DOE/EA-1339

Final Environmental Assessment for Waste Disposition Activities at the Paducah Site
Paducah, Kentucky

FINDING OF NO SIGNIFICANT IMPACT
WASTE DISPOSITION ACTIVITIES AT THE
PADUCAH SITE
PADUCAH, KENTUCKY

AGENCY: U.S. DEPARTMENT OF ENERGY

ACTION: FINDING OF NO SIGNIFICANT IMPACT

SUMMARY: The U.S. Department of Energy (DOE) has completed an environmental assessment (DOE/EA-1339), which is incorporated herein by reference, for proposed disposition of polychlorinated biphenyl (PCB) wastes, low-level radioactive waste (LLW), mixed low-level radioactive waste (MLLW), and transuranic (TRU) waste from the Paducah Gaseous Diffusion Plant Site (Paducah Site) in Paducah, Kentucky. All of the wastes would be transported for disposal at various locations in the United States. Based on the results of the impact analysis reported in the EA, DOE has determined that the proposed action is not a major federal action that would significantly affect the quality of the human environment with in the context of the National Environmental Policy Act of 1969 (NEPA). Therefore, preparation of an environmental impact statement is not necessary, and DOE is issuing this Finding of No Significant Impact (FONSI).

PUBLIC AVAILABILITY OF EA AND FONSI: The EA and FONSI may be reviewed at and copies of the document obtained from:

Gary Bodenstein, NEPA Document Manager
U.S. Department of Energy
5600 Hobbs Road
West Paducah, KY 42001
(270) 441-6831

Paducah Public Library
555 Washington Street
Paducah, KY 42001

FURTHER INFORMATION ON THE NEPA PROCESS: For further information on the NEPA process, contact

David R. Allen, NEPA Compliance Officer
U.S. Department of Energy
200 Administration Road
Oak Ridge, TN 37831
(865) 576-0411

BACKGROUND: DOE must continue to manage (i.e., treat, store, and dispose) and control its wastes safely, efficiently, and cost effectively in compliance with applicable federal and state laws while protecting public health and the environment. The wastes considered in the assessment are limited to DOE's ongoing and legacy non-CERCLA waste management operations at the Paducah Site. These wastes include LLW, MLLW, and TRU waste, as well as materials stored in DOE Material Storage Area

(DMSAs). Also included is storage of USEC program wastes, which are characterized as one or more of these waste types. Wastes not covered in this EA are those associated with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) activities, including decontamination and decommissioning activities, and disposition of wastes associated with USEC operational activities. The cumulative impacts section of the EA does take these wastes into consideration.

The assessment is intended to supplement and update the previous NEPA evaluation of waste disposition activities conducted as part of the final Waste Management Programmatic Environmental Impact Statement (WM-PEIS) for radioactive and hazardous waste. This assessment expands the scope of previous analyses to include possible transportation to commercial facilities.

DOE's proposed action includes waste disposition activities such as storage, on-site treatment, waste transport to off-site treatment and disposal facilities, waste management supporting activities, and DMSA waste characterization. The following table summarizes the proposed action:

Activity	Proposed Action
Storage	Storage at the Paducah Site until scheduled for treatment, disposal, or transport from the Paducah Site. Existing facilities would be used for waste storage. Applies to all wastes evaluated.
On-Site Treatment	On-site treatment would be conducted in existing facilities and treatment technologies are neutralization, solidification, carbon adsorption, and photocatalytic conversion. Applies to approximately 200 m^3 (7060 ft^3) of the 11,000 m^3 (390,000 ft^3) volume of wastes.
Waste Transport	Transport to off-site treatment and disposal facilities by truck, rail or intermodal carrier. Representative receiving locations include: Andrews, Texas; Deer Park, Texas; Hanford, Washington; Clive, Utah; Mercury, Nevada; Oak Ridge, Tennessee; Atomic City, Idaho, and Calsbad New Mexico.
Waste Management Supporting Activities	Supporting activities include waste staging, on-site waste movement, packaging, repackaging, sorting, volume reduction, waste container decontamination, inspection, labeling, characterization, facility modifications and/or upgrades, and others as necessary for waste management and maintenance.
DMSA Waste Characterization	Nuclear Criticality Safety (NCS) characterization in addition to standard waste management operations. Based upon the completion of the NCS characterization, standard waste management supporting activities would commence.

The impact analysis in the EA addressed the potential effects of storing all legacy and newly generated wastes on site, on site treatment of a subset of wastes (approximately 200m^3), waste handling, and transporting accumulated legacy and ongoing operations wastes from Paducah to destinations representative of other DOE sites and licensed commercial treatment/disposal facilities. The potential effects of transport over both highway and rail routes were evaluated. Evaluations of waste generation were estimated based on volumes anticipated over a 10 year life cycle. On-site treatment technologies are limited by the Paducah Site RCRA Part B permit. RCRA-permitted on-site treatment technologies include sedimentation, precipitation, oxidation, reduction, neutralization, and cementation/solidification. Of these treatment processes only neutralization, stabilization, carbon adsorption, and photocatalytic conversion are applicable to waste types included in the analysis. Building C-752-A is evaluated as the on-site treatment facility.

ALTERNATIVES: In addition to the proposed action, impacts were also evaluted for two alternatives 1) no action alternative and 2) enhanced storage.

No Action Alternative - In the No Action alternative (i.e., long-term storage), DOE would not perform disposition activities except for those needed for waste management and maintenance. No disposal of the existing and projected quantities of various wastes discussed under the proposed action would occur. Because existing storage space would be rapidly exhausted, new facilities would have to be constructed on-site to store newly generated wastes and some legacy wastes that cannot remain in outside storage. On-site treatment would be performed on wastes that require some type of stabilization prior to storage. Any on-site waste treatment requiring indoor processing would occur in Bldg. C-752-A or another suitable location. Relatively small volumes of waste would continue to be shipped to DOE or commercial facilities under existing categorical exclusions (CXs). As these CXs expire, no new ones would be placed, and the waste would then be stored on-site.

Enhanced Storage Alternative – The Enhanced Storage alternative (i.e., fortified, long-term storage) was added to the analysis as a result of public comments on the EA. This alternative is identical to the No Action alternative with the exception that storage facilities would be constructed for resistance to disasters (such as earthquakes and fires). No disposal of the existing and projected quantities of various wastes discussed under the proposed action would occur. Because existing storage space does not meet enhanced storage definitions, new facilities would have to be constructed on-site to store wastes.

ENVIRONMENTAL IMPACTS

PROPOSED ACTION

Radiological Risks

Radiological consequences for on-site treatment of waste - Detailed analysis of radiological impacts to the public and to workers resulting from on-site treatment of waste was performed in the EA. The analysis indicated that impacts are not notable for the entire treatment process or for individual waste stream groups.

Radiological Impacts from normal Truck Transportation - The potential effects of transporting waste by highway from Paducah to each of the potential final destination sites were evaluated on an annual basis during the major shipment year groupings and on a total 10-year shipping campaign basis. Truck shipments to receiving facilities were evaluated for the probability of a latent cancer fatality (LCF) to the truck crew, the general population, and the MEI. It turns out that the worst-case results for the truck crew, general population, and MEI all occur during the shipment to Mercury, Nevada. However, all values were calculated to be less than 1 (largest value being 2.4×10^{-2} for the crew), so risks to these receptors are considered negligible.

Radiological Impacts from normal Rail Transportation – The potential radiological effects of routinely transporting LLW, MLLW, and TRU waste by rail from Paducah to each of the potential final destination sites were estimated for all waste subgroups on an annual basis during the major shipment year groupings and on a total 10-year shipping campaign basis. Rail shipments were evaluated for the probability of an

LCF to the train crew, the general population, and the MEI. It turns out that the worst-case results for truck crew, general population, and MEI all occur during the shipment to Mercury, Nevada. However, all values were calculated to be less than 1 (largest value being 4.1×10^{-2} for the population), so risks to these receptors are considered negligible.

Nonradiological Risks. During the normal operations of the proposed action, it is estimated that the wastes are stored and monitored, transported to waste treatment locations on-site, and prepared for transportation off-site. It is estimated that these activities require 60 full-time equivalents or 120,000 person-h/year over the 10-year duration. Based on the 3.4×10^{-3}/200,000 person-h industrial fatality rate, 2.0×10^{-3} fatalities/year or 2.0×10^{-2} fatalities/ 10 years are expected as a result of industrial accidents.

Accident Analysis.

Handling Mishap - The computations for analyzing the vehicle mishap/mishandling accident evaluated the risks (expected fatalities) resulting from rupturing the ThF_4 drum or any of the 24 drums containing TRU waste. This analysis took into account the estimated accident frequency and the probability that the damaged drum would be either the ThF_4 drum or 1 of the 24 TRU waste drums out of a total of 56,000 drums. The results of the computations showed that the risk of the vehicle mishap/mishandling accident is negligible but slightly greater than for the EBE.

In addition to releases of radionuclides during a vehicle impact/mishandling accident, it is also possible that a PCB-containing transformer could be ruptured with ensuing combustion of the PCB oil. Concentrations of HCl and PCB soot arising from a PCB fire were calculated and compared to benchmarks. Neither the calculated HCl nor PCB soot occurs in concentrations that would create adverse health effects to the MUW or MEI.

Evaluation Basis earthquake (EBE) – In the event of a major earthquake, the horizontal ground acceleration is estimated to be capable of creating differential movement between the top and bottom box layers, resulting in drums being toppled into the aisles. Two source terms were considered during the risk computations: the airborne source term (AST) in which radioactivity is released to, and dispersed by, the air; and the liquid source term (LST) in which radiologically contaminated liquids are released to, and dispersed by, surface water. In summary, the computed risks (expected fatalities) from radiological dose resulting from an EBE accident are negligible. Effects of exposure to toxic metals were also considered. No toxic metals are known to be in the liquid waste streams being considered in this EA. Therefore, only the AST was considered. The results of the computations demonstrate that the concentration of toxic metals in the AST resulting from an EBE would be negligible compared to the most conservative benchmark for human exposure.

Vehicle-Related Impacts **–** Potential vehicle-related impacts, including expected accidents, expected fatalities from accidents, and impacts from vehicle emissions were evaluated. Impacts from vehicle-related accidents and emissions were highest for the Mercury (Nevada Test Site), Nevada, and Clive (Envirocare), Utah, destinations because of the larger number of shipments and the total miles traveled to and from these destinations. However, vehicle-related impacts for these locations are calculated to be minimal. In addition, the radiological dose resulting from these accidents was calculated and the risk of LCFs to the general public were also calculated. The worst-case calculated number is far less than 1 LCF (1.5×10^{-3}) for shipment to Mercury, Nevada. For the entire waste transportation campaign, the calculated value is still less than 1 latent cancer fatality (2.5×10^{-3}).

Rail-Related Impacts **–** Potential rail-related impacts, including expected accidents, expected fatalities from accidents, and impacts from vehicle emissions were evaluated. Impacts from rail-related accidents and emissions are highest for the Mercury (Nevada Test Site), Nevada, and Clive (Envirocare), Utah, destinations because of the larger number of shipments and the total miles traveled to and from these destinations. However, all calculated values are much less than 1, indicating negligible impacts from rail-related accidents. In addition, the radiological dose resulting from these accidents was calculated and the risks of LCFs to the general public were also calculated. The worst-case calculated number is far less than 1 latent cancer fatality (1.6×10^{-3}) for shipment to Mercury, Nevada. For the entire waste transportation campaign, the calculated value is still less than 1 LCF (2.8×10^{-3}). Calculated population risk for rail transportation is equivalent to that for transportation by truck

Ecological resources.

Aquatic Biota **–** Under normal operations, impacts to aquatic biota from the proposed action should be negligible. Long-term impacts to aquatic biota would be beneficial after implementation of the proposed action, because much of the on-site waste would be removed reducing the amount stored on-site. The reasonable worst-case accident (earthquake) scenario involving radionuclides is unlikely to cause harm to aquatic biota in the Ohio River as a result of exposure to radionuclides. However, aquatic receptors in Bayou and Little Bayou creeks and other water conveyances by which the waste would reach the Ohio River would suffer minor impacts resulting from the caustic nature of the waste. Accident impacts analysis to aquatic biota from the reasonable worst-case accident scenario (earthquake) involving nonradionuclides indicated that PCBs are the only constituents whose ratio of concentration to toxicity benchmark (2.08) exceeds 1, indicating that PCBs could pose minor, short-term adverse impacts to aquatic biota in Bayou and Little Bayou creeks.

Terrestrial Biota **-** Short-term impacts to terrestrial biota from normal operations of the proposed activity should be negligible because the repackaging and on-site maintenance of wastes should not result in the release of constituents at concentrations that would be harmful to the biota. The accident scenario for chronic radionuclide exposure indicates that in this worst-case accident scenario (earthquake), long-term radiation effects to soil biota would be negligible. Two organics (PCBs and 1,2,4-trichlorobenzene) and two inorganics (cadmium and chromium) have modeled concentrations that would likely pose minor adverse impacts to soil biota if the worst-case spill accident occurred. However, these impacts would be reduced by the use of mitigative controls such as dikes, spill control measures, and expeditious cleanup.

Threatened and Endangered Species **–** Mussels including the orange-footed pimpleback (*Plethobasus cooperianus*), pink mucket pearly mussel (*Lampsilis arbrupta),* ring pink (*Obovaria retusa*), fat pocketbook (*Potamilis capax*), as well as the Indiana bat (*Myotis sodalis*) are federally listed endangered species that may be found in or near McCracken County. No proposed operations or hypothesized accidents have been identified that would affect potential Indiana bat roosting or foraging habitat. Under normal operating conditions, any small quantities of PCBs released would not adversely affect the creeks or be expected to reach the Ohio River. However, if a highly unlikely or incredible accident were to occur, wastes might reach the Ohio River. During a flooding rainfall (which occurred less than once in 25 years), Bayou Creek, Little Bayou Creek, and the Ohio River would be flooded and sediments would move downstream. This would be a negligible addition to the concentration of contaminants already present in Ohio River sediments. This additional quantity of contaminants would be well within the measured variability of concentrations in river sediments. The addition of contaminants in the Ohio River would quickly (in minutes) pass mussel beds during flood conditions as sediments were moved rapidly downstream. An accidental release of contaminants would be extremely small and too brief to increase concentrations in the mussel species.

Noise. The normal operations of the proposed action within the Paducah Site boundaries would have no impact on the noise level at the site. Operation of trucks and drum-handling machinery, such as forklifts, and physical volume reduction machines, such as chippers and crushers, would occur. However, these activities currently take place at the site; therefore, no increase in the current noise level is anticipated.

Air quality. Emissions of criteria pollutants are the primary concern from area (nonpoint) sources such as waste packaging/sorting and storage areas. No notable emissions of criteria air pollutants are expected from the routine packaging, handling, and storage activities of existing or future generated waste at the Paducah Site.

All treatment activities would be conducted at existing facilities, so there would be no impacts from construction or site disturbance. The wastes proposed for on-site treatment would be processed by technologies, such as solidification, that historically have not produced notable air emissions and result in no anticipated ambient air impacts at the Paducah Site.

The Paducah Site anticipates making 762 waste shipments per year (up to 3 per day). During transportation, nonattainment areas are of most concern for potential air quality impacts. Nonattainment areas associated with each transportation route are associated with large metropolitan areas. Three shipments per day would not discernibly increase the daily rate of truck traffic for these metropolitan areas. In the *Environmental Assessment for Transportation of Low-Level Radioactive Mixed Waste from the Oak Ridge Reservation to Off-Site Treatment and Disposal Facilities* (DOE/EA-1317) analysis was undertaken to determine the impact of the proposed shipments relative to the threshold emission levels in nonattainment areas described by EPA in its air conformity regulations [40 *CFR* 93.153(b)(1)]. The receiving facilities for Paducah Site wastes are the same as in this analysis. The results determined that air emissions within all nonattainment areas along shipment routes are well below the EPA threshold emission levels, and thus require no formal conformity analysis. The deduction is made that the Paducah Site's proposed action of similar shipments per year along the same routes would also be de minimus.

Socioeconomics and environmental justice. The processing and repackaging of affected wastes for shipment are expected to result in an increase of 30 full-time-equivalent jobs per year. Transportation employment would similarly create 15 or fewer full-time-equivalent jobs. An increase of 45 total jobs would represent less than a 1% change from 1997 employment in McCracken County, which does not constitute a notable impact. Because the actual employment impact is likely to be smaller and would be spread over additional counties, there would be no notable economic impact from the proposed action. For the treatments considered in this EA, populations considered under environmental justice guidance are those that live within 80 km (50 miles) of the Paducah Site. However, these groups would be subject to the same negligible impacts as the general population.

Irreversible and Irretrievable Commitment of Resources. The proposed action would result in the decrease of the irreversible and irretrievable use of necessary fuel, power, and materials for maintaining the wastes and the storage facilities. No new storage facilities would be constructed. Funding could eventually be decreased for the management of wastes and facilities since the waste volume would decrease.

Cumulative Effects. Implementation of the proposed action would decrease the current risks for exposure of workers, the public and ecological resources to radiological emissions and nonradiological contaminants because it would decrease the amount of wastes present at the site.

NO ACTION ALTERNATIVE

Radiological Risks. Worker doses under the No Action alternative would result in less than 1 Latent Cancer Fatality per waste type based on a worker population of 30 full-time employees. The estimated radiological doses are highly conservative because the calculations assumed that workers would spend the entire workday in the waste storage areas, which is not likely.

The potential for public exposure to radiological emissions resulting from LLW and TRU waste management activities under the No Action alternative is limited at the Paducah Site. It is unlikely that routine waste management activities would result in measurable quantities of radiation at the Paducah Site boundaries. A perimeter-monitoring program and warning system are in place around the Paducah Site boundaries and elsewhere to evaluate impacts from routine operations as well as emergency conditions. There are off-site regulatory limits that are adhered to by the Paducah Site as well. Environmental monitoring activities are conducted routinely and reported in the Annual Environmental Monitoring Report. This report has not indicated any adverse impact from the Paducah Site operations that include waste management activities. Therefore, it is unlikely that the No Action alternative would impact the public above current levels in terms of radiological impacts from continued storage of LLW and TRU waste.

Nonradiological Risks. Continued storage of LLW and TRU waste at the Paducah Site under the No Action alternative would increase safety risks to workers by requiring additional handling of the waste as maintenance and repackaging activities are needed. In addition, there would be routine monitoring activities in the storage locations that can present typical safety risks. These risks have been evaluated based on the average industrial accident rates for operations at similar industries. The estimated number of total recordable cases for the 30 workers associated with the No Action alternative would be 0.78 cases per year. The estimated lost workdays (LWDs) due to occupational illness or injury would be approximately 11 per year. In addition, as waste inventories grow over time, additional storage facilities or expansion of current capacity would be needed. This would require the use of heavy equipment and would introduce accident risks during facility construction.

Accident Analysis. The EBE and vehicle impact/mishandling accidents were evaluated for the No Action alternative. Because the waste characteristics and the accident scenarios are the same as those evaluated for the proposed action, the accident consequences are identical to the proposed action. However, while the frequency of the earthquake accident is the same for both alternatives, the frequency of vehicle impact/mishandling accidents is much lower due to the lower activity level. Based on the revised accident frequencies under the No Action alternative, expected fatalities are less than for the proposed action. However, because the institutional control period is assumed to be 100 years under the No Action alternative and is only 10 years under the proposed action, fatalities from the EBE increase by a factor of 10 under the No Action alternative. However, in both cases, the calculated number of expected fatalities remains negligible under the No Action alternative.

Ecological resources.

Aquatic Biota **–** Short- and long-term impacts to aquatic resources resulting from normal operations of the No Action alternative would be similar to those currently occurring from the Paducah Site activities. Accident impacts to resources from the worst-case accident scenario (i.e., earthquake) involving radionuclides should be no different from impacts associated with the proposed action. The earthquake scenario is highly unlikely to cause harm to aquatic biota in the Ohio River as a result of exposure to radionuclides. However, just as with the proposed action, aquatic receptors in Bayou and Little Bayou creeks and other water conveyances by which the waste would reach the Ohio River would likely be affected by the caustic nature of the waste. Accident impacts to resources from the worst-case accident scenario (i.e., earthquake) involving nonradionuclides are the same as for the proposed action. PCBs could pose adverse impacts to aquatic biota in the Ohio River, as well as in Bayou and Little Bayou creeks. None of the other nonradionuclide contaminants would reach concentrations in the Ohio River to pose adverse impacts to aquatic biota.

Terrestrial Biota **–** Short- and long-term impacts to terrestrial biota from normal operations of the No Action alternative should be similar to those currently occurring from the Paducah Site activities. Impacts to terrestrial biota from the modeled worst-case spill accident scenario (i.e., earthquake) are the same as for the proposed action. Just as for the proposed action, long-term radiation effects to soil biota as the result of an earthquake would be negligible. Accident impacts to terrestrial biota from the worst-case accident scenario (i.e., earthquake) involving nonradionuclides would likely pose adverse impacts to soil biota under the No Action alternative.

Noise. Noise levels would be similar to those currently at the site since the activities included under the No Action Alternative are already being conducted on the site. If construction of new storage facilities is required, noise levels in the vicinity of the construction would increase during the construction period.

Air quality. The No Action alternative would not alter air quality at the Paducah Site or in the surrounding region since the activities included in this alternative are already being conducted at the site.

Socioeconomics and environmental justice. The No Action alternative would result in no net change in employment and therefore would have no notable socioeconomic impact on the ROI. Impacts from noise, air emissions, radiological emissions, and accidents would be low for both the residents closest to the site and the low-income communities. Exposures for the general public and the relevant workers would continue at historical levels for the Paducah Site.

Irreversible and Irretrievable Commitment of Resources. The no action alternative would result in the irreversible and irretrievable use of necessary fuel, power, and materials for maintaining the wastes and the storage facilities. If new storage facilities are constructed, additional building materials and energy would be used. Additional funding would be required for managing the increasing volumes of wastes and new facilities.

Cumulative Effects. Implementation of the no action alternative would add incrementally to current risks for exposure of workers, the public and ecological resources to radiological emissions and nonradiological contaminants because it would increase the amount of wastes present at the site.

ENHANCED STORAGE ALTERNATIVE

Radiological Risks. Worker doses under the No Action alternative would result in less than 1 LCF per waste type based on a worker population of 30 full-time employees. These doses would remain the same under the Enhanced Storage alternative because the work force required for storage facility workers would remain the same. The potential for public exposure to radiological emissions resulting from LLW and TRU waste management activities under the No Action alternative is limited at the Paducah Site. This potential would be further reduced under the Enhanced Storage alternative because the new/upgraded facilities would provide additional confinement to reduce the potential for radiological materials releases. Therefore, it is unlikely that the Enhanced Storage alternative would impact the public above current levels in terms of radiological impacts from continued storage of LLW and TRU waste.

Nonradiological Risks. Continued storage of LLW and TRU waste at the Paducah Site under the No Action alternative would increase safety risks to workers by requiring additional handling of the waste as maintenance and repackaging activities are needed. In addition, there would be routine monitoring activities in the storage locations that can present typical safety risks. These risks have been evaluated based on the average industrial accident rates for operations at similar industries. The estimated number of total recordable cases for the 30 workers associated with the No Action alternative would be 0.78 cases per year. The estimated lost workdays (LWDs) due to occupational illness or injury would be approximately 11 per year under the No Action alternative. These risks would remain the same under the Enhanced Storage alternative.

Accident Analysis. During the alternative, the packaged waste containers would be transported to an on-site location and stored. The containers would be inspected periodically to verify that the containers are intact and repaired if required. These containers would be subject to the same conditions as the stored containers in the proposed action. They would, however, be at risk for a longer period of time. The EBE and vehicle impact/mishandling accidents were evaluated. The waste characteristics and the accident scenarios are the same for the Enhanced Storage alternative as those evaluated for the No Action alternative; however, the accident consequences would be expected to be less for the EBE because the enhanced storage facilities would provide additional confinement, thus reducing the amount of material released outside the building. The frequencies for both accidents remain the same as the No Action alternative.

Comparison of Accident Risks. Risks were computed for both process accidents and industrial accidents for the proposed action and the No Action alternatives. The highest radiological accident risk was 1.5×10^{-7} expected fatalities for the MIW/MUW at the edge of the waste storage area during and following an earthquake. This risk would be expected to be at least a factor of ten lower for the Enhanced Storage alternative because the buildings would provide additional confinement to reduce releases outside the facility. This risk would be computed for the 100-year no-action and enhanced storage institutional period. The second highest risk, 7.9×10^{-8} expected fatalities, was computed for the vehicle impact/mishandling accident impacting the ThF_4 container during the 10-year proposed action operating period. The risks are the same for all three alternatives, but the proposed action has a shorter duration.

The calculated industrial accident risks, while higher than the radiological accident risks, were small. The computed risk for the proposed action was 0.02 expected fatalities over the 10-year operating period. The corresponding industrial accident risk for the No Action alternative was 0.1 expected fatalities over the 100-year institutional control period and would be the same for the Enhanced Storage alternative. Neither the risks nor the differences between them are considered notable.

Ecological resources.

The Enhanced Storage alternative would not adversely affect any threatened or endangered species.

Aquatic Biota - Short- and long-term impacts to aquatic biota from the Enhanced Storage alternative would be no greater than those currently occurring from the Paducah Site activities. Accident impacts to aquatic biota from the worst-case accident scenario (i.e., earthquake) involving radionuclides were described for the proposed action, and the impacts should be no greater for the Enhanced Storage alternative. Because of this, the earthquake scenario is highly unlikely to cause harm to aquatic biota in the Ohio River as a result of exposure to radionuclides. However, just as with the proposed action, aquatic receptors in Bayou and Little Bayou creeks and other water conveyances by which the waste would reach the Ohio River would likely be less affected under the Enhanced Storage alternative because less radioactive materials would escape from the storage facilities.

Nonradionuclide accident impacts to aquatic biota from the worst-case accident scenario (i.e., earthquake) were also described for the proposed action. Again, the impacts should be no greater for the Enhanced Storage alternative. PCBs could pose adverse impacts to aquatic biota in the Ohio River, as well as in Bayou and Little Bayou creeks. None of the other nonradionuclide contaminants would reach high enough concentrations in the Ohio River to pose adverse impacts to aquatic biota.

Terrestrial Biota - Short- and long-term impacts to terrestrial biota from the Enhanced Storage alternative should be no greater than those currently occurring from the Paducah Site activities. Impacts to terrestrial biota from the modeled worst-case spill accident scenario (i.e., earthquake) are no greater than for the proposed action. Just as for the proposed action, long-term radiation effects to soil biota as the result of an earthquake would be negligible under the Enhanced Storage alternative. Accident impacts to terrestrial biota from the worst-case accident scenario (i.e., earthquake) involving nonradionuclides under the proposed action were described. The impacts to terrestrial biota under the Enhanced Storage alternative should be less. Nonradionuclides would likely pose less impact to biota if the worst-case spill accident occurred under the Enhanced Storage alternative because less material would escape from the storage facilities.

Air quality. Under the Enhanced Storage alternative, potential impacts resulting from on-site treatment, transport, and disposal would not apply. Other potential impacts would be no greater than those identified for the proposed action.

Socioeconomics and environmental justice. The Enhanced Storage alternative may result in a slight increase in employment due to construction and/or upgrades required for storage facilities. In addition, long-term surveillance and maintenance of facilities designed to withstand increased EBE loads might result in additional staff. Impacts from noise, air emissions, radiological emissions, and accidents would be low for both the residents closest to the site and the low-income communities. Exposures for the general public and the relevant workers would be no greater than those at historical levels for the Paducah Site

Irreversible and Irretrievable Commitment of Resources. The Enhanced Storage alternative would result in the irreversible and irretrievable use of necessary fuel, power, and materials for maintaining the wastes and building the enhanced storage facilities. New storage facilities would be constructed and additional building materials and energy would be used. Additional funding would be required for building facilities and managing the increasing volumes of wastes and new facilities.

Cumulative Effects. Implementation of the Enhanced Storage alternative would add incrementally to current risks for exposure of workers, the public and ecological resources to radiological emissions and nonradiological contaminants because it would increase the amount of wastes present at the site.

DETERMINATION: Based on the findings of this EA, DOE has determined that the proposed action does not constitute a major federal action that would significantly affect the quality of the human environment within the context of the National Environmental Policy Act. Therefore, preparation of an environmental impact statement is not required.

Issued at Oak Ridge, Tennessee, this___day of_________2002.

DOE/EA-1339
FINAL

Final Environmental Assessment for Waste Disposition Activities at the Paducah Site Paducah, Kentucky

Date Issued—November 2002

U.S. Department of Energy
Office of Environmental Management

00-347(doc)/071702

CONTENTS

THIS PAGE INTENTIONALLY LEFT BLANK.

FIGURES

THIS PAGE INTENTIONALLY LEFT BLANK

TABLES

THIS PAGE INTENTIONALLY LEFT BLANK

ACRONYMS

AST	airborne source term
BCK	Bayou Creek kilometer
BJC	Bechtel Jacobs Company, LLC
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CFR	*Code of Federal Regulations*
COE	U.S. Army Corps of Engineers
CX	categorical exclusion
D&D	decommissioning and decontamination
DCG	derived concentration guide
DMSA	DOE Material Storage Area
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
EA	environmental assessment
EBE	evaluation-basis earthquake
EPA	U.S. Environmental Protection Agency
ESD	Environmental Sciences Division
ETTP	East Tennessee Technology Park
FFCA	Federal Facility Compliance Agreement
FWS	U.S. Fish and Wildlife Service
HC1	hydrochloric acid
HDDV	heavy duty diesel-powered vehicle
HEPA	high-efficiency particulate air
IDLH	immediately dangerous to life or health
KAR	*Kentucky Administrative Regulations*
KDEP	Kentucky Department for Environmental Protection
KDFWR	Kentucky Department of Fish and Wildlife Resources
KPDES	Kentucky Pollutant Discharge Elimination System
KSNPC	Kentucky State Nature Preserves Commission
LCD	Lower Continental Deposits
LCF	latent cancer fatality
LDR	land disposal restriction
LLW	low-level radioactive waste
LST	liquid source term
LUK	Little Bayou Creek kilometer
LWD	lost workdays
MEI	maximally exposed individual (off-site individual at site boundary)
MEWC	Materials & Energy/Waste Control Specialists
MIW	maximally exposed involved worker
MLLW	mixed low-level waste
MSL	mean sea level
MUW	maximally exposed uninvolved worker
NAAQS	National Ambient Air Quality Standards
NCS	Nuclear Criticality Safety
NEPA	National Environmental Policy Act of 1969
NRC	U.S. Nuclear Regulatory Commission
ORNL	Oak Ridge National Laboratory
Paducah Site	Paducah Gaseous Diffusion Plant Site

PCB	polychlorinated biphenyl
PPE	personal protective equipment
PSD	prevention of significant deterioration
RCRA	Resource Conservation and Recovery Act of 1976
RGA	Regional Gravel Aquifer
ROD	Record of Decision
ROI	region of influence
RPCB	radiological polychlorinated biphenyl
SIP	state implementation plan
STP	Site Treatment Plan
TRE	toxicity reduction evaluation
TRU	transuranic
TSCA	Toxic Substances Control Act of 1976
TVA	Tennessee Valley Authority
UCD	Upper Continental Deposits
UCRS	Upper Continental Recharge System
USEC	United States Enrichment Corporation
WIPP	Waste Isolation Pilot Plant
WKWMA	West Kentucky Wildlife Management Area
WM-PEIS	Waste Management Programmatic Environmental Impact Statement
WWTP	wastewater treatment plant

1. INTRODUCTION

The U.S. Department of Energy (DOE) proposes disposition activities for polychlorinated biphenyl (PCB) wastes, low-level radioactive waste (LLW), mixed low-level radioactive waste (MLLW), and transuranic (TRU) waste from the Paducah Gaseous Diffusion Plant Site (Paducah Site) in Paducah, Kentucky (Table 1.1). All of the wastes would be transported for disposal at various locations in the United States. As a federal agency, DOE must comply with the National Environmental Policy Act of 1969 (NEPA) by considering, in the decision-making process, potential environmental impacts associated with its proposed action. The Council on Environmental Quality (CEQ) promulgated regulations to implement NEPA [40 *Code of Federal Regulations* (*CFR*) 1500 et seq.] and directed federal agencies to develop their own implementing regulations. DOE regulations (10 *CFR* 1021) provide additional direction for conducting NEPA reviews of proposed DOE activities. This environmental assessment (EA) for the disposition of various DOE wastes stored and/or generated at nonleased portions of the Paducah Site has been prepared in accordance with both CEQ and DOE regulations and with DOE orders and guidance regarding these waste types.

Table 1.1. Paducah EA waste information

Waste type	Approximate total volume (m^3, unless noted otherwise)	Proposed treatment		Proposed disposal		Approximate volume to be shipped (m^3)
		On-site	Off-site	On-site	Off-site	
PCB	128 metric tons		X		X	200
LLW (T-Hoppers)	22 units					
LLW	5,000	X		~~X~~	X	4,950
MLLW	5,700	X	X	~~X~~	X	5,800
TRU	6	X			X	12

EA = environmental assessment
LLW = low level radioactive waste
MLLW = mixed low level waste
PCB = polychlorinated biphenyl
TRU = transuranic

1.1 PURPOSE AND NEED FOR AGENCY ACTION

DOE must continue to manage (i.e., treat, store, and dispose) and control its wastes safely, efficiently, and cost effectively in compliance with applicable federal and state laws and protecting public health and the environment.

DOE is under regulatory agreements to treat and dispose several waste types. Regulatory agreements pursuant to the Resource Conservation and Recovery Act of 1976 (RCRA) and the Toxic Substances Control Act of 1976 (TSCA) require that DOE develop waste treatment options to meet required schedules.

DOE developed a site treatment plan (STP) for MLLW, as required by the Federal Facility Compliance Act of 1992. The Commonwealth of Kentucky approved the STP, and the Agreed Order was signed on September 10, 1997. The STP Agreed Order supercedes the Federal Facility Compliance Agreement (FFCA) for land disposal restrictions (LDRs) between DOE and the U.S. Environmental Protection Agency (EPA) (referred to as the LDR FFCA). The STP requires that DOE characterize MLLW and RCRA/TSCA-regulated mixed waste streams and develop and implement a plan for their treatment.

The TSCA FFCA, which DOE entered into with EPA in 1992, establishes requirements for compliance with TSCA. DOE developed a TSCA Implementation Plan for the Paducah Site to ensure compliance with the TSCA FFCA requirements. Both the TSCA FFCA and the TSCA Implementation Plan for the Paducah Site have requirements for the disposal of TSCA-regulated, TSCA-regulated mixed, and RCRA/TSCA-regulated mixed wastes. The TSCA FFCA requires that disposal of these wastes begin as soon as EPA approves a disposal method. Moreover, it requires that such wastes generated after 1992 be disposed within 10 years of their generation date.

DOE is required by the Atomic Energy Act (42 United States Code 2011 et seq.) and DOE Order 435.1 to manage the radioactive wastes that it generates. DOE has determined that it will dispose LLW and MLLW at the Hanford Site in Washington state and at the Nevada Test Site, as documented in the *Record of Decision (ROD) for the Department of Energy's Waste Management Program: Treatment and Disposal of Low-Level Waste and Mixed Low-Level Waste* (January 1998, 63 Federal Register 3629). Generally, the proposed action would aid implementation of the high tier NEPA documentation and RODs. Pertinent documents are presented in Tables 1.2 and 1.3.

There are 160 DOE Material Storage Areas (DMSAs) at the Paducah Site. DOE needs to characterize the materials in the DMSAs consistent with RCRA/TSCA regulations and Nuclear Criticality Safety requirements. DOE has prepared the Paducah Gaseous Diffusion Plant Department of Energy Material Storage Area Characterization Remediation Plan (BJC 2001). This document outlines activities for the characterization of wastes managed in the 160 DMSAs.

As described above, DOE-Oak Ridge Operations has various waste types located at the Paducah Site that must undergo disposition activities. In this anlaysis, disposition activities include any activity, primary or supporting, needed to effectively manage Paducah Site wastes. Examples of primary disposition activities include waste storage, on-site and/or off-site treatment, transportation, and disposal. Supporting activities may include vehicle fueling, facility maintenance, staging, packaging, sorting, volume reduction, storage container inspections, etc.

1.2 SCOPE OF THIS ASSESSMENT

In October 1992, Congress passed the Energy Policy Act of 1992, which established the U.S. Enrichment Corporation (USEC). Effective July 1, 1993, DOE leased the plant production operation facilities to USEC. Under the terms of the lease, USEC assumed responsibility for environmental compliance activities that were directly associated with uranium enrichment operations. Generally, DOE retained responsibility for the site environmental restoration program and the legacy waste management program, including waste inventories predating July 1, 1993, and wastes generated by ongoing DOE activities.

This EA provides an evaluation of the potential effects of disposition of accumulated legacy and ongoing operational wastes at the Paducah Site. The potential effects of waste transportation over both highway and rail routes are evaluated. It should also be noted that the 10-year waste disposition assumptions result in a baseline disposal time frame and produce a reasonable "worst-case" scenario for risk analysis. This assumption does not imply that risks are eliminated after the 10-year period. It is anticipated that as long as newly generated waste does not exceed the contaminant concentration assumptions made in the risk impact analysis and volume parameters presented in Table 1.1, this document would apply past the 10-year time frame. This is reasonable, because the impact analysis for any newly generated wastes that match the waste parameters would be very similar to those presented within this document. If ongoing operations produce a waste that differs from the wastes described herein, additional NEPA review may be required. Wastes not considered part of the proposed action and alternative include waste for which treatment and disposal are addressed pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA). CERCLA wastes are the primary wastes (by volume) at the Paducah Site. NEPA values for these wastes are addressed in project-specific CERCLA documents. Additionally, the cumulative impacts section of this document takes CERCLA wastes into consideration.

Table 1.2. Additional DOE documents addressing Paducah Site wastes

Waste Type	Activity	Proposed action	Documents providing analysis/decisions								
			NEPA					Record of decision			
			This document	WM PEIS	WIPP EIS	TRU EIS	Facility documents	65-FR-10061	63-FR-3629	65-FR-82985	65-FR-48683
Mixed low-level waste	Storage	On-site	X[1]	X							
	Transport to treatment	NA	–	–	–	–	–	–	–	–	–
	Treatment	On-site as consistent with STP	X[2]	X				X			
	Transport	Truck transport	X								
	Disposal	Commercial	X[3]				X	X			
Low-level waste (solids)	Storage	On-site	X[1]	X							
	Transport to treatment	NA	–	–	–	–	–	–	–	–	–
	Treatment	NA	–	–	–	–	–	–	–	–	–
	Transport	Truck transport	X								
	Disposal	NTS		X			X	X			
Wastewater	Storage	On-site	X								
	Transport to treatment	NA	–	–	–	–	–	–	–	–	–
	Treatment	On-site	X								
	Transport	NA	–	–	–	–	–	–	–	–	–
	Disposal	NA	–								
TRU waste	Storage	On-site	X[1]	X					X		
	Transport to treatment	NA	–	–	–	–	–	–	–	–	–
	Treatment	On-site	X[2]	X					X		X
	Transport to staging	Truck transport to ORNL	X								
	Transport to disposal	Truck transport from ORNL to WIPP				X					
	Disposal	WIPP		X	X		X			X	
PCB waste	Storage	On-site	X								
	Transport to treatment	NA	–	–	–	–	–	–	–	–	–
	Treatment	NA	–	–	–	–	–	–	–	–	–
	Transport	Truck transport	X								
	Disposal	Deer Park	X[3]				X				

Table 1.2. Additional DOE documents addressing Paducah Site wastes (continued)

[1] Current inventory impacts were assessed under the WM-PEIS. Ongoing operations impacts are addressed in the waste EA.
[2] Although the basic concept of this activity was addressed in the WM-PEIS, the specific process that would be implemented at the site is addressed in the waste EA.
[3] Qualitative analysis performed in the waste EA.
– = not applicable
FR = Federal Register
NA = not applicable
NTS = Nevada Test Site
ORNL = Oak Ridge National Laboratory
PCB = polychlorinated biphenyl
STP = Site Treatment Plan
TRU = transuranic
WIPP = Waste Isolation Pilot Plant
WM-PEIS = Waste Management Programmatic Environmental Impact Statement

REFERENCES:

WM-PEIS = Final Waste Management Programmatic Environmental Impact Statement for Managing Treatment, Storage, and Disposal of Radioactive and Hazardous Waste. DOE/EIS-0200-F, May 1997.

WIPP EIS = Final Environmental Impact Statement for the Waste Isolation Pilot Plant, DOE/EIS-0026, October 1980.

TRU EIS = Final Environmental Impact Statement for Treating Transuranic (TRU)/Alpha Low Level Waste at the Oak Ridge National Laboratory, Oak Ridge, Tennessee, DOE/EIS-0305-F, June 2000.

Waste EA = This document.

65-FR-10061 = Record of Decision for the Department of Energy's Waste Management Program: Treatment and Disposal of Low-Level Waste and Mixed Low-Level Waste; Amendment of the Record of Decision for the Nevada Test Site, February 2000.

63-FR-3629 = Record of Decision for the Department of Energy's Waste Management Program: Treatment and Storage of Transuranic Waste, January 1998.

65-FR-82985 = Revision to the Record of Decision for the Department of Energy's Waste Management Program: Treatment and Storage of Transuranic Waste, December 2000.

65-FR-48683 = Record of Decision on Treating Transuranic (TRU)/Alpha Low-Level Waste at the Oak Ridge National Laboratory, August 2000.

63-FR-41810 = Record of Decision for the Department of Energy's Waste Management Program: Treatment of Non-wastewater Hazardous Waste, August 1998.

Table 1.3. Summary of Waste Management PEIS Record of Decisions (ROD) Issued to Date for Paducah Site Waste Types

Waste Type	Activity	ROD(s)	Decision	Rationale
Mixed Low Level Waste	Treatment	65 FR 10061	Treat at Hanford, INEEL, ORR and SRS or onsite as consistent with current STP.	Takes advantage of infrastructure capabilities that already exist. Also avoids environmental impacts and costs associated with construction of new facilities.
	Disposal	65 FR 10061	Dispose at Hanford or NTS. Decision does not preclude DOE's use of commercial disposal facilities consistent with current DOE policy.	Based on low impacts to human health, operational flexibility, and relative implementation costs. No foreseeable need for construction of a third facility due to volume of waste anticipated.
Low Level Waste	Treatment	65 FR 10061	Perform minimal treatment at the site.	Volume reduction would not offer sufficient benefits to offset the increase in human health effect and costs it would entail.
	Disposal	65 FR 10061	Offsite disposal at Hanford, NTS, or commercal facility. Potential continued on-site disposal at LANL, SRS, INEEL, and ORR.	Based on low impacts to human health, operational flexibility, and relative implementation costs.
Transuranic Waste	Treatment	63 FR 3629	May decide to ship TRU wastes from sites for preparation and disposal.	It may be impractical for sites with small amounts of TRU wastes to develop capabilities to prepare them for disposal. It would be more cost effective to transfer them to sites where DOE has the existing capability. The sites that could receive such shipments include the ORR.
	Storage	63 FR 3629	Prepare and store its TRU waste on site.	On site storage results in the lowest impacts among the alternatives analyzed in the WM PEIS.
	Treatment (revised)	65 FR 82985	Develop capability at WIPP to prepare TRU waste for disposal.	Revision of earlier ROD to create a centralized capability to dispose of TRU waste at WIPP. This would expedite the removal of waste from sites with smaller inventories of TRU wastes.
	Storage (revised)	65 FR 82985	Increase above ground storage time at WIPP to 1 year and the total above-ground storage capacity increased by 25%.	Allows DOE to accumulate the necessary amount of waste for approval of the program by EPA and NMED. Also allows to store wastes during disposal delays.
Non-wastewater Hazardous Waste	Treatment	63 FR 41810	Continue to use off-site facilities for the treatment of major portions of this waste.	The potential health, environmental, and cost impacts of continued use of off-site commercial facilities are low. The additional costs of expanding existing facilities and/or constructing new ones is not justified in view of commercial facility availability.
	Disposal	63 FR 41810	Continue to use off-site facilities for the disposal of major portions of this waste.	Upon receipt of wastes for treatment, the facility takes title to the wastes and, after treatment, dispose of it.
PCB Waste	Treatment	None	None	None
	Disposal	None	None	None

Current typical disposition activities include actions taken to maintain and/or manage Paducah Site wastes. These include, but are not limited to, the following: storage, drum movement, overpackaging/ repackaging, equipment and drum sorting and flushing, physical volume reduction, equipment and waste-container decontamination, marking, relabeling, inspection, drip/spill cleanup, waste tracking, and inventory. Other activities include standard waste characterization (which includes waste sampling), waste analysis and data management, waste treatment and disposal, and miscellaneous supporting activities. Minor facility modifications/upgrades, for example, new alarm systems, would be made as necessary.

This assessment also presents the most current waste volumes for Environmental Management Program wastes at the Paducah Site (Table 1.1). Changes from the previous forecast have resulted from waste-minimization and pollution-prevention efforts on the Paducah Site, coupled with changes in operational plans. Therefore, there has been a decrease in the forecasted volumes of various waste streams that would be generated. If this trend continues, it would result in lower anticipated impacts and risks in the future.

This environmental assessment is tiered under other currently existing NEPA documents. Generally, DOE site-specific NEPA documents are tiered under DOE programmatic NEPA documents. Therefore, analysis performed and decisions made in programmatic documents do not have to be repeated for similar site-specific actions.

This assessment is intended to supplement and update the previous NEPA evaluation of waste disposition activities conducted as part of the final Waste Management Programmatic Environmental Impact Statement (WM-PEIS) for radioactive and hazardous waste (DOE 1997). This assessment expands the scope of previous analyses to include possible transportation to commercial facilities. Tables 1.2 and 1.3 provide a summary of analyses performed for Paducah wastes in other NEPA documents. These tables also provide a summary of decisions made in applicable record-of-decision documents.

A public information meeting was held on October 26, 2000, in which DOE sought input on the contents of this EA. Some comments were in opposition to any new on-site landfills for waste disposal, and some people expressed concern about incineration as a treatment option at any site. No new landfills are proposed for this action. Some MLLW is proposed for off-site treatment at the TSCA Incinerator in Oak Ridge, Tennessee. Residual wastes from incineration will be dispositioned in accordance with TSCA Operating Procedures and the TSCA Incinerator Residual Management Plan. Appendix B presents a distribution list of individuals who received this document.

The wastes considered in this assessment are limited to DOE's ongoing and legacy non-CERCLA waste management operations at the Paducah Site. These wastes include LLW, MLLW, and TRU waste, as well as materials stored in DMSAs. Also included is storage of USEC program wastes, which are characterized as one or more of these waste types.

Wastes not covered in this EA are those associated with CERCLA activities, including decontamination and decommissioning activities, and disposal of wastes associated with USEC uranium enrichment activities.

Environmental impacts from the disposal and/or treatment of waste at DOE facilities have been evaluated as part of the NEPA documents associated with ongoing facility operations. The EA does not include detailed consideration of impacts from treatment and disposal operations at commercial facilities. Per DOE guidance, while analysis of impacts from a vendor's action may be within the scope of DOE's review obligation, "the level of detail should be commensurate with the importance of the impacts or issues related to the impacts. If DOE's proposed waste load would be a small part of the facility's throughput and the facility would operate well within established standards, then the vendor's part of DOE's proposal would be low on the *sliding (sic)* scale, and a statement of this context would adequately characterize the impacts" (DOE 2000d, "*Lessons Learned*"). Waste volumes anticipated over a 10-evaluation period comprise, or would comprise, less than 1 percent of the combined capacity of the commercial treatment and/or disposal facilities and less than 4 percent of the capacity of any one individual commercial facility. The commercial treatment and disposal facilities that will be used to treat or dispose the waste are required to operate within the bounds of federal and state requirements such as U.S. Nuclear Regulatory Commision (NRC) or Agreement State licenses, RCRA permits, TSCA authorizations, air and water permits, and Occupational Safety and Health Administration regulations. Also, the waste planned to be transported is typical of waste being treated at the commercial waste treatment facilities.

There are three other environmental and waste management activities associated with the Paducah Site that are not covered by CERCLA or this EA: (1) the depleted uranium hexaflouride conversion project, (2) the disposal of nonradioactive waste containing residual radioactivity at the C-746-U landfill, and (3) DOE's proposal to implement a long-term management plan for its inventory of potentially reusable low-enriched uranium. DOE is currently in the process of preparing appropriate NEPA reviews for all of these activities.

1.2.1 PCB Waste

Polychlorinated biphenyls (PCBs) are mixtures of synthetic organic chemicals with the same basic chemical structure and similar physical properties, ranging from oily liquids to waxy solids. Due to their nonflammability, chemical stability, high boiling point, and electrical insulating properties, PCBs are used in hundreds of industrial and commercial applications, including electrical, heat transfer, and hydraulic equipment; as plasticizers in paints, plastics, and rubber products; in pigments, dyes, and carbonless copy paper; and in many other applications.

1.2.2 Low-Level Waste

LLW is radioactive waste that is not high-level radioactive waste, spent nuclear fuel, TRU waste, byproduct material (as defined in section 11e.(2) of the *Atomic Energy Act of 1954,* as amended), or naturally occurring radioactive material (DOE G 435.1-1).

1.2.3 Mixed Low-Level Waste

MLLW is waste that contains LLW (as defined above) and hazardous waste. Hazardous wastes are a subset of solid wastes that pose substantial or potential threats to public health or the environment and meet any of the following criteria identified by 40 *CFR* 260 and 261:

- they are specifically listed as a hazardous waste by EPA,
- they exhibit one or more of the characteristics of hazardous waste (ignitability, corrosiveness, reactivity, and/or toxicity),
- they are generated by the treatment of hazardous waste, or
- they are contained in a hazardous waste.

1.2.4 TRU Waste

TRU waste contains, for each gram of waste, more than 100 nanocuries of alpha-emitting TRU isotopes, with half-lives greater than 20 years. A waste can meet this definition without being considered TRU waste if it is (1) high-level radioactive waste; (2) waste that DOE has determined, with the concurrence of EPA, does not need the degree of isolation required by EPA's high-level waste rule (40 *CFR* 191); or (3) waste that has been approved for disposal on a case-by-case basis in accordance with the NRC's radioactive land disposal regulation (10 *CFR* 61). TRU is not generally found outside the DOE complex and is produced mainly from the reprocessing of spent nuclear fuel, nuclear weapons production, and reactor fuel assembly. TRU wastes emit mainly alpha particles as they break down.

1.2.5 DMSA Waste

DMSA wastes are located throughout the Paducah Site. These storage areas (approximately 160 of them) are located within buildings and areas that have been leased to USEC. Detailed descriptions of DMSA waste are not available because the majority of it has not been characterized. However, based upon visual surveillance, the majority of this waste appears to be discarded furniture, equipment, and assorted rubble. After the materials in these areas are characterized, any RCRA/TSCA/solid waste that is identified would be grouped and properly dispositioned as the waste types listed in this section. Other DMSA waste types would remain in storage until they are evaluated during CERCLA-related decommissioning and decontamination (D&D) activities.

2. PROPOSED ACTION AND ALTERNATIVES

2.1 PROPOSED ACTION

DOE proposes to disposition site wastes as needed. For the purpose of this EA, disposition activities are defined as any actions taken to maintain and/or manage Paducah Site wastes. Disposition activities may include characterization, storage, packaging, treatment, loading, and shipping existing and forecasted Paducah Site wastes to treatment/disposal locations. For analysis purposes, Table 1.1 presents typical Paducah Site wastes and approximate volumes. Mitigations and best management practices may be applied for each disposition activity. Mitigations are identified in Chap. 4. Approximated waste volumes for each of the following activities include anticipated quantities of postcharacterized DMSA wastes.

2.1.1 Storage

Under the proposed action, all waste would be stored at the Paducah Site until it is scheduled for treatment, disposal, or transport from the Paducah Site. Existing facilities would be used for waste storage. At this time, it is not anticipated that any new waste storage facilities would be constructed. DMSA wastes that are not characterized as RCRA/TSCA waste would remain in storage until analyzed during D&D CERCLA actions.

2.1.2 On-Site Treatment

On-site treatment applies to approximately 200 m^3 (7060 ft^3) of the approximate 11,000 m^3 (390,000 ft^3) non-PCB waste volume covered in this EA, which includes up to 120 m^3 (4238 ft^3) of MLLW solids, 12 m^3 (424 ft^2) of ^{99}Tc-contaminated MLLW, and 6 m^3 (211 ft^3) of TRU waste. On-site treatment technologies are limited by the Paducah Site RCRA Part B permit. RCRA-permitted on-site treatment technologies include sedimentation, precipitation, oxidation, reduction, neutralization, and cementation/solidification. Currently, only neutralization, stabilization, carbon adsorption, and photocatalytic conversion are proposed on-site. These are the only technologies discussed in subsequent sections because they are the ones applicable to waste types presented. Building C-752-A has been proposed as the site for processing any on-site waste that needs to be treated.

Another 52 m^3 (1836 ft^3)/year of wastewater would also be treated on-site. Volumes listed are approximate. Wastewater would be treated on-site by carbon adsorption, photocatalyic conversion, and/or lime precipitation. These treatment activities would be compliant with the applicable Kentucky Pollutant Discharge Elimination System (KPDES) permit(s). Short descriptions of the proposed treatment technologies are presented in the following sections.

2.1.2.1 Neutralization

Neutralization reduces the acidity or alkalinity of hazardous wastes in a waste stream to a more neutral condition. The process consists of blending acids and bases in order to adjust the pH (a measure of acidity or alkalinity) to yield a neutral solution of salt and water. Alkaline wastes often are mixed with acid wastes, thereby neutralizing two waste streams at the same time. Neutralized waste is safer to store, transport, and dispose than acidic or alkaline waste.

2.1.2.2 Cementation/solidification

In a cementation/solidification process, some fixation renders the waste less hazardous by reducing the ability of the waste constituents to migrate. Solidification and encapsulation bind wastes into a solid mass that would not readily break down. Chemical fixation treatment methods often are employed to tie up hazardous components. These methods reduce leachability, even though the hazardous waste constituents may not be altered. Inorganic materials in aqueous solutions and suspension of metals or inorganic salts are most amenable to this technique. This process reduces mobility of the hazardous constituent or waste and makes the waste easier to handle. The most common stabilization agents added to the waste streams are Portland cement, lime, fly ash, and cement kiln dust.

A portion of the MLLW streams would be treated by on-site or off-site stabilization (Table 1.1). Approximately 10 m^3 (353 ft^3) of TRU liquids and solids would be treated on-site by solidification.

2.1.2.3 Carbon adsorption

Carbon adsorption is a process that uses activated carbon to adsorb hazardous waste constituents. Upon contact with waste containing soluble organic materials, granular activated carbon selectively removes these materials by adsorption. Adsorption is the phenomenon whereby molecules adhere to a surface with which they come into contact, due to forces of attraction at the surface.

Only the wastewater stream, consisting of approximately 52 m^3 (1836 ft^3) of waste, may be potentially treated on-site annually by this method. The wastewater, which has some organic contamination, would be treated until KPDES limits are met; this waste would then be discharged at a permitted site outfall.

2.1.2.4 Photocatalytic conversion.

Photocatalytic conversion is a system that uses ultraviolet radiation in the presence of a catalyst to treat waste by breaking down the contaminants. Only the wastewater stream may be treated by this method. The wastewater would be tested after treatment and would then be discharged through an existing permitted outfall.

2.1.3 Off-site Treatment

DOE’s proposed action for off-site treatment varies by waste type. The characteristics of the waste govern where and how each waste type may be treated. The proposed treatment scenario for each type of currently known waste is listed below.

2.1.3.1 PCB waste

Fifty metric tons of capacitors containing PCBs are proposed for shipment to Deer Park, Texas, for treatment and disposal. The capacitors would be shipped in 23 7A, Type A containers. Thirteen empty transformers weighing 78 metric tons would be shipped for off-site treatment and disposal at Deer Park, Texas, as well. These transformers contain some residual PCB contamination.

2.1.3.2 Mixed low-level waste

The approximate 5700 m^3 (201,294 ft^3) of MLLW addressed in this proposed action represents a very heterogeneous grouping of wastes; most of this waste would be treated and disposed at various off-site, permitted facilities. A small portion contains PCBs, metals, and organics, and it is proposed that they be treated at the DOE TSCA Incinerator in Oak Ridge, Tennessee.

2.1.4 Waste Transport

Waste would generally be transported by truck but may also be transported by rail or intermodal carrier when advantageous. Figures 3.2 through 3.13 in Chap. 3 of this document depict the most direct representative truck and rail routes. Intermodal options are too numerous to present but could be used to comply with state requirements and stakeholder requests. Characterized DMSA wastes would be transported with similar wastes described herein.

2.1.5 Waste Disposal

All wastes are proposed to be disposed offsite. DOE's proposed action for waste disposal varies by waste type. The characteristics of the waste govern where and how each waste type may be disposed. The volume of wastes to be transported from the Paducah Site to each proposed receiving facility represents only a small portion of the total waste each facility receives annually. The proposed action for each waste type is listed below.

2.1.5.1 PCB wastes

Fifty metric tons of capacitors containing PCBs are proposed for shipment to Deer Park, Texas, for treatment and disposal. The capacitors would be shipped in 23 7A, Type A containers. Thirteen empty transformers weighing 78 metric tons would be shipped for off-site treatment and disposal at Deer Park, Texas, as well. These transformers contain some residual PCB contamination.

2.1.5.2 Low-level wastes

Approximately 4600 m^3 (162,447ft^3) of LLW would be disposed, primarily at the Nevada Test Site. In addition to these wastes, there are 22 T-Hoppers (5-ton containers) of UF_4 stored at the site. If it is determined that this material is a waste, it would likely be shipped as an LLW to the Nevada Test Site.

2.1.5.3 Mixed low-level wastes

Some MLLW would be shipped to Envirocare for treatment and disposal. The majority of this waste would be shipped to one or more of the Broad Spectrum Contractors (Waste Control Specialists LLC, Andrews, Texas; Allied Technology Group, Richland, Washington; Materials & Energy/Waste Control Specialists, Oak Ridge, Tennessee) for treatment and/or disposal.

2.1.5.4 TRU wastes

Approximately 6 m^3 of TRU liquids and solids are proposed for treatment on-site by cementation/ solidification and shipment to the TRU Waste Program at Oak Ridge National Laboratory (ORNL) for ultimate disposition. The state department of environment and conservation contends that off-site TRU waste whipments to Tennessee shall be for undelayed treatment, packaging, and shipment to the Waste Isolation Pilot Plant (WIPP) near Carlsbad, New Mexico. Impacts associated with further processing and shipment to the WIPP are addressed in the Final Environmental Impact Statement for Treating TRU and Alpha LLW (DOE 2000a).

2.1.6 Waste Disposition Supporting Activities

The proposed action for supporting waste disposition activities is to perform these activities in accordance with DOE orders, federal and state regulations, and approved Bechtel Jacobs Company, LLC (BJC) or BJC subcontractor procedures. These activities are performed mainly during waste management and maintenance at the Paducah Site. Applicable procedures are implemented to ensure that activities are performed in a safe and accountable manner. Examples of supporting activities include, but are not limited to, the following:

- waste staging,
- on-site waste movement,

- packaging/repackaging,
- sorting,
- volume reduction,
- physical,
- waste container decontamination,
- inspection,
- marking/labeling,
- characterization, and
- facility modifications or upgrades.

2.1.7 DMSA Characterization

Quantities of DMSA solid and liquid waste are stored on-site at approximately 160 locations at the Paducah Site. The DMSA waste volumes include approximately 20,000 m^3 (705,000 ft^3) of solid and liquid waste of which potentially 2.5% or approximately 500 m^3 (17,625 ft^3) could be RCRA/TSCA waste. Due to the undetermined nature of a majority of the DMSA wastes, Nuclear Criticality Safety (NCS) characterization must be performed. DOE's proposed action includes this type of characterization in addition to standard waste management operations. NCS characterization provides the information necessary to move or manage materials safely without the threat of uncontrolled nuclear criticality. NCS characterization includes the DMSA inspector's determination of the proper NCS status for items that would be based upon a review of documentation, process knowledge, and/or visual inspection. Based upon the completion of the NCS characterization, standard waste management operations would commence, including waste sampling, characterization, sorting, and movement.

2.2 NO ACTION ALTERNATIVE

In the No Action alternative (i.e., long-term storage), DOE would not perform disposition activities except for those needed for waste management and maintenance. No disposal of the existing and projected quantities of various wastes outlined in Table 1.1 and discussed under the proposed action would occur. It should be noted that the No Action alternative would not be compliant with regulatory agreements or the statutory and regulatory provisions described in Sect. 1.1. Ongoing non-CERCLA waste management operations would continue.

