a semi-tractor used to move semi-trailers within a cargo yard or warehouse facility.

transmission lines, employee and maintenance vehicular traffic, and maintenance facilities (DOI 2015a).

- **Biofuels processing facilities** – these facilities require equipment such as biomass power plant heat recovery systems, milling rooms and boilers, wood chippers, steam turbine generators, exhaust stacks, mechanical-draft cooling systems, electrical substation switchgear, transmission lines, vehicular traffic, and maintenance facilities (DOI 2015b).

As described in Appendix B, an analysis of construction environmental noise (acoustic and vibration) is based upon a source-path-receiver concept. The same concept applies to facility operations. There will be many sources from facility operations as the Focused Study Area lands are developed. There will also be many receivers including the people, equipment, and buildings in the surrounding government, commercial, and industrial sites, residential and tribal members of the public, and other users of the conveyed lands.

It is assumed that the facility operation employers on the Focused Study Area lands transferred, once developed, would protect their employees and comply with the Washington Department of Labor and Industries, Division of Occupational Safety and Health, "General Safety and Health Standards" (WAC 296-24). It is also assumed that all operations-related activities would comply with the Washington Administrative Code for the residential, commercial, and industrial maximum permissible environmental noise levels (WAC 173-060-040) and the associated durations and times of day. **Sections 3.9** and **3.14** of this EA discuss compliance with the Washington Administrative Code for human health and safety. Similarly, vibration in the workplace would be kept within ergonomic standards because of the U.S. Occupational Health and Safety Administration's (OSHA's) "General Duty Clause" (*Occupational Safety and Health Act of 1970*, Section 5(a)(1)) requiring employers by reference to comply with the American Conference of Governmental Industrial Hygienists' Threshold Limit Values for Physical Agents ergonomic standard for whole-body vibration and any "known" vibration-related health issues.

These state, federal, and organizational standards are for the comfort and protection of humans, and this EA assumes that by complying with these standards, the future site workers and members of the public will be protected since that is the intent of the standards. However, as mentioned in **Appendix A**, the Pacific Northwest National Laboratory (PNNL) and Laser Interferometer Gravity-wave Observatory (LIGO) identified equipment sensitivity to acoustic noise and vibration at levels that are not protected by these regulations as their threshold levels of concern (see Appendix A) and that are below levels perceptible to humans. Therefore, this appendix focuses on providing supporting information to address acoustic noise and vibration important to determining impacts to PNNL and the LIGO operations. Also, as mentioned above, it is the stationary and mobile equipment located outside (on top of and around) that are of most concern to this EA since noise from these sources would be the most likely to propagate their sound and vibrational energy to potential receivers on- and off-site.

C.2 ACOUSTIC NOISE FROM FACILITY OPERATIONS

The characteristics of sound and human sensitivity presented in **Appendix B** apply equally to construction or facility operations. The environmental factors affecting sound propagation presented in **Appendix B** are also directly relevant to facility operations. Construction and operations have some equipment in common, but most of the acoustic noise sources for operations are different. An example of where some construction heavy equipment would be used in facility operations is the biofuels processing facility.

This section focuses on the major acoustic noise sources for facility operations that are not used in construction. These are predominantly located outside of buildings. These account for six main noise sources:

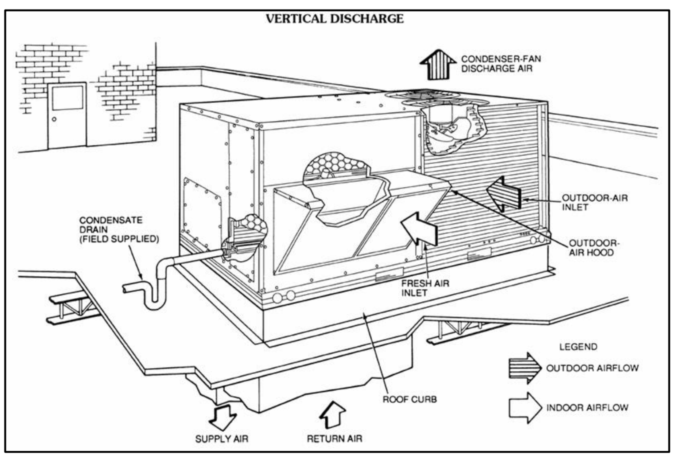
1. HVAC systems (Section C.2.1)
2. Automotive vehicles (Section C.2.2)
3. Railroad trains (Section C.2.3)
4. Emergency generators (Section C.2.4)
5. Electrical energy transmission equipment (Section C.2.5)
6. Solar energy equipment (other than electrical transmission equipment) (Section C.2.6).

Railroad trains are included because they are integral to the operation of one of the warehouse and distribution representative examples, the Railex® facility. They also have the potential to be used in other facility types, but are not integral to them.

C.2.1 Acoustic Noise from Heating, Ventilation, and Air Conditioning Systems

One of the most-recognized acoustic noise-generating pieces of equipment for buildings is the HVAC system. Recognized components of these systems are electric or thermal chillers, cooling towers, air distribution systems (such as fans), and water distribution systems (such as cooling coils, pipes and pumps). Moving gases and fluids generates the acoustic noise. The larger the facility, the bigger or greater amount of equipment, and the more noise generated. Inside buildings, parts of the HVAC systems are enclosed in sound reduction rooms. Outside buildings, the other parts are placed on the roof (see Figures C-1 and C-2) or on outdoor concrete slabs in enclosures separated from the buildings to isolate the noise from workers and customers (see Figures C-3 and C-4).

Figure C-1. Packaged HVAC rooftop unit.

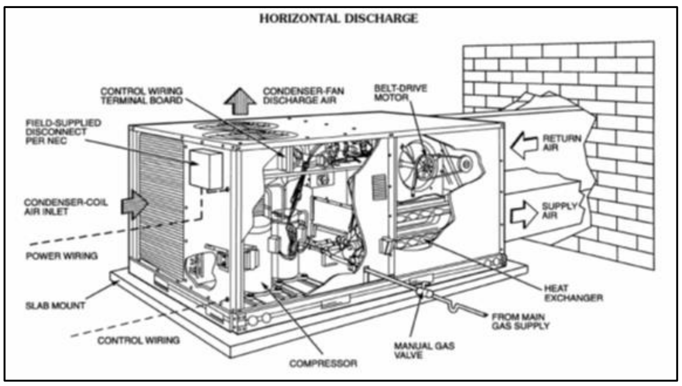


Source: Brandemuehl 2015.

Figure C-2. Photo of HVAC rooftop unit on commercial building roof.

Source: BRD 2015.

Figure C-3. HVAC outdoor concrete slab installation.



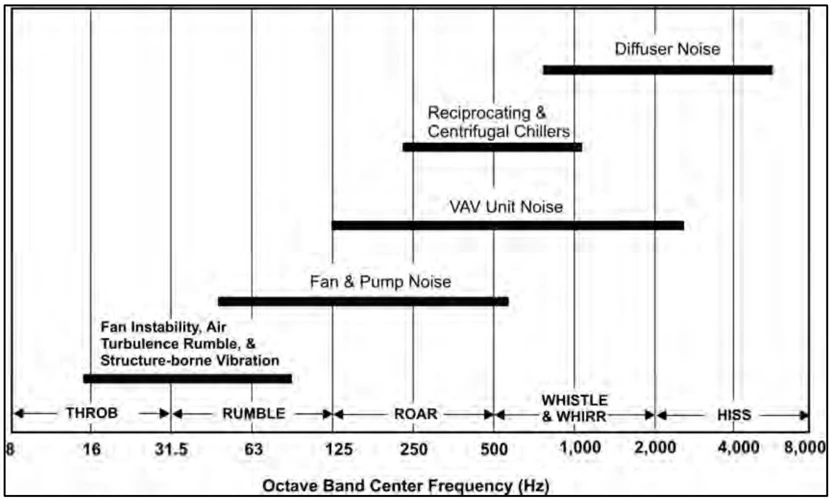
Source: Brandemuehl 2015.

Figure C-4. HVAC outdoor concrete slab photo.

Source: BRD 2015.

Figure C-5 is a horizontal bar chart showing the acoustic noise frequency ranges for various types of HVAC equipment by octave band center frequency. The diffuser and variable air volume (labeled as "VAV" in the figure) are building interior HVAC components and not important to this discussion. Note that the audible sound descriptors (that is, throb, rumble, roar, and whistle & whirr) are mostly in the low frequency ranges associated with an octave band (McQuay 2004) and are what an individual hearing these would experience. As fan components wear from nearly continuous use, some become worn and unstable, creating additional noise in the low octave bands (fan instability).

Figure C-5. Sound frequency ranges for various components of HVAC equipment.



Source: McQuay 2004

Tables C-1 and **C-2** provide some indication of the sound pressure levels (SPL) associated with the different octave band center frequencies at 30 and 80 feet, respectively, from four example HVAC chillers (BRD 2015). Since these are measured values, they would consider both fan and pump noise internal to the chillers.

Table C-1. Sound pressure levels at 30 feet from the source for four different chiller manufacturers and models.

	Sound Pressure Levels (dBA) Measured at 30 Feet from the Source								**Overall A-Weighted**
	Octave Band Center Frequency (Hz)								
	63	125	250	500	1000	2000	4000	8000	(dBA)
1	70	67	65	70	63	61	57	55	70
2	75	76	72	72	71	67	60	57	75
3	40	43	52	56	62	64	61	53	68
4	66	72	70	73	70	64	61	53	74

Source: BRD 2015.
Key: dBA = A-weighted decibel; Hz = hertz.

Notice that, for the "overall" measurement, there is on the order of a 10-dBA drop between 30 and 80 feet for each of the four chiller examples. However, it is important to remember that this drop is a function of the site environmental characteristics (such as soft or hard ground, reflections, directivity). The closer the receiver is to the source, the less impact that site characteristics have on the noise propagation.

Table C-2. Sound pressure levels at 80 feet from source for four different chiller manufacturers and models.

	Sound Pressure Levels (dBA) Measured at 80 Feet from the Source								Overall A-Weighted
	Octave Band Center Frequency (Hz)								
	63	125	250	500	1000	2000	4000	8000	(dBA)
1	63	57	57	59	54	48	44	42	60
2	52	60	61	59	56	54	46	41	62
3	31	33	43	46	49	51	48	42	56
4	57	63	61	61	60	55	52	42	64

Source: BRD 2015.
Key: dBA = A-weighted decibel; Hz = hertz.

C.2.2 Acoustic Noise from Automotive Vehicles

It is generally recognized that the heavier traffic volumes, higher speeds, and greater numbers of trucks increase the loudness of highway automotive vehicle traffic noise. The source of automotive vehicle traffic noise comes primarily from vehicle exhausts, vehicle engines or powertrains, and tire interactions with pavement, but defective mufflers or other malfunctioning equipment can increase the loudness. Once highways speeds are achieved, the predominant noise from light trucks and cars is from tire/pavement interaction, but for heavy trucks noise volume comes from all three sources. Any condition that causes motor vehicle engines to labor more heavily, such as starting from a dead stop or going up a steep incline, also increases traffic noise levels (FHWA 2014). The level of highway traffic noise primarily depends upon three things: the volume of traffic, the speed of the traffic, and the number of trucks in the flow of traffic (FHWA 2014).

For the purpose of highway traffic noise analyses, automotive vehicles fall into one of the five types listed below:

1. **Automobiles**: all vehicles with two axles and four tires, designated primarily for transportation of nine or fewer passengers (automobiles) or for transportation of cargo (light trucks). Generally, the gross vehicle weight is less than 4,500 kilograms (kg) (9,900 pounds [lb]).
2. **Medium trucks**: all cargo vehicles with two axles and six tires. Generally, the gross vehicle weight is greater than 4,500 kg (9,900 lb) but less than 12,000 kg (26,400 lb).
3. **Heavy trucks**: all cargo vehicles with three or more axles. Generally, the gross vehicle weight is greater than 12,000 kg (26,400 lb).
4. **Buses**: all vehicles having two or three axles and designated for transportation of nine or more passengers.
5. **Motorcycles**: all vehicles with two or three tires with an open-air driver and/or passenger compartment.

The *Noise Control Act of 1972* gave the U.S. Environmental Protection Agency (EPA) the authority to establish noise regulations to control major sources of noise, including transportation vehicles and construction equipment. Accordingly, **Table C-3** shows the Maximum Noise Emission Levels established by EPA for medium and heavy trucks with a gross vehicle weight rating over 10,000 lb engaged in interstate commerce (40 Code of Federal Regulations [CFR] Part 205). These standards do not apply to highway, city, and school buses or to special purpose equipment, which include (but are not limited to) construction equipment, snow plows, garbage compactors, and refrigeration equipment (40 CFR 205.50). The standards are based upon actual driving on either concrete or sealed asphalt (without gravel) and therefore represent noise from the vehicle including vehicle exhausts, vehicle engines or powertrains, tire interactions with pavement, and defective mufflers or other malfunctioning equipment. It can be assumed for this EA that the makeup of medium and heavy trucks would almost entirely be post-1988 manufactured truck vehicles. Those used on roads within the City of Richland would not be allowed to emit noise greater than 80 dBA at 50 feet from the centerline of the roadway when idling or underway (Table C-3). Any pre-1988 vehicles would not appreciably affect the site noise levels. However, this does not include any auxiliary equipment such as tractor-trailer refrigeration units.

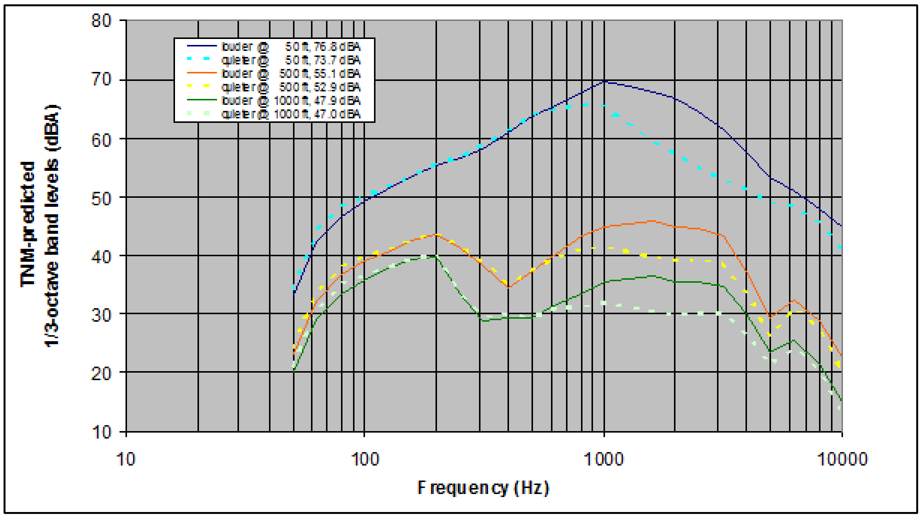
Table C-3. Maximum noise emission levels allowed by EPA for in-use medium and heavy trucks with gross vehicle weight rating over 10,000 pounds engaged in interstate commerce.

	Effective Date January 1, 1979 (Vehicles Manufactured After this Date)	**Effective Date January 1, 1988 (Vehicles Manufactured After this Date)**
Truck Speed (miles per hour)	Maximum Noise Level at 50 feet from the Centerline of Travel (dBA)	Maximum Noise Level at 50 feet from the Centerline of Travel (dBA)
Less than 35	83	80
Greater than 35	87	80
Stationary	85	80

Source: FHWA 2012.
Key: dBA = A-weighted decibels.

The Federal Highway Administration's (FHWA's) Traffic Noise Model (TNM) is the recognized standard for evaluating potential noise impacts from traffic. The data in **Figure C-6**, presented in dBA, show the most significant SPL drop off of the mid- and upper-range frequencies with distance from 50 to 500 to 1,000 feet, consistent with the "soft ground" surface characteristic. The shape of the 500- and 1,000-foot curves indicates the influence of the environmental factors in sound propagation. The 50-foot curve reflects the source frequency and SPL make-up.

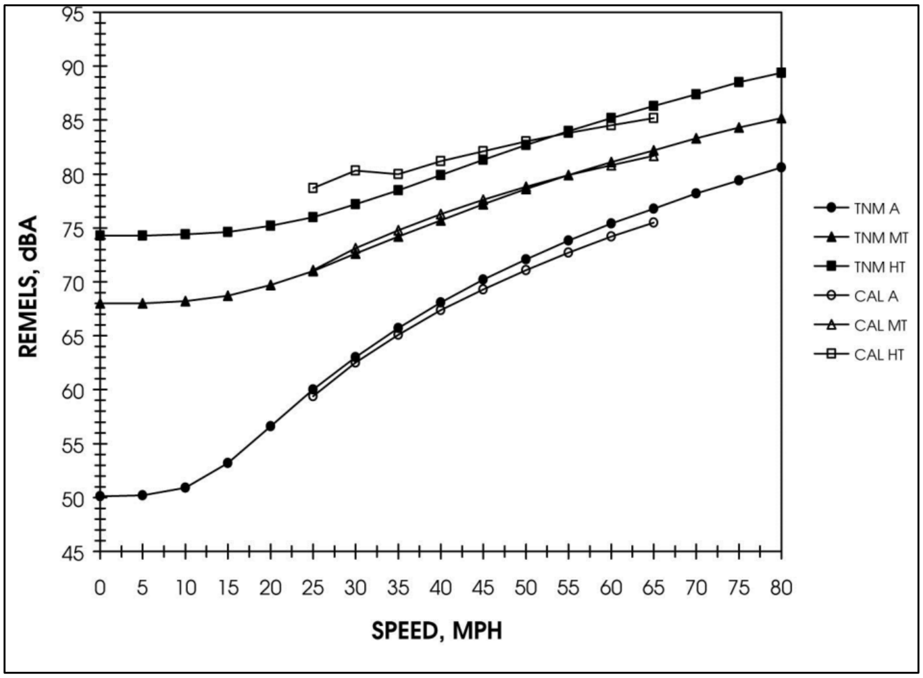
Figure C-6. FHWA Traffic Noise Model output of predicted sound pressure spectral levels for a flat site, with no noise barriers, and acoustically soft ground. Curves represent different distances and louder and quieter pavement.



Source: FHWA 2012.

Figure C-7 shows that the noise emission levels of automobiles, medium trucks, and heavy trucks all increase in direct proportion to their speed. The open-circled symbol plots are measured values for a California Department of Transportation study. The filled-in symbol plots are modeled data using the FHWA TNM model. Overall, highway traffic noise SPLs increase with increasing speed limits. Note that the predicted TNM heavy truck values underestimated the actual values at slow speeds. At these speeds, as a truck changes gears it can “rev” more or less depending upon the driver’s skill or practice, with higher engine “revving” or revolutions per minute (rpm) resulting in increased noise. This circumstance is very important since it is experienced when, for example, a heavy truck starts up after a stop at a traffic light, at a railroad crossing, or exiting from a side road onto a major thoroughfare.

Figure C-7. A-Weighted noise emission levels for vehicles at different highway speeds.



Source: CT 2013.
Legend: A= automobiles, MT = medium trucks, and HT = heavy trucks. REMELS = reference energy mean emission levels.

Table C-4 represents measured SPLs for continuous (dBA) or impulse noise (A-weighted impulse decibel [dBAI]) associated with certain on-site operations at a proposed truck warehouse distribution center. The moving tractor-trailer or shunter truck is also called a yard truck (Buckeye Western Star & Yard Trucks of Ohio 2015). Coupling refers to the act of connecting a semi-tractor cab to a semi-trailer. At a warehouse distribution center, semi-trailers are frequently coming and going and being backed up to loading and unloading docks on the sides of a building. Because of the high level of vehicle activity onsite, many facilities use the shunter yard trucks to move the trailers more economically and with greater precision to avoid accidents. These vehicles may have a top speed of only 25 mile per hour and are often not licensed for travel on highways.

Table C-4. Overall A-weighted source power levels for a proposed truck warehouse distribution center.

Source	Sound Power Level
Moving tractor-trailer or shunter truck	101 dBA
Forklift – impulsive	110 dBAI
Coupling – impulsive	116 dBAI
Container stacking – impulsive	111 dBAI

Source: HGC 2013.

Although not specifically identified, the impulse noise in **Table C-4** is likely related to backup alarms. OSHA regulations (29 CFR 1926.601) require a reverse signal alarm, also known as a backup alarm, for any construction vehicle with an obstructed view to the rear when backing up. The regulation pertains specifically to construction but, as a safety precaution, equipment such as forklifts and yard trucks have electric backup alarms as do delivery trucks and many other commercial vehicles. A comparison of sound propagation and perception of three types of backup alarms with regards to worker safety (Vaillancourt et al. 2013) describes the frequency spectra for three types of backup alarms and their respective SPLs in unweighted dB. The broadband alarm, as its name implies, covers a wide frequency spectrum with no identifiable peaks or center. The multi-tone has three sharp SPL peaks around the most audible range of human hearing around 1,000 Hz. The tonal alarm has one main singular peak. The multi-tone and tonal peaks reach over 100 dB. The intent is for them to be heard easily over conversation and other yard noise. Any of these alarm types could be present in facility operations' onsite vehicles.

C.2.3 Acoustic Noise from Railway Trains

Railroad noise emissions are regulated by EPA and the Federal Railroad Administration (FRA); see **Table C-5**. Operations within a rail yard are addressed in 40 CFR Parts 201 and 210. Sound emitted by locomotive horns and other audible warning devices are regulated in 49 CFR Part 229, the Railroad Locomotive Safety Standards. Under these standards, the locomotive horn must be able to produce an audible 96 dBA at 100 feet and the *Swift Rail Development Act* (Public Law 103-440) requires that it be used at all highway-railroad grade crossings.

Table C-5. Regulations governing railroad noise emissions.

Agency	Code of Federal Regulations Section	Title
EPA	40 CFR Part 201	Noise Emission Standards for Transportation Equipment; Interstate Rail Carriers
FRA	49 CFR Part 210	Railroad Noise Emission Compliance Regulations
FRA	49 CFR Part 222	Use of Locomotive Horns at Public Highway-rail Grade Crossings
FRA	49 CFR Part 229	Railroad Locomotive Safety Standards (Locomotive Horns and Locomotive Cab Interior Noise)

Source: FRA 2009.

Noise compliance levels for line-haul (when the train is not in the yard) are shown in **Table C-6**. These levels represent the maximum noise levels allowed while trains are moving to and from the site. The EA assumes these will be the maximum levels permitted outside the yard.

Table C-6. Summary of line-haul measurement regulatory requirements (FRA 2009).

Noise Source	Governing Regulation	Compliance Level	Tolerance	Operating Condition	Duration	Measurement Location
Locomotives (including all switchers, regardless of build date)	40 CFR 201.12(a)	90 dBA	+ 2 dB	Moving	Duration of locomotive or rail car pass-by	Sideline: 30 meters (100 feet) Microphone height: 1.2 meters (4 feet)
Locomotives built before 12/31/79[a]	40 CFR 201.12(b)	96 dBA	+ 2 dB			

Table C-6. Summary of line-haul measurement regulatory requirements (FRA 2009). (continued)

Noise Source	Governing Regulation	Compliance Level	Tolerance	Operating Condition	Duration	Measurement Location
Rail cars speed ≤ 75 kilometers/hour (45 miles per hour)	40 CFR 201.13	88 dBA	+2 dB			
Rail cars speed > 75 kilometers/hour (45 miles per hour)	40 CFR 201.13	93 dBA	+2 dB			

[a] If the build date of a locomotive cannot be established, then it should be evaluated as if it had a build date before December 31, 1979.
Source: FRA 2009.
Key: CFR = Code of Federal Regulations; dB = decibel; dBA = A-weighted decibel.

The Federal Transit Administration's *Transit Noise and Vibration Impact Assessment Manual* (FTA 2006) reports the following "approximate" maximum SPLs measured at 100 feet:

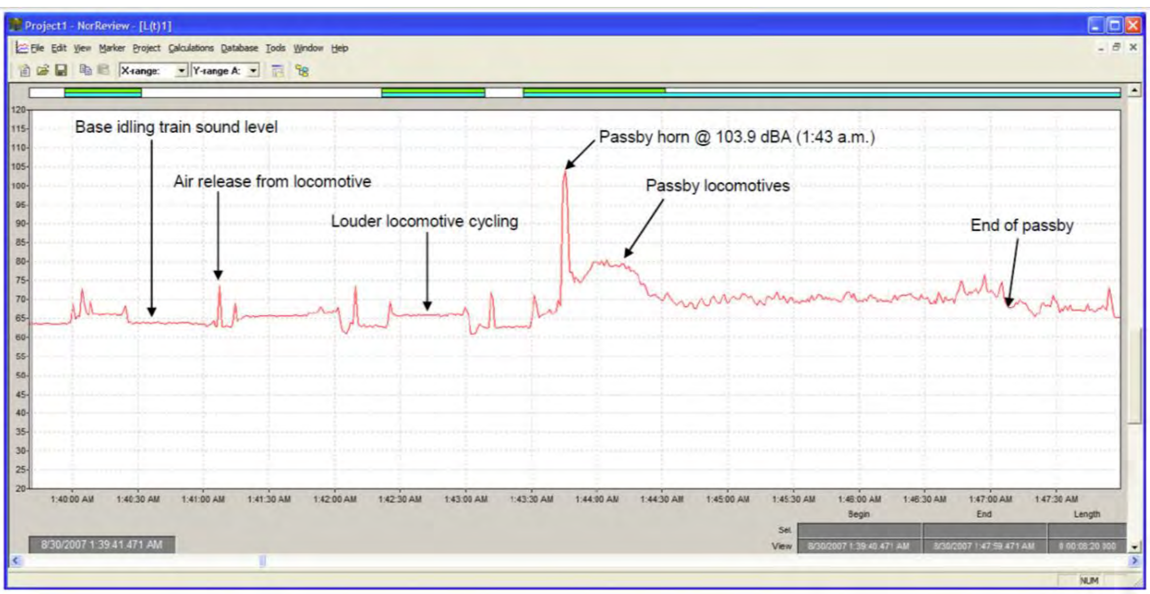
- Diesel locomotives – 85 dBA
- Electric locomotives – 83 dBA
- Rail cars – 77 dBA.

While the **Table C-6** levels provide the regulatory thresholds, a study conducted by a masters student at Rutgers University in 2009 provides information that is particularly relevant as it provides actual SPLs and frequency range noise measurements of trains (Anderson 2009). **Figure C-8** shows the SPLs in dBA for an idling train locomotive (about 65 dBA) with cycling of the engines and compressors from the railway air-braking system (that is, the air-releases and clicking sounds from the air dryer purging moisture). **Figure C-9** shows an idling train being passed by (a "passby") another train. The graph is dominated first by the passby train horn, followed by the sound of the locomotive, then the railcars, and finally the end of the passby and return to the idling train. As the train passes by, the horn is sounded with the SPL exceeding 100 dBA. These idling and passby SPLs are indicative of the levels that might occur at a Railex type facility if constructed on Hanford Site conveyed lands.

Figure C-8. Sound pressure levels during railway train idling.

Source: Anderson 2009.

Figure C-9. A passby railway train blowing its horn while passing an idling train.



Source: Anderson 2009.

Table C-7 provides Z-scale and A-scale SPLs for the measured octave band center frequencies from 31.5 to 16, 000 Hz for an average passby train, a single idling locomotive, and an average horn from a passby train (Anderson 2009). Z-scale is a zero scale or un-weighted SPL scale and does not take into consideration the human ability to hear certain frequencies like the A-scale is meant to do.

Table C-7. Z- and A-weighted sound pressure levels and octave band frequencies for average passby and idling railway trains, and average horn from passby trains at a distance of 100 feet.

	Average Passby Train		Single Idling Locomotive		Average Horn from Passby Train	
Octave Band Center Frequency (Hz)	Z-Scale (dB)	A-Scale (dBA)	Z-Scale (dB)	A-Scale (dBA)	Z-Scale (dB)	A-Scale (dBA)
31.5	83.3	43.9	76.5	37.1	88.6	49.2
63	88.9	62.7	80.7	54.5	98.5	72.3
125	83.2	67.1	68.0	51.9	93.0	76.9
250	75.7	67.1	60.8	52.2	96.6	88.0
500	73.4	70.2	61.1	57.9	103.8	100.6
1,000	71.8	71.8	56.5	56.5	100.3	100.3
2,000	69.2	70.4	55.2	56.4	93.9	95.1
4,000	68.6	69.6	55.8	56.8	86.5	87.5
8,000	69.1	68.0	56.1	55.0	79.9	78.8
16,000	68.1	61.1	46.7	39.7	71.9	64.9

Source: data from Anderson 2009.

Measurement procedures for operations inside a rail yard differ from those used for moving railroad equipment traveling along a rail corridor, since the yard operations are more event-driven. The following rail yard operations are covered by specific regulatory noise limits shown in **Table C-8** (FRA 2009):

- Stationary locomotives, including switcher locomotives, operating at maximum throttle settings connected to load test cells, and at idle (40 CFR 201.11)
- Switcher locomotives performing switching operations (40 CFR 201.12)
- Car-coupling (car connection) impacts (40 CFR 201.15)
- Retarders[2] (40 CFR 201.14)
- Load cell test stands[3] (40 CFR 201.16 and 201.27).

[2] A major source of noise present in hump yards is railroad car retarders. These devices occasionally emit high frequency squeals due to a stick-slip process between the car wheel, the rail, and the retarder brake shoes. Retarders operate by having a movable brake shoe press each wheel against a stationary shoe. The resulting frictional forces serve to slow down the rolling car (FRA 2009).
[3] Load cell test stands are external, electrically resistive devices found primarily in rail yards and railroad testing facilities that simulate locomotive performance under heavy load during a stationary test.

Table C-8. Summary of rail yard operation regulatory requirements.

Noise Source	Operating Conditions	Governing Regulation	Compliance Level (dBA)	Tolerance	Duration	Measurement Location
Locomotive	Stationary – idle	40 CFR 201.11(a)	L_{ASmx} = 70	+2 dB	Minimum of 30 seconds	Sideline at 30 m (100 ft) Mic. ht. = 1.2 m (4 ft.)
Locomotive built before 12/31/79		40 CFR 201.11(b)	L_{ASmx} = 73			
Locomotive attached to a load cell	Stationary – any throttle setting (except idle)	40 CFR 201.11(a)	L_{ASmx} = 87	+ 2 dB	Minimum of 30 seconds	Sideline at 30 m (100 ft) Mic. ht. = 1.2 m (4 ft)
Locomotive built before 12/31/79, attached to a load cell		40 CFR 201.11(b)	L_{ASmx} = 93			
Switcher locomotive	Stationary idle	40 CFR 201.11(c)	L_{ASmx} = 70	+ 2 dB	Minimum of 30 seconds	Sideline at 30 m (100 ft) Mic. ht. = 1.2 m (4 ft)
Switcher locomotive	Stationary – any throttle setting (except idle)		L_{ASmx} = 87			
Load cell test stand	With stationary locomotive at maximum throttle setting	40 CFR 201.16(a)	L_{ASmx} = 78	+2 dB	Minimum of 30 seconds	Sideline at 30 m (100 ft) Mic. ht. = 1.2 m (4 ft)
Switcher locomotives ("trigger" for sideline measurements)[a]	Stationary, maximum throttle setting, without load cell	40 CFR 201.11(c) and 201.12(c)	L_{90}(fast) = 65	+2 dB	Measure at least once every 10 seconds, for 100 measure-ments	Receiving property Mic. ht. = 1.2 m (4 ft)
Car-coupling impacts	All	40 CFR 201.15	$L_{adjavemax}$(fast) = 92	+2 dBA [+4 for Type 2 meters]	Between 60 and 240 minutes	Receiving property Mic. ht. = 1.2 m (4 ft)
Retarders	All	40 CFR 201.14	$L_{adjavemax}$(fast) = 83	+6 dB [+6 for Type 2 meters]	Between 60 and 240 minutes	Receiving property Mic. ht. = 1.2 m (4 ft)

Table C-8. Summary of rail yard operation regulatory requirements. (continued)

Noise Source	Operating Conditions	Governing Regulation	Compliance Level (dBA)	Tolerance	Duration	Measurement Location
Load cell test stands ("trigger" for sideline measurements) [a]	All load cell stands in a rail yard, in conjunction with stationary locomotive at maximum throttle setting	40 CFR 201.16(b) and 201.27	L_{90}(fast) = 65	+2 dB	Measure at least once every 10 seconds, for 100 measure-ments	Receiving property Mic. ht. = 1.2 m (4 ft)

[a] The 65 dBA receiving property criteria is the "trigger" for requiring the sideline test of switcher locomotives or load cell test stands. If the receiving property measurements are not in compliance, then both moving and stationary sideline measurements must be conducted.

Source: FRA 2009.

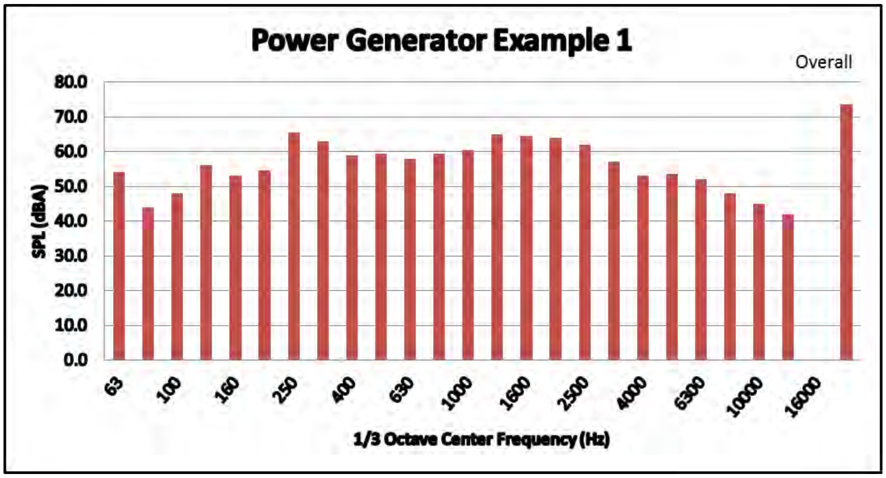
Key: CFR = Code of Federal Regulations; dB = decibel; dBA = A-weighted decibel; $L_{adjavemax}$ = adjusted average maximum; L_{ASmx} = maximum A-weighted sound level with slow time-weighting; L_{90} = background noise level; ft = feet; m = meters; mic. ht. = microphone height.

C.2.4 Acoustic Noise from Emergency Generators

According to Gries (2004), the noise frequency spectrum for power generators varies widely, but the noise sources are typically the same. These are engine noise and exhaust, cooling fan turbulent airflow and blade passage, and alternator noise. The noise spectrum of each component depends on respective device configuration or geometry, output power and load conditions.

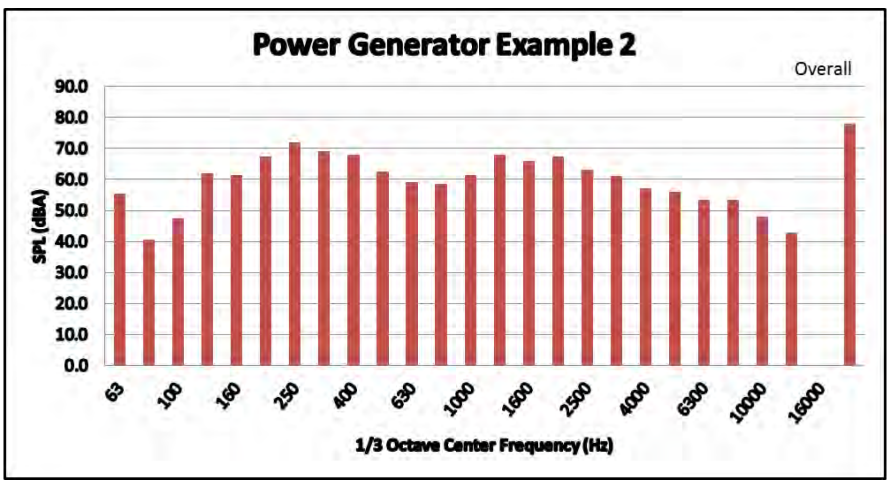
Figure C-10 provides the baseline SPLs for one-third octave frequencies for an example power generator without acoustical insulation taken from Gries (2004). The spectrum represents an eight-position average SPL (measured at eight near-proximity locations around the generator). The overall SPL is 73.5 dBA. **Figure C-11** provides another baseline for a second generator example from Gries (2004) but with an overall SPL of 78.1 dBA. These are indicative of the SPLs and one-third octave band frequencies that could be seen if emergency generators are used on site lands.

Figure C-10. Baseline sound pressure levels for one-third octave frequencies for a power generator without acoustical insulation.



Source: data from Gries 2004.

Figure C-11. Baseline sound pressure levels for one-third octave frequencies for a second power generator without acoustical insulation.

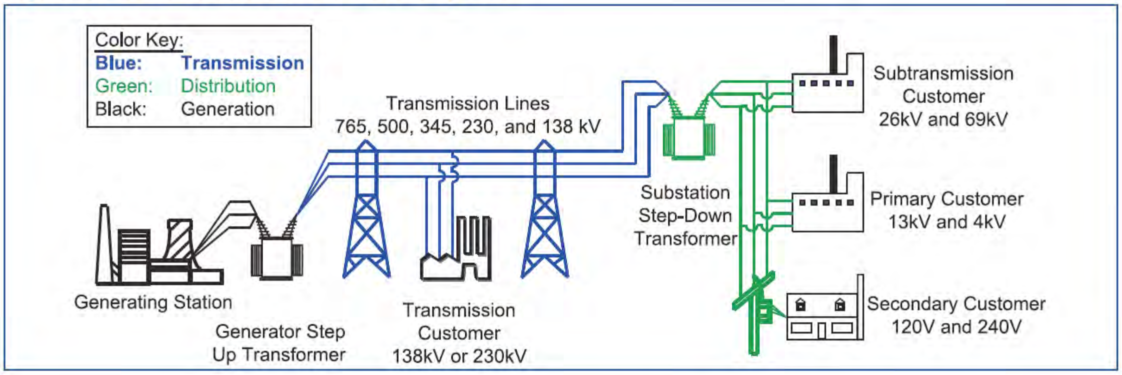


Source: Gries 2004.

C.2.5 Acoustic Noise from Electrical Energy Transmission

The electrical energy transmission system used in the U.S. has many components (**Figure C-12**). However there are only three that could be located on Hanford Site lands and are known to produce acoustic noise. These are transmission power lines, electrical substations, and power transformers. Transmission lines are high-voltage (110 or more kilovolt [kV]) and 60 cycle (60 Hz) alternating current to reduce energy loss over distances. Electrical substations switch, change, or regulate electrical voltage. Transformers operate on magnetic principles to increase (step up) or decrease (step down) voltage.

Figure C-12. Basic structure of the electrical energy transmission system.



Source: US-Canada 2004.

C.2.5.1 Acoustic Noise from Transmission Lines

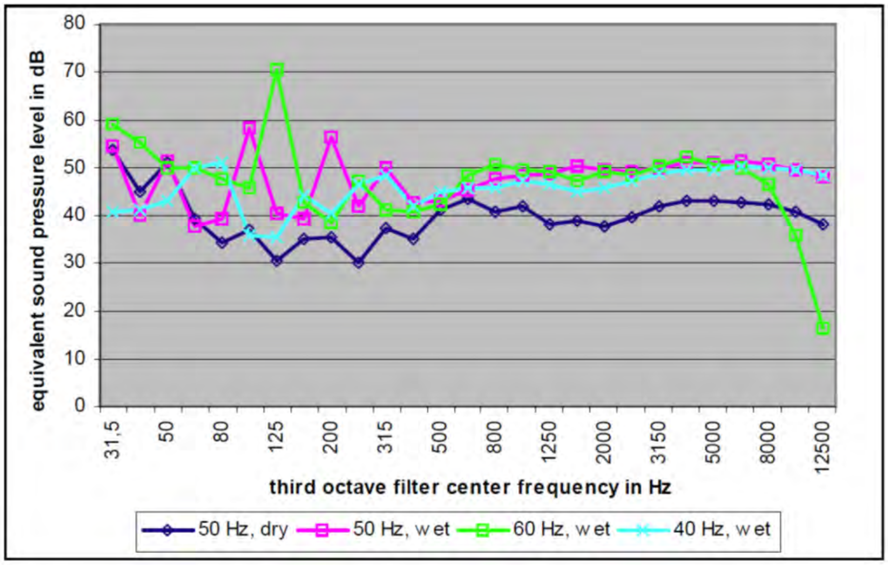
Transmission lines bring high-voltage electrical power from a source to a substation. According to Robert Dent, former president of the IEEE Power Engineering Society:

> The audible noise emitted from high-voltage lines is caused by the discharge of energy that occurs when the electrical field strength on the conductor surface is greater than the 'breakdown strength' (the field intensity necessary to start a flow of electric current) of the air surrounding the conductor. This discharge is also responsible for radio noise, a visible glow of light near the conductor, an energy loss known as corona loss and other phenomena associated with high-voltage lines.
>
> The degree or intensity of the corona discharge and the resulting audible noise are affected by the condition of the air--that is, by humidity, air density, wind and water in the form of rain, drizzle and fog. Water increases the conductivity of the air and so increases the intensity of the discharge. Also, irregularities on the conductor surface, such as nicks or sharp points and airborne contaminants, can increase the corona activity. Aging or weathering of the conductor surface generally reduces the significance of these factors. (Dent 1999)

Corona activity normally produces a low frequency noise component, a 120-Hz "hum," and a high frequency component described by many as a sizzling, crackling, or snapping sound. This latter sound is due to corona discharge and sparking gaps that are most obvious during very humid or wet weather conditions. The 120-Hz hum is more of a continuous sound while the other sounds are very intermittent. Studies have shown that corona noise occurs only when the power line voltage is 220 kV or greater (Egger et al. 2009).

Figure C-13 shows typical SPLs (in unweighted dB) relative to the one-third octave band frequency spectra for electric transmission power lines for several operating frequencies (40-, 50-, and 60-Hz) (Muhr et al. 2014). Only the green, U.S. standard 60-Hz operating frequency line is applicable to this EA. The major peak at 120 Hz is a doubling of the 60-Hz operating frequency. This doubling frequency is the source of a noticeable "hum," the corona effect, while the remainder of the noise is less noticeable broadband noise related to wind and other noise related to the environment where the measurements were taken. Measurements were taken in close proximity to the source.

Figure C-13. Typical one-third octave frequency spectrum of transmission line noise showing the "corona" effect.



Source: Muhr et al. 2014.

Table C-9 shows measured SPL data from the *Falcon to Gonder 345 kV Transmission Project EIS* (BLM 2001) for existing power lines. These do not show the "corona" effect since the humidity is low. The overall SPLs are also lower, probably because these data come from a fairly remote area in north central Nevada (see Figure C-14). The C-scale data are more reflective of unweighted decibel readings.

Table C-9. Example sound pressure level measurement data along an existing transmission line route in north central Nevada at the 80 foot right-of-way edge.

			Octave Band Center Frequency (Hz) and SPL in dBA								
Configuration - Time of Day - Weather Conditions	Overall A-Scale (dBA)	Overall C-Scale (dBC)	31.5 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz
Existing 66/25/120kV Power Lines - 10:15 am - 84°F - 10-12% humidity - 2-4 mph winds	23	54	50	31	32	16	15	10	10	11	13
Existing 230 kV Power Lines - 11:15 am - 89°F - 10-12% humidity - 2-7 mph winds	27	60	53	46	32	23	14	13	11	12	13

Source: BLM 2001, data from Table 3.11.

Figure C-14. Photo of the existing transmission line where Table C-9 data were collected.

Source: BLM 2001.

C.2.5.2 Acoustic Noise from Electrical Substations

Table C-10 shows measured SPL data from the *Falcon to Gonder 345-kV Transmission Project EIS* (BLM 2001) for an existing electrical substation. **Figure C-15** is a photo of the electrical substation where these data were collected. The C-scale data are more reflective of un-weighted decibel readings.

Table C-10. Example sound pressure level measurement data along an existing substation property line at a north central Nevada site.

			Octave Band Center Frequency (Hz) and SPL in dBA								
Configuration - Time of Day - Weather Conditions	Overall A-Scale (dBA)	Overall C-Scale (dBC)	31.5 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz
Existing Property Line - 4:20 pm - 90°F - 10-12% humidity - 2-5 mph winds	49	66	55	61	67	50	41	35	25	20	21
Existing Property Line - 1:20 pm - 47°F - 10-12% humidity - 2-4 mph winds	42	56	46	54	57	47	37	28	21	17	18

Source: BLM 2001, Table 3.11-5.

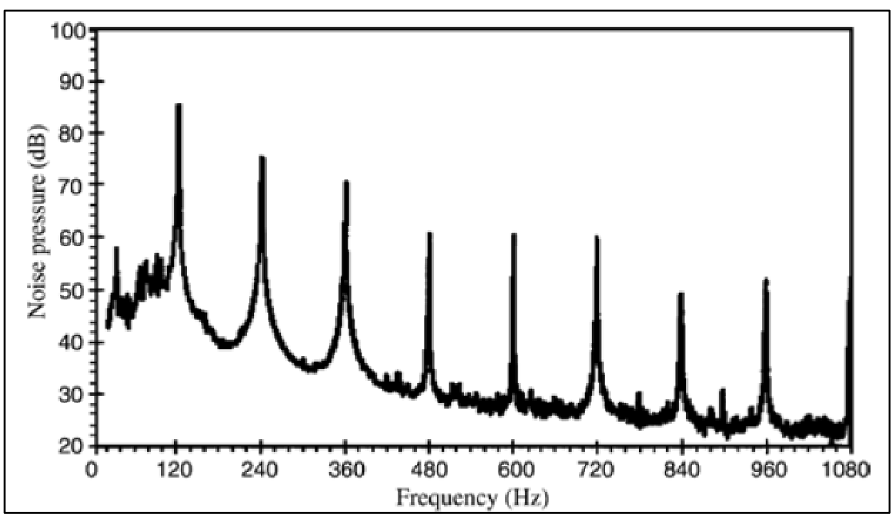
Figure C-15. Photo of the substation in north central Nevada where Table C-10 SPL data were collected.

Source: BLM 2001.