2.2.1 Storage

The majority of wastes discussed would remain in on-site storage and would require regular maintenance and surveillance by the Paducah Site staff. Also included under the No Action alternative would be facility upgrades and repackaging as needed. The WM-PEIS (DOE 1997) assessed long-term storage as its No Action alternative.

Because existing storage space would be rapidly exhausted, new facilities would have to be constructed on-site to store newly generated wastes and some legacy wastes that cannot remain in outside storage. The siting of a new waste storage facility has not been determined. Construction and operation of a potential new storage facility at a location in the northwest portion of the Paducah Site was analyzed in an environmental assessment and found to have no significant impact (DOE 1994).

2.2.2 On-Site treatment

On-site treatment would be performed on wastes that require some type of stabilization prior to storage. Any on-site waste treatment requiring indoor processing would occur in Bldg. C-752-A or another suitable location. The on-site treatment technologies are limited by the RCRA Part B permit. Only a subset of permitted technologies are anticipate to be implemented and are discussed in detail in Sect. 2.1.

2.2.3 Off-site treatment

Under the No Action alternative, no waste would be shipped off-site for treatment.

2.2.4 Waste Transport

Relatively small volumes of waste would continue to be shipped to DOE or commercial disposal facilities under existing and previously approved categorical exclusions (CXs). As these CXs expire, no new ones would be placed, and the waste would then be stored on-site.

2.2.5 Waste Disposal

No waste disposal would occur under the No Action alternative.

2.2.6 Waste Disposition Supporting Activities

Supporting activities for waste under the No Action alternative are the same as for the proposed action, as discussed in Sect. 2.1.6.

2.2.7 DMSA Characterization

No DMSA characterization would occur under the No Action alternative. The DMSA materials would remain stored as they are currently.

2.3 ENHANCED STORAGE ALTERNATIVE

In the Enhanced Storage Alternative (i.e., fortified, long-term storage), DOE would not perform disposition activities except for those needed for waste management and maintenance. This alternative is identical to the No Action alternative except the storage facilities would be constructed for resistance to disasters (such as earthquakes, fires and breech accidents). No disposal of the existing and projected quantities of various wastes outlined in Table 1.1, and discussed under the proposed action, would occur. It should be noted that the enhanced storage alternative would not be compliant with regulatory agreements or the statutory and regulatory provisions described in Sect. 1.1. Ongoing non-CERCLA waste management operations would continue.

2.3.1 Storage

The wastes discussed would be placed in an enhanced on-site storage facility and would require regular maintenance and surveillance by the Paducah Site staff. Also included under this alternative are facility upgrades and waste repackaging as needed.

Because existing storage space does not meet enhanced storage definitions, new facilities would have to be constructed on-site to store wastes. The location of a new enhanced storage facility has not been determined. Construction and operation of a potential new storage facility at a location in the northwest portion of the Paducah Site was analyzed in an environmental assessment and found to have no significant impact (DOE 1994).

2.3.2 On-Site treatment

On-site treatment would be performed on wastes that require stabilization prior to storage. Any on-site waste treatment requiring indoor processing would occur in Bldg. C-752-A or another suitable location. The on-site treatment technologies are limited by the RCRA Part B permit. Only a subset of permitted technologies is anticipated to be implemented and is discussed in detail in Sect. 2.1.

2.3.3 Off-site treatment

Under the Enhanced Storage alternative, no waste would be shipped off-site for treatment.

2.3.4 Waste Transport

Relatively small volumes of waste would continue to be shipped to DOE or commercial disposal facilities under existing and previously approved CXs. As these CXs expire, no new ones would be placed, and the waste would then be stored on-site.

2.3.5 Waste Disposal

No waste disposal would occur under the Enhanced Storage alternative.

2.3.6 Waste Disposition Supporting Activities

Supporting activities for waste under the Enhanced Storage alternative are the same as for the proposed action, as discussed in Sect. 2.1.6.

2.3.7 DMSA Characterization

DMSA characterization would occur as planned for the proposed alternative under the Enhanced Storage alternative.

2.4 ALTERNATIVES CONSIDERED BUT DISMISSED

2.4.1 On-Site Treatment of All Wastes

On-site treatment of all wastes has been dismissed because some technologies needed for waste treatment do not currently exist at the site. Building new facilities to treat all waste types would not be cost effective, would be contrary to decision documents already placed by DOE (see Tables 1.2 and 1.3), and, finally, would not be compliant with the regulatory agreements discussed in Sect. 1.1. On-site treatment of a small amount of waste is proposed under the proposed action and would be accomplished in accordance with the site's RCRA permit and regulatory agreements.

2.4.2 Off-Site Treatment of All Wastes

Off-site treatment of all wastes has been dismissed because some treatment activities are necessary to meet U.S. Department of Transportation (DOT) transportation requirements. Shipping certain waste without treatment would result in violation of DOT regulations. This alternative would also be contradictory to decision documents already placed by DOE (Table 1.2).

2.4.3 On-Site Disposal of All Wastes

DOE considered the option to dispose all wastes on-site. This action would result in the need for new landfill cells built for this purpose. This alternative was not considered reasonable. DOE has already analyzed waste from across the DOE complex and has decided where various waste types should be disposed (see Tables 1.2 and 1.3). In addition, some wastes would have to be shipped offsite for treatement then back to the Paducah site for disposal. Risks associated with shipment of wastes offsite for treatment back to the site for disposal, combined with the impacts from constructing new landfill cells, argue against such an alternative. Finally, this alternative is opposed by local residents; therefore, it was not evaluated further.

THIS PAGE INTENTIONALLY LEFT BLANK.

3. AFFECTED ENVIRONMENT

This chapter describes the existing environment in and around the site of the proposed project at the Paducah Site. Information presented pertaining to the proposed transportation routes includes the total mileage (with a breakdown of rural, suburban, and urban miles) and the population density along the highway and rail transportation routes. Methods for determining impacts to the existing area are presented in Appendix C.

The Paducah Site is located within the Jackson Purchase region of western Kentucky in McCracken County, approximately 5.6 km (3.5 miles) south of the Ohio River and 32 km (20 miles) east of the confluence of the Ohio and Mississippi rivers. Even though disposal of USEC program wastes are not evaluated in this document, the following descriptions include all of the Paducah Site, including the portion of the plant that is leased to USEC.

3.1 LAND USE

The Paducah Site is located on a 3423-acre site owned by DOE. Most plant facilities (with the exception of landfills) lie within a fenced security area consisting of 749 acres. Surrounding the security area, DOE maintains a buffer zone of approximately 595 acres, which is used for support services, including the wastewater treatment plant (WWTP) and lagoons for plant water influx and efflux. The buffer zone also contains a construction/demolition debris landfill. The remaining 2079 acres are licensed to the Commonwealth of Kentucky for the purpose of wildlife management in the West Kentucky Wildlife Management Area (WKWMA). The Kentucky Department of Fish and Wildlife Resources (KDFWR) manages this area for the purpose of establishing or maintaining viable wildlife habitat. The property within the buffer zone is not licensed to the Commonwealth of Kentucky, although some is managed by KDFWR with the permission of DOE. DOE maintains the right to assume possession of any property within the buffer zone immediately, if deemed necessary.

The closest municipality to the Paducah Site is the city of Paducah, located approximately 16 km (10 miles) to the east. Several small communities are situated within an 8-km (5-mile) radius of the DOE property boundaries; these include Heath and Grahamville to the east and Kevil to the southwest. Metropolis, Illinois, is located north of the Paducah Site across the Ohio River. Bordering the DOE property to the northeast is the Shawnee Steam Plant, which is owned and operated by Tennessee Valley Authority (TVA). The area surrounding the Paducah Site is predominantly rural, with residences and farms scattered throughout the region.

3.2 GEOLOGY AND SEISMICITY

3.2.1 Geology

The near-surface geology at the Paducah Site, to a depth of approximately 30 m (100 ft), consists of clastic (made up of fragments) continental and marine deposits. The clastic continental deposits are represented by two sedimentary sequences from two distinct depositional periods. The younger clastic sequence, known as the Upper Continental Deposits (UCD), is a silt and clay lacustrine deposit with isolated sand and gravel lenses; it frequently contains perched water zones that comprise the Upper Continental Recharge System (UCRS).

The older clastic sequence, known as the Lower Continental Deposits (LCD), contains a 6- to 21-m (20- to 70-ft)-thick sand and gravel facies that forms the Regional Gravel Aquifer (RGA), which is the primary source of drinking water north of the Paducah Site. No residences in the immediate vicinity of the Paducah Site rely upon the RGA for groundwater supply, as most have been supplied with municipal water. No economic geological resources (e.g., mineral deposits) have been identified at the Paducah Site.

3.2.2 Seismicity

The Paducah Site is located in an area with a seismic risk rating of 3, the most severe rating on a scale of 1 to 3. Several minor seismic tremors have been recorded at the Paducah Site since the early 1950s; the largest, in 1962, measured 5.5 on the Richter scale. There has, however, never been a release of contaminants or structural failure at the Paducah Site as the result of seismic activity.

3.3 SOILS AND PRIME FARMLAND

3.3.1 Soils

The soils in the vicinity of the Paducah Site consist of silty loam and silty clay loam lying above the loess and alluvium surficial deposits. Six soil series are mapped in proximity to the Paducah Site (USDA 1976). These soil series include the Calloway silt loam, Grenada silt loam, Loring silt loam, Falaya-Collins silt loam, Vicksburg silt loam, and Henry silt loam. The Calloway-Henry association is the predominant soil association found in the vicinity of the Paducah Site. All but the Henry series can be considered prime farmland based on general soil properties.

Henry soils are nearly level, poorly drained soils with a fragipan (having a higher bulk density than the soil above, seemingly cemented when dry, but showing moderate to weak brittleness when moist) that formed in thick deposits of loess or alluvium. Henry soils have moderate permeability [from 1.6 to 5.08 cm/h (0.63 to 2.0 in./h)] above the fragipan, which forms between 43 and 66 cm (17 and 26 in.) from the surface, and slow permeability [<0.5 cm/h (<0.2 in./h)] within and below the fragipan. The water table is perched above the fragipan and extends to the surface during wet seasons (USDA 1976).

Calloway silt loam is somewhat poorly drained with a fragipan that formed in loess. These soils have moderate permeability [from 1.6 to 5.08 cm/h (0.63 to 2.0 in./h)] above the fragipan, which is between 66 and 127 cm (26 and 50 in.) below the surface, and slow permeability [<0.5 cm/h (<0.2 in./h)] within and below the fragipan. These soils have perched water tables that are from 15 to 46 cm (6 to 18 in.) below the surface during wet seasons. Slopes range from 0 to 6%.

Soils in the Grenada series are moderately well drained and were formed in loess on relatively smooth uplands and in alluvium washed mostly from loess on stream terraces. The depth to the fragipan ranges from 30 to 61 cm (12 to 24 in.), with an average depth of 36 cm (14 in.). The soil above the fragipan is moderately permeable [from 1.6 to 5.08 cm/h (0.63 to 2.0 in./h)], while the fragipan is relatively impermeable [<0.5 cm/h (<0.2 in./h)]. Soils below the fragipan have moderately slow permeability [from 0.5 to 1.6 cm/h (0.2 to 0.63 in./h)]. The water table is perched above the fragipan during wet periods.

The Vicksburg series consists of well-drained, nearly level soils on floodplains of branches and creeks. These soils formed in sediments washed mainly from loess. These soils have moderate permeability [from 1.6 to 5.08 cm/h (0.63 to 2.0 in./h)]. The water table is generally from 0.6 to 0.9 m (2 to 3 ft) below ground surface. Some soils are subject to flooding, but the floods are generally for short duration, and the erosion hazard is slight (USDA 1976).

3.3.2 Prime Farmland

Prime farmland, as defined by the U.S. Department of Agriculture Natural Resources Conservation Service, is land that is best suited for food, feed, forage, fiber, and oilseed production. It does not include "urban built-up land or water" (7 *CFR* 657 and 658). The Natural Resources Conservation Service determines prime farmland primarily on the basis of soil types found to exhibit desirable soil properties. These soil properties include soil quality, growing season, moisture supply, and other properties needed to produce sustained high yields of crops in an economical manner.

The following soil series, located in the vicinity of the Paducah Site, are considered to be representative of prime farmland: Calloway silt loam, Falaya-Collins silt loam, Grenada silt loam, Loring silt loam, and Vicksburg silt loam. These soil types are not likely to be found at the site. The soils at the site have been disturbed as a result of construction and maintenance activities at the Paducah Site since the early 1950s.

3.4 WATER RESOURCES AND WATER QUALITY

3.4.1 Water Resources

The Paducah Site is located in the western part of the Ohio River Basin. The confluence of the Ohio and Tennessee rivers is approximately 16 km (10 miles) upstream of the site. The confluence of the Ohio River with the Mississippi River is approximately 32 km (20 miles) downstream of the site.

The Paducah Site is located on a local drainage divide; surface flow is to the east and northeast toward Little Bayou Creek and to the west and northwest toward Bayou Creek. The confluence of the creeks is approximately 5 km (3 miles) north of the site. Little Bayou Creek originates in the WKWMA and flows north toward the Ohio River along a 10.5-km (6.5-mile) course through the eastern portion of the DOE reservation.

The 11,910-acre drainage basin of Bayou Creek is about twice that of Little Bayou Creek (approximately 6000 acres). During dry periods, natural runoff makes up the flow in Bayou and Little Bayou creeks.

Bayou Creek is a perennial stream; its drainage basin extends from approximately 4 km (2.5 miles) south of the Paducah Site to the Ohio River. Bayou Creek flows north toward the Ohio River along a 14-km (9-mile) course that passes along the western boundary of the site..

3.4.2 Water Quality

Kentucky Department of Environmental Protection (KDEP) has not formally classified Little Bayou Creek. According to state regulations [401 *Kentucky Administrative Regulations* (*KAR*) 5:026], however, any waters not specifically classified by KDEP are otherwise designated for the following uses: warm water aquatic habitat, primary contact recreation, secondary contact recreation, and domestic water supply; therefore Little Bayou Creek is classified for these uses by default. Little Bayou Creek receives point and nonpoint source effluent discharges from the Paducah Site, including process effluent, treated sewage, and storm water discharge under KPDES permit KY00040. The Paducah Site's effluent discharges account for nearly all of the flow in Little Bayou Creek.

Bayou Creek receives effluent discharge from the Paducah Site, including process effluent, treated sewage, and storm water discharge under KPDES permit KY0004049 (October 22, 1986) and an Agreed Order with the Commonwealth of Kentucky (October 12, 1987). The most current KPDES permit became effective on April 1, 1998, and has an expiration date of March 31, 2003.

3.4.3 Groundwater

The uppermost aquifer in the Paducah Site area, the RGA, is developed in the lower gravel facies of the LCD. Recharge occurs as leakage from the UCD, including the UCRS. In general, flow in the RGA is to the north, to discharge into the Ohio River or alluvial deposits along the river. The predominantly fine-grained deposits of the McNairy Formation act as a basal confining layer for the RGA. Groundwater movement within the McNairy aquifer is north toward the Ohio River (DOE 2000c).

The UCRS is composed of heterogeneous silt and clay layers with interbedded or interlensed layers of sand and gravel. The distribution and depth of the sand and gravel layers determine the location of the water table within this recharge system. The discontinuous sandy horizons interbedded with finer-grained units result in perched groundwater throughout the UCRS.

Groundwater flow through the loess and clay-silt facies of the UCD is predominantly downward in the Paducah Site area. Seasonally saturated perched zones occur in the surficial soils above fragipans and in isolated sand lenses of the UCD. These sand lenses can produce only limited quantities of water during wet seasons. The limited extent of sands in the UCD offers little enhancement of pathways for pollution migration. Use of perched aquifers for water supply is unknown in the Paducah Site area but cannot be ruled out. Groundwater flow through the UCD is predominantly vertically downward rather than horizontally outward, and the sands are generally saturated only seasonally.

3.4.4 Floodplains

Flooding in the vicinity of the storage site and the proposed on-site treatment area would be caused by headwater flooding from Little Bayou Creek and would not be affected by backwater flooding from the Ohio River for a 500-year or lesser flood. The 100-year flood elevation for Little Bayou Creek ranges from about 108 to 110 m (355 to 360 ft) above mean sea level (MSL) about 1.6 km (1 mile) east of the site. The elevation of the nearest tributary to Little Bayou Creek is approximately 105 m (345 ft) above MSL. Ground surface elevations are approximately 111 m (365 ft) above MSL, which is well above the 100-year and 500-year flood elevations.

Headwater flooding from Bayou Creek could cause flooding in the vicinity of the storage site and would not be affected by backwater flooding from the Ohio River for a 500-year or lesser flood. The 100-year flood elevation for Bayou Creek ranges from about 111 to 111.5 m (365 to 366 ft) above MSL. The 500-year flood elevation ranges from about 111.5 to 112 m (366 to 367 ft) above MSL.

3.4.5 Wetlands

According to the U.S. Army Corps of Engineers (COE) Wetlands Investigation Report (COE 1994, Vol. IV), there are no wetlands within the boundaries of the storage site and the on-site treatment area. However, a small wetland of about 1 acre is mapped near the northwest corner of the site. As previously stated in the COE report, none of the potentially affected wetlands is of high ecological value in a regional context.

3.5 ECOLOGICAL RESOURCES

3.5.1 Vegetation

The DOE reservation at Paducah is a highly disturbed area. Vegetation communities are indicative of old-field succession (i.e., grassy fields, field scrub-shrub, and upland mixed hardwoods).

Open grassland areas managed by WKWMA are periodically mowed or burned to maintain early successional vegetation, which is dominated by members of the composite family and various grasses. Management practices of the WKWMA encourage re-establishment of once-common native grasses such as eastern gama grass (*Tripsacum dactyloids*) and Indian grass (*Sogastrum sp*.). Commonly cultivated for wildlife forage are corn, millet, milo, and soybean (CH2M HILL 1992). Field scrub-shrub communities consist of sun-tolerant woody species such as persimmon (*Diospyros virginiana*), maples (*Acer spp.*), black locust (*Robinia pseudoacacia*), sumac (*Rhus spp.*), scattered oaks (*Quercus spp.*), and mixed hardwood species (CH2M HILL 1992). The understory may vary depending on the location of the woodlands. Wooded areas near maintained grasslands may have an understory dominated by grasses. Other communities may contain a thick understory of shrubs, including sumac, pokeweed (*Phytolacca americana*), honeysuckle (*Lonicera japonica*), blackberry (*Rubus sp*.), and grape (*Vitis sp*.).

Upland mixed hardwoods contain a variety of upland and transitional species. Dominant species include oaks, shagbark and shellbark hickory (*Carya ovata, C. laciniosa*), and sugarberry (*Celtis laevigata*) (CH2M HILL 1992). The understory may vary from very open, with limited vegetation for more mature stands of trees, to dense undergrowth similar to those described for a scrub-shrub community.

3.5.2 Wildlife

This section describes the terrestrial (Sect. 3.5.2.1) and aquatic (Sect. 3.5.2.2) animals that have been observed at the Paducah Site and surrounding area.

3.5.2.1 Terrestrial Wildlife

Wildlife commonly found at the Paducah Site consists of species indigenous to open grassland, thickets, and forest habitats. Observations by ecologists during investigations at the site and information from WKWMA staff provided a qualitative description of wildlife likely to inhabit the vicinity of the site. The primary game species hunted for food in the area are deer (*Odocoileus virginianus*), turkey *(Meleagris gallopavo),* opossum *(Didelphis marsupialia),* rabbit *(Sylvilagus floridanus),* raccoon *(Procyon lotor),* and squirrel *(Sciurus* spp. and *Tamiasciurus hudsonicus).* Both game and nongame species are attracted to the area because of the intense habitat management program that has been implemented in the WKWMA (CH2M HILL 1991). Herpetofauna (amphibian and reptile), bird, and mammal species occurring at the Paducah Site are listed in tables in Appendix D of this report.

Small mammal surveys conducted on the WKWMA [Kentucky State Nature Preserves Commission (KSNPC) 1991] documented the presence of southern short-tailed shrew *(Blarina carolinensis),* prairie vole *(Microtus ochrogaster),* house mouse *(Mus musculus),* rice rat *(Oryzomys palustris),* and deer mouse *(Peromyscus sp.).* Larger mammals commonly present in the area include coyote *(Canis latrans),* eastern cottontail *(Sylvilagus floridanus),* opossum *(Didelphis marsupialis),* groundhog *(Marmota monax),* white-tailed deer *(Odocoileus virginianus),* raccoon *(Procyon lotor),* striped skunk *(Mephitis mephitis),* and gray squirrel *(Sciurus carolinensis).* Mist-netting activities in the Paducah Site area have captured red bat *(Lasiurus borealis),* little brown bat *(Myotis lucifugus),* Indiana bat *(Myotis sodalis)*, northern long-eared bat *(Myotis septentrionalis),* evening bat *(Nycticeus humeralis)*, and eastern pipistrelle *(Pipistrellus subfavus).*

Late spring roadside surveys conducted by Battelle (1978) reported 45 species of birds in the Paducah Site area, with northern bobwhite *(Colinus virginianus),* northern cardinal *(Cardinalis cardinalis),* indigo bunting *(Passerina cyanea),* common grackle *(Quiscalus quiscula),* eastern towhee (*Pipilo erythrophthalmus),* and European starling *(Sturnus vulgaris)* being the most abundant. Other common species include mourning dove *(Zenaida macroura),* barn swallow *(Hirundo rustica),* blue jay *(Cyanocitta cristata),* common crow *(Corvus brachyrhynchos),* northern mockingbird *(Mimus polyglottos),* brown thrasher *(Toxostoma rufum),* common yellowthroat *(Geothlypis trichas),* eastern meadowlark *(Sturnella magna),* and red-winged blackbird *(Agelaius phoeniceus).* The red-tailed hawk *(Buteo jamaicensis)* and American kestrel *(Falco sparverius)* were the most common raptors.

Several reptile and amphibian species are present in the vicinity of the Paducah Site. Herpetofauna documented by the KSNPC include cricket frogs *(Acris crepitans),* Fowler's toad *(Bufo woodhousii fowleri),* common snapping turtle *(Chelydra serpentina),* green treefrog *(Hyla cineria),* chorus frog *(Psuedacris triseriata),* southern leopard frog *(Rana ultricularia),* eastern fence lizard *(Sceloporus undulatus),* and red-eared slider *(Trachemys scripta elegans)* (KSNPC 1991).

3.5.2.2 Aquatic Wildlife

Streams. Semiannual surveys conducted by the ORNL Environmental Sciences Division (ESD) from 1992 through 1998 documented fish diversity in Bayou and Little Bayou creeks (Roy et al. 1996; Ryon and Carrico 1998; Kszos et al. 1997). A list of species occurring in both creeks during the ESD survey period is shown in Table I.4 of Appendix D. Over all surveys, Bayou and Little Bayou creeks yielded 51 and 39 species, respectively. Based on density, central stoneroller *(Campostoma anomalum)* and longear sunfish *(Lepomis megalotis)* are the predominant fish inhabiting these streams. Four minnow species found in both creeks [common carp *(Cyprinus carpio),* red shiner *(Notropis lutrensis),* golden shiner *(Notemigonus crysoleucas),* and fathead minnow *(Pimephales promelas)*] and grass carp *(Ctenopharyngodon idellus),* collected in Bayou Creek, are not native to western Kentucky.

Slight differences in species composition between Bayou and Little Bayou creeks are probably attributable to differences in stream size and watershed area. More taxa were collected from Bayou Creek, which has an 11,910-acre catchment that is almost twice as large as the 6000-acre Little Bayou Creek catchment. Species that prefer large bodies of water—bowfin *(Amia calva),* river carpsucker (*Carpiodes carpio*), smallmouth buffalo *(Ictiobus bubalus),* bigmouth buffalo *(Ictiobus cyprinellus),* and black buffalo *(Ictiobus niger)*—were present in Bayou Creek but absent in Little Bayou Creek. Habitat conditions in Little Bayou Creek tend to favor mosquitofish *(Gambusia affinis),* blackspotted topminnow *(Fundulus olivaceous),* and green sunfish *(Lepomis cyanellus)* populations. Headwaters are more variable in flow regime and temporal habitat quality than are downstream areas; therefore, they favor species that are adapted either to consume a broader breadth of resources or to feed in a broader number of habitats. Mosquitofish and blackspotted topminnow, which both feed almost exclusively on insects at or near the surface, and green sunfish, a generalist omnivore, constitute a larger portion of communities in the upper reaches of Little Bayou Creek than at other sites in area streams.

Lakes and Ponds. Lentic habitats, including 13 ponds used for fishing, are located primarily in the WKWMA. No ponds are present within the Paducah Site security fence. Largemouth bass *(Micropterus salmoides),* bluegill *(Lepomis macrochirus),* and, to a lesser extent, green sunfish are the predominant species inhabiting ponds. Recently, contaminants were found in ponds located in the Kentucky Ordnance Works area, resulting in posting of warning signs. Little Bayou Creek also was previously fished; however, detection of elevated concentrations of PCBs in fish taken from Little Bayou Creek resulted in posting of consumption warnings. Amphibians, muskrat *(Ondatra zibethicus),* beaver *(Castor canadensis),* and many species of water birds, including wood duck (Aix *sponsa),* Canada goose *(Branta canadensis),* great blue heron *(Ardea herodias),* and green heron *(Butorides striatus),* use pond habitats and associated riparian areas. In addition to fishing ponds, there are many smaller ponds and abandoned gravel pits in the area that usually contain water and may support aquatic life.

3.5.3 Threatened and Endangered Species

Mussels including the orange-footed pimpleback (*Plethobasus cooperianus*), pink mucket pearly mussel (*Lampsilis arbrupta),* ring pink (*Obovaria retusa*), fat pocketbook (*Potamilis capax*), as well as the Indiana bat (*Myotis sodalis*) are federally listed endangered species that may be found in or near McCracken County (COE1994).

The KDFWR conducted a mist net survey during the summer of 1999 on the WKWMA, which surrounds the Paducah Site. Five Indiana bats were captured during the survey (KDFWR 2000). The four mussel species have not been identified in water resources near the Paducah Site however they have been recorded between river miles 945 and 949 of the Ohio River, downstream from Metropolis, Illinois, and downstream of the confluence of Bayou Creek and the Ohio River (KSNPC 2000).

Indiana bats winter in caves, but during their reproductive season (usually from May 15 to August 15), the bats would form colonies in mature trees with loose bark, such as shagbark hickory, especially near water (CH2M HILL 1992). The range of the endangered Indiana bat is the eastern United States from Oklahoma, Iowa, and Wisconsin east to Vermont and south to northwestern Florida. Distribution is associated with major cave regions and areas north of cave regions. The present total population is estimated at ca. 352,000 with more than 85 percent hibernating at only nine locations - two caves and a mine in Missouri, three caves in Indiana, and three caves in Kentucky.

The orange-footed pearly mussel, a clam, is a federally listed endangered species that inhabits sand and gravel shoals and riffles. Current range of this species includes the Ohio River in reaches adjacent to Ohio, Indiana, Illinois, and Kentucky. It is a species associated with large rivers.

The federally endangered pink mucket pearly mussel (41 FR 24062; June 14, 1976) is a bivalve aquatic mollusk in the Unionidae family with an elliptical-shaped shell. The pink mucket is found in medium to large rivers. It seems to prefer larger rivers with moderate- to fast-flowing water, at depths from 0.5 to 8.0 m (1.6 to 26.2 ft). The species has been found in substrates including gravel, cobble, sand, or boulders. Currently, the pink mucket is known in 16 rivers and tributaries from 7 states, with the greatest concentrations in the Tennessee (Tennessee, Alabama) and Cumberland (Tennessee, Kentucky) rivers and in the Osage and Meramec rivers in Missouri. Smaller populations have been found in the Clinch River (Tennessee); Green River (Kentucky); Ohio River (Illinois); Kwanawha River (West Virginia); Big Black, Little Black, and Gasconde rivers (Missouri); and Current and Spring rivers (Arkansas).

The ring pink mussel was listed as an endangered species without critical habitat on September 29, 1989 (54 FR 40109). The U.S. Fish and Wildlife Service (FWS) (FWS 1991) formerly referred to this mussel as the golf stick pearly mussel. The ring pink mussel is one of the most endangered mussels because all of the known populations are apparently too old to reproduce. This mussel is characterized as a large-river species (FWS 1991). Historically, this mussel was widely distributed and found in several major tributaries of the Ohio River, including those that stretched into Alabama, Kentucky, Illinois, Indiana, Ohio, Pennsylvania, and West Virginia. However, the species was last taken in Pennsylvania in 1908, and in Ohio in 1938 (FWS 1991). According to records, this species has not been collected in Indiana in decades, and has not been collected from Illinois in over 30 years (FWS 1991).

The fat pocketbook mussel was listed as a federally endangered species in 1976 (41 FR 24064). The fat pocketbook mussel inhabits rivers and streams with sand, mud, or gravel substrates. It prefers slow-flowing water where depths range from a few inches to 8 ft. There are few published records on the historical distribution of this species for the period prior to 1970. Museum records indicated that most fat pocketbook occurrences were from three areas; the upper Mississippi River (above St. Louis, Missouri), the Wabash River in Indiana, and the St. Francis River in Arkansas. There are a few historic records of this species occurring in the Illinois River, but is has not been found in recent years (FWS 1989). Currently, the fat pocketbook in the mid-west is found only in the lower Wabash River in Indiana, the Ohio River adjacent to Kentucky, Indiana, and Illinois, and in the lower Cumberland River in Kentucky (FWS 1989).

The potential occurrence of federally and state-listed threatened and endangered species at the Paducah Site was determined by contacting the USFWS, KDFWR, and the KSNPC. Consultation letters describing the proposed action were submitted to the agencies requesting comments regarding potential effects of the proposed action. Copies of these letters and responses from the agencies are in Appendix E.

The consultation response from the FWS dated August 16, 2001, requested that a Biological Assessment be prepared for the Indiana bat and 4 mussel species. Preparation of the Biological Assesment determined that the project, as proposed, would be unlikely to adversely affect the Indiana bat or any mussel species of concern because:

- while a potential for exposure of the bat and mussel species to waste as a result of an accident during implementation of the proposed action would be small and there is nothing conclusive to indicate that such exposure would be detrimental to the species;

- proposed waste disposition activities are currently being performed at the Paducah Site with no known detriment to the local Indiana bat or mussel populations. The numbers of Indiana bats caught from mist netting in the area has risen from 1 in 1991 to 5 in 2000 and mussel species have been sampled on the opposite side of the Ohio River as recently as 2000; (KSMC 2000)

- no bat foraging or roosting habitat is present inside the site fence where waste disposition activities would occur. Potential habitats identified outside the site fence would not be affected by routine waste disposition activities;

- the majority of mussel habitat in the area has been identified up stream from the Paducah Site would not be affected by routine waste disposition operations; no mussel habitat exists inside the site fence and where waste disposition activities are proposed;

- bat foraging habitat (riparian vegetation along intermittent tributaries) present near the site of the proposed action is unlikely to become contaminated;

- routine waste management operating procedures would leave minimal opportunity for direct exposure of local biota and their prey, to wastes. This practice would also decrease the probability of accidents; and

- no bat or mussel habitat alteration or destruction would occur as a result of the proposed action.

A copy of the Final Biological Assessment in its entirety is included in Appendix F of this document.

There is no official listing of threatened or endangered species for the Commonwealth of Kentucky. A list of plant and animal species identified is maintained for monitoring purposes, by KSNPC (Table 3.1). There are currently no compliance requirements for these “state-listed” species.

Of the state-listed birds for the area [i.e., the endangered hooded merganser (*Lophodytes cucullatus*), the fish crow (*Corvus ossifragus*), and Bell’s vireo (*Vireo Bellii*)—all of which are species of special concern, only Bell’s vireo has been observed recently on the DOE reservation (CH2M HILL 1992). Commonwealth-listed mammals potentially occurring in the area include the evening bat (*Nycticeius humeralis*) and the northern long-eared bat (*Myotis septentrionalis*). None of the mammals has been observed on the DOE reservation. The KDFWR database lists the northern crawfish frog (*Rana areolata circulosa*), a species of special concern, as occurring within the Heath quadrangle, which contains the Paducah Site (KSNPC 1991). Additional animal species noted by other investigators as occurring within the area, but not listed by KDFWR or KSNPC as occurring in McCracken County, include the lake chubsucker

(*Erimyzon sucetta*), a state-threatened species, and the great blue heron (*Ardea herodias*), a species of special concern. The lake chubsucker has been found in Bayou Creek (CH2M HILL 1991), and the great blue heron has been observed during site reconnaissance near KPDES Outfall 001 (CDM 1994) and in other plant industrial ponds. Commonwealth-listed animal species known from McCracken County are presented in Table 3.1; however, not all of these species are known from the vicinity of the Paducah Site.

Commonwealth-listed endangered and threatened plants that may occur in the area include the endangered Carolina silverbell (*Halesia carolina*) and the threatened compass plant (*Silphium laciniatum*). The Carolina silverbell occurs in moist or hydric areas often associated with floodplains or other low-lying areas in which water collects (KSNPC 1991). The compass plant occurs within open fields and sometimes along roadsides (KSNPC 1991). Commonwealth-listed plant species known from McCracken County are listed in Table 3.2; however, not all of these species are known from the vicinity of the Paducah Site. Commonwealth of Kentucky-listed species are not afforded any special protection but should be monitored, if possible, for location and abundance.

No commonwealth or federally listed plant species are known or are likely to occur within the Paducah Site security fence. Habitat at the proposed work site has been previously disturbed, is mowed on a regular basis, and is unlikely to support any of the aforementioned listed species. Because of the availability of suitable habitat at the Paducah Site, the following three Commonwealth of Kentucky-listed species might occur: (1) Bell’s vireo (but this species has not been sighted near the Paducah Site recently), (2) the great blue heron (which has been observed), and (3) the Carolina silverbell, due to the moist woodlands on the site. Thorough evaluations, however, have not identified the Carolina silverbell at the site. Shagbark hickories and elms, known to occur in the wooded areas, may provide suitable habitat for the federally listed Indiana bat. Given the close proximity to industrial operations, it is unlikely that Indiana bats would select an area at the Paducah Site for colonization, especially when more suitable areas (i.e., more secluded and mature woodlands) are readily available in the vicinity.

Habitat for the Bachman’s sparrow (*Aimophila aestivalis*), a federal candidate species, includes pasture, old-field habitat, short shrub or fencerow ecotones, or previously disturbed grassland areas. Such habitat does exist in the vicinity. No formal information exists related to sightings of this species in the vicinity of the proposed work areas; however, this species is not afforded any special protection, and Sect. 7 requirements of the Endangered Species Act do not apply.

3.5.4 Parks and Scenic Rivers

There are no state or national parks, forests, conservation areas, or scenic and wild rivers in the vicinity of the Paducah Site.

3.6 NOISE

Ambient noise levels are not measured at the Paducah Site or at any nearby facilities. There are currently no local ordinances concerning noise regulation. The Commonwealth of Kentucky has a law concerning noise regulation; however, no enforcement or monitoring program exists, and no regulations governing the implementation of this law have been promulgated.

Noise from industrial processes taking place at the plant is generally restricted to the interior of the plant buildings. Noise levels beyond the plant security fence are generally the result of vehicular traffic moving through the area.

Table 3.1. Commonwealth of Kentucky threatened, endangered, and "special concern" animal species known from McCracken County, Kentucky

Threatened species	Endangered species	"Special concern" species
Erimyzon sucetta (lake chubsucker)	*Acipenser fulvescens* (lake sturgeon)	*Ardea herodias* (great blue heron)
Hyla avivoca (bird voiced tree frog)	*Hialaeetus leucocephalus** (bald eagle)	*Corvus ossifragus* (fish crow)
Lepomis punctatus (spotted sunfish)	*Hybognathus hayi* (cypress minnow)	*Esox niger* (chain pickerel)
Lepomis minatus (redspotted sunfish)	*Lampsilis abrupta** [pink mucket (mussel)]	*Hyla cinerea* (green tree frog)
Macroclemys temminckii (alligator snapping turtle)	*Lepisosteus spatula* (alligator gar)	*Ichthyomyzon castaneus* (chestnut lamprey)
Notropis maculatus (taillight shiner)	*Lophodytes cucullatus* (hooded merganser)	*Ictiobis niger* [black buffalo (fish)]
Nycticeius humeralis (evening bat)	*Myotis sodalis* (Indiana bat)	*Lota lota Burbot* (fresh water cod)
	Orconectes lancifer (crayfish)	*Myotis septentrionalis* (northern long-ear bat)
	Obovaria retusa [rink pink (mussel)]	*Nerodia erythrogaster* (copperbelly water snake)
	*Plethobasus cooperianus** [orange foot pimpleback (mussel)]	*Notropis venustus* (blacktail shiner)
		Noturus stigmosus [northern madtom (fish)]
	Myotis austroriparius (Southeastern bat)	*Rana areolata* (northern crawfish frog)
	Potamilus capax [fat pocketbook (mussel)]	*Riparia riparia* (bank swallow)
		Vireo bellii [bell's vireo (bird)]

Table 3.2. Commonwealth of Kentucky threatened, endangered, and "special concern" plant species known from McCracken County, Kentucky

Threatened species	Endangered species	"Special concern" species
Halesia carolina (carolina silverbell)	*Hypericum adpressum* (creeping St. John's-wort)	*Baptisia leucophaea* (cream wild indigo)
Rudbeckia subtomentosa (sweet coneflower)	*Prenanthes aspera* (rough rattlesnake-root)	*Carex triangularis* (fox sedge)
Silphium laciniatum (compass plant)		*Carya aquatica* (water hickory)
		Heterotheca latifolia (broad-leaf golden aster)
		Lathyrus palustris (vetchling peavine)
		Malus angustifolia (Southern crab apple)
		Muhlenbergia glabriflora (hair grass)
		Solidago buckleyi (buckley's goldenrod)

3.7 CULTURAL, ARCHAEOLOGICAL, AND NATIVE AMERICAN RESOURCES

Inside a study area of about 12,000 acres in and around the Paducah Site, there are 35 sites of cultural significance recorded with the State Historic Preservation Officer and several more unrecorded sites (COE 1994). Most of these are prehistoric and located in the Ohio River floodplain. Six of the sites are on DOE property at the Paducah Site but are not within the site fence. None of the sites is included in, or has been nominated to, the National Register of Historic Places, even though some are potentially eligible. There are no identified Native American resources in the area.

3.8 CLIMATE AND AIR QUALITY

3.8.1 Climate

The Paducah area is located in the humid continental zone, characterized by warm summers and moderately cold winters. The annual temperature in the Paducah area averages about 14°C (57°F), with the highest monthly average temperature of 26°C (79°F) in July and the lowest of approximately 2°C (35°F) in January (DOE 2000b, 1999). Annual precipitation averages about 124 cm (49 in.) and is primarily in the form of rain. Data for the period 1985–1993 indicate that the average relative humidity is about 86% at 6 a.m. and about 58% at noon (DOE 1999a).

Average wind speed in the area is about 8.1 mph based on the most recent available data collected at the Barkley Regional Airport near Paducah for the period 1985–1992 (EPA 2000). As shown in Fig. 3.1, dominant wind directions are from the south and south-southwest at an average wind speed of about 9.0 mph.

3.8.2 Air Quality and Applicable Regulations

The Paducah area is located in the Paducah-Cairo Interstate Air Quality Control Region. The commonwealth's ambient air quality standards for six criteria of air pollutants—sulfur oxides as sulfur dioxide (SO^2), particulate matter with an aerodynamic diameter less than 10 μm (PM_{10}), carbon monoxide, ozone, nitrogen dioxide, and lead—are identical to the national ambient air quality standards (401 *KAR* 53:010). The primary ambient air quality standards, which are for the protection of public health, and the secondary ambient air quality standards, which are for the protection of welfare and the environment, are listed in Table 3.3. In addition, the Commonwealth of Kentucky has promulgated ambient standards for hydrogen sulfide, gaseous and total fluorides, and odors. These standards also are shown in Table 3.3.

Current air quality is good in the Paducah area. The area is designated as a Class II prevention of significant deterioration (PSD) area. New emission sources are not permitted to "notably" degrade air quality, with significance, defined in terms of maximum ambient air increments established for a Class II area (401 *KAR* 51:017). The nearest Class I PSD areas, where more stringent ambient air quality requirements must be met, are the Mingo National Wildlife Refuge in Missouri, approximately 145 km (90 miles) west of the Paducah Site, and Mammoth Cave National Park in Mammoth Cave, Kentucky, 217 km (135 miles) east of the Paducah Site (DOE 1999a).

3.8.3 Ambient Air Monitoring Near the Paducah Site

The ambient air quality is monitored regularly in the Paducah area and at the Paducah Site. Both the Commonwealth of Kentucky and USEC operate a monitoring network to determine ambient air concentrations of regulated pollutants. Table 3.3 lists the highest background concentrations that can be considered representative of the Paducah area based on 1996 background data.

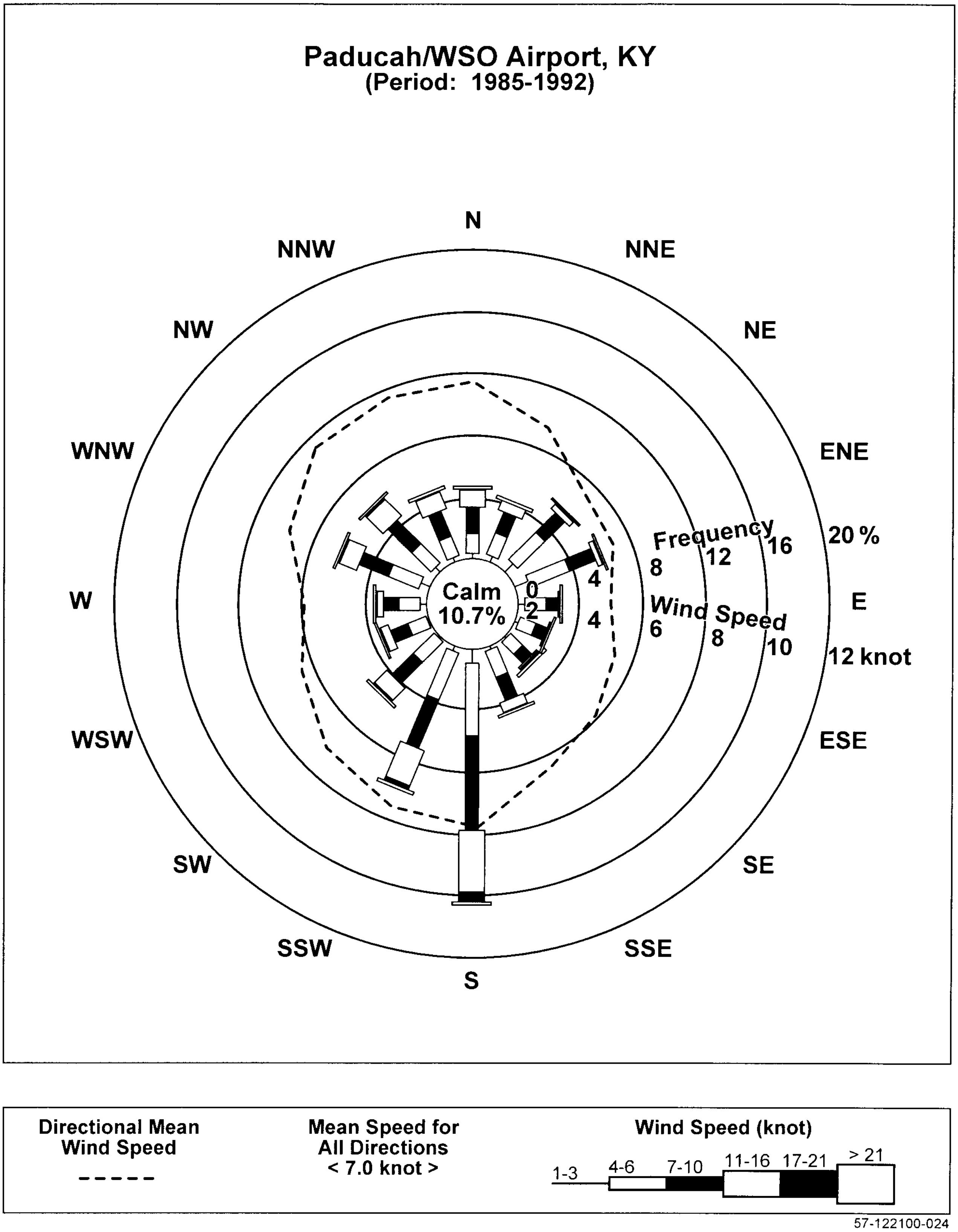


Fig. 3.1. Wind rose patterns of wind speed frequency and directional wind speed at the Barkley Airport.

Table 3.3. Commonwealth of Kentucky ambient air quality standards and highest background levels representative of the Paducah area*

Pollutant	Primary standard	Secondary standard	Highest background level
Sulfur oxides (sulfur dioxide) ($\mu g/m^3$)			
Annual arithmetic mean	80 (0.03 ppm)	–	13
Maximum 24-h average	365 (0.14 ppm)	–	55
Maximum 3-h average	–	1300 (0.50 ppm)	138
Particulate matter, measured as PM_{10} ($\mu g/m^3$)			
Annual arithmetic mean	50	50	24
Maximum 24-h average	150	150	83
Carbon monoxide (mg/m^3)			
Maximum 8-h average	10 (9 ppm)	Same as primary	4.9
Maximum 1-h average	40 (35 ppm)	Same as primary	6.9
Ozone ($\mu g/m^3$)			
Maximum 1-h average	235 (0.12 ppm)	Same as primary	182
Nitrogen dioxide ($\mu g/m^3$)			
Annual arithmetic mean	100 (0.05 ppm)	Same as primary	24
Lead ($\mu g/m^3$)			
Maximum arithmetic mean averaged over a calendar quarter	1.5	Same as primary	0.04
Hydrogen sulfide ($\mu g/m^3$)			
Maximum 1-h average	–	14 (0.01 ppm)	I
Gaseous fluorides, expressed as hydrogen fluoride ($\mu g/m^3$)			
Annual arithmetic mean	400 (0.5 ppm)	–	0.16
Maximum 1-month average	–	0.82 (1.00 ppb)	–
Maximum 1-week average	–	1.64 (2.00 ppb)	0.615
Maximum 24-h average	800 (1.0 ppm)	2.86 (3.50 ppb)	–
Maximum 12-h average	–	3.68 (4.50 ppb)	–
Total fluorides (ppm) Dry-weight basis (as fluoride ion) in and on forage for consumption by grazing ruminants. The following concentrations are not to be exceeded:			
• Average concentration of monthly samples over growing season (not to exceed six consecutive months)	–	40 (w/w)**	–
• 2-month average	–	60 (w/w)**	–
• 1-month average	–	80 (w/w)**	–

* Based on 1996 background data.
** w/w = weight/weight basis

The Paducah area, including the DOE Paducah Site, is currently an attainment area for all criteria pollutants. The largest air pollution sources near the Paducah area include USEC and TVA's coal-fired Shawnee Power Plant, approximately 5 km (3 miles) north-northeast of the Paducah Site. The Joppa Power Plant and the Allied Signal Metropolis Works Uranium Hexafluoride Conversion Plant are located across the Ohio River in Illinois; they are approximately 10 km (6 mi) northwest and 8 km (5 mi) northeast of the Paducah Site, respectively.

3.9 SOCIOECONOMICS AND ENVIRONMENTAL JUSTICE

3.9.1 Socioeconomics

The region of influence (ROI) for the socioeconomic impact analysis includes McCracken County, Kentucky, where the Paducah Site is located. Although surrounding counties also could be included, the assumption that all socioeconomic impacts would occur within the county identifies an upper bound on potential impacts. To the extent that any impacts spread to the surrounding counties, the relative effect on any one county would be smaller than those estimated here.

As of 1997, McCracken County's population totaled 64,773, with total employment of 45,879 and per capita income of $24,231 (BEA 1999). DOE and USEC currently employ about 2200 individuals at the Paducah Site (BJC 2000).

3.9.2 Environmental Justice

For the purposes of this analysis, a minority population consists of any area in which minority representation is greater than the national average of 24.2%. Minorities include individuals classified by the U.S. Bureau of the Census as Negro/Black/African-American, Hispanic, Asian and Pacific Islander, American Indian, Eskimo, and Aleut. Since Hispanics may be of any race, nonwhite Hispanics are included in only the Hispanic category and not under their respective minority racial classifications. The demographics of the Paducah Site, with respect to income level and minority status, were evaluated in detail in the WM-PEIS (DOE 1997). Overall, the population within an 80-km (50-mile) radius of the Paducah Site does not contain a higher minority representation than the national average. While several census tracts to the north and southwest include minority populations above the national average, these locations are not near the Paducah Site (DOE 1999a).

Because any adverse health or environmental impacts are likely to fall most heavily on the individuals nearest the Paducah facility, it is also important to examine the populations in the closest census tracts. As of the 1990 census, none of the tracts closest to the site contained minority populations above the national average. The highest minority representation was 5.2% in tract 314 (McCracken County) (Bureau of the Census 1990a). No federally recognized Native American tribes are in the area.

The WM-PEIS did determine that a higher percentage of the population surrounding the Paducah Site qualified as low income than the national average. In this analysis, a low-income population includes any census tract in which the percentage of persons with incomes below the poverty level is greater than the national average of 13.1% (Bureau of the Census 1990b). Of the tracts closest to the site, 9701, 9703, and 9501 show percentages of low-income populations above the national average; approximately 17% of each of these populations is low income. Tracts 9701 and 9703 are directly across the Ohio River in Massac County, Illinois. Tract 9501 is west of the site in Ballard County (Bureau of the Census 1990a).

3.10 TRANSPORTATION

Interstate 24 passes through Paducah, Kentucky, approximately 16 km (10 miles) east of the Paducah Site. Four federal highways (US 45, 60, 62, and 68) and many state highways traverse the area. Main access to the plant is via US Highway 60. Because the Paducah Site is located in a secured area, traffic is minimal within the plant and surrounding area and generally is limited to trucks or service vehicles that move equipment and supplies within the facility. Rail access is available on-site at the Paducah Site.

3.10.1 Transportation Routes from the Paducah Site

Wastes are transported in approved DOT, NRC, and DOE containers that meet the requirements of the waste receiver (see Sect. 4.1.2 for assumptions relating to waste types and containers). The proposed action would adhere to these requirements. If LLW were transported by commercial truck, the waste would be transported along interstate highways or other primary highways well suited to cargo-truck transport. If waste were transported by rail, existing commercial rail routes and schedules would be used.

3.10.2 Truck Routes from the Paducah Site to Treatment and Disposal Sites

The highway route characteristics from the Paducah Site to the representative treatment and proposed disposal sites in the proposed action are provided in Table 3.4. Table 3.5 shows the population along the representative routes.

Table 3.4. Highway route distances from the Paducah Site to each proposed destination

Destination	Rural distance (miles)	Suburban distance (miles)	Urban distance (miles)	Total distance (miles)
Andrews, TX	943.4	171.7	11.9	1127.0
Deer Park, TX	711.5	171.9	13.5	897.0
Hanford, WA	1977.8	206.0	23.1	2207.0
Clive, UT	1497.7	163.8	29.5	1691.0
Mercury, NV	1648.2	187.1	25.0	1861.0
Oak Ridge, TN	252.5	54.8	2.7	310.0
Atomic City, ID	1594.9	175.6	20.4	1791.0

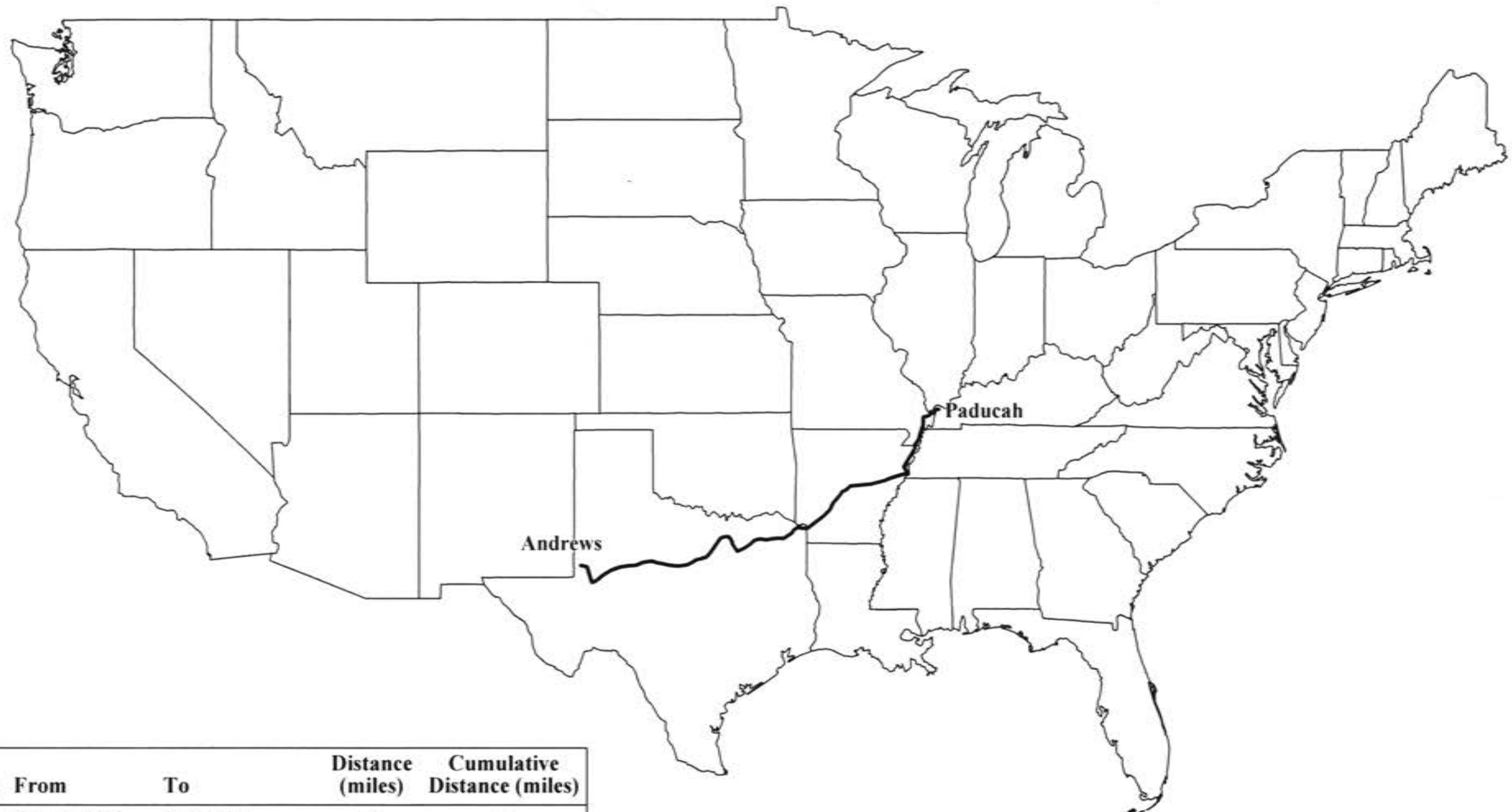
Source: Highway 3.4 code

Table 3.5. Potentially exposed populations along highway routes from the Paducah Site to each proposed destination

Route to	Potentially exposed population*
Andrews, TX	241,841
Deer Park, TX	236,130
Hanford, WA	353,676
Clive, UT	346,071
Mercury, NV	334,455
Oak Ridge, TN	56,958
Atomic City, ID	340,497

*Derived using population densities along highway links (source: Highway 3.4 code).

Representative highway transportation routes between the Paducah Site and proposed disposal destinations are outlined in Figs. 3.2 through 3.7. Routes were selected using TRAGIS® software. A



Roadway	From	To	Distance (miles)	Cumulative Distance (miles)
Local	Paducah GDP	Kevil, KY	4	4
U60	Kevil	Wickliffe, KY	19	23
U51	Wickliffe	Cairo, IL	5	28
I-57	Cairo	Charleston, MO	12	40
I-55	Charleston	Sikeston, MO	13	53
I-55	Sikeston	Hayti, MO	49	102
I-55	Hayti	West Memphis, AR	83	185
I-40	West Memphis	Galloway, AR	118	303
I-30	Galloway	Little Rock, AR	10	313
I-30	Little Rock	Texarkana, AR	136	449
I-30	Texarkana	Dallas, TX	179	628
I-35	Dallas	Dallas	.5	629
I-20	Dallas	White Settlement, TX	45	674
I-20	White Settlement	Odessa, TX	304	978
U385	Odessa	Andrews, TX	36	1014
S176	Andrews	Andrews	31	1045
S176	Andrews	WCS Site, TX	1	1046

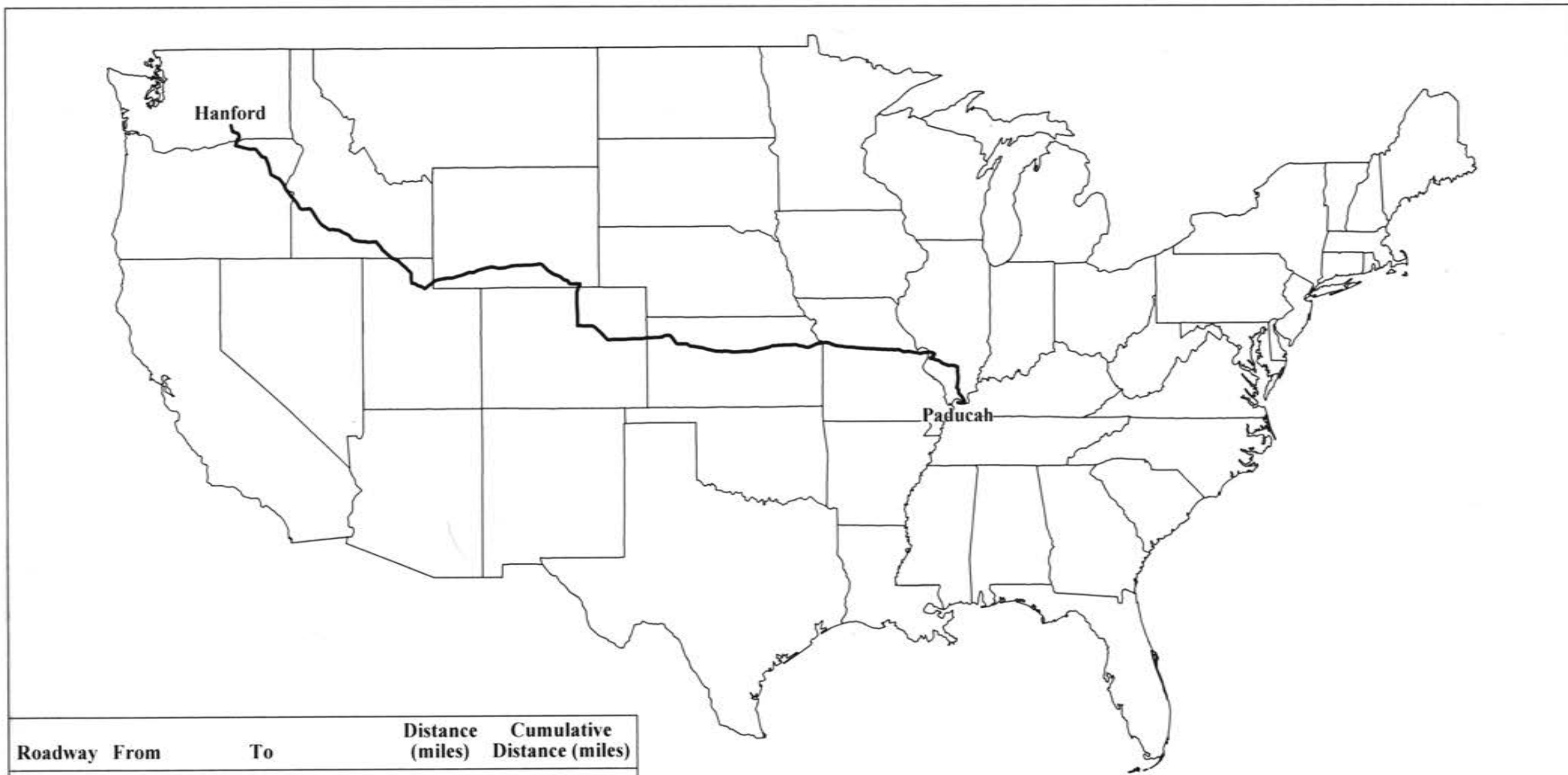
57-121800-019 G

Fig. 3.2. Representative route for transportation of waste by truck from Paducah, Kentucky, to Andrews, Texas.

Roadway	From	To	Distance (miles)	Cumulative Distance (miles)
I-24	Paducah	Pulleys Mill, IL	44	55
I-57	Pulleys Mill	Sikeston, MO	67	122
I-55	Sikeston	W. Memphis, AR	131	253
I-55	W. Memphis	Jackson, MS	213	469
I-20	Jackson	Hammond, LA	128	597
I-55	Hammond	Baton Rouge, LA	38	635
I-12	Baton Rouge	Channelview, TX	258	893
I-10	Channelview	Deer Park, TX	4	897

57-121800-019 E

Fig. 3.3. Representative route for transportation of waste by truck from Paducah, Kentucky, to Deer Park, Texas.



Roadway	From	To	Distance (miles)	Cumulative Distance (miles)
I-24	Paducah	Pulleys Mill, IL	44	55
I-57	Pulleys Mill	Mt. Vernon, IL	48	103
I-65	Mt. Vernon	Washington PK, IL	67	175
I-255	Washington PK	Edwardsville, IL	11	186
I-270	Edwardsville	St. Louis, MO	22	208
I-270	St. Louis	Kansas City, KS	224	432
I-435	Kansas City	Bonner Springs, KS	4	467
I-70	Bonner Springs	Topeka, KS	42	521
I-70	Topeka	Denver, CO	526	1047
I-270	Denver	Commerce City, CO	5	1052
I-25	Commerce City	Cheyenne, WY	91	1144
I-80	Cheyenne	Echo, UT	389	1533
I-84	Echo	Ogden, UT	39	1572
I-84	Ogden	Tremonton, UT	39	1611
I-84	Tremonton	Hermiston, OR	11	2180
I-84	Hermiston	W. Richland, WA	41	2164
I-82	W. Richland	Richland, WA	5	2176
S-240	Richland	Hanford, WA	11	2180

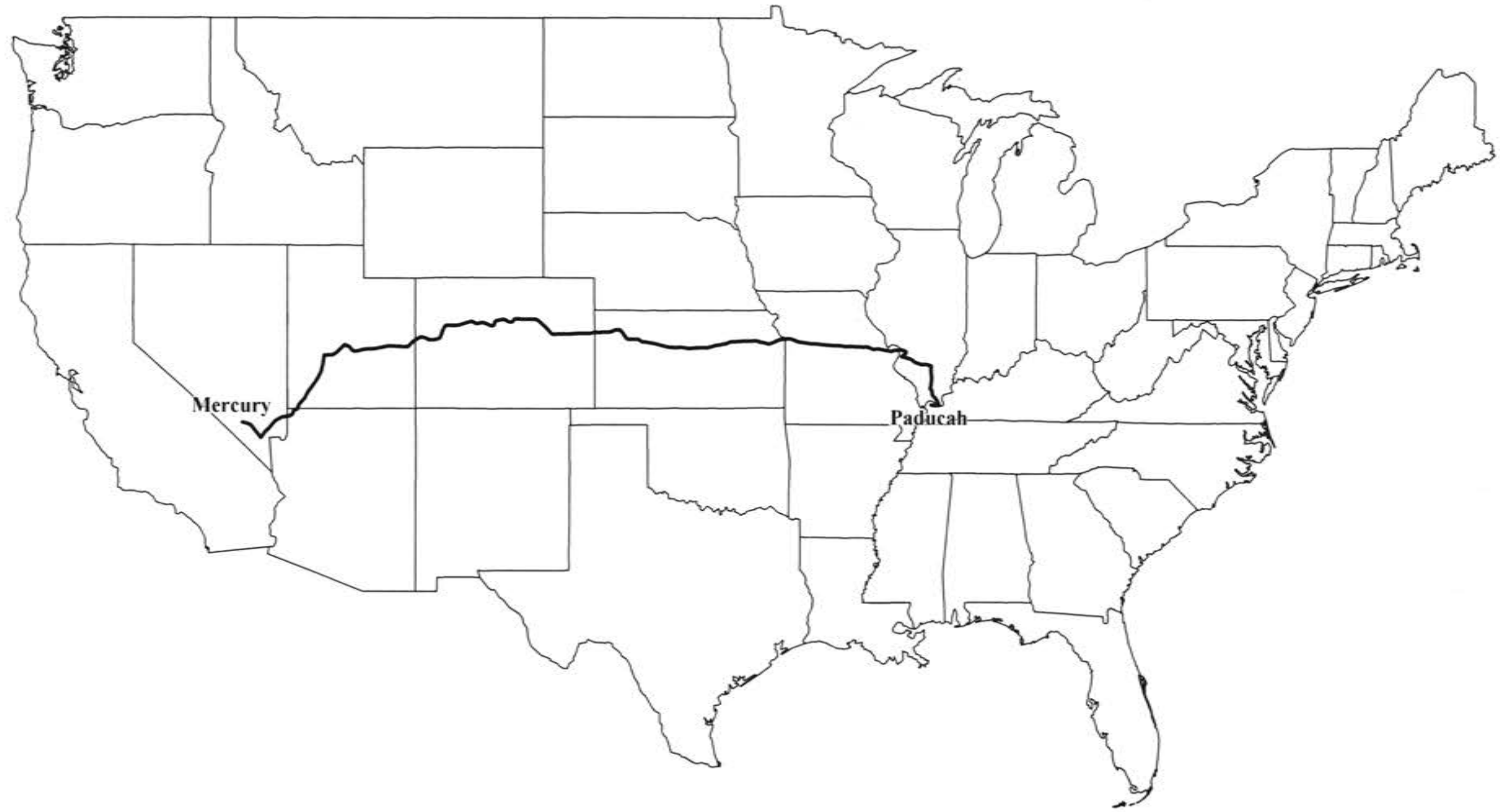
57-121800-019 D

Fig. 3.4. Representative route for transportation of waste by truck from Paducah, Kentucky, to Hanford, Washington.

Roadway	From	To	Distance (miles)	Cumulative Distance (miles)
I-24	Paducah	Pulleys Mill, IL	44	55
I-57	Pulleys Mill	Mt. Vernon, IL	48	103
I-65	Mt. Vernon	Washington PK, IL	67	175
I-255	Washington PK	Edwardsville, IL	11	186
I-270	Edwardsville	St. Louis, MO	22	208
I-270	St. Louis	Kansas City, KS	224	432
I-435	Kansas City	Bonner Springs, KS	4	467
I-70	Bonner Springs	Topeka, KS	42	521
I-70	Topeka	Denver, CO	526	1047
I-270	Denver	Commerce City, CO	5	1052
I-25	Commerce City	Cheyenne, WY	91	1144
I-80	Cheyenne	Holladay, UT	427	1571
I-215	Holladay	Salt Lake City, UT	22	1593
I-215	Salt Lake City	Argonite, UT	62	1655
I-80	Argonite	Clive, UT	9	1664

57-121800-019 F

Fig. 3.5. Representative route for transportation of waste by truck from Paducah, Kentucky, to Clive, Utah.



Roadway	From	To	Distance (miles)	Cumulative Distance (miles)
I-24	Paducah	Pulleys Mill, IL	44	55
I-57	Pulleys Mill	Mt. Vernon, IL	48	103
I-65	Mt. Vernon	Washington PK, IL	67	175
I-255	Washington PK	Edwardsville, IL	11	186
I-270	Edwardsville	St. Louis, MO	22	208
I-270	St. Louis	Kansas City, KS	224	432
I-435	Kansas City	Bonner Springs, KS	4	467
I-70	Bonner Springs	Topeka, KS	42	521
I-70	Topeka	Cove Fort, UT	1037	1158
I-15	Cove Fort	N. Las Vegas, NV	235	1793
I-15	N. Las Vegas	Las Vegas, NV	13	1806
U-95	Las Vegas	Mercury, NV	54	1861

57-121800-019 B

Fig. 3.6. Representative route for transportation of waste by truck from Paducah, Kentucky, to Mercury, Nevada.

Roadway	From	To	Distance (miles)	Cumulative Distance (miles)
I-24	Paducah	Inglewood, TN	135	146
I-24	Inglewood	Nashville, TN	5	151
I-40	Nashville	Lenoir City, TN	152	305
I-40	Lenoir City	X-10	3	308
S-95	X-10	ORNL	2	310

57-121800-019 C

Fig. 3.7. Representative route for transportation of waste by truck from Paducah, Kentucky, to Oak Ridge, Tennessee.

comparison was performed between shortest-distance and shortest-time routes. Little difference was identified. Therefore, shortest distance routes were used for analysis.

The following constraints were applied in truck route selection:

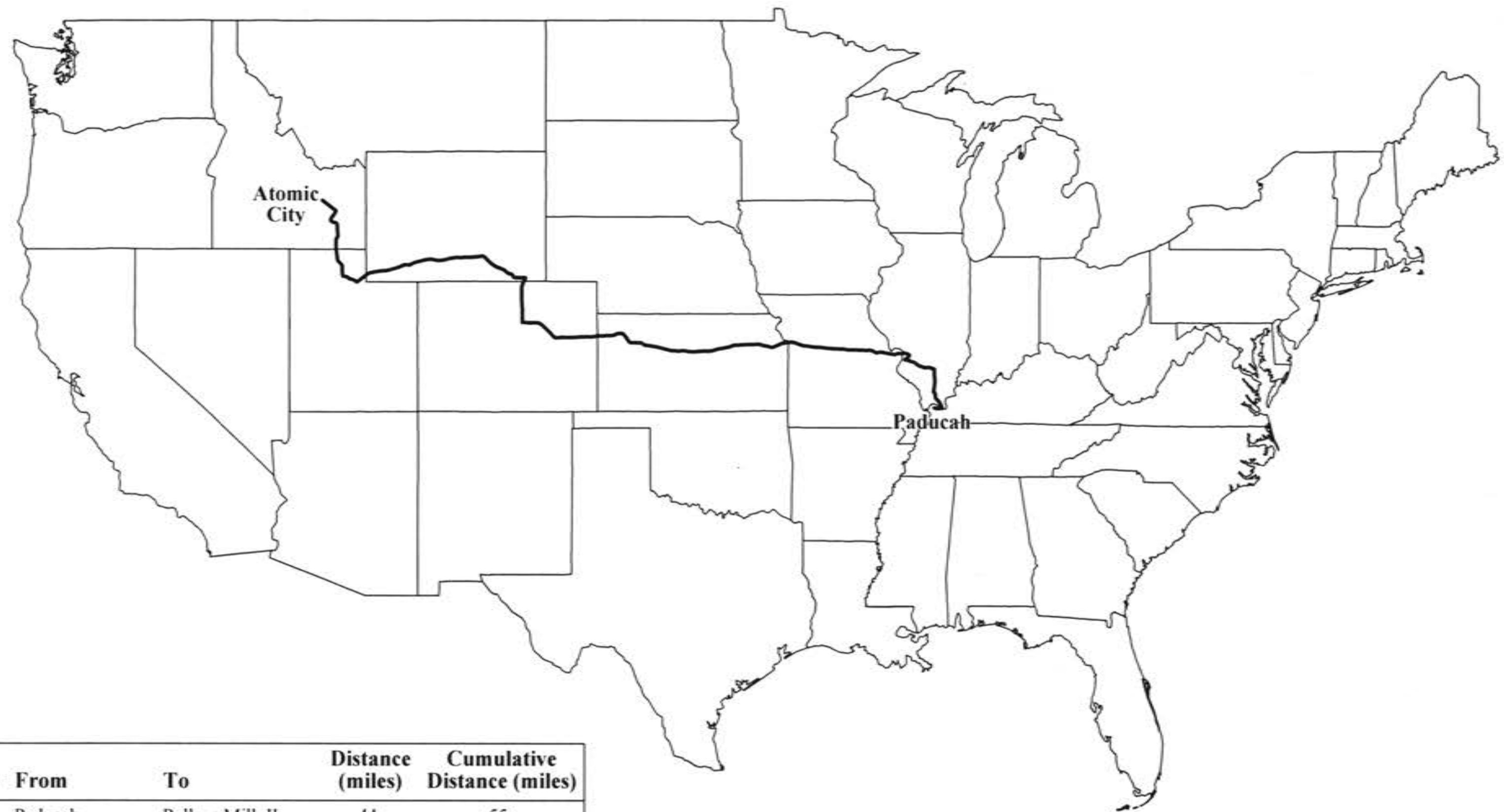
1. avoidance of road segments prohibiting truck use,
2. following of HM-164/state-preferred routes for high-level radioactive waste,
3. avoidance of ferry crossings, and
4. avoidance of access roads between nonintersecting interstate highways.

Waste treatment may be conducted at the Paducah Site or at broad spectrum contractors. The route outlined in Fig. 3.4 serves as a representative route to any of several commercial treatment facilities in the Oak Ridge, Tennessee area.

3.10.3 Rail Routes from the Paducah Site to Treatment and Disposal Sites

Representative rail routes between the Paducah Site and proposed disposal destinations are shown in Figs. 3.8 through 3.13. The rail routes to Nevada, Texas, and Idaho do not terminate at the same location as the truck routes. However, the rail routes do end within the boundaries of the receiving sites.

Table 3.6 provides the characteristics of the proposed rail routes. The total potentially exposed populations residing along the rail routes are estimated in Table 3.7.



Roadway	From	To	Distance (miles)	Cumulative Distance (miles)
I-24	Paducah	Pulleys Mill, IL	44	55
I-57	Pulleys Mill	Mt. Vernon, IL	48	103
I-65	Mt. Vernon	Washington PK, IL	67	175
I-255	Washington PK	Edwardsville, IL	11	186
I-270	Edwardsville	St. Louis, MO	22	208
I-270	St. Louis	Kansas City, KS	224	432
I-435	Kansas City	Bonner Springs, KS	4	467
I-70	Bonner Springs	Topeka, KS	42	521
I-70	Topeka	Denver, CO	526	1047
I-270	Denver	Commerce City, CO	5	1052
I-76	Commerce City	Cheyenne, WY	91	1144
I-80	Cheyenne	Echo, UT	389	1533
I-15	Echo	Ogden, UT	39	1572
I-84	Ogden	Tremonton, UT	39	1611
I-15	Tremonton	Blackfoot, ID	112	1723
U26	Blackfoot	Atomic City, ID	36	1759
U20	Atomic City	ID Natl Eng Lab	5	1764

57-121800-019 A

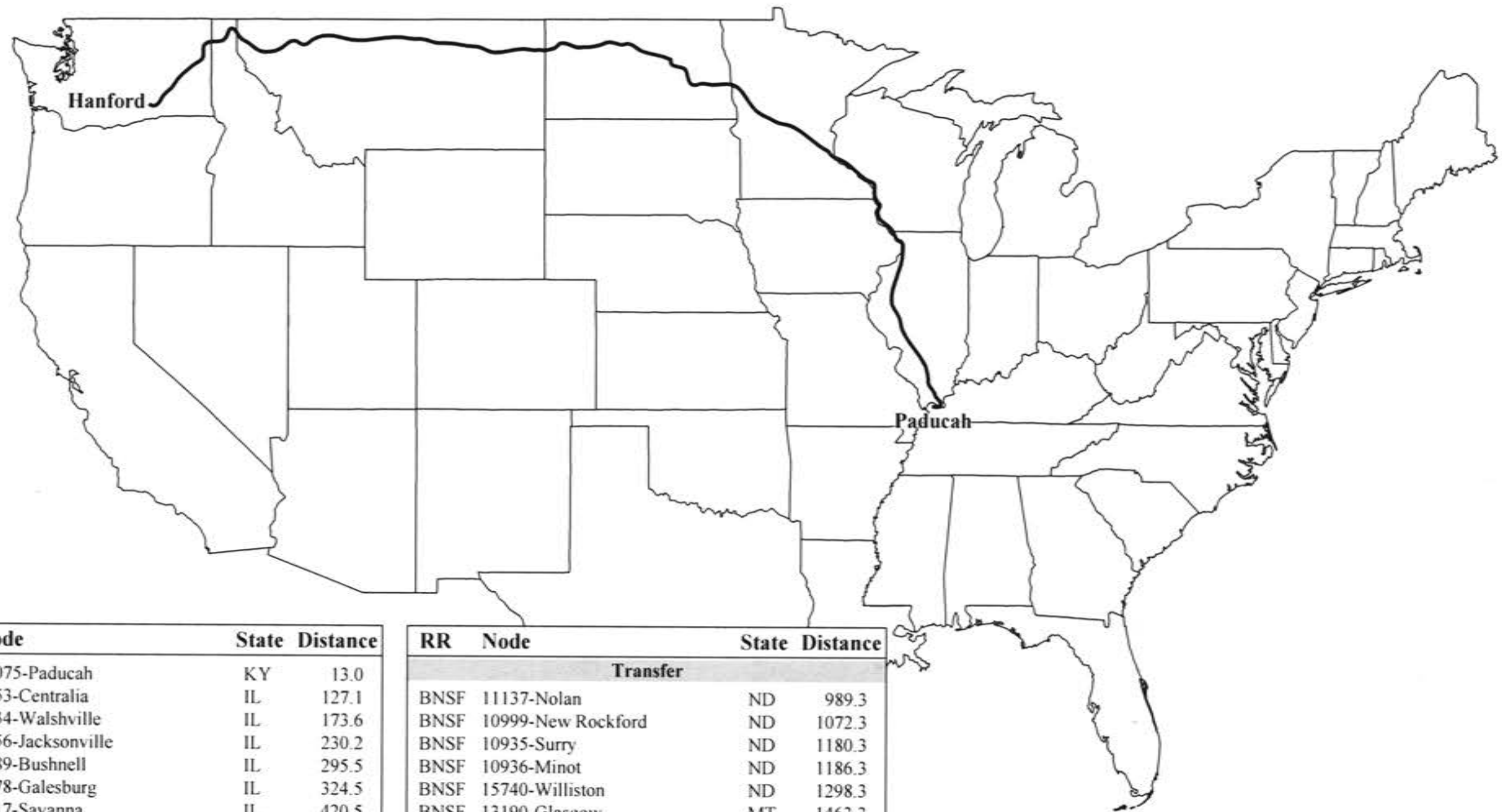
Fig. 3.8. Representative route for transportation of waste by truck from Paducah, Kentucky, to Atomic City, Idaho.

RR	Node	State	Distance
IC	7075-Paducah	KY	13.0
IC	7078-Maxon	KY	21.0
IC	7080-Fulton	KY	62.0
IC	15300-Aulon IC/CSX	TN	183.1
IC	17475-NS Forrest Yard	TN	184.9
	Transfer		
UP	17475-NS Forrest Yard	TN	184.9
UP	17482-NS/UP Crossing	TN	187.3
UP	17480-KC Jct NS/UP	TN	187.8
UP	18042-Memphis	TN	190.1
UP	7153-Bridge Junction	AR	192.5
UP	9343-Wynne	AR	234.4
UP	9342-Fair Oaks	AR	248.4
UP	9340-Bald Knob	AR	279.4
UP	15545-N. Little Rock	AR	324.7
UP	9308-NLR Crest	AR	327.3
UP	9311-Little Rock	AR	332.6
UP	9289-Gurdon	AR	412.6
UP	9278-Hope	AR	443.6
UP	12223-Texarkana	TX	478.6
UP	12259-Pittsburg	TX	550.6
UP	12265-Big Sandy	TX	584.6
UP	12658-Dallas	TX	684.2
UP	12687-Fort Worth	TX	717.4
UP	12836-Abilene	TX	877.9
UP	12830-Sweetwater	TX	915.9
UP	16050-Midland	TX	1025.0
UP	16051-Odessa	TX	1053.5
UP	12870-Monahans	TX	1089.0
	Transfer		
TNER	12870-Monahans	TX	1089.0
TNER	160860-Hobbs	NM	1159.5

Fig. 3.9. Representative route for transportation of waste by rail from Paducah, Kentucky, to Hobbs, New Mexico.

RR	Node	State	Distance
IC	7075-Paducah	KY	13.0
IC	7078-Maxon	KY	21.0
IC	7080-Fulton	KY	62.0
IC	15300-Aulon IC/CSX	TN	183.1
IC	17475-NS Forrest Yard	TN	184.9
	Transfer		
UP	17475-NS Forrest Yard	TN	184.9
UP	17482-NS/UP Crossing	TN	187.3
UP	17480-KC Jct NS/UP	TN	187.8
UP	18042-Memphis	TN	190.1
UP	7153-Bridge Junction	AR	192.5
UP	9343-Wynne	AR	234.4
UP	9342-Fair Oaks	AR	248.4
UP	9340-Bald Knob	AR	279.4
UP	15545-N. Little Rock	AR	324.7
UP	9308-NLR Crest	AR	327.3
UP	9311-Little Rock	AR	332.6
UP	9289-Gurdon	AR	412.6
UP	9278-Hope	AR	443.6
UP	12223-Texarkana	TX	478.6
UP	12261-Jefferson	TX	529.6
UP	12262-Marshall	TX	545.6
UP	12264-Longview	TX	568.6
UP	12484-Palestine	TX	650.5
UP	12396-Conroe	TX	762.5
UP	12398-Spring	TX	778.5
UP	12399-Houston	TX	802.6
UP	12393-Strang	TX	828.4

Fig. 3.10. Representative route for transportation of waste by rail from Paducah, Kentucky, to Strang, Texas.

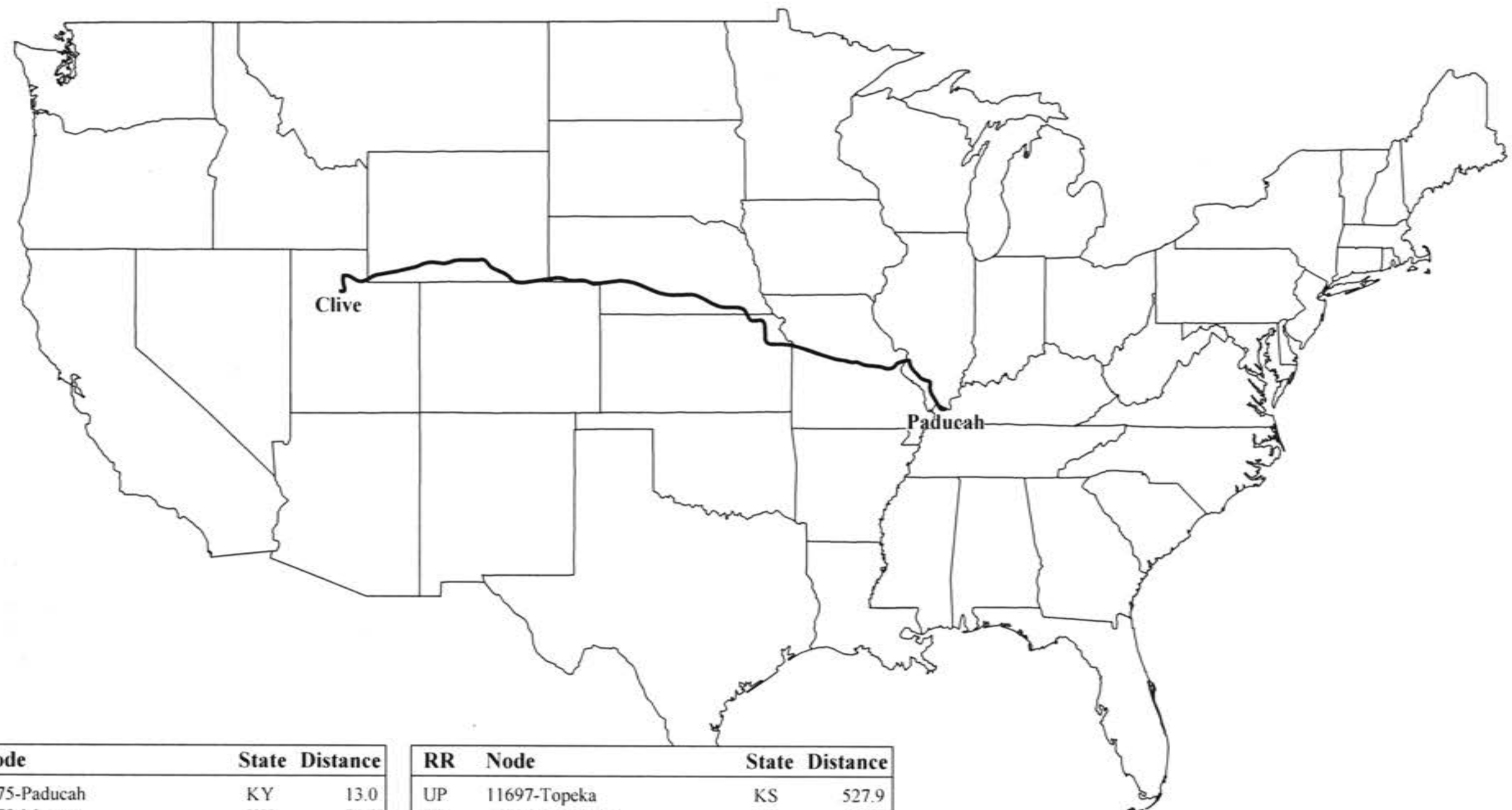


RR	Node	State	Distance
BNSF	77075-Paducah	KY	13.0
BNSF	4953-Centralia	IL	127.1
BNSF	4934-Walshville	IL	173.6
BNSF	5156-Jacksonville	IL	230.2
BNSF	4489-Bushnell	IL	295.5
BNSF	4478-Galesburg	IL	324.5
BNSF	4317-Savanna	IL	420.5
BNSF	4327-E. Dubuque	IL	460.5
BNSF	5736-La Crosse	WI	571.5
BNSF	9814-Hastings	MN	665.5
BNSF	9830-St.Paul	MN	692.7
BNSF	9800-Westminster St.	MN	693.7
BNSF	9793-SOO Line Jct.	MN	695.2
BNSF	15603-E. Minneapolis	MN	702.6
BNSF	15605-Shoreham	MN	705.4
BNSF	9798-Northtown Yard	MN	708.0
BNSF	9826-Coon Creek	MN	713.3
BNSF	9671-Sauk Rapids	MN	763.3
BNSF	9663-Staples	MN	828,3
BNSF	9578-Detroit Lakes	MN	894.3
BNSF	11131-Moorhead	MN	942.3
BNSF	11132-Fargo	ND	945.3
BNSF	11134-Casselton	ND	965.3

RR	Node	State	Distance
	Transfer		
BNSF	11137-Nolan	ND	989.3
BNSF	10999-New Rockford	ND	1072.3
BNSF	10935-Surry	ND	1180.3
BNSF	10936-Minot	ND	1186.3
BNSF	15740-Williston	ND	1298.3
BNSF	13190-Glasgow	MT	1463.3
BNSF	13168-Havre	MT	1617.3
BNSF	13089-Shelby	MT	1718.3
BNSF	13077-Whitefish	MT	1880.3
BNSF	13299-Bonner's Ferry	ID	2029.3
BNSF	13300-Sandpoint	ID	2067.3
BNSF	13304-Hauser	ID	2118.3
BNSF	13828-Spokane	WA	2137.6
BNSF	13821-Fish Lake	WA	2150.9
BNSF	13890-Pasco	WA	2285.4
BNSF	13964-Kennewick	WA	2286.6
BNSF	13941-Richland	WA	2295.2
	Transfer		
USG	13941-Richland	WA	2295.2
USG	16212-Hanford	WA	2302.9

57-121800-021 A

Fig. 3.11. Representative route for transportation of waste by rail from Paducah, Kentucky, to Hanford, Washington.

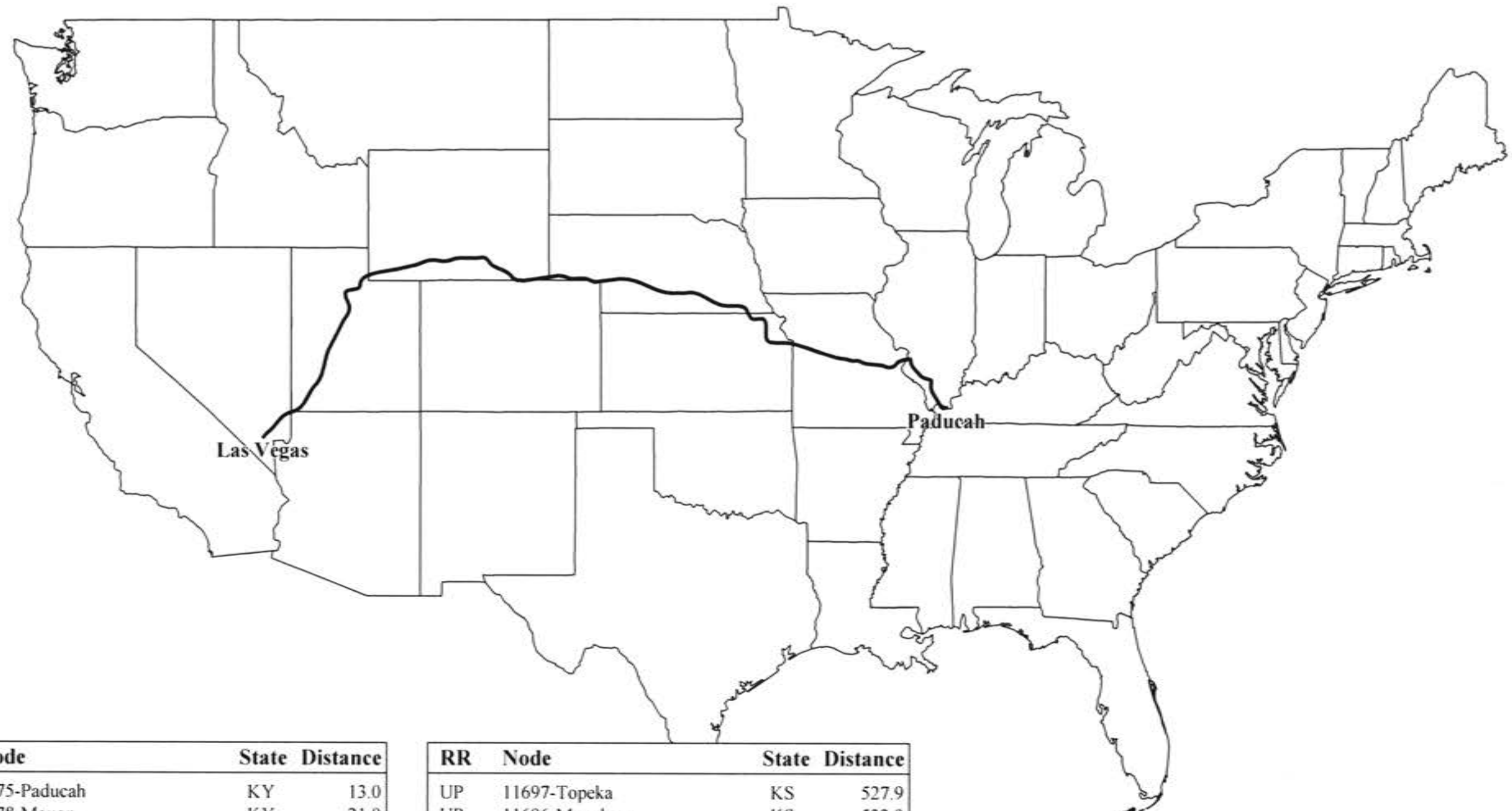


RR	Node	State	Distance
IC	7075-Paducah	KY	13.0
IC	7078-Maxon	KY	21.0
IC	5079-Du Quoin	IL	117.1
IC	5077-Pinckneyville	IL	127.1
IC	10867-Viner	IL	180.1
IC	10827-Valley Jct	IL	181.7
IC	10859-E. St. Louis	IL	183.6
	Transfer		
UP	10859-E. St. Louis	IL	183.6
UP	10858-St. Louis	MO	184.6
UP	10875-Grand Ave (St. Louis)	MO	187.4
UP	10860-Pacific	MO	211.4
UP	10656-Jefferson City	MO	309.4
UP	10627-Pleasant Hill	MO	425.5
UP	15708-Sheffield	MO	453.1
UP	15709-Kansas City Union Station	MO	458.1
UP	10617-Kansas City	KS	459.1
UP	11823-Lawrence	KS	497.9

RR	Node	State	Distance
UP	11697-Topeka	KS	527.9
UP	11696-Menoken	KS	532.9
UP	11681-Marysville	KS	607.9
UP	11487-Endicott	NE	639.9
UP	11405-Hastings	NE	715.9
UP	11410-Gibbon	NE	741.9
UP	11352-North Platte	NE	861.0
UP	11358-O'Fallon	NE	872.4
UP	13703-Julesburg	CO	940.4
UP	11287-Sidney	NE	983.4
UP	13465-Cheyenne	WY	1086.4
UP	13462-Laramie	WY	1138.4
UP	13494-Granger	WY	1414.4
UP	13568-Ogden	UT	1557.5
UP	13595-Salt Lake City	UT	1593.0
UP	13594-Garfield	UT	1605.1
UP	13524-Clive	UT	1667.1

57-121800-021 B

Fig. 3.12. Representative route for transportation of waste by rail from Paducah, Kentucky, to Clive, Utah.



RR	Node	State	Distance
IC	7075-Paducah	KY	13.0
IC	7078-Maxon	KY	21.0
IC	5079-Du Quoin	IL	117.1
IC	5077-Pinckneyville	IL	127.1
IC	10867-Viner	IL	180.1
IC	10827-Valley Jct	IL	181.7
IC	10859-E. St. Louis	IL	183.6
	Transfer		
UP	10859-E. St. Louis	IL	183.6
UP	10858-St. Louis	MO	184.6
UP	10875-Grand Ave (St. Louis)	MO	187.4
UP	10860-Pacific	MO	211.4
UP	10656-Jefferson City	MO	309.4
UP	10627-Pleasant Hill	MO	425.5
UP	15708-Sheffield	MO	453.1
UP	15709-Kansas City Union Station	MO	458.1
UP	10617-Kansas City	KS	459.1
UP	11823-Lawrence	KS	497.9

RR	Node	State	Distance
UP	11697-Topeka	KS	527.9
UP	11696-Menoken	KS	532.9
UP	11681-Marysville	KS	607.9
UP	11487-Endicott	NE	639.9
UP	11405-Hastings	NE	715.9
UP	11410-Gibbon	NE	741.9
UP	11352-North Platte	NE	861.0
UP	11358-O'Fallon	NE	872.4
UP	13703-Julesburg	CO	940.4
UP	11287-Sidney	NE	983.4
UP	13465-Cheyenne	WY	1086.4
UP	13462-Laramie	WY	1138.4
UP	13494-Granger	WY	1414.4
UP	13568-Ogden	UT	1557.5
UP	13595-Salt Lake City	UT	1593.0
UP	13594-Garfield	UT	1605.1
UP	13630-Lynndyl	UT	1708.1

57-121800-021 D

Fig. 3.13. Representative route for transportation of waste by rail from Paducah, Kentucky, to Las Vegas, Nevada.

RR	Node	State	Distance
PAL	7075-Paducah	KY	13.0
PAL	7059-Madisonville	KY	91.0
PAL	15293-Central City	KY	111.2
PAL	7008-Louisville	KY	235.0
	Transfer		
NS	7008-Louisville	KY	235.0
NS	6979-Danville	KY	335.0
NS	7260-Harriman	TN	496.8
NS	15317-Blair	TN	506.3
	Transfer		
C3	15317-Blair	TN	506.3
C3	15316-K 25	TN	511.8

57-121800-021 E

Fig. 3.14. Representative route for transportation of waste by rail from Paducah, Kentucky, to Oak Ridge, Tennessee.

RR	Node	State	Distance
IC	7075-Paducah	KY	13.0
IC	7078-Maxon	KY	21.0
IC	5079-Du Quoin	IL	117.1
IC	5077-Pinckneyville	IL	127.1
IC	10867-Viner	IL	180.1
IC	10827-Valley Jct	IL	181.7
IC	10859-E. St. Louis	IL	183.6
	Transfer		
UP	10859-E. St. Louis	IL	183.6
UP	10858-St. Louis	MO	184.6
UP	10875-Grand Ave (St. Louis)	MO	187.4
UP	10860-Pacific	MO	211.4
UP	10656-Jefferson City	MO	309.4
UP	10627-Pleasant Hill	MO	425.5
UP	15708-Sheffield	MO	453.1
UP	15709-Kansas City Union Station	MO	458.1
UP	10617-Kansas City	KS	459.1

RR	Node	State	Distance
UP	11823-Lawrence	KS	497.9
UP	11697-Topeka	KS	527.9
UP	11696-Menoken	KS	532.9
UP	11681-Marysville	KS	607.9
UP	11487-Endicott	NE	639.9
UP	11405-Hastings	NE	715.9
UP	11410-Gibbon	NE	741.9
UP	11352-North Platte	NE	861.0
UP	11358-O'Fallon	NE	872.4
UP	13703-Julesburg	CO	940.4
UP	11287-Sidney	NE	983.4
UP	13465-Cheyenne	WY	1086.4
UP	13462-Laramie	WY	1138.4
UP	13494-Granger	WY	1414.4
UP	13369-McCammon	ID	1607.7
UP	13370-Pocatello	ID	1630.7
UP	13336-Scoville	ID	1686.7

57-121800-021 C

Fig. 3.15. Representative route for transportation of waste by rail from Paducah, Kentucky, to Scoville, Idaho.

Table 3.6. Rail route distances from the Paducah Site to each proposed destination[a]

Destination	Rural distance (miles)	Suburban distance (miles)	Urban distance (miles)	Total distance (miles)
Hobbs, NM	1064.4	216.5	27.7	1308.6
Strang, TX	1064.4	216.5	27.7	1308.6
Hanford, WA	1775.1	208.5	32.5	2016.1
Clive, UT	1575.4	187.9	31.5	1794.8
Las Vegas, NV	1956.8	189.6	34.3	2180.7
Oak Ridge, TN[b]	402.8	77.4	15.4	495.6
Scoville, ID	1679.2	178.1	28.6	1885.9

[a]*Source*: Interline Data Network 15.0.

[b]Oak Ridge destinations (Oak Ridge National Laboratory, East Tennessee Technology Park, and Materials & Energy/Waste Control Specialists).

Table 3.7. Potentially exposed populations along railway routes from the Paducah Site to each proposed destination

Route to	Potentially exposed population[a]
Hobbs, NM	380,284
Strang, TX	380,284
Hanford, WA	409,207
Clive, UT	381,473
Las Vegas, NV	413,971
Oak Ridge, TN[b]	168,524
Scoville, ID	342,689

[a]Derived using population densities along railway links (Source: Interline Data Network 15.0).

[b]Oak Ridge destinations (Oak Ridge National Laboratory, East Tennessee Technology Park, and Materials & Energy/Waste Control Specialists).

THIS PAGE INTENTIONALLY LEFT BLANK.

4. ENVIRONMENTAL CONSEQUENCES

4.1 IMPACTS OF THE PROPOSED ACTION

Potential impacts resulting from the proposed action are presented in five sections: (1) impacts to Paducah Site area resources, (2) potential impacts to human health from an onsite accident, (3) impacts resulting from off-site transportation, (4) impacts resulting from on-site treatment, and (5) impacts from DMSA characterization.

4.1.1 Resource Impacts

The following sections present potential impacts to Paducah Site and area resources resulting from proposed waste disposition activities.

4.1.1.1 Land use

Waste Storage. In the proposed action, waste would continue to be stored in the current locations. This would result in no changes in land use.

Waste Treatment. Waste treatment would be performed at Bldg. C-752-A. This building is now used for industrial purposes, and the proposed action would not change this classification. The proposed action and the implementation of treatment technologies different from those now being performed would result in a minor modification to the current use for this building. This building is currently being used for other waste treatment activities that have been covered under separate analysis.

Building C-746-A is the proposed location for physical volume reduction of waste. This building is currently being used for this purpose, so no change in use would occur.

Under the proposed action, a portion of the wastes is proposed for off-site treatment at existing, licensed/permitted facilities. This would result in no anticipated impacts at the Paducah Site.

Waste Disposal. Under normal operations of the proposed action, all of the wastes are proposed to be disposed off-site at existing, licensed/permitted facilities. Therefore, no impacts are anticipated at the Paducah Site.

Supporting Activities. Supporting activities are currently being performed at the site and take place within the Paducah Site boundaries. The continuation of these activities would have no impact on land use.

4.1.1.2 Geology and seismicity

Waste Storage. Under the proposed action, waste would continue to be stored in the current locations. Continuation of normal operations would result in no impacts to the site geology. Storage accidents, such as a spill, would likely not have an impact on the site geology due to mitigative measure that are in place, such as dikes and spill controls. However, should an accident occur that contaminates the soil, a small portion of the geology may be disturbed during spill cleanup should the area need to be excavated. Under this scenario, the impact is still estimated to be minor.

Impacts resulting from a seismological event are addressed in Sect. 4.1.2.

Waste Treatment. Neither normal operations nor a reasonable worst-case accident scenario for waste treatment would affect the site geology. Waste treatment would be performed at an existing building; therefore, no new excavation for construction is anticipated. Treatment accidents, such as a release during treatment, would likely not have an impact on the site geology due to mitigative measures that are in place, such as dikes and spill controls. However, should an accident occur that contaminates the soil, a small portion of the geology may be disturbed during spill cleanup should the area need to be excavated. Under this scenario, the impacts are still estimated to be minor and the probability of an accident is small.

Impacts from seismic events are addressed under Sect. 4.1.2.

Under the proposed action, a portion of the wastes is proposed for off-site treatment at existing, licensed, and/or permitted facilities. This would result in no anticipated impacts at the Paducah Site.

Waste Disposal. Under normal operations of the proposed action, all of the wastes are proposed to be disposed off-site at existing, licensed/permitted facilities. Therefore, no impacts resulting from disposal are anticipated at the Paducah Site.

Accidents related to transport of the waste to the disposal facility are addressed under Sect. 4.1.3.

Supporting Activities. The normal operations and continuation of supporting activities within the Paducah Site boundaries, which currently do not involve geological disturbance, would have no impact on the site geology. However, should an accident occur that contaminates the soil, a small portion of the geology may be disturbed during spill cleanup should the area need to be excavated. Under this scenario, the impacts are still estimated to be minor, since probability of an accident is small.

4.1.1.3 Soils and prime farmland

No prime farmlands are located within the Paducah Site boundary where waste disposition activities are proposed to occur. Therefore, impacts to prime farmlands are not anticipated from any waste disposition activity. The following discussion focuses on impacts to local soils only.

Waste Storage. Under the proposed action, waste would continue to be stored in the current locations. Continuation of normal operations would result in no impacts to the site soils. Storage accidents, such as a contaminant spill, would have minimal impact on soils due to mitigative measures that are in place, such as dikes and spill controls.

Waste Treatment. Neither normal operations nor a reasonable worst-case accident scenario described in Sect. 4.1.4 for on-site waste treatment would notably affect the site soils. Waste treatment would be performed at an existing building that is equipped with spill controls such as nonporous floors and dikes. Accidents, such as a release during treatment, would have minimal impact on the site soils due to the mitigative measures that were previously mentioned. Treatment facilities would have pertinent permits to control treatment processes.

Impacts to soils from activities related to wastes shipment off-site for treatment are addressed under Sect. 4.1.3.

Under the proposed action, a portion of the wastes is proposed for off-site treatment at existing, licensed, and/or permitted facilities. This would result in no anticipated impacts at the Paducah Site.

Waste Disposal. Under normal operations of the proposed action, all of the wastes are proposed to be disposed off-site at existing, licensed/permitted facilities. Therefore, no impacts are anticipated at the Paducah Site.

Accidents related to transport of the waste to the disposal facility are addressed under Sect. 4.1.3.

Supporting Activities. The normal operations and continuation of supporting activities within the Paducah Site boundaries would have no impact on the site soils. Accidents, such as a contaminant spill, would have minimal impact on soils due to mitigative measures that are in place, such as dikes and spill controls.

4.1.1.4 Water and water quality

Waste Storage. Normal waste storage operations should not result in the release of constituents at concentrations that would exceed water quality standards or other benchmarks. Long-term impacts to water quality would be beneficial after implementation of the proposed action because much of the on-site wastes would be removed from the site or repackaged and stored. When the current waste inventories are reduced or repackaged, potential releases of contaminants into the surface water are reduced, beneficially impacting the water quality.

Accident impacts to water quality from the reasonable worst-case, on-site accident scenario (earthquake) involving radionuclides are described in detail in Appendix C. Water quality in Bayou and Little Bayou creeks and other water conveyances by which the waste would reach the Ohio River could be adversely impacted in the short term because of the low pH of the waste and radiation exposure. However, the high flow volume of the Ohio River, averaged at 315,000 ft^3/sec (USGS 2001), would result in quick dilution of contaminants when the spill reached the river. No chemical or radionuclide contaminants would occur in the Ohio River at high enough concentrations to have adverse impacts to water quality according to the accident analysis. Thus, the earthquake scenario is likely to cause harm to water quality in creeks draining into the Ohio River, but Ohio River water quality should not be adversely impacted.

Waste Treatment. Although wastewater would be treated and released to existing outfalls, the treated water would meet the waste requirements for the on-site WWTP, so the water is not expected to exceed KPDES permit limits. No new contaminants are expected to be introduced to the WWTP, because the wastes described are consistent with waste historically produced at the site. Since the Paducah Site waste inventory would be maintained within the Paducah Site fence, potential impacts resulting from normal operations and treatment would be the same as for waste storage. See previous discussion for potential impacts to water resources in the area.

Under the proposed action, a portion of the wastes is proposed for off-site treatment at existing, licensed, and/or permitted facilities. This would result in no anticipated impacts at the Paducah Site.

Waste Disposal. Under normal operations of the proposed action, all of the wastes are proposed to be disposed off-site at existing, permitted and/or licensed facilities. These facilities were constructed with controls to contain the contamination within the facility. No impacts are anticipated at the Paducah Site.

Supporting Activities. The performance of supporting activities would potentially release the same waste constituents to the same water resources as discussed above in the waste storage section. No impacts are anticipated.

4.1.1.5 Groundwater, floodplains, and wetlands

No wetlands or floodplains are located within the Paducah Site boundary where waste disposition activities would occur. Therefore, no impacts to wetlands or floodplains are anticipated from any waste disposition activity. The following discussion focuses on groundwater impacts only.

Waste Storage. Continuation of normal waste storage operations would result in no impacts to the site groundwater. Storage accidents, such as spills, would have minimal impact on the groundwater due to mitigative measures that are in place, such as dikes and spill controls, and due to an estimated small release during the accident.

Waste Treatment. Neither normal operations nor a reasonable worst-case accident scenario for waste treatment would affect groundwater resources. Waste treatment would be performed at an existing building that is equipped with spill controls such as nonporous floors and dikes that would lower the risk of groundwater contamination. Accidents, such as a release during treatment, would have minimal impact on the groundwater due to these mitigative measures and to the estimated small release volume during an accident.

Impacts to groundwater related to wastes being transported for treatment are addressed under Sect. 4.1.3.

Under the proposed action, a portion of the wastes is proposed for off-site treatment at existing, licensed, and/or permitted facilities. This would result in no anticipated impacts at the Paducah Site.

Waste Disposal. Under normal operations of the proposed action, all of the wastes are proposed to be disposed off-site at existing, licensed/permitted facilities. These facilities were constructed with controls to contain the contamination within the facility; therefore, no impacts are anticipated at the Paducah Site.

Groundwater impacts related to accidents during transport of the waste to the disposal facility are addressed under Sect. 4.1.3.

Supporting Activities. The normal operations and continuation of supporting activities within the Paducah Site boundaries would have no impact on groundwater. Accidents that may occur during the performance of supporting activities would not have notable impact on groundwater due to mitigative measures and to the estimated small release during an accident.

4.1.1.6 Ecological resources

Normal operational activities associated with the proposed action would not adversely impact site vegetation or wildlife species at the Paducah Site. Accidents could result in some impacts to vegetation and wildlife resources in the area of occurrence. The indirect impacts from accidents to these resources could be derived from the movement of contamination through groundwater or surface water to these receptors. However, with the implementation of routine mitigative measures such as spill controls, the impacts are estimated to be minimal.

Aquatic Biota

Waste Storage. Under normal operations, waste storage impacts to aquatic biota from the proposed action should be negligible, because the on-site storage of wastes should not result in the release of constituents at concentrations that would be harmful to aquatic biota. Long-term impacts to aquatic biota would be beneficial after implementation of the proposed action, because much of the on-site waste would be removed from the site, reducing the amount stored on-site. When the current waste inventories are reduced, the potential exposure of aquatic biota is reduced, benefiting the biota.

The accident scenario description and impacts to aquatic biota from the reasonable worst-case accident (earthquake) scenario involving radionuclides are described in detail in Appendix C. As shown in Appendix C, Table C.1, the earthquake scenario is highly unlikely to cause harm to aquatic biota in the Ohio River as a result of exposure to radionuclides. However, aquatic receptors in Bayou and Little Bayou creeks and other water conveyances by which the waste would reach the Ohio River would suffer minor impacts resulting from the caustic nature of the waste. Radiation exposure could be of an acute nature.

Accident impacts to aquatic biota from the reasonable worst-case accident scenario (earthquake) involving nonradionuclides are described in Appendix C. As shown in Appendix C, Table C.2, PCBs are the only constituents whose ratio of concentration to toxicity benchmark (2.08) exceeds 1, indicating that PCBs could pose minor, short-term adverse impacts to aquatic biota, as well as in Bayou and Little Bayou creeks near the Kentucky bank of the Ohio River.

Waste Treatment. Short-term impacts to aquatic biota from the proposed action should be negligible, because the normal operation of on-site waste treatment should not result in the release of constituents at concentrations that would be harmful to aquatic biota. Although wastewater would be treated, the treated water would meet the waste requirements for the on-site WWTP. No notable adverse impacts resulting from the WWTP have been observed. Therefore, no negative impacts are expected to result form the additional treatment activities.

Long-term impacts to aquatic biota would be beneficial after implementation of the proposed action, because much of the on-site waste would be treated, resulting in a more stable waste form. When the current waste inventories are reduced, the potential exposure of aquatic biota is reduced.

Accident impacts to aquatic biota from the worst-case accident scenario (earthquake) are described in detail in Appendix C. The impacts are similar to the waste storage activity analysis because the waste constituents, receptors, and scenarios are the same. However, realistically, these impacts would be smaller, since the volume of waste defined for treatment is smaller than the waste storage volume. See discussion under the waste storage activity.

Under the proposed action, a portion of the wastes is proposed for off-site treatment at existing, licensed, and/or permitted facilities. This would result in no anticipated impacts at the Paducah Site.

Waste Disposal. Under normal operations of the proposed action, all of the wastes are proposed to be disposed off-site at existing, licensed/permitted facilities. Therefore, no impacts are anticipated at the Paducah Site.

Supporting Activities. The normal operations and accident impacts are identical to the waste storage activity analysis because the waste constituents, receptors, and scenarios are the same. See discussion under the waste storage activity. Accident impacts to aquatic biota from supporting activities under the worst-case accident scenario involving radionuclides are described in detail in Appendix C.

Terrestrial Biota

Waste Storage. Short-term waste storage impacts to terrestrial biota from normal operations of the proposed storage activity should be negligible because the repackaging and on-site maintenance of wastes should not result in the release of constituents at concentrations that would be harmful to the biota.

Impacts to terrestrial biota from the worst-case accident scenario (earthquake), along with soil concentrations, screening benchmarks, and results for individual radionuclides, are shown in Appendix C, Table C.1. The scenario for chronic radionuclide exposure indicates that in even this worst-case accident scenario, long-term radiation effects to soil biota would be negligible. As shown in Appendix C, Table C.2, two organics (PCBs and 1,2,4-trichlorobenzene) and two inorganics (cadmium and chromium) have modeled concentrations that would likely pose minor adverse impacts to soil biota if the worst-case spill accident occurred. However, these impacts would be reduced by the use of mitigative controls such as dikes, spill control measures, and cleanup.

Waste Treatment. Short-term waste treatment impacts to terrestrial biota from normal operations of the proposed action should be negligible because the repackaging and on-site treatment of wastes should not result in the release of constituents in concentrations that would be harmful to the biota.

Impacts resulting from radiological and nonradiological accidents would be identical to those discussed under waste storage because the same wastes would be released through the same scenarios to the same resources. See the waste storage section for discussion.

Under the proposed action, a portion of the wastes is proposed for off-site treatment at existing, licensed, and/or permitted facilities. This would result in no anticipated impacts at the Paducah Site.

Waste Disposal. Under normal operations of the proposed action, all of the wastes are proposed to be disposed off-site at existing, licensed/permitted facilities. Therefore, no impacts are anticipated at the Paducah Site.

Supporting Activities. Short-term impacts to terrestrial biota from activities executed to support waste management storage activity should be negligible because the maintenance of wastes should not result in the release of constituents at concentrations that would be harmful to the biota.

Impacts resulting from radiological and nonradiological accidents would be identical to those discussed under waste storage. This is true because the same wastes would be released through the same scenarios to the same resources. See the waste storage section for discussion.

4.1.1.7 Threatened and Endangered Species

No threatened or endangered species occur within the Paducah Site fence where the proposed action would take place. However, five species have been identified in the vicinity surrounding the site.

Indiana Bat. There is poor to fair summer habitat for the Indiana bat along portions of Bayou Creek to the west of the Paducah Site. The FWS (Barclay 1999) had several recommendations to protect the bats' habitat and food supply: (1) control erosion and maintain water quality in all streams, (2) minimize removal of mature riparian and upland forest; (3) create an equal amount of maternity or foraging habitat, should such habitat be lost; and (4) perform periodic inspections to ensure the protection of any habitat and the success of any mitigation.

No proposed operations or hypothesized accidents have been identified that would affect potential Indiana bat roosting or foraging habitat.

Mussel Species. Bayou Creek enters the Ohio River about 8 km (5 miles) downstream of the Paducah Site. Under normal operating conditions, any small quantities of PCBs released to a KPDES Outfall would not adversely affect the creeks or be expected to reach the Ohio River. However, if a highly unlikely or incredible accident were to occur, wastes might reach the Ohio River. During a flooding rainfall (which occurred less than once in 25 years), Bayou Creek, Little Bayou Creek, and the Ohio River would be flooded and sediments would move downstream. This would be a negligible addition to the concentration of contaminants already present in Ohio River sediments. This additional quantity of contaminants would be well within the measured variability of concentrations in river sediments. The addition of contaminants in the Ohio River would quickly (in minutes) pass mussel beds during flood conditions as sediments were moved rapidly downstream. An accidental release of contaminants would be extremely small and too brief to increase concentrations in the mussel species.

4.1.1.8 Noise

Waste Storage. Continuation of normal storage operations would result in no increase in the noise level of the area.

Waste Treatment. The proposed on-site waste treatment process does not include the use of large machinery, other than trucks for waste transport, or other noisy equipment. Therefore, the noise level is not anticipated to increase due to treatment activities.

Under the proposed action, a portion of the wastes is proposed for off-site treatment at existing, licensed, and/or permitted facilities. This would result in no anticipated impacts at the Paducah Site. Impacts to the noise environment from activities related to wastes being shipped for treatment are addressed under Sect. 4.1.3.

Waste Disposal. Under normal operations of the proposed action, all of the waste is proposed to be disposed off-site at existing, licensed/permitted facilities. Noise impacts related to transport of the wastes to the disposal facilities are addressed under Sect. 4.1.3.

Supporting Activities. The normal operations of supporting activities within the Paducah Site boundaries would have no impact on the noise level at the site. Operation of trucks and drum-handling machinery, such as forklifts, and physical volume reduction machines, such as chippers and crushers, would occur. However, these activities currently take place at the site; therefore, no increase in the current noise level is anticipated.

4.1.1.9 Cultural, archaeological, and Native American resources

No cultural, archaeological, or Native American resources are identified where waste storage, treatment, or supporting waste disposition activities are proposed to occur. Therefore, no impacts to these resources are anticipated from any waste disposition activity.

4.1.1.10 Air quality

Waste Storage. Emissions of criteria pollutants are the primary concern from area (nonpoint) sources such as waste packaging/sorting and storage areas. No notable emissions of criteria air pollutants are expected from the routine packaging, handling, and storage activities of existing or future generated waste at the Paducah Site. All waste streams that are repackaged or stored would be in a stable configuration, so that minimal air emissions would occur. Liquid and volatile materials would be packaged in a manner that would avoid spillage or release to the atmosphere. Proper containers for the waste would be selected to ensure that emissions to the atmosphere during storage would be minimized. In addition, inspections would be conducted on a regular basis to ensure that there are no container breaches that could cause emissions into the air.

Waste Treatment. Particulates and dust would be the primary criteria pollutants emitted during movement of waste to on-site and off-site treatment facilities. All treatment activities would be conducted at existing facilities, so there would be no impacts from construction or site disturbance. The wastes proposed for on-site treatment would be processed by technologies, such as solidification, that historically have not produced notable air emissions. High-efficiency particulate air (HEPA) filters that would be located in the building would screen out a high percentage of airborne contaminants resulting from treatment. These facility controls result in no anticipated ambient air impacts at the Paducah Site. For further discussion of potential on-site treatment accident emissions, see Sect. 4.1.4.

Wastewater treatment techniques would be used to remove contaminants from aqueous waste streams that are suitable for on-site discharge through the permitted wastewater treatment system. Minimal air emissions would be expected from the wastewater treatment system since these proposed processes are not a notable source of air pollutants.

Under the proposed action, a portion of the wastes is proposed for off-site treatment at existing, licensed, and/or permitted facilities. This would result in no anticipated impacts at the Paducah Site.

Waste Disposal. The pollutants that would be emitted by transportation vehicles during waste movement to disposal facilities include nitrogen oxides, carbon monoxide, volatile organic compounds, particulates, and fugitive road dust emissions. Impacts on air quality from the exhaust emissions of the vehicles used to transport wastes from the Paducah Site would be very small, because only a few vehicles and a small number of daily or weekly trips would be involved. Transportation would impact the ambient air quality for a small segment of the general public for only a short period of time as the waste was being transported to a treatment and/or disposal location. The roads that would be used for transportation would be paved, with the possible exception of access roads at a treatment, storage, and disposal facility; therefore, fugitive road dust emissions would be limited and temporary. Overall, air quality impacts associated with transportation activities would be small, localized, and temporary. See Sect. 4.1.3 for more detailed air quality analysis.

All wastes are proposed to be disposed off-site at existing, licensed/permitted facilities. Therefore, non-transportation related disposal impacts are not anticipated at the Paducah Site.

Supporting Activities. Air emissions associated with supporting activities would be a combination of potential impacts discussed in previous sections on waste storage and waste treatment. Refer to these sections for further information.

4.1.1.11 Socioeconomics and environmental justice

The processing and repackaging of affected wastes for shipment are expected to result in an increase of 30 full-time-equivalent jobs per year. Transportation employment would similarly create 15 or fewer full-time-equivalent jobs. An increase of 45 total jobs would represent less than a 1% change from 1997 employment in McCracken County, which does not constitute a notable impact. Because the actual employment impact is likely to be smaller and would be spread over additional counties, there would be no notable economic impact from the proposed action. Executive Order 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low Income Populations," requires agencies to identify and address disproportionately high and adverse human health or environmental effects that their activities may have on minority and low-income populations. For the treatments considered in this EA, populations considered are those that live within 80 km (50 miles) of the Paducah Site. However, these groups would be subject to the same negligible impacts as the general population.

Socioeconomic impacts and environmental justice issues regarding waste transport are addressed in Sect. 4.1.3.

4.1.2 On-Site Accident Analysis and Human Health Impacts

An analysis has been performed to evaluate the potential consequences and risks of accidents affecting the PCB, LLW, MLLW, and TRU wastes currently stored at the Paducah Site. For evaluation purposes, all wastes are estimated to be treated and disposed over a 10-year period. In this option, wastes may be shipped off-site for treatment and/or disposal following on-site treatment, if required.

Accidents have been postulated and the consequences and risks evaluated. The types of accidents considered included natural phenomena, process accidents such as vehicle impacts and dropped waste packages, and industrial accidents. Consequences included radiological exposure, toxic chemical exposure, and industrial hazards leading to injuries and fatalities.

The methodology, waste characterization, and a summary of the analysis of accidents affecting the alternative are discussed in the following sections. Calculations that derive the accident analysis are presented in Appendix G.

4.1.2.1 Methodology

The estimated accident consequences were based on the inventories and material characteristics of the wastes stored on the Paducah Site. Methods used to evaluate the importance of the potential adverse effects from postulated accidents are listed in Appendix G.

4.1.2.2 Waste characterization

The wastes stored on the Paducah Site consist of PCB-containing capacitors and nearly empty transformers, LLW, MLLW, and TRU waste. The packaged wastes (excluding the capacitors and transformers) include approximately 600 m^3 (21,189 ft^3) of liquids, 350 m^3 (12,360 ft^3) of solid combustible wastes, and 10,700 m^3 (377,867 ft^3) of noncombustible solid wastes.