C.2.5.3 Acoustic Noise from Transformers

Transformer noise comes from two sources, electrical and mechanical. Transformer noise has characteristic constant low-frequency "hum" with a fundamental frequency of 120 Hz (double the 60-Hz operating frequency) and even harmonics of line frequency of 60 Hz, such as 240 Hz, 360 Hz, and up to 1,200 Hz or higher, primarily due to the vibration of its electrical core. Cooling fans and oil pumps are also noise generators for large transformers producing broadband noise; however, this noise is usually less noticeable than tonal noise (ANL 2013). **Figure C-16** shows a typical 60-Hz transformer frequency spectrum and A-weighted SPLs. This graph shows the 2-, 4-, 6-, 8-, 10-, 12, 14, and 18 times 60-Hz harmonic peaks along with the broadband noise.

Figure C-16. Typical frequency spectrum of acoustic noise produced by a 60-Hz transformer.



Source: Chang et al. 2009.

The average SPL at a distance of about 500 feet from a transformer core would be about 51 dBA for 938 million volt-amperes. For divergent (that is, geometric) spreading only, the noise level at a distance of about 1,800 feet would be about 40 dBA (ANL 2013). Ratings for self-cooled transformers in average SPL dBs (unweighted) range from 50 dB for a 112-kilovolt-ampere (kVA) transformer to 68 dBs for a 3,000 kVA transformer (Federal Pacific 2015). Similar ratings for forced-air cooled transformers range from 67 dBs for a 300-kVA transformer to 71 dBs for a 3,000-kVA transformer (Federal Pacific 2015).

C.2.6 Acoustic Noise from Solar Energy Equipment

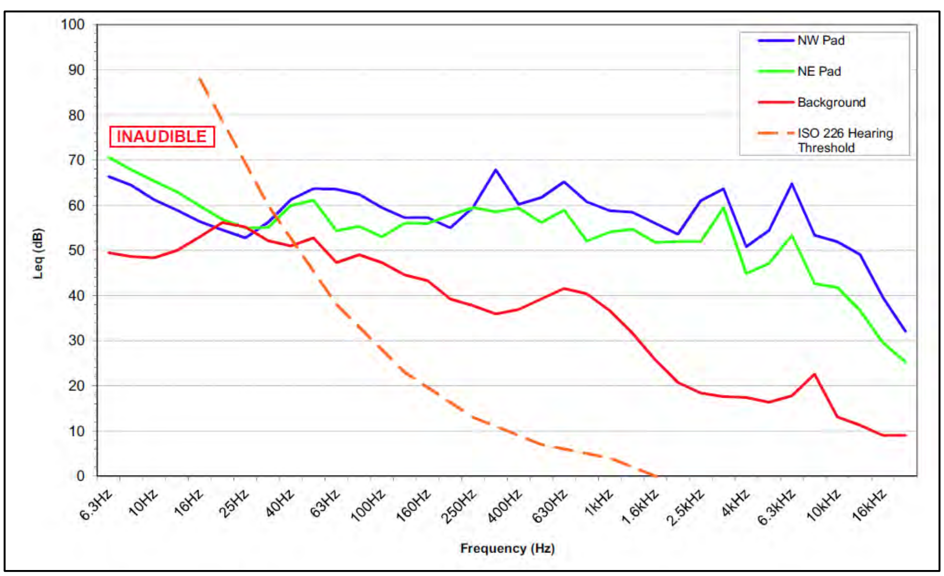
The solar technologies relevant to this EA are single-axis tracking photovoltaic (PV) flat panel arrays and concentrating solar power (CSP) or dish thermal. The potential stationary noise sources for PV systems come from transformers, inverters, electrical substations, transmission lines, and electric motors in the case of tracking systems (LDN 2011). Solar dish technology does not use inverters because it does not need to convert direct current to alternating current, but it does have the other potential noise sources as seen for PV. Solar dish thermal also uses a sun-heated turbine engine to generate electricity and it has an electric motor to continually adjust the position of the dish towards the sun. For operations that only provide energy from the sun's energy like these, the predominant noise sources are only operative during daylight hours.

C.2.6.1 Acoustic Noise from Solar Panel Photovoltaic Arrays

For solar panel PV array systems, the noise from substation transformers discussed in **Section C.2.5** and inverters are the primary noise sources. Noise measured at an example PV array location five feet from an inverter source was 65 dBA (LDN 2011). There are multiple transformer/inverter installations at this site located about 280 feet from each other. The environmental review concluded for that solar energy array, these noise sources do not cumulatively raise noise levels at the property line.

The frequency spectrum measured for two different inverter/transformer pads at a PV array in Massachusetts is shown in **Figure C-17**. The blue and green lines indicate the combined noise effects from both inverters and transformers. The red line represents background noise levels for that site, not applicable to this EA. The International Standards Organization (ISO) Standard 226 Hearing Threshold line indicates what is perceptible to the human ear.

Figure C-17. Frequency spectrum and SPLs in un-weighted dBs for two PV array inverter/transformer pads measured 10 feet from the source.



Source: Tech Environmental 2012.

C.2.6.2 Acoustic Noise from CSP Dish Thermal

As mentioned above, the CSP dish thermal has the electrical substation and transformers in common with the PV, but unique to this solar technology are the Stirling reciprocating engines, cooling fans, air compressors, and other associated components. **Table C-11** provides noise data for an example CSP dish Stirling installation (SES 2008). The data represent noise levels in close proximity to the dish (within 20 ft). The engine is located at the focal point of the concentrating dish (see Figure C-18) and therefore the “acoustic height” is elevated well above the ground, in this case 38 feet. The configuration for the CSP dish installation characterized in Table C-11 assumes that the dishes are evenly spaced at an interval of 112 feet by 56 feet, or 5 per acre.

Figure C-18. Example CSP solar dish (SunCatcher™ power systems) at Sandia National Laboratories, NM.

Source: SNL 2009.

Table C-11. Sound pressure levels at octave band center frequencies for a SunCatcher™ installation.

Component	Un-weighted Sound Pressure Levels (dB) at Octave Band Center Frequency (Hz)									Overall Un-weighted (dB)	Overall A-Weighted (dBA)	Acoustic Height (feet)
	31.5	63	125	250	500	1,000	2,000	4,000	8,000			
SunCatcher[1]	119	111	101	93	97	95	90	88	81	120	99	38
Power transformer (substation component)	79	85	87	82	82	76	71	66	59	91	82	23
Collector general step-up transformer	55	61	63	58	58	52	47	42	35	58	67	7

[a] SunCatcher assembly includes measured composite levels from the Stirling Engine, electric generator, cooling fan, and air compressor.
Source: SES 2008.

Each SunCatcher™ unit generates noise of about 84 dBA at a distance of 50 feet (BLM 2010). You can even hear what a SunCatcher™ sounds like from the following YouTube™ link for the Tessera Solar Project in Peoria, AZ. (https://www.youtube.com/watch?v=wEIQ2FVL_ys).

C.3 VIBRATION FROM FACILITY OPERATIONS

Like acoustic noise, vibration is a source-path-receiver problem. The most complex aspect is the path because, unlike acoustic noise whose path is largely the air, vibration's path is through the ground which is a very complex medium. See Appendix B, Section B.5 for a brief explanation of vibration and its propagation.

Also, like acoustic noise, it is assumed that worker health and safety issues related to vibration would be addressed by the future landowner companies needing to comply with the rules and requirements of the Washington State Department of Labor and Industries (WDOLI 2015). Also the OSHA "general duty clause" requires employers to protect workers from known hazards. Vibration is recognized as a known hazard to workers that could cause work-related musculoskeletal disorders (ACGIH 2014). Therefore, vibration impacts related to worker health and safety are not considered further in this section because we are assuming that applicable laws and regulations would be followed.

Vibration effects on sensitive equipment at LIGO and the PNNL are mentioned in Appendix A and are the main focus of the remainder of this appendix on vibration. In particular, LIGO identified certain vibration sources as being of concern as these might affect their ability to perform their mission to conduct research. LIGO identified the following equipment as a concern (Raab 1996):

- Reciprocating power-plant machinery, rock crushers, and heavy machinery
- Railways that operate frequently
- Non-reciprocating power-plant machinery and balanced industrial machinery
- Vehicular traffic.

LIGO cited the *Manual of Seismological Observatory Practice* (WDC 1979) as the source for these requirements, and that document in turn cited an earlier document, *The Requirements of a High-Sensitivity Seismograph Station* (Carder 1963). Between then and now equipment technology has changed dramatically and so has the understanding of health and safety effects from vibration. Vehicular traffic is common to all representative facilities and is discussed separately in **Section C.3.1**. Railways are only planned for the Railex™ type warehousing and distribution facility but they wouldn't operate frequently, only a few times per week (see Appendix E). Vibration from railways is discussed in **Section C.3.2**. Vibration from industrial machinery is discussed in **Section C.3.3**.

Two of the biggest vibration issues and LIGO-specific concerns are vehicular traffic (discussed in Section C.3.1) and railway operation (discussed in Section C.3.2). The others are concrete slab-mounted equipment such as pumps, compressors, generators, and specialized equipment used for the biofuels processing facility (discussed in Section C.3.3). For most of the representative facility types mentioned in Chapter 2 the equipment is related to the HVAC systems and the use of standby or emergency generators. The biofuels processing facility likely has the most non-vehicular activity outside of a building and has equipment that could produce vibratory impacts.

C.3.1 Vibration from Automotive Vehicles

While there has been a lot of interest and study in traffic vibration because of the potential to affect building structures, predicting ground-borne vibration impacts is, as the Federal Transit Administration put it, a "developing field" (FTA 2006). Vibration associated with traffic movement is a function of many things including the speed and number of vehicles, their size and weight, and the condition of the pavement.

Long (1993) made measurements of seismic road vibrations at two locations. He concluded, as would be expected, that heavy multi-axle vehicles have greater loading effect on roads than do passenger cars. He noted that vibration from trucks is on average four times larger than passenger cars and twice that of steady traffic (15 to 60 cars per minute with no large trucks). **Figure C-19** shows amplitudes (vibrational velocity in millimeters per second versus distance) observed for steady traffic, trucks, single cars, and construction equipment (Long 1993). However, the largest ground-borne vibrations are produced when vehicles drive over road irregularities (Hunaidi 2000).

Figure C-19. Amplitudes observed for different source types of seismic road vibration.

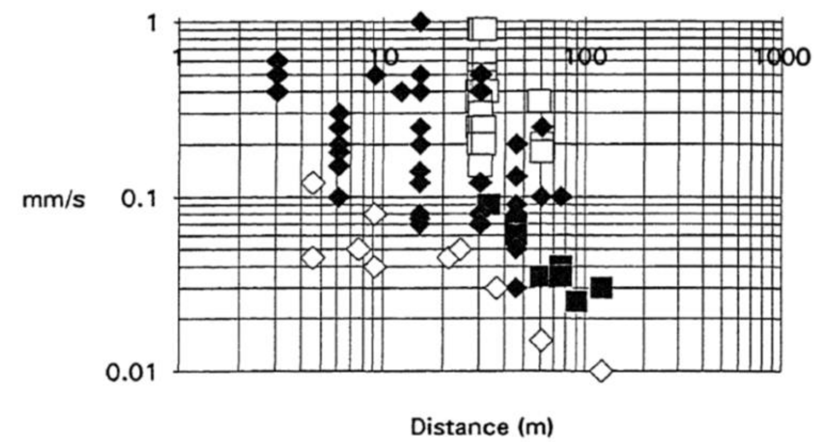


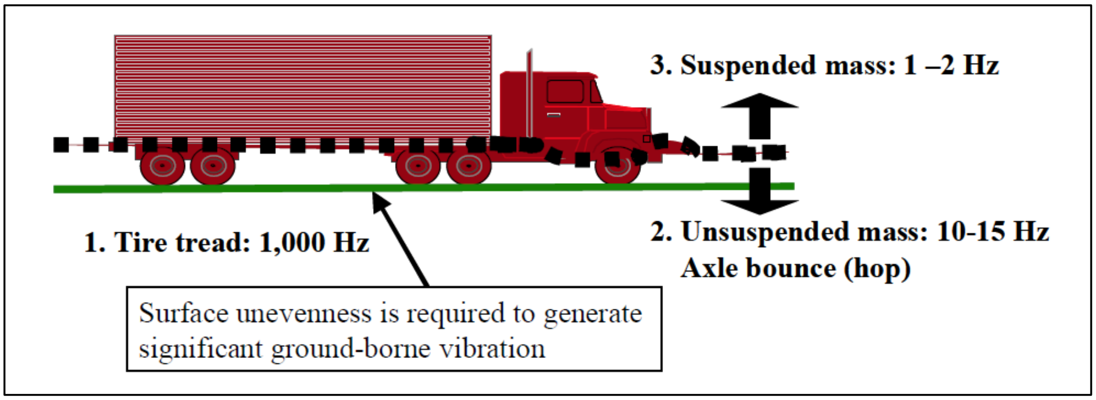
Figure 2. Amplitudes observed for different source types of seismic road vibration: ■ = steady traffic, ◆ = trucks, ◇ = single cars, and □ = construction equipment.

Source: Long 1993.

The main generators of unintentional highway traffic-induced vibration are related to trucks impacting these surface irregularities (Hajek et al. 2006). There are three basic types of impact forces acting on the pavement surface from vehicle movement (see Figure C-20):

1. those from the tire tread (in the range of 800 to 1,500 Hz)
2. those from the unsuspended mass of the vehicle (tire bounce or axle hop at 10 to 15 times per second)
3. those related to the suspended mass or the vehicle's fundamental frequency (for a five-axle semi-trailer, the suspension system heaves up and down at 1 to 2 Hz).

Figure C-20. Sources of vibration caused by a truck going down the highway.



Source: Hajek et al. 2006.

"Discrete pavement discontinuities, such as stepped transverse cracks exceeding about 4 mm [millimeters], appear to be significant enough to overshadow the effect of random surface roughness and result in specific sources of vibration. Potholes or bumps, typically more than 25 mm in depth or height and about 150 mm long, are necessary to overshadow the effect of random pavement roughness" (Hajek et al. 2006).

The vehicle weight, type of suspension system, and tire inflation can influence the amount of vibration. Heavier vehicles produce higher ground-borne vibration because of the larger vehicle mass acting on the pavement. Trucks equipped with steel leaf-spring suspension are likely to produce higher vibrations compared to trucks equipped with air suspension systems. Also, over-inflated (stiff) tires may bounce more readily over surface irregularities, resulting in higher vibration (Hajek et al. 2006).

An increase in the number of heavy trucks results in more vibration peaks, but not necessarily higher vibration peaks. This is because of the rapid drop-off of vibration peaks with distance from the source, and the short duration of the vibration peak. Higher vehicle speed increases ground-borne vibration (Hajek et al. 2006).

Also very important to vibration are the man-made irregularities in the road surface, such as uneven manhole covers and, very importantly, traffic-calming measures sometimes referred to as transverse rumble or speed strips and speed bumps (Hunaidi 2000). Of particular concern are center-lane and road shoulder rumble strips (WSDOT 2015), although data on ground-borne vibrations from these do not appear to be available.

Figure C-21 shows three types of traffic-calming features. **Table C-12** provides example vibration data for a vehicle driven at 36 kilometers per hour for the three types shown in **Figure C-21** (Mhanna et al. 2011). The vehicle used for the test was a Volvo FL6 commercial truck weighing between 12 and 15 tons.

Figure C-21. Traffic-calming features introducing road surface unevenness.

Source: Mhanna et al. 2011.

Table C-12. Vibration at different distances for three traffic-calming features.

Feature	Peak Particle Velocity (mm/second) at Various Distances					
	4 m	**8 m**	**12 m**	**16 m**	**20 m**	**24 m**
Speed cushion	1.45	0.57	0.42	0.36	0.29	0.19
Short hump	6.48	2.46	2.08	1.97	1.52	0.93
Trapezoidal	1.02	0.43	0.28	0.18	0.15	0.13

Source: Mhanna et al. 2011.

C.3.2 Vibration from Railway Trains

Ground-borne vibration generated by railway trains is a result of several factors (Suhairy 2000):

- Operational and vehicle factors such as the train speed, condition and type of suspension, and condition of the wheels
- Guideway factors such as the type and condition of rails, type of guideway and rail support system, and mass and stiffness of the structure
- Geological factors such as stiffness and internal damping of the soil, depth to bedrock, layering of soil, and the depth to water table

Note that no two locations or situations will exhibit the same set of factors. Therefore, any measured data from actual locations are only indicative of the type and levels of vibrations that could occur and cannot accurately represent the vibration levels that might actually be experienced at the Hanford Site. **Table C-13** provides some explanation of the factors important to the vibration source and path (FTA 2006).

Table C-13. Factors that influence levels of ground-borne vibration and noise.

Factors	**Influence**
Factors Related to Vibration Source	
Vehicle suspension	If the suspension is stiff in the vertical direction, the effective vibration forces will be higher. On transit cars, only the primary suspension affects the vibration levels; the secondary suspension that supports the car body has no apparent effect.
Wheel type and condition	Use of pneumatic tires is one of the best methods of controlling ground-borne vibration. Normal resilient wheels on rail transit systems are usually too stiff to provide significant vibration reduction. Wheel flats and general wheel roughness are the major cause of vibration from steel wheel/steel rail systems.
Track / roadway	Rough track or rough roads are often the cause of vibration problems. Maintaining a smooth surface will reduce vibration levels.
Track support system	On rail systems, the track support system is one of the major components in determining the levels of ground-borne vibration. The highest vibration levels are created by track that is rigidly attached to a concrete trackbed (for example, track on wood half-ties embedded in the concrete). The vibration levels are much lower when special vibration control track systems such as resilient fasteners, ballast mats, and floating slabs are used.

Table C-13. Factors that influence levels of ground-borne vibration and noise. (continued)

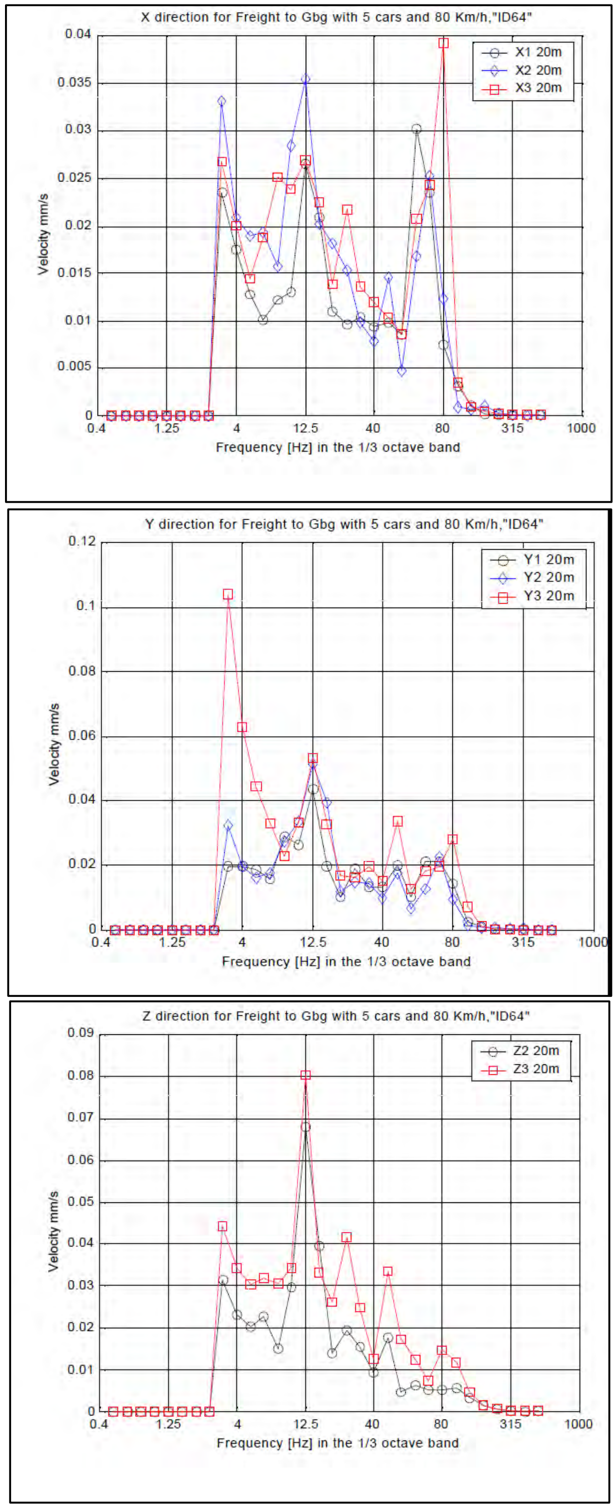
Factors	Influence
Factors Related to Vibration Source	
Speed	As intuitively expected, higher speeds result in higher vibration levels. Doubling speed usually results in a vibration level increase of 4 to 6 decibels.
Transit structure	The general rule-of-thumb is that the heavier the transit structure, the lower the vibration levels. The vibration levels from a lightweight bored tunnel will usually be higher than from a poured concrete box subway.
Depth of vibration Source	There are significant differences in the vibration characteristics when the source is underground compared to surface level.
Factors Related to Vibration Path	
Factor	**Influence**
Soil type	Vibration levels are generally higher in stiff clay-type soils than in loose sandy soils.
Rock layers	Vibration levels are usually high near at-grade track when the depth to bedrock is 30 feet or less. Subways founded in rock will result in lower vibration amplitudes close to the subway. Because of efficient propagation, the vibration level does not attenuate as rapidly in rock as it does in soil.
Soil layering	Soil layering will have a substantial, but unpredictable, effect on the vibration levels since each stratum can have significantly different dynamic characteristics.
Depth to water table	The presence of the water table may have a significant effect on ground-borne vibration, but a definite relationship has not been established.

Source: FTA 2006.

Both PNNL and LIGO are concerned about vibration generated within certain frequency bands. **Figures C-22** and **C-23** show are some examples of ground-borne vibration data from freight trains measured at distances of 20 meters and 10 meters, respectively, from railway tracks (Suhairy 2000). These measurements take into consideration the vibration components in the X, Y, and Z directions. The particle velocities are given in millimeters per second and not as peak particle velocity.

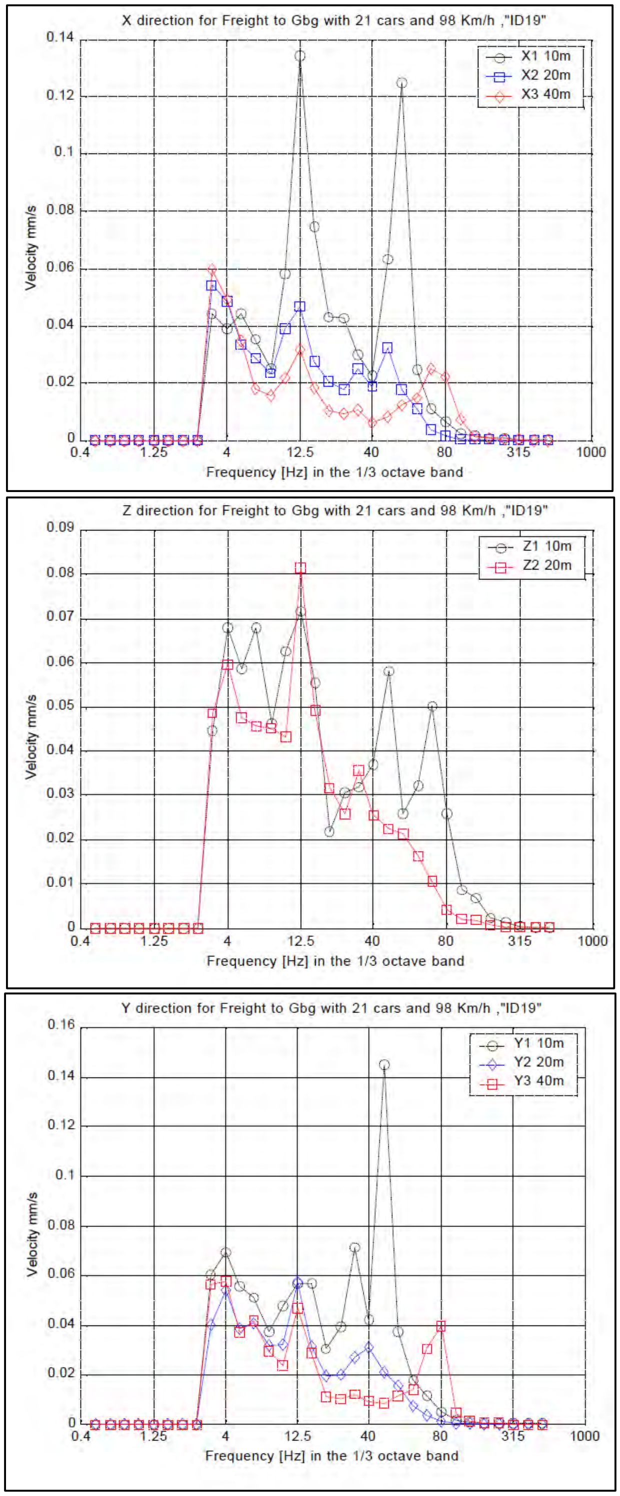
"As a rule of thumb the heavier the train the more vibration will be generated. A heavy freight train with average speed generates significant magnitude of vibration at low frequencies range, which could travel further away in the ground comparing with the high frequencies that suffer a lot of damping in the ground… From the results for more than 120 trains, one can say in general that the dominating frequency was one peak or two around 5 to 12.5 Hz and a second peak which has less amplitude around 80 to 100 Hz." Suhairy (2000) concludes that the dominating frequency direction at distances longer than about 20 meters is the Z direction; however, it should be noted that this conclusion could be highly impacted by site conditions.

Figure C-22. Vibration measurements for a freight train with 5 railcars traveling at 80 km/hour measured 20 meters from the center of the railway tracks in the X, Y, and Z direction.



Source: Suhairy 2000.

Figure C-23. Vibration measurements for a freight train with 21 railcars traveling at 98 km/hour measured at 10 meters from the center of the railway tracks in the X, Y, and Z direction.



Source: Suhairy 2000.

C.3.3 Vibration from Operating Facility Equipment

It is unknown exactly what specific equipment would be used for any of the TRIDEC TMI representative facility types simply because it is unknown what actual facilities would be constructed on the Hanford Site lands. Nevertheless, it is reasonable to make several assumptions concerning the equipment as it pertains to vibration:

- **Worker safety concerns will minimize vibrations.** Whatever equipment is installed would be configured so as to protect workers from known vibration health impacts such as, hand-arm vibration syndrome, vibration white finger disease, and whole-body vibration exposure (NIOSH 1983; ACGIH 2014). Equipment installed within buildings that requires worker protection would have vibration isolation or dampening because there is little that can be done in the way of personal protective equipment to significantly reduce impacts to workers. There is no OSHA or *Washington Industrial Safety Health Act* regulation for vibration. Under the General Duty Clause, Section 5(a)(1) of the *Occupational Safety and Health Act*, employers are required to provide their employees with a place of employment that "is free from recognizable hazards that are causing or likely to cause death or serious harm to employees." The courts have interpreted the Act's general duty clause to mean that an employer has a legal obligation to provide a workplace free of conditions or activities that either the employer or industry recognizes as hazardous and that cause, or are likely to cause, death or serious physical harm to employees when there is a feasible method to abate the hazard. The frequencies of greatest interest to protect workers from whole body vibration are 4 to 8Hz in the vertical direction, and 1 to 2 Hz in the horizontal direction (Branch 2009).
- **Economic considerations will minimize vibrations.** There are economic considerations that would strongly encourage companies to reduce vibration wherever possible:
  - Companies would install low-vibration equipment and, if not possible, install vibration isolation and damping devices to minimize possible damage to the building structure(s) and other sensitive equipment (Schaffer 2007).
  - Equipment manufacturers and installers would comply with industry "best practices" to dissipate or remove vibration and conform to industry standards (such as those established by American Society of Heating, Refrigerating and Air-Conditioning Engineers) (BRD 2015).
- **Regulatory compliance will minimize vibrations.** Employers would comply with federal, state, and local regulations for environmental protection as well as respond to pressure from the respective worker health insurance carrier. While there are no current standards, the State of Washington has adopted standards for certain projects from, for example, the ISO, the American National Standards Institute (ANSI), and the Swiss Standard 640312 (WSDOT 2011). The following three tables address potential compliance standards.

Table C-14 provides ISO and ANSI maximum vibration velocity standards for annoyance due to ground-borne vibration. **Table C-15** identifies the Swiss Standard (SARTE 1992) structural categories important to their vibration standard, SN 640312. **Table C-16** shows the vibration-level acceptance criteria from the Swiss Standard SN 640312 relative to the structure categories shown in **Table C-15**. WSDOT (2011) used some of these as criteria for a project in Seattle, WA to establish acceptable vibration levels for an environmental impact statement.

Table C-14. Criteria for annoyance caused by ground-borne vibration from Part 2 of ISO Standard 2631 (1974) and ANSI Standard S3.29-2001.

Building Use Category	Maximum Vibration Velocity (inches/second)	Comments
Hospital and critical areas	0.005	
Residential (nighttime)	0.007	
Residential (daytime)	0.01	Criterion also applies to churches, schools, hotels, and theaters
Office	0.02	Criterion applies to commercial establishments
Factory	0.03	Criterion applies to industrial establishments

Source: WSDOT 2011.

Table C-15. Structural categories according to the Swiss Standard SN 640312.

Structural Category	Definition
I	Reinforced-concrete and steel structures (without plaster), such as industrial buildings, bridges, masts, retaining walls, unburied pipelines; underground structures such as caverns, tunnels, galleries, lined and unlined
II	Buildings with concrete floors and basement walls, above-grade walls of concrete, brick or ashlar masonry; ashlar retaining walls, buried pipelines; underground structures such as caverns, tunnels, galleries, with masonry lining
III	Buildings with concrete basement floors and walls, above-grade masonry walls, and timber joist floors
IV	Buildings that are particularly vulnerable or worth preserving

Source: SARTE 1992; WSDOT 2011.

Table C-16. Acceptance criteria from the Swiss Standard SN 640312 to protect structures based on their structural category.

Structural Category	Continuous or Steady-State Vibration Sources[a]		Transient or Impact Vibration Sources[b]	
	Frequency (Hz)	Max Velocity (in/s)	Frequency (Hz)	Max Velocity (in/s)
I	10–30 30–60	0.5 0.5–0.7	10–60 60–90	1.2 1.2–1.6
II	10–30 30–60	0.3 0.3–0.5	10–60 60–90	0.7 0.7–1.0
III	10–30 30–60	0.2 0.2–0.3	10–60 60–90	0.5 0.5–0.7
IV	10–30 30–60	0.12 0.12–0.2	10–60 60–90	0.3 0.3–0.5

Key: Hz = hertz; in/sec = inches per second

[a] Continuous or steady-state vibration consists of equipment such as vibratory pile drivers, hydromills, large pumps and compressors, bull dozers, trucks, cranes, scrapers and other large machinery, jackhammers and reciprocating pavement breakers, and compactors.

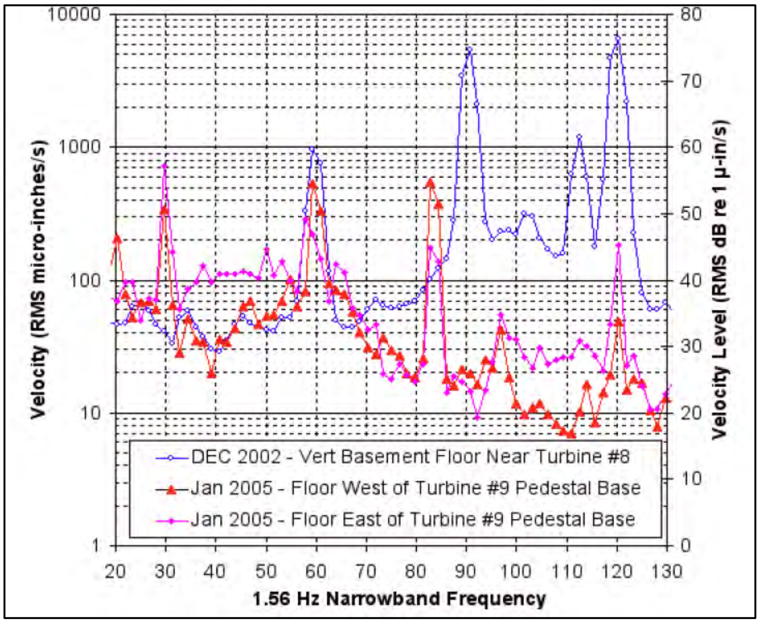
[b] Transient or impact vibration consists of activities such as blasting with explosives, drop chisels for rock breaking, buckets, impact pile drivers, wrecking balls and building demolition, gravity drop ground compactors, and pavement breakers.

Source: SARTE 1992; WSDOT 2011.

For this EA, the biofuels processing facility is likely to have the widest variety of equipment. Certain of these equipment have been identified including gas and combustion air compressors, pumps and electric motors, hoppers, cyclones, vibrating conveyors, rotary dischargers, oscillating and vibrating screens and shakers, flare stacks, and grinders (shredders and hammer mills) (NREL 2012).

DOI (2015b) identified two pieces of biofuel processing equipment that are known to produce significant vibration:, wood chippers and steam turbine generators. One industrial sized wood chipper/defibration machine (essentially a wood shredder) was found to have a vibration level of from 1.0 to 1.6 mm/sec (Moretzsohn 2010). Steam turbine generators can come in many sizes and were evaluated for vibration in one study (Evans 2005). In that study there were five existing generators, three steam (6 megawatt [MW], 6 MW, and 25 MW) and two gas (13 MW and 36 MW). The three steam generators operate at 3,600 rpm and have disturbing frequencies of 60 Hz (the lowest frequency of vibration generated by the equipment). The two gas generators operate at 4,862 and 5,400 rpm and have disturbing frequencies of 81 and 90 Hz, respectively. The vibration peaks shown in **Figure C-24** below are the disturbing frequencies and their harmonics. Those at 30-, 60-, 90- and 120-Hz are important to this EA.

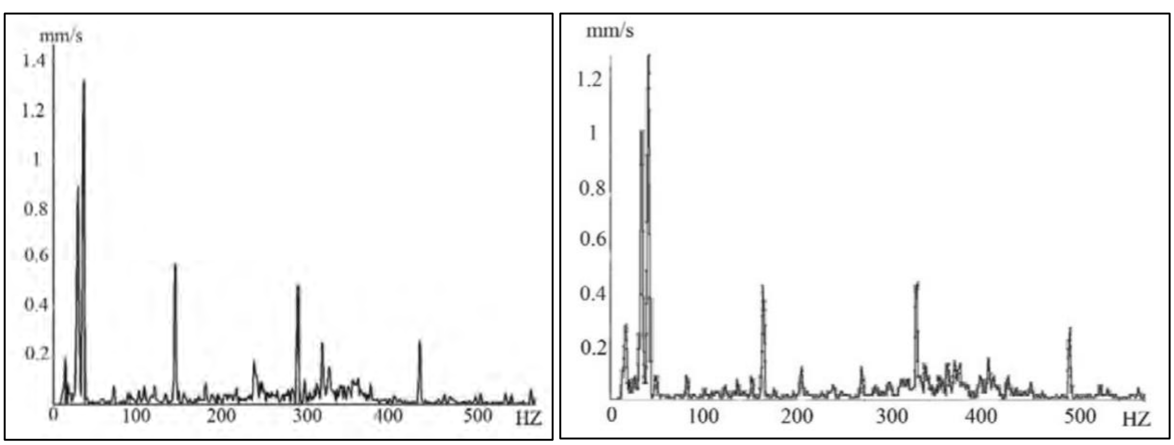
Figure C-24. Comparison of generator source vibration spectra for five generators.



Source: Evans 2005.

The other major piece of equipment important to biofuels processing is the use of large industrial compressors. Rotary screw compressors are widely used for refrigeration and compression of ammonia and other refrigerating gases. They may be simply classified as dynamic or displacement compressors. Displacement compressors confine successive volumes of gas within a closed space and increase the pressure by reducing the volume of the space. There are two types: rotary and reciprocating compressor. As a major type of rotary and positive displacement compressor, the rotary screw compressor is becoming the most common. From a vibration study of rotary screw compressor vibration (Zargar 2013), the motor, gear box, and compressor each displayed a maximum vibration velocity of 2.3, 3, and 2.8 mm/sec before repair, and 2, 1.6, and 1.6 mm/sec after repair (see Figure C-25).

Figure C-25. The velocity amplitudes of a rotary screw compressor before (a) and after (b) repair.



Key: mm/s = millimeters per second.
Source: Zargar 2013.

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APPENDIX D – ELECTROMAGNETIC FIELDS FROM CONSTRUCTION AND FACILITY OPERATION

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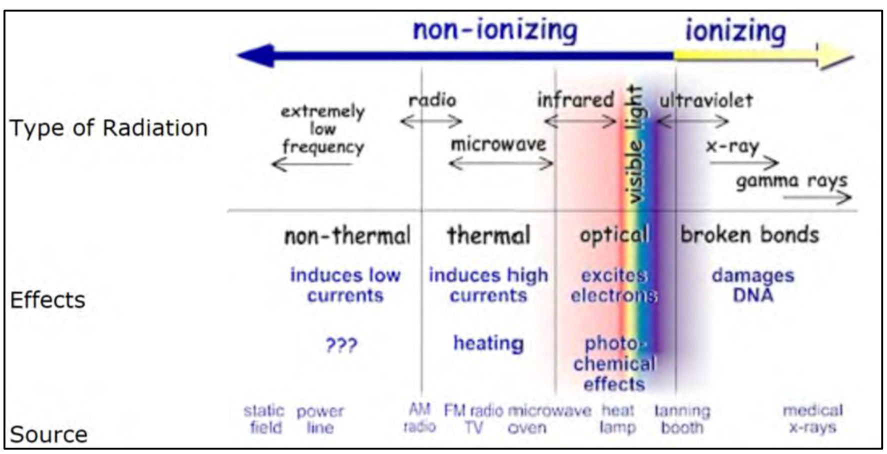
D. APPENDIX D – ELECTROMAGNETIC FIELDS FROM CONSTRUCTION AND FACILITY OPERATION

D.1 INTRODUCTION

Electric and magnetic fields (EMF) are created as a result of radiation in the electromagnetic spectrum (Figure D-1). EMF is produced through the generation, transmission, and use of electric power in some fashion, which in the United States has a fundamental frequency of 60 hertz (Hz) (one Hz is one cycle per second). In *National Environmental Policy Act* analyses, we are concerned about health and safety from both electric and magnetic fields. In this environmental assessment (EA), we are also concerned about EMF effects on existing operations (see Appendix A).

The Occupational Safety and Health Administration's non-ionizing[1] radiation regulations do not address extremely low frequency (ELF) radiation[2]. The alternative is to address health impacts based upon recognized national consensus[3] health standards that are important in the ELF range. There are two recognized consensus health standards organizations with relevance to EMF. The first is the International Commission on Non-Ionizing Radiation Protection (ICNIRP) that internationally provides scientific advice and guidance on the health and environmental effects of non-ionizing radiation. The second is a U.S. organization, the American Conference of Governmental Industrial Hygienists (ACGIH) who provides *Threshold Limit Values for Chemical Substances and Physical Agents & Biological Exposure Indices* (ACGIH 2014). These are discussed in **Section D.2**.

Figure D-1. Types of radiation in the electromagnetic spectrum.



Source: EPA 2013.

Basic information about EMF provided in the section below comes from the Electric and Magnetic Fields Research and Public Information Dissemination program, an extensive study led by the National Institutes of Environmental Health Sciences of the National Institutes of Health and the Department of Energy. This program was a six-year project focused on the issue of potential risk to human health from electric power exposure (NIEHS 2002).

[1] Non-ionizing radiation is radiation that has enough energy to move atoms and molecules around or cause them to vibrate but not enough to remove electrons. Examples are sound waves, visible light, and microwaves.
[2] Extremely low frequency or ELF is the range from 1- to 300-cycles per second.
[3] National consensus standards are those for which affected persons have previously reached substantial agreement.

D.1.1 Electric Fields

Electric power in the U.S. is alternating current (AC) with a frequency of 60 Hz with a peak-to-peak wavelength of 3,100 miles. AC electric fields and magnetic fields are characterized by their wavelength (the distance from the peak of one wave to the top of the next), frequency (the number of wavelength cycles in a given time), and amplitude (the height or strength of the wave). The amplitude of the electrical current is measured in volts and referred to as voltage and varies considerably between the point of generation and use. Electrical current that does not vary is called direct current (DC) and therefore has no frequency.

Electric fields produced by the electrical power voltage are measured in units of volts (V) or thousands of volts (kilovolts [kV]) per meter (m): V/m or kV/m. Magnetic fields are generated when electrical current flows through conductors (wires or electrical devices) and, for AC current, increase or decrease in response to the flow of electrical current. For DC current, these fields are "static" or stay the same as long as the current level does not change.

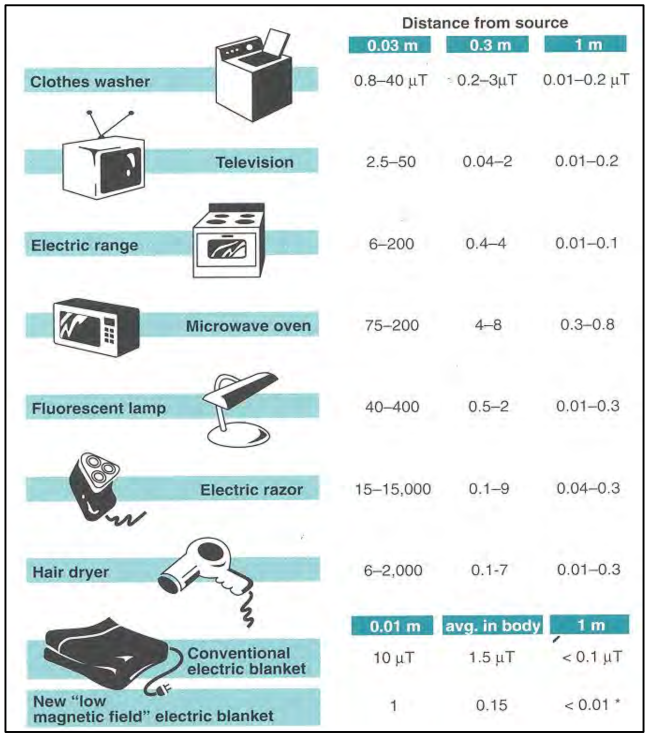
D.1.2 Magnetic Fields

Magnetic fields are measured in units of gauss[4] (G) or tesla[5] (T), where 1 T = 10,000 G. Units commonly referred to for magnetic fields are the microtesla (µT) and the milligauss (mG). A milligauss is 1/1,000 of a G or 10^{-3} G. A µT is 1/1,000,000 of a T, or 10^{-6} T. To convert µT to mG, multiply by 10. To convert mG to µT, divide by 10. The magnetic field levels of concern to Pacific Northwest National Laboratory are in units of nanoteslas (nT) (an nT is 1/1,000,000,000 of a T, or 10^{-9} T). For reference, 1,000 nT equals 1 µT or 10 mG. The earth's static magnetic field is about 500 mG. For comparison, magnetic fields related to common household devices are shown in **Figure D-2**.

[4] A gauss (G) is a unit of magnetic induction wherein 1 G corresponds to the magnetic flux density that will induce an electromotive force of one abvolt (10^{-8} volts) in a linear centimeter of wire moving laterally at one centimeter per second.

[5] A tesla is also a unit of magnetic flux density and is equal to 10^{-4} G.

Figure D-2. Magnetic field levels for common household electrical devices.



Source: EHIB 2009.

The value of a magnetic field at some distance from its source can be calculated from knowing the magnetic field strength at the source, the distance, and the configuration of the source (that is, a point source or line source). To accurately calculate these fields at a distance from the source is very complex and is customarily perform by a computer program such as that from the Bonneville Power Administration's (BPA) *Corona and Field Effects Program*. However, even though the calculations are complex, the basis for them can be generally expressed as four general arithmetic formulas for reduction of the magnetic flux density with distance (Feero 1991):

1. If the electrical circuit is a very long single circuit relative to the distance from the observer, then the magnetic flux density is given by:

   $B=6.56\ I/r$, where "B" is the magnetic flux density in mG, "I" is the electrical current in amperes flowing through the wire, and "r" is the distance from the wire to the observer.

2. More commonly it is a more complex case, with more than one current flowing and the circuit is either not long or not a straight wire. A different equation is then necessary (from classical physics the Biot-Savart Law, one of the Maxwell Equations for electromagnetic systems). For this, the magnetic flux density is given by:

   $\Delta B = k\ (I\Delta \times r)/r^3$, where "k" is a constant, "I" is the current in one of the wire sections (Δ), and "r" is the distance from the wire to the observation point.

3. For a point distance from two long parallel wire carrying equal currents, with current flowing in opposite directions, the magnetic flux density is:

   $B = 6.56\ Id/r^2$, where "d" is the distance separating the two wires and is much smaller than "r", the distance to the observer.

4. And lastly, for a continuous wire loop the magnetic flux density is:

$B = (10.31\ I \times a^2)/r^3$, where "a" is the radius of the loop.

From these equations, it can be seen that the reduction in magnetic density flux with distance is essentially a function of one of the following:

- inverse of the distance (if "r" is in the denominator, "1/r" said to be the inverse of "r")
- inverse of the square of the distance (if "r^2" is in the denominator)
- inverse of the cube of the distance (if "r^3" is in the denominator).

There are a couple of important characteristics for electric and magnetic fields. Electric fields can be shielded or weakened by electrical conducting materials even though they may be poor conductors. These include trees, buildings, and even human skin. Magnetic fields pass through most materials and are more difficult to shield or mitigate. The additional complicating factor for magnetic fields is that they can be of different strengths in the horizontal and vertical directions. This last characteristic is important to the Pacific Northwest National Laboratory PSF.

D.2 ELECTRIC AND MAGNETIC FIELD HEALTH AND SAFETY LEVELS OF CONCERN

As mentioned above, the ACGIH provides the only consensus standard for protection from EMF. The ACGIH annually publishes the *Threshold Limit Values for Chemical Substances and Physical Agents & Biological Exposure Indices* (ACGIH 2014). The ACGIH considers magnetic fields as non-ionizing radiation "physical agents" and breaks them down into static magnetic fields, sub-radiofrequency (30 kilohertz [kHz] and below) magnetic fields, radiofrequency, and microwave radiation. **Table D-1** shows the non-ionizing radiation spectrum, the region, the waveband and wavelength for the region, the frequency limits, and the applicable threshold limit value (TLV®). Note that static magnetic fields are not shown in the table. This is because the frequency of a static field is effectively zero. This EA is concerned with static magnetic fields and the sub-radiofrequency (ELF) categories. **Table D-2** provides the TLVs® for the static magnetic field (DC) consensus standards developed by the ACGIH (2014) and the ICNIRP (2002). **Table D-3** provides worker and public electric and magnetic field exposure guidelines for alternating fields (ACGIH 2014; ICNIRP 2010; ICES 2002).

Table D-1. The electromagnetic radiation spectrum and related TLV® frequency categories.

Region	Non-Ionizing Radiation			
	Sub-Radiofrequency		**Radiofrequency**	**Microwave**
Wavelength	~300,000 km to 1000 km	1000 km to 10 km	10 km to 1 m	1 m to 1 mm
Frequency	1 to 300 Hz	300 Hz to 30 kHz	30 kHz to 30 MHz	30 MHz to 300 GHz
Applicable ACGIH TLV®	Sub-radiofrequency		Radiofrequency and microwave	

Key: km = kilometer; m = meter; mm = millimeter; Hz = hertz; kHz = kilohertz; MHz = megahertz; GHz = gigahertz.
Source: ACGIH 2014.

According to the ACGIH (2014), for a non-ionizing radiation magnetic field due to sub-radiofrequencies of 1 to 300 Hz, the "ceiling value" (the value that should not be exceeded during the workday under any circumstances) for whole-body exposure is calculated as:

$$B_{TLV} = 60/f$$

where "f" is the frequency in Hz, and B_{TLV} is the magnetic flux density in milliTesla (mT).

From 300 Hz to 30 kHz, the whole-body ceiling value is 0.2 mT (ACGIH 2014).

Occupational exposures should also not exceed an electric field strength of 25 kV/m from 0 (DC) to 220 Hz. For frequencies in the range of 220 Hz to 3 kHz, the ceiling value is given by (ACGIH 2014):

$$E_{TLV} = 5.525 \times 10^6/f$$

where "f" is the frequency in Hz, and E_{TLV} is the root mean square (RMS) electric field strength in V/m.

A value of 1,842 V/m RMS is the whole-body ceiling value for frequencies from 3 to 30 kHz. It is recommended by ACGIH that those wearing a pacemaker or similar medical devices not be exposed above 1 kV/m (ACGIH 2014).

Table D-2. TLVs® and exposure limits for static magnetic fields.

Exposure	**Ceiling Value**
Occupational [a]	
Whole body (general workplace)	2 T
Whole body (special worker training and controlled workplace environment)	8 T
Limbs	20 T
Medical device wearers	0.5 mT
Public [b]: Exposure to any part of the body	400 mT

Sources: [a]ACGIH 2014; [b] ICNIRP 2009.

Table D-3. Electric and magnetic field exposure guidelines for alternating fields.

Organization	Type of Exposure	Electric Field (kV/m)	Magnetic Field (mG)
ACGIH	Occupational	25 [1a]	10,000
ICNIRP	Occupational	8.3 [b]	4,200
	General public	4.2	2,000
IEEE	Occupational	20	27,100
	General public	5 [c]	9,040

[a] Grounding is recommended above 5 to 7 kV/m and conductive clothing is recommended above 15 kV/m.
[b] Increased to 16.7 kV/m if nuisance shocks are eliminated.
[c] Within power line rights-of-way, the guideline is 10 kV/m.
Source: ACGIH 2014; ICNIRP 2010; ICES 2002.

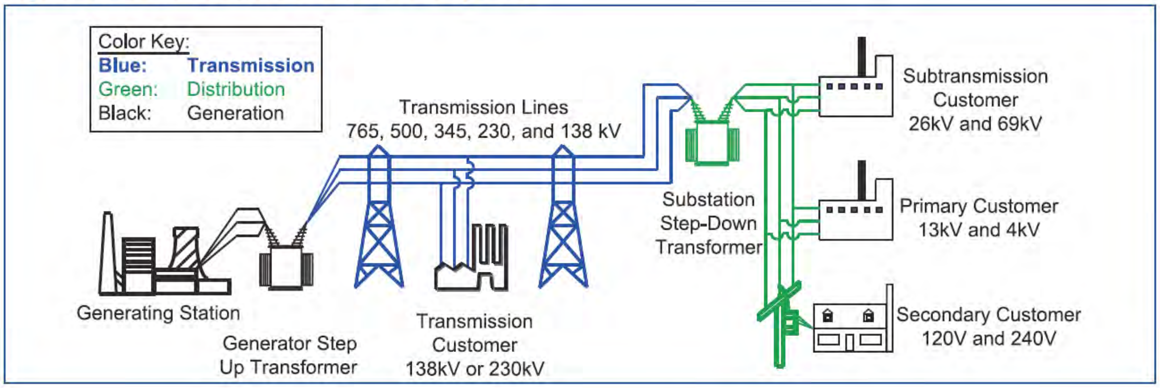
D.3 ELECTRIC AND MAGNETIC FIELDS ASSOCIATED WITH CONSTRUCTION

While there are many potential sources of EMF from reciprocating engines, compressors, electric pumps, and generators that might be present during construction activities, there is almost nothing in the literature to address magnetic fields related to those activities. In fact, for an environmental impact statement for the construction of a high-speed train, federal and state regulators go so far as to say that "There would be negligible EMF or EMI [electromagnetic interference] impacts…during construction of the HST [high-speed train] alternatives because construction equipment generates low levels of EMFs and EMI. The only EMI that might be generated during construction would be occasional licensed radio transmissions between construction vehicles" (CHRA and FRA 2012).

D.4 ELECTRIC AND MAGNETIC FIELDS ASSOCIATED WITH ELECTRICAL ENERGY TRANSMISSION

High-voltage power is carried from the generating station, using high-capacity transmission lines supported by above-ground metal structures (see Figure D-3). At transmission substations, the voltage is reduced and routed in multiple directions by subtransmission lines. Subtransmission lines are constructed on wood poles or steel poles, and sometimes placed in underground structures. Subtransmission lines end at the facilities of large power users or at distribution substations. At distribution substations, the voltage is further reduced and delivered to homes and offices on wires supported by wooden poles or in underground structures. All components of the transmission, subtransmission, distribution, and substation systems that are "energized" (carrying electricity) create EMFs (SCE 2004).

Figure D-3. Basic structure of the electrical energy transmission system.



Source: US-Canada 2004.

The minimum width of an overhead transmission/distribution line right-of-way (ROW) is determined by a number of factors such as "swing" characteristics of the line and the minimum clearances required by federal and state regulations. The minimum centerline-to-edge of right-of-way width of 100 feet was established for overhead 500-kV lines through radio interference studies conducted in the early 1960s. This 100-foot distance is about 20 feet greater than would be needed for swing considerations. Smaller than 100-foot ROW widths for 500-kV lines are found on lands under the U.S. Forest Service and Bureau of Land Management jurisdictions, due to the lack of development adjacent to the ROW (SCE 2004).

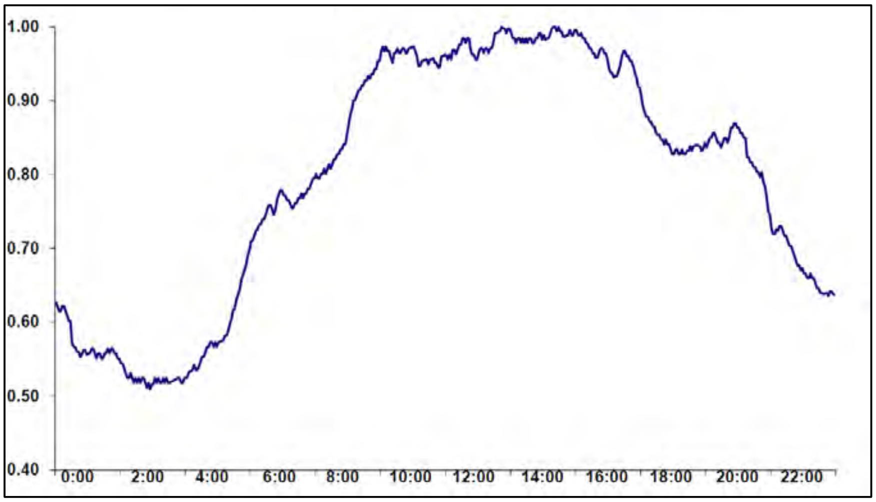
BPA has the following maximum electric field strength requirements for roads and parking lots adjacent to BPA ROWs. These limits are: in the ROW, 9 kV/m; at the edge of the ROW, 5 kV/m; at road crossings, 5 kV/m; at shopping center parking lots, 3.5 kV/m; and at commercial/industrial parking lots, 2.5 kV/m (BPA 2011).

Substations receive power from generating stations or other substations of the same type and can have both transmission and distribution components. They increase the voltage for long distance transmission or decrease it for distribution to an end user. They provide switchgear to direct the electricity to individual lines and to circuit breakers to clear lines in the event of an electric system failure.

Distribution substations receive power from transmission substations through radial or looped subtransmission lines and transform it to a lower voltage. These deliver the power to the individual customers after further transformation at locations throughout the distribution network. Distribution substations must be located close to, and generally central to, the load served due to high losses and voltage drops present in distribution lines.

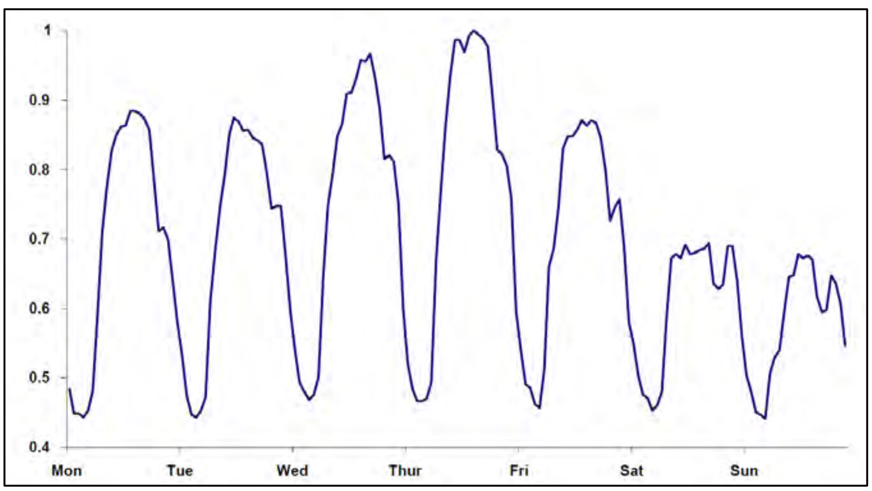
The "load" or electrical current demand is directly related to the EMF generated. Electrical system loads vary or cycle on an hourly, daily, monthly, and annual basis. **Figure D-4** shows how the load changes throughout a 24-hour period, and **Figure D-5** shows the weekly loading variation (SCE 2004).

Figure D-4. Example of an electrical substation hourly loading variation.



Source: SCE 2004.

Figure D-5. Example of an electrical substation weekly loading variation.



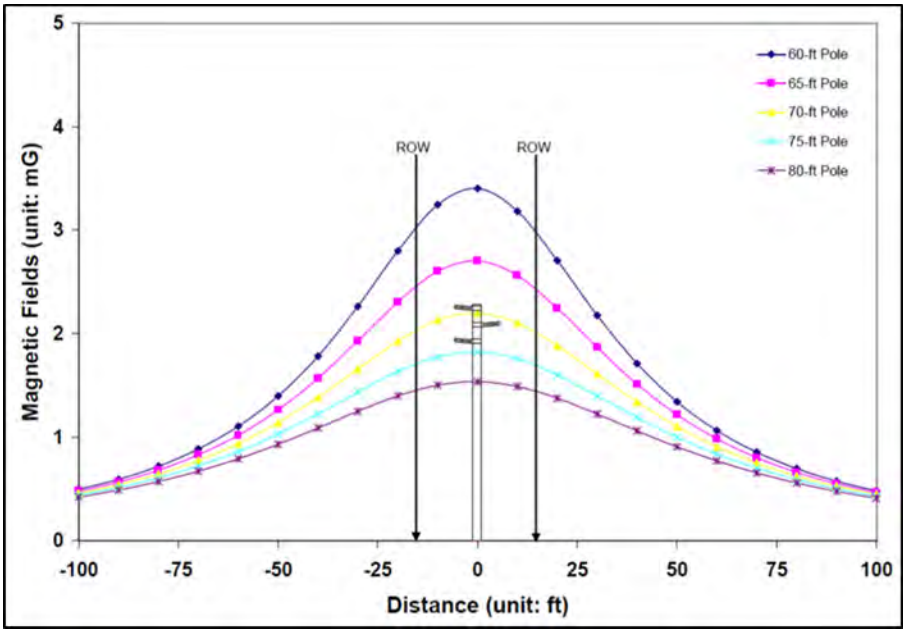
Source: SCE 2004.

These loading variations cause changes in the amount of EMF produced. Studies have been done to evaluate changes in configuration on the amount of EMF produced. **Figures D-6, D-7,** and **D-8** each show in a different way the relationship between pole height and the reduction in magnetic field strength. **Figure D-6** shows how the magnetic field is reduced from within the ROW out to 100 feet. The highest curve represents, understandably, the lowest line height. The lower the line is physically, the higher the magnetic field is at that point. It is important to note that, as each of the lines reach 100 feet from the centerline, they appear to be coming asymptotic or merge. This is because as you are farther from the source, the height of the source becomes a small component of the distance and eventually the height becomes unimportant – at a distance. The reason why pole height is important is because of those who are either within the ROW or very nearby. **Figure D-7** provides a percentage reduction for each 5 foot increment of height. **Figure D-8** shows an example situation showing magnetic field strength reduction with ROW distance for a double-circuit 220-kV line with a 30-foot ground clearance and a load of 500 amps (SCE 2004).

What is not clear from these figures is that the line height varies with distance due to sagging caused by heat expansion or the weight of water or frost on the line. The effective height is therefore what is important and not just the height at the pole.

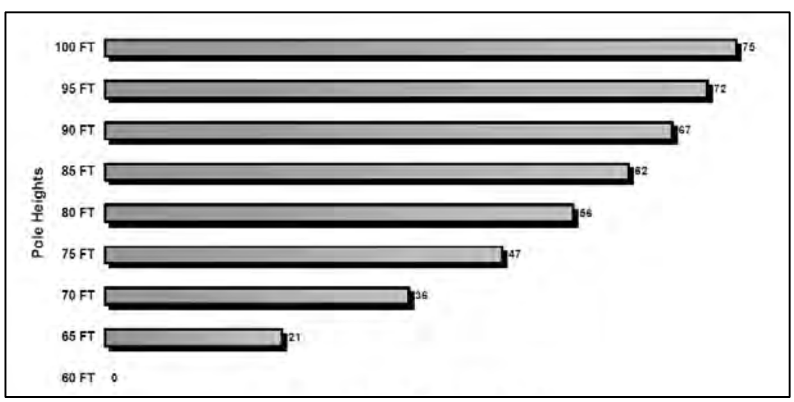
Table D-4 shows some typical measured magnetic field levels associated with overhead power transmission lines (PSCW 2013; SCE 2004). These are synoptic or spot values and would be affected by the change in loads shown in **Figures D-4** and **D-5**.

Figure D-6. Magnetic field reduction by increasing pole height in 5-foot increments.



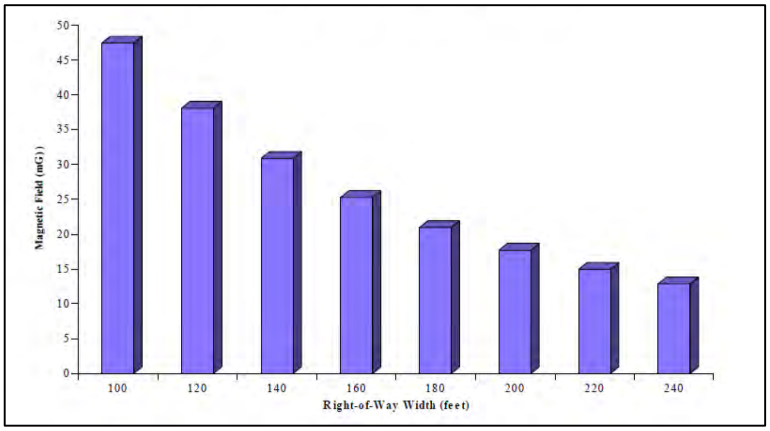
Source: EHIB 2009.

Figure D-7. Percentage of magnetic field reduction with increased transmission pole height.



Source: SCE 2004.

Figure D-8. Magnetic field strength reduction with distance for a double-circuit 220-kV line with a 30-foot ground clearance and a load of 500 amps.



Source: SCE 2004.

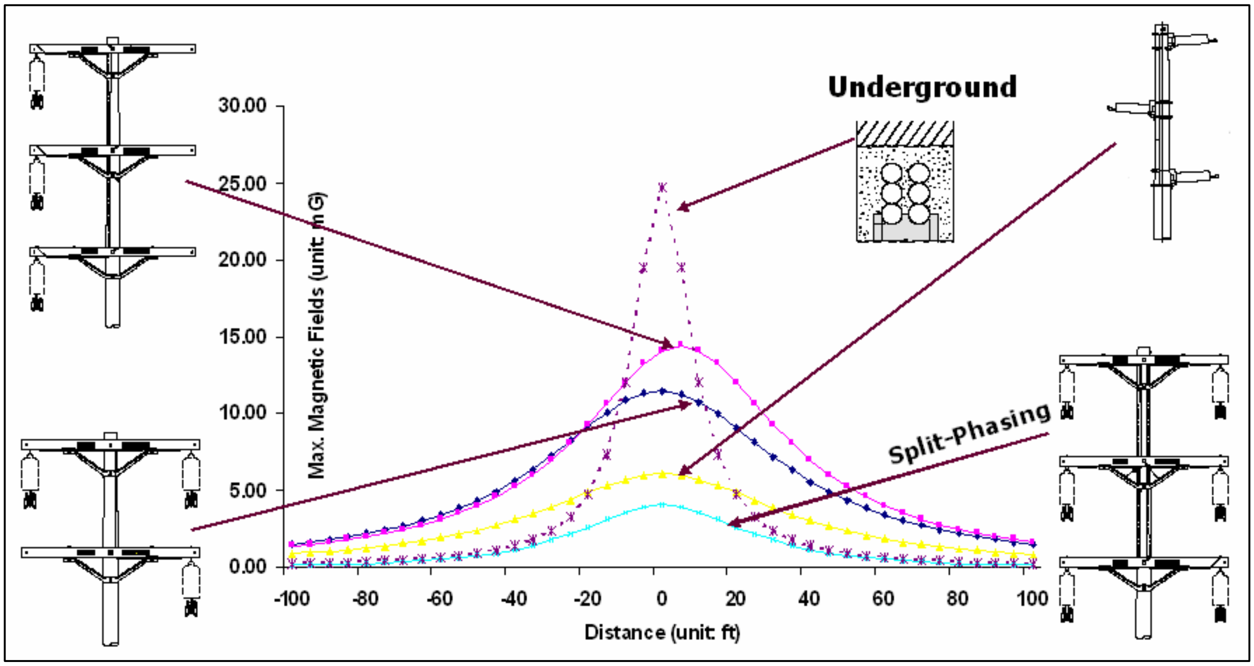
Table D-4. Typical magnetic field levels associated with overhead power transmission lines.

		Typical Magnetic Field Measurements (mG)				
		Approximate Distance from Centerline				
Overhead Transmission/Distribution Line Voltages (kV)	**Usage**	**Maximum in ROW**	**50 feet**	**100 feet**	**200 feet**	**300 feet**
12 and below	General range	0.4 - 20		0.1 - 1	0.0	
69 and 138	General range	3 - 80	0.5 - 2.5	0.1 - 10	0.1 - 3	
115	Average	30	7	2	0.4	0.2
	Peak	63	14	4	0.9	0.4
230	Average	58	20	7	1.8	0.8
	Peak	118	40	15	3.6	1.6
500	Average	87	29	13	3.2	1.4
	Peak	183	62	27	6.7	3.0

Source: PSCW 2013; SCE 2004; PPL 2004.

Figure D- 9 brings many of these issues together by showing the magnetic fields related to different pole-head and underground configurations for 66-kV subtransmission lines (SCE 2004). Power lines transmit three phases of power. Each of the three conductors (or lines) carries electricity at 60 Hz and the same voltage but each is out of phase with the others by one-third of a wavelength. So when one line is at its peak, the next line is one-third delayed and the other two-thirds delayed. Power poles sometimes have six lines or two three-phase systems. How these are configured allows for some of the EMF generated to cancel some of the other EMF. **Figure D-9** shows how the configuration of the three-phase lines can reduce the magnetic flux field. It also shows the much higher magnetic flux for an underground line.

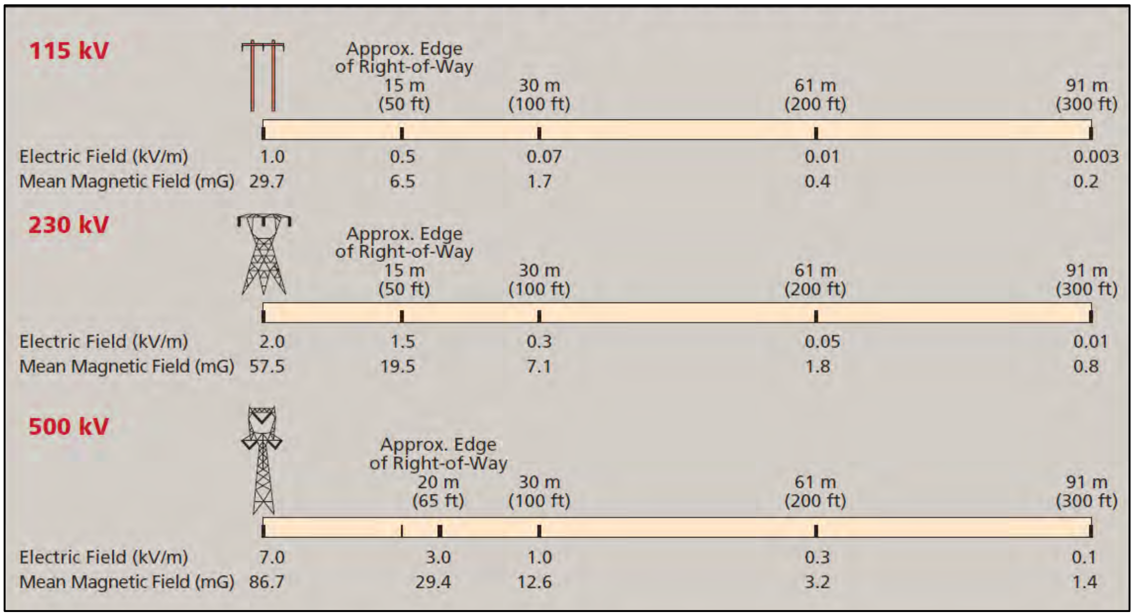
Figure D-9. Magnetic fields related to different pole-head and underground configurations for 66-kV subtransmission lines.



Source: SCE 2004.

Figure D-10 shows some typical electric and magnetic field levels for 115-, 230-, and 500-kV power transmission lines measured at one meter above ground from power lines in the Pacific Northwest (NIEHS 2002). The figure shows that the electric and magnetic field strength drops off significantly within 300 feet of the centerline.

Figure D-10. Typical electric and magnetic field levels for power transmission lines.



Source: NIEHS 2002.

Table D-5 provides information about the magnetic field strength levels produced by electrical substation equipment along with water treatment plant equipment (motors and inductor) (NYC 2004).

Table D-5. Magnetic field levels measured at 1.6 feet from electrical substation point source equipment.

Equipment	Potential Maximum Magnetic Field Strength (mG)
Motor – 2,000 horsepower	98.5
Motor –- 1,500 horsepower	71.2
4.16-kV switchgear	13.3
13.2-kV switchgear	15.6
7,500-kVA transformer	72.5
11,250-kVA transformer	108.75
Inductor	117

Source: NYC 2004.

D.5 ELECTRIC AND MAGNETIC FIELDS ASSOCIATED WITH SOLAR POWER ENERGY PRODUCTION

Solar energy production uses power lines, electrical substations, photovoltaic (PV) inverters (DC conversion to AC), power transformers, alternators (dish thermal), and grid connections. EMF associated with power lines, electrical substations, and transformers was already addressed in **Section D.4**.

Solar PV energy produced by solar panels generates DC current and must be converted for the power grid to AC using an inverter. Solar panel array systems therefore generate both a static DC-related magnetic field and an AC-generated magnetic field but at different locations on a site (DC on the array panels and AC at the inverters). Concentrating solar power dish thermal technology using Stirling turbine engines is 60 Hz AC due to the engine's alternator and does not require an inverter.

These dish systems do not generate static magnetic fields. These AC magnetic fields are generated at each solar dish installation.

According to the *Mid-Columbia Clean Energy Feasibility Assessment* (DOE 2011), "PV generation projects sometimes require upgrades to transmission lines due to access required at remote site locations (that is, away from the load); however, there are adequate substations for grid interconnections in the region to make interconnection a low-priority issue. Transmission line capacity should not be an issue, as loads at decommissioned sites no longer exist, and there is adequate room for these lines to transmit PV power on the BPA grid; however, interconnection location and line capacity must be coordinated with the existing utility system."

Table D-6. Potential magnetic field strength from various components of West Linn Solar Array.

		Magnetic Field Strength (mG)	
Source	**Field Type**	**3 feet**	**10 feet**
Parallel string of PV modules	Static	1,697	509
DC to AC inverter	Power frequency	344	3
Network grid interconnection	Power frequency	14	n/a

Source: GC 2015.

According to Chang and Jennings (1994), power inverters are the most common source of power frequency (60 Hz) magnetic fields in photovoltaic systems. The field strength of the alternating magnetic fields from a power inverter is directly related to the AC current that the inverter generates. Every solar array system will vary, but a common configuration for a large grid-connected system is to utilize one inverter for each parallel string. The design of an existing PV project (data in **Table D-5**) has twelve 260-kilowatt inverters, each with a rated maximum alternating output capacity of 301 amperes. This could theoretically produce a time-varying magnetic field of approximately 344 milligauss at three feet from the inverters. The published report calculates that at a distance of 10 feet, the magnetic field strength would be about 3 mG (GC 2015).

Table D-7. EMF background levels at three PV array inverter locations.

	Magnetic Field (mG)			Electric Field (V/m))		
Pad	**Site 1**	**Site 2**	**Site 3**	**Site 1**	**Site 2**	**Site 3**
NW boundary	<0.2	0.2	<0.2	<5	<5	<5
SW boundary	1.8	0.2	<0.2	<5	<5	<5
S center boundary	3.0			<5		
SE boundary	0.7	0.4	0.2	<5	<5	<5
NE boundary	<0.2	<0.2	<0.2	<5	<5	<5
NC boundary	0.3			<5		
Background mean	<0.2	<0.2	<0.2	<5	<5	<5

Source: Tech Environmental 2012.

Table D-8. Measured EMF levels for the same three PV array inverter sites in Table D-6 at different directions and distances from the inverter pads.

Site Number	Pad	Direction to Inverter Face	Distance (ft)	Magnetic Field (mG)	Electric Field (Vm)
1	Setback		50	0.2	<5
1	Setback		100	0.4	5.0
1	Setback		150	<0.2	<5
1	NW	Parallel	.25	500	<5
1	NW	Parallel	10.25	10.5	<5
1	NW	Parallel	15.75	2.75	<5
1	NW	Parallel	150	0.2	<5
1	NW	Perpendicular	4	500	<5
1	NW	Perpendicular	8	200	<5
1	NW	Perpendicular	12	6.5	<5
1	NW	Perpendicular	150	0.5	<5
1	NE	Parallel	3.83	500	<5
1	NE	Parallel	7.67	30	<5
1	NE	Parallel	11.83	4.5	<5
1	NE	Parallel	150	0.2	10.0
1	NE	Perpendicular	7.5	500	<5
1	NE	Perpendicular	15	10	<5
1	NE	Perpendicular	22.5	2.1	<5
1	NE	Perpendicular	150	0.1	<5
2	-	Parallel	4	200	<5
2	-	Parallel	8	10	<5
2	-	Parallel	12	0.8	<5
2	-	Parallel	95	<0.2	<5
2	-	Perpendicular	4	500	<5
2	-	Perpendicular	8	25	<5
2	-	Perpendicular	12	4.5	<5
2	-	Perpendicular	150	<0.2	<5
3	-	Parallel	3	150	<5
3	-	Parallel	6	10	<5
3	-	Parallel	9	5.0	<5
3	-	Parallel	150	<0.2	<5
3	-	Perpendicular	3	500	<5
3	-	Perpendicular	6	200	<5
3	-	Perpendicular	9	80	<5
3	-	Perpendicular	150	0.4	<5

Source: Tech Environmental 2012.

Tables D-7 and **D-8** provide background EMF readings for a PV array system with measurements taken around the sites and three inverter pads (Tech Environmental 2012).

D.6 ELECTRIC AND MAGNETIC FIELDS ASSOCIATED WITH FACILITY OPERATIONS

Everything that runs on electricity or generates an electric spark has the potential to create EMFs. Depending upon the size and type of operating facility, they may have many of the power sources previously described in this appendix. They may have power lines, electrical substations, and transformers. EMF associated with these power lines, electrical substations, and transformers was already addressed in **Section D.4**. This section focuses on magnetic fields associated with equipment and operations not described earlier.

The following two tables from the NIEHS represent magnetic field exposures to workers in a wide variety of occupations. The data reflect exposure to equipment similar to those that might be found in the representative facilities described in this EA. **Table D-9** shows some EMF exposure data for common work environments (NIEHS 2002). **Table D-10** provides data from the same reference but different sources that show EMF spot measurements for similar work environments (NIEHS 2002). In lieu of having measurements from specific pieces of equipment, these measurements reflect the magnetic fields encountered by the workers using this equipment in their facilities in close proximity to the magnetic flux density sources. Many of the industries and worker occupations shown in this table are relevant to facilities and operations described in this EA.

Table D-9. EMF measurements during a workday.

	ELF magnetic fields (mG)	
Industry and occupation of workers	**Median for occupation**	**Range for 90% of workers**
ELECTRICAL WORKERS IN VARIOUS INDUSTRIES		
Electrical engineers	1.7	0.5 – 12.0
Construction electricians	3.1	1.6 – 12.1
TV repairers	4.3	0.6 – 8.6
Welders	9.5	1.4 – 66.1
ELECTRIC UTILITIES		
Clerical workers without computers	0.5	0.2 – 2.0
Clerical workers with computers	1.2	0.5 – 4.5
Line workers	2.5	0.5 – 34.8
Electricians	5.4	0.8 – 34.0
Distribution substation operators	7.2	1.1 – 36.2
Workers off the job (home, travel, other)	0.9	0.3 – 3.7
TELECOMMUNICATIONS		
Install, maintenance, and repair technicians	1.5	0.7 – 3.2
Central office technicians	2.1	0.5 – 8.2
Cable splicers	3.2	0.7 – 15.0
AUTO TRANSMISSION MANUFACTURE		
Assemblers	0.7	0.2 – 4.9
Machinists	1.9	0.6 – 27.6
HOSPITALS		
Nurses	1.1	0.5 – 2.1
X-ray technicians	1.5	1.0 – 2.2

Table D-9. EMF measurements during a workday. (continued)

Industry and occupation of workers		ELF magnetic fields (mG)
SELECTED OCCUPATIONS FROM ALL ECONOMIC SECTORS		
Construction machine operators	0.5	0.1 – 1.2
Motor vehicle drivers	1.1	0.4 – 2.7
School teachers	1.3	0.6 – 3.2
Auto mechanics	2.3	0.6 – 8.7
Retail sales	2.3	1.0 – 5.5
Sheet metal workers	3.9	0.3 – 48.4
Sewing machine operators	6.8	0.9 – 32.0
Forestry and logging jobs	7.6	0.6 – 95.5 c

ELF = extremely low frequency – frequencies 3 to 3,000 Hz.

* The median is the middle measurement in a sample arranged by size. These personal exposure measurements reflect the median magnitude of the magnetic field produced by the various EMF sources and the amount of time the worker spent in the fields.

** This range is between the 5th and 95th percentiles of the workday averages for an occupation.

*** Chain saw engines produce strong magnetic fields that are not pure 60-Hz fields.

Source: NIEHS 2002.

Table D-10. EMF spot measurements in the workplace.

Industry and Sources	ELF magnetic fields (mG)	Comments	Other Frequencies
Mechanical equipment used in manufacturing			
Electric resistance heater	6,000 - 14,000	Tool exposures measured at operator's chest	VLF
Induction heater	10 - 460		High VLF
Hand-held grinder	3,000		
Grinder	110		
Lathe, drill press	1 - 4		
Electro-galvanizing			
Rectification room	2000 - 4,600	Rectified DC current (with an ELF ripple) galvanizes metal parts	High static fields
Outdoor electric line and substation	100 - 1,700		
Aluminum Refining			
Aluminum pot rooms	3.4 - 30	Highly rectified DC current (with an ELF ripple) refines aluminum	Very high static field
Rectification room	300 - 3,300		High static field
Steel Foundry			
Ladle refinery furnace active	170 - 1300	Highest ELF field was at the chair of control room operator	High ULF from the ladle's big magnetic stirrer
Ladle refinery furnace inactive	0.6 - 3.7		
Electro-galvanizing unit	2 - 1,100		High VLF
Television Broadcasting			
Video cameras (studio and minicam)	7.2 - 24	Measured 1 ft. away	VLF
Video tape degaussers	160 - 3,300		
Light control centers	10 - 300	Walk-through survey	
Studio and newsrooms	2 - 5		

Table D-10. EMF spot measurements in the workplace. *(continued)*

Industry and Sources	ELF magnetic fields (mG)	Comments	Other Frequencies
Telecommunications			
Relay switching racks	1.5 - 32	Measured 2 - 3 in. from relays	Static fields and ULF-ELF transients
Switching rooms (relay & electronic switches)	0.1 - 1,300	Walk-through survey	Static fields and ULF-ELF transients
Underground phone vault	3 - 5	Walk-through survey	
Hospitals			
Intensive care unit	0.1 - 220	Measured at nurse's chest	VLF
Post-anesthesia care unit	0.1 - 24		VLF
Magnetic resonance imaging (MRI)	0.5 - 280	Measured at technician's work locations	Very high static field, VLF and RF
Government Offices			
Desk work locations	0.1 - 7	Peaks due to laser printers	
Desks near power center	18 - 50		
Power cables in floor	15 - 170		
Computer center	0.4 - 6.6		
Can opener	3,000	Appliance fields measured 6 in. away	
Desktop cooling fan	1,000		
Other office appliances	10 - 200		
Building power supplies	25 - 1,800		
Transportation			
Cars, minivans, and trucks	0.1 - 125	Steel-belted tires principal ELF source	Frequencies less than 60 Hz
Bus (diesel powered)	0.5-146		Frequencies less than 60 Hz
Electric cars	0.1-181		Elevated static fields
Chargers for electric cars	4-63	Measured at 2 feet	
Electric buses	0.1-88	Measured at waist, at ankles 2-5 times higher	
Electric train passenger cars	0.1-330	Measured at waist, at ankles 2-5 times higher	25 and 60 Hz
Airliner	0.8-24.2	Measured at waist	400 Hz

Key: DC = direct current; ELF = extremely low frequency – 3 to 30 Hz; Hz = hertz; mG = milligauss; ULF = ultra low frequency - between 300 and 3,000 Hz; VLF = very low frequency – 3,000 – 30,000 Hz.
Source: NIEHS 2002.

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APPENDIX E – REPRESENTATIVE FACILITIES

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E. APPENDIX E – REPRESENTATIVE FACILITIES

E.1 INTRODUCTION

At this time, no specific end users or development proposals have been identified or proposed. To perform a meaningful analysis of environmental consequences, this environmental assessment (EA) uses representative example industry facilities for each of the "target marketing industry" (TMI) categories (TRIDEC 2011a, 2011b). According to the Tri-City Development Council's (TRIDEC's) land request, these would be built and operated on what would be single-industry "super sites" that in this EA are referred to as Single-Phase Developments. This EA also uses one additional representative Multi-Phased Development example indicative of what might be built and operated on TRIDEC's "mega site." Existing environmental analyses were used to obtain information about facility characteristics that are necessary for environmental consequence analysis (e.g., footprint, infrastructure, utilities, emissions, construction of buildings, projected workforce and traffic, water usage, and similar requirements). These were available for most of the representative types. Some of these facilities are constructed and operated by commercial private-sector enterprises and details of their construction or operation are not readily publicly available.

Disclaimer:
By selecting these facilities as representative for this EA, DOE in no way recommends or endorses these companies or their products. DOE also is not implying these companies or their operations are being considered for or are interested in building on the Hanford Site conveyance lands.

The facilities identified and used in this EA are not the only facilities that could be selected and are not inclusive of all possible example types that could have been selected. They represent the types and intensities of impacts that might result from full development of the facilities. Characteristics considered include total land area, building footprint, building height, construction duration, number of construction and operations workers, and hours of operation.

The TMIs are presented in Chapter 2 (Figure 2-3) and basic information about the representative facilities is introduced in **Table 2-1,** "Representative Target Marketing Industry and Solar Technology Example Facilities" and shown below in **Table E-1**. The table shows the TMI category, the subarea or subareas for which the representative facilities are examples, the general type of operation, the representative facility name, and a brief general use description of the facility.

This appendix presents more detailed information about these facilities and linkages to web-based information about them necessary for the resource-by-resource area analysis of environmental consequences. **Table E-2** provides general site characteristics for the facilities described in this appendix.

Table E-1. The representative target marketing industry examples and general use descriptions.

Target Marketing Industry Category	Subarea(s)	Type of Operation / Facility	Representative or Example Facility	General Use Description
Multi-Phased Development				
Warehousing and Distribution; Food and Agriculture; Back Office	Food and Agriculture; Refrigerated Warehousing and Storage; Packaging and Crating; Wine Processing; Food Processing; Administrative Processing; Information Technology	Commerce Center - Phased Development Light Multi-Use Industrial Business Park	NAPA Commerce Center, CA.	This business park includes professional and business offices, manufacturing and assembly, warehousing and limited retail developed in phases. This facility will be developed in phases over a 20-year timeframe: Phase I - 650,000 ft^2; Phase IIA - 160,000 ft^2; Phase IIB - 460,000 ft^2; Phase IIC - 575,000 ft^2; Phase IID - 500,000 ft^2; and Phase IIE - 350,000 ft^2. Phase I of this multi-phase development would be developed with all the single-phase developments.
Single-Phase Developments				
Warehousing and Distribution - A	Manufactured Parts and Materials Distribution; Material Handling; Packaging and Crating; and Logistics	Manufactured Parts Distribution Center	NAPA Auto Parts Distribution Center, Ontario, CA	This facility supplies replacement parts, specialty parts and equipment for the automotive repair, collision, heavy-duty truck, and industrial markets.

Table E-1. The representative target marketing industry examples and general use descriptions. (continued)

Target Marketing Industry Category	Subarea(s)	Type of Operation / Facility	Representative or Example Facility	General Use Description
Warehousing and Distribution - B	Food and Agriculture; Refrigerated Warehousing and Storage; Material Handling; and Logistics	Storage and Rail Distribution Center	Railex Distribution Center, Port Wallula, WA	This facility provides for storage and rail distribution across the USA of fruits, vegetables, and other temperature sensitive cargo to CA, NY, IL, and FL. This facility currently has a 500,000 ft^2 wine distribution warehouse and 210,000 ft^2 food distribution warehouse. There is a planned Phase 2 addition of over 1M ft^2 and additional track. This facility currently receives 2-55 railcar units per week with each shipping about 8 million lbs of produce shipped to east coast.
Research and Development - A	Scientific Research; Computation; Biotechnology	Biological R&D Center	Jackson Laboratory for Genomic Medicine, U Connecticut	The facility has flexible laboratory spaces, computational biology areas, scientific support services, data processing center, private offices, auditorium, conference rooms, media training areas and administrative offices.
Research and Development - B	Scientific Research; Software; Computation; Energy	Energy R&D Center	NREL Research Support Facility, Golden, CO	This facility is a LEED Platinum living laboratory for conducting research in energy efficiency and renewable energy. The building is a Net-Zero facility with a roof-mounted Photovoltaic array providing electricity to the facility.
Technology and Manufacturing - A	Defense manufacturing; Sensor; Medical Device Manufacturing	Electronics Equipment Manufacturing	John Deere Electronic Solutions, Fargo, ND	This facility manufactures navigational, measuring, electromedical, and control instruments. The company focuses on developing highly reliable, ruggedized electronic products to withstand harsh physical and electrical environments.
Technology and Manufacturing - B	Advanced Materials Manufacturing	Light Industrial	Rainesville Technology, Rainesville, AL	This facility does injection molding, painting, and assembly of automotive parts. Manufactures injection molded rubber and plastic products, glass injection moldings, and natural gas production services.
Food and Agriculture - A	Food Processing; Agricultural Products	Vegetable Food Processing	Keystone Potato Products, Frailey Township, PA	This facility takes locally grown fresh potatoes, washes them, and then cuts and cooks them. Burners are fired with methane from garbage decomposition or propane as necessary. Co-generation plant excess steam is used to run driers, peelers and blanchers. The products are mainly dehydrated potato flakes and flour that are shipped and distributed to retailers.

Table E-1. The representative target marketing industry examples and general use descriptions. (continued)

Target Marketing Industry Category	Subarea(s)	Type of Operation / Facility	Representative or Example Facility	General Use Description
Food and Agriculture - B	Wine Processing; Agricultural Products	Wine/Spirits Processing	Beringer Wine Estates, NAPA, CA	This facility has wine storage and warehousing, wine production, grape crushing, blending, bottling and shipment. The Beringer EIR evaluated…the 218-acre site with 1,167,590 ft^2 of floor space for wine storage and warehousing, 60,000 ft^2 of office space and 196,000 ft^2 for wine production, such as grape crushing, blending, bottling and associated areas. The approved development plan also included parking for 350 vehicles, site grading, and installation of wastewater treatment ponds and planting of vineyards on the western portion of the site.
Back Office - A	Call Center; Data Processing; Training	National Call Center	Sykes Enterprises Call Center, Fayetteville, NC	This facility uses telephone communications and data processing computers to provide service to customers.
Back Office - B	Administrative Processing; Data Processing; Information Technology; Professional Services; Training	Automatic Data Processing Center	ADP Inc., Dearborn, MI	This facility provides human capital management solutions including payroll services, human resource management, benefits administration, talent management, time and attendance, retirement services, and insurance services for small, mid-sized and large businesses. This facility has a 7,500 ft^2 computer room, employee cafeteria, self-contained back-up generator and support areas.
Energy	Biofuels Manufacturing	Biorefinery and Feedstock Processing Facility	Enerkem Corporation, Pontotoc, MS	This facility is a Heterogeneous Feed Biorefinery (HFB) and Materials Recovery Facility (MRF) in Pontotoc, Mississippi, that uses the biomass fraction of municipal solid waste and cellulosic material as feedstock to produce commercial ethanol. The buildings and equipment include a Gasification island, Methanol production island, Ethanol production island, Methanol compressor shed, Chiller shed, Waste water building, Feedstock storage building, Cooling tower, Motor Control Center, Heat Exchanger shed, Production Storage Tanks, Office Building, Oxygen Storage Area, and Nitrogen Storage Area

Table E-1. The representative target marketing industry examples and general use descriptions. (continued)

Target Marketing Industry Category	Subarea(s)	Type of Operation / Facility	Representative or Example Facility	General Use Description
Solar Farm				
Solar Technology A	Photovoltaic Energy Production	Electrical Production Facility	Blythe Mesa Solar Project, Riverside County, CA	This electric production facility uses single-axis PV panels that would be connected to the electrical grid. The PV cells convert sunlight into electricity by the sun's light exciting electrons in the panel's material producing an electrical current. Many panels are connected together into arrays. The single-axis rotation follows the sun's path from morning to evening.
Solar Technology B	Thermal Electric Dish Energy Production	Electrical Production Facility	Calico Solar Project, San Bernardino, CA	This facility uses thermal electric parabolic-mirror dishes each with a turbine engine to generate electrical energy. Each dish focuses the sun's energy on the turbine engine causing gas/liquid to expand and drive the turbine. The turbines motion generates electricity that is collected at substations on site and then connected to the electrical power grid.

Key: ft = feet; HFB = Heterogeneous Feed Biorefinery; LEED = Leadership in Energy and Environmental Design; MRF = Materials Recovery Facility; PV = photovoltaic; R&D = research and development.

Table E-2. General characteristics of the "Multi-Phased" and "Single-Phase Development" representative facilities listed in Table E-1.

	Phased Development	Warehousing and Distribution		Research & Development		Technology & Manufacturing		Food & Agriculture		Back Office		Energy
	Multi-Use Industrial Business Park	A	B	A	B	A	B	A	B	A	B	Biorefinery & Feedstock Processing Facility
	Napa Commerce Center, Napa, CA	NAPA Auto Parts Distribution Center, Ontario, CA	Railex Distribution Center, Wallula, WA	Jackson Laboratory for Genomic Medicine, Farmington, CT	NREL Research Support Facility, Golden, CO	John Deere Electronic Solutions, Fargo, ND	Rainesville Technology, Rainesville, AL	Keystone Potato Products, Frailey Township, PA	Beringer Wine Estates, Napa, CA	Sykes Enterprises Call Center, Fayetteville, NC	ADP Inc., Dearborn, MI	Enerkem Corporation, Pontotoc, MS
Total Land Area (acres)	180	10	30	17	29	30	50	83	218	5	6	31
Buildings	16	1	2	1	1	1	1	1	Many	1	1	14
Building Stories	1 & 2	1 & 2	1 & 2	4	3	2	1 & 2	1	1 & 2	2	2	Multi-Story
Approximate Height of Buildings (ft)	40	40	40	80	60	40	40	20	40	40	40	10 to 115
Gross Area of Buildings (gross ft^2)	2,650,000	200,000	710,000	190,000	222,000	95,000	200,000	51,000	1,500,000	50,000	85,000	61,000
Total Building Footprint (acres)	38	5	16	4	2	2	5	1	34	1	1	1
Construction Duration (months)	20-yr.	18	12	18	18	18	18	18	18	12	12	24
Paved Area (acres)	88	6	18	10	18	18	31	51	133	3	4	19

Table E-2. General characteristics of the "Multi-Phased" and "Single-Phase Development" representative facilities listed in Table E-1. (continued)

	Phased Development	Warehousing and Distribution		Research & Development		Technology & Manufacturing		Food & Agriculture		Back Office		Energy
	Multi-Use Industrial Business Park	A	B	A	B	A	B	A	B	A	B	Biorefinery & Feedstock Processing Facility
	Napa Commerce Center, Napa, CA	NAPA Auto Parts Distribution Center, Ontario, CA	Railex Distribution Center, Wallula, WA	Jackson Laboratory for Genomic Medicine, Farmington, CT	NREL Research Support Facility, Golden, CO	John Deere Electronic Solutions, Fargo, ND	Rainesville Technology, Rainesville, AL	Keystone Potato Products, Frailey Township, PA	Beringer Wine Estates, Napa, CA	Sykes Enterprises Call Center, Fayetteville, NC	ADP Inc., Dearborn, MI	Enerkem Corporation, Pontotoc, MS
Impervious Land Area (acres)	117	8	24	14	24	24	41	67	177	4	5	16
No. of Employees (full time equivalents)	2,530	400	100	1,500	825	60	340	50	610	500	389	61
Hours of Operation (hours/days per week)	24/7	24/7	24/7	8/5	10/5	24/7	24/7	24/7	24/7	24/7	24/7	24/7

Key: ft = feet.