4.1.2.3 Accident evaluation for the proposed action

In the proposed action, the wastes are stored pending on-site treatment, on-site disposal, or shipment off-site for treatment or disposal. The types of activity associated with these actions include storage of waste containers, mechanical handling of steel waste containers, and opening of waste containers under controlled conditions to allow treatment (e.g., solidification of liquids, grouting). The general approach to the analysis described in Appendix G is to postulate accidents that have the potential to breach the steel waste containers and release the contents. Once the contents are released, the accidents are postulated to suspend a fraction of the wastes in the air or surface water. The suspended wastes are then transported to individuals and populations. The dose consequences to these individuals and populations are evaluated assuming no mitigation (i.e., no evacuation or sheltering).

Five accidents were identified as having the potential to breach the waste containers:

- Evaluation-basis earthquake (EBE)
- Large aircraft impact and fire
- General aviation impact and fire
- Ground vehicle impact/mishandling
- Ground vehicle impact and fire

Accident Selection. The following accidents are postulated for evaluation:

- The earthquake scenario affects all stored containers. The EBE is a major earthquake of 0.8 gs at bedrock, or lithified rock. The earthquake scenario used to evaluate the Paducah Site facilities has a ground surface acceleration, which DOE has estimated equates to approximately 0.5-0.6 gs. An event of this caliber is judged capable of toppling stacked drums and possibly ST-90 containers. A fraction of these toppled containers is postulated to partially fail.

- The large aircraft impact accident, if it occurred, would affect a large number of containers. In addition to mechanical damage, the released fuel could ignite the combustible wastes. The likelihood, however, of a direct impact of a large aircraft into the stored wastes is extremely small and is judged not credible based on comparisons of the aircraft impact frequencies affecting the large Paducah Site buildings. Based on the extremely low likelihood of this accident and on the fact that the consequences are judged comparable to the much more likely EBE, the large aircraft accident is not considered further.

- In contrast to the large aircraft impact accident, general aviation (small aircraft) impacts are more likely. Although the number of boxes affected would be small with respect to the earthquake, the consequences might be notable if a container were affected that had high-radionuclide-concentration, combustible wastes. As shown in Table 1.1, however, the radionuclide and toxic metal concentrations in combustible wastes are negligible with respect to other constituents. The mechanical damage to other waste forms would be comparable to the more likely vehicle impact and mishandling accidents. Based on the limited source terms and the low probability of the event, general aviation impact accidents are not considered further.

- As in the case of the small aircraft impact, a ground vehicle accident could breach one or more containers and possibly initiate a fuel fire. In general, the effects of a fire are not notable for most waste packages and vehicle impacts. However, the impact and fire accident could be postulated to breach the nearly empty PCB-containing transformers. In addition, mechanical impact accidents could release a limited quantity of high-activity wastes with a higher frequency than the EBE, and they are analyzed for this reason.

Two of these accidents, large aircraft impact and general aviation impact, were ruled out as unlikely occurrence (Appendix G). As a result, three bounding accidents have been selected for the evaluation of the proposed action: an EBE, a vehicle impact/container mishandling accident, and a vehicle impact accident and fire affecting a PCB-containing transformer. Accident selection is described in detail in Appendix G.

4.1.2.4 Waste characterization and storage configuration

The physical and radiological characteristics of the four waste streams are listed in Table 1.1. The transformers and capacitors provide containment for the PCB oils within them. The listed mass is of the entire set of transformers and capacitors, including the steel containers and the contained PCB oil. Individual capacitors each contain approximately 2 gal of PCB oil. The transformers are drained but can contain up to 10% of their total capacity of PCB oil.

The waste stream volumes of packaged wastes are directly estimated quantities. The waste stream masses are based on an estimated average density of similar wastes, 1 g/cc for liquids and soft solids and 2 g/cc for all other solids. For each isotope in the waste stream, the total isotopic activity is computed as the product of the total waste stream mass and the mean isotopic activity density. This isotopic activity is then converted to an equivalent activity of uranium and summed over all isotopes in each waste stream. Similarly, the mass of each listed toxic metal is computed based on the waste stream mass and an estimated concentration of 5,000 ppm for each metal. The mass of each metal is converted to an equivalent mass of chromium for each metal and summed over each metal in the waste stream.

The transformers are large steel shells containing the PCB oil. No additional packaging is estimated. Packaged wastes would be stored in steel containers ranging from 55-gal drums to sea-land containers. Since the larger containers, however, are difficult to topple and breach, all packaged wastes are estimated conservatively to be contained in 55-gal drums and stacked two high in a square array.

Four drums are estimated to be mounted on 1.2- × 1.2-m (4- × 4-ft) pallets in double rows and stacked two containers high. To permit access to each container, a 5-m (16-ft) aisle is estimated between each double row. Assuming an approximately square array, an array of 180 × 180 m (590 × 590 ft) is required to store the estimated 56,600 drums.

Some wastes are expected to be treated on-site or shipped off-site prior to the completion of the proposed action. For purposes of this analysis, however, all wastes are estimated to be at risk of accidental release and dispersion over the entire 10-year processing period.

4.1.2.5 Analysis of the EBE accident

A detailed analysis of the EBE accident is presented in Appendix G. Following is a summary of that analysis.

In the event of a major earthquake, the horizontal ground acceleration is estimated to be capable of creating differential movement between the top and bottom box layers, resulting in drums being toppled into the aisles. It is estimated that 10% of the entire upper layer of drums (2800 boxes) topple and fail. The 10% estimate is based on an evaluation of stacked 55-gal drums during seismic events (Hand 1998).

Results of Radiological Dose Computations. Results from the Appendix G computations for the effects of radiological dose resulting from an EBE are presented in Tables 4.1 and 4.2. Two source terms were considered during the computations: the airborne source term (AST) in which radioactivity is released to, and dispersed by, the air; and the liquid source term (LST) in which radiologically contaminated liquids are released to, and dispersed by, surface water.

Table 4.1. Airborne source term risks

Receptor	Distance from area	Risk (expected fatalities)
MIW/MUW	At edge	1.5×10^{-8}
MEI	1,580 m	9.5×10^{-10}
Population	General	7.5×10^{-9}

MEI = maximally exposed individual
MIW = maximally exposed involved worker
MUW = maximally exposed uninvolved worker

Table 4.2. Liquid source term risks

Receptor	Risk (expected fatalities)
MEI	4.5×10^{-11}

MEI = maximally exposed individual

The AST has the potential for widespread dissemination of radioactivity. Therefore, four receptors were evaluated:

- the maximally exposed individual (MEI),
- the maximally exposed involved worker (MIW),
- the maximally exposed uninvolved worker (MUW), and
- the general population.

The impact of the LST would be less pervasive. Therefore, the computations considered only the MEI.

In summary, the computed risks (expected fatalities) from radiological dose resulting from an EBE accident are negligible (Tables 4.1 and 4.2).

Results of Toxic Metals Exposure Computations. Effects of exposure to toxic metals were considered. As stated in Appendix G, no toxic metals are known to be in the liquid waste streams being considered in this EA. Therefore, only the AST was considered in Appendix G. The results of the computations demonstrate that the concentration of toxic metals in the AST resulting from an EBE would be negligible compared to the most conservative benchmark for human exposure.

4.1.2.6 Analysis of the vehicle impact accident

During the proposed action, vehicles such as forklifts occasionally would be used to reposition waste containers. Impacts with drums resulting in breach are estimated to occur at a rate of one per year. Thus, it is estimated that one or more drums would be breached. For the wastes stored at the Paducah Site however, 87% of all radioactivity occurs in the single drum of ThF_4, and an additional 4% occurs in the 24 drums of TRU waste. The risks of accidents involving these wastes bound the risks of other waste streams.

The computations for analyzing the vehicle mishap/mishandling accident in Appendix G evaluated the risks (expected fatalities) resulting from rupturing the ThF_4 drum or any of the 24 drums containing TRU waste. This analysis takes into account the estimated accident frequency and the probability that the damaged drum would be either the ThF_4 drum or 1 of the 24 TRU waste drums out of a total of 56,000 drums. Other assumptions for the computations are presented in Appendix G. The results of the computations, presented in Table 4.3, show that the risk of the vehicle mishap/mishandling accident is negligible but slightly greater than for the EBE. However, it was assumed for the EBE computations that the ThF_4 drum would not be placed in a vulnerable position and would not be ruptured during the EBE. If, instead, the ThF_4 drum had been assumed to be placed in a vulnerable position for the EBE analysis, the results would have been similar to those for the vehicle mishap/mishandling computations.

Table 4.3. Vehicle impact accident risks

Contaminant	Receptor	Risk (expected fatalities)
ThF_4	MUW	7.9×10^{-8}
	MEI	1.1×10^{-9}
	Population	2.3×10^{-9}
TRU	MUW	1.7×10^{-8}
	MEI	2.4×10^{-10}
	Population	5.2×10^{-10}

MEI = maximally exposed individual
MUW = maximally exposed uninvolved worker
TRU = transuranic

4.1.2.7 Analysis of the vehicle impact/mishandling and fire accident

In addition to releases of radionuclides during a vehicle impact/mishandling accident, it is also possible that a PCB-containing transformer could be ruptured with ensuing combustion of the PCB oil. PCB combustion results in the release of several toxic substances. Essentially all of the chlorine (Aroclor 1254 is 54% chlorine) is stripped and released as hydrochloric acid (HCl). Also during combustion, approximately 1% of the PCB forms a pyrolyzed mixture of PCB, dioxins, and furans, also know as PCB soot.

Concentrations of HCl and PCB soot arising from a PCB fire were calculated in Appendix G. When compared to benchmarks (Table 4.4) neither the calculated HCl nor PCB soot occur in concentrations that would create adverse health effects to the MUW or MEI. The calculated concentration of HCl is 20% of the Emergency Response Planning Guideline—Level 2. The calculated concentration of PCB soot is 37% of the "no observed adverse effect level."

Table 4.4. Calculated concentrations of HCl and PCB soot resulting from a PCB fire compared to standard benchmarks

Substance	Calculated Concentration	Benchmark Concentration[a]
HCl	6.1 mg/m^3	30 mg/m^3
PCB soot	0.11 mg/m^3	0.3 mg/m^3 for 1 hour

[a] Benchmark for HCl is the Emergency response Planning Guideline—Level 2. For PCB soot it is the "no observed adverse affect level."

HC1 = hydrochloric acid

PCB = polychlorinated biphenyl

4.1.2.8 Analysis of industrial accidents

During the proposed action, it is estimated that the wastes are stored and monitored, transported to waste treatment locations on-site, and prepared for transportation off-site. It is estimated that these activities require 60 full-time equivalents or 120,000 person-h/year over the 10-year duration. Based on the 3.4×10^{-3}/200,000 person-h industrial fatality rate, 2.0×10^{-3} fatalities/year or 2.0×10^{-2} fatalities/ 10 years are expected.

4.1.3 Transportation Impacts

The proposed action would include shipment of heterogeneous LLW, MLLW, and TRU waste by truck, rail, or intermodal transport. LLW may be shipped only by truck and not by rail due to regulatory limits on the inventory of radionuclides.

4.1.3.1 Air quality

The Clean Air Act of 1970, Sect. 176 (c), requires EPA to establish rules to ensure that federal agency actions conform with state implementation plans (SIPs). These plans are designated to eliminate or reduce the severity and number of violations of the National Ambient Air Quality Standards (NAAQS). As a result, EPA promulgated the "General Conformity" rule (58 FR 63214-63259) in November 1993. This rule applies in areas considered "nonattainment" or "maintenance" for any of six criteria air pollutants (ozone, carbon monoxide, sulfur dioxide, nitrogen dioxide, particulate matter, and lead). A nonattainment area is one in which the air quality in an area exceeds the allowable NAAQS for one or more pollutants, while a maintenance area is one that has been redesignated from nonattainment to attainment. The general conformity rule covers direct and indirect emissions of criteria pollutants caused by federal actions and that exceed the threshold emissions levels shown in 40 *CFR* 93.153(b). Each affected state is required by Sect. 176(c) of the 1990 Clean Air Act amendments to devise a SIP, which is designed to achieve the NAAQS.

DOE has integrated the requirements of the general conformity rule with those of its NEPA process wherein, for actions not exempted, the total emissions from the proposed action are evaluated to determine when they are above de minimus thresholds and whether they are regionally important.

Since many of the representative transport routes are duplicative of routes assessed in the EA for transport of LLW from the Oak Ridge Reservation to off-site treatment and disposal facilities (DOE 2000b), the same analysis presented previously is given here. This analysis is provided as follows:

Nonattainment areas associated with each route:

- Nevada Test Site option: Las Vegas, Nevada.
- Clive, Utah, option: St. Louis, Missouri; Kansas City, Missouri-Kansas; and Salt Lake City, Utah.
- WCS (Andrews, Texas) option: Dallas-Fort Worth, Texas, area.
- Hanford option: St. Louis, Missouri; Kansas City, Missouri-Kansas; Ogden, Utah; and Boise, Idaho.
- For transport to commercial treatment facilities near Oak Ridge, there are no nonattainment areas. The Knoxville-Oak Ridge area is in an attainment region where criteria air pollutants do not exceed standards.

Air quality impacts from highway transport

The LLW transport EA (DOE 2000b) analyzed the maximum number of truck shipments that would occur in any one year: 835. It was expected that shipments would be spread evenly over the year; thus, the maximum in any 1 week would be 16, or 2 to 3 per day. All major nonattainment areas are associated with large metropolitan areas. Planned shipments of two to three per day maximum would not discernibly increase the daily rate of truck traffic for these metropolitan areas, and they are minimal compared with the daily rate of truck traffic in the areas. The Paducah Site anticipates making only 762 shipments per year. However, the Oak Ridge EA analysis provides a conservative result using an assumption of 835 per year.

In the brief Oak Ridge EA (DOE 2000b), analysis was undertaken to determine the impact of the proposed shipments relative to the threshold emission levels in nonattainment areas described by EPA in its air conformity regulations [40 *CFR* 93.153(b)(1)]. The EPA general conformity rule (58 FR 63214, November 30, 1993) requires federal agencies to prepare a written conformity analysis and determination for proposed activities only in those cases where total emissions of an activity exceed the threshold emission levels. Where it can be demonstrated that emissions from a proposed new activity fall below the thresholds, these emissions are considered to be de minimus and require no formal analysis.

The Oak Ridge EA (DOE 2000b) proposed routes were evaluated for maximum road miles proposed to be traveled for each criteria pollutant. Carbon monoxide, ozone, and particulate matter smaller than 10 micrometers (PM_{10}) were the criteria pollutants used. The maximum road miles traveled through a nonattainment area would be approximately 150 miles (includes return trip) through the Dallas-Fort Worth, Texas, area (Atlanta and St. Louis areas are nearly as large). This distance conservatively includes a return truck trip even though the return trip is not part of the Oak Ridge proposed action (no LLW on the truck), and it is likely that commercial vehicles would not return to Oak Ridge by the same route if they were able to contract a load for the return trip.

The EPA threshold for carbon monoxide for all nonattainment and maintenance areas is 200,000 lb (100 tons)/year for any new proposed activity. The EPA threshold for ozone (measured by its precursor, NO_x for "ozone attainment areas outside an ozone transport region" such as Dallas-Fort Worth) is 200,000 lb (100 tons)/year. The EPA threshold for PM_{10} for all moderate nonattainment areas is 200,000 lb (100 tons)/year for any new proposed activity. Emission factors for carbon monoxide and ozone for various motor vehicle types have been modeled for the year 1990 (Goel 1991). Emission factors for PM_{10} have been calculated using EPA's February 1995 model for that criteria pollutant. Heavy duty diesel-powered vehicles (HDDVs) are defined as any diesel-powered motor vehicle designated primarily for the transportation of property and rated at more than 8500 lb of gross vehicle weight. For HDDVs, including the standard commercial semitractor vehicles that would be used for pulling waste shipments, the average emission for carbon monoxide is estimated as 11.03 g/mile, while the NO_x (an ozone precursor) emission rate is 22.91 g/mile. Finally, the emission factor for PM_{10} is 14.87 g/mile.

Using a maximum of 835 shipments (truck round trips)/year, the carbon monoxide emission rate was estimated for the maximum distance traveled through a nonattainment area (Dallas-Fort Worth). This emission rate was approximately 3047 lb of carbon monoxide/year. This amount of emissions is below the threshold standard of 100 tons/year and is clearly a de minimus amount. Therefore, the deduction is made that the Paducah Site's proposed action of 762 shipments per year would also be de minimus.

Using a maximum of 835 shipments/year (truck round trips), an ozone emission rate was established for the maximum distance traveled within a nonattainment area (Dallas-Fort Worth area). This emission rate was approximately 6313 lb of NO_x/year (NO_x is a precursor to ozone). This amount of emissions is below the threshold standard of 100 tons/year and clearly a de minimus amount. Therefore, the deduction is made that the Paducah Site's proposed action of 762 shipments per year would also be de minimus.

Finally, using 835 shipments/year, a PM_{10} rule was established for the maximum distance within a nonattainment area (Dallas-Fort Worth). The emission rate was 4102 lb of PM_{10}/year. This amount is below the threshold standard of 100 tons/year and is clearly a de minimus amount. Therefore, the deduction is made that the Paducah Site's proposed action of 762 shipments per year would also be de minimus.

Because the Dallas-Fort Worth area example maximizes road miles traveled through a nonattainment area and also conservatively estimates emission factors, it is assumed that this example "bounds" the impacts within other nonattainment areas for the proposed action. Therefore, air emissions within all nonattainment areas along shipment routes are well below the EPA threshold emission levels, and thus require no formal conformity analysis.

4.1.3.2 Human Risk associated with truck transportation

This section discusses potential impacts associated with transporting the LLW, MLLW, and TRU waste in the following DOT- and RCRA-compliant shipping configurations[a]:

- **LLW:** The containers used for the transportation of LLW solids and liquids and the maximum load per shipment are as follows:

  — ST-90 boxes, 4 boxes/shipment;
  — 55-gal drums, 78 drums/shipment;
  — 85-gal drums, 40 drums/shipment;

[a] 762 shipments/(52 weeks/year) = 15 shipments/week. This makes the conservative assumption that each shipment takes 1 week to make a round-trip, so each shipment in a week requires a separate driver, and all shipments are made within a year. Actual shipment round-trips are likely to be shorter, reducing the number of drivers required. The number of shipments was taken from the waste stream table.

— B-25 boxes, 4 boxes/shipment; and
— tanker trucks.

- **MLLW:** The containers used for transportation of MLLW solids and liquids and the maximum load per shipment are as follows:

— 55-gal drums, 78 drums/shipment;
— 85-gal drums, 40 drums/shipment;
— B-12 boxes, 4 boxes/shipment; and
— tanker trucks.

- **TRU Waste:** The container used for transportation of TRU waste is 55-gal drums in one truck shipment. These drums will be overpacked in TRUPAC II or HALFPAC containers to met applicable protocols.

Radiological Impacts from normal Truck Transportation. The potential effects of transporting waste by highway from Paducah to each of the potential final destination sites described in Sect. 3.10 were evaluated for all three waste subgroups on an annual basis during the major shipment year groupings and on a total 10-year shipping campaign basis.

The potential radiological effects of routinely transporting waste by highway from Paducah to each of the potential final destination sites described in Sect. 3.10 were estimated for all three waste subgroups on an annual basis during the major shipment year groupings, and on a total 10-year shipping campaign basis. Details of the evaluation are presented in Appendix H. Truck shipments to Andrews, Texas, Richland Washington, Mercury, Nevada, Clive, Utah, Oak Ridge [East Tennessee Technology Park (ETTP)], Tennessee, Oak Ridge (ORNL), Tennessee, and Oak Ridge Materials & Energy/Waste Control Specialists (MEWC), Tennessee, were evaluated for the probability of an latent cancer fatality (LCF) to the truck crew, the general population, and the MEI. The results of the evaluation are summarized below in Table 4.5, which shows the worst-case results from the seven evaluated truck routes. It turns out that the worst-case results for the truck crew, general population, and MEI all occur during the shipment to Mercury, Nevada.

Table 4.5. Worst-case radiological impacts for truck shipments (to Mercury, NV)

Risk group	Annual impacts		Total for 10-year life cycle	
	Dose (person-rem)[a]	LCF	Dose (person-rem)	LCF
Crew	6.1	2.4×10^{-3}	61	2.4×10^{-2}
Population[b]	2.4	1.2×10^{-3}	24	1.2×10^{-2}
MEI[c] (rem)	3.4	1.7×10^{-3}	3.4×10^{-4}	1.7×10^{-7}

[a]Person-rem represents the collective dose received by a group of workers or members of the public.
[b]Includes population dose receptors off-link and on-link.
[c]MEI latent cancer fatality represents the probability of a latent cancer fatality occurrence.
LCF = latent cancer fatality
MEI = maximally exposed individual

The estimated risks to the public are proportional to the total number of people potentially exposed to radiation while shipments are in transit. This potentially exposed population is estimated from population density categories and the distance traveled, as described in Sect. 3.10.1. The estimated risks to the public are based on a total dose across all persons within the potentially exposed population. The differences in estimated risks to the public between destinations are due to differences in the total number of potentially exposed people and do not reflect risks to an individual due to higher dose estimates.

The estimated risks to workers differ between destinations due to the distance of the destination from Paducah and to the radiological characteristics of the waste forms being transported. The estimated risks from radiation exposure for the trucking crew would be directly proportional to the number of miles traveled, the type of waste, and the number of shipments that were used to estimate the risks for each destination.

The MEI dose estimates demonstrate the relatively small dose a single individual is likely to receive. The MEI dose estimates are also considered extremely conservative, since this individual is a hypothetical member of the public who lives 30 m (98 ft) from the highway and would be exposed to every shipment of waste. Differences between the estimated risks to the MEI between waste subgroups were due to the differences in number of shipments between subgroups and to the differences in risk from the subgroup wastes themselves.

Cargo-Related Radiological Impacts During a Highway Accident. The probability of a highway accident occurring during waste transportation by truck was evaluated for each of the seven receiving locations. In addition, the radiological dose resulting from these accidents was calculated and the risk of LCFs to the general public were also calculated. The details of this analysis are presented in Appendix H, and the results are summarized below in Table 4.6. As summarized in Table 4.6, the worst-case calculated number is far less than 1 LCF (1.5×10^{-3}) for shipment to Mercury, Nevada. For the entire waste transportation campaign, the calculated value is still less than 1 latent cancer fatality (2.5×10^{-3}).

Table 4.6. Cargo-related impacts resulting from truck transportation accidents

	Population risk[a]	
Destination	**Dose (person-rem)**	**Latent cancer fatalities**
Andrews, TX	0.07	3.5×10^{-5}
Hanford, WA	1.55	7.8×10^{-4}
Clive, UT	0.09	4.5×10^{-5}
Mercury, NV	3.0	1.5×10^{-3}
Oak Ridge (ETTP), TN	.02	1.0×10^{-5}
Oak Ridge (ORNL), TN	0.18	9.0×10^{-5}
Oak Ridge (MEWC) TN	0.02	1.0×10^{-5}
Total	**4.9**	$\mathbf{2.5 \times 10^{-3}}$

[a]Each population risk value is the product of the consequence (population dose or latent cancer fatalities) multiplied by the probability for a range of possible accidents.

ETTP = East Tennessee Technology Park
MEWC = Materials & Energy/Waste Control Specialists
ORNL = Oak Ridge National Laboratory

Vehicle-Related Impacts. Potential vehicle-related impacts, including expected accidents, expected fatalities from accidents, and impacts from vehicle emissions were evaluated in Appendix H. The results of the evaluation are summarized in Table 4.7. Impacts from vehicle-related accidents and emissions are highest for the Mercury (Nevada Test Site), Nevada, and Clive (Envirocare), Utah, destinations because of the larger number of shipments and the total miles traveled to and from these destinations. However, vehicle-related impacts for these locations are calculated to be minimal.

Table 4.7. Estimated fatalities from truck emissions and accidents (vehicle-related impacts)

Destination[a]	Incidents: Accidents	Incidents: Fatalities	Latent fatalities from emissions[b]
Andrews, TX	6.0×10^{-2}	3.1×10^{-3}	1.3×10^{-2}
Hanford, WA	9.0×10^{-3}	3.8×10^{-4}	2.1×10^{-3}
Clive, UT	7.3×10^{-1}	2.7×10^{-2}	1.6×10^{-1}
Mercury, NV	1.1	4.1×10^{-2}	2.6×10^{-1}
Oak Ridge (ETTP), TN	1.2×10^{-2}	6.8×10^{-4}	4.2×10^{-3}
Oak Ridge (ORNL), TN	5.4×10^{-4}	3.2×10^{-5}	2.0×10^{-4}
Oak Ridge (MEWC), TN	2.5×10^{-3}	1.4×10^{-4}	8.8×10^{-4}
TOTAL	**1.89**	**0.08**	**0.43**

[a]Accidents and fatalities are based on round-trip distance traveled.
[b]Calculated for travel through urban areas only.
ETTP = East Tennessee Technology Park
MEWC = Materials & Energy/Waste Control Specialists
ORNL = Oak Ridge National Laboratory

4.1.3.3 Human Risk associated with rail transportation

Radiological Impacts from normal Rail Transportation. The potential radiological effects of routinely transporting LLW, MLLW, and TRU waste by rail from Paducah to each of the potential final destination sites described in Sect. 3.10 were estimated for all three waste subgroups on an annual basis during the major shipment year groupings and on a total 10-year shipping campaign basis. Details of the evaluation are presented in Appendix H. Rail shipments to Hobbs, New Mexico, Hanford, Washington, Clive, Utah, Mercury Nevada, Oak Ridge (ETTP), Tennessee, Oak Ridge (ORNL), Tennessee, and Oak Ridge (MEWC), Tennessee, were evaluated for the probability of an LCF to the train crew, the general population, and the MEI. The results of the evaluation are summarized below in Table 4.8, which shows the worst-case results from the seven evaluated train routes. It turns out that the worst-case results for truck crew, general population, and MEI all occur during the shipment to Mercury, Nevada.

Table 4.8. Worst-case radiological impacts for rail shipments (to Mercury, Nevada)

Risk group	Annual impacts: Dose (person-rem)[a]	Annual impacts: LCF	Total for 10-year life cycle: Dose (person-rem)	Total for 10-year life cycle: LCF
Crew	2.7	1.1×10^{-3}	27	1.1×10^{-2}
Population[b]	8.1	4.1×10^{-3}	81	4.1×10^{-2}
MEI[c] (rem)	7.3×10^{-5}	3.7×10^{-8}	7.3×10^{-4}	3.7×10^{-7}

[a]Person-rem represents the collective dose received by a group of workers or members of the public.
[b]Includes population dose receptors off-link and on-link.
[c]MEI LCF represents the probability of an LCF occurrence.
LCF = latent cancer fatality
MEI = maximally exposed individual

As with truck transportation, the estimated risks to the public are proportional to the total number of people potentially exposed to radiation while shipments are in transit. This potentially exposed population is estimated from population density categories and the distance traveled, as described in Sect. 3.10.1. The estimated risks to the public are based on a total dose across all persons within the potentially exposed population. The differences in estimated risks to the public between destinations are due to differences in the total number of potentially exposed people and do not reflect risks to an individual due to higher dose estimates.

The estimated risks to workers differ between destinations due to the distance of the destination from Paducah and to the radiological characteristics of the waste forms being transported. The estimated risks from radiation exposure for the rail crew would be directly proportional to the number of miles traveled, the type of waste, and the number of shipments that were used to estimate the risks for each destination.

The MEI dose estimates demonstrate the relatively small dose a single individual is likely to receive. The MEI dose estimates are also considered extremely conservative, since this individual is a hypothetical member of the public who lives 30 m (98 ft) from the railway and would be exposed to every shipment of waste. Differences between the estimated risks to the MEI between waste subgroups were due to the differences in number of shipments between subgroups and to the differences in risk from the subgroup wastes themselves.

Maximally Exposed Individual. The MEI dose estimates presented in Appendix H demonstrate the relatively low dose a single individual is likely to receive. The MEI dose estimates are also considered extremely conservative, since this individual is a hypothetical member of the public who lives 30 m (98 ft) from the railway and would be exposed to every shipment of waste.

Differences between the estimated risks to the MEI between waste subgroups were due to the differences in the number of shipments between subgroups and to the differences in risk from the subgroup waste itself. For example, the 10-year analysis period for shipment of waste to Oak Ridge (ORNL), Tennessee, results in an MEI dose of 4.4×10^{-6} rem. The MEI dose to the Las Vegas, Nevada destination for the 10-year period is 7.3×10^{-4}, and the resultant probability of an LCF is minimal at 3.7×10^{-7}.

Cargo-Related Radiological Impacts During a Rail Accident. The probability of a railroad accident occurring during waste transportation was evaluated for each of the seven receiving locations. In addition, the radiological dose resulting from these accidents was calculated and the risk of LCFs to the general public were also calculated. The details of this analysis are presented in Appendix H, and the results are summarized below in Table 4.9. As summarized in Table 4.9, the worst-case calculated number is far less than 1 latent cancer fatality (1.6×10^{-3}) for shipment to Mercury, Nevada. For the entire waste transportation campaign, the calculated value is still less than 1 LCF (2.8×10^{-3}). Calculated population risk for rail transportation is equivalent to that for transportation by truck (Table 4.6).

Table 4.9. Cargo-related impacts from rail transportation accidents

	Population risk[a]	
Destination	**Dose (person-rem)**	**LCF**
Hobbs, NM	0.07	3.5×10^{-5}
Hanford, WA	1.74	8.7×10^{-4}
Clive, UT	0.07	3.5×10^{-5}
Las Vegas, NV	3.2	1.6×10^{-3}
Oak Ridge (ETTP), TN	0.09	4.5×10^{-5}
Oak Ridge (ORNL), TN	0.4	2.0×10^{-4}
Oak Ridge (MEWC), TN	4.4×10^{-2}	2.2×10^{-5}
Total	**5.51**	$\mathbf{2.8 \times 10^{-3}}$

[a]Each population risk value is the product of the consequence (population dose or LCF) multiplied by the probability for a range of possible accidents.

ETTP = East Tennessee Technology Park
LCF = latent cancer fatality
MEWC = Materials & Energy/Waste Control Specialists
ORNL = Oak Ridge National Laboratory

Rail-Related Impacts. Potential rail-related impacts, including expected accidents, expected fatalities from accidents, and impacts from vehicle emissions were evaluated in Appendix H. The results of the evaluation are summarized in Table 4.10. Impacts from rail-related accidents and emissions are highest for the Mercury (Nevada Test Site), Nevada, and Clive (Envirocare), Utah, destinations because of the larger number of shipments and the total miles traveled to and from these destinations. However, all calculated values are much less than 1, indicating negligible impacts from rail-related accidents.

Table 4.10. Estimated fatalities from rail-related accidents

	Incidence	
Destination[a]	**Accidents**	**Fatalities**
Hobbs, NM	4.2×10^{-3}	6.9×10^{-4}
Hanford, WA	9.8×10^{-4}	3.0×10^{-4}
Clive, UT	2.6×10^{-2}	8.6×10^{-3}
Las Vegas, NV	5.1×10^{-2}	1.5×10^{-2}
Oak Ridge (ETTP), TN	1.2×10^{-3}	2.8×10^{-4}
Oak Ridge (ORNL), TN	1.0×10^{-4}	2.3×10^{-5}
Oak Ridge (MEWC), TN	2.5×10^{-4}	5.7×10^{-5}
Total	**0.08**	**0.02**

[a]Accidents and fatalities are based on round-trip distance traveled.
ETTP = East Tennessee Technology Park
MEWC = Materials & Energy/Waste Control Specialists
ORNL = Oak Ridge National Laboratory

4.1.3.4 Socioeconomics and environmental justice

The processing and repackaging of affected wastes for shipment are expected to result in an increase of 30 full-time-equivalent jobs per year. Transportation employment would similarly create 15 or fewer full-time-equivalent jobs[a]. An increase of 45 total jobs would represent less than a 1% change from 1997 employment in McCracken County, which does not constitute a notable impact. Because the actual employment impact is likely to be smaller and would be spread over additional counties, there would be no notable economic impact from the proposed action.

Executive Order 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low Income Populations," requires agencies to identify and address disproportionately high and adverse human health or environmental effects that their activities may have on minority and low-income populations. For the treatments considered in this EA, populations considered are those that live within 80 km (50 miles) of the Paducah Site. For transportation alternatives, populations considered are those that live along the highways or rail lines where transport of packaged waste would occur (as described in Sect. 3.10) and people using the highways and/or stopping at rest stops. Individual access and use of public highways or rest stops that would be used by trucks shipping waste are not limited or restricted to any particular population group, economically disadvantaged or advantaged. Because it is expected that the percentage of minority or low-income households within the potentially exposed population would vary along the highway routes used for the proposed action, no disproportionate effects to those minority or low-income households located along the routes can be identified. These groups would be subject to the same negligible impacts as the general population.

[a] 762 shipments/(52 weeks/year) = 15 shipments/week. This makes the conservative assumption that each shipment takes 1 week to make a round-trip, so each shipment in a week requires a separate driver, and all shipments are made within a year. Actual shipment round-trips are likely to be shorter, reducing the number of drivers required. The number of shipments was taken from the waste stream table.

Most of the risk associated with incident-free transportation of waste by highway is the exposure of the public to radiation at rest stops, followed by exposure of truck crews. These exposures are put into perspective by comparison to a hypothetical MEI dose estimate (i.e., an individual who would be exposed to each shipment of waste). As discussed in Sect. 4.1.2, the MEI estimate is small compared to estimates of expected exposures from background radiation. The estimated risks of cancer resulting from vehicle emissions contributed by the waste transportation program are also anticipated to be low. Estimated risks resulting from transportation by rail are as low or lower than from highway transportation.

4.1.3.5 Natural Resource Impact

Accidents from truck and/or rail transport of wastes have the potential to impact national resources. Impacts could result from accidents that result in a waste container breach, leading to a waste spill. The introduction of contaminants into any natural resources (i.e., water, soils, wetlands, etc.) would result in short-term impacts to the receiving resource. The impacts are estimated to be short term due to cleanup efforts that would follow a spill. Impacts are also determined to be minor due to the utilization of mitigative measures exercised during waste transport. These measures, such as proper waste containerization and packaging, would decrease the amount of contamination spilled.

4.1.4 On-site Treatment Impacts

The following sections present potential impacts resulting from on-site treatment of a subset of the total waste volume on the Paducah Site.

4.1.4.1 Air Quality

Normal operation of the Waste Treatment Facility would not result in adverse impacts to the environment or to the health and safety of the public or workers. Normal airborne emissions of chemicals from the treatment processes would be treated to reduce concentrations to below permissible Clean Air Act environmental and worker exposure limits by HEPA filters before discharge from the facility enclosure, and subsequently, from Building C-752A. Workers inside the Treatment Facility would be protected from adverse effects of normal emissions of chemicals by the appropriate level of personal protective equipment (PPE). Solid (non-radioactive) wastes resulting from the Treatment Facility normal operation would be treated and/or packaged for subsequent offsite disposal, in accordance with Site Waste Management procedures, to preclude adverse impacts to the environment or public/worker health and safety.

The likelihood of accidents that may affect air quality are low due to the implementation of mitigative measures such as filters, process controls, and the proper training of treatment facility personnel. However, the airborne environmental consequence of an instantaneous release of nitric acid is evaluated in Appendix I. The evaluation shows a release of 500 gal of nitric acid would be in the form of a dispersion distance of 6.1 km (3.8 miles) to the Toxic Endpoint ["immediately dangerous to life or health" (IDLH) limit]. If the effect of the treatment facility enclosure is included in this scenario, the dispersion distance is reduced to 0.8 km (0.5 mile), which is within the nearest DOE property line. The unmitigated airborne environmental consequence of a small leak from the nitric acid storage container is a dispersion distance of 0.3 km (0.2 mile) to the Toxic Endpoint limit. The respirable impact of the alternative-case scenario on workers in the treatment facility wearing the minimum required level of personal protective equipment is an exposure to toxic chemicals at levels slightly above the IDLH limits. A release of airborne contamination from the rupture of a calcium hydroxide bag would produce lower consequences to potentially exposed workers.

4.1.4.2 Radiological consequences for on-site treatment of waste

Detailed analysis of radiological impacts to the public and to workers resulting from on-site treatment of LLW and TRU waste is contained in Appendix J. Table 4.11 summarizes the results by listing the projected health impacts to the public from routine operations of the on-site treatment facility.

The table indicates that impacts are not notable for the entire treatment process or for individual waste stream groups. The values in this table are conservative, since the dose calculations were based on atmospheric suspension of the entire radioactive quantities of each waste stream inside the treatment facility. This waste quantity was then estimated to be released to the environment via the facility high-efficiency particulate air filtration system that typically removes 99.999% of the radioactive contaminants. Actual dose from normal operations should be considerably less, since only a small fraction of the radioactive materials would become airborne during normal operations.

Table 4.11. Impacts on public health from normal operations of on-site treatment facility[a]

Waste group	Total dose: MEI[b] (mrem)	Total dose: Population (person-rem)	Population LCF[c]
Lab waste (439)	3.10×10^{-7}	2.92×10^{-4}	1.46×10^{-8}
Tc-99-contaminated waste (2802)	1.17×10^{-3}	3.28	1.64×10^{-4}
TRU waste—solids (444)	1.50×10^{-3}	1.42	7.11×10^{-5}
TRU waste—liquids (444)	2.48×10^{-3}	2.47	1.24×10^{-4}
Total	5.15×10^{-3}	7.17	3.59×10^{-4}

[a]Impacts are based on radioactive quantities for the waste streams listed here and identified in Table 1.1.
[b]MEI = Maximally exposed individual calculated to be approximately 1500 meters north of facility.
[c]LCF = Estimated number of latent cancer fatalities within the public from on-site treatment of projected waste quantities.
TRU = transuranic.

The results for the analysis of the impact to workers from an on-site treatment facility are summarized in Table 4.12. The table shows that the number of fatalities is calculated to be much less than one over the 3 to 4 months estimated to complete the on-site treatment.

Table 4.12. Impacts on workers from normal operations of on-site treatment facility

Workers	Impacts from operations
Average radiological dose to worker (rem)[a]	0.023
Total projected radiological dose to all rad workers (person-rem)[b]	0.34
Estimated number of latent cancer fatalities from total worker dose	1.4×10^{-4}

[a]Estimate of average dose to workers is based on the DOE average annual measurable total effective dose equivalent (TEDE = sum of internal and external dose) for waste processing/management facilities during 1997–1999 (DOE 2000c).
[b]Total projected worker dose calculated for an estimated 15 maximum radiological workers within the facility.
DOE = U.S. Department of Energy

The total radiation dose to the MEI of the general public for all Paducah Site operations has been estimated at 1 mrem/year (DOE 1999a), which is 1% of the radiation dose limit (100 mrem/year) set for the general public for operation of a DOE facility (DOE Order 5400.5). The external radiation dose for Paducah Site workers has ranged from 0 to 11 mrem/year in recent years (DOE 1999a). These doses are well below both the DOE administrative procedures dose limit (2000 mrem/year) and the regulatory limit of 5000 mrem/year (DOE 1999a; 10 *CFR* 835). The EPA limit is 15 mrem/year for an individual member of the public from all sources. All of these exposures are a very small fraction of the 360 mrem/year dose received by the general public and by workers from natural background and medical sources.

4.1.4.3 Socioeconomics and environmental justice

No census tracts near the site include a higher proportion of minorities than the national average. Some nearby tracts meet the definition of low-income populations, including two tracts in the north-northeast direction of the prevailing wind, but these are not the tracts closest to the Paducah Site. Impacts from noise, air emissions, radiological emissions, and accidents associated with waste treatment would be low for both the residents closest to the site and the low-income communities. Exposures for the general public and the workers affected in processing and repackaging are expected to be similar to historical exposures for Paducah Site operations overall.

Executive Order 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low Income Populations," requires agencies to identify and address disproportionately high and adverse human health or environmental effects that their activities may have on minority and low-income populations. For the activities considered in this EA, populations considered are those that live within 80 km (50 mi) of the Paducah Site. However, these groups would be subject to the same negligible impacts as the general population.

4.1.5 DMSA Characterization

The following sections present potential impacts resulting from on-site characterization for DMSA wastes. Any potential impacts associated with postcharacterized DMSA waste transport or treatment are addressed in Sects. 4.1.3 and 4.1.4, respectively.

4.1.5.1 Impacts to the public from DMSA waste characterization normal operations

The DMSA waste comprises a large portion of the LLW and mixed waste quantities being considered in this EA. However, current quantities have not resulted in adverse impacts to the public and environment within the Paducah Site surrounding areas. The public access areas and the 50-mile radius surrounding the Paducah Site is monitored for radioactive emissions, and estimated doses to the public are reported in the Paducah Site Annual Environmental Report. DOE would continue to monitor impacts to the public and take appropriate actions to keep doses at minimal levels. Based on historical data, there have been no emissions or releases of DMSA wastes that have posed a hazard to the public or environment. However, as stated earlier, DOE has placed a high priority to characterize and dispose of DMSA waste on a previously agreed-upon schedule with state regulators.

4.1.5.2 Accident analysis for impacts from DMSA waste characterization activities

The DMSA solids and liquids at the Paducah Site contain radiological as well as chemical hazards. The relatively large quantities of DMSA waste contain alpha, beta, and gamma-emitting radionuclides. This results in a potential to contribute important doses to workers if the waste is handled improperly. However, since the waste is stored in administratively controlled areas in approximately 160 locations, it is assumed that the entire contents would not be subject to likely accident scenarios. The DMSA waste would be found in well-defined limited quantities when undergoing characterization activities. The inspector would be fully trained and qualified to characterize DMSA waste, thereby minimizing the impacts from accident consequences.

Accident scenarios analyzed in previous sections include DMSA waste quantities. Refer to Sect. 4.1.3 for further discussion.

A portion of the DMSA waste may be located in non-RCRA/TSCA storage locations pending confirmation of type of waste. These wastes could result in health and safety impacts if they are not handled properly. Accidental releases to the environment via the atmospheric pathway or releases into effluent streams from DMSA solids and liquids could also result in minor impacts to the public and the environment. In order to minimize these accident-related impacts to workers, the public, and the environment, DOE has placed DMSA waste on a high priority for characterization, treatment, and disposal activities.

4.2 IMPACTS OF THE NO ACTION ALTERNATIVE

Under the No Action alternative, not only would current wastes not be removed from the site, but newly generated waste would be continually added to the current inventory. The probability of impacts would increase over time as volumes of waste increase and new storage facilities are constructed. The No Action alternative would also have ramifications related to regulatory noncompliance.

The No Action alternative is evaluated in detail in Appendix K. Following is a summary of the conclusions of Appendix K.

4.2.1 Resource Impacts

Under the No Action alternative, on-site storage of existing and newly generated waste would continue. No treatment or disposal activities would occur after expiration of existing CXs. The following sections discuss impacts resulting from the No Action alternative.

4.2.1.1 Land use

The No Action alternative would not affect land use classifications. However, new storage buildings would be required to store waste generated from ongoing operations through 2010 and beyond. NEPA analysis for new buildings would be performed as needed.

4.2.1.2 Geology

The No Action alternative would not affect site geology.

4.2.1.3 Soils and prime farmland

Prime farmland would not be affected.

4.2.1.4 Water and water quality

Evaluation of water and water quality in Appendix K shows that short-term and long-term impacts to surface water from the No Action alternative should be similar to those currently occurring from activities at the Paducah Site. This interpretation is based on the fact that the quality of water being discharged from the plant is not degrading.

Accident impacts to water quality from the worst-case on-site accident scenario (i.e., earthquake) involving radionuclides are the same as for the proposed action and are described in detail in Appendix C. Just as for the proposed action, calculations for the earthquake scenario show that there is likely to be harm done to water quality in creeks draining into the Ohio River as a result of exposure to radionuclides, but the Ohio River water quality should not be adversely impacted.

4.2.1.5 Ecological resources

The No Action alternative would not adversely affect any threatened or endangered species.

Aquatic Biota. Short- and long-term impacts to aquatic biota from the No Action alternative would be similar to those currently occurring from the Paducah Site activities. While there is some current evidence for toxicity to aquatic biota at one outfall (Appendix K), a plan for a toxicity reduction evaluation (TRE) has been submitted to state regulators for approval. The successful completion of the TRE should eliminate further toxicity.

Bioaccumulation studies for PCBs and mercury in fish show that concentrations are decreasing, which means that controls and remediation of sources have been effective. However, there is evidence of degradation in fish communities downstream of discharges from the Paducah Site, probably owing to high temperatures in the effluent or increases in sedimentation (Appendix K).

Accident impacts to aquatic biota from the worst-case accident scenario (i.e., earthquake) involving radionuclides are described in detail in Appendix C for the proposed action, and the impacts should be no different for the No Action alternative. Because of this, the earthquake scenario is highly unlikely to cause harm to aquatic biota in the Ohio River as a result of exposure to radionuclides. However, just as with the proposed action, aquatic receptors in Bayou and Little Bayou creeks and other water conveyances by which the waste would reach the Ohio River would likely be affected by the caustic nature of the waste. Radiation exposure would be of an acute nature.

Accident impacts to aquatic biota from the worst-case accident scenario (i.e., earthquake) involving nonradionuclides are also described in Appendix C for the proposed action. Again, the impacts should be no different for the No Action Alternative. PCBs could pose adverse impacts to aquatic biota in the Ohio River, as well as in Bayou and Little Bayou creeks. None of the other nonradionuclide contaminants would reach high enough concentrations in the Ohio River to pose adverse impacts to aquatic biota, according to the assumptions of the accident analysis.

Terrestrial Biota. Short- and long-term impacts to terrestrial biota from the No Action alternative should be similar to those currently occurring from the Paducah Site activities. Currently, there is some indication of impacts to terrestrial biota (Appendix K), deer and raccoon in particular, although the impacts appear to be minor and the ultimate causes and effects uncertain.

Impacts to terrestrial biota from the modeled worst-case spill accident scenario (i.e., earthquake) are the same as for the proposed action and are described in Appendix C. Just as for the proposed action, long-term radiation effects to soil biota as the result of an earthquake would be negligible under the No Action alternative.

Accident impacts to terrestrial biota from the worst-case accident scenario (i.e., earthquake) involving nonradionuclides under the proposed action are described in Appendix C. The impacts to terrestrial biota under the No Action alternative should be the same. As a result, nonradionuclides would likely pose adverse impacts to soil biota if the worst-case spill accident occurred under the No Action alternative.

4.2.1.6 Noise

Noise levels would be similar to those currently at the site.

4.2.1.7 Cultural and archaeological resources

The No Action alternative is not expected to adversely impact any known cultural or archaeological resources.

4.2.1.8 Air quality

The No Action alternative would result in the continuation of current DOE waste management activities. Under the No Action alternative, potential impacts resulting from on-site treatment, transport, and disposal would not apply. Other potential impacts are presented in Sect. 4.1.1 and would be identical to the proposed action.

4.2.1.9 Socioeconomics and environmental justice

Socioeconomic Impacts. The No Action alternative would result in no net change in employment and therefore would have no notable socioeconomic impact on the ROI.

Environmental Justice. Executive Order 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low Income Populations," requires agencies to identify and address disproportionately high and adverse human health or environmental effects its activities may have on minority and low-income populations. For the No Action alternative considered in this EA, populations considered are those that live within 80 km (50 miles) of the Paducah Site.

Impacts from noise, air emissions, radiological emissions, and accidents would be low for both the residents closest to the site and the low-income communities. Exposures for the general public and the relevant workers would continue at historical levels for the Paducah Site (Appendix K).

4.2.2 Radiological and Nonradiological Impacts

The No Action alternative would result in continued storage of LLW and TRU waste but would not address the long-term need for a final disposal plan. Potential impacts to the workers, public, and environmental resources are presented in this section.

4.2.2.1 Potential exposure of workers to radiological emissions

As described in Appendix K, worker doses under the No Action alternative would result in less than 1 LCF per waste type based on a worker population of 30 full-time employees. The estimated radiological doses are highly conservative because the calculations assumed that workers would spend the entire workday in the waste storage areas, which is not likely. The estimate presents an upper bounding level that is unlikely to be approached due to the "as low as reasonably achievable" approach practiced at the Paducah Site. Steps taken to keep worker exposures as low as possible include limiting the time employees spend in each storage area, monitoring all worker exposure to avoid exceeding established control limits, prohibiting storage of liquids in outdoor storage areas, ensuring proper maintenance of emergency equipment, and undertaking waste minimization efforts. However, if waste quantities increase beyond current foreseeable projections, then the subsequent radiological impacts would increase incrementally on a cumulative population basis.

4.2.2.2 Potential exposure of the public to radiological emissions

The potential for public exposure to radiological emissions resulting from LLW and TRU waste management activities under the No Action alternative is limited at the Paducah Site. Radiation is minimized by time, distance, and shielding. Therefore it is unlikely that routine waste management activities would result in measurable quantities of radiation at the Paducah Site boundaries. A perimeter-monitoring program and warning system are in place around the Paducah Site boundaries and elsewhere to evaluate impacts from routine operations as well as emergency conditions. There are off-site regulatory limits that are adhered to by the Paducah Site as well. Environmental monitoring activities are conducted routinely and reported in the Annual Environmental Monitoring Report (DOE 1999a). This report has not indicated any adverse impact from the Paducah Site operations that include waste management activities. Therefore, it is unlikely that the No Action alternative would impact the public above current levels in terms of radiological impacts from continued storage of LLW and TRU waste.

4.2.2.3 Nonradiological risks to workers from the No Action alternative

Continued storage of LLW and TRU waste at the Paducah Site under the No Action alternative would increase safety risks to workers by requiring additional handling of the waste as maintenance and repackaging activities are needed. In addition, there would be routine monitoring activities in the storage locations that can present typical safety risks. These risks have been evaluated based on the average industrial accident rates for operations at similar industries. The estimated number of total recordable cases for the 30 workers associated with the No Action alternative would be 0.78 cases per year. The estimated lost workdays (LWDs) due to occupational illness or injury would be approximately 11 per year under the No Action alternative.

In addition, as waste inventories grow over time, additional storage facilities or expansion of current capacity would be needed. This would require the use of heavy equipment and would introduce accident risks during facility construction.

4.2.3 Accident Analysis

During the No Action alternative, the packaged waste containers would be transported to an on-site location and stored. The containers would be inspected periodically to verify that the containers are intact and repaired if required. These containers would be subject to the same conditions as the stored containers in the proposed action. They would, however, be at risk for a longer period of time.

The transformers are estimated to remain in place within the process buildings and not be subject to the risks of vehicle impacts and fires. In the event of an accident, the combustion products of fires would be contained to the buildings, thus minimizing on-site and off-site consequences. Similar to the proposed action, accidents are postulated with the potential to breech the steel containers of the stored wastes and release the contents. The waste characteristics and the accident consequence methodology are the same as discussed for the proposed action in Appendix G.

The EBE and vehicle impact/mishandling accidents were evaluated for the No Action alternative. Because the waste characteristics and the accident scenarios are the same as those evaluated for the proposed alternative, the accident consequences are identical to those computed and discussed in Sect. 4.1.1. However, while the frequency of the earthquake accident is the same for both alternatives, the frequency of vehicle impact/mishandling accidents is much lower due to the lower activity level. Based on the revised accident frequencies under the No Action alternative, expected fatalities are less than under the proposed action. However, because the institutional control period is assumed to be 100 years under the No Action alternative and is only 10 years under the proposed action, fatalities from the EBE increase by a factor of 10 under the No Action alternative. However, in both cases, the calculated number of expected fatalities remains negligible under the No Action alternative.

4.2.4 Comparison of Accident Risks

As discussed in Sects. 4.1 and 4.2, risks have been computed for both process accidents and industrial accidents for the proposed action and the No Action alternatives. The highest radiological accident risk was 1.5×10^{-7} expected fatalities for the MIW/MUW at the edge of the waste storage area during and following an earthquake. This risk was computed for the 100-year no-action institutional period. The second highest risk, 7.9×10^{-8} expected fatalities, was computed for the vehicle impact/mishandling accident impacting the ThF_4 container during the 10-year proposed action operating period. The risks are the same for both alternatives, but the proposed action has a shorter duration. These risks are minor.

The industrial accident risks, while higher than the radiological accident risks, were small. The computed risk for the proposed action was 0.02 expected fatalities over the 10-year operating period. The corresponding industrial accident risk for the No Action alternative was 0.1 expected fatalities over the 100-year institutional control period. Neither the risks nor the differences between them are considered notable.

4.2.5 Transportation Impacts

Under this alternative, no Paducah Site waste would be transported off-site after expiration of current CXS. Therefore, there are no transportation impacts associated with this alternative.

4.2.6 On-Site Treatment Impacts

Under this alternative no on-site treatment would occur. All wastes would be maintained in storage facilities. Therefore, no treatment impacts are associated with this alternative.

4.3 IMPACTS OF THE ENHANCED STORAGE ALTERNATIVE

Under the Enhanced Storage alternative, current wastes will remain at the site and would be stored in new or upgraded buildings designed to withstand the EBE. Newly generated waste would be continually added to the current inventory. The probability of impacts would increase slightly beyond those expected for the No Action alterative as volumes of waste increase and new/upgraded storage facilities are constructed. The Enhanced Storage alternative would also have ramifications related to regulatory noncompliance.

The Enhanced Storage alternative is a variation of the No Action alternative that is evaluated in detail in Appendix K. Following is qualitative evaluation of the Enhanced Storage alternative based on the conclusions in Appendix K.

4.3.1 Resource Impacts

Under the Enhanced Storage alternative, on-site storage of existing and newly generated waste would continue. No treatment or disposal activities would occur after expiration of existing CXs under which limited treatment and disposal are currently being performed. The following sections discuss impacts resulting from the Enhanced Storage alternative.

4.3.1.1 Land use

The Enhanced Storage alternative would not affect land use classifications. However, new/upgraded storage buildings would be required to store waste generated from ongoing operations through 2010 and beyond. NEPA analysis for new/upgraded buildings would be performed as needed.

4.3.1.2 Geology

The Enhanced Storage alternative would not affect site geology.

4.3.1.3 Soils and prime farmland

Prime farmland would not be affected.

4.3.1.4 Water and water quality

Evaluation of water and water quality in Appendix K shows that short-term and long-term impacts to surface water from the No Action alternative should be similar to those currently occurring from activities at the Paducah Site. The Enhanced Storage alternative would not result in any additional short-term or long-term surface water impacts. This interpretation is based on the fact that the quality of water being discharged from the plant is not degrading.

Accident impacts to water quality from the worst-case on-site accident scenario (i.e., earthquake) involving radionuclides are likely to be less than those evaluated for the proposed action because the buildings would be designed and constructed to provide additional confinement for any materials that might be released in the EBE.

4.3.1.5 Ecological resources

The Enhanced Storage alternative would not adversely affect any threatened or endangered species.

Aquatic Biota. Short- and long-term impacts to aquatic biota from the Enhanced Storage alternative would be no greater than those currently occurring from the Paducah Site activities. While there is some current evidence for toxicity to aquatic biota at one outfall (Appendix K), a plan for a toxicity reduction evaluation (TRE) has been submitted to state regulators for approval. The successful completion of the TRE should eliminate further toxicity.

Bioaccumulation studies for PCBs and mercury in fish show that concentrations are decreasing, which means that controls and remediation of sources have been effective. However, there is evidence of degradation in fish communities downstream of discharges from the Paducah Site, probably owing to high temperatures in the effluent or increases in sedimentation (Appendix K). These conclusions would not be affected by the Enhanced Storage alternative.

Accident impacts to aquatic biota from the worst-case accident scenario (i.e., earthquake) involving radionuclides are described in detail in Appendix C for the proposed action, and the impacts should be no greater for the Enhanced Storage alternative. Because of this, the earthquake scenario is highly unlikely to cause harm to aquatic biota in the Ohio River as a result of exposure to radionuclides. However, just as with the proposed action, aquatic receptors in Bayou and Little Bayou creeks and other water conveyances by which the waste would reach the Ohio River would likely be less affected under the Enhanced Storage alternative because less radioactive materials would escape from the storage facilities.

Accident impacts to aquatic biota from the worst-case accident scenario (i.e., earthquake) involving nonradionuclides are also described in Appendix C for the proposed action. Again, the impacts should be no greater for the Enhanced Storage alternative. PCBs could pose adverse impacts to aquatic biota in the Ohio River, as well as in Bayou and Little Bayou creeks. None of the other nonradionuclide contaminants would reach high enough concentrations in the Ohio River to pose adverse impacts to aquatic biota, according to the assumptions of the accident analysis.

Terrestrial Biota. Short- and long-term impacts to terrestrial biota from the Enhanced Storage alternative should be no greater than those currently occurring from the Paducah Site activities. Currently, there is some indication of impacts to terrestrial biota (Appendix K), deer and raccoon in particular, although the impacts appear to be minor and the ultimate causes and effects uncertain.

Impacts to terrestrial biota from the modeled worst-case spill accident scenario (i.e., earthquake) are no greater than for the proposed action. Just as for the proposed action, long-term radiation effects to soil biota as the result of an earthquake would be negligible under the Enhanced Storage alternative.

Accident impacts to terrestrial biota from the worst-case accident scenario (i.e., earthquake) involving nonradionuclides under the proposed action are described in Appendix C. The impacts to terrestrial biota under the Enhanced Storage alternative should be less. Nonradionuclides would likely pose less impact to soil biota if the worst-case spill accident occurred under the Enhanced Storage alternative.

4.3.1.6 Noise

Noise levels would be similar to those currently at the site.

4.3.1.7 Cultural and archaeological resources

The Enhanced Storage alternative is not expected to adversely impact any known cultural or archaeological resources.

4.3.1.8 Air quality

The Enhanced Storage alternative would result in the continuation of current DOE waste management activities. Under the Enhanced Storage alternative, potential impacts resulting from on-site treatment, transport, and disposal would not apply. Other potential impacts are presented in Sect. 4.1.1 and would be no greater than those identified for the proposed action.

4.3.1.9 Socioeconomics and environmental justice

Socioeconomic Impacts. The Enhanced Storage alternative may result in a slight increase in employment due to construction and/or upgrades required for storage facilities. In addition, long-term surveillance and maintenance of facilities designed to withstand increased EBE loads might result in additional staff.

Environmental Justice. Executive Order 12898, “Federal Actions to Address Environmental Justice in Minority Populations and Low Income Populations,” requires agencies to identify and address disproportionately high and adverse human health or environmental effects its activities may have on minority and low-income populations. For the Enhanced Storage alternative considered in this EA, populations considered are those that live within 80 km (50 miles) of the Paducah Site.

Impacts from noise, air emissions, radiological emissions, and accidents would be low for both the residents closest to the site and the low-income communities. Exposures for the general public and the relevant workers would be no greater than those at historical levels for the Paducah Site (Appendix K).

4.3.2 Radiological and Nonradiological Impacts from the Enhanced Storage Alternative

The Enhanced Storage alternative would result in continued storage of LLW and TRU waste but would not address the long-term need for a final disposal plan. Potential impacts to the workers, public, and environmental resources are presented in this section.

4.3.2.1 Potential exposure of workers to radiological emissions

As described in Appendix K, worker doses under the No Action alternative would result in less than 1 LCF per waste type based on a worker population of 30 full-time employees. These doses would remain the same under the Enhanced Storage alternative because the work force required for storage facility workers would remain the same.

Additional workers might be required for building maintenance and surveillance activities for facilities that are designed to withstand increased EBE loads. However, these types of activities do not directly involve contact with stored materials and should not result in any additional exposures.

4.3.2.2 Potential exposure of the public to radiological emissions

The potential for public exposure to radiological emissions resulting from LLW and TRU waste management activities under the No Action alternative is limited at the Paducah Site. This potential would be further reduced under the Enhanced Storage alternative because the new/upgraded facilities would provide additional confinement to reduce the potential for radiological materials releases. Therefore, it is unlikely that the Enhanced Storage alternative would impact the public above current levels in terms of radiological impacts from continued storage of LLW and TRU waste.

4.3.2.3 Nonradiological risks to workers

Continued storage of LLW and TRU waste at the Paducah Site under the No Action alternative would increase safety risks to workers by requiring additional handling of the waste as maintenance and repackaging activities are needed. In addition, there would be routine monitoring activities in the storage locations that can present typical safety risks. These risks have been evaluated based on the average industrial accident rates for operations at similar industries. The estimated number of total recordable cases for the 30 workers associated with the No Action alternative would be 0.78 cases per year. The estimated lost workdays (LWDs) due to occupational illness or injury would be approximately 11 per year under the No Action alternative. These risks would remain the same under the Enhanced Storage alternative.

In addition, as waste inventories grow over time, additional storage facilities or upgrades of current facilities would be needed. This would require the use of heavy equipment and would introduce accident risks during facility construction.

4.3.3 Accident Analysis of the Enhanced Storage Alternative

During the No Action alternative, the packaged waste containers would be transported to an on-site location and stored. The containers would be inspected periodically to verify that the containers are intact and repaired if required. These containers would be subject to the same conditions as the stored containers in the proposed action. They would, however, be at risk for a longer period of time. These conclusions remain the same for the Enhanced Storage alternative.

The transformers would be moved to a new storage location under the Enhanced Storage alternative. Similar to the proposed action, accidents are postulated with the potential to breech the steel containers of the stored wastes and release the contents. The waste characteristics and the accident consequence methodology are the same as discussed for the proposed action in Appendix G and are the same for the Enhanced Storage alternative.

The EBE and vehicle impact/mishandling accidents were evaluated for the No Action alternative. The waste characteristics and the accident scenarios are the same for the Enhanced Storage alternative as those evaluated for the proposed alternative; however, the accident consequences would be expected to be less for the EBE because the enhanced storage facilities would provide additional confinement, thus reducing the amount of material released outside the building. The frequencies for both accidents remain the same as the No Action alternative.

4.3.4 Comparison of Accident Risks

As discussed in Sects. 4.1 and 4.2, risks have been computed for both process accidents and industrial accidents for the proposed action and the No Action alternatives. The highest radiological accident risk was 1.5×10^{-7} expected fatalities for the MIW/MUW at the edge of the waste storage area during and following an earthquake. This risk would be expected to be at least a factor of ten lower for the Enhanced Storage alternative because the buildings would provide additional confinement to reduce releases outside the facility. This risk would be computed for the 100-year no-action and enhanced storage institutional period. The second highest risk, 7.9×10^{-8} expected fatalities, was computed for the vehicle impact/mishandling accident impacting the ThF_4 container during the 10-year proposed action operating period. The risks are the same for all three alternatives, but the proposed action has a shorter duration. These risks are minor.

The industrial accident risks, while higher than the radiological accident risks, were small. The computed risk for the proposed action was 0.02 expected fatalities over the 10-year operating period. The corresponding industrial accident risk for the No Action alternative was 0.1 expected fatalities over the 100-year institutional control period and would be the same for the Enhanced Storage alternative. Neither the risks nor the differences between them are considered notable.

4.3.5 Transportation Impacts

Under this alternative, no Paducah Site waste would be transported off-site after expiration of current CXs. Therefore, there are no transportation impacts associated with this alternative.

4.3.6 On-Site Treatment Impacts

Under this alternative no on-site treatment would occur. All wastes would be maintained in storage facilities. Therefore, no treatment impacts are associated with this alternative.

5. CUMULATIVE IMPACTS

Cumulative impacts are defined as "…the impact on the environment which results from the incremental impacts of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or nonfederal) or person undertakes such other actions" (40 *CFR* 1508.7). Effects are considered cumulatively because significant effects are often the result of individually minor direct and indirect effects of multiple actions that occur over time. Cumulative effects should be considered over the "lifetime" of the effects rather than the duration of the action.

This section describes past and present actions, as well as reasonably foreseeable future actions, that are considered pertinent to the analysis of cumulative impacts for the proposed action. CERCLA activities that generate wastes are included in this section. It should be noted that considerable uncertainty as to scope and funding is associated with many of the future actions. Final decisions have not yet been made for some of these actions, and some are contingent upon additional NEPA analysis.

5.1 PADUCAH SITE ACTIVITIES

5.1.1 Environmental Management Program

The role of Environmental Management at the Paducah Site is to find, analyze, and correct site contamination problems as quickly and inexpensively as possible. Following is a list of ongoing Environmental Management projects with potential environmental impacts:

Paducah waste infrastructure

- construction of the C-746-U Landfill sedimentation pond discharge improvement.
- connection of C-746-U Landfill Phase 3 to leachate collection system.

Paducah waste operations

- performance of compliant operations of the C-746-U and C-746-S&T landfills.
- disposal of industrial waste/construction debris that met the waste acceptance criteria.
- analysis for a potential on-site CERCLA waste disposal facility.
- Paducah STP/MLLW project
- dismantling of the C-746-Q ^{99}Tc container.

Routine surveillance and maintenance

- pipeline isolation of abandoned fire water lines.

Long-term surveillance and maintenance

- working for uninterrupted Northwest/Northeast Plume Containment Systems for groundwater treatment.
- retrieval, staging, crushing and characterization of concrete rubble piles located on and off DOE property.

PAD Lasagna

The Paducah Site is a location of the Lasagna [TM] process for remediation of low-permeability soils. The Lasagna [TM] technology consists of emplacement of electrodes and use of direct current to electro-osmotically move water and contaminants through in situ treatment zones. One novel aspect of the technology is the capability to reverse electrical polarity, thereby reversing flow direction to more effectively sweep contaminants through the treatment zones.

- Continuation of system operations.

PAD groundwater fenceline action

- Conductance of Phase 1 Permeable Treatment Zone construction.
- Initiation of Phase 2 Permeable Treatment Zone construction.

PAD D&D C-410

- Pumping and treating water from basement of C-410 Complex.

Paducah Scrap Metal Removal and Disposal

The object of this project is to safely remove and disposition approximately 53,000 tons of contaminated scrap metal and miscellaneous materials contained in scrap yards. This project was initiated as a CERCLA project to address existing contamination and the potential release of hazardous substances to the environment.

5.1.2 Uranium Program

The Paducah Uranium Program has been established to provide surveillance and maintenance of DOE nonleased, inactive facilities and land areas not addressed by the Environmental Management program. There are a total of 15 inactive facilities and approximately 200 acres of land area that are maintained by the Uranium Program. Following is a list of ongoing Uranium Program projects with potential environmental impacts:

- Completion of cleanup of inactive facilities in accordance with cleanup plan.
- Maintenance of the deleased land acreage in a safe and compliant manner.
- Repaving Dyke and McCaw Road.

5.1.3 UF_6 Cylinder Storage

The mission of the UF_6 Cylinder Storage Program at Paducah is to maintain safe, long-term storage of the DOE UF_6 cylinder inventory until its disposition. The primary objective of the UF_6 Cylinder Storage Program is to implement the requirements of the Defense Nuclear Facilities Safety Board Recommendation 95-1 and applicable requirements of the Paducah Safety Analysis Report. The UF_6 cylinder storage facilities are Category II Nuclear Facilities as classified in accordance with the requirements of DOE Order 425.1A. The scope of work of the program includes surveillance and maintenance of cylinders transferred or scheduled to be transferred to DOE from USEC in accordance with the May 18, 1998, and June 30, 1998, memorandums of agreement between DOE and USEC. Following is a list of ongoing UF_6 Cylinder Storage Program projects with potential environmental impacts:

- restacking cylinders,
- annual cylinder inspections,
- quadrennial cylinder inspections,
- radiological surveys of cylinders,

- size reduction of G-yard concrete debris, and
- monthly sampling and monitoring of KPDES Outfall 017.

5.1.4 Depleted UF_6 Conversion Facility

In April 1999, DOE issued a final programmatic environmental impact statement, with preferred alternative, for long-term management of depleted UF_6 (DOE 1999b).

DOE has proposed to design, construct, and operate conversion facilities at the Paducah Site and at the Portsmouth Plant in Ohio. These facilities would convert DOE's inventory of depleted UF_6 now located at Portsmouth, Paducah, and the ETTP in Oak Ridge, Tennessee, to triuranium octaoxide, uranium dioxide, uranium tetrafluoride, uranium metal, or some other stable chemical form acceptable for transportation, beneficial use/reuse, and/or disposal. A related objective is to provide cylinder surveillance and maintenance of the DOE inventory of depleted UF_6, low-enrichment UF_6, natural assay UF_6, and empty heel cylinders in a safe and environmentally acceptable manner.

DOE currently plans to prepare an environmental impact statement for the purpose of construction, operation, and D&D of two depleted UF_6 facilities at the Paducah and Portsmouth sites. Among the potential impacts to be analyzed in the document will be the cumulative impacts associated with the facilities at both sites.

5.1.5 Disposal of Nonradioactive Wastes Containing Residual Radioactivity at the C-746-U Landfill

DOE is currently preparing appropriate supplemental NEPA documentation pertaining to the establishment of authorized limits to determine the acceptability of nonradioactive waste containing residual activity at the C-746-U Landfill. DOE intends to complete an EA for this activity within the next several months. This will also include a cumulative impacts analysis.

5.1.6 Long-Term Management Plan for DOE's Inventory of Potentially Reusable Uranium

DOE is in the process of preparing a programmatic EA for the implementation of long-term management of its inventory of potentially reusable low enriched uranium, normal uranium, and depleted uranium that is in excess of national security needs. DOE's inventories of these materials reside at more than 100 different sites, including the Paducah Site. As part of the EA, DOE will determine the safest, most effective, and most efficient location for the long-term storage of this material. The uranium EA will also include a cumulative impacts analysis.

5.1.7 USEC Programs

The PGDP is the only operating uranium enrichment facility in the United States. Owned by DOE, it is leased and operated by the USEC, a wholly owned subsidiary of USEC Inc. The plan employs about 1,500 people and provides enrichment services for commercial nuclear power plants in the United States and around the world. In May 2001, USEC completed a plan to consolidate its uranium enrichment operations at Paducah. Portsmouth now provides sampling, transfer, and shipping services for USEC's customers.

5.2 OTHER REGIONAL INDUSTRIES ACTIVITIES

Cumulative effects are derived by analyzing potential risks from the proposed action in conjunction with potential risks from other activities at the Paducah Site (listed above) and other regional industries.

Other industries located in the area include TVA's Shawnee Steam Plant, Honeywell's Metropolis Works, USEC, and the Joppa Power Plant. Other new potential sources of environmental impacts foreseeable in either McCracken County or Massac County in the near future are included generically in the impacts analysis.

5.3 CUMULATIVE IMPACTS FROM THE PROPOSED ACTION

Potential cumulative impacts that could occur from the proposed action for the Paducah Site and the other regional activities are presented in the following sections.

5.3.1 Land Use

Impacts from the other actions described in the previous sections have the potential to affect land and facility use at the Paducah Site. Actions that occur outside of the Paducah Site security fence could limit the land and facilities that could be developed for other purposes. Direct incremental impacts of the proposed action on the development of other properties in the region are unlikely.

5.3.2 Air Quality

The proposed action in combination with the other area actions is unlikely to have major impacts on local or regional air quality. The existing air quality of the region is considered to be good. Air emissions from the other actions described previously would be expected to have only minor impacts and not violate any air quality permits. This is because the actions would be controlled, to a large extent, by engineering controls and adherence to applicable regulations.

5.3.3 Soil and Water Resources

No construction-related disturbance of natural soils would occur under the proposed action. Environmental restoration activities could result in impacts if soils are disturbed to remove or treat contamination. These types of impacts would be temporary and mitigated through the use of best management practices. Accidental spills and releases of hazardous materials could also potentially impact soils. Impacts to the surface water and groundwater resources could also occur during activities, but they also would be mitigated. None of the actions discussed previously would be expected to have major discharges of industrial effluents that could adversely impact water resources. The removal and treatment of contaminated soils and groundwater and the D&D of contaminated facilities at the Paducah Site could have a beneficial impact on these resources due to the removal of the source of contamination.

5.3.4 Ecological Resources

Forest fragmentation and its associated impacts on biodiversity are increasing as more land is developed. However, development of land parcels at the Paducah Site would cause only minor impacts because none of the areas contain habitats or biota that are considered rare or unique. Additionally, no federal- or state-listed threatened and endangered species are known to exist in the area where the previously described actions are located. Emissions and effluents from the operation of the proposed action should not be of sufficient quantity to have a major adverse impact (i.e., stress, impairment, injury, or mortality) on existing habitats and biota. Accidental releases from ongoing and proposed operations would not greatly impact ecological resources due to the implementation of adequate mitigative measures.

5.3.5 Socioeconomics and Environmental Justice

The creation of new commercial/industrial jobs in the vicinity of the Paducah Site could contribute to cumulative socioeconomic impacts by inducing in-migration to the area, with corresponding demands for housing and public services. However, such in-migration is not likely to result from the currently planned activities. Even with the new projects, ongoing downsizing and workforce restructuring would continue, and employment from some of the proposed actions would be only temporary. In addition to the new direct employment in the area, new indirect jobs would be generated because new direct employment would create the need for the goods and services that are provided by indirect workers. However, these new indirect jobs also are not likely to stimulate in-migration, because nearly all the new indirect positions could possibly be filled with unemployed persons residing in the area.

No cumulative environmental justice impacts are expected to occur from any of the actions considered in this analysis, including those proposals that would be located at the Paducah Site.

5.3.6 Infrastructure and Support Activities

Cumulative transportation impacts in the region surrounding the Paducah Site could occur from increased development and growth as well as off-site shipments of other materials. Implementation of the proposed action discussed previously would not require any major upgrades to existing transportation systems or major new construction of roads or rail facilities. The potential for CERCLA waste disposal at a new Paducah Site facility would decrease traffic associated with waste material shipments off-site. Peak-hour traffic volumes could increase slightly over current levels but would depend on total employment numbers.

Associated with increases in traffic is the potential for an increased number of accidents, additional noise and air pollution, and road deterioration and damage. The increase in average daily traffic volumes could result in inconveniences for other vehicles on affected routes and connecting roads. Commercial operations could suffer temporarily reduced business while customers avoid affected areas because of traffic delays. Increased pavement deterioration and damage could increase costs associated with maintaining or resurfacing roads. Although noise associated with increased traffic is not normally harmful to hearing, increased traffic noise is considered by the public to be a nuisance. Increased accidents put an additional strain on local emergency response personnel. Increased vehicular traffic also has the greatest potential to increase air pollution in the local area, because emissions from motor vehicles are poorly regulated.

Existing utilities are considered to be sufficient for the actions in the Paducah Site area. The water and wastewater treatment plants also have enough capacity to handle the actions. Some of the systems may need to be modified or require minor upgrades, but no major utility system modifications are expected.

5.3.7 Human Health and Accidents

Cumulative public and occupational health impacts would be expected to be equal to those that currently exist in the Paducah Site area. Actions that involve environmental remediation and D&D usually have a positive impact by eliminating or reducing potential exposures to existing contamination. However, a certain amount of risk and potential exposure is involved for the workers who participate in the implementation of actions. Emissions and effluents released from industrial developments would not be expected to be a major source of potential exposure and would be controlled through the use of proper engineering and administrative controls. Standard industrial accidents would increase proportionally to the increase in facility numbers and actions taking place. Further development of the surrounding area could cause an increase in the number of people that could be exposed to off-site releases from large accidents.

5.4 CUMULATIVE IMPACTS FROM THE NO ACTION ALTERNATIVE

Potential cumulative impacts that could occur from the No Action alternative for the Paducah Site and the other actions described in Sects. 5.1 and 5.2 are presented in this section.

5.4.1 Land Use

No new facilities, or notable changes in land use, are described under the No Action alternative. Incremental impacts of this alternative on the development of other properties in the region are unlikely.

5.4.2 Air Quality

The No Action alternative, in combination with other area actions, is unlikely to have major impacts on local or regional air quality. The existing air quality of the region is considered to be good, and no new effluents are expected from the No Action alternative.

5.4.3 Soil and Water Resources

No construction-related disturbance of natural soils immediately would occur under the No Action alternative. In the future, as new storage facilities are constructed, short-term soil disturbance would occur. This minor disturbance, associated with the No Action alternative, in combination with other area actions is unlikely to have impacts on local or regional soil and water resources. Environmental restoration activities combined with construction-related disturbances under the No Action alternative could result in impacts if large quantities of soils are disturbed to remove or treat contamination. These types of impacts would be temporary and mitigated through the use of best management practices.

Impacts to the surface water and groundwater resources are not expected to occur during No Action alternative activities. No discharges are anticipated from implementation of the No Action alternative. None of the regional actions discussed previously would be expected to have major discharges of industrial effluents that could adversely impact water resources.

The removal and treatment of contaminated soils and groundwater and the D&D of contaminated facilities at the Paducah Site could have a beneficial impact on these resources due to the removal of the source of contamination.

5.4.4 Ecological Resources

Eventual construction of storage facilities on land parcels at the Paducah Site might cause minor impacts to the ecological resources of the area. Habitat loss and wildlife displacement would occur as a result of increased human presence at the new facility site. NEPA review would be conducted prior to construction startup to determine that the proposed construction site does not contain habitats and/or biota that are considered rare or unique.

No emissions or effluents from implementation of the No Action are expected. Accidental releases from ongoing operations on the site or in the region would not greatly impact ecological resources due to the implementation of adequate site controls.

5.4.5 Socioeconomics and Environmental Justice

In-migration of workers is not likely to result from the No Action alternative combined with regional activities. Any workforce increase would be offset by ongoing downsizing and workforce restructuring.

Employment from some of the actions would be only temporary. In addition to any new direct employment in the area, new indirect jobs would be generated because new direct employment would create the need for the goods and services that are provided by indirect workers. These new indirect jobs, however, also are not likely to stimulate in-migration, because nearly all the new indirect positions could possibly be filled with unemployed persons residing in the area.

No cumulative environmental justice impacts are expected to occur from any of the actions considered in this analysis, including the No Action alternative.

5.4.6 Infrastructure and Support Activities

Cumulative transportation impacts in the region surrounding the Paducah Site could occur from increased development and growth. No transportation impacts from implementation of the No Action alternative are anticipated, therefore, no major upgrades to existing transportation systems or major new construction of roads or rail facilities would be necessary.

No additional utility resources are required for the No Action alternative implementation. Existing utilities are considered to be sufficient for the actions in the Paducah Site area.

5.4.7 Human Health and Accidents

Cumulative public and occupational health impacts would be expected to be equal to those that currently exist in the Paducah Site area. The No Action alternative would result in keeping wastes on the Paducah Site. This results in more potential human health impacts than the proposed action since the proposed action would be removing wastes from the Paducah Site, thereby decreasing the human health impacts.

Actions that involve environmental remediation and D&D usually have a positive impact by eliminating or reducing potential exposures to existing contamination. A certain amount of risk and potential exposure, however, is involved for the workers who participate in the implementation of actions.

No emissions and effluents are expected to be released under the No Action alternative. Emissions and effluents from industrial developments would not be expected to be a major source of potential exposure and would be controlled through the use of proper engineering and administrative controls. Standard industrial accidents would increase proportionally to the increase in facility numbers and actions taking place. Further development of the surrounding area could cause an increase in the number of people that could be exposed to off-site releases from large accidents.

5.5 CUMULATIVE IMPACTS FROM THE ENHANCED STORAGE ALTERNATIVE

Potential cumulative impacts to land use, air quality, soil and water resources, ecological resources, socioeconomics, and area infrastructure from the Enhanced Storage alternative, in combination with other regional actions described in Sects. 5.1 and 5.2, are identical to the cumulative impacts described for the No Action alternative in Sect. 5.4. Both alternatives would affect these resources primarily through the construction of new storage facilities. The one area where these two alternatives differ is the potential cumulative human health and accident impacts.

5.5.1 Human Health and Accidents

Keeping the waste on site in an enhanced facility would increase the waste inventory that could be released during a catastrophe. This results in more potential human health impacts than the proposed action since the proposed action would be removing wastes and risks from the Paducah Site. The enhanced storage facility, however, would decrease potential human impacts by more strictly controlling storage area access, withstanding potential disasters (i.e.earthquakes), and containing container breeches more completely than standard storage buildings. Cumulative public and occupational health impacts would be expected to be less than those that currently exist in the Paducah Site area.

5.6 CUMULATIVE IMPACTS COMPARISON

It should be noted that none of the three alternatives result in notable impacts to the area's resources. For comparison purposes, however, the table below summarizes defined potential cumulative impacts of each alternative when combined with other regional activities. Each alternative is ranked between 1 and 3, with 1 indicating the least potential impact identified and 3 indicating the most impact when compared among the three alternatives. For example, the alternative with the most 1s would pose the least impact to resources when compared to the other two alternatives.

Table 5.1. Cumulative impacts comparison

Alternative	Land use	Air quality	Soil/water resources	Ecological resources	Socioeconomics	Infrastructure	Human health	Cumulative rank
Proposed	1	3	1	1	1	3	1	1
No Action	2	2	3	3	2	1	3	3
Enhanced Storage	3	1	2	2	3	2	2	2

6. REFERENCES

Battelle 1978. *Final Report on Environmental Studies at the Paducah Gaseous Diffusion Plant Paducah, Kentucky,* to Union Carbide Corporation. Battelle Laboratories, Columbus, OH.

BEA (Bureau of Economic Analysis) 1999. Regional Economic Information System 1969–97, http://govinfo.library.orst.edu, July 26–27, 2000.

BJC (Bechtel Jacobs Company LLC) 2000. Paducah Fact Sheets, www.bechteljacobs.com/emef/newsfacts/factsheetpad.htm, October 9, 2000.

BJC (Bechtel Jacobs Company LLC) 2001. *Paducah Gaseous Diffusion Plant Department of Energy Material Storage Area Characterization/Remediation Plan*. BJC/PAD-186/R4. April.

Bureau of the Census 1990a. Summary Tape File C90STF3A, available at http://venus.census.gov.cdrom/lookup, August 1, 2000.

Bureau of the Census 1990b. "Census Historical Poverty Tables," Table CPH-L-162, http://www.census.gov/hhes/poverty/census/cphl162.html.

CAIRS (Computerized Accident/Incident Reporting System) 1999. DOE and Contractor injury and Illness Experience by Year and Quarter (January 1999-December 1999 data used), Web site tis.eh.doe.gov/cairs/cairs/dtaqtr/q003a.pdf, Rev. 12/21/2000.

CDM (CDM Federal Programs) 1994. Investigations of Sensitive Ecological Resources Inside the Paducah Gaseous Diffusion Plant, 7916-003-FR-BBRY, CDM Federal Programs Corporation, August 19.

CH2M HILL 1991. *Results of the Public Health and Ecological Assessment, Phase II at the Paducah Gaseous Diffusion Plant (Draft)*, KY/SUB/13B-97777C, P-03/1991/1.

CH2M HILL 1992. *Results of the Site Investigation, Phase II at the Paducah Gaseous Diffusion Plant*, KY/SIB/13B-97777C, P-03/1991/1.

COE (U.S. Army Corps of Engineers) 1994. *Environmental Investigations at the Paducah Gaseous Diffusion Plant and Surrounding Area, McCracken County, Kentucky, Volume V: Floodplain Investigation, Part A: Results of Field Survey.* United States Army Corps of Engineers, Nashville, TN, May.

DOE (U.S. Department of Energy) 1994. *Environmental Assessment and Finding of No Significant Impact (FONSI) for the Construction and Operation of Waste Storage Facilities at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/EA-0937, June.

DOE (U.S. Department of Energy) 1997. *Waste Management Programmatic Environmental Impact Statement for Managing Treatment, Storage, and Disposal of Radioactive and Hazardous Waste,* DOE/EIS-0200-F.

DOE (U.S. Department of Energy) 1999a. *Final Environmental Assessment: Proposed Demonstration of the Vortec Vitrification System for Treatment of Mixed Wastes at the Paducah Gaseous Diffusion Plant,* DOE/EA-1230, December.

DOE (U.S. Department of Energy) 1999b. *Final Programmatic Environmental Impact Statement for Alternative Strategies for the Long-Term Management and Use of Depleted Uranium Hexafluoride*, DOE/EIS-0269, U.S. Department of Energy Office of Environmental Management, Washington, D.C.

DOE (U.S. Department of Energy) 2000a. *Environmental Impact Statement for Treating Transuranic/Alpha Low-Level Waste at the Oak Ridge National Laboratory, Oak Ridge, Tennessee*, DOE/EIS-305F, June.

DOE (U.S. Department of Energy) 2000b. *Environmental Assessment for Transportation of Low-level Radioactive Waste from the Oak Ridge Reservation to Off-Site Treatment or Disposal Facilities*, DOE/EA-1317, July.

DOE (U.S. Department of Energy) 2000c. *Paducah Site–1998 Annual Environmental Report*, prepared for BJC and DOE by CDM Federal Services Inc., Kevil, Kentucky, February.

DOE (U.S. Department of Energy) 2000d. Mini-Guidance Articles from Lessons Learned Quarterly Reports: December 1994 to September 2000, November.

EPA (U.S. Environmental Protection Agency) 2000. *Meteorological Data*, *Surface Data*, Bulletin Board System (SCRAM BBS), Support Center for Regulatory Air Models, Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina, October.

EPA (U.S. Environmental Protection Agency) 2001. *Radiation Risk Assessment Software: CAP88PC*, available at http://www.epa.gov/radiation/assessment/CAP88/index.html.

Goel, S 1991. "Impact of Carbon Monoxide Mitigation Programs in Albuquerque," Research Paper, University of New Mexico, Albuquerque, NM.

Hand, F. 1998. *Seismic Evaluation of T, SW/R, WD, and HH Buildings and Buildings 22 and 23 at the DOE Mound Site,* Rev. 2, LATA, March.

KDFWR (Kentucky Department of Fish and Wildlife Resources) 2000. *Mist Net Surveys for the Indiana Bat at West Kentucky Wildlife Management Area,* Paducah, KY, February.

Kentucky Environmental Quality Commission, 1996. 1996 State of Kentucky's Environment, Frankfort, KY, Aug.

KSNPC (Kentucky State Nature Preserves Commission) 1991. Biological Inventory of the Jackson Purchase Region of Kentucky, Kentucky State Nature Preserves Commission, Frankfort, Kentucky.

KSNPC 2000. Response to Data Services Request from SAIC. Request number 01-078. November, 14, 2000.

Kszos, L.A., B.K. Konetsky, M.J. Peterson, R.B. Petrie, M.G. Ryon, J.G. Smith, and G.R. Southworth 1997. *Report on the Biological Monitoring Program at Paducah Gaseous Diffusion Plant*, January-December 1996. Oak Ridge National Laboratories Environmental Sciences Division Publication No. 4636.

NCRP (National Council on Radiation Protection) 1991. *Effects of Ionizing Radiation on Aquatic Organisms*. NCRP Report No. 109, National Council on Radiation Protection and Measurements, Bethesda, Maryland.

NCRP (National Council on Radiation Protection) 1993. *Limitation of Exposure to Ionizing Radiation*, Report No. 116, Washington, D.C.

Roy, W.K., M.G. Ryon, R.L. Hinzman, J.G. Smith, J.J. Beauchamp, M.R. Smith, B.A. Carrico, R.P. Hoffmeister, M.K. McCracken, and R.A. Norman 1996. *Thermal Discharges from Paducah Gaseous Diffusion Plant Outfalls: Impacts on Stream Temperatures and Fauna of Little Bayou and Big Bayou Creeks.* Oak Ridge National Laboratories Environmental Sciences Division Publication No. 4524.

Ryon, M.G., and B.A. Carrizo 1998. "Distributional Records for Fishes of the Coastal Plain Province, Ballard and McCracken Counties, in Western Kentucky." *Journal of the Kentucky Academy of Sciences* 59(1): p. 51-63.

Texas Tech University 1999. *Raccoons (Procyon Lotor) as Sentinels for Polychlorinated Biphenyl and Heavy Metal Exposure and Effects at the Paducah Gaseous Diffusion Plant, McCracken County, Kentucky,* The Institute of Environmental and Human Health, Texas Tech University Health Science Center, Lubbock, Texas.

USDA (U.S. Department of Agriculture) 1976. U.S. Department of Agriculture Soil Survey for McCracken County, Kentucky.

USGS (U.S. Geological Survey) 2000. Data on Ohio River Basin, Web site at *il.water.usgs.gov/annrep_2000/data/joimanu/03611500.htm*.

USGS (U.S. Geological Survey) 2001. *Calendar Year Streamflow Statistics for Illinois, USGS 03611500 Ohio River at Metropolis, IL.* Web site at water.usgs.gov/il/nwis/annual/?site.no=03611500&agency_cd=USGS.

THIS PAGE INTENTIONALLY LEFT BLANK.

APPENDIX A

LIST OF PREPARERS

THIS PAGE INTENTIONALLY LEFT BLANK.

LIST OF PREPARERS

Name:	Wayne Tolbert
Degree:	Ph. D., Ecology
Company:	Science Applications International Corporation (SAIC)
Title:	Senior Project Manager
Years of Experience:	28
EA Responsibility:	SAIC Project Manager
Name:	Diane McDaniel
Degree:	B.S., Wildlife and Fisheries Science
Company:	SAIC
Title:	Environmental Scientist
Years of Experience:	10
EA Responsibility:	Public Involvement; Ecological Resources
Name:	Sam Leone
Degree:	M.S., Chemical Engineering
Company:	Bechtel Jacobs Company, LLC
Title:	Waste Technical Specialist
Years of Experience:	23
EA Responsibility:	Waste Description/Characterization
Name:	Heather Cothron
Degree:	M.S., Chemical Engineer
Company:	SAIC
Title:	Sr. Engineer/Project Manager
Years of Experience:	17
EA Responsibility:	Air Quality
Name:	Arthur McBride
Degree:	M.S., Mechanical Engineering
Company:	SAIC
Title:	Senior Risk Analyst
Years of Experience:	33
EA Responsibility:	Accident Risk Analysis
Name:	Sharon Bell
Degree:	M.S., Economics
Company:	SAIC
Title:	Socioeconomist and Environmental Justice
Years of Experience:	21
EA Responsibility:	Socioeconomics and Environmental Justice
Name:	Steve Mitz
Degree:	M.S., Aquatic Toxicology
Company:	SAIC
Title:	Senior Aquatic Ecologist/Environmental Scientist
Years of Experience:	19
EA Responsibility:	Aquatic Ecology and Ecological Risk

Name:	Richard F. Orthen
Degree:	B.S., Chemistry
Company:	CTR Inc.
Title:	Senior Project Manager
Years of Experience:	21 [7 preparing National Environmental Policy Act of 1969 (NEPA) documents]
EA Responsibility:	Transportation

Name:	Aparajita S. Morrison
Degree:	B.S., Health Physics
Company:	CTR Inc.
Title:	Sr. Health Physicist
Years of Experience:	15 (7 preparing NEPA documents)
EA Responsibility:	Transportation

APPENDIX B

PERSONS AND AGENCIES CONTACTED

THIS PAGE INTENTIONALLY LEFT BLANK.

PERSONS AND AGENCIES CONTACTED

Potentially Affected States
Arkansas

Tracy L. Copeland
Manager, Arkansas State Clearinghouse
Office of Intergovernmental Services
Department of Finance and Administration
1515 W. 7th Street, Room 412
Little Rock, AR 72203

Colorado

Rich Harvey
Project Manager for Border Congestion
Western Governors Association
1515 Cleveland Place, Suite 200
Denver, CO 80202-5452

The Honorable Bill Owens
Governor of Colorado
136 State Capitol Building
Denver, CO 80203-1792

Idaho

The Honorable Dirk Kempthorne
Governor of Idaho
State Capitol
700 West Jefferson, 2nd Floor
Boise, ID 83720

Ann Dold
Manager, INEEL Oversight Program
900 North Skyline, Suite C
Idaho Falls, ID 83402

Kathleen Trever
Coordinator-Manager
INEEL Oversight Program
1410 North Hilton
Boise, ID 83706

Illinois

Winifred A. Pizzano
Director, Washington Office
State of Illinois
444 North Capitol Street, NW, Suite 240
Washington, DC 20001

Kansas

Ronald Hammerschmidt
Director, Division of Environment
Kansas Department of Health and Environment
Forbes Field, Building 740
Topeka, KS 66620-0001

Kentucky

Alex Barber
KY Division for Environmental Protection
14 Reilly Road, Frankfort Office Park
Frankfort, KY 40601

Mississippi

Charles Chisolm
Executive Director
Mississippi Department of Environmental Quality
P.O. Box 20305
Jackson, MS 39289-1305

Missouri

Ms. Lois Pohl
Coordinator, Missouri Federal Assistance Clearinghouse
Office of Administration
Division of General Services
P.O. Box 809
Harry S. Truman State Office Building, Room 840
Jefferson City, MO 65102

Nebraska

Jay Ringenberg
Deputy Director, Programs
P.O. Box 98922
Lincoln, NE 68509

Nevada

Heather K. Elliott
Department of Administration
Nevada State Clearinghouse
209 East Musser Street, Room 200
Carson City, NV 89701

Oregon

The Honorable John A. Kitzhaber
Governor of Oregon
254 State Capitol
Salem, OR 97310-4001

Tennessee

Justin P. Wilson
Deputy to the Governor for Policy
Attention: Mr. David L. Harbin
Tennessee Department of Environment
and Conservation – Environmental Policy Office L&C Tower,
21st Floor, 401 Church Street
Nashville, TN 37243-1530

John Owsley
DOE Oversight
Attention: Chudi Nwangwa
Tennessee Department of Environment
and Conservation
761 Emory Valley Road
Oak Ridge, TN 37830-7072
Governor:

Ellen Smith
Chairman, Environmental Quality Advisory Board
City of Oak Ridge
P.O. Box 1
Oak Ridge, TN 37831-0001

Dr. Amy S. Fitzgerald
Special Assistant to the City Manager, Public Affairs
And
Dr. Susan Gawarecki
Oak Ridge Reservation Local Oversight Committee, Inc.
136 South Illinois Avenue, Suite 208
Oak Ridge, TN 37830

Texas

Billy Phenix
Environmental Policy Director, Governor's Policy Office
P.O. Box 12428
Austin, TX 78711

Denise S. Francis
State Single Point of Contact
Texas Governor's Office of Budget and Planning
State Insurance Building
1100 San Jacinto, Room 2.114
P.O. Box 12428
Austin, TX 78711

Utah

Carolyn Wright
Utah State Clearinghouse
Governor's Office of Planning and Budget
Room 116 State Capitol Building
Salt Lake City, UT 84114

Washington

Barbara Ritchie
NEPA Coordinator, Environmental Coordination Section
Washington Department of Ecology
P.O. Box 47703
Olympia, WA 98504-7703

Wyoming

Julie Hamilton
State Clearinghouse Coordinator, Wyoming
Federal Land Policy Office
Herschler Building
First Floor, West Wing
Cheyenne, WY 82002

Federal

Camille Mittleholtz
Environmental Team Leader
Office of Transportation Policy

U.S. Department of Transportation
Room 10309
400 7th Street, SW
Washington DC 20590-0001

Paducah Area Public

Bill Paxton
Mayor of Paducah
PO Box 2267
Paducah, KY 42002

Judge Danny Orazine
301 South 6th
Paducah, KY 42003

Wayne L. Davis
Kentucky Department of Fish and Wildlife Resources
#1 Game Farm Road
Frankfort, KY 40601

Tim Kreher
West KY Wildlife Management Area
10535 Ogden Landing Road
Kevil, KY 42053

Paducah Public Library
555 Washington Street
Paducah, KY 42001

Leon Owens
Pace International Union Local 50550
315 Palisades Circle
Paducah KY 42001

THIS PAGE INTENTIONALLY LEFT BLANK.

APPENDIX C

ANALYSIS OF ACCIDENT IMPACTS TO NATURAL RESOURCES

THIS PAGE INTENTIONALLY LEFT BLANK.

APPENDIX C

ANALYSIS OF ACCIDENT IMPACTS TO NATURAL RESOURCES

C.1 INTRODUCTION

This appendix describes the methods that were used to analyze impacts to natural resources resulting from an evaluation-basis earthquake (EBE) under the preferred and no action alternatives. The EBE scenario was selected for analysis because it would result in the most catastrophic contaminant release of the three bounding accidents described in Section 4.1.3. Additionally, the EBE accident scenario under the proposed action and the no action alternative would be the same. Therefore a single analysis was performed for both alternatives.

C.2 SURFACE WATER ANALYSIS METHODOLOGY

Impacts to surface water were evaluated by estimating the amounts of radiological and non-radiological constituents that would be introduced into the water bodies described in the affected environment (Chap. 3). Using estimated amounts of released constituents from the various waste streams (provided to Science Applications International Corporation) and activities (such as on-site accidents, on-site treatment, and on-site storage activities) estimated concentrations of the constituents in the receiving surface water were calculated and compared to existing water quality benchmarks. The first choice for water quality benchmarks was Commonwealth of Kentucky water quality criteria [401 *Kentucky Administrative Regulations* (*KAR*) 5:031. Surface water standards], followed by National Water Quality Criteria [U.S. Environmental Protection Agency (EPA) 1999]. If benchmarks were not available from either of these sources, the third choice for a benchmark was EPA Tier II Secondary Chronic Values (Suter and Tsao 1996). The discussion of the quantitative approach to this method is contained in the following section describing the analysis method for aquatic biota. In addition to this quantitative approach, qualitative estimates of water quality were performed for any activities that could result in soil erosion and runoff with subsequent impacts on sedimentation and siltation.

C.3 AQUATIC BIOTA ANALYSIS METHODOLOGY

Aquatic biota may be exposed to external radiation from radionuclides dissolved in surface water or attached to sediments, or by internal radiation from ingested radionuclides. Aquatic biota are exposed to non radionuclides by direct uptake from the surface water and sediment via direct contact, or by ingestion of contaminants. In the aquatic scenario, it is assumed that all of the liquid released travels into the Ohio River, where it is diluted by one day's flow of water. The evaluation of impacts to aquatic biota is restricted to potential consequences of the exposure scenarios.

C.3.1 Radionuclide Content of Wastes

The composition of wastes in the various storage containers varies. For this evaluation, it is assumed that equal proportions of each waste stream would be released. Under the earthquake scenario, it is assumed that 5% of the radioactivity in liquid waste is released. The total volume, mass, and activity of the seven radionuclides reported in the waste are presented in Table C.1, along with the activity of each that is assumed to be discharged by an earthquake-related spill.

Table C.1. Analysis of radionuclide exposure to aquatic and terrestrial biota under the earthquake scenario for accidental release

	Radionuclides						
	Am-241	**Cs-137**	**Np237**	**Pu-239**	**Tc-99**	**Th-230**	**U**
Volume (m^3)	5.42E+02	5.08E+02	3.69E+01	5.45E+02	8.92E+02	3.40E+01	7.81E+02
Mass (g)	5.42E+08	5.08E+08	3.69E+07	5.45E+08	8.92E+08	3.40E+07	7.81E+08
Activity (pCi)	1.72E+09	5.49E+07	1.84E+11	6.40E+11	1.46E+13	7.92E+09	9.66E+10
Activity (Ci)	1.72E-03	5.49E-05	1.84E-01	6.40E-01	1.46E+01	7.92E-03	9.66E-02
pCi spilled (5%)	8.59E-05	2.74E-06	9.19E-03	3.20E-02	7.29E-01	3.96E-04	4.83E-03
Aquatic scenario							
River conc. (pCi/L)	1.83E-04	5.84E-06	1.95E-02	6.81E-02	1.55E+00	8.43E-04	1.03E-02
Benchmark (pCi/L)	1.17E+03	7.27E+03	1.34E+03	1.25E+03	1.94E+06	4.13E+02	4.00E+03
Ratio	1.56E-07	8.03E-10	1.46E-05	5.45E-05	7.99E-07	2.04E-06	2.57E-06
Terrestrial scenario							
Soil conc. (pCi/g)	8.26E-03	2.64E-04	8.83E-01	3.08E+00	7.01E+01	3.81E-02	4.64E-01
Paducah Site NFA benchmark (pCi/g)	9.75E+02	1.24E+03	1.68E+03	2.03E+03	6.57E+03	3.99E+03	1.06E+03
Ratio	1.60E-10	1.26E-10	9.29E-11	7.69E-11	2.38E-11	3.91E-11	1.47E-10
Small mammal benchmark (pCi/g)	2.84E+03	6.99E+02	9.84E+02	4.96E+04	1.45E+03	2.27E+04	3.84E+02
Ratio	2.91E-06	1.18E-05	8.39E-06	1.66E-07	5.69E-06	3.64E-07	2.15E-05
Songbird benchmarks (pCi/g)	5.47E+03	1.72E+03	4.40E+03	5.67E+06	2.40E+03	1.05E+06	3.42E+03
Ratio	5.31E-10	1.69E-09	6.61E-10	5.13E-13	1.21E-09	2.77E-12	8.50E-10

NFA = no further action

C.3.2 Radionuclide Exposure in Surface Water

The risk to aquatic receptors in the Ohio River was estimated by using screening benchmarks. For a comparison of potential impacts to the benchmarks, it was necessary to estimate the concentrations of radionuclides diluted in the river after the spill.

The estimated flow rate in the river is 4.7×10^{11} L/24 h [U.S. Geological Survey (USGS) 2000]. The total released activity of each radionuclide was divided by this volume. The resulting concentration of each radionuclide in the river is given in Table C.1. Although the vast majority of the waste released into the river would move downstream in a short time, a portion of this activity could be deposited in sediment and would remain at one location for longer than the water. To ensure a conservative evaluation of risks to aquatic biota in the Ohio River, benchmarks for chronic exposure of aquatic biota were used.

C.3.3 Radionuclide Effects Benchmarks for Surface Water

The International Council on Radiation Protection (ICRP 1977) recommended screening levels of 0.1 rad/day for terrestrial animals and 1 rad/day for aquatic receptors. The National Council on Radiation Protection and Measurement (NCRP) also recommends a screening level of 1 rad/day for aquatic biota (NCRP 1991). A screening level of 1 rad/d was used in the preparation of screening benchmarks. Screening benchmarks for radionuclides in water were prepared by the Oak Ridge National Laboratory for the U.S. Department of Energy (DOE) [Bechtell Jacobs Company, LLC (BJC) 1998]. These benchmarks include external exposure by immersion in water and resting on sediment as well as ingestion of water, sediment, and prey that have also been exposed. The benchmark values for most of the radionuclides (plus daughters) range from 1170 pCi/L to 7270 pCi/L (Table C.1).

C.3.4 Results of Radionuclide Exposure Screening for Surface Water

As shown in Table C.1, the ratios of modeled exposure concentrations to benchmark concentrations of individual radionuclides in the Ohio River are all below 6×10^{-5} . The sum of the ratios (the total risk) is about 7.5×10^{-5}. This value is far below any concentration that could cause chronic radiation damage. In addition, the benchmarks are for chronic exposure, and conditions for chronic exposure are not likely to occur. Therefore, the earthquake scenario is highly unlikely to cause harm to aquatic biota in the Ohio River as a result of exposure to radionuclides.

Aquatic receptors in Bayou and Little Bayou Creeks and other water conveyances by which the waste would reach the Ohio River would likely be killed by the caustic nature of the waste. Radiation exposure to any survivors would be of an acute nature; ecological risk models for acute radiation of biota are not available, but it has been estimated that an acute dose of 24 rad/d is unlikely to cause long-term damage to aquatic snails (NCRP 1991). Assuming that 5% of the waste inventory is released, approximately 30,000 L of liquid would proceed down the conveyances. The concentration of radionuclides in this liquid would be on the order of 25 million pCi/L, about four orders of magnitude above benchmarks for chronic exposure of aquatic biota and probably about 1000-fold above benchmarks for acute toxicity. Therefore, it is likely that a spill of waste that travels undiluted to the Ohio River would cause acute lethality to all aquatic biota in its path until it is diluted in the Ohio River.

C.3.5 Chemical Content of Wastes

The composition of wastes in the various storage containers varies. For this evaluation, it is assumed that equal proportions of each waste stream would be released. Under the earthquake scenario, it is assumed that 5% of the chemical in liquid waste is released. The total volume and mass of the nine chemicals (six organics and three inorganics) reported in the waste are presented in Table C.2 along with the amount of each that is assumed to be discharged by an earthquake-related spill.

C.3.6 Chemical Exposure in Surface Water

The risk to aquatic receptors in the Ohio River was estimated initially by using screening benchmarks. For a comparison of potential impacts to the benchmarks, it was necessary to estimate the chemical concentrations diluted in the river after the spill.

The estimated flow rate in the river is 4.7×10^{11} L/24 h (USGS 2000). The total released mass of each chemical was divided by this volume. The resulting concentration of each chemical in the river is given in Table C.2. Although the vast majority of the waste released into the river would move downstream in a short time, a portion of the constituents could be deposited in sediment and would remain at one location for longer than the water. To ensure a conservative evaluation of risks to aquatic biota in the Ohio River, benchmarks for chronic exposure of aquatic biota were used.

C.3.7 Chemical Effects Benchmarks for Surface Water

The first choice for water quality benchmarks was Commonwealth of Kentucky water quality criteria (401 *KAR* 5:031. Surface water standards), followed by National Water Quality Criteria (EPA 1999). If benchmarks were not available from either of these sources, the third choice for a benchmark was EPA Tier II Secondary Chronic Values (Suter and Tsao 1996). If the estimated concentrations of constituents in the surface water exceed the water quality benchmarks, aquatic biota would be assumed to be at potential risk and would be further scrutinized using a weight-of-evidence analysis by considering factors such as the quality and quantity of habitat, bioaccumulation potential of the constituent and its bioavailability, and magnitude of the exceedance of the benchmark to evaluate whether the potential for adverse impacts is credible. Thus, even though a constituent concentration might exceed the toxicity benchmark, the weight of evidence analysis might indicate that mitigating factors reduce the potential adverse impacts to levels below concern.

C.3.8 Results of Chemical Exposure Screening for Surface Water

As shown in Table C.2, the ratios of modeled exposure concentrations to benchmark concentrations of individual chemicals are all below 4.15×10^{-2} except for polychlorinated biphenyls (PCBs), which has a ratio of 2.08. The weight of evidence analysis indicates that the magnitude of this ratio barely exceeds 1. In addition, PCBs, especially those with higher percentages of chlorination (e.g., aroclors 1254 or 1260), have low solubilities in water. In addition, PCBs are strongly adsorbed to sediments and particulates (EPA 1980) so the total concentration in surface water most likely represents particle- or organic-bound fractions that are not very bioavailable for uptake. Thus, even though there is PCB in the surface water, the low amount relative to the conservative benchmark and likely unavailability of that PCB to aquatic biota makes it unlikely to present adverse concentration of the biota. Therefore, the earthquake scenario is highly unlikely to cause harm to aquatic biota in the Ohio River as a result of exposure to chemical constituents.

However, aquatic receptors in Big and Little Bayou Creeks and other water conveyances by which the waste would reach the Ohio River would likely suffer acute mortality due to the caustic nature of the waste. Assuming that 5% of the waste inventory is released, approximately 30,000 L of liquid would proceed down the conveyances. Therefore, it is likely that a spill of waste that travels undiluted to the Ohio River would cause acute lethality to all aquatic biota in its path until it is diluted. Recovery of the biota via recolonization from the Ohio River should be rapid (days to weeks), however, because the transient pH pulse would not leave contaminants in the water or sediment.

Table C.2. Chemical constituent concentrations released into aquatic and terrestrial ecosystems after the earthquake accident scenario at Paducah

		Organic constituents						Inorganic constituents		
		1,1,1-Tri-chloroethane	**1,2,4-Tri-chlorobenzene**	**Polychlorinated biphenyls**	**Trichloroethene**	**Total petroleum hydrocarbons**	**Xylene**	**Cadmium**	**Chromium**	**Lead**
Volume (m^3)		5.08E+02	5.08E+02	7.84E+02	1.03E+02	5.08E+02	5.08E+02	1.05E+02	1.05E+02	1.03E+02
Mass (g)		1.22E+05	5.08E+03	2.74E+05	0.00E+00	1.13E+08	8.64E+01	5.25E+05	5.25E+05	5.15E+05
g spilled (5%)		6.10E+03	2.54E+02	1.37E+04	0.00E+00	5.66E+06	4.32E+00	2.63E+04	2.63E+04	2.58E+04
Aquatic scenario										
River conc. (µg/L)		1.30E-02	5.40E-04	2.91E-02	0.00E+00	1.21E+01	9.19E-06	5.59E-02	5.59E-02	5.48E-02
Benchmark (µg/L)		5.28E+02	4.49E+01	1.40E-02	4.70E+01	None	1.80E+00	1.42E+00	1.10E+01	1.32E+00
	Ratio	2.46E-05	1.20E-05	**2.08E+00**	0.00E+00	No benchmark	5.10E-06	3.93E-02	5.08E-03	4.15E-02
Terrestrial scenario										
Soil conc. (mg/kg)		5.86E-01	2.44E-02	1.32E+00	0.00E+00	5.45E+02	4.15E-04	2.52E+00	2.52E+00	2.48E+00
Paducah Site NFA benchmark (mg/kg)		None	1.00E-02	2.00E-02	1.00E-03	None	5.00E-02	1.10E-01	4.00E-02	2.00E+01
	Ratio	No benchmark	**2.44E+00**	**6.58E+01**	0.00E+00	No benchmark	8.30E-03	**2.29E+01**	**6.31E+01**	1.24E-01

Ratios in **bold** exceed 1.0, and thus exceed toxicity benchmarks

Aquatic benchmarks are either *KAR* water quality standard (1st choice), National Ambient Water Quality Criteria (2nd choice), or US EPA Tier II secondary chronic values (3rd choice)

NFA = no further action

C.4 TERRESTRIAL BIOTA ANALYSIS METHODOLOGY

Terrestrial receptors are exposed to external radiation from soil and to internal radiation through the food chain. External exposure to beta- and gamma-radiation is evaluated because alpha particles rarely have the power to penetrate skin. Internal radiation results from retention in tissues of radionuclides taken up directly from soil or in food that has incorporated radioactivity. Potential risks to plants, soil-dwelling invertebrates (earthworms), soil-dwelling small mammals [short-tailed shrew (*Blarina brevicauda*), and songbirds such as American robin (*Turdus migratorius*)] were evaluated for the terrestrial exposure scenario. Shrews and robins were chosen because their high level of consumption of earthworms and other soil invertebrates, as well as the accompanying soil, gives them a relatively higher exposure to soil contaminants than most other receptors. All receptors were assumed to spend all of their time in the affected area, so their dietary intake in this evaluation comes solely from the affected soil. It was assumed that if this worst-case screening evaluation indicates no important radiological exposure of the biota, it is not necessary to do a detailed evaluation at other trophic levels.

C.4.1 Radionuclide Content of Wastes

The composition of wastes in the various storage containers varies. For this evaluation, it is assumed that equal proportions of each waste stream would be released. Under the earthquake scenario, it is assumed that 5% of the radioactivity in liquid waste is released. The total volume, mass, and activity of the seven radionuclides reported in the waste are presented in Table C.1, along with the activity of each that is assumed to be discharged by an earthquake-related spill.

C.4.2 Radionuclide Exposure in Soil

Terrestrial biota are exposed to both external radiation from the soil in which they live or on which they forage. External exposure for soil-dwelling biota can include both subsurface and surface exposure. External exposure to beta- and gamma-radiation is evaluated because alpha particles rarely have the power to penetrate skin. Internal radiation results from retention in tissues of radionuclides taken up directly from soil or in food that has incorporated radioactivity. All receptors were assumed to spend all of their time in the affected area, so their dietary intake in this evaluation comes solely from the affected soil.

To estimate soil concentrations under the earthquake conditions, it was assumed that all of the liquid, containing several radionuclides, is absorbed into the top 20 cm of the 180 m-square storage area. It was assumed that the soil density is 1.6 g/cc. The affected mass of soil would be 1.8×10^4 cm × 1.8×10^4 cm × 20 cm × 1.6 g/cc = 1.04×10^{10} g. Therefore, the average concentration of each radionuclide in soil could be calculated by dividing the total activity by the mass of soil in which it is assumed to be distributed. These values were used for the screening evaluation and are shown in table C.1.

C.4.3 Radionuclide Effects Benchmarks for Soil

The ICRP (1977) recommended screening levels of 0.1 rad/day for terrestrial animals and 1 rad/day for aquatic receptors. The NCRP also recommends a screening level of 1 rad/day for aquatic biota (NCRP 1991). The International Atomic Energy Agency has stated that a chronic dose of 0.1 rad/day is unlikely to be harmful to populations of terrestrial animals and a chronic dose of 1 rad/day is unlikely to be harmful to populations of terrestrial plants and invertebrates (IAEA 1992). Paducah Gaseous Diffusion Plant site (PGDP) no further action (NFA) levels for contaminants in soil have been calculated (DOE 2000). In the screening risk assessment method for radionuclides an upper limit of 0.1 rad/d for terrestrial biota was chosen. To be consistent with this document and NCRP recommendations, the chosen screening levels for whole-organism doses were 1 rad/d for aquatic organisms and 0.1 rad/day to all terrestrial organisms.

C.4.4 Results of Radionuclide Exposure Screening for Soils

To screen exposures to soil radionuclides, PGDP NFA levels for radionuclides in soil were used. These levels were assumed not to cause harm to ecological populations at Paducah (DOE 2000). Soil concentrations, screening benchmarks, and results for individual radionuclides are shown in Table C.1. The scenario for chronic radionuclide exposure as a result of the modeled worst-case spill indicated that the sum of chronic terrestrial exposures would be about 7×10^{-10} of the tolerable daily radiation dose as indicated by NFA levels. Therefore, in even this worst-case accident scenario, long-term radiation effects to soil biota would be negligible.

C.4.5 Chemical Exposure in Soil

Terrestrial biota are exposed to both external radiation from the soil in which they live or on which they forage. All receptors were assumed to spend all of their time in the affected area.

Just as with radionuclides, in order to estimate soil concentrations under the earthquake conditions it was assumed that all of the liquid, containing several radionuclides, is absorbed into the top 20 cm of the 180 m-square storage area. It was assumed that the soil density is 1.6 g/cc. The affected mass of soil would be 1.8×10^4 cm × 1.8×10^4 cm × 20 cm × 1.6 g/cc = 1.04×10^{10} g. Therefore, the average concentration of each radionuclide in soil could be calculated by dividing the total activity by the mass of soil in which it is assumed to be distributed. These values were used for the screening evaluation and are shown in table C.2.

C.4.6 Chemical Effects Benchmarks for Soil

To screen exposures to soil chemicals, PGDP NFA levels for chemicals in soil were used (Table C.2). These levels were assumed not to cause harm to ecological populations at Paducah (DOE 2000). Two of the chemicals, total petroleum hydrocarbons and 1,1,1-trichloroethane, did not have PGDP NFA values.

C.4.7 Results of Chemical Exposure Screening for Soils

Soil concentrations, screening benchmarks, and ratios of the soil concentrations to screening benchmarks are shown in Table C.2. Two organics (PCBs and 1,2,4-trichlorobenzene) and two inorganics (cadmium and chromium) had modeled concentrations that exceeded the PGDF NFA benchmarks. PCBs in soil exceed the PGDF NFA benchmark by the largest ratio (65.8), followed by chromium (63.1). The soil cadmium modeled concentration exceeded the PGDF NFA benchmark by a ratio of 22.9. These ratios indicate that these constituents potentially pose adverse impacts to soil biota if the worst case spill accident occurred and are candidates for further weight of evidence analysis.

Although the concentrations of four constituents in soil exceed the PGDP NFA concentrations, the lack of suitable habitat for terrestrial receptors within the fenced portion of the PGDP and the spill area diminish potential adverse impacts because receptors would essentially be absent. The lack of suitable habitat within the PGDP and its large contribution to minimal risks to terrestrial receptor is further enhanced by the abundance of suitable habitat surrounding the fenced portion of PGDP, thereby providing alternative habitat for receptors. Thus, even though PCBs, 1,2,4-trichlorobenzene, cadmium, and chromium concentrations in the soil could exceed the conservative PGDP NFA benchmarks, the lack of suitable habitat within the fenced PGDP makes it unlikely to present adverse impacts of the biota. Furthermore, it is assumed that the contaminated soils from the accident would be quickly cleaned up or removed to minimize any potential adverse impacts to biota. Therefore, the earthquake scenario is highly unlikely to cause harm to terrestrial biota as a result of exposure to chemical constituents.

THIS PAGE INTENTIONALLY LEFT BLANK.

APPENDIX D

WILDLIFE SPECIES OCCURRING AT THE PADUCAH SITE

THIS PAGE INTENTIONALLY LEFT BLANK.

APPENDIX D

WILDLIFE SPECIES OCCURRING AT THE PADUCAH SITE

Table D.1. Amphibians and reptiles observed at the Paducah DOE reservation

Scientific name	Common name
Plethodon glutinosus group	slimy salamander
Bufo americanus charlesmithi	dwarf American toad
Bufo woodhousei	Woodhouse's toad
Hyla cinerea	green tree frog
Acris crepitans crepitans	northern cricket frog
Acris creptians blanchardi	Blanchard's cricket frog
Rana clamitans melanota	green frog
Rana catesbeiana	bullfrog
Rana utricularia	Southern leopard frog
Chelydra serpentina	common snapping turtle
Trachemys scripta elegans	red-eared slider
Terrapene carolina carolina	eastern box turtle
Sceloporous undulatus hyacinthinus	northern fence lizard
Thamnophis sirtalis sirtalis	eastern garter snake
Coluber constrictor priapus X C. c. foxi	southern black racer/blue racer intergrade
Elaphe obsoleta spiloides	gray rat snake
Lampropeltis getula nigra	black king snake

Adapted from Battelle (1978)

Table D.2. Bird Species observed near the Paducah Site

Scientific name	Common name
Ardea herodias	great blue heron
Butorides striatus	green heron
Aix spinosa	wood duck
Lophodytes cucullatus	hooded merganser
Cathartes aura	turkey vulture
Buteo jamaicensis	red-tailed hawk
Falco sparverius	American kestrel
Colinus virginianus	bobwhite
Charadrius vociferus	killdeer
Philohela minor	American woodcock
Zenadia macroura	mourning dove
Collyzus americanus	yellow-billed cuckoo
Otus asio	screech owl
Bubo virginianus	great horned owl
Caprimulgus carolinensis	chuck-would's widow
Caprimulgus vociferus	whip-poor-would
Chordeiles minor	common nighthawk
Chaetura pelagica	chimney swift
Megaceryle alcyon	belted kingfisher
Centurus carolinus	red-bellied woodpecker
Melanerpes erythrocephalus	red-headed woodpecker
Dendrocopus pubescens	downy woodpecker
Colaptes auratas	common flicker
Tyrannus tyrannus	eastern kingbird
Myiarchus crinitus	great crested flycatcher
Sayornis phoebe	eastem phoebe
Empidonax virescens	Acadian flycatcher
Contopus virens	eastern wood pewee
Nuttalornis borealis	olive-sided flycatcher
Hirundo rustica	barn swallow
Progne subis	purple martin
Cyanocitta cristata	bluejay
Corvus brachyrhyncos	common crow
Corvus ossifragus	fish crow
Parus atricapillus	blackcapped chickadee
Mimus polyglottos	mockingbird
Dumetella carolinensis	catbird
Toxostoma rufum	brown thrasher
Turdus migratorius	American robin
Hylocichla mustelina	wood thrush
Catharus ustulata	Swainson's thrush
Catharus fuscescens	veery
Sialia sialis	eastern bluebird
Polioptila caerulea	blue-gray gnatcatcher
Lanius ludovicianus	loggerhead shrike
Sturnus vulgaris	European starling
Vireo belli	Bell's vireo
Vireo griseus	white eyed vireo
Vireo olivaceous	red-eyed vireo
Protonotaria citrea	prothonotary warbler
Vermivora ruficapilla	Nashville warbler
Parula americana	northern parula
Dendroica petechia	yellow warbler
Dendroica magnolia	magnolia warbler
Dendroica coronata	yellow-romped warbler
Dendroica virens	black-throated green warbler
Dendroica discolor	prairie warbler
Seiurus aurocapillus	ovenbird
Seiurus motacilla	Louisiana waterthrush

Table D.2 (continued)

Scientific name	Common name
Columba livia	rockdove
Geothlypis trichas	common yellowthroat
Sturnella magna	eastern meadowlark
Icteria virens	yellow-breasted chat
Agelaius phoeniceus	red-winged blackbird
Icterus spurious	orchard oriole
Quiscalus guiscula	common grackle
Molothrus ater	brown-headed cowbird
Piranga olivacea	scarlet tanager
Piranga rubra	summer tanager
Cardinalis cardinalis	cardinal
Parus bicolor	tufted titmouse
Pheucticus ludovicianus	rose-breasted grosebeak
Passerina cyanea	indigo bunting
Spinus tristis	American goldfinch
Pipilo erythrophthalmus	rufous-sided towhee
Thryothorus ludovicianus	Carolina wren
Ammodramus savannarum	grasshopper sparrow
Junco hyemalis	dark-eyed junco
Spizella pusilla	field sparrow
Zonotrichia albicollis	white throated sparrow
Melospiza melodia	song sparrow

Adapted from Battelle (1978), CDM Federal (1994), and KSNPC (2000)

Table D.3. Mammals observed on or near the Paducah DOE reservation

Scientific name	Common name
Didelphis marsupialia	Opossum
Sorex longirostris	Southeastern shrew
Scalopus aguaticus	Eastern mole
Myotis austroriparius	Southeastern myotis
Myotis sodalis	Indiana bat (myotis)
Sylvilagus floridanus	Eastern cottontail
Sciurus carolinensis	gray squirrel
Sciurus niger	fox squirrel
Castor canadesis	beaver
Peromyscus leucopus	white-footed mouse
Microtus ochrogaster	prairie vole
Ondatra zibethicus	muskrat
Mus musculus	house mouse
Zapus hudsonius	meadow jumping mouse
Urocyon cinereoargenteus	gray fox
Vulpes vulpes	red fox
Procyon lotor	raccoon
Mustela vison	mink
Mephitis mephitis	striped skunk
Odocoileus virginianus	white-tailed deer

Adapted from Battelle (1978) and COE (1994)

Table D.4. Fish species collected in Bayou Creek and Little Bayou Creek, 1992-1998.