Sources: These data are largely from the respective facility information sources in the following sections with the following exceptions: Impervious land area is calculated in accordance with the procedure in the *User's Guide for the California Impervious Surface Coefficients* (Washburn et al. 2010). Paved area acreage was calculated using the average of 60% of the total land as determined by *Impervious Surface Reduction Study* (City of Olympia 1995). Building stories are assumed to be approximately 20 feet each. Construction durations are either as given by the source or assumed based upon the general characteristics. The hours of operation are either as given or assumed based upon the general characteristics. Building footprint is based upon the gross square footage if a one-story building, one-half the gross square footage if a two-story building, or 26% of the total land area for a mixed one- and two-story facility (City of Olympia 1995). Many values are rounded since the number of significant digits is not important for this analysis.

E.2 WAREHOUSING AND DISTRIBUTION

Warehousing is the storage of goods. Traditional or "public warehousing" is generally understood to be storing a customer's goods for a temporary period of time. However, in the context of this EA, it is not a "static" storage but rather a multi-client high-velocity warehousing operation where customers have short-term or fluctuating space requirements to maintain inventory.

> (l) "Warehouse" means an enclosed building or structure in which finished goods are stored. A warehouse building or structure may have more than one storage room and more than one floor. Office space, lunchrooms, restrooms, and other space within the warehouse and necessary for the operation of the warehouse are considered part of the warehouse as are loading docks and other such space attached to the building and used for handling of finished goods. Landscaping and parking lots are not considered part of the warehouse. A storage yard is not a warehouse, nor is a building in which manufacturing takes place… (Revised Code of Washington [RCW] 82.08.820)

Distribution is the receiving, storage, processing, and shipment of goods. Physically, warehousing and distribution centers are very similar in that they have walls, a roof, dock space, and truck doors. A distribution center also provides such services as transportation, cross-docking, order-fulfillment, labeling, and packaging along with whatever services are necessary to complete the order cycle, including order processing, order preparation, shipping, receiving, transportation, returned goods processing, and performance measurement.

> (d) “Distribution center” means a warehouse that is used exclusively by a retailer solely for the storage and distribution of finished goods to retail outlets of the retailer. “Distribution center” does not include a warehouse at which retail sales occur… (RCW 82.08.820).

The different types of warehouses include:

- *Heated and unheated general warehouses*—provide space for bulk, rack, and bin storage, aisle space, receiving and shipping space, packing and crating space, and office and toilet space.
- *Refrigerated warehouses*—preserve the quality of perishable goods and general supply materials that require refrigeration. Includes freeze and chill space, processing facilities, and mechanical areas,
- *Controlled humidity warehouses*—similar to general warehouses except that they are constructed with vapor barriers and contain humidity control equipment to maintain humidity at desired levels.

The TRIDEC TMI warehousing and distribution category subareas (all of which are included in the selected representative facilities) are listed below (TRIDEC 2011a, 2011b):

- Manufactured parts and materials distribution
- Food and agricultural
- Refrigerated warehousing and storage
- Material handling
- Packaging and crating
- Logistics.

An example of a distribution warehouse facility and the site layout can be found at http://www.phoenixrealty.net/northport/ (Newmark Grubb 2015). In the online photos, there are 37 docking bays where semi-trailers back up for loading and unloading. The site layout is indicative of the parking and road areas needed for warehousing and distribution facilities.

All distribution centers have three main areas and may have additional specialized areas. The three main areas are the receiving dock, the storage area, and the shipping dock. In small organizations, it is possible for the receiving and shipping functions to occur side by side, but in large centers, separating these areas simplifies the process. Many distribution centers have dedicated dock doors for each store in their shipping area. The receiving area can also be specialized based on the handling characteristics of freight being received, on whether the product is going into storage or directly to a store, or by the type of vehicle delivering the product.

E.2.1 Example A, Subarea - Manufactured Parts and Materials Distribution; Material Handling; Packaging and Crating; and Logistics

This facility is the National Auto Parts Association (NAPA™) Auto and Truck Parts in Ontario, CA. NAPA™ is an automotive and truck replacement parts and accessories retailer that operates over 60 distribution centers across the U.S. The description is for the renovation of an existing NAPA warehouse facility. The warehouse retrofit required removing existing floor sealer, prepping the slab, installing new densifying product, and polishing the floor. The contractor cut-in and installed five hydraulic dock levelers, and a back-up generator, as well as patched and painted the building's exterior surfaces and roof. The project required the build-out of a new retail store, hazardous rooms (International Building Code H3/H4), and an aerosol room. The 197,000 ft^2 facility has 25 loading docks and employs about 60 workers with an inventory of about $11 million (DeLoach 2013).

The existing office area was demolished for the construction of new interior offices. The new office area included cubicle farms, executive offices, a training room with accordion partitions, a kitchenette, restrooms, lockers, and indoor/outdoor break rooms. The site work involved the installation of a new driveway as well as additional parking spaces and landscaping. More information and photos of this facility can be found in the appendix references (DeLoach 2013; Oltmans 2014; PMA 2015).

E.2.2 Example B, Subarea – Food and Agriculture; Refrigerated Warehousing and Storage; Material Handling and Logistics

This facility is the Wallula Railex® facility in Burbank, WA, built in 2013 on 182 acres of heavy-industrial zoned land located adjacent to the Union Pacific Railroad mainline. **Figure E-1** below shows the Railex® Wine Services warehouse facility in the middle of the photo and the Railex® food distribution facility below (Gerola 2014).

The following description comes largely from Tri-City Herald articles (Pihl 2013, 2014; Hulse 2014). The Railex Wine Services facility is 500,000 ft^2 of temperature- and humidity-controlled warehouse and distribution with the capacity to hold on the order of five to six million cases of wine. The wine facility is the equivalent of 11 football fields under one roof.

Four trains a week currently transport produce (apples, onions, and frozen vegetables) from the Wallula food distribution facility to New York. One train carries about eight million pounds of produce in refrigerated, temperature-controlled freight cars (see Figure E-2).

The Railex® train drives through the Wallula food distribution facility which has (Railex 2010):

- 225,000 ft2 of refrigerated space
- 17,500 racked pallet positions
- 6 separate computer controlled temperature zones
- 19 enclosed refrigerated rail docks
- 38 refrigerated truck doors (see Figure E-2)
- Fully integrated radiofrequency enabled Warehouse Management System
- Products loaded and unloaded from freight cars inside the warehouse
- 2 1/2 mile rail loop track on property (see aerial photo, Figure E-1).

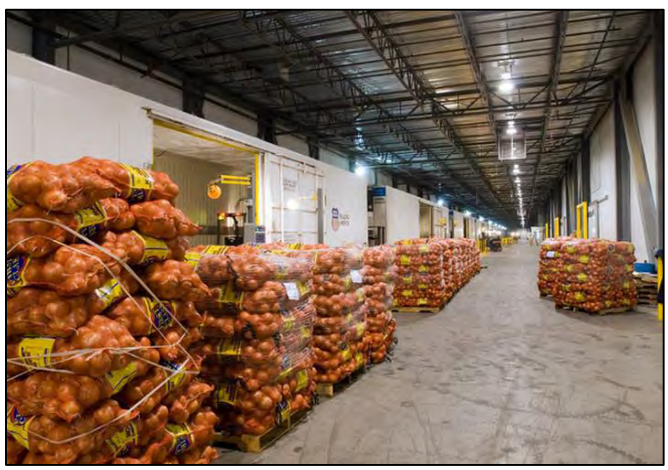
Each Railex® train uses 55-car refrigerated unit freight cars that are the equivalent of 200 trucks per week (Kuntz 2006) (see Figures E-2 and E-3). Four trains per week are the equivalent of over 800 trucks per week. More information and photos of this facility can be found in the appendix references

(Gerola 2014; Hulse 2014; Kuntz 2006; Nall 2013; Pihl 2013, 2014; Port of Walla Walla 2006, 2014; Railex 2010).

Figure E-1. The Wallula Railex® facility in Burbank, WA showing larger 500,000 ft^2 wine services distribution center, the 220,000 ft^2 food distribution warehouse, and the 2.5 mile loop railroad track.

Source: Gerola 2014.

Figure E-2. Railex® refrigerated rail cars inside the food distribution warehouse.



Source: Gerola 2014.

Figure E-3. Railex® food distribution warehouse with train starting to enter warehouse with truck loading docks.

Source: Kuntz 2006.

The Port of Walla Walla plans to add an additional 8,300 linear feet of new rail, rail switching equipment, and gravel service roads to accommodate the additional produce shipments for future expansion. **Figure E-4** shows the possible expansion areas for the Railex® facilities accounting for over a million ft^2 of additional buildings, parking areas, and multi-modal storage along with the potential location of additional track.

Figure E-4. The Railex® Wallula facility showing proposed rail infrastructure and future expansions.

Source: Gerola 2014.

E.3 RESEARCH AND DEVELOPMENT

Product research and development (R&D) is an activity performed by a team of professionals working to transform a product idea into a technically sound and promotable product. Corporate R&D departments are generally responsible for product development and testing, researching brand names, and creating an effective packaging concept. There is no unique description or characteristic of an R&D facility since R&D can apply to almost any business endeavor. TRIDEC's vision of the types of

R&D facilities that would be built on conveyed lands would be in the following category subareas (the two selected representative facilities include those subareas in bold) (TRIDEC 2011a, 2011b):

- **Scientific research**
- **Software**
- Data security
- **Computation**
- **Energy**
- Environmental
- **Biotechnology**.

The first category subarea (scientific research) is very generic in that it could include almost any area of research. The next three category subareas would take place largely in structures that appear more like college buildings or office-type buildings that would house electronics/computer laboratories and might have sophisticated computer systems beyond the standard desktop personal computers. The last three category subareas might have building structures that would include both office-type and light-industrial facility buildings including biological or chemical laboratories. **Figures E-5** and **E-6** are general examples of what these types of facilities might look like.

Figure E-5. NASA Langley Research Center, Hampton, VA is an example of an R&D facility.

Source: GSA 2014.

Figure E-6a and 6b. The U.S. Department of the Interior's Brackish Groundwater National Desalination Research Facility is another example of an R&D facility. The adjacent ponds and tanks that are part of this facility are not visible in this photo.

Source: DOI 2013.

E.3.1 Example A, Subarea – Scientific Research; Computation; Biotechnology

This facility is the Jackson Laboratory for Genomic Research, a Leadership in Energy and Environmental Design (LEED®) Gold multi-story 183,500 ft^2 facility in Farmington, CT. It opened in

October 2014 on a 17-acre site on the south lower level of the University of Connecticut Health Center Campus. Initially this site hired 115 researchers, and about 40 of them were already CT residents. It is expected that the facility will create 300 jobs in the new facility and an additional 331 research-related jobs on the Health Center Campus. About 842 construction jobs were created during construction with an estimated 6,200 spinoff and indirect jobs (Kable 2013). The budget for research and facilities over a 20-year period is expected to be about $1.1 billion (Kable 2013). **Figure E-7** shows and artist's rendering of the Jackson Laboratory after construction. More information and photos of this facility can be found in the appendix references (Benson 2013; CBIA 2012; DeFrancesco 2014; Harris 2014; Jackson Laboratory 2014, 2015; Kable 2013; Malloy 2011; Pilon 2014; Schreier 2013; UConn Health 2015).

Figure E-7. Artist's rendering of the Jackson Laboratory, Farmington, CT.

Source: Malloy 2011.

E.3.2 Example B, Subarea – Scientific Research; Software; Computation; Energy

This facility is the National Renewable Energy Laboratory's (NREL) Research Support Facility (RSF) in Golden, CO (see **Figures E-8** and **E-9**). The facility is a 360,000 ft^2 LEED® Platinum office building and is a showcase for energy efficiency and renewable energy technologies. It will house about 800 staff at NREL, but will be used by about 1,300. It cost about $57.4 million to construct for a total of $64 million with furnishings (NREL 2010) (see **Figure E-10**). More information and photos of this facility can be found in the appendix references (DOE 2012c; NREL 2009, 2010, 2014a, 2014b).

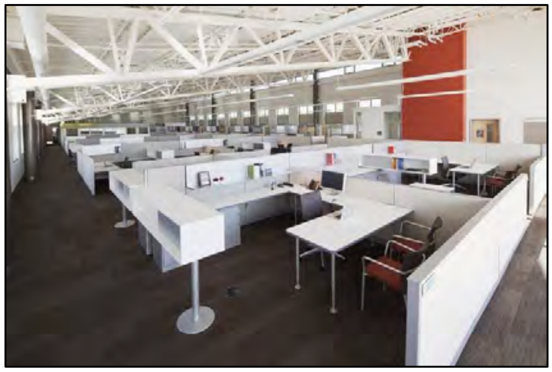
Figure E-8. NREL RSF under construction showing the "lazy H" configuration.

Source: NREL 2009.

Figure E-9. National Renewable Energy Laboratory – Research Support Facility.

Source: NREL 2014b.

Figure E-10. Open office area in the main wing of NREL's RSF.



Source: NREL 2010.

E.4 TECHNOLOGY AND MANUFACTURING

This TMI category is focused mostly on the design and fabrication of mechanical/electronic devices. This technology could require, for example, printing of circuit boards, chemical etching/milling, metal finishing, anodizing, chromating, electro-polishing, and industrial wastewater treatment for hazardous materials. The TRIDEC TMI category subareas (the two selected representative facilities include those subareas in bold) are as follows (TRIDEC 2011a, 2011b):

- **Defense manufacturing**
- **Sensor manufacturing**
- **Medical device manufacturing**
- Food processing machinery manufacturing
- **Advanced materials manufacturing**
- Carbon fiber manufacturing.

The Co-Operative Industries Aerospace & Defense Facility in Fort Worth, TX, and Bridger Photonics Inc. in Bozeman, MT, are examples of defense manufacturing facilities. Photos of these can be seen at their company websites (CIA&D 2011; BP 2015).

E.4.1 Example A, Subarea – Defense Manufacturing; Sensor; Medical Device Manufacturing

This facility is John Deere Electronics Solutions Inc. (JDES) that was formerly their subsidiary known as Phoenix International. JDES specializes in design and manufacture of ruggedized electronics for John Deere and other original equipment manufacturers in industries that need their equipment to function under harsh electrical and physical environmental conditions.

JDES's state-of-the-art design and manufacturing technologies provides a wide range of robust products: electro-hydraulic controls; telematics communication and processing modules; color, graphical, and touchscreen displays; gauge/switch panels; and custom sensors designed to withstand severe temperatures, humidity, vibration and other harsh conditions. JDES also specializes in ruggedized power electronics that include electric drive controls from low-voltage, low-power ranges (1 to 10 kilowatts [kW]) up to heavy vehicle traction drives in high-voltage, high-power ranges (20 kW to hundreds of kW).

JDES spent $22 million on their 90,000 ft^2 building in Fargo, ND. More information and photos of this facility can be found in the appendix references (John Deere 2015a, 2015b; Reuer 2012; Vaughan 2014).

E.4.2 Example B, Subarea – Advanced Materials Manufacturing

This is the Rainsville Technology Inc. (RTI) facility in Rainsville, AL. A $3.3 million expansion at their car parts facility added 30 jobs for DeKalb County and surrounding areas. RTI expanded the facility to 282,000 ft^2 to build more parts for an automobile plant in a nearby AL town. RTI makes plastic injection-molded parts, painting, and assembly of automotive parts. RTI manufactures injection-molded rubber and plastic products, and glass injection moldings; and has natural gas production services. More information and photos of this facility can be found in the appendix references (Benton 2012; Doster 2015; Guinn 2014; Moriroku Technology 2012).

E.5 FOOD AND AGRICULTURE

This TMI category is focused on agricultural processing operations. These operations commonly have separate areas for handling the raw food product, processing the food into a product, and, depending upon the food, aging, storage, and shipment/distribution. These generally require several buildings requiring the use of "chillers" to keep food spoilage to a minimum, water for cleaning and processing, heating/cooling for food processing and facility climate control, generate large quantities of by-product waste, and have correspondingly significant electrical usage. The TRIDEC TMI category subareas (the two selected representative facilities include those subareas in bold) are (TRIDEC 2011a, 2011b):

- **Wine processing**
- **Food processing**
- **Agricultural products**
- Craft beer production.

E.5.1 Example A, Subarea – Food Processing; Agricultural Products

This is the Keystone Potato Products facility in Frailey Township, PA. This facility takes locally grown fresh potatoes, washes them, and then cuts and cooks them. Burners are fired with methane from garbage decomposition or propane as necessary. Co-generation plant excess steam is used to run driers, peelers, and blanchers. The products are mainly dehydrated potato flakes and flour that are shipped and distributed to retailers. More information and photos of this facility can be found in the appendix references (Keystone Potato 2010; PR Newswire 2007; Sophy 2005).

E.5.2 Example B, Subarea – Wine Processing; Agricultural Products

This facility is the Beringer Wine Estates Devlin Road Facility (City of American Canyon 2012). Napa County approved the construction of a 1,424,400 ft^2 multi-building facility on the eastern portion of the 218-acre site Napa Commerce Center (see **Section E.9**), parallel to existing Union

Pacific railroad tracks. The western portion of the site would be used for vineyards, wastewater treatment ponds to accommodate effluent generated by on-site wine production operations, and wetland preservation areas. Approved land uses and activities included 1,167,590 ft^2 of floor space for wine storage and warehousing, 60,000 ft^2 of office space and 196,810 ft^2 for wine production, such as grape crushing, blending, bottling, and associated areas. A total of 350 onsite surface parking spaces and truck and rail loading docks were included in the project. Maximum building height was approved at 43 feet. The facility would be served by the western and northern extension of Devlin Road from its present terminus at South Kelly Road (City of American Canyon 2012). More information and photos of this facility can be found in the appendix references (City of American Canyon 2012; Eichleay 2015; Valley Architects 2009).

E.6 BACK OFFICE

The back office TMI category refers to those personnel involved in administration, order processing, or customer service that are not generally seen by customers. These facilities are commercial office-type buildings that are heavily dependent upon communications (voice and internet), and computer equipment including desktop personal computers and servers connected both as local area networks and wide area networks connecting this back office facility to other facilities or operations that could be local or states or continents away. There would likely be a main building and, because of the need for communications/computers, a generator backup. Electrical, heating/cooling, water, waste generation, and other characteristics would be consistent with normal office buildings. The TRIDEC TMI category subareas (the two selected representative facilities include those subareas in bold) are (TRIDEC 2011a, 2011b):

- **Call centers**
- **Administrative processing**
- **Data processing**
- **Information technology**
- Remote sensing
- **Professional services**
- **Training**.

E.6.1 Example A, Subarea – Call Center; Data Processing; Training

This facility is the Sykes Enterprises Call Center in Fayetteville, NC. Sykes offers customer contact management solutions and services in the business process arena. They provide these services primarily in the communications, financial services, healthcare, technology, travel, and retail industries. They provide multilingual order and payment processing, inventory control, product delivery, and returns handling (Sykes 2015). More information and photos of this facility can be found in the appendix references (City of Fayetteville 2012; Hoyle 2013; Sykes 2015).

E.6.2 Example B, Subarea – Administrative Processing; Data Processing; Information Technology; Professional Services; Training

This is the Automatic Data Processing Center in Dearborn, MI (**Figure E-32**). This facility provides human capital management solutions including payroll services, human resource management, benefits administration, talent management, time and attendance, retirement services, and insurance services for small, mid-sized, and large businesses. This facility has a 7,500 ft^2 computer room, employee cafeteria, self-contained back-up generator, and support areas. More information and photos of this facility can be found in the appendix references (ADP 2015; Baverman 2008; Olson 2014; URS 2012; Warikoo 2014).

E.7 ENERGY – GENERAL

In the energy category, TRIDEC included four subareas (the selected representative facility includes the subarea in bold) that are very different (TRIDEC 2011a, 2011b). These are:

- Small modular reactors
- **Biofuels manufacturing**
- Solar testing facilities
- Smart grid.

While the small modular reactor subarea was identified on TRIDEC's 10 CFR Part 770 request, TRIDEC subsequently determined that this technology is not reasonably foreseeable at this time (Cary 2013). Solar technology is addressed in **Section E.8** of this appendix.

E.7.1 Energy - Subarea – Biofuels Manufacturing

This facility is the Enerkem Heterogeneous Feed Biorefinery (HFB) and Materials Recovery Facility (MRF) in Pontotoc, MS. The HFB/MRF facility uses the biomass fraction of municipal solid waste and cellulosic material as feedstock to produce commercial ethanol. The facility converts mixed domestic waste and cellulosic residues into a pure synthesis gas (or syngas) that is suitable for the production of biofuels and chemicals using proven, well-established, and commercially available catalysts. With its proprietary technology platform, the company is able to chemically recycle the carbon molecules from non-recyclable waste to create a number of products including ethanol. The process reduces the volume of waste ultimately going into a landfill by more than 90% and, at the same time, extracts useful energy from the waste used as feedstock (DOE 2012d). More information and photos of this facility can be found in the appendix references (DOE 2010a, 2012d; Lane 2014; Nesseth 2014). Photos of an example biofuels facility are shown in **Figures E-11** and **E-12**.

The buildings and equipment include a gasification island, methanol production island, ethanol production island, methanol compressor shed, chiller shed, waste water building, feedstock storage building, cooling tower, motor control center, heat exchanger shed, production storage tanks, office building, oxygen storage area, and nitrogen storage area.

Figure E-11. Example of a biofuels production facility.

Source: EPA 2009.

Figure E-12. Example integrated biofuels technology production facility.

Source: DOE 2015.

E.8 ENERGY – SOLAR FARM

The solar farm is not presented specifically to address the TMI categories but does fall within one of the subareas. The TRIDEC TMI energy subareas (the subarea in bold is addressed by the solar farm analysis) are (TRIDEC 2011a, 2011b):

- Small modular reactors
- Biofuels manufacturing
- **Solar testing facilities**
- Smart grid.

TRIDEC's proposal for a 300-acre solar farm addressed an interest in three specific solar technology applications (see Chapter 2, **Section 2.2.2**) (the two in bold below are those represented by the solar farm analysis):

- Photovoltaic fixed tilt
- **Photovoltaic single-axis tracking**

- Photovoltaic two-axis tracking or **thermal electric ("dish" style)**.

Basic information about the representative facilities is shown at the beginning of this appendix in **Table E-1**. The table shows the TMI category, the subarea or subareas for which the representative facilities are examples, the general type of operation, the representative facility name, and a brief general use description of the facility. The solar farm representative facilities are shown as the last two entries on **Table E-1**. General characteristics of the solar farm representative facilities are shown on **Table E-3**.

Table E-3. General characteristics of the Solar Farm example facilities listed in Table E-1.

	Single-Axis Photovoltaic Solar		**Thermal Electric "Dish" Solar**	
Specifications	**Example Facility - Blythe Mesa Solar Project, Riverside County, CA**	**FSA - 300-acre parcel projection**	**Example Facility - Calico Solar Project, San Bernardino, CA**	**FSA - 300-acre parcel projection**
Total Land Area (acres)	3,360	300	6,215	300
Direct Land Usage (acres)	2,207	197	5,698	275
Construction Duration (months)	36	12	52	12
Impervious Land Area (acres)	12	4	517	25
Panels or Units	1,425,600 high efficiency silicon solar panels configured into blocks 660 ft wide and 470 ft long with each block comprising six trackers with 18 north-south oriented rows of PV panels (295 ft long and 140 ft wide). 310 - 1.5 MW solar arrays that are 7.12 acres each. There are 3 substations on 2.07 acres each. There are 3 O&M buildings on a total of 4.3 acres. There is one guard structure on 1.4 acres.	127,286 high efficiency silicon solar panels configured into blocks 660 ft wide and 470 ft long with each block comprising six trackers with 18 north-south oriented rows of PV panels (295 ft long and 140 ft wide), 28 - 1.5 MW solar arrays that are 7.12 acres each. There will be 1 substation on 2.07 acres. There are 2 O&M buildings on a total of 2.15 acres. There is one guard structure on 0.13 acres. Total building footprint about 2.28 acres or about 100,000 ft^2.	34,000 SunCatcher® power generating systems organized into 1.5-MW solar groups of 60 SunCatchers® per group. Groups would be connected in series to create 3-, 6-, and 9-MW solar groups connected to overhead collection lines rated at 48 MW or 51 MW. Each SunCatcher is a 25-kW solar dish comprised of an array of curved glass mirror facets. There are about 5 SunCatchers® per acre.	The same as the Calico Solar Project except that there will be 1,640 SunCatcher® power generating systems. Total building footprint 214,000 ft^2.

Table E-3. General characteristics of the Solar Farm example facilities listed in Table E-1. (continued)

	Single-Axis Photovoltaic Solar		**Thermal Electric "Dish" Solar**	
Specifications	**Example Facility - Blythe Mesa Solar Project, Riverside County, CA**	**FSA - 300-acre parcel projection**	**Example Facility - Calico Solar Project, San Bernardino, CA**	**FSA - 300-acre parcel projection**
Structural layout	The panels would be configured into trackers, and the trackers configured into blocks approximately 660 ft wide and 470 ft long. Each block comprises six trackers with 18 north-south oriented rows of PV panels (295 ft long and 140 ft wide) that rotate up to 45 degrees from east to west to track the sun (total number of rows is 35,640), with the center of rotation being approximately 4 to 8 ft above grade. Solar panels at an upright position would have a minimum clearance of 2 ft above the highest adjacent ground. Within each tracker, the rows of PV panels would be linked by a steel drive strut (295 ft long), which would be oriented perpendicular to the axis of rotation. A small 0.5 horsepower electric drive motor would move the strut back and forth. Torque tubes act as the horizontal support to the PV panels and are in turn supported by micro piles (15 to 20 ft long and having a 4.5 inch outer diameter), which are driven directly into the ground.	Same as the Blythe Mesa Solar Project.	Each SunCatcher® is 38 ft long x 38 ft wide and 40 ft high. There is one main services complex administration building (130 ft long x 70 ft wide x 14 ft high), one main services complex maintenance building (70 ft long x 70 ft wide x 14 ft high), two SunCatcher® assembly buildings (1,000 ft long x 100 ft wide x 78 ft high), 1 well-water and fire-water 220,000 gal storage tank 36 ft in diameter x 20 ft high), two demineralized 11,000 gal water tanks (10 ft in diameter and 10 ft high), one potable 5,000 gal water tank (40 ft in diameter and 20 ft high). All roads sealed with Soiltac® (polymeric sealant) for dust control.	The same as the Calico Solar Project.

Table E-3. General characteristics of the Solar Farm example facilities listed in Table E-1. (continued)

	Single-Axis Photovoltaic Solar		Thermal Electric "Dish" Solar	
Specifications	**Example Facility - Blythe Mesa Solar Project, Riverside County, CA**	**FSA - 300-acre parcel projection**	**Example Facility - Calico Solar Project, San Bernardino, CA**	**FSA - 300-acre parcel projection**
Other facility Information	Drive piers are driven 8 ft to 12 ft into the ground. Drive piers are about 19 ft apart. Multiple PV modules are connected to a combiner box. Multiple combiner boxes are connected to an inverter, and multiple inverters are connected to a medium-voltage transformer that is connected to a 34.5kV power line that connects to the electrical substation. Inverters and transformers are placed on a concrete equipment pad that is 12 ft wide and 30 ft long. The medium-voltage overhead poles are 54.5 ft tall. The three project substations (each approximately 300 ft long by 300 ft) would collect all the medium-voltage circuits and step up the voltage to 230 kV.	Same except for: The one project substations (approximately 300 ft long by 300 ft wide) would collect all the medium-voltage circuits and step up the voltage to 230 kV.		
Number of Employees (full time equivalents)	500 construction, 12 operation (1 plant manager, 5 engineering/technicians, 6 security)	166 construction (proportioned on construction time); 6 operation (1 plant manager, 2 engineering / technicians, 3 security) (based on minimum probable)	101 to 731 per month construction; 136 full-time for operation.	25 to 134 per month construction (proportioned on construction time); 7 full-time for operation (proportioned on acreage)
Paved Area (acres)	12	4	511	25
Hours of Operation (hours per day / days per week)	10/7	10/7	10/7	10/7
Electrical Generation (MW)	485	42	850	41

Key: FSA = Focused Study Area; ft = feet; gal = gallon; kV = kilovolt; kW = kilowatt; O&M = operations and maintenance; PV = photovoltaic; MW= megawatt.

The solar farm characteristic projections are for the most part extrapolations based upon the ratio of the representative facility acreage to the solar farm’s 300-acre size. Construction duration is not a direct ratio calculation since some parts (like maintenance and operating facilities) would take the same amount of time regardless of overall acreage.

E.8.1 Example A – Photovoltaic Energy Production

This facility is the Blythe Mesa Solar Project, Riverside, CA. This electric production facility uses single-axis PV panels that would be connected to the electrical grid. The PV cells convert sunlight into electricity by the sun's light exciting electrons in the panel's material producing an electrical current. Many panels are connected together into arrays. The single-axis rotation follows the sun's path from morning to evening. **Figure E-13** shows an example single-axis tracking system. **Figure E-14** shows an inverter used to convert direct current (DC) to alternating current (AC) energy. More information and photos of this facility can be found in the appendix references (BLM 2014; Jacoby 2014; Roth 2014).

Figure E-13. Example of a single-axis PV array with two drive units (NREL 2008).

Source: NREL 2008.

Figure E-14. Example string inverter to convert DC into AC electricity.

Source: NREL 2013.

E.8.2 Example B - Thermal Electric Dish Energy Production

This facility is the Calico Solar Project in San Bernardino, CA. This facility uses thermal electric parabolic-mirror dishes, each with a turbine engine to generate electrical energy. Each dish focuses the sun's energy on the turbine engine causing gas/liquid to expand and drive the turbine. The turbine's motion generates electricity that is collected at substations onsite and then connected to the electrical power grid. **Figures E-15** and **E-16** are photos from the already constructed Calico Solar Project in Peoria, AZ, but are the same type of solar dish and installation. More information and photos of this facility can be found in the appendix references (BLM 2010; CSP World 2012; DOE 2010b).

Figure E-15. SunCatcher® solar dish systems installed at Peoria, AZ for the 1.5-MW Maricopa Solar Project with administrative and maintenance buildings in the background.

Source: DOE 2010b.

Figure E-16. Maricopa Project showing the 60 SunCatcher® solar dishes with maintenance and operations on the upper right, and the electrical substation out of the photo to the left.

Source: NREL 2011.

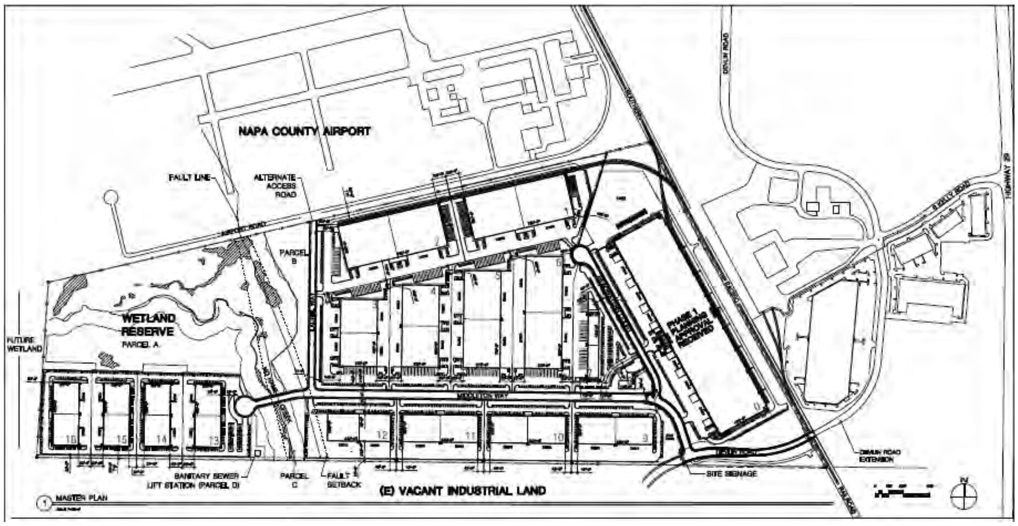
E.9 MULTI-PHASED DEVELOPMENT SITE – COMMERCE CENTER, PHASED DEVELOPMENT LIGHT MULTI-USE INDUSTRIAL BUSINESS PARK

This "Multi-Phased Development" is the Napa Commerce Center (**Figures E-17** and **E-18**) that includes professional and business offices, manufacturing and assembly, warehousing and limited retail developed in phases. This facility will be developed in phases over a 20-year timeframe (see **Figure E-19**): Phase I - 650,000 ft^2; Phase IIA - 160,000 ft^2; Phase IIB - 460,000 ft^2; Phase IIC - 575,000 ft^2; Phase IID - 500,000 ft^2; and Phase IIE - 350,000 ft^2. Phase I of this Multi-Phased Development would be developed with all the Single-Phase Developments. Most of the relevant information about this facility can be found in the Environmental Impact Report (City of American Canyon 2012).

Figure E-17. Artist's rendition of the proposed Napa Commerce Center.

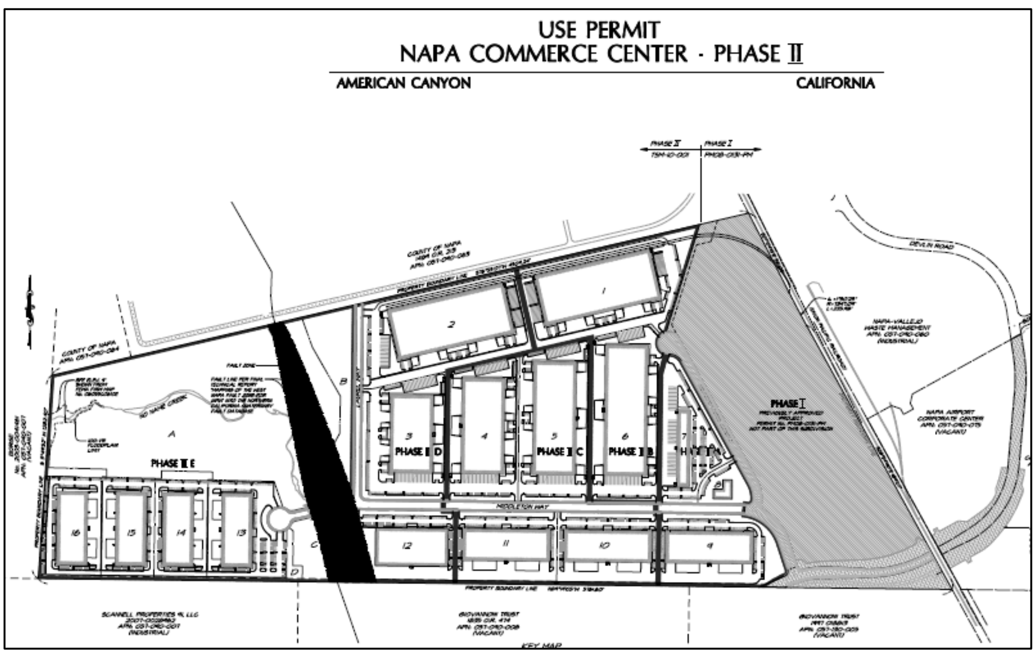
Source: City of American Canyon 2012.

Figure E-18. Napa Commerce Center Master Plan site layout.



Source: City of American Canyon 2012.

Figure E-19. Napa Commerce Center diagram from the use permit showing the projected tentative phases of development.



Source: City of American Canyon 2012.

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APPENDIX F – RADIOLOGICAL ACCIDENTS

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F. APPENDIX F – RADIOLOGICAL ACCIDENTS

F.1 GENERAL BACKGROUND AND METHODOLOGY

For the purpose of this EA, an evaluation to fully characterize the postulated bounding radiological accident impacts that could exist in or near the FSA from nearby facility accidents was conducted. The purpose of this analysis is to address the postulated bounding radiological dose from events/accidents that could occur at the 324/325 buildings to a member of the public. A series of postulated bounding accident events were screened and ultimately evaluated for the 300 Area in support of the Proposed Action. Buildings 324 and 325 in the 300 Area were the focal points for the analysis given their co-location to the FSA, as well as the potential extent/quantity of their materials-at-risk (the gross inventory of radiological material that is susceptible to release from an accident event). The analysis was based on accident scenarios and source terms reported in previous Hanford Site safety documentation for these facilities, including the *Building 325 Radiochemical Processing Laboratory Documented Safety Analysis* (PNNL 2014) and *Dose Consequences from 324 Building Accidents to Support Land Transfer* (WCH 2014).

Nuclear safety documentation has a unique purpose as compared with environmental documentation. Nuclear safety documentation is developed to document postulated bounding scenarios for the purposes of designing safety systems and processes for activities at nuclear facilities. These documents are utilized to ensure conservative planning and operation of a facility, resulting in adequate protection of workers, public, and the environment. The nuclear safety documentation processes are highly conservative.

Nuclear safety protocols require evaluating the unmitigated accident scenarios for the purposes of designing highly conservative safety systems for work activities. Unmitigated accident scenarios and consequences are not considered reasonably foreseeable for the purposes of this EA. Hazards to the workers at the 324 and 325 buildings are controlled by safety management programs (e.g., radiological protection, conduct of operations, industrial safety, etc.) and safety SSCs.

Related to the Proposed Action, hazards to the workers at the 324 and 325 buildings are controlled by safety management programs (e.g., radiological protection, conduct of operations, industrial safety, etc.) and safety SSCs. The information in this section addresses the postulated bounding radiological dose from events/accidents to a member of the public that could occur at the 324/325 buildings. A member of the public outside of DOE controlled activities and not trained in DOE emergency response requirements could hypothetically be subjected to the analyzed impacts.

One of the results of the nuclear safety documentation is the identification of safety SSCs required to be maintained operable to ensure adequate protection of the workers, public, and the environment. The nuclear safety documentation for Buildings 324/325 identifies safety SSCs that prevent or reduce the consequences to the public and the environment to a level of adequate protection. Adequate protection is defined as those measures that permit a facility to operate safely for its workers and the surrounding community.

As the phrase "adequate protection" indicates, it is not an absolute, but reflects the condition achieved when all necessary measures are being taken in a manner that is consistent with applicable requirements and regulatory processes. This is accomplished by identifying all hazards associated with facility operations and evaluating the dose consequences from events/accidents, assuming the safety SSC, where necessary, performs its intended function.

The following dose consequences and annual risk perspectives for Buildings 324 and 325 may be higher than reported in previous environmental documentation. The reason for this difference is that future remediation of the highly contaminated soil beneath the cell structure of Building 324 is now included in this analysis to ensure that the most conservative postulated bounding dose is considered. Remediation of this highly contaminated soil was not included in previous safety or environmental documentation because information about the level of contamination in the soil was not available at that time.

The accident analysis provides a conservative evaluation of a postulated bounding accident scenarios that could have the potentially highest impacts on members of the public in the Focused Study Area (FSA). For the 324 and 325 Buildings, respectively, the committed equivalent dose consequence (50 yr) and risk from postulated bounding events/accidents are 0.18 rem/0.018 rem/yr (Building 324) and 11.1 rem/0.11 rem/yr (Building 325). These doses are NOT expected, but are used for evaluating whether adequate protection has been achieved. Due to the conservatisms in the accident evaluation methodology (e.g., conservative material at risk, and several orders of magnitude in dose consequence modeling, established an upper-bound to account for uncertainties) an expected dose from the hot cell powder spill and seismic event would be a small fraction of the 0.18 rem and 11.1 rem committed equivalent dose (50 year dose) for Buildings 324 and 325 respectively.

Building 324, a three-story building that covers approximately 102,000 square feet, was utilized between 1965 and 1996 to support research and development activities associated with material and chemical processing. DOE has been preparing for the demolition of Building 324 by stabilizing and preparing for the removal of five highly contaminated hot cells. The cells were built to allow Hanford personnel to work with highly radioactive materials without being exposed to significant levels of radiation. The greatest level of contamination is in a two-story hot cell called the Radiochemical Engineering Complex B-Cell.

Building 325, a two-story building that covers approximately 65,000 square feet, also known as the Radiochemical Processing Laboratory (RPL), was originally designed to provide space for radiochemical research to support Hanford projects and programs. Today, the RPL remains a fully operational facility of the Pacific Northwest National Laboratory (PNNL) where scientists and engineers conduct research related to national missions in environmental management, nuclear energy, nuclear non-proliferation, homeland-security, and science. RPL's underlying mission is to create and implement innovative processes in support of national priority areas. Some of the work taking place at the RPL involves advancements in the cleanup of radiological and hazardous wastes, processing and disposal of nuclear fuels, detection and forensics of nuclear material, and production and delivery of medical isotopes.

Washington Closure Hanford's 2014 Calculation/Report, *Dose Consequences from 324 Building Accidents to Support Land Transfer* (WCH 2014, was the primary reference utilized for estimating potential accident risks from Building 324, and PNNL's 2012 Calculation/Report, *Accident Analyses Scoping Analysis for the Potential TRIDEC Land Transfer* (PNNL 2012), was the primary reference utilized for estimating potential accident risks from Building 325.

Through a screening process, a number of distinct accident scenarios at the subject buildings were initially identified, with two ultimately determined to depict postulated bounding events: a hot cell powder spill event at Building 324, and a seismic event at Building 325. Accident risk values are not used in establishing safety or operational restrictions on the conveyed lands, but provide a perspective of potential public impacts.

For Building 324, the calculation report (WCH 2014) determined the radiological doses (consequences) that could result from potential releases of radioactive material to the atmosphere from the assessed hot cell powder spill event. The spill event is described as a container filled with contaminated soil/powder from beneath the B-Cell part of the 324 Building that spills its contents onto the airlock floor resulting in a release of contamination to the atmosphere.

For Building 325, the calculation report (PNNL 2012) determined the radiological doses (consequences) that could result from potential releases of radioactive material to the atmosphere from the assessed seismic event. The seismic event causes uncontained, dispersible material to become airborne as a direct result of the shaking and vibratory motion associated with the event. It also causes upset conditions such as spills, drops, or breach of glove boxes/containers that result in confined or normally non-dispersible material being released.

The analysis of this seismic event also identifies the area over which exposures could exceed 5 rem. A portion of this area overlaps the FSA. Nuclear safety protocols would require establishing additional protective features not currently available at Building 325 for dose consequences exceeding 5 rem. To provide for continued public safety and cost effective management of current and future operations, DOE would establish a Controlled Area and maintain it within the PAAL lands. This area would be comprised of a total of 188 acres (see Figure 3-15).

F.2 ANALYTICAL ASSUMPTIONS

- For a hot-cell powder spill release scenario at Building 324, a gross plume duration of 0.5 hours (1,800 seconds) is assumed; for the seismic scenario at Building 325, a plume duration of 15 minutes (900 seconds) is assumed for plutonium-239 equivalence (Pu-239E) and 3 minutes (180 seconds) for tritium equivalence (H-3E) (WCH 2014; PNNL 2012).
- For the Building 324 model a member of the public is assumed to be exposed to a full release duration, without any protection, located at a distance of approximately 600 meters due west of Building 324. (WCH 2014; DOE 2014).
- A Building 325 member of the public is assumed to be exposed to a full release duration, without any protection, located at a distance of approximately 587 meters to the northwest of Building 325 (PNNL 2012).
- Consequences for potential receptors as a result of plume passage were determined without regard for emergency response measures and, therefore, are more conservative than those that might actually be experienced if evacuation and sheltering occurred (Chanin and Young 1997; DOE 2004).
- It was assumed that potential receptors would be fully exposed in fixed positions for the duration of plume passage, thereby maximizing their exposure to a plume (Chanin and Young 1997; DOE 2004).
- A total source term gross inventory of 65,000 curies (Ci) (2.405E15 becquerels [Bq]) was assumed for the Building 324 powder spill, reduced by the airborne release fraction of 4.2E-03, yields a net source term total of 273 Ci (1.010E+13 Bq) for this case. The isotopic breakdown thereof is presented below in **Table F-1** (WCH 2014; WCH 2013).

Table F-1. Isotopics and Quantities for Hot Cell Spill Event in Building 324.

Radionuclide	Becquerels (Bq)	Curies (Ci)
Co-60	9.40E+08	2.54E-02
Se-79	2.02E+06	5.46E-05
Sr-90	3.51E+12	9.47E+01
Tc-99	6.92E+07	1.87E-03
Cs-137	6.53E+12	1.76E+02
Eu-154	1.31E+10	3.55E-01
Eu-155	1.02E+10	2.75E-01
Pu-238	2.01E+09	5.42E-02
Pu-239	6.09E+08	1.65E-02
Pu-240	5.99E+08	1.62E-02
Pu-241	2.99E+10	8.08E-01
Pu-242	9.95E+05	2.69E-05
Am-241	8.81E+09	2.38E-01
Cm-243	5.59E+07	1.51E-03
Cm-244	3.89E+09	1.05E-01
TOTAL	**1.010E+13**	**2.73E+02**

Sources: WCH 2013, 2014.