Family and species	Common name	Bayou Creek	Little Bayou Creek
Amiidae	bowfins		
Amia calva	bowfin	X	
Clupeidae	herrings and shads		
Dorosoma cepedianum	gizzard shad	X	
Cyprinidae	minnows		
Campostoma anomalum	central stoncroller	X	X
Ctenopharyngodon idella	grass carp	X	
Cyprinella lutrensis	red shiner	X	X
Cyprinella spiloptera	spotfin shiner	X	X
Cyprinella whipplei	steelcolor shiner	X	X
Cyprinus carpio	common carp	X	X
Hybognathus nuchalis	Mississippi silvery minnow	X	X
Lythrurus fumeus	ribbon shiner	X	X
Lythrurus umbratilis	redfin shiner	X	X
Notemigonus crysoleucas	golden shiner	X	X
Notropis atherinoides	emerald shiner	X	X
Notropis blennius	river shiner		X
Notropis stramineus	sand shiner		X
Phenacobius mirabilis	suckermouth minnow	X	X
Pimephales notatus	bluntnose minnow	X	X
Pimephales promelas	fathead minnow	X	X
Semotilus atromaculatus	creek chub	X	X
Catostomidae	suckers		
Carpiodes carpio	river carpsucker	X	
Catostomus commersoni	white sucker	X	X
Erimyzon oblongus	creek chubsucker	X	X
Ictiobus bubalus	smallmouth buffalo	X	
Ictiobus cyprinellus	bigmouth buffalo	X	
Ictiobus niger	black buffalo	X	
Minytrema melanops	spotted sucker	X	
Moxostoma erythrurum	golden redhorse	X	X
Ictaluridae	catfishes		
Ameiurus melas	black bullhead	X	X
Ameiurus natalis	yellow bullhead	X	X
Ictalurus punctatus	channel catfish	X	
Noturus gyrinus	tadpole madtom		X
Noturus nocturnus	frecklebelly madtom	X	
Esocidae	pikes		
Esox americanus vermiculatus	grass pickerel	X	X
Aphredoderidae	pirate perch		
Aphredoderus sayanus	pirate perch	X	X
Cyprinodontidae	topminnows		
IFundulus olivaceous	blackspotted topminnow	X	X
Poeciliidae	livebearers		
Gambusia affinis	Western mosquitofish	X	X
Atherinidae	silversides		
Labidesthes sicculus	brook silverside	X	
Centrarchidae	sunfishes and basses		
Centrarchus macropterus	flier	X	X
Lepomis cyanellus	green sunfish	X	X
Lepomis gulosus	warmouth	X	X
Lepomis humilis	orangespotted sunfish	X	X
Lepomis sp. X Lepomis sp.	hybrid sunfish	X	
Lepomis macrochirus	bluegill	X	X
Lepomis microlophus	redear sunfish	X	
Lepomis miniatus	redspotted sunfish	X	X
Lepomis megalotis	longear sunfish	X	X
Micropterus punctulatus	spotted bass	X	X
Micropterus salmoides	largemouth bass	X	X

Table D.4 continued

Family and species	Common name	Bayou Creek	Little Bayou Creek
Pomoxis annularis	white crappie	X	
Percidae	perches		
Etheostoma asprigine	mud darter	X	X
Etheostoma chlorosomum	bluntnose darter	X	X
Etheostoma gracile	slough darter	X	X
Perca flavescens	yellow perch	X	
Percina caprodes	logperch	X	X
Scianidae	drums		
Aplodinotus grunniens	freshwater drum	X	

Adapted from Ryon (1998).

REFERENCES

Battelle 1978. *Final Report on Environmental Studies at the Paducah Gaseous Diffusion Plant Paducah, Kentucky, to Union Carbide Corporation*. Battelle Laboratories, Columbus, OH.

CDM Federal 1994. *Investigations of Sensitive Ecological Resources Inside the Paducah Gaseous Diffusion Plant*. 7916-003-FR-BBRY, CDM Federal Programs Corporation, August 19.

CH2M HILL 1991. *Results of the Public Health and Ecological Assessment, Phase II, at the Paducah Gaseous Diffusion Plant (Draft)*. KY/SUB/13B-97777C P03/1991/1, CH2M HILL Southeast, Inc., Oak Ridge, TN, April.

COE (U.S. Army Corps of Engineers) 1994. *Environmental Investigations at the Paducah Gaseous Diffusion Plant and Surrounding Area, McCracken County, Kentucky, Volume V: Floodplain Investigation, Part A: Results of Field Survey*, United States Army Corps of Engineers, Nashville, TN, May.

Kszos, L. A., M. J. Peterson, M. G. Ryon, J. G. Smith, and G. R. Southworth. 1998. *Report on the Biological Monitoring Program at Paducah Gaseous Diffusion Plant*, January-December 1997. Oak Ridge National Laboratories Environmental Sciences Division Publication No. 4756

Kszos, L. A., B. K. Konetsky, M. J. Peterson, R. B. Petrie, M. G. Ryon, J. G. Smith, and G. R. Southworth. 1997. *Report on the Biological Monitoring Program at Paducah Gaseous Diffusion Plant*, January-December 1996. Oak Ridge National Laboratories Environmental Sciences Division Publication No. 4636.

KSNPC (Kentucky State Nature Preserves Commission) 1991. *Biological Inventory of the Jackson Purchase Region of Kentucky*. Kentucky State Nature Preserves Commission, Frankfort, KY.

KSNPC (Kentucky State Nature Preserves Commission) 2000. *Standard Occurrence Report for the Paducah Gaseous Diffusion Plant*. Internal document submitted to SAIC upon request.

Roy, W. K., M. G. Ryon, R. L. Hinzman, J. G. Smith, J. J. Beauchamp, M. R. Smith, B. A. Carrico, R. P. Hoffmeister, M. K. McCracken, and R. A. Norman. 1996. Thermal discharges from Paducah Gaseous Diffusion Plant Outfalls: Impacts on Stream Temperatures and Fauna of Little Bayou and Bayou Creeks. Oak Ridge National Laboratories Environmental Sciences Division Publication No. 4524.

Ryon, M. G. and B. A. Carrico. 1998. “Distributional records for fishes of the Coastal Plain Province, Ballard and McCracken Counties, in Western Kentucky.” *Journal of the Kentucky Academy of Sciences* 59(1): p. 51-63.

THIS PAGE INTENTIONALLY LEFT BLANK.

APPENDIX E

CONSULTATION LETTERS AND RESPONSES

THIS PAGE INTENTIONALLY LEFT BLANK.

APPENDIX F

BIOLOGICAL ASSESSMENT FOR THE PROPOSED DISPOSITION OF WASTES AT THE PADUCAH SITE, PADUCAH, KENTUCKY

THIS PAGE INTENTIONALLY LEFT BLANK.

Endangered Species Act

FINAL BIOLOGICAL ASSESSMENT
for
Waste Disposition Activities at the Paducah Site
McCracken County, Kentucky

September 2002

Prepared by
Science Applications International Corporation

U.S. Department of Energy
Oak Ridge Operations Office
Oak Ridge, TN

SUMMARY

This biological assessment (BA) evaluates potential impacts on Federally listed animal species that could result from the implementation of the waste disposition activities at the U.S. Department of Energy (DOE) Paducah Site in McCracken County, Kentucky. The species considered in this BA are the endangered Indiana bat and the following mussel species: orangefoot pimpleback, pink mucket, ring pink, and fat pocketbook as identified in a letter from the U.S. Fish and Wildlife Service to the DOE, dated September 25, 2001 (FWS 2001).

DOE concludes, for the reasons described in the main text of this BA, that the project is not likely to adversely affect these species. Also, since no proposed or designated critical habitats are present on, or near, the locations where activities would occur, none would be affected.

CONTENTS

ACRONYMS

BA	Biological Assessment
BJC	Bechtel Jacobs Company LLC
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
DMSA	DOE Material Storage Area
DOE	U.S. Department of Energy
EA	Environmental Assessment
FWS	U.S. Fish and Wildlife Service
KDFWR	Kentucky Department of Fish and Wildlife Resources
KPDES	Kentucky Pollutant Discharge Elimination System
KSNPC	Kentucky State Nature Preserves Commission
LLW	low-level waste
MLLW	mixed low-level waste
NFA	no further action
PCB	polychlorinated biphenyl
RCRA	Resource Conservation and Recovery Act of 1976
TRU	transuranic
USEC	U.S. Enrichment Corporation
WKMA	West Kentucky Wildlife Management Area

1. INTRODUCTION AND PROJECT DESCRIPTION

The U.S. Department of Energy (DOE)-Oak Ridge Operations has various waste types located at the Paducah Site that must undergo disposition activities. Disposition activities include waste storage, sampling, characterization, packaging, surveillance, on-site and/or off-site treatment, transportation, and disposal, as well as other activities performed to support these tasks. Examples of supporting activities include vehicle fueling, facility maintenance, and storage container inspections.

The following brief project description is extracted from the Final Environmental Assessment (EA) for the project (DOE 2001b). Of the two alternatives considered in the EA, one is No Action, and the second is implementation of the preferred alternative. The preferred alternative includes an evaluation of the potential effects of disposition of accumulated legacy and ongoing operational wastes at the Paducah Site. The potential effects of waste transportation over both highway and rail routes are evaluated. Wastes considered in the proposed action and alternative does not include waste for which treatment and disposal are addressed pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA). These waste are considered in the Cumulative Impacts section.

The wastes covered by the preferred alternative are limited to DOE's ongoing and legacy non-CERCLA and DOE Material Storage Area (DMSA) waste management operations at the Paducah Site. These wastes include polychlorinated biphenyl (PCB) waste, low-level waste (LLW), mixed low-level waste (MLLW), and transuranic (TRU) waste. Also included is the storage of the U.S. Enrichment Corporation (USEC) program wastes, which are characterized as one or more of these waste types. Wastes not covered in the EA include those associated with certain USEC programs such as sand blasting and cylinder painting. However, these activities are considered in the Cumulative Impacts assessment.

Alternative 1, normal operations under the No Action alternative would not affect wildlife, including listed species; thus, it is not considered further. Accident impacts would be similar to those discussed in the proposed action. The remaining alternative is briefly described below.

Alternative 2, the preferred alternative, in the EA (DOE 2001b) proposes to disposition site wastes as needed. For the purpose of the EA, disposition activities are defined as any actions taken to maintain and/or manage Paducah Site wastes. Disposition activities may include characterization, storage, packaging, treatment, loading, and shipping existing and forecasted Paducah Site wastes to treatment/disposal locations.

1.1 WASTE STORAGE

Under the proposed action, all waste would be stored at the Paducah Site until it is scheduled for treatment, disposal, or transport. Existing facilities will be used for waste storage. At this time, it is not anticipated that any new waste storage facilities would be constructed.

1.2 WASTE TREATMENT – ONSITE

On-site treatment applies only to approximately 200 m^3 (7060 ft^3) of the 11,000 m^3 (390,000 ft^3) waste volume covered in this EA, which includes up to 120 m^3 (4238 ft^3) of MLLW solids, 12 m^3 (424 ft^2) of ^{99}Tc-contaminated MLLW, and 6 m^3 of TRU waste. On-site treatment technologies are limited by the Paducah Site Resource Conservation and Recovery Act of 1976 (RCRA) Part B permit. RCRA-permitted on-site treatment technologies include sedimentation, precipitation, oxidation, reduction, neutralization, cementation/solidification, carbon adsorption, photocatalytic conversion, and lime precipitation. Currently, only neutralization, stabilization, carbon adsorption, and photocatalytic conversion are planned on-site. These are the only technologies discussed in subsequent sections because they are the ones applicable to the waste types presented. Building C-752-A has been proposed as the site for processing any on-site waste that needs to be treated indoors. Building C-746A is the proposed location for light bulb crushing.

Another 52 m^3 (1836 ft^3)/year of LLW wastewater would also be treated on-site. All volumes listed are approximate. Wastewater would be treated on-site by carbon adsorption, photocatylic conversion, and/or lime precipitation. These treatment activities would be compliant with the applicable Kentucky Pollutant Discharge Elimination System (KPDES) permit(s).

1.3 WASTE TREATMENT – OFFSITE

DOE's proposed action for off-site treatment varies by waste type. The characteristics of the waste govern where and how each waste type may be treated. The preferred treatment scenario for each type of currently known waste is listed below.

Fifty metric tons of capacitors containing PCBs are proposed for shipment to Deer Park, Texas, for treatment and disposal. The capacitors would be shipped in 23 7A, Type A containers. Thirteen empty transformers weighing 78 metric tons would be shipped for off-site treatment and disposal as well. These transformers contain some residual PCB contamination.

The 5355 m^3 (189,110 ft^3) of MLLW addressed in this proposed action represents a very heterogeneous grouping of wastes; most of this waste will be treated and disposed at off-site, permitted facilities. A small portion contains PCBs, metals, and organics, and it is proposed that they be treated at the DOE Toxic Substances Control Act of 1976 Incinerator in Oak Ridge, Tennessee.

1.4 WASTE TRANSPORTATION

Waste will generally be transported by truck but may also be transported by rail or intermodal carrier when advantageous. Characterized DMSA wastes would be transported with similar wastes.

1.5 WASTE DISPOSAL

DOE's proposed action for waste disposal varies by waste type. The characteristics of the waste govern where and how each waste type may be disposed. The volume of wastes to be transported from the Paducah Site to each proposed receiving facility represents only a small portion of the total waste each facility receives annually. For example, it has been proposed that approximately 3750 m^3 (132,430 ft^3) of radiological PCB wastes be shipped to the Envirocare facility in Utah over the 10-year evaluation period. This results in an average of 375 m^3 (13,243 ft^3) per year. The Envirocare facility annually receives 9061 m^3 (320,000 ft^3) of waste; therefore, the annual Paducah Site shipment will represent less than 5 percent of the facility's capacity in any given year. The preferred alternative for each waste type is listed below.

Capacitors containing PCBs are proposed for shipment to Deer Park, Texas, for treatment and disposal. Thirteen empty transformers would be shipped for off-site treatment and disposal as well. These transformers contain some residual PCB contamination.

Approximately 4600 m^3 (60,166 yd^3) of LLW would be disposed, primarily at the Nevada Test Site. Only the LLW water waste stream consisting of 52 m^3 (1836 ft^3) of waste would be treated and disposed on-site. The wastewater, which has some uranium contamination, would be treated until the KPDES limits had been met; this waste would then be discharged at a permitted on-site outfall. In addition to these wastes, there are 22 T-Hoppers (5-ton containers) of UF4 stored at the site. If it is determined that this material is a waste, it would likely be shipped as a LLW to the Nevada Test Site.

Some MLLW would be shipped to Envirocare for treatment and disposal. Approximately 160 m^3 (5650 ft^3) would be shipped to one or more of the Broad Spectrum Contractors (i.e., Waste Control Specialists LLC, Andrews, Texas; Allied Technology Group, Richland, Washington; Materials and Energy/Waste Control Specialists, Oak Ridge, Tennessee).

Approximately 6 m^3 of TRU liquids and solids are proposed for treatment on-site and shipment to the TRU Waste Program at Oak Ridge National Laboratory for ultimate disposition. Impacts associated with further processing and shipment to the Waste Isolation Pilot Plant near Carlsbad, New Mexico, are addressed in the final environmental impact statement for treating TRU and alpha LLW (DOE 2001a).

1.6 SUPPORTING ACTIVITIES

The proposed action for supporting waste disposition activities is to perform these activities in accordance with DOE orders, federal and state regulations, and approved Bechtel Jacobs Company LLC (BJC) or BJC subcontractor procedures. These activities are performed mainly during waste management and maintenance at the Paducah Site. Applicable procedures are implemented to ensure that activities are performed in a safe and accountable manner. Examples of supporting activities include, but are not limited to, the following:

- waste staging,
- on-site waste movement,
- packaging/repackaging,
- sorting,
- waste container decontamination,
- inspection,
- marking/labeling,
- characterization, and
- facility modifications or upgrades.

2. STATUS AND BIOLOGY OF THE LISTED SPECIES

As reported in the Biological Assessment (BA) for the Paducah C-746-U Landfill Implementation of the Authorized Limits Process, informal consultations regarding the Indiana bat (*Myotis sodalis*) were conducted in May 2001 with the U.S. Fish and Wildlife Service (FWS), Kentucky Department of Fish and Wildlife Resources (KDFWR), and the Kentucky State Nature Preserves Commission (KSNPC) to ascertain the potential presence of any listed species. The FWS identified the Indiana bat as a Federally endangered species that could potentially occur near the site (FWS 2001). The Indiana bat is also listed as an endangered species by the Commonwealth of Kentucky. The KSNPC reported an occurrence of the Indiana bat in McCracken County (2000), but not at the Paducah site (DOE 2001a). This reported occurrence in McCracken County, a result of mist netting, was made in June 1991 and was on West Kentucky Wildlife Management Area (WKWMA) land in the Joppa Quadrangle near the Shawnee Steam Plant (Hines 2001). More recently, five individuals of the Indiana bat, *Myotis sodalis*, were captured in riparian hardwood habitat of the lower downstream reaches of Bayou Creek in the WKWMA during mist netting surveys in 1999 (KDFWR 2000). These locations were to the north of the Paducah Site. No mist net surveys have been conducted within the Paducah Site fence.

The KSNPC also reported the presence of the orange-footed pimpleback (*Plethobasus cooperianus*), pink mucket pearly mussel (*Lampsilis arbrupta)*, ring pink (*Obovaria retusa*), fat pocketbook (*Potamilis capax*) in the vicinity of Ohio River miles 945 through 949. Most recent observations of these species in the area occurred between 1992 and 1999 (KSNPC 2000).

As a result of these sightings, DOE has prepared this BA considering potential impacts of the proposed action to the Indiana bat, orange-footed pimpleback, pink mucket pearly mussel, ring pink, and fat pocketbook.

2.1 INDIANA BAT (MYOTIS SODALIS)

The general ecology of the Indiana bat is summarized as follows. Unless otherwise noted or referenced, general biological information on the species is derived from Harvey (1992 and 1999) and Webb (2000).

The range of the endangered Indiana bat is the eastern United States from Oklahoma, Iowa, and Wisconsin east to Vermont and south to northwestern Florida. Distribution is associated with major cave regions and areas north of cave regions. The present total population is estimated at ca. 352,000 with more than 85 percent hibernating at only nine locations - two caves and a mine in Missouri, three caves in Indiana, and three caves in Kentucky.

Indiana bats forage in and around tree canopies of floodplain, riparian, and upland forest. In riparian areas, Indiana bats primarily forage around and near riparian and floodplain trees (e.g., sycamore, cottonwood, black walnut, black willow, and oaks), and solitary trees and the forest edge on the floodplain. Streams, associated floodplain forests, and impounded bodies of water (e.g., ponds, wetlands, reservoirs) are the preferred foraging habitat for pregnant and lactating Indiana bats, some of which may fly up to 1.5 miles from upland roosts. Indiana bats also forage within the canopy of upland forests, over clearings with early successional vegetation (e.g., old fields), along the borders of croplands, along wooded fencerows, and over farm ponds in pastures. Indiana bats return nightly to their foraging areas. Indiana bats feed strictly on flying insects and their selection of prey items reflects the environment in which they forage. Both aquatic and terrestrial insects are consumed. Moths, caddisflies, flies, mosquitoes, and midges are major prey items. Other prey include bees, wasps, flying ants, beetles, leafhoppers, and treehoppers.

Indiana bats hibernate in limestone caves from October to April, depending upon climatic conditions. Indiana bats usually hibernate in large, dense clusters of up to several thousand individuals in sections of the hibernation cave where temperatures average 38 to 43°F and with relative humidities of 66 to 95 percent. Bat clusters may contain 300 to 384 bats per square foot. The bats leave the caves and migrate to summer roosts in mid-spring.

Summer roosting-habitat criteria for Indiana bats are frequently revised as more is discovered about this species' habits. The most recent information applicable for the region is available from the FWS Cookeville Office (Components of Suitable Habitat for the Endangered Indiana Bat). In general, Indiana bats establish summer maternity and sometimes male night roosts or bachelor colonies under the loose bark of large, usually hardwood trees (> 20 cm diameter). Indiana bats have been observed to return to the same roosting and foraging habitat year after year. Indiana bats forage at night and feed on insects.

Female Indiana bats depart the caves before the males and arrive at summer maternity roosts in mid-May. A single offspring, born in June, is raised by the mother under loose tree bark, primarily in wooded streamside habitat. Mothers and babies reside in maternity colonies that use multiple, primary roost trees throughout most of the summer. Secondary roosts are used intermittently by some of the bats, particularly during periods of extreme precipitation or extreme temperatures. Thus, there may be more than a dozen roosts used by some Indiana bat colonies (FWS 1999a). Kurta et al. (1996) found that female Indiana bats may change roosts about every three days, and a group of these bats may use more than 17 different trees in a single maternity season. They depart the summer roosts for hibernation caves in September. The summer roost of the adult males is often near the maternity roost, although a few males do stay in caves over the summer.

The first maternity colony was discovered in 1974 under the loose bark on a dead butternut hickory tree in east-central Indiana. The colony numbered about 50 individuals and also used an alternate roost under the bark of a living shagbark hickory tree. The total foraging range of the colony consisted of a linear strip along approximately 0.5 miles of creek. Foraging habitat was confined to air space from 6 ft to ca. 95 ft high near the foliage of streamside and floodplain trees. Two additional colonies were discovered during subsequent summers, also in east-central Indiana. These had estimated populations of 100 and 91 respectively, including females and pups. Habitat and foraging areas were similar to the first colony discovered. Evidence gathered during recent years indicates that, during summer, Indiana bats are widely dispersed in suitable habitat throughout a large portion of their range. Additional maternity colonies have been discovered using radiotelemetry techniques in more recent years. Data thus far reinforce the belief that floodplain forest is an important habitat for Indiana bat summer populations. However, colonies have been located in upland and in coniferous habitats as well.

A longevity record of 13 years and 10 months has been recorded for the Indiana bat. Hibernating bats leave little evidence of their past numbers; thus, it is difficult to calculate a realistic estimate of the population decline for this species. However, population estimates at major hibernacula indicated a 34 percent decline in the total Indiana bat population from 1983 to 1989.

2.2 PINK MUCKET PEARLY MUSSEL (*LAMPSILIS ARBRUPTA* SAY-1831; ALSO CALLED *L. ORBICULATA* HILDRETH-1828) (Conservation Management Institute 2001, EPA 2001)

The Federally endangered pink mucket pearly mussel (41 FR 24062; June 14, 1976) is a bivalve aquatic mollusk in the Unionidae family with an elliptical-shaped shell. The species is generally about 10.2 cm (4 inches) long, 6.1 cm (2.4 inches) wide, and 7.6 cm (3 inches) high. The valves are heavy and thick. The species is sexually dimorphic, with both males and females having rounded anterior margins, but males having a pointed posterior margin and females a truncated, expanded posterior to accommodate the gravid condition. Young mussels have a yellow to brown shell that is smooth and glossy with green rays, while older specimens are dull brown. The nacre color varies from white to pink, with the posterior margin being iridescent.

The early life stage of the mussel, glochidium, is an obligate parasite on the gills or fins of fish, but the required fish host species are unknown. The adult mussels are filter feeders and consume particulate matter that is suspended in the water column. Identifiable stomach contents from mussels invariably include mud, desmids, diatoms, protozoa, and zooplankton. However, studies on the food habits for this species have not been conducted, so its specific food requirements are not known. The species has no known commercial value. The reproductive cycle of the pink mucket is presumed to be similar to that of other freshwater mussels. Males release sperm into the water column, which is then taken up by the females during siphoning and results in the eggs being fertilized. The embryos develop into the glochidia inside the female and are then released into the water column. The glochidia must then attach to suitable fish hosts for metamorphosis to the free-living juvenile stage. There is no information on the population biology of this species.

The pink mucket is found in medium to large rivers. It seems to prefer larger rivers with moderate- to fast-flowing water, at depths from 0.5 to 8.0 m (1.6 to 26.2 ft). The species has been found in substrates including gravel, cobble, sand, or boulders. Silt clogs the species' siphon, so silty substrates and water columns are not conducive to the species being present. Habitat of the glochidia is initially within the gills of the female, then in the water column, and finally attached to a suitable fish host. Habitat requirements for the juvenile stage are unknown. Any alteration of the life-stage-specific habitats during the pink mucket's lifecycle would likely affect the long-term success of a population. In addition, impoundments and surface water contaminants are known to adversely affect this species and contribute to its decline in numbers.

Currently, the pink mucket is known in 16 rivers and tributaries from 7 states, with the greatest concentrations in the Tennessee (Tennessee, Alabama) and Cumberland (Tennessee, Kentucky) rivers and in the Osage and Meramec rivers in Missouri. Smaller populations have been found in the Clinch River (Tennessee); Green River (Kentucky); Ohio River (Illinois); Kwanawha River (West Virginia); Big Black, Little Black, and Gasconde rivers (Missouri); and Current and Spring rivers (Arkansas).

2.3 ORANGEFOOT PIMPLEBACK (*PLETHOBASUS COOPERIANUS*) (IDNR 2001)

The Federally endangered orangefoot pimpleback mussel (a.k.a orangefoot pearly mussel) is a bivalve aquatic mussel in the Unionidae family with a round-shaped shell. The shell is thick, moderately inflated to compressed, and contains pustules on the posterior three-fourths of the shell. The anterior end of the shell is rounded whereas the posterior end is rounded to bluntly pointed. The mussel is light brown in color in small specimens, becoming chestnut or dark brown in color in larger individuals. The beak cavity is very deep. The nacre is white, usually with pink or salmon tinge near the beak cavity. Length ranges up to 4 inches (10.2 cm). The foot of living specimens is orange in color.

Specific reproductive or other life history information for this species was not found in the literature. However, the reproductive cycle is presumed to be similar to that of other freshwater Unionidae mussels, as previously described for the pink mucket pearly mussel.

The orangefoot pimpleback mussel prefers large rivers with gravel or mixed sand and gravel substrates. This species does not tolerate silty conditions.

Information on this species' historical range was not found in the literature by searching the Internet using the keywords "orangefoot pimpleback." Current range of this species includes the Ohio River in reaches adjacent to Ohio, Indiana, Illinois, and Kentucky.

2.4 RING PINK (OBOVARIA RETUSA)

The ring pink mussel was listed as an endangered species without critical habitat on September 29, 1989 (54 FR 40109). The FWS (FWS 1991) formerly referred to this mussel as the golf stick pearly mussel. The ring pink mussel is one of the most endangered mussels because all of the known populations are apparently too old to reproduce. The ring pink has a medium to large shell that is ovate to subquadrate in outline. The exterior of the shell lacks rays and is yellow-green to brown in color, while older specimens are usually darker brown or black. The nacre of the shell is usually salmon to deep purple in color surrounded by a white border.

The food habits of this species are unknown, but it likely feeds on detritus, diatoms, phytoplankton, and zooplankton. These food items are common for most freshwater mussels (FWS 1991).

The reproductive biology for the ring pink is essentially unknown, but it likely reproduces similarly to other freshwater Unionidae mussels as described above for the pink mucket pearly mussel. The fish host(s) for the ring pink and habitat utilized by the juvenile mussels are unknown.

This mussel is characterized as a large-river species (FWS 1991). The mussel inhabits the sandy and gravelly but silt-free bottoms of large rivers and prefers rather shallow water depths (2 ft deep).

Historically, this mussel was widely distributed and found in several major tributaries of the Ohio River, including those that stretched into Alabama, Kentucky, Illinois, Indiana, Ohio, Pennsylvania, and West Virginia. However, the species was last taken in Pennsylvania in 1908, and in Ohio in 1938 (FWS 1991). According to records, this species has not been collected in Indiana in decades, and has not been collected from Illinois in over 30 years (FWS 1991). Most of the historically known ring pink mussel populations were apparently lost due to conversion of many sections of the large rivers to a series of large impoundments. The ring pink mussel does not survive in impounded water habitats.

The ring pink mussel is presently known from only five river reaches, including two in Kentucky, two in Tennessee, and one in West Virginia. In Kentucky, the ring pink mussel in recent years has only been taken from the Tennessee River in McCracken, Livingston, and Marshall Counties, and from the Green River in Hart and Edmonson Counties. Only two live specimens have been collected from the Tennessee River population in recent years; one in 1985 and one in 1986. The last live specimen from the Green River was collected in the mid-1960s. Two fresh-dead specimens were collected in the Green River (one in 1987, the other in 1989) in the reach between Munfordville and Mammoth Cave National Park.

According to the Recovery Plan for Ring Pink Mussel (FWS 1991), total recovery of this species is considered unlikely because none of the five extant populations are known to be reproducing. Therefore, unless reproducing populations can be found or methods can be developed to maintain or create new populations, the species will be lost in the foreseeable future.

2.5 FAT POCKETBOOK (*POTAMILIS CAPAX*) (Earth's Endangered Creatures 2001, IDNR 2001)

The fat pocketbook mussel was listed as a Federally endangered species in 1976 (41 FR 24064). Green first described the mussel in 1832 under the name *Unio capax*. The genus was changed to *Lampsilis* by Smith (1899), then moved to the genus *Proptera* Ortman (1914). In 1969, Morrison noted that Rafinesque (1818) has named this genus *Potamilus*. Since 1988, the genus name for this species has been *Potamilus*.

The fat pocketbook mussel has a quite rounded and inflated shell that is thin to moderately thick. The shell is shiny and smooth, yellow to brown in color, and lacks any distinctive markings. It has an S-shaped hinge line that distinguishes it from similar species. The beak cavity is very deep. The nacre is white, sometimes tinged with pink or salmon color. Shell length is up to 5 inches (12.7 cm).

The reproductive biology for the fat pocketbook is essentially unknown, but it is likely similar to that of other members of the Unionidae as described above for the pink mucket pearly mussel. The fat pocketbook mussel is probably a long-term breeder and is reported gravid in June, July, August, and October (FWS 1989). The fish host species are not known but are likely large river species. Fish hosts known for other mussels of this genus include freshwater drum (*Aplodinotus grunniens*), white crappie (*Pomoxis annularis*), and blackstripe topminnow (*Fundulus notatus*).

The fat pocketbook mussel inhabits rivers and streams with sand, mud, or gravel substrates. It prefers slow-flowing water where depths range from a few inches to 8 ft. The mussel buries itself in these substrates with only the edge of its shell and its feeding siphons exposed.

There are few published records on the historical distribution of this species for the period prior to 1970. Museum records indicated that most fat pocketbook occurrences were from three areas; the upper Mississippi River (above St. Louis, Missouri), the Wabash River in Indiana, and the St. Francis River in Arkansas. There are a few historic records of this species occurring in the Illinois River, but is has not been found in recent years (FWS 1989).

Currently, the fat pocketbook in the mid-west is found only in the lower Wabash River in Indiana, the Ohio River adjacent to Kentucky, Indiana, and Illinois, and in the lower Cumberland River in Kentucky. Farther south, this species is known to exist in the St. Francis floodway (west of the flood control levee) from the confluence with the St. Francis River upstream to the confluence of Iron Mines Creek, and numerous drainage ditches associated with these streams in Arkansas (FWS 1989).

3. ECOLOGICAL DESCRIPTION OF THE SITE

The Paducah Site consists of existing industrialized areas of the Paducah Gaseous Diffusion Plant and is near the WKWMA on the site's western side. The majority of the fenced site has been cleared and, where vegetative cover is present, is maintained by mowing. Vegetation on the site consists of grasses and other herbaceous ground cover, which provides no foraging or roosting habitat for the Indiana bat.

The Paducah Site is located in the western part of the Ohio River Basin. The confluence of the Ohio and Tennessee rivers is approximately 16 km (10 miles) upstream of the site. The confluence of the Ohio River with the Mississippi River is approximately 32 km (20 miles) downstream of the site. All mussel species listed in the FWS letter are present in the Ohio River, upstream of the Paducah Site.

The Paducah Site is located on a local drainage divide; surface flow is to the east and northeast toward Little Bayou Creek and to the west and northwest toward Bayou Creek. The confluence of the creeks is approximately 5 km (3 miles) north of the site. Little Bayou Creek originates in the WKWMA and flows north toward the Ohio River along a 10.5-km (6.5-mile) course through the eastern portion of the DOE reservation. These tributaries are partially bordered by a thin riparian zone of plants. Trees, when present in close proximity to the site, mainly occur along the two tributaries, and are generally less than 20 cm in diameter at breast height and do not have loose bark as required by roosting Indiana bats. The riparian area could provide foraging habitat but no roosting habitat for the Indiana bat. No mussel species of concern have been identified in the tributaries.

Although the site has no hibernating, roosting, or foraging habitat as described above, the creeks within an expanded area around the site do provide Indiana bat summer foraging habitat. No maternity roosts have been located on the WKWMA, but five individuals, including three juveniles, were captured in the WKWMA during mist netting surveys in 1999 (KDFWS 2000) and a single specimen was reported in 1991 (KSNPC 2000).

The nearby WKWMA consists primarily of stands of bottomland hardwoods interspersed with upland hardwoods and old fields. Potential summer roosting and foraging habitats for the Indiana bat are present in the WKWMA, although most trees are less than 20 cm in diameter (see reported identifications below). The Bayou Creek (formerly known as Big Bayou Creek) is the nearest blue-line stream in the area; the nearest of its tributaries to the site are on the western side of the WKWMA.

4. POTENTIAL IMPACTS TO INDIANA BAT

The proposed action would not entail alteration or loss of bat habitat because it would take place at an existing site using existing buildings. Procedures for waste management and maintenance are governed by standard operating procedures and are routinely followed. Opportunities for bats to come into contact with the waste, either directly or indirectly, are nonexistent since the wastes are contained within storage facilities. During waste disposition activities that would occur outside, such as transport, the waste would be properly packaged and covered; thus, not providing access to bats or insects on which the bats may feed.

The only scenario that could result in exposure of bats to the wastes would be an accidental release of wastes into the environment. Risks to terrestrial biota resulting from site accidents are addressed in the EA for Waste Disposition Activities at the Paducah Site and are summarized as follows.

The scenario for chronic radionuclide exposure as a result of the modeled worst-case spill indicated that the sum of chronic terrestrial exposures would be about 7×10^{-10} of the tolerable daily radiation dose as indicated by no-further-action (NFA) levels; therefore, in even this worst-case accident scenario, long-term radiation effects to soil biota would be negligible.

Two organics (PCB and 1,2,4-trichlorobenzene) and two inorganics (cadmium and chromium) have modeled concentrations that exceed the NFA benchmarks. This indicates that these constituents would likely pose adverse impacts to soil biota if the worst-case spill accident occurred. However, any insects which the bats may eat could only ingest or come into contact with the waste if they were present on the exact location where the accident occurred. These insects would then need to be available as prey for the bats, or as prey for other insects that the bats forage on, in order for radioactivity from waste to be ingested by an Indiana bat.

5. POTENTIAL IMPACTS TO MUSSELS

Potential impacts of the proposed action were evaluated for the orangefoot pearly mussel, as well as for aquatic biota, and presented in the EA for Waste Disposition Activities at the Paducah Site (DOE 2001b). The EA concluded that none of the seven radionuclide or nine chemical contaminants exceeded radiological or toxicological benchmarks for aquatic biota as a result of any waste storage, water treatment, waste disposal, or supporting activities associated with the proposed action. The EA stated that during a worst-case accident scenario (earthquake), sufficient PCBs potentially could reach the Ohio River and slightly exceed the toxicological benchmark for aquatic biota. However, the modeled PCB concentration for the earthquake accident scenario was very conservative because it assumed that all of the PCB released during the accident made its way from the Paducah site into the Ohio River, which is nearly 5 miles downstream along Bayou Creek. In addition, the contaminants would be diluted and represent a negligible addition to those already in the Ohio River. The EA concluded that the addition of contaminants from the worst-case accident would result in sediment concentrations within the measured variability reported for Ohio River sediments. As a result, the EA concluded that the contaminants reaching the Ohio River from the Proposed Action and the worst-case accident scenario would cause negligible adverse impacts to the orangefoot pearly mussel as well as other aquatic biota.

Additional evidence indicates that the four endangered mussels addressed in this BA are at a negligible risk of adverse impact from the Proposed Action. None of the four endangered mussels are known to occur on the Paducah Site where the proposed action activities would take place. In addition, none of the endangered mussels occur in Bayou Creek or Little Bayou Creek because these creeks are too small to provide the necessary habitat requirements for the mussels. This is fortunate because aquatic biota in these two creeks could be adversely impacted during the worst-case accident scenario due to the caustic nature of the waste. The only waterbody that potentially could harbor the four endangered mussels and potentially be impacted from the proposed action is the Ohio River. As previously stated, the EA (DOE 2001b) indicated that potential adverse impacts to the orangefoot pearly mussel in the Ohio River downstream of the confluence of Bayou Creek should be negligible to non-existent. Thus, the similarity of the known life history and habitat requirements for the four Unionidae endangered mussels makes it reasonable to conclude that the pink mucket, ring pink, and fat pocketbook mussels are also not at risk of adverse impacts from the proposed action.

6. CONCLUSION

The project, as proposed, would be unlikely to adversely affect the Indiana bat or any mussel species of concern because

- while a potential for exposure of the bat and mussel species to waste as a result of an accident during implementation of the proposed action would be small and there is nothing conclusive to indicate that such exposure would be detrimental to the species;
- proposed waste disposition activities are currently being performed at the Paducah Site with no known detriment to the local Indiana bat or mussel populations. The numbers of Indiana bats caught from mist netting in the area has risen from 1 in 1991 to 5 in 2000 and mussel species have been sampled on the opposite side of the Ohio River as recently as 2000;
- no bat foraging or roosting habitat is present inside the site fence and would not be affected by routine waste disposition operations;
- the majority of mussel habitat in the area has been identified up stream from the Paducah site; no mussel habitat exists inside the site fence and would not be affected by routine waste disposition operations;
- bat foraging habitat (riparian vegetation along intermittent tributaries) present near the site of the proposed action is unlikely to become contaminated;
- routine waste management operating procedures would leave minimal opportunity for direct exposure of local biota, including Indiana bats and their prey, to wastes. This practice would also decrease the probability of accidents; and
- no bat or mussel habitat alteration or destruction would occur as a result of the proposed action.

7. REFERENCES

Conservation Management Institute 2001. http://fwie.fw.vt.edu/WWW/esis/lists/e404009.htm

DOE (U.S. Department of Energy) 2001a. *Draft Environmental Assessment on the Implementation of the Authorized limits Process for Waste Acceptance at the C-746-U Landfill, Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, March.

DOE 2001b. *Environmental Assessment for Waste Disposition Activities at the Paducah Site Paducah, Kentucky*, DOE/EA-1339, Office of Environmental Management, Oak Ridge, TN.

Earth's Endangered Creatures 2001. wysiwyg://65/http://www.geocites.com/endangeredsp/NAmericaFSO10.html

EPA (U.S. Environmental Protection Agency) 2000. http://www/epa/gov/espp/arkansas/seviert.htm

FWS (U.S. Fish and Wildlife Service) 1989. *Recovery Plan for the Fat Pocketbook Pearly Mussel Pink Mussel (Potamilus capax) (Green 1832)*, Atlanta, GA, 22 pp.

FWS 1991. *Ring Pink Mussel Recovery Plan*, Atlanta, GA, 24 pp.

FWS 2001. Letter from Dr. Lee A. Barclay, FWS, to Dr. James L. Elmore, DOE, September 25.

Harvey, M. J., J. S. Altenbach, and T. L. Best 1999. *Bats of the United States*, Arkansas Game and Fish Commission and U.S. Fish and Wildlife Service, 64 pp.

Harvey, Michael J. 1992. *Bats of the Eastern United States*. Arkansas Game and Fish Commission and U.S. Fish and Wildlife Service, 46 pp, February.

Hines, Sarah 2001. Personal communication regarding a reported sighting of *Myotis sodalis* between Sarah Hines, Data Specialist, Kentucky State Nature Preserves Commission and Anne Dickie, Scientist, Tetra Tech, Inc., July 9.

IDNR (Illinois Department of Natural Resources) 2001. http://www.inhs.uiuc.edu/cbd/musselmanual/page54_5.html

KDFWR (Kentucky Department of Fish and Wildlife Resources) 2000. James S. Lane, Jr., Author. *Mist Net Surveys for the Indiana Bat (Myotis sodalis) at West Kentucky Wildlife Management Area Paducah, Kentucky*, February.

KSNPC (Kentucky State Nature Preserves Commission) 2000. *Monitored Species of McCracken County Kentucky*. Online reports at http://www.kynaturepreserves.org accessed June 25, 2001.

KSNPC 2000, Kentucky State Nature Preserves Commission. Response to Data Services Request from SAIC. Request number 01-078. November, 14, 2000.

Kurta et al. 1996. *Ecological, Behavioral, and Thermal Observations of a Peripheral Population of Indiana Bats (Myotis sodalis)*. Pages 102-117 in R. M. R. Barclay and R. M. Brigham, editors, *Bats and Forests Symposium*, Research Branch, Ministry of Forests, Province of British Columbia, Victoria, British Columbia.

Webb, Warren 2000. *Biological Assessment NABIR Project, Selection and Operation of the Proposed Field Research Center on the Oak Ridge Reservation*, February.

THIS PAGE INTENTIONALLY LEFT BLANK.

APPENDIX G

ANALYSIS OF ACCIDENT IMPACTS TO HUMANS

THIS PAGE INTENTIONALLY LEFT BLANK.

APPENDIX G

ANALYSIS OF ACCIDENT IMPACTS TO HUMANS

An analysis has been performed to evaluate the potential consequences and risks of accidents affecting the polychlorinated biphenyl (PCB), low level radioactive waste (LLW), Mixed LLW, and transuranic (TRU) wastes currently stored at the Paducah Gaseous Diffusion Plant (PGDP). As previously discussed, two waste disposition options are being considered:

- **Proposed Action (Treatment and Disposal Alternative)** – All wastes are to be treated and disposed over a 10-year period. In this option, wastes may be disposed of on-site following on-site treatment if required or shipped off-site for treatment and/or disposal following on-site treatment if required. In either case, at the end of the 10 year period the risk due to on-site accidents is eliminated

- **No Action Alternative –** The wastes are to be packaged and stored on-site for an indefinite period of time. For purposes of this analysis, a 100-year institutional period of control is assumed. During this period, the stored wastes would be inspected and deteriorated waste packages replaced as required.

For each of these alternatives, accidents are postulated and the consequences and risks evaluated. The types of accidents considered include natural phenomena, process accidents such as vehicle impacts and dropped waste packages, and industrial accidents. Consequences include radiological exposure, toxic chemical exposure, and industrial hazards leading to injuries and fatalities.

The methodology, waste characterization, and the analysis of accidents affecting the two alternatives are discussed in the following sections.

G.1 METHODOLOGY

The estimated accident consequences were based on the inventories and material characteristics of the wastes stored on the PGDP site. Methods used to evaluate the significance of the potential adverse effects from postulated accidents are listed below.

- Estimated the frequencies of potential accidents occurring for the two alternatives.
    - "anticipated" accidents have a frequency of greater than 1 in 100 per year ($>1 \times 10^{-2}$ per year);
    - "unlikely" accidents have a frequency ranging between 1 in 100 to 1 in 10,000 per year (1×10^{-2} to 1×10^{-4} per year); and
    - "extremely unlikely" accidents have a frequency ranging between 1 in 10,000 to 1 in 1,000,000 per year (1×10^{-4} to 1×10^{-6} per year). Accidents having estimated frequencies less than 1×10^{-6} per year were not considered credible as evaluation basis events, and were not evaluated.
- Quantified the estimated amount of any release to the environment resulting from an accident.
- Quantified the radiological dose to a maximally exposed individual (MEI) at the PGDP boundary, 1580 m from the release, and the radiological doses to the surrounding public populations within 50 miles of the site due to the releases.

- Evaluated the radiological effects of accidents on workers:

  — Quantified the inhalation doses to maximally exposed, non-involved workers at 100 m (or more) from the release point. For fire accidents, a plume rise of 50 feet or 15 m was assumed. Given an elevated release, the maximum ground level concentration and dose occur 500 m from the accident location.

- Qualitatively evaluated the accident effects on involved facility workers:

  — Administrative controls would be in place to protect workers.

  — Workers in process areas are expected to have appropriate breathing and other protective clothing and equipment. These workers are expected to evacuate the vicinity of an accident without important consequence.

  — Workers away from process activities are considered non-involved unless they are performing specific tasks with appropriate protective equipment.

  Based on these assumptions, the risk to involved workers is maintained acceptably low by the use of appropriate protective equipment and risk is not analyzed or discussed further.

- Determined the health consequences associated with the doses in terms of "Latent Cancer Fatalities" (LCF) for populations and probability of cancer fatalities for individuals that would result from the exposures and doses. Cancer fatality consequences to the affected populations were based on the fatal cancer incidence rates of 4×10^{-4} LCF per person-rem in the worker populations and 5×10^{-4} LCF per person-rem in the off-site public. These risk factors also were applied to MEI and maximally exposed non-involved worker doses. The product of the dose and the fatal cancer incident rate is an estimate of the probability the exposed individual would experience a cancer fatality.

- Evaluated the effects of released toxic metals and other materials based on the potential for exceeding the Emergency Response Planning Guideline – Level 2 (ERPG-2) concentration (or estimated equivalent). This concentration defines the threshold for irreversible health effects.

- The risks of industrial accidents in each treatment alternative are computed in terms of expected fatalities. These risks are computed directly from the estimated labor (person-hours) per labor category in each treatment alternative defined in Section 4.13, Socioeconomic Impacts, and U.S. Department of Energy (DOE) estimates of the injuries and fatalities per person-hour. The DOE fatality rate for operations is 3.4×10^{-3}/200,000 person-hours (DOE 1999a).

- Risk was measured as the average consequence that accounts for both the consequence and likelihood of an accident. For example, an accident with a low likelihood and high consequence can have the same risk as an accident with a high likelihood and low consequence. For the comparison of accidents affecting the No Action and the treatment alternative, the risk measure selected is total expected fatalities. This risk is computed as the product of the accident frequency, the time period in which the accident can occur, and the computed consequence. The risk is used to compare the expectation of fatalities for the no action and the treatment alternative on a consistent basis.

$$Risk = Total\ Expected\ Fatalities = \frac{Accidents}{Year} \times \frac{Years}{Alternative} \times \frac{Cancer\ \ fatalities}{Accident}$$

G.2 WASTE CHARACTERIZATION

The wastes stored on the PGDP site consist of PCB containing capacitors and transformers, LLW, Mixed LLW, and TRU waste. The packaged wastes (excluding the capacitors and transformers) include approximately 600 m^3 of liquids, 350 m^3 of solid combustible wastes, and 10,700 m^3 of non-combustible solid wastes.

In general, the waste streams contain a mixture of radioactive isotopes and toxic metals. To evaluate the health impacts of releasing these wastes, a basis for summing the effects of individual isotopes or toxic metals is needed. The basis selected is to define a quantity of a characteristic isotope or toxic metal having the same health impact as the mixture. The selected characteristic isotope is 2% enriched uranium. For each individual isotope, the equivalent uranium activity in Ci is computed as the isotope activity times the ratio of dose conversion factor (DCF) of the isotope to the DCF for 2% enriched uranium, 2.64×10^6 rem/Ci. The individual activities in equivalent curies of uranium (Ci U) can be summed. As shown in Table 1.1, there is a total of 7830 equivalent Ci U in the 11,700 m^3 of waste.

A similar computation is performed for the toxic metals in the mixed LLW streams. In these streams, the specific metal contaminants are identified. Based on process knowledge, the concentration of each contaminant is estimated to be 5000 ppm. Chromium is the selected characteristic metal. The equivalent mass of chromium producing the same toxic effect is computed for each metal as the mass of the specific metal in the waste stream times the ratio of the metal's ERPG-2 to the ERPG-2 concentration for chromium, 1.5 mg/m^3. Similar to the equivalent uranium, the equivalent masses of chromium can be summed. The ERPG-2 concentration was selected as the toxicity characteristic since it is the threshold concentration for irreversible health effects following a one-hour exposure. An estimate based on Table 1.1 shows that the 11,700 m^3 of site wastes contain 1.5×10^8 equivalent g Cr.

G.3 ACCIDENT EVALUATION FOR THE PROPOSED ACTION

In the Proposed Action, the wastes are stored pending on-site treatment, on-site disposal, or shipment off-site for treatment or disposal. The types of activities associated with these actions include storage of waste containers, mechanical handling of steel waste containers, and opening of waste containers under controlled conditions to allow treatment (e.g. solidification of liquids, grouting). The general approach to performing the analysis is to postulate accidents, associated with the expected activities that have the potential to breech the steel waste containers and release the contents. Once released, the accidents are postulated to suspend a fraction of the wastes the air or surface waters. The suspended wastes are then transported to individuals and populations. The dose consequences to these individuals and populations are evaluated assuming no mitigation (i.e., no evacuation or sheltering).

G.4 ACCIDENT SELECTION

The following accidents are postulated for evaluation:

- The earthquake, as shown in Table D.1, affects all stored containers. The evaluation-basis earthquake (EBE) is a major earthquake used to evaluate the PGDPaducah Site facilities. This earthquake has a surface ground acceleration judged capable of toppling stacked drums and possibly ST-90 containers. A fraction of these toppled containers is postulated to partially fail.

Table G.1. Accidents with the potential to breech waste containers

Accident	Wastes affected	Estimated frequency
Evaluation-basis earthquake	All (12,000 m^3)	10^{-2} to 10^{-4}/year
Large aircraft impact and fire	10% (1200 m^3)	Not credible
General aviation impact and fire	2 m^3	10^{-4} to 10^{-6}/year
Ground vehicle impact/mishandling	1 m^3	$>10^{-2}$/year
Ground vehicle impact and fire	1 m^3	10^{-2} to 10^{-4}/year

- The large aircraft impact accident, if it occurred, would affect a large number of containers. In addition to mechanical damage, the released fuel could ignite the combustible wastes. The likelihood, however, of a direct impact of a large aircraft into the stored wastes is extremely small and is judged not credible based on comparisons of the aircraft impact frequencies affecting the large Paducah Site buildings. Based on the extremely low likelihood of this accident and on the fact that the consequences are judged comparable to the much more likely EBE, the large aircraft accident is not considered further.

- In contrast to the large aircraft impact accident, general aviation (small aircraft) impacts are more likely. Although the number of boxes affected would be small with respect to the earthquake, the consequences might be notable if a container were affected that had high-radionuclide-concentration, combustible wastes. As shown in Table 1.1, however, the radionuclide and toxic metal concentrations in combustible wastes are negligible with respect to other constituents. The mechanical damage to other waste forms would be comparable to the more likely vehicle impact and mishandling accidents. Based on the limited source terms and the low probability of the event, general aviation impact accidents are not considered further.

- As in the case of the small aircraft impact, a ground vehicle accident could breech one or more containers and possibly initiate a fuel fire. In general, the effects of a fire are not notable for most waste packages and vehicle impacts. However, the impact and fire accident could be postulated to breech the nearly empty PCB-containing transformers. In addition, mechanical impact accidents could release a limited quantity of high-activity wastes with a higher frequency than the EBE, and they are analyzed for this reason.

In summary, three bounding accidents have been selected for the evaluation of the proposed action: an EBE, a vehicle impact/container mishandling accident, and a vehicle impact accident and fire affecting a PCB-containing transformer.

G.5 WASTE CHARACTERIZATION AND STORAGE CONFIGURATION

The transformers and capacitors provide containment for the PCB oils within them. The listed mass is of the entire set of transformers and capacitors including the steel containers and the contained PCB oil. Individual capacitors contain approximately 2 gal of PCB oil each. The transformers are drained but can contain a residual quantity of up to 10% of the 1500 gal PCB oil capacity

The waste stream volumes of packaged wastes are directly estimated quantities. The waste stream masses are based on an assumed average density of similar wastes, 1 g/cc for liquids and soft solids and 2 g/cc for all other solids. For each isotope in the waste stream, the total isotopic activity is computed as the product of the total waste stream mass and the mean isotopic activity density. This isotopic activity is then converted to an equivalent activity of uranium and summed over all isotopes in each waste stream.

Similarly, the mass of each listed toxic metal is computed based on the waste stream mass and an assumed concentration of 5000 ppm for each metal. The mass of each metal is converted to an equivalent mass of chromium for each metal and summed over each metal in the waste stream.

The transformers are large steel shell containing the PCB oil. No additional packaging is assumed. Packaged wastes would be stored in steel containers ranging from 55 gal drums to sea-land containers. However, since the larger containers are difficult to topple and breech, all packaged wastes are assumed conservatively to be contained in 55 gal drums and stacked two high in a square array.

Four drums are assumed to be mounted on 4 foot by 4 foot pallets in double rows and stacked two containers high. To permit access to each container, a 16 foot aisle is assumed between each double row. Assuming an approximately square array, an array 180 m by 180 m is required to store the assumed 56,600 drums.

Some wastes are expected to be treated on-site or shipped off-site prior to the completion of the Proposed Action. However, for purposes of this analysis, all wastes are assumed to be at risk of accidental release and dispersion over the entire 10-year processing period.

G.6 ANALYSIS OF THE EVALUATION BASIS EARTHQUAKE ACCIDENT

In the event of a major earthquake, the horizontal surface acceleration is assumed capable of creating differential movement between the top and bottom box layers resulting in drums being toppled into the aisles. It is assumed that 10% of the entire upper layer of drums (2800 boxes) topple and fail. The 10% estimate is based on an evaluation of stacked 55 gal drums during seismic events (Hand 1998).

G.6.1 Radiological Source Term Computations

The physical characteristics of the packaged wastes vary importantly. However, for purposes of this analysis it is assumed that 10% of the entire radionuclide activity in the failed drums containing solids is in the form of a powder. Of this amount, 10% is released from the drum upon drum failure and subject to suspension in the air. For failed drums containing liquids, 10% of the drum inventory is assumed immediately released and subject to suspension in the air and the remaining inventory leaks onto the ground. The radioactive materials are assumed released proportionally from all waste streams and are assumed released uniformly over the entire 180 m by 180 m storage area.

The released radionuclides are assumed transported in the air and by surface waters to individuals and populations. The airborne source term (AST) is computed as the fraction of the released material that remains suspended as a respirable aerosol. For fine powders dropped 3 m, this fraction is empirically determined to be 6×10^{-4}; for liquids, this fraction is 1×10^{-4} (DOE-HDBK-3010, 1994). Summarizing, the AST is computed as:

$$\begin{aligned}
\text{AST} = {} & (\text{Total solid isotopic activity}) \times 5\%\ \text{Boxes Damaged} \times 1\%\ \text{Re leased as powder} \\
& \times 6 \times 10^{-4}\ \text{suspended in air} \\
& + (\text{Total liquid isotopic activity}) \times 5\%\ \text{Boxes Damaged} \times 10\%\ \text{Re leased} \\
& \times 1 \times 10^{-4}\ \text{suspended in air} \\
& = 3 \times 10^{-7} \times (\text{Total solid isotopic activity}) + 5 \times 10^{-7} \times (\text{Total liquid activity})
\end{aligned}$$

$$\text{AST} = 2.4 \times 10^{-3}\ \text{Ci U}$$

The surface water source term (LST) is computed similarly. In this case, it assumed that 100% of the released liquid radionuclides (i.e., that fraction not suspended as an aerosol) is transported to the Ohio River via the Little or Big Bayou creeks:

$$
\begin{aligned}
LST &= (Total\ isotopic\ activity\ ) \times 5\%\ Boxes\ Damaged \\
&= 8\ Ci\ U
\end{aligned}
$$

G.6.2 Radiological Dose Computations

The doses resulting from the AST and LST are computed as the product of a dispersion factor, an ingestion/inhalation rate, and the corresponding DCFs for U. These doses are computed assuming no action is taken to protect individuals or populations from exposure to the transported radionuclides.

Airborne doses are computed for a maximally exposed involved or uninvolved worker [maximally exposed involved worker (MIW) or maximally exposed uninvolved worker (MUW) at the downwind edge of the storage area, a MEI 1580 m from the area, and the surrounding population of 500,000 persons living within 50 miles of PGDP.

For individual doses, the atmospheric dispersion factor, χ/Q, is computed for a 180 m × 180 m square area source at the distances indicated. Using this method, the waste activities are assumed to be uniformly distributed over the area. These area χ/Q values are computed using standard methods (Turner, 1969). The individual doses are computed using a breathing rate of 1.2 m^3/hour or 3.33×10^{-4} m^3/s and the assumption that the individual remains in place for the entire time the wastes are being suspended and transported.

Population doses are computed based on the population dose model used in the *PGDP Environmental Report for 1991*. During 1991,a total source term of 0.0032 Ci of U, ^{99}Tc, ^{239}Pu, ^{237}Np, and ^{230}Th was released to the atmosphere. This source term is equivalent to an activity of 0.0061 Ci U. The total dose to the 500,000 persons living within 50 miles of PGDP was computed to be 0.0039 person-rem. On average, the population dose is proportional to the source term. As such, the population dose due to the earthquake can be computed as the ratio of the earthquake source term to the 1991 source term times the 1991 population dose. This reduces to the earthquake source term (Ci U) times 0.64 person-rem/Ci U.

The airborne source term doses, consequences, and risks are computed below. As discussed in Section 4.1.11, Methodology, risk is computed as the product of the earthquake median frequency, 1×10^{-3}/yr, the consequence, LCF, and the 10 year period of operation.

MIW/MUW at edge of area:

$\chi/Q = 1.8 \times 10^{-3}\ s/m^3$ (based on F stability, 1 m/s atmospheric conditions)

Dose $= AST \times \chi/Q \times$ Breathing Rate $\times$ DCF

$= 2.4 \times 10^{-3}$ Ci U $\times 1.8 \times 10^{-3}\ s/m^3 \times 3.33 \times 10^{-4}\ m^3/s \times 2.64\ 10^6$ rem/Ci U

$= 3.8 \times 10^{-3}$ rem or 3.8 mrem

MIW/MUW Consequence:

Consequence = Dose × Fatality rate

$= 3.8 \times 10^{-3}$ rem × 1 person × 4×10^{-4} LCF per person-rem

$= 1.5 \times 10^{-6}$ LCF

MIW/MUW Risk $= 1.5 \times 10^{-8}$ expected fatalities

MEI 1580 m from area:

$\chi/Q = 8.8 \times 10^{-5}$ s/m^3 (based on F stability, 1 m/s atmospheric conditions)

Dose = AST × χ/Q × Breathing Rate × DCF

$= 2.4 \times 10^{-3}$ Ci U $\times 8.8 \times 10^{-5}$ s/m^3 $\times 3.33 \times 10^{-4}$ m^3/s $\times 2.64\ 10^6$ rem/Ci U

$= 1.9 \times 10^{-4}$ rem or 0.19 mrem

MEI Consequence:

Consequence = Δοσε × Fatality rate

$= 1.9 \times 10^{-4}$ rem × 1 person $\times 5 \times 10^{-4}$ LCF per person-rem

$= 9.5 \times 10^{-8}$ LCF

MEI Risk $= 9.5 \times 10^{-10}$ expected fatalities

Population:

Dose = AST × 0.64 person-rem/Ci U

$= 2.4 \times 10^{-3}$ Ci U × 0.64 person-rem/Ci U

$= 1.5 \times 10^{-3}$ person-rem

Population Consequence:

Consequence = Dose×Fatality rate

$= 1.5 \times 10^{-3}$ person-rem $\times 5 \times 10^{-4}$ LCF per person-rem

$= 7.5 \times 10^{-7}$ LCF

Population Risk $= 7.5 \times 10^{-9}$ expected fatalities

Doses resulting from the liquid source term are computed based on the LST and a surface water transport model. Based on the 1991 Environmental Report, neither the Big or Little Bayou Creeks or the Ohio River within 4 miles of PGDP are used as a drinking water source. Furthermore, the major local population centers, Paducah, KY and Metropolis, IL are upstream of PGDP. It is assumed that a MEI downstream on the Ohio consumes surface water at a rate of 2 L/day. Populations using the Ohio River downstream of PGDP as a drinking water source are not known. Downstream of the confluence with the Mississippi River, the massive dilution is assumed to eliminate important population doses.

The entire LST is assumed suspended and mixed in the Ohio River over a 24-hour period. The Flowrate of the Ohio River at Metropolis, Il is 191,000 ft^3/s or 4.7×10^{11} L/24 h [U.S. Geological Survey (USGS) 2000]. The MEI ingestion dose is computed as the product of LST, the dilution in the Ohio River, the consumption volume, and the ingestion DCF:

MEI Dose = 8 Ci U × $(1/4.7 \times 10^{11}$ L/24 h) × 2 L/24 h × $2.6\ 10^5$ rem/Ci

$= 9 \times 10^{-6}$ rem or 0.009 mrem

MEI Consequence $= 9 \times 10^{-6}$ rem × 1 person $\times 5 \times 10^{-4}$ LCF per person-rem

$= 4.5 \times 10^{-9}$ LCF

MEI Risk $= 4.5 \times 10^{-11}$ expected fatalities

This dose and consequence are considered negligible even if a small downstream population did consume the untreated, contaminated water over the 24-hour period at risk.

G.6.3 Toxic Metal Source Term and Dose

The toxic metal source term is computed similarly to the radiological source term. However, no toxic metals were identified in liquid waste streams. As estimated from Table 1.1, the total toxic metal mass is 1.49×10^8 g Cr.

$$
\begin{aligned}
AST &= (Total\ toxic\ metal\ mass) \times 5\%\ Boxes\ Damaged \times 1\%\ \mathrm{Re}leased\ as\ \ powder \\
&\quad \times 6 \times 10^{-4}\ suspended\ in\ air \\
&= 3 \times 10^{-7} \times (Total\ toxic\ metal\ mass) \\
AST &= 45\ g\ Cr
\end{aligned}
$$

Assuming an 1- hour exposure period, the MIW and MUW would be exposed to a toxic metal concentration of:

$$
\begin{aligned}
Concentration &= \frac{45\ g\ Cr}{3600\ s} \times \chi / Q = 1.24 \times 10^{-2}\ g\ Cr / s \times 1.8 \times 10^{-3}\ s / m^3 \\
&= 2.2 \times 10^{-5}\ g\ Cr / m^3\ or\ 0.02\ mg\ Cr / m^3
\end{aligned}
$$

This concentration is negligible with respect to the 1.5 mg/m^3 ERPG-2 concentration for chromium. Based on this calculation, toxic metals would not be considered further.

G.7 ANALYSIS OF THE VEHICLE IMPACT ACCIDENT

During the storage period, it assumed that vehicles, such as forklift trucks, are used to reposition waste containers occasionally. Impacts with drums resulting in breech are assumed to occur at a rate of 1 in 10 years. Given an impact of a vehicle into the stored waste drums, it is assumed that one or more drums are breached. For the wastes stored at PGDP, 87% of the activity occurs in the single drum of ThF_4 and an additional 4% occurs in the 24 drums of TRU waste. The risks of accidents involving these wastes bound the risks of other waste streams.

The frequency of accidents involving these particular wastes includes the overall accident frequency, 1/yr, and the conditional probability of striking the particular waste form given an impact. The conditional probability of striking 1 drum out of 56,000 is 1.8×10^{-5} and 4.3×10^{-4} for striking one of the 24 drums of TRU. Based on this, impact accidents involving the ThF_4 drum occurs with a frequency of 1.8×10^{-5}/yr in the 10^{-4} to 10^{-6}/yr Extremely Unlikely frequency range and those impacting TRU waste drums occur with a frequency of 4.3×10^{-4}/yr in the Unlikely frequency range.

The source term for the ThF_4 release accident is based on the configuration of a glass container, within a steel container, within the drum. Given the accident it is assumed that 1% of the 8 lb of ThF_4 powder is released and a 6×10^{-4} fraction is suspended as a respirable aerosol. The AST for this accident is 0.041 Ci U.

For the TRU waste accident, it is assumed that 4 drums of the 10 solid TRU waste drums are impacted. As in the earthquake accident, 10% of the waste is assumed to be powder and 10% of the contents of each impacted drum is released. The AST for the TRU release is 3.8×10^{-4} Ci U.

The doses resulting from the ThF_4 release are computed similarly to the earthquake. For a single drum release, however, a point source versus area model is used. The distance to the MEI is 1580 m and the distance to the MUW is 100 m. In both cases F stability, 1 m/s atmospheric conditions are assumed. The MIW is assumed to have adequate protective equipment to allow rapid evacuation to an upwind location with minimal exposure. The MIW dose is assumed bound by the MUW dose. The MUW, MEI and population doses and risks are computed below. Risks are computed based on the 1.8×10^{-5}/yr frequency and an 10-year operating period.

MUW 100 m from release:

χ/Q = 3×10^{-2} s/m^3 (based on F stability, 1 m/s atmospheric conditions)
Dose = AST $\times$ χ/Q $\times$ Breathing Rate$\times$DCF
= 0.041 Ci U $\times$ 3×10^{-2} s/m^3 $\times$ 3.33×10^{-4} m^3/s $\times$ 2.64 10^6 rem/Ci U
= 1.1 rem

Consequence = 1.1 rem $\times$ 1 person $\times$ 4×10^{-4} LCF per person-rem
= 4.4×10^{-4} LCF

MUW Risk = 7.9×10^{-8} expected fatalities

MEI 1580 m from release:

χ/Q = 3.4×10^{-4} s/m^3 (based on F stability, 1 m/s atmospheric conditions)
Dose = AST $\times$ χ/Q$\times$Breathing Rate$\times$DCF
= 0.041 Ci U $\times$ 3.4×10^{-4} s/m^3 $\times$ 3.33×10^{-4} m^3/s $\times$ 2.64 10^6 rem/Ci U
= 1.2×10^{-2} rem or 12 mrem

Consequence = 1.2×10^{-2} rem $\times$ 1 person $\times$ 5×10^{-4} LCF per person-rem
= 6×10^{-6} LCF

MEI Risk = 1.1×10^{-9} expected fatalities

Population:

Dose = AST $\times$ 0.64 person-rem/Ci U
= 0.041 Ci U $\times$ 0.64 person-rem/Ci U
= 2.6×10^{-2} person-rem

Consequence = 2.6×10^{-2} person-rem $\times$ 5×10^{-4} LCF per person-rem
= 1.3×10^{-5} LCF

Population Risk = 2.3×10^{-9} expected fatalities

It is noted that the vehicle impact source term and consequence are a factor of 17 higher than those for the earthquake accident. This is due to the assumption that 5% of the drums are ruptured and would not necessarily include the ThF_4 drum. It is very likely that the very high activity concentration ThF_4

drum would not be stacked or otherwise placed in a vulnerable position. If it is assumed that the ThF_4 is damaged by the earthquake, the source term and consequence would be comparable to the impact accident source term and consequence. However, the frequency for this unique earthquake accident would decrease by a factor of 20 to the Extremely Unlikely category.

The doses resulting from the TRU release are computed using the same assumptions and χ/Q as the ThF_4 release. The MUW, MEI, and population doses and risks are computed below. The risks are based on a 4.3×10^{-4}/yr frequency and a 10-year operating period.

MUW 100 m from release:

Dose = 3.8×10^{-4} Ci U $\times$ 3×10^{-2} s/m^3 $\times$ 3.33×10^{-4} m^3/s $\times$ 2.64 10^6 rem/Ci U
= 0.01 rem or 10 mrem

Consequence = 0.01 rem $\times$ 1 person $\times$ 4×10^{-4} LCF per person-rem
= 4.0×10^{-6} LCF

MUW Risk = 1.7×10^{-8} expected fatalities

MEI 1580 m from release:

Dose = 3.8×10^{-4} Ci U $\times$ 3.4×10^{-4} s/m^3 $\times$ 3.33×10^{-4} m^3/s $\times$ 2.64 10^6 rem/Ci U
= 1.1×10^{-4} rem or 0.11 mrem

Consequence = 1.1×10^{-4} rem $\times$ 1 person $\times$ 5×10^{-4} LCF per person-rem
= 5.5×10^{-8} LCF

MEI Risk = 2.4×10^{-10} expected fatalities

Population:

Dose = 3.8×10^{-4} Ci U $\times$ 0.64 person-rem/Ci U
= 2.4×10^{-4} person-rem

Consequence = 2.4×10^{-4} person-rem $\times$ 5×10^{-4} LCF per person-rem
= 1.2×10^{-7} LCF

Population Risk = 5.2×10^{-10} expected fatalities

G.8 ANALYSIS OF THE VEHICLE IMPACT AND FIRE ACCIDENT

An impact of a gasoline powered truck or large forklift vehicle with a drained electrical transformer is assumed. The transformer is assumed punctured, and 10% of the 145 gal residual PCB oil residual volume coating the internal surfaces is released. The mass of PCB (assumed to be 100% Aroclor 1254) is:

Mass PCB = 145 gal $\times$ 3785 cm^3/gal $\times$ 1.5 g/cm^3 = 8.2×10^5 g

The accident is assumed to cause the release and ignition of the gasoline fuel which pyrolizes the released mass of PCB oil over an 1-hour period.

Two combustion products are formed. Essentially all of the chlorine (Aroclor 1254 is 54% Cl) is stripped and released as HCl. In addition, approximately 1% of the PCB forms a pyrolized mixture of PCB, dioxins, and furans. The toxicity of this substance, PCB-soot, has been independently characterized [Martin Marietta Energy Systems (MMES) 1994].

The masses of combustion products are:

Mass HCl $= 0.1 \times 8.2 \times 10^5$ g $\times 0.54 = 4.4 \times 10^4$ g HCl

Mass PCB-soot $= 0.1 \times 8.2 \times 10^5$ g $\times 0.01 = 8.2 \times 10^2$ g PCB-soot

The combustion of the PCB oil requires relatively large fire since PCBs are difficult to burn. The combustion products are assumed to rise to an elevation of 50 ft or 15 m before dispersing downwind. The maximum χ/Q for a 15 m elevated release, assuming F stability and 1 m/s conditions, is 5×10^{-4} occurring approximately 500m from the fire. The concentrations of these combustion products are:

$$C_{HCl} = \frac{4.4 \times 10^7 \ mg\ HCl}{3600\ s} \bullet 5 \times 10^{-4}\ s/m^3 = 6.1\, mg\ HCl/m^3$$

This concentration is 20% of the ERPG-2 concentration for HCl

$$C_{PCB-soot} = \frac{8.2 \times 10^5 \ mg\ PCB-soot}{3600} \bullet 5 \times 10^{-4}\ s/m^3$$
$$= 0.11\, mg\ PCB-soot/m^3$$

The no-observed-adverse-effect limit (NOAEL) for PCB-soot is 19 mg-min/m^3 or 0.3 mg/m^3 for 1 h. As indicated, the computed concentration is 37% of the NOAEL.

Based on these computed concentrations, the estimated health effects of PCB release accidents are small and recoverable for the MUW and negligible for the MEI 1580 m from the accident.

G.9 ACCIDENT EVALUATION FOR THE NO ACTION ALTERNATIVE AND COMPARISON OF RISKS TO THE PROPOSED ACTION

During the No Action Alternative, the packaged waste containers would be transported to an on-site location and stored. The containers would be inspected periodically to verity that the containers are intact and repaired if required. These containers would be subject to the same conditions as the stored containers in the Proposed Action. However, they would be at risk for a longer period of time.

The transformers are assumed to remain in place within the process buildings and not be subject to the risks of vehicle impacts and fires. In the event of an accident, the combustion products of fires would be held up in the buildings minimizing on-site and off-site consequences.

Similar to the Proposed Action, accidents are postulated with the potential to breech the steel containers of the stored wastes and release the contents. The waste characteristics and the accident consequence methodology are the same as discussed for the Proposed Action. The accident selection and analysis results are discussed in Section 4.2.11. The risks for both the Proposed Action and No Action Alternative are calculated and compared in Section 4.2.11.

G.9.1 Accident Selection and Analysis

The following accidents are selected for evaluation of the No Action Alternative based on the process discussed for the Proposed Action:

Accident	Wastes Affected	Estimated Frequency
Evaluation Basis Earthquake	all (12,000 m^3)	10^{-2} to 10^{-4}/year
Ground Vehicle Impact/Mishandling	1 m^3	$>10^{-2}$/year

As discussed above, the PCB containing transformers are assumed stored indoors and not subject to the hazards assumed in the Proposed Action. Since other packaged wastes do not have important radionuclide or toxic metal concentrations, fire accidents are not considered for the No Action Alternative.

In summary, two bounding accidents are selected for evaluation: an EBE and a vehicle impact/container mishandling accident. Since the waste characteristics and the accident scenarios are the same as those evaluated for the Proposed Alternative, the accident consequences are identical to those computed and discussed in Section 4.1.11. However, while the frequency of the earthquake accident is the same for both alternatives, the frequency of vehicle impact/mishandling accidents is much lower due to the lower activity level. It is estimated that vehicle impact/mishandling accidents occur with a frequency of 0.1/yr for the No Action Alternative versus 1/yr for the Proposed Action. The conditional probability of striking a particular drum or set of drums is the same as discussed for the Proposed Action: 1.8×10^{-5} for the ThF_4 drum and 4.3×10^{-4} for the TRU waste drums. The corresponding accident frequency for accidents involving these drums are, respectively, 1.8×10^{-6}/yr for the ThF_4 drum and 4.3×10^{-5}/yr for the TRU waste drums. The risks for the accidents occurring in the No Action Alternative are summarized below based on the revised accident frequencies and the 100-year institutional control period:

Earthquake:

MIW/MUW Risk = 1.5×10^{-7} expected fatalities
MEI Risk = 9.5×10^{-9} expected fatalities
Population Risk = 7.5×10^{-8} expected fatalities

Vehicle Impact/Mishandling-ThF_4 Container

MUW Risk = 7.9×10^{-8} expected fatalities
MEI Risk = 1.1×10^{-9} expected fatalities
Population Risk = 2.3×10^{-9} expected fatalities

Vehicle Impact/Mishandling-TRU Containers

MUW Risk = 1.7×10^{-8} expected fatalities
MEI Risk = 2.4×10^{-10} expected fatalities
Population Risk = 5.2×10^{-10} expected fatalities

As shown, the risks for the No Action Alternative increase for the earthquake by a factor of 10 due to the longer period at risk. However, the risks for the impact accidents remain the same due to the compensating longer risk period and lower annual frequencies. Similar to the risks for the Proposed Action, these risks are considered inimportant.

In contrast to the accident consequences affecting the waste packages, the consequences of industrial accidents are smaller on a yearly basis due to the smaller workforce required. During the No Action Alternative, it is assumed that the stored wastes are monitored for possible deterioration on a periodic basis. It is assumed that this activity requires 30 full-time employees or 60,000 person-hours/yr over the 100-year alternative duration. Based on the 3.4×10^{-3}/200,000 person-hours industrial fatality rate, 1.0×10^{-3} fatalities/yr. Over the 100-year duration of the No Action Alternative 0.1 fatalities are expected. This represents a factor of 5 increases in the risk over the Proposed Action due to the longer duration of No Action Alternative.

G.9.2 Comparison of Accident Risks

Risks have been computed for both process accidents and industrial accidents for the Proposed Action and the No Acton Alternatives. The highest radiological accident risk was 1.5×10^{-7} expected fatalities for the MIW/MUW at the edge of the waste storage area during and following an earthquake. This risk was computed for the 100 year No Action institutional period. The second highest risk, 7.9×10^{-8} expected fatalities, was computed for the Vehicle Impact/Mishandling accident impacting the ThF_4 Container during the 10 year Proposed Action operating period and during the 100 year No Action Alternative. The risks are the same for both alternatives due higher per year frequency but lower overall duration of the Proposed Action. These risks are inimportant.

The industrial accident risks, while higher than the radiological accident risks, were small. The computed risk for the Proposed Action was or 0.02 expected fatalities over the 10-year operating period. The corresponding industrial accident risk for the No Action Alternative was 0.1 expected fatalities over the 100-year institutional control period. Neither risk nor the difference between them is considered important.

G.10 REFERENCES

MMES (Martin Marietta Energy Systems, Inc.) 1994. *Guidance on Health Effects of Toxic Chemicals*, ES/CSET-20, Martin Marietta Energy Systems, Inc., Oak Ridge TN, February 1994.

Turner 1969. R. Bruce Turner, *Workbook of Atmospheric Dispersion Estimates*, U.S.H.E.W., 1969.

THIS PAGE INTENTIONALLY LEFT BLANK.

APPENDIX H

TRANSPORTATION ACCIDENT ANALYSIS

THIS PAGE INTENTIONALLY LEFT BLANK

APPENDIX H

TRANSPORTATION ACCIDENT ANALYSIS

H.1 METHODOLOGY

The RADTRAN computer code is used for risk and consequence analysis of radioactive material transportation. The RADTRAN computer code was developed at Sandia National Laboratory in Albuquerque, New Mexico. RADTRAN is used to calculate the dose to transportation workers and persons residing near or sharing transportation links with radioactive materials shipment routes. Exposures may also occur as a result of accidents. Accident-related doses are also computed using the RADTRAN code. The current version used in the Paducah Site ecological assessment is RADTRAN 5 (Neuhauser and Kanipe 2000).

Cargo-Related. Cargo-related accidents are accidents that directly involve the waste being transported. Impact to human populations resulting from cargo-related accidents arises from the radioactivity of the wastes. Radiation doses for population zones (rural, suburban, and urban) are weighted by the accident probabilities to yield accident risk using the RADTRAN 5.2 computer code. Differences in waste types result into different radioactive material characteristics under accident conditions. Characterization data for the representative waste types were developed based on Table 1.1. Transportation accidents are grouped into accident severity categories as described in NUREG/CR-4829 and NUREG-0170. The small percentage of accidents (<1 %) that could result in a breach of the shipping package is represented in a spectrum of accident severities and radioactive release conditions. RADTRAN uses these established severity categories and determines population radiological consequences weighted by the joint probability of 1) accident occurrence and 2) severity.

Radioactive material releases from transportation accidents were calculated by assigning release fractions (the fraction of the radioactivity that could be released in a given severity of accident) to each accident severity. These representative release fractions were identified based on the Idaho high-level waste and Facilities Disposition Draft Environmental Impact Statement. This methodology is consistent with U.S. Department of Energy’s (DOE's) methodology for waste-related transportation impact analyses in other environmental impact statements.

Collective doses were then used to determine human health effects in terms of latent cancer fatalities (LCFs) as recommended by the International Commission on Radiological Protection.

Vehicle-Related. Vehicle-related accidents are accidents not related to transportation of waste or materials but simply related to the number of miles traveled by vehicles and the risk of accidents occurring based accident statistics on a per state basis. Mileage through states along a given route were multiplied by state-specific accident and fatality rates to determine the potential numbers of route-specific accidents and fatalities.

H.2 RESULTS

H.2.1 Radiological and Nonradiological Impacts from Routine Truck Transportation of Waste

Radiological Impacts from Routine Highway Transportation. The potential effects of transporting waste by highway from Paducah to each of the potential final destination sites described in Sect. 2.1 were estimated for all three waste subgroups on an annual basis during the major shipment year groupings and on a total 10-year shipping campaign basis. Tables H.1 through H.9 present the estimated risks of shipping the three subgroups of waste to the specified destinations on both annual and 10-year bases for the shipping campaign presented in Table 3.4. The transportation analysis is representative of the various waste types being sent to the specified designations. Therefore, the impacts should not be compared among the various routes, but the overall impact should be evaluated as presented in terms of annual impacts and shipping campaign impacts.

Table H.1. Radiological impacts for truck shipments to Andrews, Texas

	Annual impacts		Total for 10-year life cycle	
Risk Group	Dose (person-rem)	LCF	Dose (person-rem)	LCF
Crew	0.4	1.5E-04	3.7	1.5E-03
Population[a]	0.2	8.5E-05	2.0	1.0E-03
MEI[b] (rem)	3.6E-06	1.8E-09	3.6E-05	1.8E-08

[a]Includes population dose receptors off-link and on-link.
[b]Maximally exposed individual latent cancer fatality represents the probability of a latent cancer fatality occurrence.
LCF = latent cancer fatality

Table H.2. Radiological impacts for truck shipments to Richland, Washington

	Annual impacts		Total for 10-year life cycle	
Risk Group	Dose (person-rem)	LCF	Dose (person-rem)	LCF
Crew	0.06	2.4E-05	0.6	2.4E-04
Population[a]	0.02	1.0E-05	0.2	1.0E-04
MEI[b] (rem)	2.9E-07	1.0E-05	2.9E-06	1.5E-09

[a]Includes population dose receptors off-link and on-link.
[b]Maximally exposed individual latent cancer fatality represents the probability of a latent cancer fatality occurrence.
LCF = latent cancer fatality

Table H.3. Radiological impacts for truck shipments to Mercury, Nevada

	Annual impacts		Total for 10-year life cycle	
Risk Group	Dose (person-rem)	LCF	Dose (person-rem)	LCF
Crew	6.1	2.4E-03	61	2.4E-02
Population[a]	2.4	1.2E-03	24	1.2E-02
MEI[b] (rem)	3.4E-00	1.7E-03	3.4E-04	1.7E-07

[a]Includes population dose receptors off-link and on-link.
[b]Maximally exposed individual latent cancer fatality represents the probability of a latent cancer fatality occurrence.
LCF = latent cancer fatality

Table H.4. Radiological impacts for truck shipments to Clive, Utah

Risk Group	Annual impacts Dose (person-rem)	Annual impacts LCF	Total for 10-year life cycle Dose (person-rem)	Total for 10-year life cycle LCF
Crew	4.6	1.8E-03	46	1.8E-02
Population[a]	2.1	1.1E-03	21	1.1E-02
MEI[b] (rem)	2.8E-05	1.5E-08	2.8E-04	1.4E-07

[a]Includes population dose receptors off-link and on-link.
[b]Maximally exposed individual latent cancer fatality represents the probability of a latent cancer fatality occurrence.
LCF = latent cancer fatality

Table H.5. Radiological impacts for truck shipments to Oak Ridge (ETTP), Tennessee

Risk Group	Annual impacts Dose (person-rem)	Annual impacts LCF	Total for 10-year life cycle Dose (person-rem)	Total for 10-year life cycle LCF
Crew	0.2	8.0E-05	2.0	8.0E-04
Population[a]	0.06	3.0E-05	0.6	3.0E-04
MEI[b] (rem)	4.0E-06	2.0E-09	4.0E-05	2.0E-08

[a]Includes population dose receptors off-link and on-link.
[b]Maximally exposed individual latent cancer fatality represents the probability of a latent cancer fatality occurrence.
ETTP = East Tennessee Technology Park
LCF = latent cancer fatality

Table H.6. Radiological impacts for truck shipments to Oak Ridge (ORNL), Tennessee

Risk Group	Annual impacts Dose (person-rem)	Annual impacts LCF	Total for 10-year life cycle Dose (person-rem)	Total for 10-year life cycle LCF
Crew	0.008	3.2E-06	0.08	3.2E-05
Population[a]	3.0E-03	1.5E-06	0.03	1.5E-05
MEI[b] (rem)	1.9E-07	9.5E-11	1.9E-06	9.5E-10

[a]Includes population dose receptors off-link and on-link.
[b]Maximally exposed individual latent cancer fatality represents the probability of a latent cancer fatality occurrence.
LCF = latent cancer fatality
ORNL = Oak Ridge National Laboratory

Table H.7. Radiological impacts for truck shipments to Oak Ridge (MEWC), Tennessee

Risk Group	Annual impacts: Dose (person-rem)	Annual impacts: LCF	Total for 10-year life cycle: Dose (person-rem)	Total for 10-year life cycle: LCF
Crew	0.05	2.0E-05	0.5	2.0E-04
Population[a]	0.01	5.0E-06	0.14	7.0E-05
MEI[b] (rem)	8.7E-07	4.4E-10	8.7E-06	4.4E-09

[a]Includes population dose receptors off-link and on-link.

[b]Maximally exposed individual latent cancer fatality represents the probability of a latent cancer fatality occurrence.

LCF = latent cancer fatality

MEWC = Materials & Energy/Waste Control Specialists

Table H.8. Cargo-related impacts from truck transportation accidents

Destination	Population risk[a]: Dose (person-rem)	Population risk[a]: Latent cancer fatalities
Andrews, TX	0.07	3.5E-05
Richland, WA	1.55	7.8E-04
Clive, UT	0.09	4.5E-05
Mercury NV	3.0	1.5 E-03
Oak Ridge (ETTP), TN	.02	1.0E-05
Oak Ridge (ORNL), TN	0.18	9.0E-05
Oak Ridge (MEWC) TN	0.02	1.0E-05
Total	4.9	2.5E-03

[a]Each population risk value is the product of the consequence (population dose or latent cancer fatalities) multiplied by the probability for a range of possible accidents.

ETTP = East Tennessee Technology Park

MEWC = Materials & Energy/Waste Control Specialists

ORNL = Oak Ridge National Laboratory

Table H.9. Estimated fatalities from truck emissions and accidents (vehicle-related impacts)

Destination[a]	Incidents: Accidents	Incidents: Fatalities	Latent fatalities from emissions[b]
Andrews, TX	6.0E-02	3.1E-03	1.3E-02
Richland, WA	9.0E-03	3.8E-04	2.1E-03
Clive, UT	7.3 E-01	2.7 E-02	1.6E-01
Mercury, NV	1.1 E+00	4.1 E-02	2.6E-01
Oak Ridge (ETTP), TN	1.2 E-02	6.8 E-04	4.2E-03
Oak Ridge (ORNL), TN	5.4 E-04	3.2 E-05	2.0E-04
Oak Ridge (MEWC), TN	2.5 E-03	1.4 E-04	8.8E-04
TOTAL	1.89	0.08	0.43

[a]Accidents and fatalities are based on round-trip distance traveled.

[b]Calculated for travel through urban areas only.

ETTP = East Tennessee Technology Park

MEWC = Materials & Energy/Waste Control Specialists

ORNL = Oak Ridge National Laboratory

Workers and the Public. Dose and risk estimates were modeled using the RADTRAN 5 computer code for dose assessment. The potential exposed populations along these routes are estimated from the route distances and appropriate population densities. This information is derived using the Highway 3.4 computer code for the shortest truck route from Paducah to each of the seven destination sites. The highway code is a routing model that computes population densities along all highway links based on rural, suburban, and urban population groupings.

The estimated risks to the public are proportional to the total number of people potentially exposed to radiation while shipments are in transit. This potentially exposed population is estimated from population density categories and the distance traveled, as described in Sect. 3.10.1. The estimated risks to the public are based on a total dose across all persons within the potentially exposed population.

The differences in estimated risks to the public between destinations are due to differences in the total number of potentially exposed people and do not reflect risks to an individual due to higher dose estimates. Risk estimates are based on risks to a population. For example, the risks of a cancer occurrence due to exposure to radiation from routine (incident-free) shipments of low level radioactive waste (LLW) to Mercury (Nevada Test Site), Nevada, through an average shipping year is 1.2×10^{-3} (less than one within the entire potentially exposed population; see Table C3.4) based on a dose estimate for the entire potentially exposed population along the urban, suburban, and rural routes (Table 3.5). The highest public dose of 24 person-rem for the Mercury (Nevada Test Site), Nevada, destination results in a risk of cancer occurrence of 1.2×10^{-2} (less than one within the entire exposed population; see Table C3.4). The radiological impacts at the various destinations are due primarily to the distance traveled and the number of shipments to each destination rather than any one particular type of shipment.

The estimated risks to workers differ between destinations due to the distance of the destination from Paducah and to the radiological characteristics of the waste forms being transported. The estimated risks from radiation exposure for the trucking crew would be directly proportional to the number of miles traveled, the type of waste, and the number of shipments that were used to estimate the risks for each destination. The estimated highest risk of a cancer occurrence of 2.44×10^{-2} for the entire 10-year shipping period (less than one within the entire crew population; see TableE.9) would occur for the Mercury (Nevada Test Site), Nevada shipping campaign. It is important to note that these estimates are conservative, because it is unlikely that the same trucking crew would be involved over the entire 10-year period. This maximum dose-related cancer occurrence is based primarily on the large number of shipments of LLW. The next highest radiological dose and resultant risk of cancer occurrence for crew members (1.84×10^{-2}; see Table 4.10) is estimated for the Clive (Envirocare), Utah, destination due to the large number of total shipments of radiological polychlorinated biphenyl waste.

Maximally Exposed Individual. The maximally exposed individual (MEI) dose estimates presented in Tables C3.1 through C3.7 demonstrate the relatively small dose a single individual is likely to receive. The MEI dose estimates are also considered extremely conservative since this individual is a hypothetical member of the public who lives 30 m (98 ft) from the highway and would be exposed to every shipment of waste.

Differences between the estimated risks to the MEI between waste subgroups were due to the differences in number of shipments between subgroups and to the differences in risk from the subgroup wastes themselves. The 10-year MEI dose ranged from 1.9×10^{-6} rem for the Oak Ridge (Oad Ridge National Laboratory (ORNL)], Tennessee, destinations to 3.4×10^{-4} rem for the Mercury, Nevada, destination. All MEI dose estimates result in the probability of a LCF of much less than 1.

H.2.2 Radiological and nonradiological impacts from routine rail transportation of waste

The potential effects of transporting LLW, Mixed LLW, and transuranic (TRU) waste by rail from Paducah to the specified potential destinations were estimated for the various subgroups on annual and 10-year shipping campaign bases. As discussed earlier in Chap. 4, a variety of containers would be used to transport the waste. The number of containers per shipment was conservatively doubled for the railcar analysis. Rail shipments would include 55-gal drums, 85-gal drums, ST-90 boxes, B-12 boxes, and B-25 boxes.

Tables C3.10 through C3.16 present the estimated risks of shipping the various waste form subgroups to the specified destinations on annual and 10-year total shipping campaign bases. As for highway transport, shipping campaign estimates were calculated based on shipping waste to the specific destinations and were not analyzed for comparison to various potential destinations; therefore, each of these tables represents radiological impacts to each destination based on the type of waste, number of shipments, and length of rail route to the final destination.

Radiological Impacts from Routine Rail Operations. The estimated risks resulting from incident-free shipments of LLW, MLLW, and TRU waste using rail transportation are presented in Tables H.10 through H.16. These risks were calculated using the same basic methods as the highway analyses. Rail route (Table 3.6) estimates of the potentially exposed populations (Table 3.7) and assumptions for underlying conditions are specific to rail transportation.

Table H.10. Radiological impacts for rail shipments to Hobbs, New Mexico

	Annual impacts		Total for 10-year life cycle	
Risk Group	Dose (person-rem)	LCF	Dose (person-rem)	LCF
Crew	0.2	8.0E-05	1.5	6.0E-04
Population[a]	0.7	3.5E-04	6.8	3.4E-03
MEI[b] (rem)	4.4E-06	2.2E-09	4.4E-05	2.2E-08

[a]Includes population dose receptors off-link and on-link.
[b]Maximally exposed individual latent cancer fatality represents the probability of a latent cancer fatality occurrence.
LCF = latent cancer fatality

Table H.11. Radiological impacts for rail shipments to Hanford, Washington

	Annual impacts		Total for 10-year life cycle	
Risk group	Dose (person-rem)	LCF	Dose (person-rem)	LCF
Crew	0.02	8.0E-06	0.2	8.0E-05
Population[a]	0.1	5.0E-05	1.1	5.5E-04
MEI[b] (rem)	4.4E-07	2.2E-10	4.4E-06	2.2E-09

[a]Includes population dose receptors off-link and on-link.
[b]Maximally exposed individual latent cancer fatality represents the probability of a latent cancer fatality occurrence.
LCF = latent cancer fatality

Table H.12. Radiological impacts for rail shipments to Clive, Utah

Risk group	Annual impacts		Total for 10-year life cycle	
	Dose (person-rem)	LCF	Dose (person-rem)	LCF
Crew	1.4	5.6E-04	13.7	5.5E-03
Population[a]	5.7	2.9E-03	57	2.9E-02
MEI[b] (rem)	3.2E-05	1.6E-08	3.2E-04	1.6E-07

[a]Includes population dose receptors off-link and on-link.
[b]Maximally exposed individual latent cancer fatality represents the probability of a latent cancer fatality occurrence.
LCF = latent cancer fatality

Table H.13. Radiological impacts for rail shipments to Las Vegas, Nevada

Risk Group	Annual impacts		Total for 10-year life cycle	
	Dose (person-rem)	LCF	Dose (person-rem)	LCF
Crew	2.7	1.1E-03	27	1.1E-02
Population[a]	8.1	4.1E-03	81	4.1E-02
MEI[b] (rem)	7.3E-05	3.7E-08	7.3E-04	3.7E-07

[a]Includes population dose receptors off-link and on-link.
[b]Maximally exposed individual latent cancer fatality represents the probability of a latent cancer fatality occurrence.
LCF = latent cancer fatality

Table H.14. Radiological impacts for rail shipments to Oak Ridge (ETTP), Tennessee

Risk group	Annual impacts		Total for 10-year life cycle	
	Dose (person-rem)	LCF	Dose (person-rem)	LCF
Crew	0.1	4.0E-05	1.3	5.2E-04
Population[a]	0.9	4.5E-04	9.2	4.6E-03
MEI[b] (rem)	5.0E-06	2.5E-09	5.0E-05	2.5E-08

[a]Includes population dose receptors off-link and on-link.
[b]Maximally exposed individual latent cancer fatality represents the probability of a latent cancer fatality occurrence.
ETTP = East Tennessee Technology Park
LCF = latent cancer fatality

Table H.15. Radiological impacts for rail shipments to Oak Ridge (ORNL), Tennessee

Risk group	Annual impacts		Total for 10-year life cycle	
	Dose (person-rem)	LCF	Dose (person-rem)	LCF
Crew	0.01	4.0E-06	0.10	4.0E-05
Population[a]	0.04	2.0E-05	0.4	2.0E-04
MEI[b] (rem)	4.4E-07	2.2E-10	4.4E-06	2.2E-09

[a]Includes population dose receptors off-link and on-link.
[b]Maximally exposed individual latent cancer fatality represents the probability of a latent cancer fatality occurrence.
LCF = latent cancer fatality
ORNL = Oak Ridge National Laboratory

Table H.16. Radiological impacts for rail shipments to Oak Ridge (MEWC), Tennessee

Risk group	Annual impacts		Total for 10-year life cycle	
	Dose (person-rem)	LCF	Dose (person-rem)	LCF
Crew	0.04	1.6E-05	0.35	1.6E-04
Population[a]	0.1	5.0E-05	1.03	5.2E-04
MEI[b] (rem)	1.1E-06	5.5E-10	1.1E-05	5.5E-09

[a]Includes population dose receptors off-link and on-link.

[b]Maximally exposed individual latent cancer fatality represents the probability of a latent cancer fatality occurrence.

LCF = latent cancer fatality

MEWC = Materials & Energy/Waste Control Specialists

Table H.17. Cargo-related impacts from rail transportation accidents

Destination	Population risk[a]	
	Dose (person-rem)	LCF
Hobbs, NM	0.07	3.5E-05
Hanford, WA	1.74	8.7E-04
Clive, UT	0.07	3.5E-05
Las Vegas, NV	3.2	1.6E-03
Oak Ridge (ETTP), TN	0.09	4.5E-05
Oak Ridge (ORNL), TN	0.4	2.0E-04
Oak Ridge (MEWC), TN	4.4E-02	2.2E-05
Total	5.51	2.8E-03

[a]Each population risk value is the product of the consequence (population dose or latent cancer fatalities) multiplied by the probability for a range of possible accidents.

ETTP = East Tennessee Technology Park

LCF = latent cancer fatality

MEWC = Materials & Energy/Waste Control Specialists

ORNL = Oak Ridge National Laboratory

Table H.18. Estimated fatalities from rail-related accidents

Destination[a]	Incidence	
	Accidents	Fatalities
Hobbs, NM	4.2 E-03	6.9 E-04
Hanford, WA	9.8 E-04	3.0 E-04
Clive, UT	2.6 E-02	8.6 E-03
Las Vegas, NV	5.1 E-02	1.5 E-02
Oak Ridge (ETTP), TN	1.2 E-03	2.8 E-04
Oak Ridge (ORNL), TN	1.0 E-04	2.3 E-05
Oak Ridge (MEWC), TN	2.5 E-04	5.7 E-05
Total	**0.08**	**0.02**

[a]Accidents and fatalities are based on round-trip distance traveled.

ETTP = East Tennessee Technology Park

MEWC = Materials & Energy/Waste Control Specialists

ORNL = Oak Ridge National Laboratory

Maximally Exposed Individual. The MEI dose estimates presented in Tables E.10 through E.16 demonstrate the relatively low dose a single individual is likely to receive. The MEI dose estimates are also considered extremely conservative, since this individual is a hypothetical member of the public who lives 30 m (98 ft) from the railway and would be exposed to every shipment of waste.

Differences between the estimated risks to the MEI between waste subgroups were due to the differences in the number of shipments between subgroups and to the differences in risk from the subgroup waste itself. For example, the 10-year analysis period for shipment of waste to Oak Ridge (ORNL), Tennessee, results in an MEI dose of 4.4×10^{-6} rem. The MEI dose to the Las Vegas, Nevada, destination for the 10-year period is 7.3×10^{-4}, and the resultant probability of an LCF is minimal at 3.7×10^{-7}.

H.2.2 Risks from rail accidents

Cargo-Related Radiological Impacts. The impacts from the transportation impact analysis are shown in Table C3.17 for cargo-related accident impacts for rail shipments. Each value in the table represents the product of consequence (population dose or LCFs) multiplied by the probability for a range of possible accidents. For rail shipments, the Las Vegas (Nevada Test Site), Nevada, destination would result in the highest doses. This destination results in 3.2 person-rem (1.6×10^{-3} LCF). The total dose and number of LCFs for the entire waste transportation campaign are 5.5 person-rem and 2.8×10^{-3} (less than one LCF), respectively.

Rail-Related Nonradiological Impacts. DOE's analysis of potential rail-related impacts included expected accidents and expected fatalities from accidents. Rail-related accidents are accidents related to the number of miles traveled by rail and to the risk of accidents occurring based on the increase in miles traveled. Mileage through states along a given route was multiplied by state-specific accident and fatality rates to determine the potential numbers of route-specific accidents and fatalities.

As shown in Table C3.18, impacts from rail-related accidents are highest for the Mercury (Nevada Test Site), Nevada, and Clive (Envirocare), Utah, destinations because of the number of shipments and the total miles traveled to and from these destinations.

H.3 REFERENCES

K.S. Neuhauser and F.L. Kanipe, 2000, "RADTRAN 5 User Guide," Transportation Safety and Security Analysis Department, Sandia National Laboratories, Albuquerque, New Mexico.

THIS PAGE INTENTIONALLY LEFT BLANK.

APPENDIX I

ANALYSIS OF WASTE TREATMENT FACILITY AIRBORNE CHEMICAL RELEASES

THIS PAGE INTENTIONALLY LEFT BLANK

APPENDIX I

ANALYSIS OF WASTE TREATMENT FACILITY AIRBORNE CHEMICAL RELEASES

I.1 METHODOLOGY

The methodology adapted for the analysis of airborne chemical releases during postulated accidents in the proposed waste treatment facility is based on the U.S. Environmental Protection Agency's (EPA's) Risk Management Program (RMP) for Highly Hazardous Chemicals [40 *Code of Federal Regulations (CFR)* Part 68].

The RMP provides a methodology to simply, yet conservatively, estimate the dispersion impacts of airborne chemical releases. However, this regulation is not expected to be required for the small quantities of wastes and treatment chemicals planned for the proposed treatment facility. Nevertheless, the application of this program permits a readily useful approach to bound the effects of accidental releases. EPA has published software to enable facility owners to calculate the worst-case and alternative-case releases. This software, RMP*Comp, is available from EPA's Chemical Emergency Preparedness and Prevention Office Web site.

The scope of the analyses in this appendix includes airborne chemical releases only (i.e., gases, vapors, and volatile liquids.) The radiological effects (doses) from the waste streams are not addressed in this analysis. Consequences are determined in terms of maximum safe distance of a postulated release and worker exposure concentrations. Since the accidents posed by EPA's approach are intended to be bounding for all potential releases, no frequencies, and therefore, risks, are addressed.

The liquid waste streams considered are based on the specification in Sect. 2.1.2 of this document, as further clarified in discussions with Paducah Gaseous Diffusion Plant (PGDP) staff [Bechtel Jacobs Company, LLC (BJC) 2001]. The liquid waste streams to be processed in the treatment facility are shown in Table I.1.

Table I.1. Liquid wastes and treatment chemicals enclosure inventories*

Material	Quantity, m^3 (gal)	Inventory
Waste stream		
Tc-contaminated liquid, acid	1 (264)	3 drums
TRU-contaminated liquid, base	5 (1320)	35 containers
Treatment chemical		
Nitric acid	1.9 (500)	1-2 Bulk containers
Calcium hydroxide (lime)	---	90 lb. bags

* Ref: EA, Sect. 2.1.2, as modified per discussion with BJC staff (BJC 2001).
TRU = transuranic

In addition, the treatment processes (neutralization and solidification) require chemical reagents to process the candidate wastes into forms acceptable for storage. These chemicals (Table I.1) are represented by nitric acid (100% concentration) and calcium hydroxide. The RMP threshold quantity for nitric acid is 15,000 lb (40 *CFR* 68.130), which equates to more than 1200 gal. Since the planned treatment inventory is not expected to require such quantities of reagent at one time, the treatment facility is not required to comply with the EPA's RMP requirements. [Note: The Occupational Safety and Health Administration (OSHA) Process Safety Management regulations, 29 *CFR* Part 1910.119, apply to quantities of nitric acid ≥ 500 lb.] Typical chemical bulk containers used for treatment range from 175 to 550 gal in size. Given that such containers are typically filled to less than 90% of capacity, for analysis purposes, a 500-gal chemical inventory would be estimated to represent the largest expected quantity of any treatment chemical stored in the treatment facility. Since calcium hydroxide is not defined as a hazardous material, its presence does not require adherence to the requirements of the RMP. Calcium hydroxide is typically used in treating acids by means of a hopper that is fed with individual bags of material. Therefore, for analysis purposes, the maximum quantity of calcium hydroxide available for release in an accident is estimated to be 90 lb.

The treatment facility is to be located within Bldg. C-752-A, in the northwest quadrant of the PGDP site. The distance to the nearest boundary of the controlled area is approximately. 520 m (1700 ft). The distance from C-752-A to the nearest U.S. Department of Energy (DOE) property line is approximately 1.6 km (1 mile). The treatment facility is an enclosed building composed of seismic wall panels of stainless steel and similar ceiling panels of Lexan. high-efficiency particulate air (HEPA) filters with dampers purify the enclosure exhaust to the interior of C-752-A. Access to the interior of the treatment facility is via personnel doors, equipment roll-up doors, and transfer sleeve openings. The interior is divided into two sections; for analysis purposes, only the treatment portion of the facility area and volume would be credited in consequence calculations. The facility floor area of the treatment portion is 50 m^2 (540 ft^2); the facility volume of the treatment portion is 240 m^3 (8640 ft^3). The HEPA filters are estimated to have an efficiency greater than 99.9% (reduction factor = 1000) (U.S. Nuclear Regualatory Commission 1998).

I.2 WORST-CASE SCENARIOS

The RMP methodology for worst-case off-site consequence analyses is defined as follows (EPA 1999):

- "The release of the largest quantity of a regulated substance from a vessel or process line failure, and

- "The release that results in the greatest distance to the endpoint for the regulated toxic or flammable substance.

> "You may take administrative controls into account when determining the largest quantity. Administrative controls are written procedures that limit the quantity of a substance that can be stored or processed in a vessel or pipe at any one time or, alternatively, procedures that allow the vessel or pipe to occasionally store larger than usual quantities (e.g., during shutdown or turnaround). Endpoints for regulated substances are specified in the rule (40 *CFR* 68.22(a), and Appendix A to part 68 for toxic substances). For the worst-case analysis, you do not need to consider the possible causes of the worst-case release or the probability that such a release might occur; the release is simply estimated to take place. You must assume all releases take place at ground level for the worst-case analysis.
>
> "This guidance assumes meteorological conditions for the worst-case scenario of atmospheric stability class F (stable atmosphere) and wind speed 1.5 meters per second (3.4 mph). Ambient air temperature for this guidance is 25 ºC (77 ºF). If you use this guidance, you may assume this

ambient temperature for the worst case, even if the maximum temperature at your site in the last three years is higher.

"The rule provides two choices for topography, urban and rural. EPA (40 *CFR* 68.22(e)) has defined urban as many obstacles in the immediate area, where obstacles include buildings or trees. Rural, by EPA's definition, means there are no buildings in the immediate area, and the terrain is generally flat and unobstructed. Thus, if your site is located in an area with few buildings or other obstructions (e.g., hills, trees), you should assume open (rural) conditions. If your site is in an area with many obstructions, even if it is in a remote location that would not usually be considered urban, you should assume urban conditions.

"For toxic liquids, you must assume that the total quantity in a vessel is spilled. This guidance assumes the spill takes place onto a flat, non-absorbing surface. For toxic liquids carried in pipelines, the quantity that might be released from the pipeline is estimated to form a pool. You may take passive mitigation systems (e.g., dikes) into account in consequence analysis. …The temperature of the released liquid must be the highest daily maximum temperature occurring in the past three years or the temperature of the substance in the vessel, whichever is higher (40 *CFR* 68.25(d)(2)). The release rate to air is estimated as the rate of evaporation from the pool. If liquids at your site might be spilled onto a surface that could rapidly absorb the spilled liquid (e.g., porous soil), the methods presented in this guidance may greatly overestimate the consequences of a release. Consider using another method in such a case.

"Exhibit B-2 of Appendix B presents the endpoint for air dispersion modeling for each regulated toxic liquid (the endpoints are specified in 40 *CFR* part 68, Appendix A)."

The worst-case off-site consequence analysis for the PGDP waste treatment facility consists of the instantaneous release of 500 gal of nitric acid in the facility interior. The choice of nitric acid as the most hazardous species is conservative in that nitric acid has the lowest toxic endpoint value [EPA criterion for nitric acid, equivalent to "immediately dangerous to life or health" (IDLH) limit of 25 ppm, or 0.026 mg/L National Institute for Occupational Safety and Health (NIOSH) 1997)] among typical industry highly hazardous treatment acids (e.g., hydrochloric acid, hydrogen sulfide). The quantity of nitric acid for this analysis is estimated to bound the maximum available quantity of the liquid waste streams in a single container (Table E.1). The temperature of the nitric acid is estimated to be less than 38°C (100°F) under worst-case conditions. No worst-case model was prepared for releases of calcium hydroxide, since it is not regarded as a toxic substance for purposes of EPA's RMP regulation. The exposure to dust arising from opening a bag of calcium hydroxide is a typical industrial condition, albeit one that requires worker health and safety protective measures. Therefore, this scenario was not modeled for off-site consequences. However, the potential exposure to the contents of a bag of calcium hydroxide is addressed below in Sect. E.3.

Using the RMP*Comp software, the maximum distance to the condition of the toxic endpoint for an unmitigated release of 500 gal of nitric acid is 6.1 km (3.8 miles). Rural conditions were estimated, since there are few structures in the vicinity of the release. The results and assumptions used in the RMP*Comp analysis are shown in Table E.2.

If the effect of the treatment facility enclosure, but excluding the HEPA filters, is accounted for, the distance to the toxic endpoint condition is reduced to 0.8 km (0.5 mile), which is located just beyond the nearest controlled area fence but within the DOE property line. The results of this revised analysis are shown in Table E.3.

I.3 ALTERNATIVE-CASE SCENARIOS

The RMP methodology for alternative-case off-site consequence analysis is defined as follows (EPA 1999):

> "You are required to analyze at least one alternative release scenario for each listed toxic substance you have in a … process above its threshold quantity. …According to the rule (40 *CFR* 68.28), alternative scenarios should be more likely to occur than the worst-case scenario and should reach an endpoint off-site, unless no such scenario exists. Release scenarios considered should include, but are not limited to, the following:

Table I.2. Worst-case release—nitric acid, no mitigation

RMP*Comp Ver. 1.06
Results of Consequence Analysis

Chemical: Nitric acid (100%)
CAS #: 7697-37-2
Category: Toxic Liquid
Scenario: Worst-case
Quantity Released: 500 gal
Liquid Temperature: 100 °F

Mitigation Measures: NONE
Release Rate to Outside Air: 68.1 lb/min
Evaporation Time: 93.0 min
Topography: Rural surroundings (terrain generally flat and unobstructed)
Toxic Endpoint: 0.026 mg/L; basis: EHS-LOC (IDLH)
Estimated Distance to Toxic Endpoint: 6.1 km (3.8 miles)

--------Assumptions About This Scenario---------
Wind Speed: 1.5 m/s (3.4 mph)
Stability Class: F
Air Temperature: 25 °C (77 °F)

Table I.3. Worst-case release—nitric acid, release into enclosure

----

RMP*Comp Ver. 1.06
Results of Consequence Analysis

Chemical: Nitric acid (100%)
CAS #: 7697-37-2
Category: Toxic Liquid
Scenario: Worst-case
Quantity Released: 500 gal
Liquid Temperature: 100 °F

Mitigation Measures:
Release into building with floor area of 50 m^2 (540 ft^2)

Release Rate to Outside Air: 1.81 lb/min
Evaporation Time: 3490 min
Topography: Rural surroundings (terrain generally flat and unobstructed)
Toxic Endpoint: 0.026 mg/L; basis: EHS-LOC (IDLH)
Estimated Distance to Toxic Endpoint: 0.8 km (0.5 miles)

--------Assumptions About This Scenario---------
Wind Speed: 1.5 m/s (3.4 mph)
Stability Class: F
Air Temperature: 25 °C (77 °F)

- "Transfer hose releases due to splits or sudden hose uncoupling;
- "Process piping releases from failures at flanges, joints, welds, valves and valve seals, and drains or bleeds;
- "Process vessel or pump releases due to cracks, seal failure, or drain, bleed, or plug failure;
- "Vessel overfilling and spill, or overpressurization and venting through relief valves or rupture disks; and
- "Shipping container mishandling or puncturing leading to a spill.

> "Alternative release scenarios for toxic substances should be those that lead to concentrations above the toxic endpoint beyond your fenceline. …Those releases that have the potential to reach the public are of the greatest concern. You should consider unusual situations, such as start-up and shut-down, in selecting an appropriate alternative scenario. For alternative release scenarios, you are allowed to consider active mitigation systems, such as interlocks, shutdown systems, pressure relieving devices, flares, emergency isolation systems, and fire water and deluge systems, as well as passive mitigation systems …"

Although no risk assessment has been performed of the chemical release scenarios, the alternative-case release is considered more credible than the worst-case release in that a leak from the nitric acid bulk storage container is estimated to occur while workers are in the vicinity. The leak is postulated to be the equivalent of a small hose leak or a similar size crack in the container. For analysis purposes, the hole size is estimated to be 0.64-cm (0.25-in.) diameter, located 91 cm (36 in.) below the container liquid level. No credit is taken in the off-site consequence analysis for any mitigation features, including facility ventilation. The results and assumptions used in the RMP*Comp analysis are shown in Table E.4 for a 10-min release, which is a conservative estimate of the maximum duration of worker exposure to the postulated release. For comparison, for the alternative case without any mitigation (other than administrative controls limiting the worker exposure time after an accidental release), the calculated distance to the endpoint condition is reduced to 0.3 km (0.2 mile), which is located within the controlled area fence. (Note: In the 10-min worker exposure time, approximately 17 gal is released during this scenario.)

Using the spill evaporation rate calculated by RMP*Comp in Table E.4, 4.04 lb/min, and assuming that the workers remain in the enclosure for no more than 10 min, the breathing air concentration can be calculated as follows:

$$C, ppm = (M \times T) \div (V \times F)$$

where,

C = concentration, ppm
M = chemical evaporation rate, mg/min
T = exposure time, min
V = enclosure volume, m^3
F = ppm conversion factor for nitric acid, mg/m^3-ppm
M = (4.04 lb/min) × (454,000 mg/lb) = 1,834,160 mg/min
T = 10 min
V = (8640 ft^3) × (0.02832 m^3/ft^3) = 245 m^3
F = 2.58 mg/m^3-ppm (NIOSH 1997)

Table I.4. Alternative-case release—container leak

RMP*Comp Ver. 1.06
Results of Consequence Analysis

Chemical: Nitric acid (100%)
CAS #: 7697-37-2
Category: Toxic Liquid
Scenario: Alternative
Quantity Released: 219 lb
Release Duration: 10 min
Storage Parameters: Tank under Atmospheric Pressure
Hole or puncture area: 0.32 cm^2 (.05 $in.^2$)
Height of Liquid Column Above Hole: 91 cm (36 in.)

Release Rate: 1.73 gal/min
Liquid Temperature: 38°C (100°F)

Mitigation Measures: NONE
Release Rate to Outside Air: 4.04 lb/min
Evaporation Time: 54.3 min
Topography: Rural surroundings (terrain generally flat and unobstructed)
Toxic Endpoint: 0.026 mg/L; basis: EHS-LOC (IDLH)
Estimated Distance to Toxic Endpoint: 0.3 km (0.2 miles)

--------Assumptions About This Scenario---------
Wind Speed: 3 m/s (6.7 mph)
Stability Class: D
Air Temperature: 25 °C (77 °F)

$$C = \left[(1{,}834{,}160) \times (10)\right] \div \left[(245) \times (2.58)\right]$$

Therefore,

$$= 29{,}000 \text{ ppm}$$

This equation assumes that the toxic vapor is dispersed in the enclosure as a uniform distribution that increases at a constant rate and neglects enclosure ventilation effects. If workers are wearing Level A personal protective equipment (PPE), the OSHA Respirator Selection Guide (*OSHA 2001*) provides a value of >1000 for the assigned protection factor for pressure demand self-contained breathing apparatus (SCBA). Using the minimum value, the workers could be exposed to 29 ppm during this release. This level is greater than the nitric acid IDLH limit of 25 ppm (NIOSH 1997). Keep in mind that this is the calculated air concentration at the end of a 10-min release. Lower concentrations would occur for less exposure time. Also, the enclosure exhaust ventilation through the HEPA filters would further dilute the concentration to the exposed worker. If this postulated scenario is used as a planning basis for the treatment facility, it is recommended that the PPE assigned protection factor be > 1160.

For workers outside the treatment facility during the postulated alternative-case release, the HEPA filter system reduces the concentration at the enclosure boundary to a maximum of 29 ppm at the end of

10 min. This concentration would be diluted by the C-752-A building environment in proportion to the cube of the distance from the enclosure exhaust locations. Thus, the worker exposure would likely be less than the IDLH concentration, even if the worker were to remain in the vicinity for at least 10 min after the leak occurs. The basis for the IDLH determination is for a 30-min exposure to the specific chemical. Therefore, the consequences of a leak inside the treatment facility to a worker outside is considered to be manageable given that appropriate administrative controls are incorporated into standard operating procedures.

As a second alternative case, a bag of calcium hydroxide is estimated to break open during handling, completely releasing its contents. Realistically, this scenario would result in a fraction of the bag's contents becoming airborne as a dust or vapor. The airborne release fraction (ARF) for a typical powder is 2×10^{-3}, and the respirable fraction (RF) is 0.3 (DOE 1994). Using the equation above, the exposure concentration for this alternative case is given by:

$$C = \left[M \times ARF \times RF)\right] \div \left[V \times F\right]$$

where,

M = mass of chemical released, mg
ARF = 2×10^{-3}
RF = 0.3
V = enclosure volume, m^3
F = ppm conversion factor for calcium hydroxide, mg/m^3-ppm

M = (90 lb) × (454,000 mg/lb) = 4.086×10^7 mg
V = (8640 ft^3) × (0.02832 m^3/ft^3) = 245 m^3
F = (no NIOSH value. Assume = 1.0)

Therefore,

$$C = \left[(4.086x10^{7}) \times (2x10^{-3}) \times (0.3)\right] \div \left[(245) \times (1.0)\right]$$
$$= 100 \text{ ppm} = 100 \text{ mg/m}^3$$

If the exposed workers are wearing SCBAs with the assigned protection factor of >1000, the breathing zone concentration is < 0.1 mg/m^3. This result is within the NIOSH permissible respirable exposure limit of 5 mg/m^3 for calcium hydroxide (NIOSH 1997). Therefore, the consequences of the rupture of one bag of calcium hydroxide are within the range of acceptable conditions for the proposed treatment operations.

I.4 CONCLUSIONS

The hypothetical worst-case scenario for an accidental chemical release from the PGDP waste treatment facility in Bldg. C-752-A was determined to be the instantaneous release of 500 gal of nitric acid. The airborne environmental consequence of this scenario is a dispersion distance of 6.1 km (3.8 miles) to the toxic endpoint limit for nitric acid (0.026 mg/L). If the effect of the treatment facility enclosure is included in this scenario, the dispersion distance is reduced to 0.8 km (0.5 mile), which is within the nearest DOE property line.

Alternative-case scenarios were developed that addressed a more credible leak from the estimated nitric acid bulk storage container. The unmitigated airborne environmental consequence of this scenario is a dispersion distance of 0.3 km (0.2 mile) to the toxic endpoint limit. The calculated respirable impact of the alternative-case scenario on workers in the treatment facility wearing the minimum required level of PPE is an exposure to toxic chemicals at levels slightly above the IDLH limit. In conjunction with other administrative controls, an acceptable level of worker protection is available during an accidental chemical airborne release.

Similarly, a release of airborne contamination from the rupture of a calcium hydroxide bag is expected to produce lower consequences to potentially exposed workers.

The impact of the alternative-case scenario results in manageable airborne exposures to unprotected workers located outside of the treatment facility enclosure.

I.5 REFERENCES

BJC (Bechtel Jacobs Company LLC) 2001. Personal communication with S. Leone (BJC-Paducah).

DOE (U.S. Department of Energy) 1994. *Airborne Release Fractions/Rates and Respirable Fractions for Nonreactor Nuclear Facilities,* DOE-HDBK-3010-94, December.

EPA (U.S. Environmental Protection Agency). *RMP*Comp, Ver. 1.06,* [Off-site Consequence Analysis software supporting Risk Management Program as required by Sect. 112 (r) of the 1990 Clean Air Act.]

EPA 1999. *Risk Management Program Guidance For Offsite Consequence Analysis,* EPA 550-B-99-009, April.

NIOSH (National Institute for Occupational Safety and Health) 1997. *NIOSH Pocket Guide To Chemical Hazards,* (available on www.cdc.gov.)

NRC (Nuclear Regulatory Commission) 1998. *Nuclear Fuel Cycle Facility Accident Analysis Handbook,* U. S. Nuclear Regulatory Commission, NUREG/CR-6410, March.

OSHA (Occupational Safety and Health Administration) 2001. *Respirator Selection Guide,* (available on OSHA's Respiratory Advisor Web site), January.

THE PAGE INTENTIONALLY LEFT BLANK

APPENDIX J

ANALYSIS OF ON-SITE TREATMENT OF LLW AND TRU WASTE

THIS PAGE INTENTIONALLY LEFT BLANK

APPENDIX J

ANALYSIS OF ON-SITE TREATMENT OF LLW AND TRU WASTE

This appendix contains a radiological impact analysis for the on-site treatment of transuranic (TRU) and mixed low level radioactive waste (MLLW) at the Paducah Gaseous Diffusion Plant (PGDP). The characteristics of the waste are estimated to be as described in Table 1.1 of this environmental assessment. Specific known waste streams to be addressed are TRU waste streams 439 and 444, and MLLW waste stream 2802. Specifically, on-site treatment applies to:

- up to 120 m^3 (4,238 ft^3) of MLLW solids/sludge that would require only stabilization by solidification,
- 12 m^3 (424 ft^3) of ^{99}Tc–contaminated MLLW of which approximately 1 m^3 (35 ft^3) is liquid that would require neutralization, then solidification, and the remainder are solids/sludge that would require only stabilization by solidification, and
- up to 10 m^3 (353 ft^3) of TRU waste estimated to be half liquid and half solids. The liquids are basic and would require neutralization, then solidification. The solids would require only stabilization by solidification.