- The net source terms provided in **Table F-2** were used for modeling the seismic scenario in Building 325. Pu-239E is used to represent radioactive materials in solid, solution, or particulate forms, and H-3E is used to represent radioactive materials in gaseous or volatile forms. This permits the accident analysis to be generically depicted in terms of these two radionuclides, although other radionuclides may be involved (PNNL 2012).

Table F-2. Isotopics for postulated seismic event in Building 325.

Event/Radionuclide	Becquerels (Bq)	Curies (Ci)
Seismic		
Pu-239E	3.497E+10	0.945
H-3E	7.400E+15	200,000

Source: PNNL 2012
Key: Pu-239E = plutonium-239 equivalence; H-3E = tritium equivalence.

F.3 COMPARATIVE RADIOLOGICAL RISK

Radiological risk values provide a simplified method to compare risks from radiation dose to other types of human health risks. For determining the following table, the Committee on Interagency Radiation Research and Policy Coordination (CIRRPC 1992) conversion factor of 6 x10^{-4} fatal cancers per rem was used to determine the nominal cancer fatality probability resulting from this set of accident analyses. This risk value provides for comparative mortality estimates of risk from radiation dose to members of the general public. Note that the determination of these comparative radiological risk values does not reflect actual human health risk, but are presented for comparative information only.

Table F-3. Nominal Public Cancer Fatality Probability (LCFs) - Building 324 & 325 Events.

Event	Probability of an LCF (per person)
324 – Hot Cell Powder Spill –approximately 600 meters to the west	1.1×10^{-4}
325 - Seismic: approximately 587 meters to the northwest (Stevens Drive and eastern FSA border)	6.7×10^{-3}
325 - Seismic: approximately 1218 meters to the northwest of Building 325	3.0×10^{-3}

F.4 RESULTS

The complete set of accident consequence results for Buildings 324 and 325 are presented in **Table F-3**.

Table F-4. Estimated radiological accident consequences for Buildings 324 and 325.

Event	Dose (rem)*
Building 324	
Hot Cell Powder Spill –approximately 600 meters to the west	0.18
Building 325	
Seismic: approximately 587 meters to the northwest (Stevens Drive and eastern FSA border)	11.1
Seismic: approximately 1218 meters to the northwest of Building 325	5.0

Sources: WCH 2014; PNNL 2012.
*The doses are based on safety SSC for Building 324 and no safety SSC for Building 325

As the above doses are within the DOE Controlled Areas and meet applicable nuclear safety protocols, no explicit calculation of potential dose was calculated spanning across the FSA. However, calculated doses from both 324 and 325 Buildings will diminish across the FSA due to atmospheric dispersion.

The annual frequencies in **Table F-4** were utilized for the postulated events per safety basis information provided in WCH (2013) and PNNL (2014).

Table F-5. Estimated accident event annual frequencies for Buildings 324 and 325.

Event	Frequency (yr^{-1})
Building 324	
Hot Cell Powder Spill – Filtered: approximately 600 meters to the west (ground level)	10^{-2} - 10^{-1}
Building 325	
Seismic: approximately 587 meters to the northwest (Stevens Drive and eastern FSA border)	10^{-4} - 10^{-2}

Sources: WCH 2013; PNNL 2014.

The resulting overall annual radiological risks, in terms of equivalent-dose, were calculated for each event scenario based on the product of consequence times frequency. They are provided in **Table F-5**.

Table F-6. Estimated annual radiological risk ranges for Building 324 and 325 accidents.

Event	Annual Risk (rem/yr)
Building 324	
Hot Cell Powder Spill – Filtered: approximately 600 meters to the west (ground level)	0.0018 – 0.018
Building 325	
Seismic: approximately 587 meters to the northwest (Stevens Drive and eastern FSA border)	0.0011 – 0.11

F.5 EMERGENCY RESPONSE

As required by law, DOE orders and policies, Hanford has established a comprehensive emergency management program that provides detailed, hazard-specific planning and preparedness measures to protect worker and public health and safety, and the environment in the event of an emergency at the Hanford Site. Following implementation of the proposed action to transfer FSA lands to TRIDEC, DOE and the local and state agencies responsible for performing the function of emergency management, would apply the same emergency planning and response actions to members of the public in the transferred lands as applied to the population at large.

DOE maintains DOE/RL-94-02, *Hanford Emergency Management Plan*, which addresses the full scope of emergencies that may occur at the Hanford Site. These potential emergencies include building and range fires, earthquakes, accidental release of radiological and toxicological materials from Hanford Contractor operated facilities and transportation incidents, and other external events.

The areas addressed by emergency planning include the following:

- Emergency Response Organization (ERO)
- Hazards analysis and consequence assessment actions
- Notification and communication
- Protective actions and incident response
- Emergency facilities and equipment
- Training, drills, and exercises
- Recovery and re-entry.

The Hanford ERO and its roles and responsibilities are specified in DOE/RL-94-02, Rev 4, Section 2.0. Emergency response on the Hanford Site is compliant with the National Incident Management System. As such, the Hanford Site Incident Command System is an integrated emergency management system with defined roles, responsibilities, and communication pathways that allows pre-designated, trained individuals to jointly determine and implement incident mitigation strategies.

The Hanford ERO has two distinct components: the Incident Command Organization and the Hanford EOC. The Incident Command Organization consists of the facility/building ERO with responsibility for implementing emergency response activities at the event facility, and emergency response personnel (i.e., Hanford Fire Department and the Hanford Patrol) that have responsibility for on-scene mitigation, depending on the event. The Incident Command Organization has the authority to commit the resources necessary for emergency response, and is required to be familiar with the applicable plans, procedures, operations, activities, and layout of the facility.

DOE maintains the Hanford emergency plan and implementing procedures by which DOE and its contractors will respond in the event of an accident. DOE also provides technical assistance to other federal agencies and to state and local governments. Hanford contractors are responsible for maintaining emergency plans and response procedures for all facilities, operations, and activities under their jurisdiction and for implementing those plans and procedures during emergencies. The DOE, contractor, and state and local government plans are fully coordinated and integrated. An EOC has been established by DOE to provide oversight and support to emergency response actions on the Hanford Site.

The Hanford EOC is an emergency response facility maintained by DOE for the purpose of providing a facility where personnel may convene during an emergency situation to provide essential response functions, including liaison with governmental officials and agencies, public information, consequence assessment, offsite protective action recommendations, and oversight of onsite emergency response operations and activities. The Hanford EOC is generally operational within one hour upon declaration of an Alert or higher emergency.

The Hanford EOC consists of several teams. The Policy Team provides oversight of onsite activities, approval, and communication of offsite protective action recommendations, approval of reclassification recommendations, oversight of public information activities, and coordination with offsite agencies. The Joint Information Center disseminates accurate and timely information to the media, public, and employees. The Site Management Team provides support to the Incident Command Organization by providing resources not easily obtained by the IC, tracking the status of onsite protective actions, developing and directing implementation of additional onsite protective actions away from the event scene as required and providing communications support. The Site Emergency Director is responsible for coordination of Site Management Team activities. As part of the Site Management Team, the Security and Event Support team interfaces with local law enforcement agencies, coordinates with the Federal Bureau of Investigation, and oversees onsite patrol activities. The Unified Dose Assessment Center (UDAC) supports the Site Management Team by monitoring and evaluating existing emergency conditions in order to develop additional protective action recommendations. The UDAC is responsible for field team activities that include plume tracking, monitoring, and sampling.

Predetermined protective actions are developed in accordance with DOE/RL-94-02. Protective actions are taken to preclude or reduce the exposure of individuals after an emergency at the Hanford Site. Emergencies at site facilities may require actions only on the Hanford Site or may affect offsite areas. Emergency Planning Zones (EPZs) are designated areas, based on hazards assessments, in which predetermined protective actions may be required. The DOE develops EPZs, as determined necessary by hazard assessments, and shares them with the emergency planning authorities in the affected states and counties for their use in emergency planning.

The predetermined protective actions include the following:

- Methods for providing timely protective action recommendations, such as sheltering, evacuation, and relocation, to appropriate offsite agencies
- Plans for timely sheltering and/or evacuation
- Methods for controlling access to contaminated areas and for decontaminating personnel or equipment exiting the area
- Protective action criteria prepared in accordance with DOE-approved guidance applicable to actual or potential releases of hazardous materials to the environment for use in protective action decision making.

Evacuation routes for the Hanford Site are provided in DOE/RL-94-02. Specific routes are determined at the time of an event based on the event magnitude, location, and meteorology conditions.

DOE and adjacent counties have predetermined initial offsite protective action recommendations appropriate for each emergency classification. These initial, preplanned protective action recommendations, as indicated by the event classification and location, are communicated to the offsite agencies with the initial notification. The determination for the need for additional protective action recommendations are based on ongoing consequence assessments.

Immediate protective action decisions within the plume exposure pathway are the responsibility of the applicable county. The decision and notification process to populations within the plume EPZ is also the responsibility of the counties and is primarily provided using the Emergency Alert System (EAS). Benton, Franklin, and Grant County residents within the radiological EPZs receive the EAS messages via tone-alert radios in their homes.

Notifications to populations within the ingestion EPZ are accomplished by the affected counties and states using the EAS, as appropriate, and news media reports.

Relaxation or lifting of protective actions is based on facility conditions and consequence assessments. Based on recommendations from the Site Emergency Director, the Hanford EOC Policy Team will decide when onsite protective actions can be modified. The Policy Team will provide recommendations to affected counties and states for relaxation of offsite emergency protective actions. The states are responsible for decisions on relaxation of offsite protective actions.

Information on the Hanford Site's potential hazards and emergency response plans are provided to the public residing within the EPZ through a brochure distributed by county emergency management organizations. Offsite agencies participate annually in Hanford Site exercises. Area hospitals and local ambulance providers receive training on the handling and care of radiological-contaminated patients from Energy Northwest and county emergency management organizations.

F.6 REFERENCES

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APPENDIX G – TRIBAL STUDIES EXECUTIVE SUMMARIES

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G. APPENDIX G – TRIBAL STUDIES EXECUTIVE SUMMARIES

G.1 INTRODUCTION

The following tribal study executive summaries were requested by DOE-RL for the 4,413-acre Initial Hanford Site Land Conveyance Project Area and were provided by the respective tribal staffs. These summaries are included herein as written by the tribal staffs and have not been modified in any way.

G.2 EXECUTIVE SUMMARY FOR THE CONFEDERATED TRIBES OF THE UMATILLA INDIAN RESERVATION – *HANFORD LAND CONVEYANCE TRADITIONAL USE STUDY, BENTON COUNTY, WASHINGTON*

Confederated Tribes *of the* **Umatilla Indian Reservation**

Department of Natural Resources

46411 Timine Way
Pendleton, OR 97801

Phone 541-276-3447

January 22, 2014

James Payne
Executive Director
Fort Walla Walla Museum
755 Myra Road
Walla Walla, WA 99362

Dear Mr. Payne,

On behalf of the Confederated Tribes of the Umatilla Indian Reservation, Cultural Resources Protection Program (CRPP), enclosed is an Executive Summary pertaining to the report entitled, *Hanford Land Conveyance Traditional Use Study, Benton County, Washington* prepared by Dr. Jennifer Karson Engum, Cultural Anthropologist/Ethnographer. This document was prepared for you and for Los Alamos Technical Associates, Inc. to use in your public records.

Should you have any questions or concerns, please feel free to contact me at (541) 429-7216.

Respectfully,

Jennifer Karson Engum, Ph.D.
Cultural Anthropologist, Ethnographer
Cultural Resources Protection Program
Confederated Tribes of the Umatilla Indian Reservation

Cc: Mona Wright, Archaeologist, U.S. Department of Energy

Treaty June 9, 1855 ~ Cayuse, Umatilla and Walla Walla Tribes

Hanford Land Conveyance Traditional Use Study, Benton County, Washington
EXECUTIVE SUMMARY

The Confederated Tribes of the Umatilla Indian Reservation (CTUIR) Cultural Resources Protection Program (CRPP) conducted research on the traditional uses surrounding the proposed Department of Energy's Hanford Land Conveyance project resulting in a report entitled, *Hanford Land Conveyance Traditional Use Study, Benton County, Washington* prepared by Dr. Jennifer Karson Engum, Cultural Anthropologist/Ethnographer. The purpose of this study was to identify historic properties of religious and cultural significance (also called traditional cultural properties or TCP's) to the CTUIR in and in the vicinity of the project area. In addition to conducting oral history interviews with Tribal Elders, an ethnobotanical sampling inventory was also conducted by the CTUIR as part of the traditional use survey to assess potential impacts of the Hanford Land Conveyance project to the traditional plant resources of the Umatilla (*Imatalamláma*), Walla Walla (*Waláulapam*), and Cayuse (*Weyíiletpu*) people.

The project is located entirely on U.S. Department of Energy (DOE) -owned lands in Benton County, Washington, in the southeastern corner of the Hanford site. The analysis area associated with this project includes 4,413 acres and runs along Horn Rapids Road to the south, Stevens Drive to the east, and Route 4S along the northeastern edge. The project's analysis area is located within the ceded territory of the CTUIR.

Within and adjacent to the project area are important historic properties of religious and cultural significance to the CTUIR. Thirty-five place names are documented in the vicinity of the project area and three of those are documented near the project area. This signifies to tribal members that the project area has been used by ancestors of today's CTUIR since time immemorial. Five historic properties of religious and cultural significance to the CTUIR are located in and adjacent to the project area. These include three place name locations, First Foods gathering areas, and the burial area known as the EMSL cemetery. The ethnobotanical survey identified seven traditional First Foods in the project area.

The CRPP believes that these are historic properties that are potentially eligible for inclusion in the National Register of Historic Places. Together these historic properties are linked in a spatial context, but also in a broad tribal narrative that include villages, fishing sites, legendary sites, native place names, ceremonial areas, First Foods procurement areas, and maintenance of burial areas. The traditional place names inform *Imatalamláma, Weyíiletpu, Waláulapam* of their function, resources located in the area, and serve to place (or identify) these historic properties in ongoing stories and legends associated with these locations.

The Hanford Land Conveyance project could directly and indirectly affect the historic properties identified in this traditional use study. The project could adversely affect the integrity of setting, feeling and association of these properties and their associated cultural landscape. The project area and its larger vicinity have been and continue to be critically tied to the CTUIR's history and ongoing culture. The CRPP looks forward to working with DOE to make recommendations on how to protect, avoid, minimize, or to mitigate for effects to historic properties that this report identifies.

Based on the findings presented in this report, the CRPP recommends that a Tribal monitor be present during all ground disturbing activities and that the CRPP continues to be consulted throughout the process. Additionally, the CRPP has recommended not to nominate this area to the National Register of Historic Places due to the sensitive nature of publicizing culturally sacred areas. The CTUIR would like to ensure that the cultural and natural resources are protected, therefore the presence of a Tribal monitor is recommended if development should occur.

G.3 EXECUTIVE SUMMARY FOR THE CONFEDERATED TRIBES AND BANDS OF THE YAKAMA NATION – YAKAMA NATION CULTURAL RESOURCES PROGRAM HANFORD LAND CONVEYANCE TRADITIONAL CULTURAL PROPERTY STUDY

The Confederated Tribes and Bands of the Yakama Nation conducted a Traditional Cultural Property Inventory for the proposed project. The Yakama Nation Cultural Resources Program conducted a literature review and interviews with elders who are knowledgeable with the proposed project area. As a result of this Traditional Cultural Property, the Yakama Nation Cultural Resources Program identified seven Traditional Cultural Properties within the vicinity of the proposed project area. Four of these TCPs were identified as having the potential to be directly impacted by development of the project area. The other three TCPs would likely be indirectly effected by development of the proposed project area.

G.4 EXECUTIVE SUMMARY FOR THE NEZ PERCE TRIBE – CULTURAL SIGNIFICANCE OF LANDS TO BE CONVEYED FROM THE U.S. DEPARTMENT OF ENERGY TO TRI-CITIES WASHINGTON DEVELOPMENT COUNCIL

Executive Summary

This report of work fulfills the terms of Purchase Order ABO-13-126 from Las Alamos Technical Associates, Inc (LATA). The objective of this work was "…to document Nez Perce ethnographic information to articulate the connection [of the Nez Perce Tribe] with resources in and around the project area." Standard ethnographic and ethnohistoric methods were used by the Principal Investigator, Alan G. Marshall, Ph.D., to investigate this socio-cultural relationship. Nez Perce interests in the area were acknowledged in the 1855 Treaty with the United States in Article 3, and they have continued into the present, as have the provisions of Article 3.

Little direct evidence of use at the Hanford Site by Nez Perce people was found; this finding is not surprising given the 50+ years of exclusion from this area.

Indirect evidence of a significant relationship with the area was found. This evidence is comprised of ethnohistorical data and reconstructions of Nez Perce use of this area in the early and mid-nineteenth century. The area was part of the Nez Perces' socio-economic realm during the 19^{th} and pre-Hanford 20^{th} centuries. Further evidence is visits to this area by contemporary Niimíipuu since access to some parts of the Hanford area has opened.

Visits are occasioned by three highly significant locations overlooking the proposed conveyance area: Rattlesnake Mountain, Saddle Mountain, and Gable Mountain. These three mountains remain significant places for the Nez Perce

Tribe as locations for cultural maintenance. They are important for spiritual, educational, and other enculturational purposes that require looking at the geography. The proposed land conveyance area includes historical/ancestral use-areas as evidenced by four archaeological features. The area thus has contemporary significance as part of a viewshed from these mountains.

Additionally, a cemetery now called the "EMSL cemetery" is nearby. Its current name is the result of an attempt to build the Environmental Molecular Sciences Laboratory on the site. The Nez Perce Tribe is concerned for its setting; Tribal members continue to have religious, kinship, and other attachments to the place.

This indirect (i.e., not on-the-ground) socio-cultural significance underlies the concerns expressed by Tribal members regarding the area. These concerns reflect attitudes towards "the land" (cosmology). The Tribal concerns are for the cumulative negative effects of industrial development on these intangible resources. Indeed, industrial development creates significant "opportunity costs" to Nez Perce people through the loss of geographic contexts – places – for learning traditional values and knowledge.

The loss of these geographic contexts also means the loss of the material dimensions of the spiritual world. These include food and medicinal resources.

In summary, the proposed conveyance and subsequent development will have direct effects on the Nez Perce Tribe through:

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- further destruction of a significant viewshed that provides contexts for education and, hence, cultural maintenance;
- encroachment on a sacred site, the EMSL cemetery;
- continued erosions of food and medicinal resources.

Three alternatives for dealing with conveyance area are presented. In descending order of preference they are: 1) do not develop the area, in accordance with the Nez Perce Tribe's "End-state Vision," 2) avoid disturbing the sites during development, and 3) "mitigate" each site through excavation and "data-recovery."

G.5 EXECUTIVE SUMMARY FOR THE WANAPUM – TRADITIONAL CULTURAL PROPERTY ASSESSMENT STUDY OF THE PROPOSED HANFORD LAND CONVEYANCE PROJECT, BENTON COUNTY, WASHINGTON

Traditional Cultural Property Assessment Study of the Proposed Hanford Land Conveyance Project, Benton County, Washington

Executive Summary

Northwest Anthropology LLC
Richland, WA 99352
6 June 2014

Introduction

Northwest Anthropology LLC (NWA), Richland, Washington, has conducted an assessment of the potential effects of the proposed Hanford Land Conveyance Project (Project) on traditional cultural places (TCPs) important to the Wanapum of Priest Rapids. The assessment was funded by the U.S. Department of Energy (DOE) through Fort Walla Walla Museum and Los Alamos Technical Associations. The findings are to be incorporated and addressed in an National Environmental Policy Act (NEPA) environmental assessment (EA) being prepared by the U.S. Department of Energy Richland Operations Office (DOE 2012). They may also be summarized in documents being prepared by Fort Walla Walla Museum for review under the National Historic Preservation Act (NHPA) .

Per direction from DOE, the assessment sought to identify TCPs associated with resources, beliefs, and practices valued by the Wanapum people, following guidance issued by the National Park Service (NPS 1990). The assessment also sought to identify the potential impacts of the Project on such places, and on the resources, beliefs and practices that give them significance. Consideration of impacts follows directions set forth in the NEPA regulations of the Council on Environmental Quality (CEQ), specifically 40CFR1508.8 and 1508.27. Cumulative impacts were addressed following that 40CFR1508.7) and using the approach recently used by the Nuclear Regulatory Commission at the Columbia Generating Plant License Renewal Environmental Impact Statement (NRC 2011, 2013). With reference to the same regulations, we have developed recommendations for eliminating or reducing adverse effects and enhancing positive effects.

To guide the assessment of impacts of the proposed action, we used the standard of significance for impacts also used by the NRC (2013) and based on Council on Environmental Quality guidance (40 CFR 1508.27). The three significance levels and definitions are as follows:

- SMALL – Environmental effects are not detectable or are so minor that they will neither destabilize nor noticeably alter any important attribute of the resource.
- MODERATE – Environmental effects are sufficient to alter noticeably, but not to destabilize, important attributes of the resource.
- LARGE – Environmental effects are clearly noticeable and are sufficient to destabilize important attributes of the resource.

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The proposed action is located within the ancestral and contemporary homeland of the Wanapum people of Priest Rapids on the Columbia River in southeast Washington State (Relander 1956). The Wanapum are an indigenous group who continue to practice their religion and live a traditional subsistence lifestyle, to the extent they can, given the loss of access to traditional resources that has occurred over the last 150 years. The Wanapum have no reservation or federal funds. Agreements made with agencies and individuals during the twentieth century have enabled the Wanapum to access traditional places and resources important in maintaining their religion and way of life (Nickens 1998).

Traditional Cultural Landscapes

The assessment began with background research and discussions with Wanapum elders and contacts designated by the Wanapum leader, Rex Buck Jr., about the importance of the project area to the Wanapum. The Wanapum, for a variety of good reasons, do not discuss their cultural places and practices with non-Wanapum, so to the extent we have been able to document the important places associated with the Project, they are described in the detailed study filed at Grant County PUD (Northwest Anthropology LLC 2014). However, we can say that the following landscapes are of deep and abiding cultural significance to the Wanapum, and appear to meet National Register Criterion "A" as TCPs for their association with significant patterns of events in Wanapum traditional history and culture. Based on this information, we have identified two specific places of traditional importance that extend into the land conveyance project area:

- One area of cultural importance is *Shu Wipa*, the Wanapum place name for the area known today as the Hanford 300 Area. This area was one of many villages and fishing areas used by Wanapum until the mid-1800s when epidemics led to depopulation and abandonment of many villages; the area continues to be important today for cosmological reasons. While activities conducted at this location have contaminated the land and groundwater, the Wanapum fully expect to make use of this area to perform traditional activities in the future when it is safe to do so. *Shu Wipa* includes the area of about a mile radius from the 300 Area and includes cemeteries, ancient living areas, and islands (Thoms 1983). *Shu Wipa* also has an integral relationship to Wanapum cosmology as it is a location where certain cultural and spiritual events occur on an annual basis.
- The second area of cultural importance is *Wanawish*, which describes both the traditional fishing area of the Wanapum at Horn Rapids on the Yakima River, and the landscape encompassing an area around the southern and eastern sides of *Lalik* (Rattlesnake Mountain/Cold Creek drainage), which is also called *Wanawish*. This landscape has an integral relationship to Wanapum cosmology as it is a location where events occur on an annual basis that must continue.

While the Wanapum choose not to document these areas on Traditional Cultural Property (TCP) forms used by the Washington Department of Archaeology and Historic Preservation, and not to evaluate them for eligibility for listing on the National Register of Historic Places, it is the position of the Wanapum that each qualifies as a TCP and each is eligible for listing on the National Register, following criteria established by the National Park Service (NPS 1990). Additional information about these two traditional cultural areas is found in the full assessment report on file in the Wanapum Archives, for which there is restricted access due to cultural sensitivity of the information. The archives are located at the Wanapum Heritage Center at the

Grant County Public Utility District's Wanapum Dam. In addition, Wanapum leaders are available to discuss the significance of these places with decision makers if that is necessary.

Effects

It is traditional in NEPA and NHPA analyses to distinguish among direct, indirect and cumulative effects. Such a distinction would be fatuous in this case. The proposed DOE action will make possible the wholesale development of the area, as already outlined in various TRIDEC and DOE plans (cite plans, etc.) This development will have potentially devastating effects on the Wanapum and their culture, including relationships with the landscapes.

Because it is common to distinguish among direct, indirect, and cumulative effects, the NWA assessment team worked with Wanapum representatives to determine the significance of the direct, indirect, and cumulative impacts from the proposed action on the traditional Wanapum resources located in and adjacent to the project area.

Direct Effects of the Conveyance

The direct effects, that is, those effects caused by the action and occurring at the same time of the land conveyance (40CFR1508.8) are difficult to determine at this time because development plans for the area are not known and specific lands for conveyance have not been determined. In the case of *Wanawish*, the land to be conveyed is located at the eastern edge of the large *Wanawish* landscape. Depending on what is constructed and where, impacts may be adverse or not. In the case of *Shu Wipa*, the land to be conveyed is located at the western edges of the catchment area, areas used for hunting and gathering resources, and for travel to the Wanawish fishing site. If parts of the area that are selected for conveyance contain traditional resources (e.g., cultural plants) or archaeological resource, mitigation may be necessary. Cosmological impacts will need to be addressed through consultation as construction details are developed. For the purposes of this assessment, potential direct effects will noticeably alter the traditional resources, but not destabilize important attributes. Finally, some direct effects are likely to occur outside the lands to be conveyed, for example there will be emissions, noise, and visual impacts; there will also be additional ground disturbance on adjacent lands as infrastructure and support facilities are constructed. Based on the results of this analysis, the direct effects of the land conveyance are determined to be MODERATE, because while they will noticeably alter important attributes of *Wanawish* and *Shu Wipa*, they should not destabilize these attributes if appropriate mitigation actions are taken.

Indirect Effects of the Conveyance

Indirect effects are caused by the action and are later in time or farther removed in distance, but are still reasonably foreseeable (40CFR1508.8). TRIDEC, the local organization that will receive the land and ultimately transfer it to a private entity, indicates that the facilities constructed in the land conveyance area eventually will be part of a much larger development, referred to as the Mid-Columbia Energy Park (MCEI 2013). In addition to the direct effects discussed about, there will be indirect impacts from the Project because the land conveyance development will stimulate additional activity, facilities, infrastructure, and use (i.e., industrial sprawl) not tied directly to what is constructed on land conveyance lands. Indirect effects such as visual, noise, and damage to the land and its resources from industrial sprawl will be considerable on *Shu Wipa*. Those areas of *Shu Wip*a that remain undeveloped and relatively undisturbed will be at an increased threat. Johnson Island, the EMSL Cemetery, and the fishing sites will be at increased risk as activity and development occurs in adjacent parcels. As the development moves to the west, indirect effects are possible on the larger *Wanawish* and the *Wanawish* fishing site. The indirect effects of the land conveyance to areas adjacent to the land conveyance are a major concern to the Wanapum.

For the purposes of this assessment, potential indirect effects will noticeably alter the traditional resources, and will be sufficient to destabilize the important attributes. *Shu Wipa* is in a perilous state and cannot withstand additional impact. *Wanawish*, specifically the fishery at Horn Rapids Dam, is similarly at peril; the industrial sprawl that will accompany the land conveyance and eventual implementation of the Mid-Columbia Energy Initiative will destabilize the resources. For this reason, potential impacts from the indirect effects of the Land Conveyance are determined to be LARGE.

Cumulative Effects of the Conveyance

To assess the cumulative effects of the proposed land conveyance, three geographic regions, described above in the Wanapum Traditional Cultural Landscapes section, were examined. The first area was the immediate cultural landscape, the area known to the Wanapum as *Shu Wipa*. Table 1 identifies the past, present and foreseeable future projects included in this analysis. The second geographic region considered was the Hanford-Tri-Cities cultural landscape. Table 2 identifies the past, present and foreseeable future projects included in this analysis. The third geographic region was the larger Wanapum landscape, the area that is used by the Wanapum historically and today to carry on their traditional way of life. The assessment of effects on this geographic region was based on the social impacts that will accrue on the Wanapum population. Social impacts refer to the consequences of the Proposed Action that will alter the ability of the Wanapum to live their traditional way of life, including their ability to practice their religion.

The cumulative assessment determined that cumulative effects of the proposed Project on the immediate *Shu Wipa* geographic region will be significant. The area has already sustained impacts from past actions by DOE in the 300 Area and north Richland. In addition to the proposed Land Conveyance are other projects ongoing or planned in the foreseeable future. For example, a natural gas pipeline is being constructed under the Columbia River and will deliver large quantities of gas to the Hanford 300 Area and 200 Area. After the Land Conveyance occurs and the lands are developed, development associated with the Mid-Columbia Energy Initiative will continue. The resulting industrial sprawl will increasingly cause visual, auditory, and direct damage to places and the resources that require a base level of integrity. Plans to open the area for public use have potential for additional impacts, ranging from direct effects associated with construction of recreational facilities, to direct effects on plants and animals associated with overuse. Further impacts on the already heavily impacted resources will destabilize the resource base of the immediate region. Therefore, the cumulative effect of the Land Conveyance on the immediate *Shu Wipa* landscape is determined to be LARGE.

In a similar way, the assessment finds that the cumulative effect of the proposed Land Conveyance on the Hanford and the Tri-Cities geographic region will be significant. This landscape has sustained considerable impact in the past from Hanford production and cleanup activities, from river erosion caused by hydroelectric dam operations, and general development in the Tri-Cities. The Hanford and the Tri-Cities geographic region will continue to be impacted by Hanford cleanup activities, development, and increasingly by recreational activities as DOE

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opens Hanford to public use. Given the potential effects from the Land Conveyance associated with indirect industrial sprawl (e.g., potential diversion of natural gas to the Mid-Columba Energy initiative and the City of Richland's development plans for the 300 Area), further impacts on the resource base will destabilize the resource base of the Hanford and Tri-Cities geographic region. Therefore, the cumulative effect of the Land Conveyance on the Hanford and Tri-Cities geographic region is determined to be LARGE.

Table 1
Past, Present and Foreseeable Future Projects in Immediate Geographic Area

Project Name	Project Summary	Location	Status
DOE Comprehensive Land Use Plan	EIS designed to define industrial and conservation areas	All Hanford, and specifically area defined for industrial development	Completed in 2000, updated 2006, five year update past due
DOE 300 Area clean-up efforts	Due to radioactive contamination resulting from fuel rod production, the clean-up/removal of large amounts of topsoil occurred	300 Area operable units (surface, groundwater)	Some completed, some ongoing, some planned
City of Richland 300 Area electrical service project	City of Richland Construction of power-line to 300 Area	North Richland to Battelle 300 Area facilities	Near operational planned through 2040.
Cascade Corporation Natural Gas Pipeline	Construction of pipeline from Pasco through 300 Area to deliver natural gas to vitrification plant	Pasco through 300 Area to 200 Area	2015 start date
Port of Benton (POB) development	Continued development of POB lands	North Richland	Ongoing
DOE-Pacific Northwest Site Office	Construction of new facilities, infrastructure upgrade	North Richland, adjacent to 300 Area	Ongoing
DoD Upgrade Barge Facility	Improving barge facility to accommodate next generation of nuclear submarine reactors	Port of Benton barge facility in North Richland	Upcoming
Mid-Columbia Energy Initiative	Construction of Energy Technology Park	25+ square miles of South Hanford including all of *Shu Wipa* west of Columbia River	Incipient

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Table 2
Past, Present and Foreseeable Future Projects in Hanford and the Tri-Cities Geographic Area

Project	Project Summary	Location	Status
Energy Northwest NRC relicensing	Obtain 20 year license for operation of operating plant	East-central Hanford	Obtained 2011 (NRC 2011)
BPA power line upgrades	Upgrade and construct new power transmission lines	Throughout	Ongoing
DOE Vitrification plant	Construct plant and associated facilities	200 Area	Ongoing
Fish and Wildlife Hanford Reach National Monument	Implement Comprehensive Conservation Plan e.g., protection and recreational access	165,000 acres of Hanford lands	Completed in 2006, implementation ongoing (FWS 2006)
Columbia Irrigation District	Horn Rapids Dam and irrigation canals	Yakima River, Tri-Cities	Operational
WA Department of Transportation	Highway 240 improvement and Vernita Rest Area	Tri-Cities to Vernita	Ongoing
Local Governments	Cities, Ports, Counties, ongoing and planned developments	Tri-Cities	Ongoing

Finally, the assessment determined that the cumulative effect of the proposed Land Conveyance on the larger Wanapum geographic region will be significant. The Wanapum, whose future is tied to the integrity of their traditional landscape, cannot endure further deterioration of the landscape. The ability of the Wanapum to maintain their way of life—their subsistence lifestyle, which is inextricably tied to their religion—is at peril. The additional outright loss of traditional places and resources has made it almost impossible for the Wanapum to continue practicing their religion. When the Wanapum can no longer practice their religion, the Wanapum culture will be destabilized. Therefore, because the land conveyance will further cause deterioration of the Wanapum cultural landscape, the cumulative effect of the land conveyance on the larger Wanapum geographic region is determined to be LARGE.

Summary and Recommendations

DOE is preparing an EA. In an EA, one analyzes the potential impacts of a project against the variables set forth at 40 CFR 1508.27 to determine if they are likely to be significant. The assessment has considered the context of the land conveyance in three geographic settings, and documented the severity (intensity) of the impacts and determined them to be significant. Similarly, DOE is preparing an historic properties report to analyze potential impacts of the land

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conveyance on historic properties, that is properties eligible for listing in the National Register of Historic Places. The assessment has identified two areas important to the Wanapum of Priest Rapids that meet the criteria established in Bulletin 38 (NPS 1990) and which will be affected by the proposed Hanford Land Conveyance. As discussed above, if these effects occur, they will be felt far beyond these two locations. They will affect the Wanapum people and their ability to survive as Indian people. Having withstood a century and a half of continual destruction of their homeland, and suffering of their families as a result of displacement (Cernea 2000:18–31), the Wanapum do not have much more to give (Longenecker, Stapp, and Buck 2002). It is time for the dominant society to reverse this trend and go beyond ambivalent mitigation, and look for ways to lift the Wanapum away from the tipping point of extinction.

The Wanapum are willing to consult with DOE and others through the EA and the NHPA process about actions to resolve the adverse effects of this undertaking. Below are examples of the actions that the Wanapum have indicated could begin to resolve some of the effects.

<u>Recommendations to Address Direct and Indirect Effects of the Land Conveyance</u>

1. DOE should continue to consult with the Wanapum throughout the planning and execution of the Hanford Land Conveyance Project.
2. DOE should explore with the Wanapum the conduct of activities to improve the condition of resources in and around *Shu Wipa* and the *Wanawish* corridor. Such activities include:
    a. cleaning up of contamination
    b. restoring terrestrial habitats to foster native species of both plants and animals through avoidance, compensation and rectification, with Wanapum consultation on techniques, species emphasis, and Wanapum economic participation.
    c. restoring/renovating fishing areas in the *Shu Wipa* area, which may include habitat restoration for native fish, and/or programs for controlling non-native species, and/or programs for the promotion of culturally important species (sucker, salmon, sturgeon, etc.)
    d. developing better fishing access in the *Shu Wipa* area when cleanup has been completed. This may include setting aside of fishing sites, assistance in constructing semi-permanent fishing stations, and providing boat access for the purpose of gillnetting.
3. The Wanapum want DOE to use its existing relationships, including those with private, local, state, and federal agencies involved in future development of the conveyed lands (e.g., the Mid-Columbia Energy Initiative) within and adjacent to *Shu Wipa*, and *Wanawish* to assist the Wanapum in making long-term agreements to improve consultation, economic opportunity, access to resources, and protection of resources.

<u>Recommendations to Addressing Cumulative Effects of the Land Conveyance</u>

The long-term cumulative effects of the Land Conveyance Project are significant. The following recommendations can help mitigate the cumulative effects of the land conveyance described above:

1. The Wanapum want to work with DOE to improve access to resources across the Hanford Site, including its lands currently administered by the U.S. Fish and Wildlife Service in the Hanford Reach National Monument;

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2. The Wanapum want to discuss with DOE opportunities for identifying and protecting important resources across the Hanford Site, including on its lands currently administered by the U.S. Fish and Wildlife Service in the Hanford Reach National Monument, and the Bonneville Power Administration;
3. The Wanapum want DOE to help develop economic opportunities for the Wanapum in two areas: a) jobs across the spectrum for Wanapum individuals that will provide the training and career path and accommodate the flexibility Wanapum individuals need to practice their religion and perpetuate their culture; and b) project work for the Wanapum in the area of cultural resource protection and habitat restoration, coordinated through the Wanapum Interface Office.

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APPENDIX H – WILDLIFE SURVEY

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Environmental Assessment for the Proposed Conveyance of Land at the Hanford Site

2013 Wildlife Survey

September 16, 2013

HDR

2805 Saint Andrews Loop
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Pasco, WA 99301-6121
(509) 546-2040

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1.0 Introduction

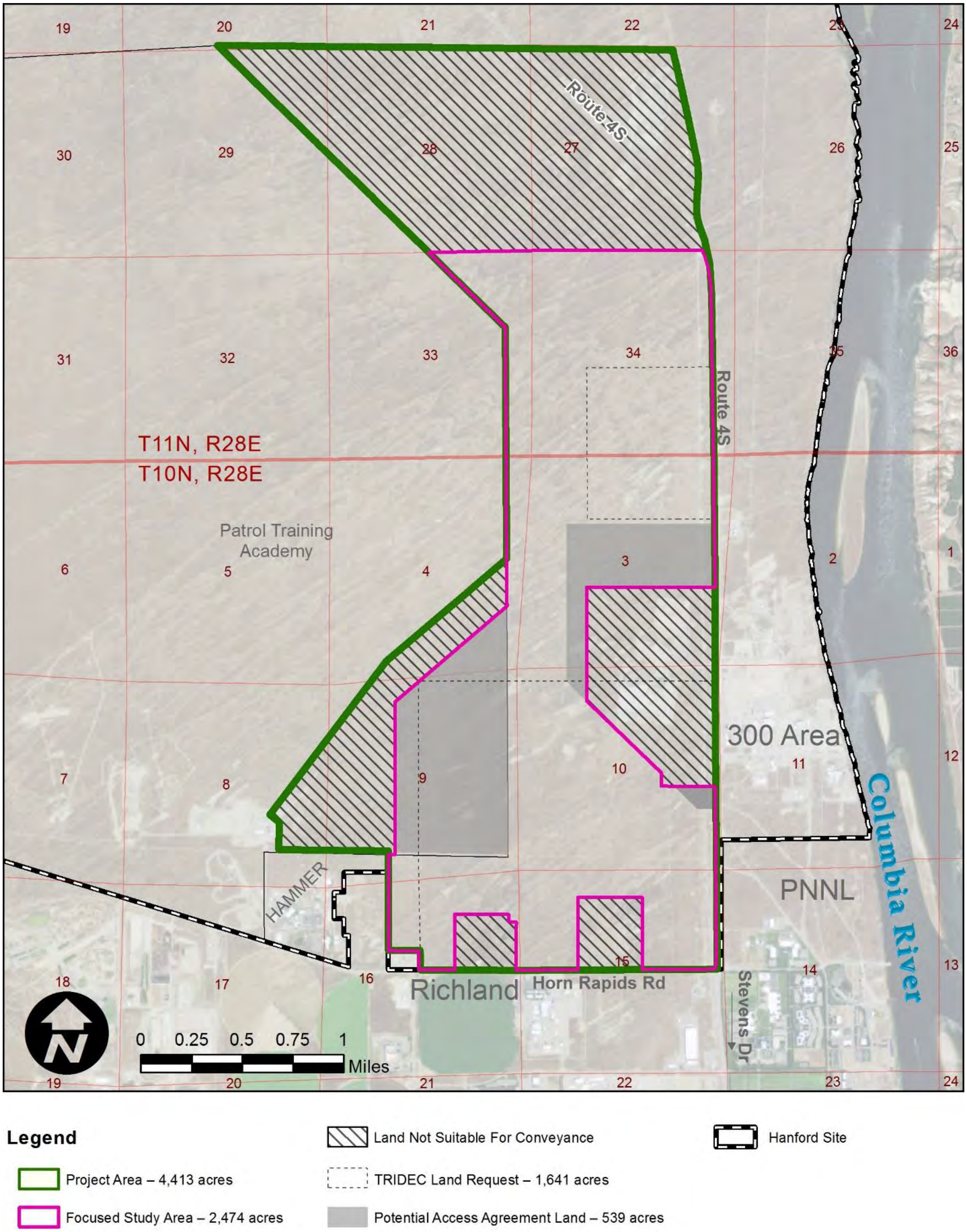
Department of Energy (DOE) is proposing a land conveyance of approximately 1,641 acres of undeveloped land to the local Community Resource Organization (CRO). Preparation of an Environmental Assessment (EA) is required under the National Environmental Policy Act (NEPA) to examine the potential impacts to the environment from a federal action. In addition to the 1,641 acres of the proposed land, DOE also anticipates that there may be continuing mission needs for retaining security and health and safety buffer zones around portions of the 1,641-acre lands. Therefore, the total study area for the proposed land conveyance encompasses 4,413 acres of undeveloped parcels that include the 1,641-acres requested, as well as, an additional 2,722 acres of adjacent parcels. During the EA data collection process, the need for technical and field studies pertaining to biological and ecological resources was identified because the entire 4,413-acre site had not been evaluated in detail to date. The purpose of this report is to document the results of the wildlife survey conducted in May and June 2013 in the 4,413 acre land conveyance study area at the Hanford Site located near the City of Richland, Washington (Figure 1).

1.1 Background

The Hanford Site is a relatively undisturbed area of shrub-steppe supporting a rich diversity of plant and animal species adapted to the semi-arid environment of the Columbia Plateau. The Hanford Site contains biologically diverse shrub-steppe plant communities that have been protected from most disturbances, except for fire, for more than 65 years and consequently retains the largest remaining blocks of relatively undisturbed shrub-steppe in the Columbia Basin Ecoregion (DOE 2012a). Hanford is located within the driest and hottest portion of the Columbia Basin Ecoregion (Franklin and Dyrness 1973). Although this may result in unique species assemblages relative to the rest of the ecoregion, these extreme conditions also make the Hanford shrub-steppe a fragile ecosystem that is less resilient to disturbance and not readily restored (DOE 2013a).

Inventories of plants and animals throughout Hanford were conducted in the late 1990s and provide extensive lists of the species that inhabit the upland areas. A field investigation of the 4,413 acres of the proposed conveyance land was conducted in June 2012, but did not report on wildlife species observed (DOE 2012b). Multiple field investigations of isolated areas have also been conducted at various months of the year between 2001 and 2012. These surveys provide limited snapshots of plant and animal species occurrence. These studies were done mostly in the southern area of the site, near the Hazardous Materials Management and Emergency Response (HAMMER) training facility. No Federal or Washington State listed species were reported in these earlier surveys. The entire study area is upland and therefore is not home to riparian or aquatic species. The majority of federally listed species for the Hanford area are plants and animals that inhabit the riverine and riparian environments in the Columbia River. The USFWS lists the gray wolf (*Canis lupus*) and the Columbia Basin pygmy rabbit (*Brachylagus idahoensis*) as the terrestrial species that are federally listed in Benton County. Neither of these species is known to inhabit the study area.

Figure 1 – Project Vicinity Map



Many federal and state species of concern as well as migratory birds protected under the Migratory Bird Treaty Act (MBTA) are documented to occur in the area and throughout the Hanford Reservation. Burrowing owls (*Athene cunicularia*), a state candidate species, have been observed historically in the southern end of the study area, as have Ferruginous hawks (*Buteo regalis*) and their nest sites. Migratory bird species including western meadowlark (*Sturnella neglecta*), horned lark *(Eremophilia alpestris*), and long-billed curlew (*Numenius americanus*) have been reported in the open, grassy areas, and sagebrush sparrows (*Amphispiza belli*) have been reported recently in surveys conducted in the shrub habitats of the study area.

2.0 Survey Objectives

Surveys were conducted to capture the occurrence of wildlife species and habitats within the 4,413 acres to be considered as part of the potential land conveyance area or the adjacent buffer area. Although all species encountered were recorded, the main goal was to determine the occurrence of listed or candidate plant and animal species protected under the Federal Endangered Species Act (ESA), species listed as threatened, endangered, candidate, sensitive, or monitor by the state of Washington, and species protected under the MBTA. Lists that document priority habitats and species of concern in Washington State are maintained by the Washington Department of Fish and Wildlife (WDFW) and Washington State Department of Natural Resources (WDNR). Washington State officials maintain additional lower level lists of species, including a monitor list for animals and review and watch lists for plants. Species on the state monitor, watch, and review lists are not considered species of concern, but are monitored for status and distribution and are managed as needed by the state to prevent them from becoming endangered, threatened, or sensitive. Lists that document plant and animal species with federally endangered, threatened, proposed, or candidate status are maintained in Title 50 of the Code of Federal Regulations (CFR) Part 17 (50 CFR 17.11; 50 CFR 17.12). A list that documents migratory birds protected under the MBTA is maintained by the U.S. Fish and Wildlife Service.

A wildlife survey was conducted in two field visits occurring in May and June 2013. A separate botanical survey was conducted in three sessions in May, June, and July 2013. HDR wildlife biologists performed pedestrian and visual surveys along transects that encompassed a representation of the entire study area, and botanists from SEE Botanical performed visual encounter surveys using a transect or grid methodology survey technique. This report summarizes the results of the wildlife survey. The results of the botanical surveys are presented in a separate report, *Vegetation Survey of the Proposed Land Conveyance, Central Hanford, Washington* (Salstrom and Easterly 2013).

2.1 Methods

Surveys were conducted daily from May 14 through May 16, and from June 4 through June 6, 2013. The wildlife survey consisted of pedestrian surveys, point counts, and driving surveys. During the pedestrian and driving surveys, all species including birds, mammals, reptiles, and amphibians were recorded from visual observation, sound, and sign such as tracks, scat, and active burrows. General habitat associations were also recorded. Surveys were conducted in the spring to capture the presence of migratory and breeding birds. Opportunistic surveying was also done any time the crew was on site including driving between sites and transects.

Pedestrian surveys were conducted along 24 transects that were placed within each of the representative habitats within the entire study area. These transect lines ranged from 1 mile to 2 miles in length. Walking transects avoid the inherent bias in roadside sampling, but reduce the area that can be covered in a given amount of time. Species data were collected along standardized walking routes.

Point counts are an easily replicable method for estimating diversity and abundance within specific habitat types. For all point count stations, the number of birds of each species seen and/or heard within a 10 minute period was recorded. Point counts for birds were conducted at sunrise each day at 6 locations accessible from unimproved access roads on the site. Starting locations for point counts were conducted in a different order each day.

Sunset and dusk driving surveys were conducted throughout the area along the unimproved access roads that spanned the north to south extent of the study area. Driving surveys have the advantage of quickly covering a large area. However, they restrict sampling to road edges, which limits the area that can be sampled and may create biases in the data. All driving between sites was also used as driving surveys, and any opportunistic sightings of birds or mammals were recorded. The sunset and dusk driving surveys were conducted on June 4, 2013.

3.0 Results

The following sections list the birds, mammals, and reptiles observed during all surveys. The frequency at which individuals from these species was observed was used to provide a general indicator of abundance in four broad categories: Common; Fairly Common; Uncommon; and Rare. Rare indicates that individuals were seen only once or twice throughout all surveys. These designations reflect the species relative occurrence in our surveys and do not necessarily represent the general species abundance in the region.

3.1 Birds

In previous studies, nearly 120 species of birds have been observed on the Hanford Site in surveys conducted during the breeding season (April-June) from 1988 through 2009. The most diverse assemblage of species was found along the river (81 species), while fewer species inhabited the shrub areas (61 species); bunchgrass habitat had the fewest (42 species) (Poston et al. 2009).

Most bird species that occur in shrub-steppe habitats also can be found in steppe habitats. Six species best characterize steppe habitats in both Washington and Oregon. These are the long-billed curlew, vesper sparrow (*Pooecetes gramineus*), grasshopper sparrow, lark sparrow (*Ammodramus savannarum*), savannah sparrow (*Passerculus sandwichensis*), and western meadowlark (*Sturnella neglecta*) (DOE 2000). Several introduced game species also use steppe and shrub-steppe habitats within the Columbia Basin Ecoregion. These include the chukar (*Alectoris chukar*), ring-necked pheasant (*Phasianus colchicus*), and gray partridge (*Perdix perdix*) (DOE 2000). The entire study area is upland habitat, and consequently species diversity is lower compared to the riparian areas alongside the Columbia River to the east.

Table 1 below lists all bird species that were recorded during all surveys and the relative frequency at which they were observed, and Figure 2 shows the vegetation types and recorded wildlife points within the study area. The majority of bird species encountered during the surveys were most often seen during the early morning point counts, with the exception of raptors, ravens, and magpies which were most often seen during transect surveys. Meadowlarks were very abundant and seen during all surveys. Horned larks were nearly as abundant as meadowlarks and also seen during all surveys.

Table 1: Bird species observed during surveys of the Hanford Land Conveyance Property in late May and early June, 2013.

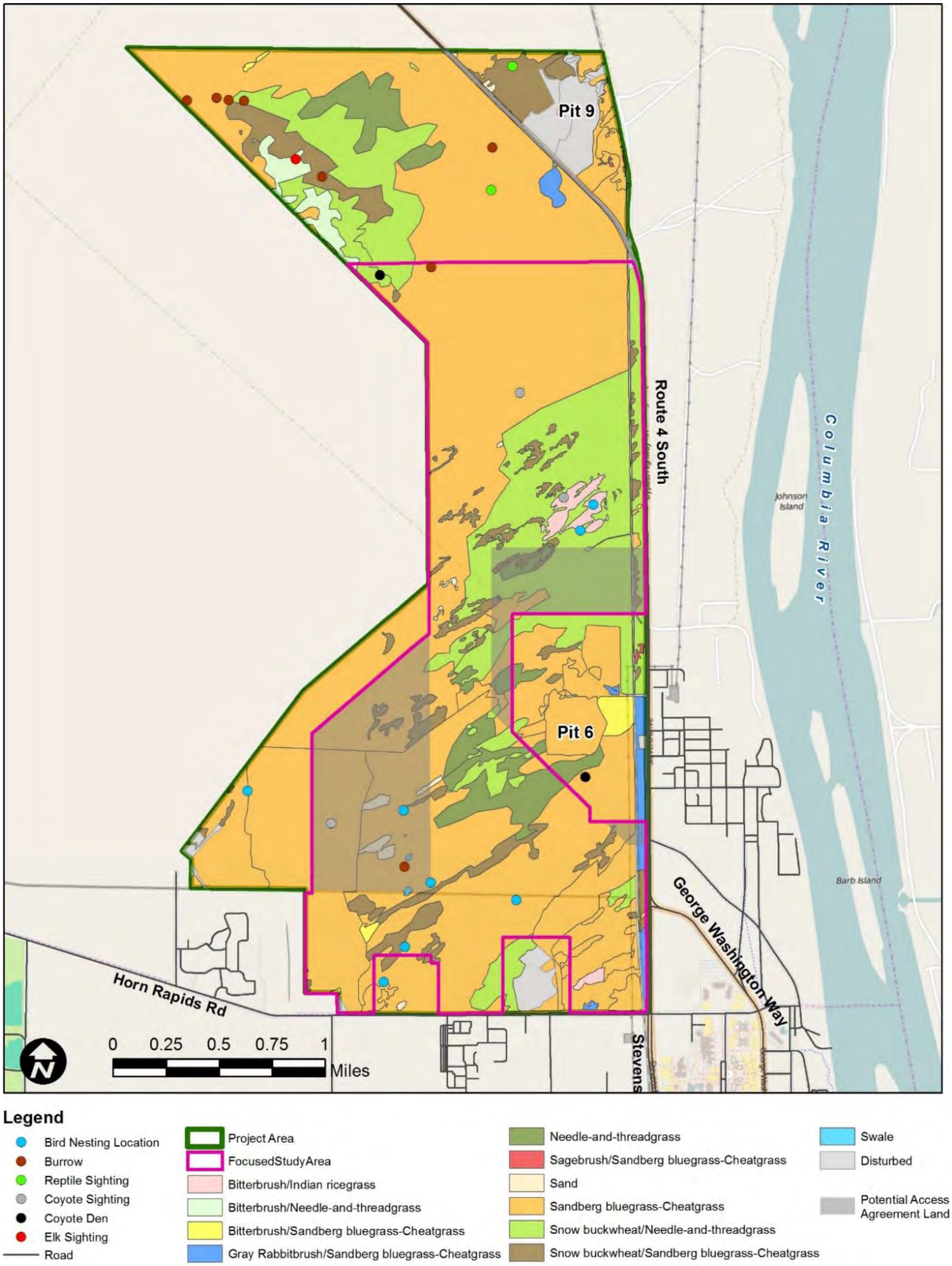
Common Name/Scientific Name	Status[1, 2]	Occurrence During Surveys[3]
Western Meadowlark (*Sturnella neglecta*)	MBTA	C
Horned Lark (*Eremophila alpestris*)	MBTA	C
Western Kingbird (*Tyrannus verticalis*)	MBTA	FC
Long-billed Curlew (*Numenius americanus*)	MBTA; State Monitored	FC
Mourning Dove	MBTA	FC
Common Nighthawk (*Chordeiles minor*)	MBTA	FC
Black-billed Magpie (*Pica hudsonia*)	MBTA	U
Common Raven (*Corvus corax*)	MBTA	FC
Barn swallow (*Hirundo rustica*)	MBTA	U
Grasshopper sparrow (*Ammodramus savannarum)*	State Monitored; MBTA	R
Lark sparrow (*Chondestes grammacus*)	MBTA	R
European Starling (*Sturnus vulgaris*)		U
Chukar (*Alectoris chukar*)		R
American kestrel (*Falco sparverius*)	MBTA	U
Swainsons Hawk	State Monitored	U
Ferruginous Hawk (*Buteo regalis*)	Federal Species of Concern State Threatened; MBTA	R
Red Tailed Hawk (*Buteo jamaicensis*)	MBTA	U

[1]MBTA = Species is listed under the Migratory Bird Treaty Act

[2]Source: USFWS 2013

[3]C = Common, FC = Fairly Common, U = Uncommon, R = Rare

Figure 2 – Wildlife Survey Results within the Study Area



Western meadowlarks, horned larks and western kingbirds were plentiful in the area and although no nests were directly observed, presence of pairs and their prevalence in the area indicated that these species were nesting throughout much of the study area. Ferruginous hawks are known to use transmission towers and utility poles for breeding in the Hanford Site (DOE 2013b), but no nests were observed within the PA, although one individual was observed flying overhead in the southern portion of the PA during the surveys. An active Swainson's hawk nest was observed in the southern portion of the study area (Photos 1 and 2, Figure 2). Nighthawks were also directly observed nesting in the area. The botanists came across an occupied Common nighthawk nest on the ground that contained 3 eggs on July 13, 2013. As they approached, the adult flushed off the nest and they briefly observed the eggs before retreating to allow the adult to return to the nest (Photo 3). Long-billed Curlews were persistently seen throughout much of the surveyed area, within the majority in the southern half of the study area. A pair of Long-billed Curlews with 3 chicks was observed in the southwest portion of the study area (Figure 2) providing evidence that this species also currently nests in the area. Signs warning people to avoid curlew nesting areas near the access road along the southeastern end of the study area also indicated that curlews have nested in the area previously (Photo 4).

Lark sparrows were observed on fences near the Pit 6 area and were only seen during the June surveys. A single Grasshopper sparrow was sighted on a fence at the western end of the study area near the boundary with the HAMMER facility firing range (Figure 2). This individual was also seen during the early June surveys. Potential sagebrush sparrow habitat lies to the north and east of the NE corner of the study area near Pit 9. Surveys in this area did not detect any sagebrush sparrows visually and no sagebrush sparrow vocalizations were heard.

3.2 Mammals

Mammal diversity in the Columbia Basin Ecoregion is lower than most other arid areas of the Pacific Northwest. To inhabit this region, mammals must either be adapted to the semi-arid climate or live close to a permanent water source. Many species that occur in the Columbia Basin range far beyond its borders and most exist in greater numbers outside of the ecoregion (DOE 2000).

Very few mammals were observed during the surveys (Table 2). Coyotes were directly observed on two occasions, and scat was found throughout the surveyed area with most in the southern and western portion of the study area. There were three coyote den sites observed throughout the surveys, and all three sites appeared to be active (Figure 2; Photos 5 and 6). One den was located in the northwest portion of the study area, and the other two were in the southern end. Fresh tracks, trails in the grass, and scat were present at all three sites.

Table 2: Mammal species observed during surveys of the Hanford Land Conveyance Property in late May and early June, 2013.

Species	Status	Occurrence During Surveys[1]
Coyote (*Canis latrans*)	None	U
Mule Deer (*Odocoileus hemionus*)	None	R
Elk (*Cervus elaphus*)	None	R

[1]C = Common, FC = Fairly Common, U = Uncommon, R = Rare

A single mule deer doe was sited at the north eastern end of the study area, north of Pit 9. During the botanical surveys, a single female elk was observed in the northern portion of the study area (Figure 2; Photo 7).

3.2.1 Mammal sign

Although no small mammals were directly observed, a few burrows were observed that were of adequate size (approximately 2 inches in diameter) to be inhabited by ground squirrels, while many were smaller and potentially used by mammals such as mice, voles, and shrews. Burrows were seen periodically throughout the study area, but very few were located in the middle section (Figure 2). Most burrows appeared inactive at the time of the surveys, but some showed signs of recent digging.

Previous data shows ground squirrel (*Urocitellus spp*.) colonies located in the 300 area to the east of the study area (MSA 2013). No ground squirrels were observed during the wildlife surveys in May and June within the land conveyance site, but several small burrows were found that could potentially be inhabited by ground squirrels (Photo 8). Some of these burrows showed signs that they were recently used, but it was not possible to determine their current activity on site due to lack of conclusive evidence such as tracks.

Several larger burrows were located in the northern end of the study area (Figure 2; Photo 9). These were of adequate size for badgers (*Taxidea taxus*) and provide evidence of badger presence. These burrows were in tact, but cobwebs across the entrances and the lack of tracks indicated that they may not be currently occupied.

3.3 Reptiles and Amphibians

Very few reptiles and no amphibians were observed during the surveys. The area is arid upland with no water sources located nearby; therefore, it does not provide suitable habitat for amphibian species. Only two species of reptiles were observed: a few gopher snakes and a short-horned lizard (Table 3).

Table 3: Reptile species observed during surveys of the Hanford Land Conveyance Property in late May and early June, 2013.

Species	Status	Occurrence during surveys[1]
Gopher Snake (Bull Snake) (*Pituophis catenifer*)	None	U
Short-horned lizard (*Phrynosoma douglassii*)	State Monitored	R

[1]C = Common, FC = Farily Common, U = Uncommon, R = Rare

Gopher snakes, also known as bull snakes, primarily occur in the Columbia Basin and Okanogan ecoregions although a few occurrences are reported in the East Cascades Ecoregion. Gopher snakes are found in warm, dry habitat – deserts, grasslands, and open woodlands. They spend a majority of their time below the surface in animal burrows (WDNR 2013). A gopher snake was observed during the pedestrian transect surveys in the northeast portion of the project site (Figure 2). This area was dominated by snow buckwheat, sandberg bluegrass, and cheatgrass with bare sandy soil.

Short-horned lizards inhabit primarily the shrub-steppe. They also require well-drained soils so that they can burrow below the surface and substrate. Short-horned lizards in Washington are reported to occur in loamy terrain without lithosols on vegetated sand dunes and in some agricultural fields where patches of native habitat are present (WDNR 2013). During the surveys, one short-horned lizard was observed on a sand dune towards the north end of the site (Photo 10, Figure 2).

4.0 Discussion

Much of the shrub-steppe habitat native to the area and throughout western North America has been transformed as a result of agriculture, grazing, and urbanization (Poston et al. 2009). Along with the decrease in habitat, the bird species that depend on this habitat have also declined (Poston et al. 2009). The number of species observed in surveys at Hanford over previous years has declined since 1989 with 18 species per survey to approximately 7 species in 2008 and 2009 (Poston et al. 2009). The surveys in May and early June of 2013 demonstrated few mammals and a limited number of bird species inhabit the study area.

No federally listed threatened, endangered, or candidate species were observed or are documented to occur in the study area (WDFW 2013). The only species that have been documented as occurring in the vicinity of the study area are burrowing owls and ferruginous hawk. Ferruginous hawks are known to use transmission towers utility poles for breeding in the Hanford site (DOE 2013b; WDFW 2013), but no nests were observed within the project site and its vicinity during the wildlife survey.

Burrowing owl is federally listed as a species of concern and a Washington State candidate species. Primary causes for population declines throughout North America include habitat loss and degradation caused by land development and declines of burrowing mammal populations (Klute et al. 2003; Poston et al. 2009). In previous surveys of the Hanford area, seventy-one percent of burrowing owl nests were located in abandoned badger burrows, 26 percent in old irrigation pipes, and 3 percent in coyote dens. Additional evidence suggests that burrowing owls frequently nest near roadsides, which may have important implications with respect to human activities (Poston et al. 2009). In 2001, burrowing owls were observed near the HAMMER facility, and one single active burrow was located during the 2001 survey (Sackschewsky 2001). This nest is located approximately 3,000 feet west of the study area, and it has not been documented that the nest is still active or not. Burrowing owl's territory tends to be located closer to their nesting sites but can expand during their foraging activities ranging from 35 to 241 hectares (Klute, et al. 2003). The project site is too far out from the recorded nesting site; therefore, they are unlikely to forage within the project site. No active nests were observed during the wildlife survey.

The bald eagle (*Haliaeetus leucocephalus*) was removed from the federal threatened and endangered species list in July 2007 and its status changed from threatened to sensitive in Washington State in January 2008. Federal and state protection is still applied to bald eagle through the Bald and Golden Eagle Protection Act, the MBTA, and the Washington Administrative Code. Bald eagles are reported to occur during the winter months in the Yakima River and along the Columbia River. They are known to use riparian trees for perching and nesting (USFWS 2008); however, they are not known to use the study area for nesting. A Bald Eagle Management Plan for the Hanford Site, South-Central Washington, (DOE/RL-94-150, Rev. 1) outlines seasonal access restrictions around documented nesting and sites at the Hanford Site between November 15 and March 15 (DOE 2012a). These sites are located in riparian areas along the Columbia River and are well outside the study area.

The WDFW currently lists the black-tailed jackrabbit (*Lepus californicus*) and white –tailed jackrabbit (*Lepus townsendii*) as 'candidate' species of concern (WDFW 2013). Recent surveys, including night spotlight surveys along seven transects throughout the Hanford Site, yielded no jackrabbit sightings (DOE 2012a). No rabbits or rabbit sign was observed during the wildlife surveys for this project.

The only mammals observed inhabiting the study area site were coyotes. Several burrows that could potentially currently be occupied by ground squirrels and badgers were observed, but it was not possible to conclusively determine if they were recently active. Incidental sightings of a single mule deer and a single female elk occurred on the study area during the wildlife and plant surveys.

The Hanford Site Biological Resources Management Plan (BRMP) was developed to provide DOE-RL and its contractors with a consistent approach to protect biological resources and monitor, assess, and mitigate impacts to them from site development and environmental cleanup and restoration activities. This approach accounts for differences in resources that warrant different levels of management attention such as rare native sagebrush/bunchgrass communities (DOE 2013a).

To address these differences in "value" DOE-RL classifies Hanford Site biological resources by six levels of management concern (0-5). Level 0 represents the lowest level of management concern and Level 5 the highest. Each level has a specific set of associated management actions and requirements (DOE 2013a). Level 0 includes non-native plants and animals and non-vegetated areas such as industrial sites, paved and compacted gravel areas (DOE 2013).

Biological resources categorized at Level 1 include native fish, wildlife, invertebrate and plant species not otherwise included in higher levels and require actions to minimize or avoid impacts to these species as practicable under regulatory compliance such as the Migratory Bird Treaty Act. At higher levels of concern, however, the number of management actions increases, and the actions become more restrictive. Habitats within the conveyance property are listed as Level 2 and 3 (DOE 2013a). All species observed during the wildlife surveys are classified as level 1 or level 2, with the majority as Level 2, being listed as monitor species or listed under the MBTA.

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Appendix A
Photos

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Photo 1. Tree with Swainson's Hawk Nest

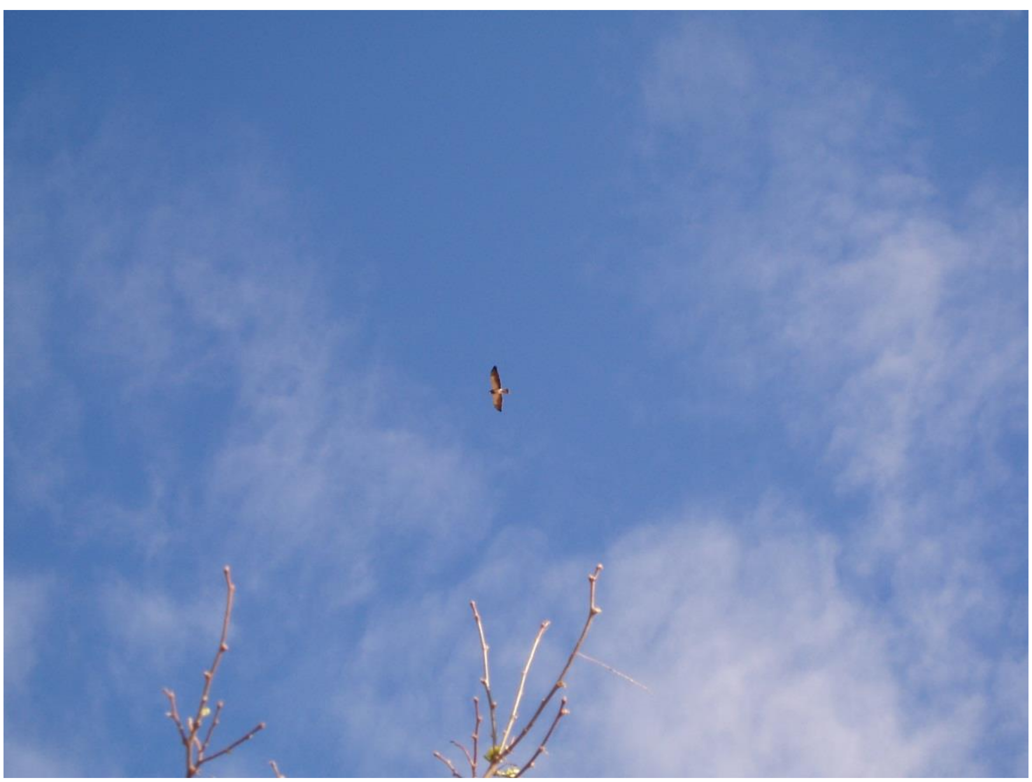

Photo 2. Swainson's hawk circling above the site

Photo 3. Common Nighthawk eggs observed in July 2013 located in the middle portion of the site where bitterbrush and Indian ricegrass dominate

Photo 4. Curlew nesting sign along the access road at the southeast end of the study area

Photo 5. Coyote den located southern part of the site

Photo 6. Coyote den located northwestern portion of the site

Photo 7. Elk observed at the northwest end of the project site in July 2013

Photo 8. Possible ground squirrel burrow

Photo 9. Possible badger burrow located north end of the site

Photo 10. Short-horned lizard observed in May 2013 on a sand dune located at the northern portion of the site

Photo 11. Typical vegetation type observed at the site (Sandberg bluegrass and cheatgrass primarily dominate the area)

Photo 12. Sand dune areas observed throughout the site, photo facing northwest

APPENDIX I – SALSTROM AND EASTERLY, VEGETATION SURVEY OF THE PROPOSED LAND CONVEYANCE, CENTRAL HANFORD, WASHINGTON

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Vegetation Survey of the Proposed Land Conveyance

Central Hanford, Washington

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September 5, 2013 (Rev 1)

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September 5, 2013
(minor revision April 23, 2015)

All photos by (or of) Richard Easterly

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INTRODUCTION

LANDSCAPE DESCRIPTION

All of the study area has been shaped by the Pleistocene cataclysmic floods. The higher elevation area in the northwest corner is part of a gravel flood terrace downstream of a major flood bar (the 200 Area). The remaining study area includes lower flood terraces within the main flood channelways of the cataclysmic floods. As flood waters became temporarily ponded behind Wallula Gap, the slackwater repeatedly deposited fine-textured sediments across the site. These slackwater fines are capped by discontinuous eolean sand sheets, which in turn are capped by an eolean parabolic dune colony (Fecht et al. 2004). The dune colony has a repeating longitudinal pattern trending to the northwest (which is the predominate direction of strong wind in the region). The dunes are stabilized by vegetation except for limited blowouts.

The blanket of eolean deposition provides limited exposure to fluvial deposits of the late Pleistocene and Holocene. While the geomorphic forms of the fluvial deposits can generally be recognized beneath the dune sheets, they are not distinguishable beneath the deeper dunes (Fecht et al. 2004).

DISTURBANCE HISTORY

Farming and ranching was conducted throughout the region before acquisition by the government in the early 1940s (Parker 1979). In an attempt to establish irrigated farmland, a number of irrigation canals were built across some of the lower elevation portions of the study site. Portions of the canals, which were built beginning around 1908 (Parker 1979), are still evident in aerial photos and on the ground. Sites where the canals crossed through deeper stabilized dunes have created blowouts at a number of sites, and the sand remobilization has created openings that provide limited dune habitat.

Currently, powerline right-of-ways, roads, quarries and an asbestos disposal landfill occur in the study area.

The area was mapped as being burned by wildfire in 1984 and 2000 (PNNL 2011a) as well as other smaller fires (mapped and unmapped) before and after those dates.

In 2003 the southwestern area, and in 2006 most of the remaining portion of the study area, was aerially sprayed with the herbicide Tordon© to control weedy species, possibly rush skeletonweed (*Chondrilla juncea*) or perhaps a postfire increase of Russian thistle (*Salsola tragus*)[1]. In addition to Tordon©, Liberate © was used in the 2006 herbicide treatment, and Vetran© and Quick© were also used in 2004. Herbicide treatment is not recorded in the northeast section of the study area, east of Highway 4 South, around Pit 9 (PNNL 2011b).

METHODS:

Rare plant species (WNHP 2013) with the potential to occur in the study area are listed in Table 1. 'Potential to occur' was broadly interpreted so as to include species not currently known from Central Hanford, but whose habitat was potentially present within the project area.

[1] Cover of Russian thistle typically increases for a short period of time after fire on sandy soils, unless herbicides are used, which often prolongs the high cover of the species (personal observation).

Table 1. Plant species of conservation concern (WNHP 2013) potentially found on Central Hanford within the area proposed for conveyance.

Species	**Common name**	**Status: WNHP(Federal)***	**Known on Central Hanford**
Aliciella leptomeria	Great Basin gilia	Threatened	Yes
Astragalus columbianus	Columbia milkvetch	Sensitive (Species of Concern)	Yes
Astragalus geyeri	Geyer's milkvetch	Threatened	No
Atriplex canescens* var. *canescens	hoary saltbush	Review Group 1	Yes
Camissonia minor	small-flower evening-primrose	Sensitive	Yes
Camissonia pygmaea	dwarf evening-primrose	Sensitive	Yes
Camissonia scapoidea* ssp. *scapoidea	naked-stemmed evening primrose	Sensitive	No
Cistanthe rosea	rosy pussypaws	Threatened	Yes
Corispermum americanum* var. *americanum	American bugseed	Review Group 2	No
Corispermum pallidum	pale bugseed	Possibly extirpated	No
Corispermum villosum	hairy bugseed	Review Group 2	Yes
Cryptantha leucophaea	Gray cryptantha	Sensitive(Species of Concern)	Yes
Eremogone franklinii* var. *thompsonii	Thompson's sandwort	Review Group 1	Yes
Erigeron piperianus	Piper's daisy	Sensitive	Yes
Erigeron poliospermus* var. *cereus	hairy-seeded daisy	Review Group 1	No
Gilia inconspicua	shy gily-flower	Review Group 1	No
Lathrocasis tenerrima	delicate gilia	Review Group 1	No
Leymus flavescens	yellow wildrye	Review Group 1	Yes
Leymus triticoides	beardless wildrye	Review Group 1	No
Loeflingia squarrosa* var. *squarrosa	loeflingia	Threatened	Yes
Micromonolepis pusilla	red poverty-weed	Threatened	No
Mimulus suksdorfii	Suksdorf's monkey-flower	Sensitive	Yes
Minuartia nuttallii* ssp. *fragillis	brittle sandwort	Threatened	No
Minuartia pusilla	annual sandwort	Review Group 1	Yes
Monolepis spathulata	prostrate poverty-weed	Sensitive	No
Nicotiana attenuata	Coyote tobacco	Sensitive	Yes
Oenothera caespitosa* ssp. *caespitosa	caespitose evening-primrose	Sensitive	Yes
Physaria didymocarpa* var. *didymocarpa	common twinpod	Threatened	No
Physaria douglasii* ssp. *tuplashensis	White Bluffs bladderpod	Threatened (Proposed Threatened)	No
Physaria geyeri* var. *geyeri	Geyer's twinpod	Review Group 1	No
Polygonum austiniae	Austin's knotweed	Threatened	No
Uropappus lindleyi	Lindley's microseris	Review Group 1	No
Verbena stricta	hoary verbena	Review Group 1	No

*** Categories of conservation status are the following (WNHP 2013):**

State (Washington Natural Heritage Program)
E = Endangered. In danger of becoming extinct or extirpated from Washington.
T = Threatened. Likely to become endangered within the near future in Washington if the factors contributing to population decline or habitat loss continue.
S = Sensitive. Vulnerable or declining and could become endangered or threatened in the state without active management or removal of threats.
X = Possibly extinct or Extirpated. Documented to have previously occurred within Washington, but no longer thought to be present here.
Review Group 1 = Of potential concern but needs more field work to assign another rank.
Review Group 2 = Of potential concern but with unresolved taxonomic questions.

Federal
LE = Listed Endangered. The plant is in danger of extinction throughout all or a significant portion of its range.
LT = Listed Threatened. The plant is likely to become endangered within the foreseeable future throughout all or a significant portion of its range.
PE = Proposed Endangered. A plant that is proposed to be listed as endangered and is undergoing a review process
PT = Proposed Threatened. A plant that is proposed to be listed as threatened and is undergoing a review process
C = Candidate species. A plant for which FWS or NOAA Fisheries has on file sufficient information on biological vulnerability and threats to support a proposal to list as endangered or threatened.
Species of Concern = An informal term referring to a species that might be in need of conservation action. Such species receive no legal protection and use of the term does not necessarily imply that a species will eventually be proposed for listing.

The survey was done during three sessions: a complete survey of the study area during early May, a reconnaissance visit during early June to check the phenology of key species (particularly annuals, see below), and a follow-up survey during early July. Sites identified during the first visit as potentially having habitat for rare species with later phenology were revisited and resurveyed completely during early June and/or early July. Those habitats included areas with loose sand and blowouts, dune trains and a swale area in the southern portion of the site that hosted unusual species (see below).

The timing of the visits was adjusted to accommodate the effects of the patterns of precipitation for the year, which included a lack of significant precipitation during winter and early spring, a hot spell in early May, and significant precipitation during late May/early June. The later visits were timed to give plants that might have germinated after the spring rains time to develop. It was dry enough prior to the late spring rain that annuals typically detected in June during wet years probably would not have been present. This theory was tested during the early June visit and found to be the case. Survey time was therefore shifted to July to detect plants that may have been stimulated by the late rain, particularly species detectable throughout most of the summer such as Coyote tobacco (*Nicotiana attenuata*) and several species of bugseed (*Corispermum pallidum, C. villosa* and *C. americanum* var. *americanum*). Annuals with the potential to develop during late spring and early summer, including *Camissonia pygmaea* and *C. minor,* were also considered to have relatively high potential to occur later.

Updating the map of existing vegetation was approached by first reviewing imagery from aerial photos and satellites to detect locations and potential identity of existing shrubs and areas with open sand and drawing a preliminary map. These areas were subsequently visited to identify the existing vegetation and evaluate the ecological condition of the areas. To the extent practical, the dominant species were tracked independently, so that maps can be constructed from the dataset that indicate the distribution and density for each of the tracked species. Species that occurred in the area whose distributions were tracked are listed in Table 2. Mapping methodology is described in Appendix A.

Table 2. Species occurring within the study area whose distributions were tracked for the map of current vegetation.

Shrubs		**Priority for mapping****
Antelope bitterbrush	*Purshia tridentata*	High
Big sagebrush	*Artemisia tridentata*	High
Grey rabbitbrush*	*Ericameria nauseosus*	Low
Green rabbitbrush*	*Chrysothamnus viscidiflorus*	Low
Snow buckwheat*	*Eriogonum niveum*	Medium
Grasses		
Bluebunch wheatgrass	*Pseudoroegneria spicata*	High
Cheatgrass*	*Bromus tectorum*	Low
Indian ricegrass	*Achnatherum hymenoides*	High
Needle-and-threadgrass	*Hesperostipa comata*	High
Sandberg bluegrass*	*Poa secunda*	Low

*Distribution not closely tracked.

**See Appendix A.

In addition, more than 100 photo points were established at representative and unique sites and at vantage points to document the components and patterns of the existing vegetation. These points consisted of overlapping photos taken systematically, beginning to the facing north and proceeding counterclockwise for a full rotation. Additional photos of the ground were taken to document ground cover. The location was recorded with a GPS unit (Garmin eTrex Venture; accuracy of approximately three meters). In addition to being useful for updating the map of existing vegetation, the photos will provide an archive of information about the structure and composition of the vegetation and habitat at and near those sites.

RESULTS AND DISCUSSION

RARE PLANTS

Plant species observed within the study area are listed in Table 2. No species currently considered to be rare were found on the study area. However, one species for which sufficient information is not currently available to assign a conservation status (beardless wildrye, WNHP Review Group 1) was present.

Beardless wildrye (*Leymus triticoides*) was associated with an unusual swale habitat located in the southern portion of the site (see below). The taxon has not been collected in Washington during recent decades (Burke Museum 2013, Consortium of PNW Herbaria 2013).[2] The species' distribution within the study area was limited to a sites associated with a swale complex. In the central swale, the species formed thick, monotypic swards, as it did to a lesser extent in the northernmost swale (Figure 1). To the south of the relatively high longitudinal dune, patches were much more diffuse, with significant cover of other species such as cheatgrass, along with some of the other unusual species found in the swales (see below). The overall distribution of the species at this site is likely tied to some sort of aquatard located at depth (see 'Swale', below). Additional site details are provided in Appendix B (Washington Natural Heritage Program sighting form).

No other species currently of (potential) conservation concern were found during the survey. While the study can be considered a clearance for perennial species, many of the rare annual species likely did not have their environmental conditions met during 2013. Those requirements include specific environmental conditions in order for them to be present in any given year. Thus the lack of their detection does not rule out that they are present, only that the conditions were not conducive for them to be growing in 2013. Areas with the highest potential for those species are associated with the open sands in 'blowouts' on the stabilized dunes, which is limited in the study area (see below).

[2] The label from a collection made by Henderson in 1892 from Yakima County states: '*Moist meadows. A valuable grass, yielding large crops of hay.*' (Burke Museum, 2013).

 

Figure 1. Beardless wildrye (*Leymus triticoides*) in the southern portion of the study area.

VEGETATION COMMUNITIES

A map of the current vegetation and maps in which the distributions of dominant species are depicted are presented in figures 2 and 3.

The shrub cover was burned off most of the survey area by the wildfire in 2000 (and others). While sagebrush is generally absent from areas that burned, some other shrubs have regenerated since the fire, primarily snow buckwheat and green and grey rabbitbrush.

Though most of the study area has been burned by wildfire during recent decades, limited areas on several of the larger dune blowouts have not burned, likely due to lower fuel loads and the varied local topography there. This has created limited refugia for late(r)-seral dune communities (antelope bitterbrush/Indian ricegrass dune complex). These areas, primarily in the central portion of the study area, are examples of higher quality plant communities on the Hanford Site (Level of Concern 3, Biological Resources Management Plan [BRMP, US DOE 2013]; see 'Levels of Concern' below). While limited in aerial extent, several of these sites are in relatively good condition, with a high proportion of cover and diversity of native species, and low cover of non-native species (figures 4-6). This habitat, which is adapted to openings, occurs where the dunes have been blown-out such as on tops and sideslopes, and where disturbance, such as from railroad and road cuts, has created openings for blowouts to occur downwind.

One other area that did not burn (although portions burned partially) was in the northwest of the site, which is on the edge of the higher terrace and included an area with geomorphic and topographic complexity. Shrub survival and reestablishment there includes antelope bitterbrush and sagebrush, as well as snow buckwheat and green and grey rabbitbrush (Figure 7). This area represents a model of the potential plant communities on the Hanford site and is herein identified as being in Resource Level of Concern 3 (US DOE 2013, see 'Levels of Concern' below). However, portions of that site are currently partially choked with tumbleweed carcasses that arrived from upwind (and post fire) sites.

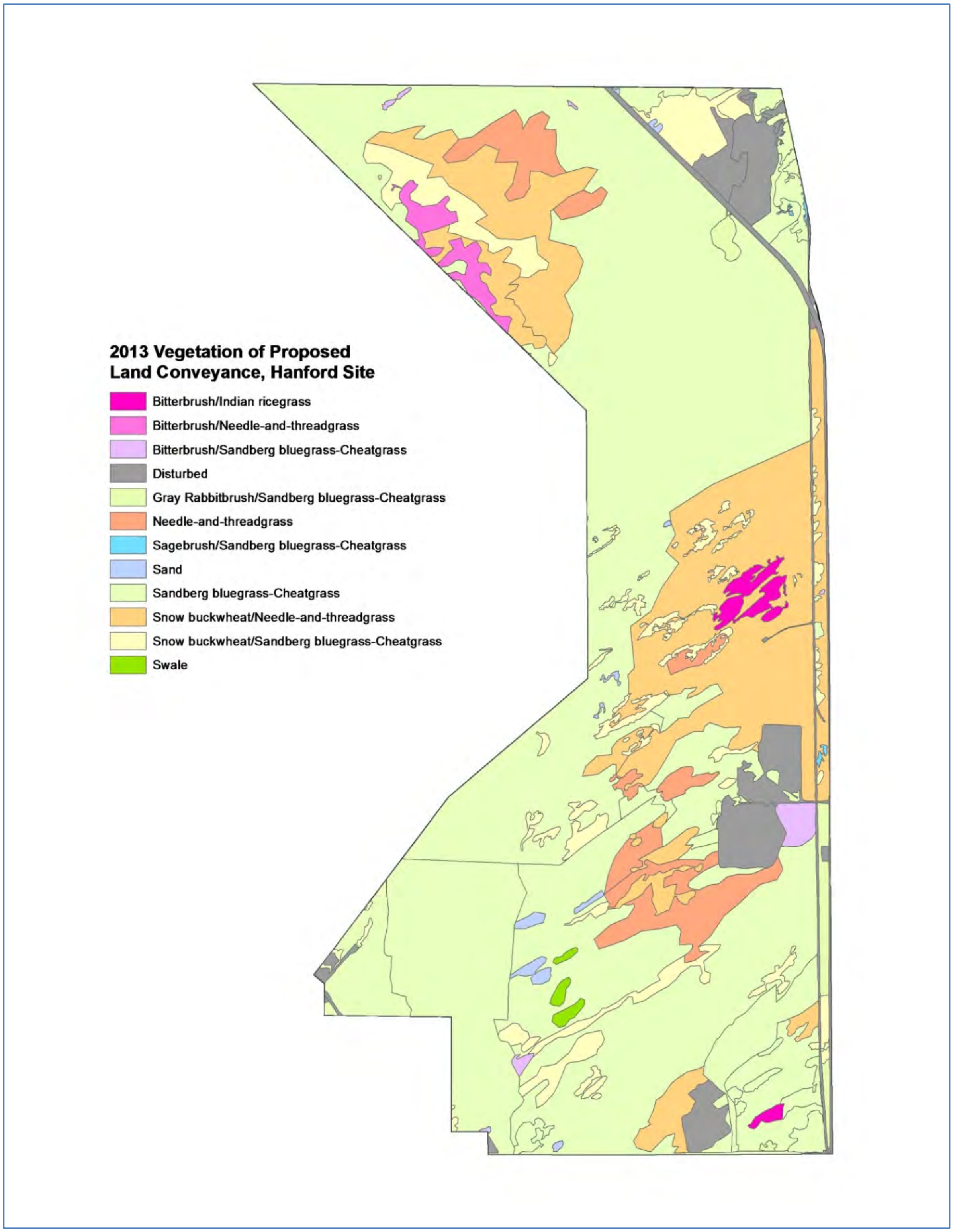

Figure 2. Distribution of generalized vegetation community types on the proposed land conveyance, Hanford Site, 2013.

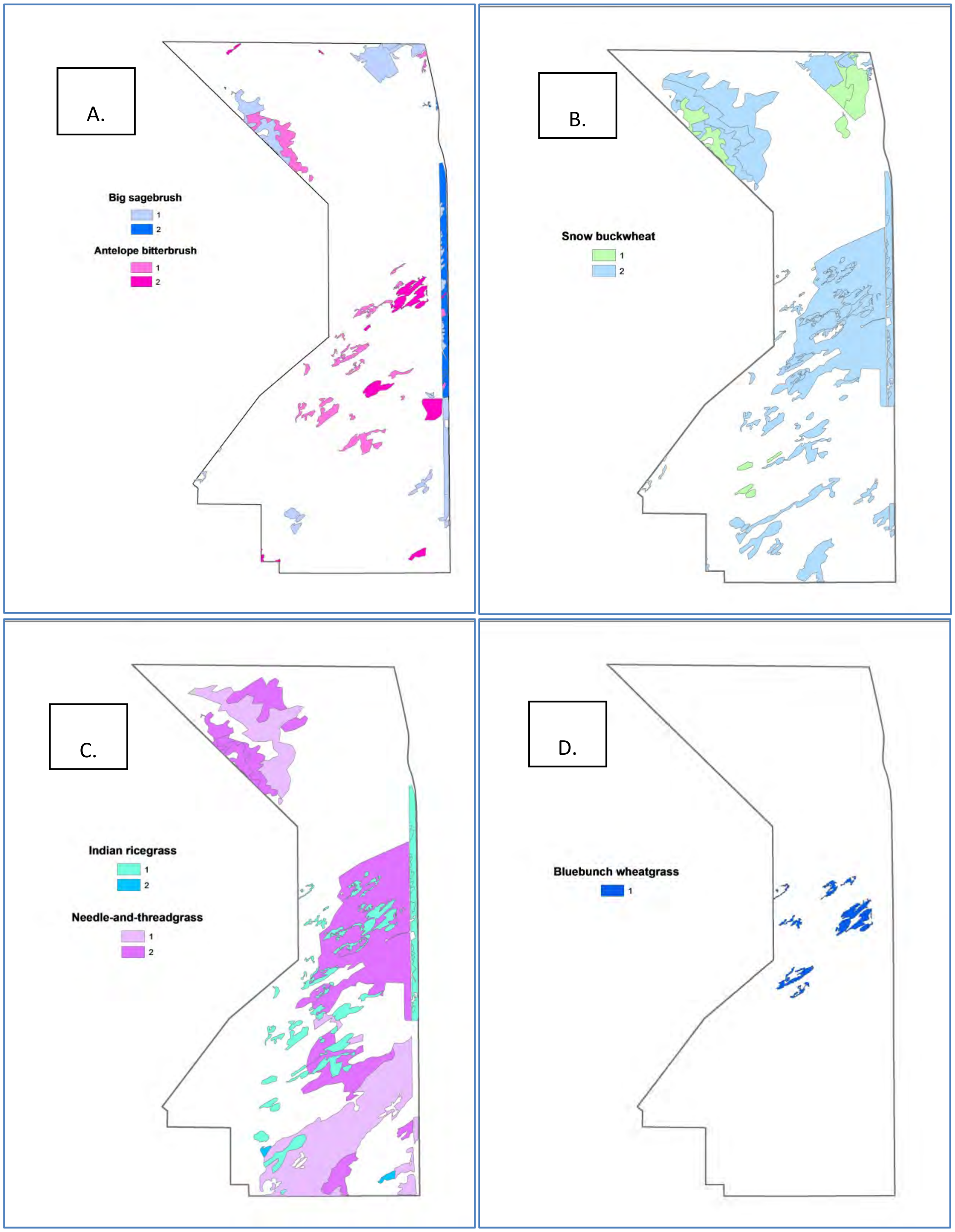

Figure 3. Distribution of representative shrub and grass species on the proposed land conveyance study area, Hanford, 2013. Distribution is noted at two levels. 1: Low cover (to approximately 5%). 2: Patchy or clumpy distribution within the polygon; the scale of the patches is not indicated and may indicate codominance with another species of that growth form (i.e., shrubs or grasses). Note that for maps with more than one species there may be an overlap of distribution that is not depicted (the map favors the species at the top of the legend). A. Big sagebrush and antelope bitterbrush. B. Snow buckwheat (under-represented on map; i.e., more widely distributed than indicated). C. Indian ricegrass and needle-and-threadgrass. D. Bluebunch wheatgrass.

Needle-and-threadgrass is regularly present in significant portions of the site (see Figure 6). Cover of the species appear to have increased after being burned, likely a result of subtle variations in the finer components of eolean soil deposition (not captured in the current soils map) and a seedbank from prefire plants that expanded after fire. We have observed and reported needle-and-threadgrass to increase in cover after fire in several other areas in the Pasco Basin with similar soils, such as on the USFWS Hanford Reach National Monument on the Wahluke (e.g., Easterly and Salstrom 2013a, 2013b, Salstrom and Easterly 2011), McGee-Riverland (Easterly and Salstrom 2003) and ALE units (personal observation). Areas with significant patches of needle-and-threadgrass are identified as being Resource Level of Concern 3 (US DOE 2013, see 'Levels of Concern' below).

Bluebunch wheatgrass plants occurred frequently on stabilized dunes, primarily on the tops and northerly aspects of those dune sets located near the middle of the site (see Figure 6). The species was usually present as scattered plants, although patches were occasionally present. A few patches of sand dropseed (*Sporobolus cryptandrus*) were observed, but the species was not dominant or widespread. In addition, while thickspike wheatgrass (*Elymus lanceolatus* ssp. *lanceolatus*) occurred intermittently (especially in more open areas), one patch of sand-dune wheatgrass (*E. lanceolatus* ssp. *psammophilus*) was observed in north-central portion of the site.[3]

Elsewhere the cover of cheatgrass was frequently heavy, sometimes having developed a thatch in which other species were excluded. However, this pattern typically varied at a relatively fine scale, where sites with even a slight north aspect had a more dominant cover of Sandberg bluegrass. Basins typically had high coverage of cheatgrass, although Sandberg bluegrass sometimes co-dominated. The pattern of Sandberg bluegrass being dominant on slight north aspects was typically also reflected with the cover and distribution of microbiotic crust, especially on fine-textured soils; coarser soils usually did not reflect this pattern. Areas with high cheatgrass cover typically did not support a noticeable microbiotic crust.

Cheatgrass die-off circles[4] were widespread in the study area, especially in the northern portion and near the unusual swale area (see below) in the south (Figure 8). These sites typically had higher cover of other species, sometimes the other species were not observed outside of the clearly-defined circular patches, such as weakstem cryptantha (*Cryptantha flaccida*), tarweed fiddleneck (*Amsinckia lycopsoides*), needle-and-threadgrass, Sandberg bluegrass, tumblemustard (*Sisymbrium altissimum*) and microbiotic crust.

Rush skeletonweed (*Chondrilla juncea*) was present in low densities over much of the site. West of the Highway 4 South the coverage was generally low, whereas east of the highway (north of Pit 9), the species' cover was sometimes very high. The latter area also had diffuse knapweed (*Centaurea diffusa*) and a patch of Dalmatian toadflax (*Linnaria dalmatica*); that area was apparently excluded from the herbicide treatment(s).

---

[3] We have not observed that subspecies previously, although we have been looking for it for the past couple years.