Human Health Impacts from Normal Operations

Impacts to the Public. This analysis considers the activities to be performed during normal operations of the on-site treatment facility to be located in Bldg. C-752-A and bulb crushing in Bldg. C.746A. The potential impacts to the public from exposure to radiation and radioactive material from facility emissions are identified. The impacts to the public are based on atmospheric releases only. Neither liquid effluent nor releases are expected from routine operations of the treatment facilities. Any liquid contamination would be contained and disposed according to established site administrative controls for spills containing radioactive liquids. To estimate the radiological impacts from facility air emissions, the radioactive quantities of the waste and facility layout data are used to estimate the potential dose to the maximally exposed individual and the public surrounding the PGDP. The proposed treatment facility is located approximately 520 m (1700 ft) from the site boundary. Air emissions dispersion modeling and dose calculations are performed using the U.S. Environmental Protection Agency Corrective Action Plan (CAP)-88, PC-based, version 2.0 computer code. CAP-88 allows for calculation of individual and population doses based on atmospheric emissions. The CAP-88 computer code is based on U.S. Nuclear Regulatory Commission Regulatory Guide 1.109.

After the total radiation dose to the public from waste treatment operations is calculated, the dose-to-risk conversion factors established by the National Council on Radiation Protection and Measurements (NCRP) is used to estimate the latent cancer fatalities (LCFs) that could result from the estimated exposure. This analysis uses the NCRP factors of 0.0005 LCF for each person-rem of radiation exposure to the general public and 0.0004 LCF for each person-rem of exposure to radiation workers (NCRP 1993).

Table J.1 lists the projected health impacts to the public from routine operations of the on-site treatment facility. The table indicates that impacts are not notable for the entire treatment process or for individual waste stream groups. The values in this table are conservative, since the dose calculations were based on atmospheric suspension of the entire radioactive quantities of each waste stream inside the treatment facility. This waste quantity was then estimated to be released to the environment via the facility high-efficiency particulate air filtration system that typically removes 99.999% of the radioactive contaminants. Actual dose from normal operations should be considerably less, since only a small fraction of the radioactive materials would become airborne during normal operations.

Table J.1. Impacts on public health from normal operations of on-site treatment facility[a]

Waste group	Total dose: MEI[b] (mrem)	Total dose: Population (person-rem)	Population LCF[c]
Lab waste (439)	3.10E-07	2.92E-04	1.46E-08
Tc-99-contaminated waste (2802)	1.17E-03	3.28E+00	1.64E-04
TRU waste—solids (444)	1.50E-03	1.42E+00	7.11E-05
TRU waste—liquids (444)	2.48E-03	2.47E+00	1.24E-04
Total	5.15E-03	7.17E+00	3.59E-04

[a]Impacts are based on radioactive quantities for the waste streams listed here and identified in Table 1.1.

[b]MEI = Maximally exposed individual calculated to be approximately 1500 meters north of facility.

[c]LCF = Estimated number of latent cancer fatalities within the public from on-site treatment of projected waste quantities.

TRU = transuranic.

Impacts to Workers. Potential impacts to workers from exposure to radiation and radioactive materials from facility operations have been estimated. These estimates of radiation doses to workers are based on historical experience at the PGDP waste treatment/handling operations. The number of workers who could be exposed was projected and the total dose to workers and subsequent LCF incidence was determined. Table J.2 presents the radiological health impacts to the workers from routine operations of the on-site treatment facility.

The average measurable worker dose is based on historical U.S. Department of Energy data for waste processing facilities for the years 1997-1999. It is estimated that the on-site treatment activities would take approximately 3 to 4 months to complete. Therefore, dose projections are based on exposure for this time period. The total worker dose is conservatively provided for a maximum projected work force within the on-site treatment building of 15 radiological workers. The actual number of workers directly involved with the waste handling/processing activities is expected to be 6 to 8 people.

Table J.2. Impacts on workers from normal operations of on-site treatment facility

Workers	Impacts from operations
Average radiological dose to worker (rem)[a]	0.023
Total projected radiological dose to all rad workers (person-rem)[b]	0.34
Estimated number of latent cancer fatalities from total worker dose	1.4E-04

[a]Estimate of average dose to workers is based on the DOE average annual measurable total effective dose equivalent (TEDE = sum of internal and external dose) for waste processing/management facilities during 1997–1999 (DOE 2000c).

[b]Total projected worker dose calculated for an estimated 15 maximum radiological workers within the facility.

DOE = U.S. Department of Energy

APPENDIX K

EVALUATION OF THE NO ACTION ALTERNATIVE

THIS PAGE INTENTIONALLY LEFT BLANK

APPENDIX K

DETAILED EVALUATION OF THE NO ACTION ALTERNATIVE

Under the No Action alternative not only would current wastes not be removed from the site, but newly generated waste would be continually added to the current inventory. Probability of impacts would increase over time as volumes of waste increase and new storage facilities are constructed. The no action alternative would also have ramifications related to regulatory noncompliance.

K.1 RESOURCE IMPACTS

Under the No Action alternative, on-site storage of existing and newly generated waste would continue. No treatment or disposal activities would occur. The following sections discuss impacts resulting from the No Action alternative.

K.1.1 Land use

The No Action alternative would not affect land use classifications. However, new storage buildings would be required to store waste generated from ongoing operations through 2010 and beyond.

K.1.2 Geology and seismicity

The No Action alternative would not affect site geology or seismicity.

K.1.3 Soils and prime farmland

Prime farmland would not be affected. Approximately 3 acres of surficial and near-surface soils would be affected by the construction of the new waste storage building.

K.1.4 Water and water quality

Short-term and long-term impacts to surface water from the No Action alternative should be similar to those currently occurring from activities at the Paducah Site. The surface water data from 1998 {U.S. Department of Energy (DOE) 2000c] for the five Kentucky Pollutant Discharge Elimination System (KPDES) outfalls (Outfalls K001, K015, K017, K018, and K019) for which DOE has responsibility at the Paducah Site, and the six surface water environmental surveillance stations [SW 1 (upstream Bayou Creek), SW 5 (downstream Bayou Creek), SW 10 (downstream Little Bayou Creek), SW 11 (downstream Little Bayou Creek), SW 29 (upstream Ohio River), and SW 64 (Massac Creek reference)] can be used as a baseline condition. The water quality results for 1998 for radionuclides and nonradionuclides at these five KPDES outfalls and six environmental monitoring locations are briefly summarized in this section.

For radionuclides, DOE Orders 5400.1 and 5400.5 specify the requirements for effluent monitoring and annual dose standards for members of the public exposed to radionuclides resulting from DOE operations. Although no specific effluent limits for radiological parameters are included in the KPDES permit for the Paducah Site, DOE Order 5400.5 does list derived concentration guides (DCGs), which are concentrations of specific radionuclides that would result in an effective dose equivalent of 100 mrem/year (the maximum allowable annual dose to a member of the public via all exposure pathways from radionuclides from DOE operations). Total average uranium concentrations in each of the five KPDES outfalls (1.1 pCi/L at Outfall K017 to 71.1 pCi/L at Outfall K015) were all well under the DCG for uranium (600 pCi/L). Similarly, the average ^{99}Tc concentrations in the five outfalls (0 pCi/L at K019 to 16 pCi/L at K015) were far below the DCG for ^{99}Tc (100,000 pCi/L).

At the surface water environmental surveillance locations, comparisons of downstream data with upstream data and reference waters can be done to evaluate the influence of the Paducah Site effluents on Bayou and Little Bayou creeks as well as on the Ohio River. Comparison of upstream Bayou Creek (SW 1) with the downstream location (SW5) shows an increase in uranium but no change for ^{99}Tc. The downstream Little Bayou Creek location showed an increase in total uranium, ^{99}Tc, ^{239}Pu, and ^{230}Th compared to the upstream location. Although the Paducah Site does add small quantities of these radionuclides to Bayou and Little Bayou creeks, the impacts to water quality are negligible, because the concentrations are far below the DCGs.

Nonradionuclide parameters that are measured at the five KPDES outfalls are currently limited to acute toxicity measurements (DOE 2000c). For 1998, there were only two exceedances of the permit limit, and they were at Outfall K017 during the third quarter. The first exceedance was for a sample collected on October 6, 1998. Because the sample was toxic, a retest was conducted on December 21, 1998, and it also was toxic. Because the toxicity exceeded the permit limit in both tests, a Toxicity Reduction Evaluation (TRE) was required and conducted in 1999.

The purpose of the TRE was to identify the cause(s) of the toxicity and remedial measures to prevent it from occurring.

At the surface water environmental surveillance locations, the concentrations for several constituents (acetone, aluminum, iron, uranium, chloride, suspended solids, and trichloroethylene) were reported for 1998 (DOE 2000c). Uranium and chloride concentrations increased in the downstream locations of Bayou and Little Bayou creeks, indicating that the Paducah Site contributes small quantities of these two constituents (Table 4.28). However, all the sample results for the Bayou and Little Bayou creeks are within the KPDES standards, which are based on warm water aquatic habitat criteria established by the Kentucky Division of Water (KDOW) [401 *Kentucky Administrative Regulations* 5:031].

Accident impacts to water quality from the worst-case on-site accident scenario (i.e., earthquake) involving radionuclides are described in detail in Appendix C. Assuming that 5% of the waste inventory is released, approximately 30,000 L of liquid would proceed down the conveyances. Therefore, it is likely that a spill of waste that travels undiluted to the Ohio River would adversely impact water quality until it was diluted in the river. This dilution would occur almost immediately upon the spill reaching the river. Therefore, the earthquake scenario is likely to cause harm to water quality in creeks draining into the Ohio River as a result of exposure to radionuclides, but the Ohio River water quality should not be adversely impacted.

K.1.5 Ecological resources

The No Action alternative would not adversely affect any threatened or endangered species. However, the vegetation and the wildlife using the vegetation on the 3-acre storage facility site would be affected. The vegetation would be permanently removed, and the birds, small mammals, and other wildlife using this habitat would be displaced.

Aquatic Biota. Short- and long-term impacts to aquatic biota from the No Action alternative should be similar to those currently occurring from the Paducah Site activities.

Table K.1. Selected nonradiological surface water surveillance results (average concentrations)

Parameter	SW 1 Upstream Bayou	SW 5 Downstream Bayou	SW 10 Downstream Little Bayou	SW 11 Upstream Little Bayou	SW 29 Upstream Ohio River	SW 64 Massac Creek
Acetone (µg/L)	ND	ND	1061	ND	ND	ND
Aluminum (mg/L)	4.58	ND	ND	ND	1.64	ND
Chloride (mg/L)	12.3	47.9	26.4	22.5	12.4	12.4
Iron (mg/L)	4.30	0.232	ND	0.534	1.63	1.13
Suspended solids (mg/L)	35.3	ND	10.8	ND	47	12
TCE (µg/L)	ND	ND	ND	1.3	ND	1.14
Uranium (mg/L)	0.006	0.007	0.008	ND	ND	ND

Source: DOE 2000c.
ND = Not detected.
SW = surface water environmental surveillance station
TCE = trichloroethylene

The impacts to aquatic biota can be evaluated by examining the results of the watershed monitoring program for Bayou and Little Bayou creeks. The watershed monitoring program for these two creeks has been conducted since 1987 and consists of three activities: (1) effluent toxicity monitoring, (2) bioaccumulation studies, and (3) fish community biosurveys (DOE 2000c). The results of these three studies for 1998 are briefly summarized below, and they provide an estimate of the impacts for the No Action alternative.

The results of the effluent toxicity tests for KPDES Outfalls K001, K015, K017, and K019 have already been discussed in Sect. 4.1. The only toxicity observed during the year was during two tests at Outfall K017. Because this outfall was toxic on two occasions, a plan for a TRE to identify the causes of the toxicity and remedial actions to eliminate it was submitted to KDOW for approval. Although the presence of toxicity at Outfall K017 is a direct indication of adverse impact to aquatic biota, the successful completion of the TRE should eliminate further toxicity.

The bioaccumulation study for polychlorinated biphenyls (PCBs) and mercury in fish focused on three locations in Bayou Creek [Bayou Creek kilometer (BCK) 12.5, BCK 10.0, and BCK 9.1], one location in Little Bayou Creek [Little Bayou Creek kilometer (LUK) 7.2], and one off-site reference location on Massac Creek (Massac Creek kilometer 13.8). These same locations were also used for the fish community biosurveys (DOE 2000c). Average PCB concentrations in fillets of longear sunfish *(Lepomis megalotis)* from Little Bayou Creek (0.11 to 1.33 mg/kg wet weight) were 2- to 133-fold higher than the average concentrations in longear sunfish from the reference site (DOE 2000c). In addition, the location in Little Bayou Creek closest to the Paducah Site had longear sunfish with the highest PCB concentrations. This indicates that the Paducah Site contributes PCBs to Little Bayou Creek, but the low concentrations also indicate that controls and remediation of PCB sources within the site are effective.

Average mercury concentrations in spotted bass (*Micropterus punctulatus*) from Bayou Creek in 1988 (approximately 0.17 mg/kg wet weight) was much lower than from the previous year (approximately 0.4 mg/kg wet weight) (DOE 2000c). The trend in mercury concentration in spotted bass from Bayou Creek has been declining since 1992.

The fish community biosurvey results indicate a slight degradation in the fish communities downstream of the discharges from the Paducah Site (DOE 2000c). The greatest impacts to the fish community [low number of total species (11) and absence of more sensitive species such as benthic insectivores, suckers, and darters] were at BCK 10.0, which was nearest to the discharges from the Paducah Site. At location BCK 9.1, approximately 900 m (2950 ft) downstream from BCK 10.0, the fish community showed fewer signs of impact as evidenced by the larger number of total species (21) and intolerant species. Intolerant species are fish that do not tolerate pollutants or degraded conditions. The fish community at LUK 7.2 showed minor impacts associated with the Paducah Site, as evidenced by a decline in fish density (number of fish per square meter). It is likely that high temperatures in the effluents or increases in sedimentation may have caused the fish community impacts (DOE 2000c).

Accident impacts to aquatic biota from the worst-case accident scenario (i.e., earthquake) involving radionuclides are described in detail in Appendix C. As shown in Appendix C, Table C.1, the ratios of modeled exposure concentrations versus benchmark concentrations of individual radionuclides are all less than 6.00×10^{-5}. The sum of the ratios (the total risk) is about 7.5×10^{-5}. This value is far below any concentration that could cause chronic radiation damage. In addition, the benchmarks are for chronic exposure, and conditions for chronic exposure are not likely to occur. Therefore, the earthquake scenario is highly unlikely to cause harm to aquatic biota in the Ohio River as a result of exposure to radionuclides.

Aquatic receptors in Bayou and Little Bayou creeks and other water conveyances by which the waste would reach the Ohio River would likely be killed by the caustic nature of the waste. Radiation exposure to any survivors would be of an acute nature; ecological risk models for acute radiation of biota are not available, but it has been estimated that an acute dose of 24 rad/day is unlikely to cause long-term damage to aquatic snails (National Council on Radiation Protection and Measurements 1991). Assuming that 5% of the waste inventory is released, approximately 30,000 L of liquid would proceed down the conveyances. Therefore, it is likely that a spill of waste that traveled undiluted to the Ohio River would kill all aquatic biota in its path until it was diluted.

Accident impacts to aquatic biota from the worst-case accident scenario (i.e., earthquake) involving nonradionuclides are described in Appendix C. As shown in Appendix C, Table C.2, PCBs are the only constituents whose ratio of river concentration to toxicity benchmark (2.08) exceeds 1, indicating that PCBs could pose adverse impacts to aquatic biota in the Ohio River, as well as in Bayou and Little Bayou creeks. None of the other nonradionuclide contaminants would reach high enough concentrations in the Ohio River to pose adverse impacts to aquatic biota, according to the assumptions of the accident analysis.

Terrestrial Biota. Short- and long-term impacts to terrestrial biota from the No Action alternative should be similar to those currently occurring from the Paducah Site activities. Construction of the new storage building could result in short-term disturbance to terrestrial wildlife due to the activities of land-clearing equipment.

There would be minimal long-term adverse impacts to terrestrial biota, along with some beneficial ones, after implementation of the proposed action. For example, construction of the new storage building for wastes would result in the long-term loss of potential habitat equal to the size of the building footprint. The adverse impact from the building is anticipated to be minor due to the small size of the building in relation to habitat available on the DOE reservation and to the lack of overall suitable habitat within the Paducah Site boundary. As mentioned above, data from the annual deer harvest, nonroutine rabbit sampling, and nonroutine raccoon sampling for 1998 (DOE 2000c) provide some indication of impacts to terrestrial biota and are briefly discussed in this section.

The annual deer harvest examined eight deer from the West Kentucky Wildlife Management Area (WKWMA) and two from the Ballard Wildlife Management Area to serve as reference samples (DOE 2000c). Selected analyses for the deer tissues included radionuclides, PCBs, silver, beryllium, nickel, and vanadium. No radionuclides were detected in the background deer, but ^{230}Th was detected in muscle from three deer from the Paducah Site. Liver samples from all deer had no detectable radionuclides. None of the deer had detectable PCBs in fat, muscle, or liver. Of the detected inorganics, silver was detected in the muscle of two deer from the WKWMA area. Data for the rest of the Paducah Site deer were not substantially different from the reference site deer (DOE 2000c).

At the request of the Kentucky Department of Fish and Wildlife Resources (KDFWR), rabbit sampling was conducted in 1998 and analyzed for radionuclides, PCBs, and inorganics (DOE 2000c). Six rabbits were harvested from the WKWMA. No radionuclides or PCBs were detected in the rabbits. Copper, iron, manganese, and zinc were detected in several muscle samples. However, these are all nutrients for mammals, so their presence is not unexpected.

At the request of KDFWR, raccoon sampling was conducted, with several raccoons being trapped from the WKWMA and Ballard Wildlife Management Area, which was used as the reference location (DOE 2000c). The raccoons were analyzed for PCBs and heavy metals. The study concluded that raccoons were being exposed to PCBs and metals at both locations, but it made no conclusions as to what impact the constituents had on the raccoons (Texas Tech University 1999).

Impacts to terrestrial biota from the modeled worst-case spill accident scenario (i.e., earthquake), along with soil concentrations, screening benchmarks, and results for individual radionuclides, are shown in Appendix C, Table C.1. The scenario for chronic radionuclide exposure as a result of the modeled worst-case spill indicated that the sum of chronic terrestrial exposures would be about 7×10^{-10} of the tolerable daily radiation dose as indicated by no further action (NFA) levels. Therefore, in even this worst-case accident scenario, long-term radiation effects to soil biota would be negligible.

Accident impacts to terrestrial biota from the worst-case accident scenario (i.e., earthquake) involving nonradionuclides are described in Appendix C. As shown in Appendix C, Table C.2, two organics (PCBs and 1,2,4-trichlorobenzene) and two inorganics (cadmium and chromium) have modeled concentrations that exceed the Paducah Site NFA benchmarks. PCBs in soil exceed the Paducah Site NFA benchmark by the largest ratio (65.8), followed by chromium (63.1). The soil cadmium modeled concentration exceeds the Paducah Site NFA benchmark by a ratio of 22.9. These ratios indicate that these constituents would likely pose adverse impacts to soil biota if the worst-case spill accident occurred.

K.1.6 Noise

There would no anticipated change in noise levels at the Paducah Site.

K.1.7 Cultural and archaeological resources

The No Action alternative is not expected to adversely impact any known cultural or archaeological resources. Should any new or suspected resources be discovered during the site preparation or construction activities for the new storage building, the State Historic Preservation Officer would be notified immediately, and consultations would begin to determine how to proceed.

K.1.8 Air quality

The No Action alternative would result in the continuation of current DOE waste management activities. Under the No Action alternative, potential impacts resulting from on-site treatment and disposal apply.

K.1.9 Socioeconomics and environmental justice

Socioeconomic Impacts. The No Action alternative would result in no net change in employment and, therefore, would have no notable socioeconomic impact on the region of influence.

Environmental Justice. Executive Order 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low Income Populations," requires agencies to identify and address disproportionately high and adverse human health or environmental effects its activities may have on minority and low-income populations. For the No Action alternative considered in this ecological assessment (EA), populations considered are those that live within 80 km (50 miles) of the Paducah Site.

Impacts from noise, air emissions, radiological emissions, and accidents would be low for both the residents closest to the site and the low-income communities. Exposures for the general public and the relevant workers would continue at historical levels for the Paducah Site.

The total radiation dose to the maximally exposed individual of the general public for all the Paducah Site operations has been estimated at 1 mrem/year (DOE 1999a), which is 1% of the radiation dose limit (100 mrem/year) set for the general public for operation of a DOE facility (DOE Order 5400.5). The external radiation dose for Paducah Site workers has ranged from 0 to 11 mrem/year in recent years (DOE 1999a). These doses are well below both the DOE administrative procedures dose limit (2000 mrem/year) and the regulatory limit of 5000 mrem/year (DOE 1999a; 10 *Code of Federal Regulations* 835). The U.S. Environmental Protection Agency limit is 25 mrem/year for an individual member of the public from all sources. All of these exposures are a very small fraction of the 360 mrem/year dose received by the general public and workers from natural background and medical sources.

K.2 RADIOLOGICAL AND NONRADIOLOGICAL IMPACTS FROM THE NO ACTION ALTERNATIVE

The No Action alternative is typically used as a baseline for evaluation of effects for proposed alternatives. Storage and management of low level radioactive waste (LLW) and transuranic (TRU) waste produce environmental resource impacts as well as economic impacts. These effects are added to those of the other waste management, operations, and environmental restoration activities at the Paducah Site. Storage buildings must be maintained, enlarged, and replaced as necessary to ensure the safety of the workers, public, and environment. If the No Action alternative were selected and construction of a new facility were required at a later date, the previously prepared EA that addressed storage facility construction would be reviewed for adequacy and revised if needed.

The No Action alternative would result in continued storage of LLW and TRU waste but would not address the long-term need for a final disposal plan. Potential impacts to the workers, public, and environmental resources are presented in this section.

K.2.1 Potential exposure of workers to radiological emissions

Workers are exposed to radiological emissions in the course of conducting waste management activities at the Paducah Site. These activities include, but are not limited to, routine inspections of storage areas for LLW and for TRU waste. The inspections are conducted to identify deteriorating or leaking containers and to verify inventories, placement of new waste, replacement of labels degraded by exposure to weather conditions, etc. In addition, repackaging of waste containers, checking radiation monitors, and replacement of barricades and postings are part of the routine maintenance activities. If a leak or spill occurs, workers in the immediate area and emergency response personnel may also receive radiological doses in proportion to the size of the spill and type of waste.

Exposure to radiation contributes incrementally to cancer risks for workers. Exposure levels and subsequent health impact evaluations are reported on an annual basis per DOE requirements. The

Paducah Site Annual Environmental Report provides the annual worker dose and latent cancer fatalities (LCFs) as a result of routine and nonroutine operations. The waste management activities associated with storage of LLW and TRU waste are part of the current operations at the Paducah Site. According to the latest annual report (DOE 1999a), the risks are well within the DOE controlled administrative and site-specific administrative levels. An estimate of the radiological dose and health impacts to workers from storage of LLW and TRU waste for the No Action alternative are presented in Table 4.29. Radiological dose and resultant LCFs are presented per waste type for the worker population expected to handle or work in the vicinity of the storage locations. As shown in this table, worker doses result in less than one latent cancer fatality per waste type based on a worker population of 30 full-time employees. The estimated radiological doses in this table are highly conservative, since it is not likely that workers would spend the entire workday in the waste storage areas. This estimate presents an upper bounding level that is unlikely to be approached due to the "as low as reasonably achievable" approach practiced at the Paducah Site. Steps taken to keep worker exposures as low as possible include limiting the time employees spend in each storage area, monitoring all worker exposure to avoid exceeding established control limits, prohibiting storage of liquids in outdoor storage areas, ensuring proper maintenance of emergency equipment, and undertaking waste minimization efforts. However, if waste quantities increase beyond current foreseeable projections, then the subsequent radiological impacts would increase incrementally on a cumulative population basis.

K.2.2 Potential exposure of the public to radiological emissions

The potential for public exposure to radiological emissions resulting from LLW and TRU waste management activities is limited at the Paducah Site. Since radiological emissions are minimized by time, distance, and shielding, it is unlikely that routine waste management activities would result in measurable quantities of radiological emissions at the Paducah Site boundaries. A perimeter-monitoring program and warning system are in place around the Paducah Site boundaries and elsewhere to evaluate impacts from routine operations as well as emergency conditions. There are off-site regulatory limits that are adhered to by the Paducah Site as well. Environmental monitoring activities are conducted routinely and reported in the Annual Environmental Monitoring Report (DOE 1999a). This report has not indicated any adverse impact from the Paducah Site operations that include waste management activities. Therefore, it is unlikely that the No Action alternative would impact the public above current levels in terms of radiological impacts from continued storage of LLW and TRU waste.

K.2.3 Nonradiological risks to workers from the No Action alternative

There are nonradiological safety risks associated with industrial facilities including activities at the Paducah Site. Workers can be injured or become ill due to workplace chemical hazards, work involving physical activity such as work around equipment, improper lifting, tripping hazards, etc. These risks are generally increased with an increase in the number of workers. These safety-related risks can be minimized through safety standards and worker safety awareness training at the Paducah Site as at other industrial facilities. Continued storage of LLW and TRU waste at the Paducah Site under the No Action alternative would increase these safety risks by requiring additional handling of the waste as maintenance and repackaging activities are needed. In addition, there would be routine monitoring activities in the storage locations that can present typical safety risks. These risks have been evaluated based on the average industrial accident rates for operations at similar industries. The estimated number of total recordable cases (TRCs) for the 30 workers associated with the No Action alternative would be 0.78 cases per year. A TRC is a case that includes work-related death, illness, or injury that resulted in loss of consciousness, restriction of work or motion, transfer to another job, or required medical treatment beyond first aid. The estimated lost workdays (LWDs) due to occupational illness or injury would be approximately 11 per year. The LWD is the number of workdays (consecutive or not) beyond the day of injury or onset of illness that the employee was away from work or limited to restricted work activity because of an occupational injury or illness. These estimates are based on the DOE and contractor illness and injury statistical averages for 1999 (CAIRS 1999).

In addition, as waste inventories grow over time, additional storage facilities or expansion of current capacity would be needed. This would require the use of heavy equipment and would introduce accident risks during facility construction. The added risk of construction activity would be evaluated as required when more specific details are known.

K.3 ACCIDENT ANALYSIS OF THE NO ACTION ALTERNATIVE

During the No Action alternative, the packaged waste containers would be transported to an on-site location and stored. The containers would be inspected periodically to verify that the containers are intact and repaired if required. These containers would be subject to the same conditions as the stored containers in the proposed action. They would, however, be at risk for a longer period of time.

The transformers are estimated to remain in place within the process buildings and not be subject to the risks of vehicle impacts and fires. In the event of an accident, the combustion products of fires would be contained to the buildings, thus minimizing on-site and off-site consequences.

Similar to the proposed action, accidents are postulated with the potential to breech the steel containers of the stored wastes and release the contents. The waste characteristics and the accident consequence methodology are the same as discussed for the proposed action. The accident selection and analysis results are discussed in Appendix C. The risks for both the proposed action and No Action alternative are compared in Sect. 4.2.4.

K.3.1 Accident selection and analysis

The accidents selected for evaluation of the No Action alternative based on the process discussed for the proposed action are shown in Table I.3.

As aforementioned, the PCB-containing transformers are estimated stored indoors and are not subject to the hazards estimated in the proposed action. Since other packaged wastes do not have notable radionuclide or toxic metal concentrations, fire accidents are not considered for the No Action alternative.

In summary, two bounding accidents are selected for evaluation: an evaluation-basis earthquake (EBE) and a vehicle impact/container mishandling accident. Since the waste characteristics and the accident scenarios are the same as those evaluated for the proposed alternative, the accident consequences are identical to those computed and discussed in Sect. 4.1. However, while the frequency of the earthquake accident is the same for both alternatives, the frequency of vehicle impact/mishandling accidents is much lower due to the lower activity level. It is estimated that vehicle impact/mishandling accidents occur with a frequency of 0.1/year for the No Action alternative versus 1/year for the proposed action. The conditional probability of striking a particular drum or set of drums is the same as discussed for the proposed action: 1.8×10^{-5} for the ThF_4 drum and 4.3×10^{-4} for the TRU waste drums. The corresponding frequencies for accidents involving these drums are, respectively, 1.8×10^{-6}/year for the ThF_4 drum and 4.3×10^{-5}/year for the TRU waste drums. The risks for the accidents occurring in the No Action alternative are summarized below based on the revised accident frequencies and the 100-year institutional control period.

Table K.2. Radiological impacts to workers from the No Action alternative

Waste type	Dose rate at 1 m (mrem/hr)	Annual impact worker population dose (person-rem/year)	LCF[a]
Acids/bases	0.028	1.75	0.001
Activated carbon	3.69	230.26	0.092
Batteries	NA[b]	NA	NA
Ash UF_6MgF_2	2.41	150.38	0.060
Contact cement	16.21	1011.50	0.405
Debris and rubble	2.41	150.38	0.060
DMSA liquid	11.79	735.70	0.294
DMSA solid	0.2	12.48	0.005
Grease	16.69	1041.46	0.417
Lab waste	2.7	168.48	0.067
LLW asbestos	0.21	13.10	0.005
LLW misc. equip	2.89	180.34	0.072
LLW other solids A	2.89	180.34	0.072
LLW other solids B	2.41	150.38	0.060
LLW other solids C	2.41	150.38	0.060
MLLW liquids A	0.23	14.35	0.006
MLLW liquids B	11.79	735.70	0.294
MLLW liquids C	11.79	735.70	0.294
MLLW other solids	0.21	13.10	0.005
MLLW solids A	0.23	14.35	0.006
MLLW solids B	0.27	16.85	0.007
MLLW soft solids A	0.23	14.35	0.006
MLLW soft solids B	0.23	14.35	0.006
Oil filters	8.43	526.03	0.210
PCB caps	3.98	248.35	0.099
PCB transformers	NA	NA	NA
Petroleum jelly	16.21	1011.50	0.405
Pure Th F	16.21	1011.50	0.405
Radium source	16.21	1011.50	0.405
RPCB liquids	11.79	735.70	0.294
RPCB solids	0.41	25.58	0.010
RPCB soft solids	0.21	13.10	0.005
RPCB soils A	0.42	26.21	0.010
RPCB soils B	0.26	16.22	0.006
Soil/trash/gravel	NA	NA	NA
Tc-99 grout tile	16.21	1011.50	0.405
T-99 waste	2.41	150.38	0.060
TRU liquids	0.46	28.70	0.011
TRU solids	0.74	46.18	0.018

[a]LCF = Estimated number of latent cancer fatalities from annual exposure.
[b]NA = Not enough data available.
DMSA = DOE Material Storage Area
LLW = low-level radioactive waste
MLLW = mixed low-level waste
PCB = polychlorinated biphenyl
RPCB = radiological polychlorinated biphenyl
TRU = transuranic

Table K.3. Accidents selected for evaluation of the No Action alternative

Accident	Wastes affected	Estimated frequency
EBE	all (12,000 m^3)	10^{-2} to 10^{-4}/year
Ground vehicle impact/mishandling	1 m^3	$>10^{-2}$/year

Earthquake:

MIW/MUW risk = 1.5×10^{-7} expected fatalities
MEI risk = 9.5×10^{-9} expected fatalities
Population risk = 7.5×10^{-8} expected fatalities

Vehicle impact/mishandling—ThF_4 container:

MUW risk = 7.9×10^{-8} expected fatalities
MEI risk = 1.1×10^{-9} expected fatalities
Population risk = 2.3×10^{-9} expected fatalities

Vehicle impact/mishandling—TRU containers:

MUW risk = 1.7×10^{-8} expected fatalities
MEI risk = 2.4×10^{-10} expected fatalities
Population risk = 5.2×10^{-10} expected fatalities

As shown, the risks for the No Action alternative increase for the earthquake by a factor of 10 due to the longer period at risk. The risks, however, for the impact accidents remain the same due to the compensating longer risk period and lower annual frequencies. Similar to the risks for the proposed action, these risks are considered minor.

In contrast to the accident consequences affecting the waste packages, the consequences of industrial accidents are smaller on a yearly basis due to the smaller work force required. During the No Action alternative, it is estimated that the stored wastes are monitored for possible deterioration on a periodic basis. It is estimated that this activity requires 30 full-time equivalents or 60,000 person-h/year over the 100-year alternative duration. Based on the 3.4×10^{-3}/200,000 person-h industrial fatality rate, the result would be 1.0×10^{-3} fatalities/year. Over the 100-year duration of the No Action alternative, 0.1 fatalities are expected. This represents a factor of 5 increases in the risk over the proposed alternative due to the longer duration.

K.4 COMPARISON OF ACCIDENT RISKS

As discussed in Sects. 4.1.3 and 4.3.3, risks have been computed for both process accidents and industrial accidents for the proposed action and the No Action alternatives. The highest radiological accident risk was 1.5×10^{-7} expected fatalities for the maximally exposed involved worker/maximally exposed uninvolved worker at the edge of the waste storage area during and following an earthquake. This risk was computed for the 100-year no-action institutional period. The second highest risk, 7.9×10^{-8} expected fatalities, was computed for the vehicle impact/mishandling accident impacting the ThF_4

container during the 10-year proposed action operating period. The risks are the same for both alternatives, but the proposed action has a shorter duration. These risks are minor.

The industrial accident risks, while higher than the radiological accident risks, were small. The computed risk for the proposed action was 0.02 expected fatalities over the 10-year operating period. The corresponding industrial accident risk for the No Action alternative was 0.1 expected fatalities over the 100-year institutional control period. Neither the risks nor the differences between them are considered notable.

K.4.1 Transportation Impacts

Under this alternative no Paducah waste would be transported off-site. Therefore, there are no transportation impacts associated with this alternative.

K.4.2 On-site Treatment Impacts

Under this alternative no on-site treatment would occur. All wastes would be maintained in storage facilities. Therefore, no treatment impacts are associated with this alternative.

REFERENCES

CAIRS (Computerized Accident/Incident Reporting System) 1999. DOE and Contractor injury and Illness Experience by Year and Quarter (January 1999-December 1999 data used), Web site tis.eh.doe.gov/cairs/cairs/dtaqtr/q003a.pdf, Rev. 12/21/2000.

DOE (U.S. Department of Energy) 1999b. *Final Programmatic Environmental Impact Statement for Alternative Strategies for the Long-Term Management and Use of Depleted Uranium Hexafluoride*, DOE/EIS-0269, U.S. Department of Energy Office of Environmental Management, Washington, D.C.

DOE (U.S. Department of Energy) 2000c. *Paducah Site–1998 Annual Environmental Report*, prepared for BJC and DOE by CDM Federal Services Inc., Kevil, Kentucky, February.

Texas Tech University 1999. *Raccoons (Procyon Lotor) as Sentinels for Polychlorinated Biphenyl and Heavy Metal Exposure and Effects at the Paducah Gaseous Diffusion Plant, McCracken County, Kentucky*, The Institute of Environmental and Human Health, Texas Tech University Health Science Center, Lubbock, Texas.

THIS PAGE INTENTIONALLY LEFT BLANK.

APPENDIX L

PUBLIC COMMENT RESPONSE TABLE

THIS PAGE INTENTIONALLY LEFT BLANK.

COMMENTS FOR THE PREDECISIONAL DRAFT ENVIRONMENTAL ASSESSMENT FOR WASTE DISPOSITION ACTIVITIES AT THE PADUCAH SITE, PADUCAH, KENTUCKY JANUARY 2002

Comment No.	Page/ Section	Comment	Response
Robert R. Loux, State of Nevada			
1.	Fig. 3.6	The highway route shown assumes that waste would be shipped into Nevada on I-15 and connect with U.S. 95 in Las Vegas. NNSA/NTS requires that shippers of LLW to NTS for disposal use highway routes that avoid the metropolitan Las Vegas area, Hoover Dam, and the I-15/U.S. 95 interchange. This policy has been in effect for over two years. A "representative" highway route for shipments of LLW from Paducah must conform with these stipulations. The map in Fig. 3.6 should be revised to reflect an acceptable "representative" route.	Text and Figure will be modified. See comments on last page of this document.
2.	Fig. 3.13	The rail route shown assumes that waste would be shipped into Las Vegas on the Union Pacific mainline. There is no intermodal facility in Las Vegas—or in Nevada—for the transfer of LLW from rail cars to trucks. The State of Nevada strongly opposes ANY intermodal transfer of LLW within its borders. The map in Figure 3.13 should be revised to reflect either (1) that rail/intermodal transport is not feasible to the NTS or (2) that an intermodal facility outside Nevada must be used for such shipments.	See comments on last page of this document.
3.	p. 66	The predecisional draft EA assumes that "the container used for transportation of TRU waste is 55-gal drums in one truck shipment." The WIPP Land Withdrawal Act requires that TRU waste be transported using NRC-certified shipping containers. The reference TRU waste shipping container for contact-handled TRU waste should be the TRUPAC II or the HALFPAC container. The Western Governors' Association has negotiated a series of protocols with DOE governing shipments of TRU waste. These protocols require that TRU waste be transported in appropriate and certified TRUPAC II or HALFPAC containers.	Noted. Text has been added to state that the 55 gallon drums will be overpacked in TRUPAC II or HALFPAC containers.
Ruby English, Neighbor and Chairman of ACT			
1.	General	What guarantee can the Department of Energy give to us, the neighbors, that in the process of loading these contaminants in containers and loading them on trucks or by rail that NO accidents will take place to contaminate the surrounding area to the public?	During waste handling DOE procedures will be followed. These procedures are prepared with attention to the workers, public and the environment and are in place to minimize the possibility of accidents. All workers will be trained in these procedures. Appendix G analyzes the potential risk impacts from container handling.

Comment No.	Page/ Section	Comment	Response
2.	General	How can you determine that at the end of the 10-year period the risk of an on-site accident is eliminated for humans? I don't see how you can evaluate what you don't or haven't had happen at this time, let alone ten years down the road. You cannot say that in five years an earthquake won't occur, nor a train derailment will not occur, or that one or more containers will not rupture and release toxic chemicals into the air and ground, as they are in such poor condition. There is no way you can assume what may or may not happen in the future.	The EA does not assume that all risks are completely gone at the end of 10 years. This clarification will be made in the section defining the scope of the analysis (Section 1.2). The 10-year time frame is for bounding the risk analysis for legacy wastes. However, the risk is anticipated to greatly reduce due to the majority of wastes having been moved or disposed.
3.	General	As you state in your report, your evaluation of an earthquake affects all stored containers. Your idea of a large air crash is also probable. Look at New York. No one expected that to happen, but it did. So don't think it couldn't happen at Paducah or one of your other locations.	Point noted.
4.	General	In the rail transportation route, what assurance will be made to make sure that the general public along the route will be protected from any mishaps or accidents that will or could possible harm the public?	All waste packaging will be done in accordance with applicable DOT and rail requirements. During waste transportation applicable procedures will be followed. These procedures are prepared with attention to the workers, public and the environment and are in place to minimize the possibility of accidents. All workers will be trained in these procedures. Appendix H analyzes the potential risk impacts from waste transportation.
		Helen Belencan, DOE	
1.	General	The authors of this document have incorrectly cited and misinterpreted the Department's Record of Decision for the treatment and disposal of LLW and MLLW. The correct citation for the ROD is "*Record of Decision for the Department of Energy's Waste Management Program: Treatment and Disposal of Low-Level Waste and Mixed Low-Level Waste; Amendment of the Record of Decision for the Nevada Test Site*, February 25, 2000, 65 Federal Register 10061."	Citation has been corrected. Misinterpretation will be revisited (see next comment).
2.	General	In the EA, the authors state "DOE has determined to dispose LLW and MLLW at the Hanford Site in Washington state and at the Nevada Test Site …" Further, Table 1.3, the summary of waste management PEIS RODs, identifies disposal at NTS or Hanford as the decision for LLW disposal. These interpretations are not fully correct. As noted in Table 1.3 for MLLW disposal, the programmatic decision did not preclude DOE's use of commercial disposal facilities. The same condition holds for LLW. Under the programmatic ROD, LLW from any DOE site may be disposed at Hanford, NTS, or commercial disposal facilities. Table 1.3, LLW disposal, should be corrected. Use of	Agreed. Document text and tables will be modified to provide DOE the maximum flexibility in selecting a disposal facility for wastes.

Comment No.	Page/ Section	Comment	Response
		commercial disposal facilities is consistent with DOE's waste management order (O 435.1) and the commercial disposal policy. Additionally, LLW may also continue to be disposed on site at Los Alamos, Savannah River, INEEL, and Oak Ridge. The programmatic ROD does not restrict DOE facilities to disposing of LLW only at Hanford and NTS. The authors of the Paducah EA have unnecessarily restricted the site's flexibility in choosing an off-site disposal facility. To allow Paducah the greatest flexibility in its disposition of LLW, the EA should instead identify off-site disposal, at either of DOE's regional disposal sites (NTS or Hanford) or at a commercial disposal facility. The decision as to which off-site disposal facility should be used should be based upon the characteristics of the waste stream, the waste acceptance criteria of each disposal facility, the schedule requirements, and the full cost of disposal, which includes the disposal fee as well as the costs to characterize, package, and transport the waste.	
		Mark Donham, RACE/Heartwood	
1.		We believe that your finding that the enhanced storage alternative was not feasible and was not fully developed was wrong. For one thing, the reason given for rejecting the alternative only applies to about 1/3 of the waste. Even so, we believe that it is possible that an enhanced storage facility alternative could be feasible for that 1/3 of the waste, because the agency is supposed to consider feasible alternatives even if it requires a change in the law.	Your concern is noted and the enhanced storage alternative has been added.
2.		For the agency to conclude that an enhanced storage alternative is so severely outweighed by the shipping and landfilling alternative seems very suspect. For example, if there is an accident the cost of cleanup and liability could be considerable. Is this possibility figured into the cost/benefit analysis? What about long term stewardship? You are proposing to dump these wastes into landfills, but what if, in the future, they leak? You have to admit this is likely. Is long term stewardship dollars included in the cost benefit analysis?	See #1.
3.		Why can't the agency consider building new structures around the existing ones? That way none of the waste would have to be moved, but the containment could be significantly improved, and we could avoid the risks associated with shipping and landfilling. Even new buildings only would require 3 acres, which is an insignificant part of the site. However, these structures would have to consider and design for the significant earthquake risk associated with the Paducah site at the edge of the zone 10 intensity (maximum) of the New Madrid seismic zone.	See #1.

Comment No.	Page/ Section	Comment	Response
4.		While we appreciate the fact that DOE is sharing the proposed waste shipping routes with the public, we doubt if the communities along the route have been adequately notified about the volumes and content of the shipments planned through their proposal. For example, some of your shipping routes propose that rail shipments will go to Carbondale, Illinois where the track south across the Mississippi will be accessed south to Texas. This track runs right through the center of Carbondale, and yet, we don't believe that the city officials nor the public have been properly notified. We believe that is probably the rule and not the exception along all the shipping routes. The EA should be reissued for public comment with notices in all of the papers along the shipping routes.	Public involvement for the EA included: 1) EA availability was published in the Federal Register 2) The EA was sent to states through which the wastes would travel. A list of states to which the document was distributed is presented in Appendix B. 3) The EA is posted in its entirety on the DOE public web page. 4) Public involvement that is tiered under the public involvement performed for the higher-level NEPA documents presented in table 1.2. For example, the Programmatic Waste EIS where a nation wide public involvement process was executed 5) Compliance with requirements described in 40 CRF 1506.6
5.		We wonder what is going to happen to all of the other legacy waste not dealt with in this EA. For example, it has been commonly stated for years that there are approximately 50,000 barrels of legacy waste at the site, and yet this EA only covers approximately 11,000 cubic meters, including the DMSAs (DOE Material Storage Areas) or at least part of it. A cubic meter has to be approximately equivalent to a barrel, and so the waste volumes provided only represent a small percent of the previously identified legacy waste. What is going to happen to the rest?	One cubic meter is equal to 35.3 cubic feet. One 55-gallon drum is equal to 7.4 cubic feet. So there are 4.8 55-gallon drum in one cubic meter. So 11,000 cubic meters will be approximately 52,470 55-gallon containers. Therefore this EA addresses all the legacy waste located at the Paducah Site.

Comment No.	Page/ Section	Comment	Response
6.		Finally, the cumulative impact analysis is inadequate. We have told the agency over and over that what is needed is a site wide analysis with public involvement. The agency is doing every sidestep to avoid doing this, when all of the major oversight groups who have looked at the site, including even the GAO, all agree that it should be done. A cumulative impacts analysis during the EA process must consider past, present, and reasonably foreseeable future actions in a cumulative impact analysis. Those impacts must be considered in combination. At the PGDP, there is a variety of activities which are reasonably foreseeable, such as production, groundwater remediation, surface water remediation, construction and reconstruction of landfills, UF6 conversion, metals decontamination and recycling, and other activities. Each of those activities has an environmental impact, and we would like to know what the cumulative impact of all those activities is? DOE's own attorney's argued in court when we sued for the site wide EIS that we should challenge the cumulative impact analysis in an ongoing EA, and this is precisely the vehicle, and we are taking your advice and challenging it.	The cumulative impacts analysis has been revisited and the DOE feels the impacts analysis is in compliance with NEPA requirements.
7.		We also are very concerned about how the site characterizes waste as wither LLW, MLLW, and TRU. We think a full rationale should be articulated in the EA about how DOE makes that determination. It seems to us that wastes that likely should be classified as TRU is being classified as LLW. This needs to be reviewed.	Waste is characterized through the use of physical sampling and process knowledge. Waste types are categorized in accordance with DOE order 435.1 that defines the characterization parameters for each waste type. Sampling to ensure compliance with the Waste Acceptance Criteria (WAC) of the disposal facility is performed before waste shipment.
8.		We favor enhanced storage at the Paducah site, combined with intensive research into ways to stabilize the wastes to facilitate enhanced storage. It will take some real effort to make this an environmentally sound method to deal with this waste, but in the end it deals with the transportation and disposal risks, and improves the status quo. If it doesn't comply with current regulations, which we question, then the agency needs to look at changing regulations. This needs to be considered in the EA.	See #1.
9.		Finally, if you did a proper cumulative impact analysis, we believe that it would be difficult if not impossible to support a FONSI. Of course, we have advocated for a site wide EIS for how many years now? Considering that DOE is now asking for a clean slate and a new cleanup plan overall, don't you think the time is right for the site wide EIS?	Comment noted.
John Owsley, Department of Environment and Conservation, DOE Oversight Division			
1.	General	The major issues of concern for the state are issues relating to the potential treatment and/or storage of waste from other DOE facilities at the Oak Ridge Reservation.	Concern noted.

Comment No.	Page/ Section	Comment	Response
2.	Sect. 1.2, p. 4, para. 4, 4th sent.	This sentence states that "*Some MLLW is proposed for off-site treatment at the TSCA incinerator in Oak Ridge, Tennessee*." The state will continue to reiterate its position regarding the management of out-of-state wastes that are treated in Oak Ridge, which is that, all the residues from these wastes must be properly disposed or returned to the generator. The document should clearly explain the disposition methods and pathways of residual wastes that result from these wastes that are sent to Oak Ridge for treatment.	Text will be added to state the state's position. Residual wastes will be dispositioned in accordance with TSCA operating procedures and the Residual Management Plan fort the TSCA incinerator which is shared with the state of KY under the STP..
3.	Table 1.2, p. 5	Additional DOE documents addressing Paducah Site wastes: This table outlines the various documents pertaining to the wastes as well as their proposed actions. The table includes information on transuranic waste (TRU) proposed for staging and for transportation from Oak Ridge National Laboratories (ORNL) for disposal at Waste Isolation Pilot Plant (WIPP). Likewise, in a letter of February 14, 2001, addressed to the manager of DOE's Carlsbad, New Mexico office, on the subject of Transuranic Waste Shipment Schedules to the Waste Isolation Pilot Plant, we stated "*Oak Ridge is shown as a potential destination for three shipments from Battelle Columbus beginning March 2001. This is not an option. Tennessee will not become an interim radioactive waste storage facility for the DOE complex. As discussed with Oak Ridge Operations Staff, the state will consider treatment and packaging of out-of-state transuranic waste on a case-by-case basis after the Oak Ridge TRU Processing Facility is operational and Oak Ridge Waste is routinely shipped to WIPP*." This document should reflect the state's contention that off-site TRU waste shipments to Tennessee shall be for undelayed treatment and packaging in preparation to WIPP, and furthermore is contingent upon routine ORR TRU waste shipments to WIPP.	A text insertion was made to section 2.1.5.4 to include the state's position on out of state TRU waste shipment through Oak Ridge in route to WIPP.
		Charles & Vicki Jurka	
1.	P K-7, K.1.6, Noise; p 11, 2.1.1	Storage is inconsistent and will be rewritten stating only "existing facilities would be used" and that no new buildings "would be constructed".	Agreed. Correction will be made.
2.	p. 2, Table 1.1	Paducah EA waste information shows the approximate total volume of TRU waste at 5m-3 while other sections of this EA indicate greater amounts (eg: pg. 11, 2.2.2 On-Site Treatment, "10m-3 of TRU waste"). Page 6, Quantities of Legacy Waste On-site, presented during the April 9, 2002 public meeting, put the quantity of TRU waste at "about 6 cubic meters". This entire EA should be adjusted to reflect the correct amount of TRU waste at Paducah. Further, any analysis in this EA that was based on incorrect volumes of TRU waste should be recalculated and all pertinent risk re-evaluated.	Agreed. Page 11 was corrected to reflect the $6m^3$ of TRU waste presented in Table 1.1. This also makes the volume consistent with the public meeting information. Analysis was confirmed for $6m^3$ of TRW waste.

COMMENTS FOR THE PREDECISIONAL DRAFT ENVIRONMENTAL ASSESSMENT FOR WASTE DISPOSITION ACTIVITIES AT THE PADUCAH SITE, PADUCAH, KENTUCKY JANUARY 2002

Comment No.	Page/ Section	Comment	Response
3.	p. F-15, 5.	"…..during a worst-case accident scenario (earthquake), sufficient PCBs potentially could reach the Ohio River and slightly exceed the toxicological benchmark for aquatic biota." When modeling this earthquake scenario, what was the source of the PCBs and were the levels of PCB currently in the soil and ground/surface water, at PGDP and surrounding environment, included in the calculations?	Current contamination levels in the soil and water resources was considered in the site baseline conditions. The breach of stored waste containers were the source of the PCB release and these levels were additive to the baseline. Appendix table C-2 presents the baseline concentration numbers as well as the concentrations and volumes of the modeled accidental releases.
4.	p. C.3, C.3.1	"Under the earthquake scenario, it is assumed that 5% of the radioactivity in the liquid waste is released." Further, Table C.1 shows Pu-239 as one of the radionuclides considered under the 5% assumption. When modeling this earthquake scenario, what was the source of the Pu-239 and were the levels of total Pu, currently in the environment (at and around PGDP), included in the calculations? During the public meeting the response to this question was that the 5% assumption was based on industry standard. Please provide the titles of the documents that present that standard and answer the rest of this question.	Current Pu contamination in the soil and water resources was considered in the site baseline conditions. The breach of stored waste containers are the source of the release under this accident scenario and these levels were additive to the baseline. Appendix table C-1 presents the baseline concentration numbers as well as the concentrations and volumes of the modeled accidental releases.
5.		What is the name of the nitric acid/TRU neutralization process?	The TRU waste treatment process will include sedimentation, pH neutraslization, and cementation or solidification.
6.	p. I-4, 4.1.1	Methodology "…..nearest boundry…550m…" Page J-3, Human Health Impacts…, "…..located approximately 520m…". During the public meeting it was agreed that the distances in this EA would be standardized to reflect the correct distance.	Agreed. Measurement will be confirmed and corrected.

Comment No.	Page/ Section	Comment	Response
7.	p. K-3&4	What is the derived concentration guide for Pu-239? What outfall(s) releases the Pu-239 found in Little Bayou Creek? What PGDP operations (EM, USEC, etc.) release effluent to each individual outfall bearing Pu waste?	No reference to Pu239 was found on these pages. The source for the Uranium numbers presented on these pages is the 1998 ASER, pages 4-4 and 4-5. Plutonium concentrations at various surface water locations are presented in the ASER on page 5-3. A map showing the location of the sampling locations is on page 5-2 of the ASER. Although no specific effluent limits for radiological parameters are included in the KPDES permit for the Paducah Site, DOE Order 5400.5 lists derived concentration guides (DCGs), which are concentrations of specific radionuclides that would result in an effective dose equivalent of 100 mrem/year, the maximum allowable annual dose to a member of the public via all exposure pathways from radionuclides from DOE operations (10 CFR 835.100). DOE Order 5400.5 also provides the requirements to keep exposures as low as reasonably acheiveable (ALARA).
8.	p. F-15, 5	For this earthquake scenario, how many gallons of PCB would need to be released from the site in order to “slightly exceed the toxicological benchmark for aquatic biota”?	The analysis for the biological assessment is the same as for that of the EA (appendix C). The appendix states that for the terrestrial and aquatic resource impact analysis 13,700 gallons (Table C.2) of PCB contaminated liquid (not pure PCBs) were assumed released. The impact analysis is extremely conservative; this analysis is approximately 2 times greater than what would be anticipated in the event of an accident.
9.	p. 23	Threatened and Endangered Species: The scientific name Plethobasus cooperianus is incorrectly spelled throughout this EA as Plethrobasus cooperianus.	Agreed. This was corrected.

Comment No.	Page/ Section	Comment	Response
10.	p. 24 4, F-12, F15&16	In the 1990's, populations of the federally endangered Plethobasus cooperianus were found in the lower Ohio River near and below the "Paducah site". The Commonwealth of Kentucky has identified Plethobasus cooperianus habitat at Ohio River mile 940.7 to 943.3 (McCracken County, Ky.) and at Ohio River mile 966.3 to 969.5 (Ballard County, Ky.). The Kentucky State Nature Preserves Commission lists Plethobasus cooperianus and Obovaria retusa as endangered species with Ballard County, Ky., Ohio River habitat. Also, the U.S. EPA, Office of Pesticide Programs, similiarly identifies Plethobasus cooperianus Ballard County, Ky., Ohio River habitat. Their literature states "other populations (of Plethobasus cooperianus) survive in the lower Ohio River between Metropolis and Mound City, Illinois". Others have identified a shoal containing endangered mussels on the Kentucky side of the Ohio River (opposite Mound City, Il.) at Ohio River mile 971.3 to 973.3. The Illinois Department of Natural Resources identified Plethobasus cooperianus Ohio River habitat near Mound City, Il. and near Cairo, Il.. They also cite federally endangered Lampsilis ovata habitat in the Ohio River at Alexander County, Il… Shawnee National Forest (USDA) publications identify federally endangered Lampsilis arbrupta, Ohio River habitat, at Massac County, Il. and Plethobasus cooperianus, Ohio River habitat, at Pulaski County, Il.. Additionally, the U.S. Army Corps of Engineers speaks about "two mussel beds containing the "endangered orange-footed pearly mussel (Plethobasus cooperianus)".. "near Olmsted, Il." (Ohio River) below the Paducah site. The endangered orange-footed pearly mussels in the beds near Olmstead "are suspected to be reproducing, so any adverse effect on this population could threaten the survival of the species."	The EA looks at the locations in the Ohio River where potential populations of mussels would be most greatly affected, i.e. at the conveyance of Bayou Creek with the Ohio River. The accident analysis found that no or little impact would occur to populations located in the area of the conveyance. Therefore, any subsequent populations located downstream would suffer less impact due to dilution of contaminants in the Ohio River.

Comment No.	Page/ Section	Comment	Response
11.	General	After reading this EA we are not satisfied that "qualified biologists" have adequately assessed the "potential impacts" of waste disposition activities and determined how "the proposed project might (may) affect the species" (pg. E-8). 1) In this situation actual calculations, specific to the Paducah site, should be the measure; rather than relying on assumptions based on industry standards that can vary from project to project. 2) Well researched reports regarding the impact of radionuclides and PCBs on mussels are readily available and should be reviewed before determining this projects impact on the endangered mussels below the Paducah site (Ohio River). 3) Particular attention should be given to the future impact of long-term on-site disposal (i.e. landfills).	1) Actual calculations specific to the Paducah site were performed based on the specific Paducah Site waste characteristics. All impact analysis considered available site data from Paducah Site reports. The industry standards were only used in making assumptions as to the potential release of contaminants due to accidents. The standard, which is a 5% release of materials, is a low probability high consequence scenario that binds the analysis within the document. There is no existing data for an actual percentage of container breaches resulting from a significant accident therefore industry standards are acceptable. 2) Literature review was performed. The states of Kentucky and Illinois as well as the EPA and FWS were sent copies of the EA for review and comment. As of this date no comments have been received from these agencies. 3) No on-site disposal is considered within the proposed action of this document. Biologists' qualifications are presented in Appendix A.

Comment No.	Page/ Section	Comment	Response
National Nuclear Security Administration Nevada Operations Office (NNSA/NV)			
1.	p. 38, Fig. 3.6	This figure is a map showing a proposed waste transportation route through the Las Vegas Valley. This map should show the preferred route identified by the state of Nevada stakeholders that avoids waste transportation through the Las Vegas Valley or over Hoover Dam. The NNSA/NV encourages generators to avoid the Las Vegas Valley and the Hoover Dam Area. <u>Recommendation:</u> Please change route to avoid the Las Vegas Valley and/or Hoover Dam Area by showing the following route: Route to Topeka, Kansas, is unchanged from Topeka, Colorado, on I-25 to Cheyenne, Wyoming from Cheyenne, Wyoming, on I-80 to West Wendover, Nevada from West Wendover, Nevada, on US-93 to Ely, Nevada from Ely, Nevada, on US-6 to Tonopah, Nevada from Tonopah, Nevada, on US-95 to Mercury, Nevada **An alternate route, used during winter conditions, would be:** From Paducah, Kentucky, on US-62 to Wickliffe, Kentucky from Wickliffe, Kentucky, on US-62 to the I-57 Interchange near Charleston, Missouri from I-57 Interchange in Missouri to I-55 Interchange in Missouri from I-55 Interchange in Missouri to the I-40 Interchange in West Memphis, Arkansas from I-40 Interchange in West Memphis, Arkansas, to Needles, California from Needles, California on US-95 to Searchlight, Nevada from Searchlight, Nevada, on Nevada State Route-164 to the I-15 Interchange in California from the I-15 Interchange in California to Baker, California from Baker, California, on US-127 to Nevada State Route 373 to Amargosa Valley, Nevada From Amargosa Valley, Nevada, on US-95 to Mercury, Nevada	The route will be changed as defined in the comment to avoid waste being transported through the Las Vegas Valley.

Comment No.	Page/ Section	Comment	Response
2.	p. 46, Fig. 3.13	This figure is a map showing a proposed waste rail transportation route through the Las Vegas Valley. State of Nevada stakeholders prefer to avoid rail transportation of radioactive waste through Nevada. The NNSA/NV encourages generators to avoid rail transportation of radioactive waste through Nevada. Recommendation: There are companies in Utah that are currently working on intermodal transportation routes. For example, one company stationed in Milford, Utah, would receive rail transported waste at its Utah site, transfer the waste to trucks, and transport the waste to Mercury, Nevada, using the following possible routes: 1. From Milford, Utah- West on UT-21 (turns to NV-487) to US 6/50 to Ely, Nevada. From Ely, Nevada - Southwest on US-6 to Tonopah, Nevada. From Tonopah, Nevada - South on US-95 to Mercury, Nevada. 2. From Milford, Utah - South on UT-257/130 to Cedar City, Utah. From Cedar City, Utah - West on UT-56 (turns to NV-319) to Panaca, Nevada. From Panaca, Nevada - Southwest on US-93 to NV-375 to Warm Springs, Nevada. From Warm Springs, Nevada - West on US-6 to Tonopah, Nevada. From Tonopah, Nevada - South on US-95 to Mercury, Nevada.	Intermodal options are not fully defined and are too numerous to present in detail. Text has been added to page 13, section 2.1.4, to present the option of intermodal transport as agreed to by DOE, the individual state, and stakeholders.
Envirocare of Utah, Inc.			
1.		As also noted in comments submitted by Helen Belencan, Mixed Low-Level and Low-Level Waste Program Manager of DOE's Office of Integration and Disposition, EM-22, DOE is not and should not be precluded from using commercial disposal facilities. Therefore, such restrictions should not appear in the Paducah Environmental Assessment nor should they be applied to the disposition of waste from the Paducah Gaseous Diffusion Plant.	Noted. Document text and tables will be modified to provide DOE the maximum flexibility in selecting a disposal facility for wastes.
2.		It is suggested that the Environmental Assessment Waste Disposition Activities at the Paducah Gaseous Diffusion Plant include an evaluation of implementation of the best-value alternative for disposition of wastes, also considering available commercial disposal options.	Agreed. Document text will be modified to provide DOE the maximum flexibility in selecting a disposal facility for wastes.