[4] Cheatgrass crop circles are a phenomenon that causes clearly-demarked holes in the fabric of dense cover of cheatgrass in several areas within the Pasco Basin, as on Central Hanford (Easterly and Salstrom 1997) and the Wahluke Slope (e.g., Salstrom and Easterly 2013). The circles are typically one to four (seven) meters diameter, and appear to get progressively fuzzy edged with time. These 'circles' appear to be nurse areas (or cheatgrass-free zones) for at least a few years in which a wide assortment of species, some of which are native grasses and forbs, occur. While each footprint's clear pattern of opportunity fades, this transition towards higher diversity appears to allow for establishment of mid and later seral species. The circles likely occur as a result of a soil fungus (Dr. Ann Kennedy, WSU, personal communication).

Figure 4. Dune complex in central portion of the site, with Indian ricegrass, snow buckwheat, needle-and-threadgrass and antelope bitterbrush.

Figure 5. Antelope bitterbrush, snow buckwheat and Indian ricegrass in the central portion of the study area.

Figure 6. Small dune blowout in distance with antelope bitterbrush and snow buckwheat, interdunal area with needle-and-threadgrass in middle, and bluebunch wheatgrass plants near foreground.

Figure 7. Area with relatively open sand in dune complex in the northwest portion of the study area, with antelope bitterbrush, turpentine wave-wing (*Pteryxia terebinthina)* and Carey's balsamroot (*Balsamorhiza careyana*).


Figure 8. Cheatgrass 'crop circles' were extremely common in extensive portions of the study area.

SWALES

There is an unusual assemblage of plant species at and near three swales in the southern portion of the area that appears to be unique on Central Hanford and possibly unique over a broader area (figures 9-12). Species that occur there include some not known to occur elsewhere on the site (Sackschewsky and Downs 2001, personal observation): beardless wildrye (*Leymus triticoides; s*ee above) and the non-native hairy crabgrass (*Digitaria sanguinalis).* In addition, two species considered to be 'facultative wetland' species that do not generally occur outside of riparian areas on Hanford were present: coyote willow (*Salix exigua*) and 'mountain' rush (*Juncus arcticus* var*. littoralis*)*.* Other unusual species occurring in and around the swales were salt heliotrope *(Heliotropium curassavicum*)[5]*,* Douglas' sedge (*Carex douglasii*) and yellow beeplant (*Cleome lutea*), none of which are typically found on Central Hanford (Sackschewsky and Downs 2001; personal observation).

The insect activity was relatively intense, being orders of magnitude higher than observed elsewhere in the study area every time we visited (during May, June and July), and included caterpillars, bees, wasps, butterflies and beetles. Nearly all the mountain rush stems had been girdled by caterpillars. The beardless wildrye and yellow beeplant plants provided aggregation sites for some insects.

Together, these species suggest that the local area has increased seasonally available moisture relative to other places in the region. Likely related to this, immediately to the south a thick layer of Mazama ash[6] is exposed where an old irrigation ditch bisected the dune and created a blowout (Figure 13). It seems probable that the ash underlies at least the low areas below the eolean sand, creating an aquatard and causing water to accumulate at some depth. The area with the most concentrated and diverse occurrence of the unusual species occurs within a series of basins on the topography. Elsewhere, to the south, the topography is open, but the species occurrences are likely related to an exposed shelf of the site-specific, seasonal water table.

[5] Salt heliotrope was known from a couple of early collections on the site with imprecise location information and which are probably not extant (Sackschewsky and Downs 2001; Sackschewsky personal communication), in addition to vernal pools on the east end of Gable Mountain (Burke Museum 2013). The species is classified as a 'Facultative upland' species in the arid west, although it is classified as an obligate wetland species in most other places within its range in the continental United States (USDA, NRCS. 2013)

[6] Mazama ash was derived from the eruption that created Crater Lake, Oregon, about 7000 years ago.

Figure 9. Salt heliotrope, closeup.

Figure 10. Portion of the northern swale in the southern portion of the study area. Salt heliotrope in the foreground, mountain rush (brown, erect stems) in the middle of the photo, Richard holding large carcass of a previous year's yellow beeplant, and sward of beardless wildrye behind him.

Figure 11. Swale area: salt heliotrope in foreground, large patch of hairy crabgrass in front of vehicles.

Figure 12. Yellow beeplant in front of beardless wildrye (cheatgrass in middle).

Figure 13. Exposure of thick layer of Mazama ash where old irrigation ditch cut through longitudinal dune (see location in Figure 14).

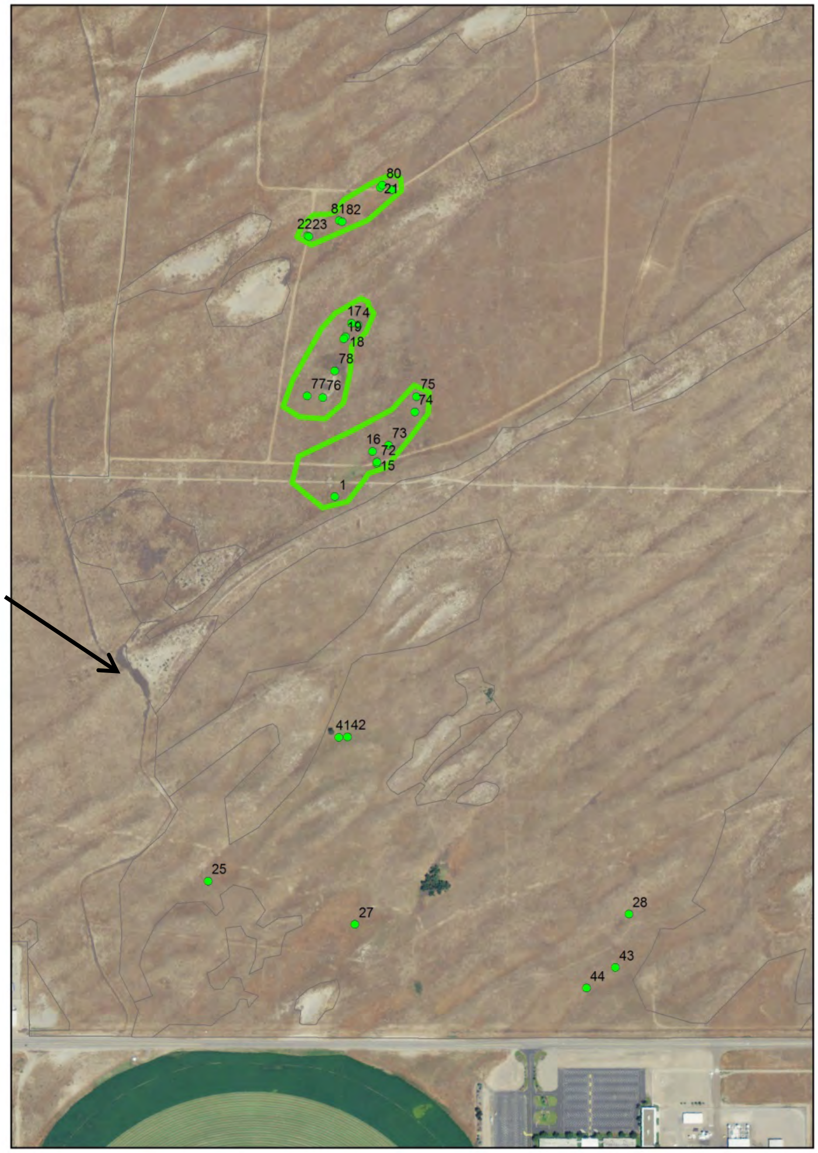

Figure 14. Detail of swale areas. Also depicted are outlier sites with the unusual species south of the longitudinal dune. 25, 27*: Leymus triticoides*. 41, 42: *Carex douglasii* and *Salix exigua*. 28, 44, 43*: Carex douglasii.* Arrow points to the location of and exposure of a thick layer of Mazama ash.

LEVELS OF RESOURCE CONCERN

A map with provisional levels 3 and 4 Resources (see BRMP, US DOE 2013) identified within the study area is presented in Figure 15; no Level 5 Resources (vegetation based) were identified in the study area. The assessment was based on the quality of habitat and/or the presence of species of conservation concern, and includes habitat associated with dune blowouts, an unburned site dominated by antelope bitterbrush (to the north), other small occurrences of antelope bitterbrush, and the site of the unusual swales in the south where beardless wildrye occurs (Review Group 1 [WNHP 2013]; see 'Rare Plants', above). Also depicted are areas in which significant patches of needle-and-threadgrass (representing Level 3 steppe habitat) occurs within a matrix of lower quality habitat.

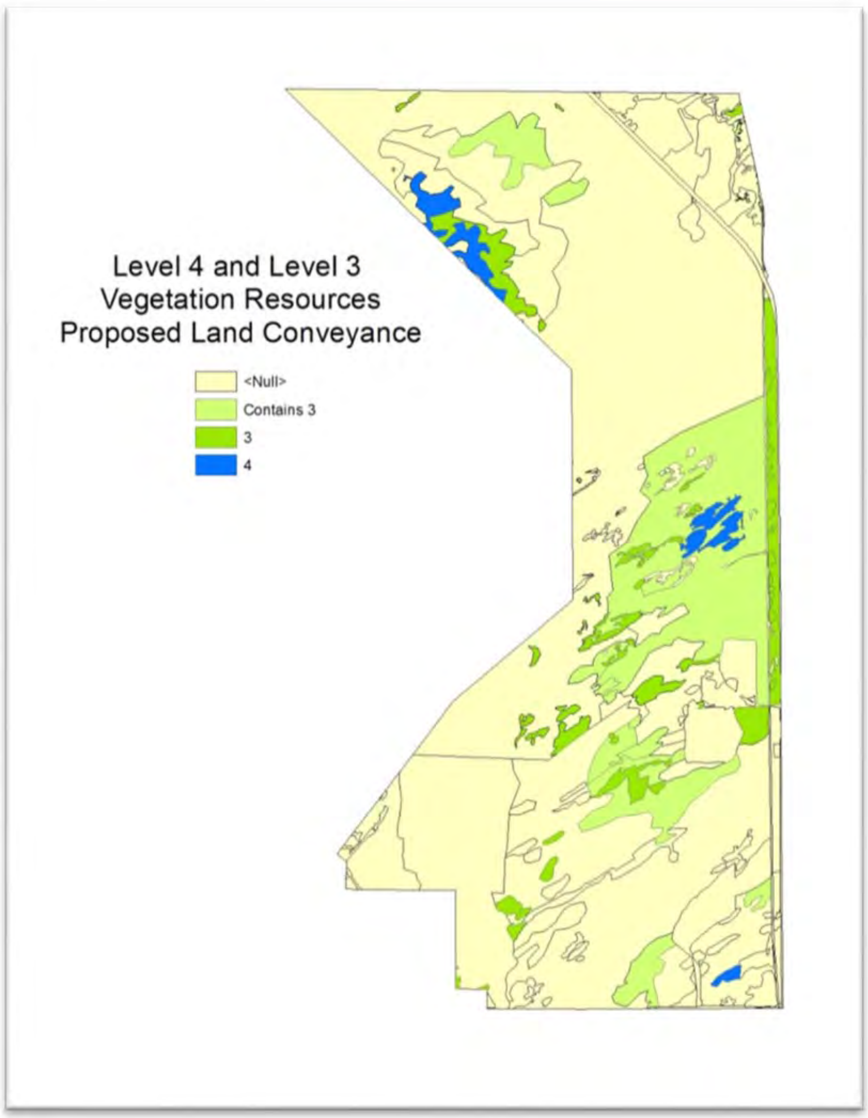

Figure 15. Areas identified as Level 4 and Level 3 Resources and areas containing patches of Level 3 Resources within the Proposed Land Conveyance study area.

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APPENDIX A

Methods used to map vegetation

Both the original map of existing vegetation and this updated map were created using the distributions of key plant species to delineate polygon boundaries. When observable, the species were tracked independently of one another to create map unit names that list several priority species and indicate their cover or distribution within the polygon. Tracking each species independently permits the map to be easily updated, to apply classification schemes as they are revised, and creates more detailed habitat information.

Mapping criteria for each species depended on the species' dominance, use in classifying vegetation, importance for indicating particular wildlife habitat, predictability of its distribution, and visibility from a distance. Polygon boundaries were drawn to reflect changes in cover of high- and medium-priority species. As much as possible, the boundaries were drawn to reflect the sinuosity of vegetation boundaries; this allows for better understanding of future fire behavior and recovery, wildlife use patterns, and other ecotone-driven 'edge-effects'.

High and medium priority species occurring in the polygon were listed as a component of the polygon name. High and medium priority species not listed in the polygon name were those that could be assumed to occur, given the presence of a 'trump' species (Table 2). For example, Sandberg's bluegrass generally occurs with Needle-and-thread grass (but not vice-versa) and when the latter was in a map unit, the former was not included in the name. Low priority species were also usually included in the map unit name, but precision of their cover on the map was lower, and their distributions were not generally used to draw polygon boundaries. The boundaries showing changes in shrub densities were drawn by extrapolating field observations using aerial photographs; grasses were assigned to these polygons based on field observations combined with local geomorphic patterns that they have been observed to follow.

To capture information about mosaics, ecotones, and possibly resiliency to disturbance, cover of high- and medium-priority species (see Table 1) was indicated at three levels of cover for each polygon.

(1) **Level 1**: Low cover (present to approximately 5%), indicated by parentheses, (...), around that species name/code in map unit name.
(2) **Level 2**: Irregular or clumpy distribution within a polygon was indicated with brackets, [...], around the species name/code in the map unit name. The scale at which the 'clumps' occurred varied; at finer scales, this designation may indicate co-dominance. No attempt was made to indicate the scale or pattern of clumps, and this designation intergrades with levels (1) and (3).
(3) **Level 3**: Moderate to dense cover and a relatively even distribution in the polygon was indicated by no modifier of the species name in the map unit name.

The low cover and the 'clumpy' levels may be a product of historic fire patterns, site potential due to geomorphology and soils, patterns of reestablishment following disturbance (i.e. fire) or other undefined reasons. Geomorphic limits on a site's productivity and potential cover may be suggested by the map unit name with lithosol indicator species and/or level one or two of the dominant grass (generally bluebunch wheatgrass).

Cover of species with low mapping priority was noted at only levels one or two of cover. Species for which density levels of 3 were not recorded, levels 2 and 3 were not distinguished and cover greater than approximately 5% was recorded as '2'. For example, *Poa secunda* and *Bromus tectorum* are widespread in most of the drier cover types within the shrub steppe, with the latter frequently co-dominant on south-facing slopes. While we attempted to indicate their relative distributions, in many (most) cases they varied on a fine scale. We therefore extrapolated from observed distribution trends on substrate, slope, aspect, and fire and disturbance history; accuracy for these low priority species will be greater on a large scale rather than for any one polygon.

APPENDIX B

Rare plant sighting form: *Leymus triticoides*

Washington Natural Heritage Program
Rare Plant Sighting Form

Taxon Name: ***Leymus triticoides***

Are you confident of the identification? **Identification of specimen awaiting expert confirmation.**

Survey Site Name: **Swale, Central Hanford**

Surveyor's Name/Phone/Email: **Debra Salstrom & R. Easterly /360 481-1786/SEEbotanical@gmail.com**

Survey Date: **13-05-04** (yr-mo-day) County: **Benton**

Ownership (if known): **USDOE (Central Hanford)**

I used GPS to map the population: **Yes**

X Coordinates are in electronic file on diskette (preferred)
Description of what coordinates represent: **Centers of patches**
GPS accuracy: **Garmin 60CSx**

x Uncorrected
GPS datum: **WGS 1984**

To the best of my knowledge, I mapped the entire extent of this population: **Yes**

Is a revisit needed? **Yes**

Population Size (# of individuals or ramets) or estimate: **1000's**

Population (EO) Data (include population vigor, microhabitat, phenology, etc): **Patches in central and northern swales highly vigorous, in flower early June. Patches to the south diffuse, low vigor.**

Associated Species (include % cover by layer and by individual species for dominants in each layer):

Lichen/moss layer: **0**
Herb layer: ***Heliotropium curassavicum, Cleome lutea, Carex douglasii, Juncus arcticus ssp. littoralis, Bromus tectorum, Sisymbrium altissimum, Lactuca serriola, Digitaria sanguinalis.***
Shrub layer(s): **0**

General Description (include description of landscape, surrounding plant communities, land forms, land use, etc.):
Unusual complex of 'swales' in the southern part of Central Hanford. Surrounding communities typical (burned) shrub-steppe on sandy substrate, heavy cover of Bromus tectorum, with Poa secunda and Hesperostipa comate/Achnatherum hymenoides in places. Area has unusual forb associates for the Site (see above) and a few *Salix exigua* shrubs occur nearby.

Minimum elevation (ft.): **360** Maximum elevation (ft.): **380**
Size (acres): < **2** Aspect: **0** Slope: **0**
Photo taken? **Yes**

Management Comments (exotics, roads, shape/size, position in landscape, hydrology, adjacent land use, cumulative effects, etc.): S**easonally perched water table, possibly from an aquatard created by Mazama ash (layer exposed in blowout dip within longitudinal dune nearby).**

Protection Comments (legal actions/steps/strategies needed to secure protection for the site): **Occurrence is within area of proposed land conveyance, Central Hanford.**

Additional Comments (discrepancies, general observations, etc.): **Central Hanford: Security badge required for access.**

APPENDIX C

Species observed within the proposed land conveyance, Hanford Site, 2013
Achillea millifolium
Achnatherum hymenoides
Agoseris heterophylla
Agoseris sp.
Ambrosia acanthicarpa
Amsinckia lycopsoides
Artemisia tridentata
Asperugo officanallis
Astragalus caricinus
Balsamorhiza careyana
Bromus tectorum
Cardaria pubescens
Carex douglasii
Centaurea repens
Chaenactis douglasii
Chenopodium leptophyllum
Chrondrilla juncea
Chrysothamnus viscidiflorus
Cleome lutea
Coldenia nuttallii
Comandra umbellatum
Convolvulus arvensis
Crepis atribarba
Cryptantha circumscissa
Crypthantha flaccida
Crypthantha pterocarya
Dalea ornata
Descurainia sophia
Digitaria sanguinalis
Draba verna
Elaeagnus angustifolia
Elymus lanceolatus
Elymus elymoides
Ericameria nauseosa
Erigeron pumilus
Eriogonum niveum
Eriogonum strictum ssp. proliferum var. anserinum
Eriogonum strictum ssp. proliferum var. proliferum

Eriogonum vimineum/baleyi
Erodium circinatum
Erysimum occidentale
Euphorbia glyptosperma
Filago arvensis
Gilia sinuata
Heliotropium curassavicum
Hesperostipa comata
Holosteum umbellatum
Hymenopappus filifolius
Juncus arcticus* var. *littoralis
Kochia scoparia
Lactuca serriola
Lagophylla ramosissima
Layia glandulosa
Lepidium perfoliatum
Leymus triticoides
Linaria dalmatica
Lomatium macrocarpum
Machaeranthera canescens
Mentzelia albicaulis
Nepeta cataria
Oenothera pallida
Opuntia x columbiana
Penstemon acuminatus
Phacelia hastata
Phacelia linearis
Plantago patagonica
Poa bulbosa
Poa secunda* ssp. *secunda
Poa secunda* ssp. *juncifolia
Pseudoroegneria spicata
Psoralea lanceolata
Pteryxia terebinthina
Purshia tridentata
Robinia pseudo-acacia
Rumex venosus
Salix exigua
Salsola tragus
Sisymbrium altissimum
Sonchus sp.

Sporobolus cryptandrus
Stephanomeria paniculata
Tragopogon dubius
Tribulus terrestris
Vulpia microstachys
Vulpia sp.

APPENDIX J – AIR EMISSIONS ESTIMATES

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J. APPENDIX J – AIR EMISSIONS ESTIMATES

J.1 INTRODUCTION

Appendix J is the raw output of the program used to estimate the air emissions from the Proposed Action. It is designed to show the technical factors and assumptions that run "under the hood." Pertinent details of the program have been summarized in the body of the environmental assessment as well as the paragraphs in **Sections J.2** and **J.3**.

J.2 CONSTRUCTION EMISSIONS ASSUMPTIONS

Because the exact footprint and design of each building to be constructed is not known, numerous assumptions were made in the air emission estimates to establish parameters for the analysis. The intent of these assumptions was to bracket the potential air impacts to show the upper bound scenario.

The key assumptions include the following:

- Only 1,341 acres would be disturbed by construction in 1 year (this is the size of the larger TRIDEC parcel).
- The proposed buildings would occupy 70 percent (939 acres); roadways, parking, and pavement 25 percent (335 acres); and landscaping and open space 5 percent (67 acres) of the 1,341-acre parcel. These are standard modeling parameters for air emissions analysis.
- Each building proposed to be constructed would be one story in height. Even though some representative facilities are shown to be multi-story, this simplification does not appreciably affect the air quality estimates because the amount of ground disturbance would not change based on the number of floors in each building.
- The 300-acre parcel would be disturbed during the construction of the solar site but no buildings and roadways would be constructed and no landscaping would occur at this area. Grading for the 300-acre solar site would take three months and construction of the solar site would take 1 year.
- Only 10 percent of the 539-acre PAAL parcel would be disturbed from the construction of utilities and infrastructure.

The following pages provide detailed background information on the air emissions estimated to be generated from construction activities.

Table J-1. Summary air emissions from construction on the 1,341-acre Parcel.

Air Emissions from Construction on the 1,341-acre Parcel

		NO_x (ton)	VOC (ton)	CO (ton)	SO_2 (ton)	PM_{10} (ton)	$PM_{2.5}$ (ton)	CO_2 (ton)
Each Construction Year	Combustion	500.716	43.983	218.694	39.910	35.442	34.379	57,175.102
	Fugitive Dust	-	-	-	-	1,991.385	199.139	-
	Haul Truck On-Road	67.972	6.328	36.332	0.218	2.182	2.073	17,622.489
	Construction Commuter	9.310	9.555	91.857	0.129	1.077	0.690	13,218.305
	Total	***577.997***	***59.867***	***346.883***	***40.257***	***2,030.087***	***236.281***	***88,015.896***

Note: Total $PM_{10/2.5}$ fugitive dust emissions are assuming USEPA 50% control efficiencies.

Each Construction Year CO_2 emissions converted to metric tons = ***79,830.42*** ***metric tons***

Summary
Estimated Emissions from Construction on the 1,341-acre Parcel

Table J-2. Combustion emissions from Construction on the 1,341-acre parcel.

Combustion Emissions

Combustion Emissions of VOC, NO_x, SO_2, CO, $PM_{2.5}$, PM_{10} and CO_2 due to Construction and Demolition

Construction on the 1,341-acre Parcel	Area Disturbed		
Total Building Construction Area	939 acres		
Total Roadway Construction Area	335 acres		
Total Landscaping or Open Space Area	67 acres	Total Disturbance Area:	1,341 acres

Summary of Parameters		
Total Building Construction Area:	40,889,772 ft^2	
	939 acres	
Total Demolition Area:	0 ft^2	
	0 acres	
New Roadway Construction Area:	14,603,490 ft^2	
	335 acres	
Total Disturbed Area:	58,413,960 ft^2	
	1,341 acres	
Construction Duration:	12 months	
Annual Construction Activity:	240 days	Assumes 4 weeks per month, 5 days per week of work.

Project Combustion
Estimated Emissions from Construction on the 1,341-acre Parcel

Table J-3. Emission factors used for construction equipment on the 1,341-acre parcel.

Emission Factors Used for Construction Equipment

References: Guide to Air Quality Assessment, SMAQMD, 2004; and U.S. EPA NONROAD Emissions Model, Version 2005.0.0
Emission factors are taken from the NONROAD model and were provided to HDR by Larry Landman of the Air Quality and Modeling Center (Landman.Larry@epamail.epa.gov) on 12/14/07. Factors provided are for the weighted average US fleet for CY2007.
Assumptions regarding the type and number of equipment are from SMAQMD Table 3-1 unless otherwise noted.

Grading

Equipment	No. Reqd.[a] per 10 acres	NO_x (lb/day)	VOC[b] (lb/day)	CO (lb/day)	SO_2[c] (lb/day)	PM_{10} (lb/day)	$PM_{2.5}$ (lb/day)	CO_2 (lb/day)
Bulldozer	1	13.597	0.957	5.502	1.017	0.895	0.868	1456.904
Motor Grader	1	9.689	0.726	3.203	0.797	0.655	0.635	1141.647
Water Truck	1	18.356	0.894	7.004	1.635	0.996	0.966	2342.975
Total per 10 acres of activity	3	41.641	2.577	15.710	3.449	2.546	2.469	4941.526

Paving

Equipment	No. Reqd.[a] per 10 acres	NO_x (lb/day)	VOC[b] (lb/day)	CO (lb/day)	SO_2[c] (lb/day)	PM_{10} (lb/day)	$PM_{2.5}$ (lb/day)	CO_2 (lb/day)
Paver	1	3.831	0.374	2.055	0.281	0.350	0.340	401.932
Roller	1	4.825	0.443	2.514	0.374	0.434	0.421	536.074
Truck	2	36.712	1.788	14.009	3.271	1.992	1.932	4685.951
Total per 10 acres of activity	4	45.367	2.606	18.578	3.926	2.776	2.693	5623.957

Demolition

Equipment	No. Reqd.[a] per 10 acres	NO_x (lb/day)	VOC[b] (lb/day)	CO (lb/day)	SO_2[c] (lb/day)	PM_{10} (lb/day)	$PM_{2.5}$ (lb/day)	CO_2 (lb/day)
Loader	1	13.452	0.992	5.579	0.949	0.927	0.899	1360.098
Haul Truck	1	18.356	0.894	7.004	1.635	0.996	0.966	2342.975
Total per 10 acres of activity	2	31.808	1.886	12.584	2.585	1.923	1.865	3703.074

Building Construction

Equipment[d]	No. Reqd.[a] per 10 acres	NO_x (lb/day)	VOC[b] (lb/day)	CO (lb/day)	SO_2[c] (lb/day)	PM_{10} (lb/day)	$PM_{2.5}$ (lb/day)	CO_2 (lb/day)
Stationary								
Generator Set	1	2.381	0.317	1.183	0.149	0.227	0.220	213.059
Industrial Saw	1	2.618	0.316	1.966	0.204	0.325	0.315	291.920
Welder	1	1.124	0.378	1.504	0.078	0.227	0.220	112.393
Mobile (non-road)								
Truck	1	18.356	0.894	7.004	1.635	0.996	0.966	2342.975
Forklift	1	5.342	0.560	3.332	0.399	0.554	0.537	572.235
Crane	1	9.575	0.665	2.393	0.651	0.500	0.485	931.929
Total per 10 acres of activity	6	39.396	3.130	17.382	3.116	2.829	2.744	4464.512

Note: Footnotes for tables are on following page

Project Combustion
Estimated Emissions from Construction on the 1,341-acre Parcel

Table J-3. Emission factors used for construction equipment on the 1,341-acre parcel (continued).

Architectural Coatings

Equipment	No. Reqd.[a] per 10 acres	NO_x (lb/day)	VOC[b] (lb/day)	CO (lb/day)	SO_2[c]	PM_{10} (lb/day)	$PM_{2.5}$ (lb/day)	CO_2 (lb/day)
Air Compressor	1	3.574	0.373	1.565	0.251	0.309	0.300	359.773
Total per 10 acres of activity	1	3.574	0.373	1.565	0.251	0.309	0.300	359.773

a) The SMAQMD 2004 guidance suggests a default equipment fleet for each activity, assuming 10 acres of that activity, (e.g., 10 acres of grading, 10 acres of paving, etc.). The default equipment fleet is increased for each 10 acre increment in the size of the construction project. That is, a 26 acre project would round to 30 acres and the fleet size would be three times the default fleet for a 10 acre project.
b) The SMAQMD 2004 reference lists emission factors for reactive organic gas (ROG). For the purposes of this worksheet ROG = VOC. The NONROAD model contains emissions factors for total HC and for VOC. The factors used here are the VOC factors.
c) The NONROAD emission factors assume that the average fuel burned in nonroad trucks is 1100 ppm sulfur. Trucks that would be used for the Proposed Action will all be fueled by highway grade diesel fuel which cannot exceed 500 ppm sulfur. These estimates therefore over-estimate SO2 emissions by more than a factor of two.
d) Typical equipment fleet for building construction was not itemized in SMAQMD 2004 guidance. The equipment list above was assumed based on SMAQMD 1994 guidance.

Project Combustion
Estimated Emissions from Construction on the 1,341-acre Parcel

Table J-4. Combustion emissions summary for Construction on the 1,341-acre parcel.

PROJECT-SPECIFIC EMISSION FACTOR SUMMARY

Source	Equipment Multiplier*	Project-Specific Emission Factors (lb/day) NO_x	VOC	CO	SO_2**	PM_{10}	$PM_{2.5}$	CO_2
Grading Equipment	134	5579.924	345.316	2105.127	462.214	341.099	330.866	662164.531
Paving Equipment	34	1542.488	88.594	631.667	133.475	94.387	91.556	191214.533
Demolition Equipment	1	31.808	1.886	12.584	2.585	1.923	1.865	3703.074
Building Construction	94	3703.254	294.202	1633.937	292.937	265.930	257.952	419664.097
Air Compressor for Architectural Coating	94	335.962	35.079	147.150	23.606	29.076	28.204	33818.696
Architectural Coating**			521.153					

*The equipment multiplier is an integer that represents units of 10 acres for purposes of estimating the number of equipment required for the project.

**Emission factor is from the evaporation of solvents during painting, per "Air Quality Thresholds of Significance", SMAQMD, 1994

Example: SMAQMD Emission Factor for Grading Equipment NOx = (Total Grading NOx per 10 acre)*(Equipment Multiplier)

Summary of Input Parameters

	Total Area (ft^2)	Total Area (acres)	Total Days	
Grading:	58,413,960	1,341.000	6	(from "Grading" worksheet)
Paving:	14,603,490	335.250	47	
Demolition:	0	0.000	0	
Building Construction:	40,889,772	938.700	240	
Architectural Coating	40,889,772	938.700	20	(per SMAQMD "Air Quality of Thresholds of Significance", 1994)

NOTE: The 'Total Days' estimate for paving is calculated by dividing the total number of acres by 0.21 acres/day, which is a factor derived from the 2005 MEANS Heavy Construction Cost Data, 19th Edition, for 'Asphaltic Concrete Pavement, Lots and Driveways - 6" stone base', which provides an estimate of square feet paved per day. There is also an estimate for 'Plain Cement Concrete Pavement', however the estimate for asphalt is used because it is more conservative. The 'Total 'Days' estimate for demolition is calculated by dividing the total number of acres by 0.02 acres/day, which is a factor also derived from the 2005 MEANS reference. This is calculated by averaging the demolition estimates from 'Building Demolition - Small Buildings, Concrete', assuming a height of 30 feet for a two-story building; from 'Building Footings and Foundations Demolition - 6" Thick, Plain Concrete'; and from 'Demolish, Remove Pavement and Curb - Concrete to 6" thick, rod reinforced'. The 'Total Days' estimate for building construction is assumed to be 240 days.

Total Project Emissions by Activity (lbs)

	NO_x	VOC	CO	SO_2	PM_{10}	$PM_{2.5}$	CO_2
Grading Equipment	33,479.547	2,071.897	12,630.759	2,773.287	2,046.594	1,985.196	3,972,987.183
Paving	72,451.556	4,161.332	29,669.751	6,269.405	4,433.426	4,300.423	8,981,459.093
Demolition	-	-	-	-	-	-	-
Building Construction	888,780.938	70,608.518	392,144.908	70,304.868	63,823.214	61,908.518	100,719,383.370
Architectural Coatings	6,719.238	11,124.636	2,942.997	472.117	581.522	564.077	676,373.924
Total Emissions (lbs):	**1,001,431.278**	**87,966.383**	**437,388.415**	**79,819.676**	**70,884.756**	**68,758.213**	**114,350,203.570**

Results: Total Project Annual Emission Rates

	NO_x	VOC	CO	SO_2	PM_{10}	$PM_{2.5}$	CO_2
Total Project Emissions (lbs)	1,001,431.278	87,966.383	437,388.415	79,819.676	70,884.756	68,758.213	114,350,203.570
Total Project Emissions (tons)	500.716	43.983	218.694	39.910	35.442	34.379	57,175.102

Project Combustion
Estimated Emissions from Construction on the 1,341-acre Parcel

Table J-5. Construction fugitive dust emissions on the 1,341-acre parcel.

Construction Fugitive Dust Emissions

Construction Fugitive Dust Emission Factors

	Emission Factor	Units	Source
Construction and Demolition Activities	0.190	ton PM_{10}/acre-month	MRI 1996; EPA 2001; EPA 2006
New Road Construction	0.420	ton PM_{10}/acre-month	MRI 1996; EPA 2001; EPA 2006
$PM_{2.5}$ Emissions			
$PM_{2.5}$ Multiplier	0.100	(10% of PM_{10} emissions assumed to be $PM_{2.5}$)	EPA 2001; EPA 2006
Control Efficiency	0.500	(assume 50% control efficiency for PM_{10} and $PM_{2.5}$ emissions)	EPA 2001; EPA 2006

New Roadway Construction (0.42 ton PM_{10}/acre-month)

Duration of Construction Project	12	months
Area	335	acres

General Construction and Demolition Activities (0.19 ton PM_{10}/acre-month)

Duration of Project	12	months
Area	1,006	acres

	Project Emissions (tons/year)			
	PM_{10} uncontrolled	PM_{10} controlled	$PM_{2.5}$ uncontrolled	$PM_{2.5}$ controlled
New Roadway Construction	1689.660	844.830	168.966	84.483
General Construction Activities	2293.110	1146.555	229.311	114.656
Total	**3982.770**	**1991.385**	**398.277**	**199.139**

Project Fugitive
Estimated Emissions from Construction on the 1,341-acre Parcel

Table J-6. Construction Fugitive Dust emission factors on the 1,341-acre parcel.

Construction Fugitive Dust Emission Factors

General Construction Activities Emission Factor

0.190 ton PM_{10}/acre-month Source: MRI 1996; EPA 2001; EPA 2006

The area-based emission factor for construction activities is based on a study completed by the Midwest Research Institute (MRI) Improvement of Specific Emission Factors (BACM Project No. 1), March 29, 1996. The MRI study evaluated seven construction projects in Nevada and California (Las Vegas, Coachella Valley, South Coast Air Basin, and the San Joaquin Valley). The study determined an average emission factor of 0.11 ton PM_{10}/acre-month for sites without large-scale cut/fill operations. A worst-case emission factor of 0.42 ton PM_{10}/acre-month was calculated for sites with active large-scale earth moving operations. The monthly emission factors are based on 168 work-hours per month (MRI 1996). A subsequent MRI Report in 1999, Estimating Particulate Matter Emissions From Construction Operations, calculated the 0.19 ton PM_{10}/acre-month emission factor by applying 25% of the large-scale earthmoving emission factor (0.42 ton PM_{10}/acre-month) and 75% of the average emission factor (0.11 ton PM_{10}/acre-month). The 0.19 ton PM_{10}/acre-month emission factor is referenced by the EPA for non-residential construction activities in recent procedures documents for the National Emission Inventory (EPA 2001; EPA 2006). The 0.19 ton PM_{10}/acre-month emission factor represents a refinement of EPA's original AP-42 area-based total suspended particulate (TSP) emission factor in Section 13.2.3 Heavy Construction Operations. In addition to the EPA, this methodology is also supported by the South Coast Air Quality Management District as well as the Western Regional Air Partnership (WRAP) which is funded by the EPA and is administered jointly by the Western Governor's Association and the National Tribal Environmental Council. The emission factor is assumed to encompass a variety of non-residential construction activities including building construction (commercial, industrial, institutional, governmental), public works, and travel on unpaved roads. The EPA National Emission Inventory documentation assumes that the emission factors are uncontrolled and recommends a control efficiency of 50% for PM_{10} and $PM_{2.5}$ in PM nonattainment areas.

New Road Construction Emission Factor

0.420 ton PM_{10}/acre-month Source: MRI 1996; EPA 2001; EPA 2006

The emission factor for new road construction is based on the worst-case conditions emission factor from the MRI 1996 study described above (0.42 tons PM_{10}/acre-month). It is assumed that road construction involves extensive earthmoving and heavy construction vehicle travel resulting in emissions that are higher than other general construction projects. The 0.42 ton PM10/acre-month emission factor for road construction is referenced in recent procedures documents for the EPA National Emission Inventory (EPA 2001; EPA 2006).

$PM_{2.5}$ Multiplier **0.100**

$PM_{2.5}$ emissions are estimated by applying a particle size multiplier of 0.10 to PM_{10} emissions. This methodology is consistent with the procedures documents for the National Emission Inventory (EPA 2006).

Control Efficiency for PM_{10} and $PM_{2.5}$ **0.500**

The EPA National Emission Inventory documentation recommends a control efficiency of 50% for PM_{10} and $PM_{2.5}$ in PM nonattainment areas (EPA 2006). Wetting controls will be applied during project construction.

References:

EPA 2001. *Procedures Document for National Emissions Inventory, Criteria Air Pollutants, 1985-1999.* EPA-454/R-01-006. Office of Air Quality Planning and Standards, United States Environmental Protection Agency. March 2001.

EPA 2006. *Documentation for the Final 2002 Nonpoint Sector (Feb 06 version) National Emission Inventory for Criteria and Hazardous Air Pollutants.* Prepared for: Emissions Inventory and Analysis Group (C339-02) Air Quality Assessment Division Office of Air Quality Planning and Standards, United States Environmental Protection Agency. July 2006.

MRI 1996. *Improvement of Specific Emission Factors (BACM Project No. 1).* Midwest Research Institute (MRI). Prepared for the California South Coast Air Quality Management District, March 29, 1996.

Project Fugitive
Estimated Emissions from Construction on the 1,341-acre Parcel

Table J-7. Haul truck emissions for Construction on the 1,341-acre parcel.

Haul Truck Emissions

Emissions from hauling construction supplies are estimated in this spreadsheet.

Emission Estimation Method:
United States Air Force (USAF). 2009. *Air Emission Factor Guide to Air Force Mobile Sources. Methods for Estimating Emissions of Air Pollutants For Mobile Sources at U.S. Air Force Installations.* December 2009.

Assumptions:
Haul trucks carry 20 cubic yards of material per trip.
The average distance from the project site to the materials source is 15 miles; therefore, a haul truck will travel 30 miles round trip.
Estimated number of trips required by haul trucks = total amount of material/20 cubic yards per truck
Assumes soil would not need to be hauled to or from the site.

Amount of Building Materials = 6,057,744 cubic yards — Assumes 4 cubic feet of building material are needed per square foot of building sp
Amount of Paving Material = 540,870 cubic yards — Assumes 1 cubic foot of pavement material is needed per square foot of new paver

Number of trucks required = 329,931 heavy duty diesel haul truck trips
Miles per trip = 30 miles

Heavy Duty Diesel Vehicle (HDDV) Average Emission Factors (grams/mile)

	NO_x	VOC	CO	SO_2	PM_{10}	$PM_{2.5}$	CO_2
HDDV	6.23	0.58	3.33	0.02	0.20	0.19	1615.20

Notes:
Assumes Haul Trucks are Class 8b (HDDV8b; >60,000 lbs Gross Vehicle Weight)
The project site is located at a low altitude (<5,000 feet above sea level)
Construction assumed to occur in Calendar Year 2015, and construction vehicles are assumed to be on average 10 years old (Model Year 2005).
Emission factors for all pollutants are from USAF 2009, Appendix A, On-Road Vehicle Emission Factors, electronic pages 458-464.

HDDV Haul Truck Emissions

	NO_x	VOC	CO	SO_2	PM_{10}	$PM_{2.5}$	CO_2
lbs	135943.668	12656.072	72663.309	436.416	4364.163	4145.955	35244977.952
tons	67.972	6.328	36.332	0.218	2.182	2.073	17622.489

Example Calculation: NO_x emissions (lbs) = 30 miles per trip * 5,021 trips * NO_x emission factor (g/mile) * lb/453.6 g

Haul Truck On-Road
Estimated Emissions from Construction on the 1,341-acre Parcel

Table J-8. Construction commuter emissions for the 1,341-acre parcel.

Construction Commuter Emissions

Emissions from construction workers commuting to the job site are estimated in this spreadsheet.

Emission Estimation Method: Emission factors from the South Coast Air Quality Management District (SCAQMD) EMFAC 2007 (v 2.3) Model (on-road) were used. These emission factors are available online at http://www.aqmd.gov/ceqa/handbook/onroad/onroad.html.

Assumptions:
Passenger vehicle emission factors for scenario year 2012 are used.

The average roundtrip commute for a construction worker =	40	miles
Number of construction days =	240	days
Number of construction workers (daily) =	2500	people

Passenger Vehicle Emission Factors for Year 2012 (lbs/mile)

NO_x	VOC	CO	SO_2	PM_{10}	$PM_{2.5}$	CO_2
0.00078	0.00080	0.00765	0.00001	0.00009	0.00006	1.10153

Source: South Coast Air Quality Management District. EMFAC 2007 (ver 2.3) On-Road Emissions Factors. Last updated April 24, 2008. Available online: <http://www.aqmd.gov/ceqa/handbook/onroad/onroad.html>. Accessed 16 November 2011.
Notes:
The SMAQMD 2007 reference lists emission factors for reactive organic gas (ROG). For purposes of this worksheet ROG = VOC.

Construction Commuter Emissions

	NO_x	VOC	CO	SO_2	PM_{10}	$PM_{2.5}$	CO_2
lbs	18619.880	19110.689	183713.919	257.473	2154.998	1379.896	26436609.488
tons	9.310	9.555	91.857	0.129	1.077	0.690	13218.305

Example Calculation: NO_x emissions (lbs) = 40 miles/day * NO_x emission factor (lb/mile) * number of construction days * number of workers

Construction Commuter
Estimated Emissions from Construction on the 1,341-acre Parcel

Table J-9. Summary of air emissions from construction on the 300-acre parcel.

Air Emissions from Construction on the 300-acre Parcel

		NO_x (ton)	VOC (ton)	CO (ton)	SO_2 (ton)	PM_{10} (ton)	$PM_{2.5}$ (ton)	CO_2 (ton)
Each Construction Year	Combustion	3.748	0.232	1.414	0.310	0.229	0.222	444.737
	Fugitive Dust	-	-	-	-	85.500	8.550	-
	Haul Truck On-Road	-	-	-	-	-	-	-
	Construction Commuter	0.372	0.382	3.674	0.005	0.043	0.028	528.732
	Total	***4.120***	***0.614***	***5.088***	***0.316***	***85.772***	***8.800***	***973.470***

Note: Total $PM_{10/2.5}$ fugitive dust emissions are assuming USEPA 50% control efficiencies.

Each Construction Year CO_2 emissions converted to metric tons = ***882.94*** ***metric tons***

Summary
Estimated Emissions from Construction on the 300-acre Parcel

Table J-10. Combustion emissions from construction on the 300-acre parcel.

Combustion Emissions

Combustion Emissions of VOC, NO_x, SO_2, CO, $PM_{2.5}$, PM_{10} and CO_2 due to Construction and Demolition

Construction on the 300-acre Parcel	**Area Disturbed**
Total Land Disturbance for the solar array	300 acres

Summary of Parameters per Year			
Total Building Construction Area per Year:	0	ft^2	
	0	acres	
Total Demolition Area per Year:	0	ft^2	
	0	acres	
New Roadway Construction Area per Year:	0	ft^2	
	0	acres	
Total Disturbed Area per Year:	13,068,000	ft^2	
	300	acres	
Construction Duration:	12	months	
Annual Construction Activity:	240	days	Assumes 4 weeks per month, 5 days per week of work

Project Combustion
Estimated Emissions from Construction on the 300-acre Parcel

Table J-11. Emission factors used for construction equipment on the 300-acre parcel.

Emission Factors Used for Construction Equipment

References: Guide to Air Quality Assessment, SMAQMD, 2004; and U.S. EPA NONROAD Emissions Model, Version 2005.0.0
Emission factors are taken from the NONROAD model and were provided to HDR by Larry Landman of the Air Quality and Modeling Center (Landman.Larry@epamail.epa.gov) on 12/14/07. Factors provided are for the weighted average US fleet for CY2007.
Assumptions regarding the type and number of equipment are from SMAQMD Table 3-1 unless otherwise noted.

Grading

Equipment	No. Reqd.[a] per 10 acres	NO_x (lb/day)	VOC[b] (lb/day)	CO (lb/day)	SO_2[c] (lb/day)	PM_{10} (lb/day)	$PM_{2.5}$ (lb/day)	CO_2 (lb/day)
Bulldozer	1	13.597	0.957	5.502	1.017	0.895	0.868	1456.904
Motor Grader	1	9.689	0.726	3.203	0.797	0.655	0.635	1141.647
Water Truck	1	18.356	0.894	7.004	1.635	0.996	0.966	2342.975
Total per 10 acres of activity	3	41.641	2.577	15.710	3.449	2.546	2.469	4941.526

Paving

Equipment	No. Reqd.[a] per 10 acres	NO_x (lb/day)	VOC[b] (lb/day)	CO (lb/day)	SO_2[c] (lb/day)	PM_{10} (lb/day)	$PM_{2.5}$ (lb/day)	CO_2 (lb/day)
Paver	1	3.831	0.374	2.055	0.281	0.350	0.340	401.932
Roller	1	4.825	0.443	2.514	0.374	0.434	0.421	536.074
Truck	2	36.712	1.788	14.009	3.271	1.992	1.932	4685.951
Total per 10 acres of activity	4	45.367	2.606	18.578	3.926	2.776	2.693	5623.957

Demolition

Equipment	No. Reqd.[a] per 10 acres	NO_x (lb/day)	VOC[b] (lb/day)	CO (lb/day)	SO_2[c] (lb/day)	PM_{10} (lb/day)	$PM_{2.5}$ (lb/day)	CO_2 (lb/day)
Loader	1	13.452	0.992	5.579	0.949	0.927	0.899	1360.098
Haul Truck	1	18.356	0.894	7.004	1.635	0.996	0.966	2342.975
Total per 10 acres of activity	2	31.808	1.886	12.584	2.585	1.923	1.865	3703.074

Building Construction

Equipment[d]	No. Reqd.[a] per 10 acres	NO_x (lb/day)	VOC[b] (lb/day)	CO (lb/day)	SO_2[c] (lb/day)	PM_{10} (lb/day)	$PM_{2.5}$ (lb/day)	CO_2 (lb/day)
Stationary								
Generator Set	1	2.381	0.317	1.183	0.149	0.227	0.220	213.059
Industrial Saw	1	2.618	0.316	1.966	0.204	0.325	0.315	291.920
Welder	1	1.124	0.378	1.504	0.078	0.227	0.220	112.393
Mobile (non-road)								
Truck	1	18.356	0.894	7.004	1.635	0.996	0.966	2342.975
Forklift	1	5.342	0.560	3.332	0.399	0.554	0.537	572.235
Crane	1	9.575	0.665	2.393	0.651	0.500	0.485	931.929
Total per 10 acres of activity	6	39.396	3.130	17.382	3.116	2.829	2.744	4464.512

Note: Footnotes for tables are on following page

Project Combustion
Estimated Emissions from Construction on the 300-acre Parcel

Table J-11. Emission factors used for construction equipment on the 300-acre parcel (continued).

Architectural Coatings

Equipment	No. Reqd.[a] per 10 acres	NO_x (lb/day)	VOC[b] (lb/day)	CO (lb/day)	SO_2[c]	PM_{10} (lb/day)	$PM_{2.5}$ (lb/day)	CO_2 (lb/day)
Air Compressor	1	3.574	0.373	1.565	0.251	0.309	0.300	359.773
Total per 10 acres of activity	1	3.574	0.373	1.565	0.251	0.309	0.300	359.773

a) The SMAQMD 2004 guidance suggests a default equipment fleet for each activity, assuming 10 acres of that activity, (e.g., 10 acres of grading, 10 acres of paving, etc.). The default equipment fleet is increased for each 10 acre increment in the size of the construction project. That is, a 26 acre project would round to 30 acres and the fleet size would be three times the default fleet for a 10 acre project.

b) The SMAQMD 2004 reference lists emission factors for reactive organic gas (ROG). For the purposes of this worksheet ROG = VOC. The NONROAD model contains emissions factors for total HC and for VOC. The factors used here are the VOC factors.

c) The NONROAD emission factors assume that the average fuel burned in nonroad trucks is 1100 ppm sulfur. Trucks that would be used for the Proposed Action will all be fueled by highway grade diesel fuel which cannot exceed 500 ppm sulfur. These estimates therefore over-estimate SO2 emissions by more than a factor of two.

d) Typical equipment fleet for building construction was not itemized in SMAQMD 2004 guidance. The equipment list above was assumed based on SMAQMD 1994 guidance.

Project Combustion
Estimated Emissions from Construction on the 1,341-acre Parcel

Table J-12. Combustion emissions summary for construction on the 300-acre parcel.

PROJECT-SPECIFIC EMISSION FACTOR SUMMARY

Source	Equipment Multiplier*	Project-Specific Emission Factors (lb/day)						
		NO_x	VOC	CO	SO_2**	PM_{10}	$PM_{2.5}$	CO_2
Grading Equipment	30	1249.237	77.310	471.297	103.481	76.365	74.074	148245.790
Paving Equipment	1	45.367	2.606	18.578	3.926	2.776	2.693	5623.957
Demolition Equipment	1	31.808	1.886	12.584	2.585	1.923	1.865	3703.074
Building Construction	1	39.396	3.130	17.382	3.116	2.829	2.744	4464.512
Air Compressor for Architectural Coating	1	3.574	0.373	1.565	0.251	0.309	0.300	359.773
Architectural Coating**			0.000					

*The equipment multiplier is an integer that represents units of 10 acres for purposes of estimating the number of equipment required for the project.

**Emission factor is from the evaporation of solvents during painting, per "Air Quality Thresholds of Significance", SMAQMD, 1994

Example: SMAQMD Emission Factor for Grading Equipment NOx = (Total Grading NOx per 10 acre)*(Equipment Multiplier)

Summary of Input Parameters

	Total Area (ft^2)	Total Area (acres)	Total Days	
Grading:	13,068,000	300.000	6	(from "Grading" worksheet)
Paving:	0	0.000	0	
Demolition:	0	0.000	0	
Building Construction:	0	0.000	0	
Architectural Coating	0	0.000	0	(per SMAQMD "Air Quality of Thresholds of Significance", 1994)

NOTE: The 'Total Days' estimate for paving is calculated by dividing the total number of acres by 0.21 acres/day, which is a factor derived from the 2005 MEANS Heavy Construction Cost Data, 19th Edition, for 'Asphaltic Concrete Pavement, Lots and Driveways - 6" stone base', which provides an estimate of square feet paved per day. There is also an estimate for 'Plain Cement Concrete Pavement', however the estimate for asphalt is used because it is more conservative. The 'Total 'Days' estimate for demolition is calculated by dividing the total number of acres by 0.02 acres/day, which is a factor also derived from the 2005 MEANS reference. This is calculated by averaging the demolition estimates from 'Building Demolition - Small Buildings, Concrete', assuming a height of 30 feet for a two-story building; from 'Building Footings and Foundations Demolition - 6" Thick, Plain Concrete'; and from 'Demolish, Remove Pavement and Curb - Concrete to 6" thick, rod reinforced'. The 'Total Days' estimate for building construction is assumed to be 240 days.

Total Project Emissions by Activity (lbs)

	NO_x	VOC	CO	SO_2	PM_{10}	$PM_{2.5}$	CO_2
Grading Equipment	7,495.421	463.858	2,827.782	620.885	458.193	444.447	889,474.742
Paving	-	-	-	-	-	-	-
Demolition	-	-	-	-	-	-	-
Building Construction	-	-	-	-	-	-	-
Architectural Coatings	-	-	-	-	-	-	-
Total Emissions (lbs):	**7,495.421**	**463.858**	**2,827.782**	**620.885**	**458.193**	**444.447**	**889,474.742**

Results: Total Project Annual Emission Rates

	NO_x	VOC	CO	SO_2	PM_{10}	$PM_{2.5}$	CO_2
Total Project Emissions (lbs)	7,495.421	463.858	2,827.782	620.885	458.193	444.447	889,474.742
Total Project Emissions (tons)	3.748	0.232	1.414	0.310	0.229	0.222	444.737

Project Combustion
Estimated Emissions from Construction on the 300-acre Parcel

Table J-13. Construction fugitive dust emissions on the 300-acre parcel.

Construction Fugitive Dust Emissions

Construction Fugitive Dust Emission Factors

	Emission Factor	Units	Source
Construction and Demolition Activities	0.190	ton PM_{10}/acre-month	MRI 1996; EPA 2001; EPA 2006
New Road Construction	0.420	ton PM_{10}/acre-month	MRI 1996; EPA 2001; EPA 2006
$PM_{2.5}$ Emissions			
$PM_{2.5}$ Multiplier	0.100	(10% of PM_{10} emissions assumed to be $PM_{2.5}$)	EPA 2001; EPA 2006
Control Efficiency	0.500	(assume 50% control efficiency for PM_{10} and $PM_{2.5}$ emissions)	EPA 2001; EPA 2006

New Roadway Construction (0.42 ton PM_{10}/acre-month)

Duration of Construction Project	3	months
Area	0.000	acres

General Construction and Demolition Activities (0.19 ton PM_{10}/acre-month)

Duration of Project	3	months
Area	300.000	acres

	Project Emissions (tons/year)			
	PM_{10} uncontrolled	**PM_{10} controlled**	**$PM_{2.5}$ uncontrolled**	**$PM_{2.5}$ controlled**
New Roadway Construction	0.000	0.000	0.000	0.000
General Construction Activities	171.000	85.500	17.100	8.550
Total	**171.000**	**85.500**	**17.100**	**8.550**

Project Fugitive
Estimated Emissions from Construction on the 300-acre Parcel

Table J-14. Construction fugitive dust emission factors on the 300-acre parcel.

Construction Fugitive Dust Emission Factors

General Construction Activities Emission Factor

0.190 ton PM_{10}/acre-month Source: MRI 1996; EPA 2001; EPA 2006

The area-based emission factor for construction activities is based on a study completed by the Midwest Research Institute (MRI) Improvement of Specific Emission Factors (BACM Project No. 1), March 29, 1996. The MRI study evaluated seven construction projects in Nevada and California (Las Vegas, Coachella Valley, South Coast Air Basin, and the San Joaquin Valley). The study determined an average emission factor of 0.11 ton PM_{10}/acre-month for sites without large-scale cut/fill operations. A worst-case emission factor of 0.42 ton PM_{10}/acre-month was calculated for sites with active large-scale earth moving operations. The monthly emission factors are based on 168 work-hours per month (MRI 1996). A subsequent MRI Report in 1999, Estimating Particulate Matter Emissions From Construction Operations, calculated the 0.19 ton PM_{10}/acre-month emission factor by applying 25% of the large-scale earthmoving emission factor (0.42 ton PM_{10}/acre-month) and 75% of the average emission factor (0.11 ton PM_{10}/acre-month). The 0.19 ton PM_{10}/acre-month emission factor is referenced by the EPA for non-residential construction activities in recent procedures documents for the National Emission Inventory (EPA 2001; EPA 2006). The 0.19 ton PM_{10}/acre-month emission factor represents a refinement of EPA's original AP-42 area-based total suspended particulate (TSP) emission factor in Section 13.2.3 Heavy Construction Operations. In addition to the EPA, this methodology is also supported by the South Coast Air Quality Management District as well as the Western Regional Air Partnership (WRAP) which is funded by the EPA and is administered jointly by the Western Governor's Association and the National Tribal Environmental Council. The emission factor is assumed to encompass a variety of non-residential construction activities including building construction (commercial, industrial, institutional, governmental), public works, and travel on unpaved roads. The EPA National Emission Inventory documentation assumes that the emission factors are uncontrolled and recommends a control efficiency of 50% for PM_{10} and $PM_{2.5}$ in PM nonattainment areas.

New Road Construction Emission Factor

0.420 ton PM_{10}/acre-month Source: MRI 1996; EPA 2001; EPA 2006

The emission factor for new road construction is based on the worst-case conditions emission factor from the MRI 1996 study described above (0.42 tons PM_{10}/acre-month). It is assumed that road construction involves extensive earthmoving and heavy construction vehicle travel resulting in emissions that are higher than other general construction projects. The 0.42 ton PM10/acre-month emission factor for road construction is referenced in recent procedures documents for the EPA National Emission Inventory (EPA 2001; EPA 2006).

$PM_{2.5}$ Multiplier 0.100

$PM_{2.5}$ emissions are estimated by applying a particle size multiplier of 0.10 to PM_{10} emissions. This methodology is consistent with the procedures documents for the National Emission Inventory (EPA 2006).

Control Efficiency for PM_{10} and $PM_{2.5}$ 0.500

The EPA National Emission Inventory documentation recommends a control efficiency of 50% for PM_{10} and $PM_{2.5}$ in PM nonattainment areas (EPA 2006). Wetting controls will be applied during project construction.

References:

EPA 2001. *Procedures Document for National Emissions Inventory, Criteria Air Pollutants, 1985-1999.* EPA-454/R-01-006. Office of Air Quality Planning and Standards, United States Environmental Protection Agency. March 2001.

EPA 2006. *Documentation for the Final 2002 Nonpoint Sector (Feb 06 version) National Emission Inventory for Criteria and Hazardous Air Pollutants.* Prepared for: Emissions Inventory and Analysis Group (C339-02) Air Quality Assessment Division Office of Air Quality Planning and Standards, United States Environmental Protection Agency. July 2006.

MRI 1996. *Improvement of Specific Emission Factors (BACM Project No. 1).* Midwest Research Institute (MRI). Prepared for the California South Coast Air Quality Management District, March 29, 1996.

Project Fugitive
Estimated Emissions from Construction on the 300-acre Parcel

Table J-15. Haul truck emissions for the 300-acre parcel.

Haul Truck Emissions

Emissions from hauling construction supplies are estimated in this spreadsheet.

Emission Estimation Method:
United States Air Force (USAF). 2009. *Air Emission Factor Guide to Air Force Mobile Sources. Methods for Estimating Emissions of Air Pollutants For Mobile Sources at U.S. Air Force Installations.* December 2009.

Assumptions:
Haul trucks carry 20 cubic yards of material per trip.
The average distance from the project site to the materials source is 15 miles; therefore, a haul truck will travel 30 miles round trip.
Estimated number of trips required by haul trucks = total amount of material/20 cubic yards per truck
Assumes soil would not need to be hauled to or from the site.

Amount of Building Materials =	0 cubic yards	Assumes 4 cubic feet of building material are needed per square foot of building space
Amount of Paving Material =	0 cubic yards	Assumes 1 cubic foot of pavement material is needed per square foot of new pavement
Number of trucks required =	0 heavy duty diesel haul truck trips	
Miles per trip =	30 miles	

Heavy Duty Diesel Vehicle (HDDV) Average Emission Factors (grams/mile)

	NO_x	VOC	CO	SO_2	PM_{10}	$PM_{2.5}$	CO_2
HDDV	6.23	0.58	3.33	0.02	0.20	0.19	1615.20

Notes:
Assumes Haul Trucks are Class 8b (HDDV8b; >60,000 lbs Gross Vehicle Weight)
The project site is located at a low altitude (<5,000 feet above sea level)
Construction assumed to occur in Calendar Year 2015, and construction vehicles are assumed to be on average 10 years old (Model Year 2005).
Emission factors for all pollutants are from USAF 2009, Appendix A, On-Road Vehicle Emission Factors, electronic pages 458-464.

HDDV Haul Truck Emissions

	NO_x	VOC	CO	SO_2	PM_{10}	$PM_{2.5}$	CO_2
lbs	0.000	0.000	0.000	0.000	0.000	0.000	0.000
tons	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Example Calculation: NO_x emissions (lbs) = 30 miles per trip * 5,021 trips * NO_x emission factor (g/mile) * lb/453.6 g

Haul Truck On-Road
Estimated Emissions from Construction on the 300-acre Parcel

Table J-16. Construction commuter emissions for the 300-acre parcel.

Construction Commuter Emissions

Emissions from construction workers commuting to the job site are estimated in this spreadsheet.

Emission Estimation Method: Emission factors from the South Coast Air Quality Management District (SCAQMD) EMFAC 2007 (v 2.3) Model (on-road) were used. These emission factors are available online at http://www.aqmd.gov/ceqa/handbook/onroad/onroad.html.

Assumptions:
Passenger vehicle emission factors for scenario year 2012 are used.

The average roundtrip commute for a construction worker =	40	miles
Number of construction days =	240	days
Number of construction workers (daily) =	100	people

Passenger Vehicle Emission Factors for Year 2012 (lbs/mile)

NO_x	VOC	CO	SO_2	PM_{10}	$PM_{2.5}$	CO_2
0.00078	0.00080	0.00765	0.00001	0.00009	0.00006	1.10153

Source: South Coast Air Quality Management District. EMFAC 2007 (ver 2.3) On-Road Emissions Factors. Last updated April 24, 2008. Available online: <http://www.aqmd.gov/ceqa/handbook/onroad/onroad.html>. Accessed 16 November 2011.
Notes:
The SMAQMD 2007 reference lists emission factors for reactive organic gas (ROG). For purposes of this worksheet ROG = VOC.

Construction Commuter Emissions

	NO_x	VOC	CO	SO_2	PM_{10}	$PM_{2.5}$	CO_2
lbs	**744.795**	**764.428**	**7348.557**	**10.299**	**86.200**	**55.196**	**1057464.380**
tons	**0.372**	**0.382**	**3.674**	**0.005**	**0.043**	**0.028**	**528.732**

Example Calculation: NO_x emissions (lbs) = 40 miles/day * NO_x emission factor (lb/mile) * number of construction days * number of workers

Construction Commuter
Estimated Emissions from Construction on the 300-acre Parcel

Table J-17. Summary of air emissions from construction on the 539-acre PAAL parcel.

Air Emissions from Construction of Infrastructure and Utilties on the PAAL

		NO_x (ton)	VOC (ton)	CO (ton)	SO_2 (ton)	PM_{10} (ton)	$PM_{2.5}$ (ton)	CO_2 (ton)
Each Construction Year	Combustion	0.625	0.039	0.236	0.052	0.038	0.037	74.123
	Fugitive Dust	-	-	-	-	61.446	6.145	-
	Haul Truck On-Road	1.792	0.167	0.958	0.006	0.058	0.055	464.470
	Construction Commuter	0.745	0.764	7.349	0.010	0.086	0.055	1,057.464
	Total	***3.161***	***0.970***	***8.542***	***0.068***	***61.628***	***6.291***	***1,596.057***

Note: Total $PM_{10}/_{2.5}$ fugitive dust emissions are assuming USEPA 50% control efficiencies.

Each Construction Year CO_2 emissions converted to metric tons = ***1,447.62*** ***metric tons***

Summary
Estimated Emissions from Construction of Infrastructure and Utilties on the PAAL

Table J-18. Combustion emissions from construction on the 539-acre PAAL parcel.

Combustion Emissions

Combustion Emissions of VOC, NO_x, SO_2, CO, $PM_{2.5}$, PM_{10} and CO_2 due to Construction and Demolition

	Area Disturbed		
Construction of utilities and infrastructure on the PAAL	54	acres	Assumes 10% of the PAAL would be distrubed by construction.
Summary of Parameters			
Total Building Construction Area:	0	ft^2	
	0	acres	
Total Demolition Area:	0	ft^2	
	0	acres	
New Roadway Construction Area:	0	ft^2	
	0	acres	
Total Disturbed Area:	2,347,884	ft^2	
	54	acres	
Construction Duration:	12	months	
Annual Construction Activity:	240	days	Assumes 4 weeks per month, 5 days per week of work.

Project Combustion
Estimated Emissions from Construction of Infrastructure and Utilities on the PAAL

Table J-19. Emission factors used for construction equipment on the 539-acre PAAL parcel.

Emission Factors Used for Construction Equipment

References: Guide to Air Quality Assessment, SMAQMD, 2004; and U.S. EPA NONROAD Emissions Model, Version 2005.0.0
Emission factors are taken from the NONROAD model and were provided to HDR by Larry Landman of the Air Quality and Modeling Center (Landman.Larry@epamail.epa.gov) on 12/14/07. Factors provided are for the weighted average US fleet for CY2007.
Assumptions regarding the type and number of equipment are from SMAQMD Table 3-1 unless otherwise noted.

Grading

Equipment	No. Reqd.[a] per 10 acres	NO_x (lb/day)	VOC[b] (lb/day)	CO (lb/day)	SO_2[c] (lb/day)	PM_{10} (lb/day)	$PM_{2.5}$ (lb/day)	CO_2 (lb/day)
Bulldozer	1	13.597	0.957	5.502	1.017	0.895	0.868	1456.904
Motor Grader	1	9.689	0.726	3.203	0.797	0.655	0.635	1141.647
Water Truck	1	18.356	0.894	7.004	1.635	0.996	0.966	2342.975
Total per 10 acres of activity	3	41.641	2.577	15.710	3.449	2.546	2.469	4941.526

Paving

Equipment	No. Reqd.[a] per 10 acres	NO_x (lb/day)	VOC[b] (lb/day)	CO (lb/day)	SO_2[c] (lb/day)	PM_{10} (lb/day)	$PM_{2.5}$ (lb/day)	CO_2 (lb/day)
Paver	1	3.831	0.374	2.055	0.281	0.350	0.340	401.932
Roller	1	4.825	0.443	2.514	0.374	0.434	0.421	536.074
Truck	2	36.712	1.788	14.009	3.271	1.992	1.932	4685.951
Total per 10 acres of activity	4	45.367	2.606	18.578	3.926	2.776	2.693	5623.957

Demolition

Equipment	No. Reqd.[a] per 10 acres	NO_x (lb/day)	VOC[b] (lb/day)	CO (lb/day)	SO_2[c] (lb/day)	PM_{10} (lb/day)	$PM_{2.5}$ (lb/day)	CO_2 (lb/day)
Loader	1	13.452	0.992	5.579	0.949	0.927	0.899	1360.098
Haul Truck	1	18.356	0.894	7.004	1.635	0.996	0.966	2342.975
Total per 10 acres of activity	2	31.808	1.886	12.584	2.585	1.923	1.865	3703.074

Building Construction

Equipment[d]	No. Reqd.[a] per 10 acres	NO_x (lb/day)	VOC[b] (lb/day)	CO (lb/day)	SO_2[c] (lb/day)	PM_{10} (lb/day)	$PM_{2.5}$ (lb/day)	CO_2 (lb/day)
Stationary								
Generator Set	1	2.381	0.317	1.183	0.149	0.227	0.220	213.059
Industrial Saw	1	2.618	0.316	1.966	0.204	0.325	0.315	291.920
Welder	1	1.124	0.378	1.504	0.078	0.227	0.220	112.393
Mobile (non-road)								
Truck	1	18.356	0.894	7.004	1.635	0.996	0.966	2342.975
Forklift	1	5.342	0.560	3.332	0.399	0.554	0.537	572.235
Crane	1	9.575	0.665	2.393	0.651	0.500	0.485	931.929
Total per 10 acres of activity	6	39.396	3.130	17.382	3.116	2.829	2.744	4464.512

Note: Footnotes for tables are on following page

Project Combustion
Estimated Emissions from Construction of Infrastructure and Utities on the PAAL

Table J-19. Emission factors used for construction equipment on the 539-acre PAAL parcel (continued).

Architectural Coatings

Equipment	No. Reqd.[a] per 10 acres	NO_x (lb/day)	VOC[b] (lb/day)	CO (lb/day)	SO_2[c]	PM_{10} (lb/day)	$PM_{2.5}$ (lb/day)	CO_2 (lb/day)
Air Compressor	1	3.574	0.373	1.565	0.251	0.309	0.300	359.773
Total per 10 acres of activity	1	3.574	0.373	1.565	0.251	0.309	0.300	359.773

a) The SMAQMD 2004 guidance suggests a default equipment fleet for each activity, assuming 10 acres of that activity, (e.g., 10 acres of grading, 10 acres of paving, etc.). The default equipment fleet is increased for each 10 acre increment in the size of the construction project. That is, a 26 acre project would round to 30 acres and the fleet size would be three times the default fleet for a 10 acre project.

b) The SMAQMD 2004 reference lists emission factors for reactive organic gas (ROG). For the purposes of this worksheet ROG = VOC. The NONROAD model contains emissions factors for total HC and for VOC. The factors used here are the VOC factors.

c) The NONROAD emission factors assume that the average fuel burned in nonroad trucks is 1100 ppm sulfur. Trucks that would be used for the Proposed Action will all be fueled by highway grade diesel fuel which cannot exceed 500 ppm sulfur. These estimates therefore over-estimate SO2 emissions by more than a factor of two.

d) Typical equipment fleet for building construction was not itemized in SMAQMD 2004 guidance. The equipment list above was assumed based on SMAQMD 1994 guidance.

Project Combustion
Estimated Emissions from Construction of Infrastructure and Utilities on the PAAL

Table J-20. Combustion emissions summary for construction on the 539-acre PAAL parcel.

PROJECT-SPECIFIC EMISSION FACTOR SUMMARY

Source	Equipment Multiplier*	Project-Specific Emission Factors (lb/day)						
		NO_x	VOC	CO	SO_2**	PM_{10}	$PM_{2.5}$	CO_2
Grading Equipment	5	208.206	12.885	78.549	17.247	12.728	12.346	24707.632
Paving Equipment	1	45.367	2.606	18.578	3.926	2.776	2.693	5623.957
Demolition Equipment	1	31.808	1.886	12.584	2.585	1.923	1.865	3703.074
Building Construction	1	39.396	3.130	17.382	3.116	2.829	2.744	4464.512
Air Compressor for Architectural Coating	1	3.574	0.373	1.565	0.251	0.309	0.300	359.773
Architectural Coating**			0.000					

*The equipment multiplier is an integer that represents units of 10 acres for purposes of estimating the number of equipment required for the project.

**Emission factor is from the evaporation of solvents during painting, per "Air Quality Thresholds of Significance", SMAQMD, 1994

Example: SMAQMD Emission Factor for Grading Equipment NOx = (Total Grading NOx per 10 acre)*(Equipment Multiplier)

Summary of Input Parameters

	Total Area (ft^2)	Total Area (acres)	Total Days	
Grading:	2,347,884	53.900	6	(from "Grading" worksheet)
Paving:	0	0.000	0	
Demolition:	0	0.000	0	
Building Construction:	0	0.000	0	
Architectural Coating	0	0.000	0	(per SMAQMD "Air Quality of Thresholds of Significance", 1994)

NOTE: The 'Total Days' estimate for paving is calculated by dividing the total number of acres by 0.21 acres/day, which is a factor derived from the 2005 MEANS Heavy Construction Cost Data, 19th Edition, for 'Asphaltic Concrete Pavement, Lots and Driveways - 6" stone base', which provides an estimate of square feet paved per day. There is also an estimate for 'Plain Cement Concrete Pavement', however the estimate for asphalt is used because it is more conservative. The 'Total 'Days' estimate for demolition is calculated by dividing the total number of acres by 0.02 acres/day, which is a factor also derived from the 2005 MEANS reference. This is calculated by averaging the demolition estimates from 'Building Demolition - Small Buildings, Concrete', assuming a height of 30 feet for a two-story building; from 'Building Footings and Foundations Demolition - 6" Thick, Plain Concrete'; and from 'Demolish, Remove Pavement and Curb - Concrete to 6" thick, rod reinforced'. The 'Total Days' estimate for building construction is assumed to be 240 days.

Total Project Emissions by Activity (lbs)

	NO_x	VOC	CO	SO_2	PM_{10}	$PM_{2.5}$	CO_2
Grading Equipment	1,249.237	77.310	471.297	103.481	76.365	74.074	148,245.790
Paving	-	-	-	-	-	-	-
Demolition	-	-	-	-	-	-	-
Building Construction	-	-	-	-	-	-	-
Architectural Coatings	-	-	-	-	-	-	-
Total Emissions (lbs):	**1,249.237**	**77.310**	**471.297**	**103.481**	**76.365**	**74.074**	**148,245.790**

Results: Total Project Annual Emission Rates

	NO_x	VOC	CO	SO_2	PM_{10}	$PM_{2.5}$	CO_2
Total Project Emissions (lbs)	1,249.237	77.310	471.297	103.481	76.365	74.074	148,245.790
Total Project Emissions (tons)	0.625	0.039	0.236	0.052	0.038	0.037	74.123

Project Combustion
Estimated Emissions from Construction of Infrastructure and Utilities on the PAAL

Table J-21. Construction fugitive dust emissions on the 539-acre PAAL parcel.

Construction Fugitive Dust Emissions

Construction Fugitive Dust Emission Factors

	Emission Factor	Units	Source
Construction and Demolition Activities	0.190	ton PM_{10}/acre-month	MRI 1996; EPA 2001; EPA 2006
New Road Construction	0.420	ton PM_{10}/acre-month	MRI 1996; EPA 2001; EPA 2006
$PM_{2.5}$ Emissions			
$PM_{2.5}$ Multiplier	0.100	(10% of PM_{10} emissions assumed to be $PM_{2.5}$)	EPA 2001; EPA 2006
Control Efficiency	0.500	(assume 50% control efficiency for PM_{10} and $PM_{2.5}$ emissions)	EPA 2001; EPA 2006

New Roadway Construction (0.42 ton PM_{10}/acre-month)

Duration of Construction Project 12 months
Area 0 acres

General Construction and Demolition Activities (0.19 ton PM_{10}/acre-month)

Duration of Project 12 months
Area 54 acres

	Project Emissions (tons/year)			
	PM_{10} uncontrolled	PM_{10} controlled	$PM_{2.5}$ uncontrolled	$PM_{2.5}$ controlled
New Roadway Construction	0.000	0.000	0.000	0.000
General Construction Activities	122.892	61.446	12.289	6.145
Total	**122.892**	**61.446**	**12.289**	**6.145**

Project Fugitive
Estimated Emissions from Construction of Infrastructure and Utilities on the PAAL

Table J-22. Construction fugitive dust emission factors on the 539-acre PAAL parcel.

Construction Fugitive Dust Emission Factors

General Construction Activities Emission Factor

0.190 ton PM_{10}/acre-month Source: MRI 1996; EPA 2001; EPA 2006

The area-based emission factor for construction activities is based on a study completed by the Midwest Research Institute (MRI) Improvement of Specific Emission Factors (BACM Project No. 1), March 29, 1996. The MRI study evaluated seven construction projects in Nevada and California (Las Vegas, Coachella Valley, South Coast Air Basin, and the San Joaquin Valley). The study determined an average emission factor of 0.11 ton PM_{10}/acre-month for sites without large-scale cut/fill operations. A worst-case emission factor of 0.42 ton PM_{10}/acre-month was calculated for sites with active large-scale earth moving operations. The monthly emission factors are based on 168 work-hours per month (MRI 1996). A subsequent MRI Report in 1999, Estimating Particulate Matter Emissions From Construction Operations, calculated the 0.19 ton PM_{10}/acre-month emission factor by applying 25% of the large-scale earthmoving emission factor (0.42 ton PM_{10}/acre-month) and 75% of the average emission factor (0.11 ton PM_{10}/acre-month). The 0.19 ton PM_{10}/acre-month emission factor is referenced by the EPA for non-residential construction activities in recent procedures documents for the National Emission Inventory (EPA 2001; EPA 2006). The 0.19 ton PM_{10}/acre-month emission factor represents a refinement of EPA's original AP-42 area-based total suspended particulate (TSP) emission factor in Section 13.2.3 Heavy Construction Operations. In addition to the EPA, this methodology is also supported by the South Coast Air Quality Management District as well as the Western Regional Air Partnership (WRAP) which is funded by the EPA and is administered jointly by the Western Governor's Association and the National Tribal Environmental Council. The emission factor is assumed to encompass a variety of non-residential construction activities including building construction (commercial, industrial, institutional, governmental), public works, and travel on unpaved roads. The EPA National Emission Inventory documentation assumes that the emission factors are uncontrolled and recommends a control efficiency of 50% for PM_{10} and $PM_{2.5}$ in PM nonattainment areas.

New Road Construction Emission Factor

0.420 ton PM_{10}/acre-month Source: MRI 1996; EPA 2001; EPA 2006

The emission factor for new road construction is based on the worst-case conditions emission factor from the MRI 1996 study described above (0.42 tons PM_{10}/acre-month). It is assumed that road construction involves extensive earthmoving and heavy construction vehicle travel resulting in emissions that are higher than other general construction projects. The 0.42 ton PM10/acre-month emission factor for road construction is referenced in recent procedures documents for the EPA National Emission Inventory (EPA 2001; EPA 2006).

$PM_{2.5}$ Multiplier **0.100**

$PM_{2.5}$ emissions are estimated by applying a particle size multiplier of 0.10 to PM_{10} emissions. This methodology is consistent with the procedures documents for the National Emission Inventory (EPA 2006).

Control Efficiency for PM_{10} and $PM_{2.5}$ **0.500**

The EPA National Emission Inventory documentation recommends a control efficiency of 50% for PM_{10} and $PM_{2.5}$ in PM nonattainment areas (EPA 2006). Wetting controls will be applied during project construction.

References:

EPA 2001. *Procedures Document for National Emissions Inventory, Criteria Air Pollutants, 1985-1999.* EPA-454/R-01-006. Office of Air Quality Planning and Standards, United States Environmental Protection Agency. March 2001.

EPA 2006. *Documentation for the Final 2002 Nonpoint Sector (Feb 06 version) National Emission Inventory for Criteria and Hazardous Air Pollutants.* Prepared for: Emissions Inventory and Analysis Group (C339-02) Air Quality Assessment Division Office of Air Quality Planning and Standards, United States Environmental Protection Agency. July 2006.

MRI 1996. *Improvement of Specific Emission Factors (BACM Project No. 1).* Midwest Research Institute (MRI). Prepared for the California South Coast Air Quality Management District, March 29, 1996.

Project Fugitive
Estimated Emissions from Construction of Infrastructure and Utilities on the PAAL

Table J-23. Haul truck emissions for the 539-acre PAAL parcel.

Haul Truck Emissions

Emissions from hauling construction supplies are estimated in this spreadsheet.

Emission Estimation Method:
United States Air Force (USAF). 2009. *Air Emission Factor Guide to Air Force Mobile Sources. Methods for Estimating Emissions of Air Pollutants For Mobile Sources at U.S. Air Force Installations.* December 2009.

Assumptions:
Haul trucks carry 20 cubic yards of material per trip.
The average distance from the project site to the materials source is 15 miles; therefore, a haul truck will travel 30 miles round trip.
Estimated number of trips required by haul trucks = total amount of material/20 cubic yards per truck.
Assumes soil would not need to be hauled to or from the site.

Amount of Building Materials = 173,917 cubic yards   Assumes 2 cubic feet of building material are needed per square foot of utility disturbance

Number of trucks required = 8,696 heavy duty diesel haul truck trips
Miles per trip = 30 miles

Heavy Duty Diesel Vehicle (HDDV) Average Emission Factors (grams/mile)

	NO_x	VOC	CO	SO_2	PM_{10}	$PM_{2.5}$	CO_2
HDDV	6.23	0.58	3.33	0.02	0.20	0.19	1615.20

Notes:
Assumes Haul Trucks are Class 8b (HDDV8b; >60,000 lbs Gross Vehicle Weight)
The project site is located at a low altitude (<5,000 feet above sea level)
Construction assumed to occur in Calendar Year 2015, and construction vehicles are assumed to be on average 10 years old (Model Year 2005).
Emission factors for all pollutants are from USAF 2009, Appendix A, On-Road Vehicle Emission Factors, electronic pages 458-464.

HDDV Haul Truck Emissions

	NO_x	VOC	CO	SO_2	PM_{10}	$PM_{2.5}$	CO_2
lbs	3583.019	333.572	1915.161	11.502	115.025	109.273	928939.407
tons	1.792	0.167	0.958	0.006	0.058	0.055	464.470

Example Calculation: NO_x emissions (lbs) = 30 miles per trip * 5,021 trips * NO_x emission factor (g/mile) * lb/453.6 g

Haul Truck On-Road
Estimated Emissions from Construction of Infrastructure and Utilities on the PAAL

Table J-24. Construction commuter emissions for the 539-acre PAAL parcel.

Construction Commuter Emissions

Emissions from construction workers commuting to the job site are estimated in this spreadsheet.

Emission Estimation Method: Emission factors from the South Coast Air Quality Management District (SCAQMD) EMFAC 2007 (v 2.3) Model (on-road) were used. These emission factors are available online at http://www.aqmd.gov/ceqa/handbook/onroad/onroad.html.

Assumptions:
Passenger vehicle emission factors for scenario year 2012 are used.

The average roundtrip commute for a construction worker =	40	miles
Number of construction days =	240	days
Number of construction workers (daily) =	200	people

Passenger Vehicle Emission Factors for Year 2012 (lbs/mile)

NO_x	VOC	CO	SO_2	PM_{10}	$PM_{2.5}$	CO_2
0.00078	0.00080	0.00765	0.00001	0.00009	0.00006	1.10153

Source: South Coast Air Quality Management District. EMFAC 2007 (ver 2.3) On-Road Emissions Factors. Last updated April 24, 2008. Available online: <http://www.aqmd.gov/ceqa/handbook/onroad/onroad.html>. Accessed 16 November 2011.
Notes:
The SMAQMD 2007 reference lists emission factors for reactive organic gas (ROG). For purposes of this worksheet ROG = VOC.

Construction Commuter Emissions

	NO_x	VOC	CO	SO_2	PM_{10}	$PM_{2.5}$	CO_2
lbs	1489.590	1528.855	14697.113	20.598	172.400	110.392	2114928.759
tons	0.745	0.764	7.349	0.010	0.086	0.055	1057.464

Example Calculation: NO_x emissions (lbs) = 40 miles/day * NO_x emission factor (lb/mile) * number of construction days * number of workers

Construction Commuter
Estimated Emissions from Construction of Infrastructure and Utilities on the PAAL

J.3 OPERATIONAL EMISSIONS ASSUMPTIONS

Because the specific types of development and industries that would occupy the proposed land conveyance area are not known at this time, it is difficult to make accurate estimates on the amount of air emissions that would be produced from the operation of the proposed future development. Key variables, such as the square footage of the building space to be heated, the number and capacity of the emergency electrical generators, the types of industry-specific manufacturing equipment used onsite, and the number of staff to commute to work by vehicle, are unknown and won't be known until well into the facility planning process. Therefore, numerous simplifying assumptions were developed and used in this air emissions estimate to establish parameters for the analysis. The key assumptions used include those listed below.

For building heating:

- Natural gas-fired boilers would provide heating to all buildings.
- Each building would be one story in height. Total interior building space would measure 939 acres or 40,902,840 square feet. All interior building space would be heated.
- On average, heating would consume 35 cubic feet of natural gas per square foot of building space annually. The actual amount of natural gas consumed would vary based on daily weather conditions and the types of industries that could occupy the proposed buildings. (By comparison, office spaces use approximately 32 cubic feet of natural gas annually; warehouses use approximately 20 cubic feet of natural gas annually; and industrial facilities use highly variable amounts of natural gas depending on the industrial subsector [TXU Energy 2013].) Generally, the types of industries proposed would not use large quantities of natural gas.

For the emergency electrical generators:

- A total of 50 emergency generators would be installed.
- Each emergency generator would have 500 kilowatts of electrical output.
- Each generator would be used for 150 hours per year.

For truck traffic:

- The number of truck trips per day is 250.
- Trucks would travel 100 miles on average per trip.
- Trucks would travel on 240 days per year.

For employee commuter emissions:

- A total of 4,000 personnel would work at the proposed buildings. Each employee would travel 30 miles roundtrip, each day, for 240 days per year.

Operational emissions are only from the main Focused Study Area because no operational air emissions are expected from the 300-acre solar array parcel. The following pages provide detailed background information on the air emissions estimated to be generated from operational activities.

Table J-25. Summary of air emissions from the proposed operational activities.

Air Emissions from the Proposed Operational Activities

		NO_x (ton)	VOC (ton)	CO (ton)	SO_2 (ton)	PM_{10} (ton)	$PM_{2.5}$ (ton)	CO_2 (ton)
Each Operational Year	Boiler	71.580	3.937	60.127	0.429	5.440	5.440	85,895.964
	Diesel Generator	94.110	7.682	20.273	6.189	6.615	6.615	3,499.787
	Truck Traffic	41.204	3.836	22.024	0.132	1.323	1.257	10,682.540
	Employee Commuter	11.172	11.466	110.228	0.154	1.293	0.828	15,861.966
	Total	***218.066***	***26.922***	***212.652***	***6.905***	***14.671***	***14.140***	***115,940.256***

Note: Total $PM_{10/2.5}$ fugitive dust emissions are assuming USEPA 50% control efficiencies.

Each Operational Year CO_2 emissions converted to metric tons = ***105,157.81*** ***metric tons***

Summary
Estimated Emissions for the Proposed Action

Table J-26. Calculated emissions from the operation of natural gas-fired boilers.

Calculates Emissions from the Operation of Natural Gas-Fired Boilers:

Assumptions:

35	cubic feet of natural gas are required annually per square foot
40,902,840	square feet are to be heated (assumes all building space)
1,431,599,400	cubic feet of natural gas would be burned each year
1,431.599400	million cubic feet (mmft3) of natural gas would be burned each year under normal operating conditons

Pollutant	Emission Factor	Units	Potential Annual Emissions (lb/yr)	Conversion to Tons	Estimated Annual Emissions (tons/yr)
SO2	0.6	lb/mmft3	858.96	0.0005	0.429
PM	7.6	lb/mmft3	10,880.16	0.0005	5.440
NOx	100	lb/mmft3	143,159.94	0.0005	71.580
CO	84	lb/mmft3	120,254.35	0.0005	60.127
CO2	120,000	lb/mmft3	171,791,928.00	0.0005	85895.964
VOC	5.5	lb/mmft3	7,873.80	0.0005	3.937

Source: EPA 1998. AP-42. *Emission Factors for Natural Gas Combustion*. Table 1.4-1 and Table 1.4-2. Pages 1.4-5 and 1.4-6

Assumption: Uncontrolled (Small Boilers <100 MMBtu/hr) for NOx

Boiler Emissions
Estimated Emissions from the Proposed Action

Table J-27. Calculated air emissions from an emergency generator.

Calculates Air Emissions from an Emergency Generator

Assumptions:
Number of Generators: 50
Generator Power Rating: 500 kilowatts
Generator Fuel: Diesel

Generator Kilowatts		Conversion from kW to Btu/hr	Engine Btu/hr (Assume 30% efficiency converting mechanical to electrical power)	Engine MMBtu/hr
500		3414.4	5,690,710	5.69

Diesel Industrial Engine Emission Factors from AP-42, Section 3.3	NOx	CO	TOC	PM-10	SO_2	CO_2
	lb/MMBtu	lb/MMBtu	lb/MMBtu	lb/MMBtu	lb/MMBtu	lb/MMBtu
Emission Factor	4.41	0.95	0.36	0.31	0.29	164

Source: EPA 1996. AP-42. Emission Factors for Uncontrolled Gasoline and Diesel Industrial Engines. Table 3.3-1. Page 3.3-6.

Assume max. 150 hrs/yr	NOx	CO	TOC	PM-10	SO_2	CO_2
	(lbs/yr)	(lbs/yr)	(lbs/yr)	(lbs/yr)	(lbs/yr)	(lbs/yr)
Emissions (lbs/yr)	188,220.23	40,546.31	15,364.92	13,230.90	12,377.29	6,999,573.10

	NOx	CO	TOC	PM-10	SO_2	CO_2
	(tons/yr)	(tons/yr)	(tons/yr)	(tons/yr)	(tons/yr)	(tons/yr)
Emissions (tons/yr)	**94.110**	**20.273**	**7.682**	**6.615**	**6.189**	**3499.787**

Total Organic Compounds (TOCs) have been used in place of VOCs for this anaylsis

Diesel Generator
Estimated Emissions for the Proposed Action

Table J-28. Truck traffic emissions.

Truck Traffic Emissions

Emissions from truck traffic associated with the various industries are estimated in this spreadsheet.

Emission Estimation Method:
United States Air Force (USAF). 2009. *Air Emission Factor Guide to Air Force Mobile Sources. Methods for Estimating Emissions of Air Pollutants For Mobile Sources at U.S. Air Force Installations*. December 2009.

Assumptions:

Number of truck trips associated with the proposed industries per day=	250	
Number of truck trips per year =	60,000	Assumes 240 days of work per year
Average distance driven by a truck per trip =	100	miles
Total miles per year =	6,000,000	

Heavy Duty Diesel Vehicle (HDDV) Average Emission Factors (grams/mile)

	NO_x	VOC	CO	SO_2	PM_{10}	$PM_{2.5}$	CO_2
HDDV	6.23	0.58	3.33	0.02	0.20	0.19	1615.20

Notes:
Assumes Haul Trucks are Class 8b (HDDV8b; >60,000 lbs Gross Vehicle Weight)
The project site is located at a low altitude (<5,000 feet above sea level)
Emission factors for all pollutants are from USAF 2009, Appendix A, On-Road Vehicle Emission Factors, electronic pages 458-464.

HDDV Haul Truck Emissions

	NO_x	VOC	CO	SO_2	PM_{10}	$PM_{2.5}$	CO_2
lbs	82407.407	7671.958	44047.619	264.550	2645.503	2513.228	21365079.365
tons	41.204	3.836	22.024	0.132	1.323	1.257	10682.540

Truck Traffic
Estimated Emissions for the Proposed Action

Table J-29. Commuter emissions.

Commuter Emissions

Emissions from workers commuting to the job site are estimated in this spreadsheet.

Emission Estimation Method: Emission factors from the South Coast Air Quality Management District (SCAQMD) EMFAC 2007 (v 2.3) Model (on-road) were used. These emission factors are available online at http://www.aqmd.gov/ceqa/handbook/onroad/onroad.html.

Assumptions:
Passenger vehicle emission factors for scenario year 2012 are used.

The average roundtrip commute for a worker =	30	miles
Number of work days =	240	days
Number of workers (daily) =	4000	people

Passenger Vehicle Emission Factors for Year 2012 (lbs/mile)

NO_x	VOC	CO	SO_2	PM_{10}	$PM_{2.5}$	CO_2
0.00078	0.00080	0.00765	0.00001	0.00009	0.00006	1.10153

Source: South Coast Air Quality Management District. EMFAC 2007 (ver 2.3) On-Road Emissions Factors. Last updated April 24, 2008. Available online: <http://www.aqmd.gov/ceqa/handbook/onroad/onroad.html>. Accessed 16 November 2011.
Notes:
The SMAQMD 2007 reference lists emission factors for reactive organic gas (ROG). For purposes of this worksheet ROG = VOC.

Commuter Emissions

	NO_x	VOC	CO	SO_2	PM_{10}	$PM_{2.5}$	CO_2
lbs	22343.857	22932.827	220456.702	308.968	2585.998	1655.875	31723931.385
tons	11.172	11.466	110.228	0.154	1.293	0.828	15861.966

New Employee Commuter Emissions
Estimated Emissions for the Proposed Action

J.4 REFERENCES

EPA 1996. AP-42. Emission Factors for Uncontrolled Gasoline and Diesel Industrial Engines. Table 3.3-1. Page 3.3-6.

EPA 1998. AP-42. Emission Factors for Natural Gas Combustion. Table 1.4-1 and Table 1.4-2. Pages 1.4-5 and 1.4-6.

EPA 2001. *Procedures Document for National Emissions Inventory, Criteria Air Pollutants, 1985-1999,* EPA-454/R-01-006, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, March. Available online: http://www.epa.gov/ttn/chief/trends/procedures/neiproc_99.pdf (accessed February 15, 2015).

EPA 2005. NONROAD Emissions Model, Version 2005.0.0, U.S. Environmental Protection Agency. Available online: http://www.epa.gov/otaq/nonrdmdl.htm (accessed February 15, 2015).

EPA 2006. *Documentation for the Final 2002 Nonpoint Sector (Feb 06 Version) National Emission Inventory for Criteria and Hazardous Air Pollutants,* Prepared for: Emissions Inventory and Analysis Group (C339-02) Air Quality Assessment Division Office of Air Quality Planning and Standards, United States Environmental Protection Agency, July. Available online: http://www.epa.gov/ttnchie1/net/2002inventory.html (accessed February 15, 2015).

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TXU Energy 2013. Managing Energy Costs in Warehouses.

USAF 2009. *Air Emission Factor Guide to Air Force Mobile Sources, Methods for Estimating Emissions of Air Pollutants For Mobile Sources at U.S. Air Force Installations*, U.S. Air Force, December. Available online: http://aqhelp.com/Documents/Air%20Emissions%20Factor%20Guide%20to%20Air%20Force%20Stationary%20Sources%20%20-%20December%202009.pdf (accessed February 15, 2015).

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