APPENDIX A

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APPENDIX B

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APPENDIX C

ANALYSIS OF ACCIDENT IMPACTS TO NATURAL RESOURCES

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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.

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APPENDIX D

WILDLIFE SPECIES OCCURRING AT THE PADUCAH SITE

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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).

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APPENDIX E

CONSULTATION LETTERS AND RESPONSES

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Department of Energy

Oak Ridge Operations Office
P.O. Box 2001
Oak Ridge, Tennessee 37831—

August 16, 2001

Dr. Lee Barclay
Fish and Wildlife Service
United States Department of Interior
446 Neal Street
Cookeville, Tennessee 38501

Dear ~~Dr. Barclay~~ Lee:

INFORMAL CONSULTATION UNDER SECTION 7 OF THE ENDANGERED SPECIES ACT FOR THE PROPOSED DISPOSITION OF WASTES AT THE PADUCAH SITE, PADUCAH, KENTUCKY

The United States Department of Energy (DOE) has various waste types at the Paducah site in Paducah, Kentucky that must be treated and transported or transported to treatment and disposal facilities. DOE is under regulatory agreements to treat and dispose of these wastes. The wastes would be transported offsite over a ten-year period, starting in 2001.

Under the proposed action, several thousand cubic meters of low-level, mixed low-level and hazardous (PCB) waste and about 12 m^3 of transuranic (TRU) waste would be transported from the Paducah site to eight DOE and commercial treatment and disposal facilities. Some minor onsite treatment is proposed. Annually DOE would dispose of approximately 52 m^3 low level waste (LLW) water after onsite treatment (lime precipitation) to meet Kentucky Permit Discharge Elimination System (KPDES) limits. The TRU waste would be treated (stabilization) onsite before shipment to Oak Ridge. Also, approximately 1800 m^3 of soil and debris containing some residual radioactivity but meeting the waste acceptance criteria for the onsite C-746U landfill would be disposed at the Paducah site without treatment. The remaining wastes would be shipped offsite for treatment and/or disposal. Some Resource Conservation and Recovery Act (RCRA) wastes would be shipped to the Toxic Substances Control Act incinerator in Oak Ridge. Most of the LLW would be shipped to the Nevada Test Site. The PCB waste would be shipped to Utah and Texas. Some waste will go to DOE's Hanford site in Hanford, Washington and some will go to various commercial contractors in Texas, Tennessee, and Utah. Wastes will be shipped by either truck or rail in the Department of Transportation (DOT) or other approved containers in accordance with waste shipping regulations.

There will be minimal onsite construction at the Paducah site. Some interiors of existing buildings would be modified to expedite repackaging, waste handling, and in some cases treatment of wastes. No new landfills or other major site modifications are proposed.

This letter is intended to serve as informal consultation under the Endangered Species Act. In this regard, DOE requests an updated list of protected species or habitat on or near the project site and solicits your recommendations and comments about the potential effects of this proposed action. Your input will be used in the preparation of an environmental assessment for this action pursuant to the National Environmental Policy Act.

If you need further information on this request, please do not hesitate to call me at (865) 576-0938.

Sincerely,

James L. Elmore

James L. Elmore, Ph.D.
Alternate NEPA Compliance Officer

cc:
Gary Bodenstein, EM-98/PAD
David Tidwell, EM-98/PAD
Diane McDaniel, SAIC

Department of Energy

Oak Ridge Operations Office
P.O. Box 2001
Oak Ridge, Tennessee 37831—

August 16, 2001

Mr. Keith Wethington
Kentucky Department of
Fish and Wildlife Resources
#1 Game Farm Road
Frankfort, Kentucky 40601

Dear Mr. Wethington:

CONSULTATION CONCERNING STATE-LISTED SPECIES FOR THE PROPOSED DISPOSITION OF WASTE AT THE PADUCAH SITE, PADUCAH, KENTUCKY

The United States Department of Energy (DOE) has various waste types at the Paducah site in Paducah, Kentucky that must be treated and transported or transported to treatment and disposal facilities. DOE is under regulatory agreements to treat and dispose of these wastes. The wastes would be transported offsite over a ten-year period, starting in 2001.

Under the proposed action, several thousand cubic meters of low-level, mixed low-level and hazardous (PCB) waste and about 12 m^3 of transuranic (TRU) waste would be transported from the Paducah site to eight DOE and commercial treatment and disposal facilities. Some minor onsite treatment is proposed. Annually DOE would dispose of approximately 52 m^3 low level waste (LLW) water after onsite treatment (lime precipitation) to meet Kentucky Permit Discharge Elimination System (KPDES) limits. The TRU waste would be treated (stabilization) onsite before shipment to Oak Ridge. Also, approximately 1800 m^3 of soil and debris containing some residual radioactivity but meeting the waste acceptance criteria for the onsite C-746U landfill would be disposed at the Paducah site without treatment. The remaining wastes would be shipped offsite for treatment and/or disposal. Some Resource Conservation and Recovery Act (RCRA) wastes would be shipped to the Toxic Substances Control Act incinerator in Oak Ridge. Most of the LLW would be shipped to the Nevada Test Site. The PCB waste would be shipped to Utah and Texas. Some waste will go to DOE's Hanford site in Hanford, Washington and some will go to various commercial contractors in Texas, Tennessee, and Utah. Wastes will be shipped by either truck or rail in the Department of Transportation (DOT) or other approved containers in accordance with waste shipping regulations.

There will be minimal onsite construction at the Paducah site. Some interiors of existing buildings would be modified to expedite repackaging, waste handling, and in some cases treatment of wastes. No new landfills or other major site modifications are proposed.

This letter is intended to serve as a request for an updated list of state-protected species that may occur on or in the vicinity of the proposed action and to solicit your recommendations and comments about the potential effects of this action. Your input will be used in the preparation of an Environmental Assessment of the proposed action. A prompt reply would be appreciated.

If you need any further information on this request, please do not hesitate to call me at (865) 576-0938.

Sincerely,

James L. Elmore

James L. Elmore, Ph. D.
Alternate NEPA Compliance Officer

cc:
Gary Bodenstein, EM-98/PAD
David Tidwell, EM-98/PAD
Diane McDaniel, SAIC

United States Department of the Interior

FISH AND WILDLIFE SERVICE
446 Neal Street
Cookeville, TN 38501

September 25, 2001

Mr. James L. Elmore, Ph.D.
U.S. Department of Energy
Oak Ridge Operations Office
P.O. Box 2001
Oak Ridge, Tennessee 37831

Dear Dr. Elmore:

Thank you for your letter and enclosures of March 4, 1999, regarding the preparation of an Environmental Assessment (EA) for the Proposed Disposition of Wastes at the Paducah Site, Paducah, Kentucky. Under the proposed action, several thousand cubic meters of low-level, mixed low-level, and hazardous (PCB) waste, as well as 12 m^3 of transuranic waste, would be transported from the Paducah Gaseous Diffusion Plant (PGDP) in McCracken County, Kentucky, to eight Department of Energy (DOE) and commercial treatment and disposal facilities. Resource Conservation and Recovery Act waste would be shipped to the Toxic Substances Control Act incinerator at Oak Ridge, Tennessee. Annually, DOE would discharge 52 m^3 of low-level wastewater after on-site treatment at the PGDP to meet Kentucky Pollutant Discharge Elimination System permit requirements. Approximately 1800 m^3 of soil and debris containing some residual radioactivity, but meeting the waste acceptance criteria (WAC) for the on-site C-746-U landfill, would be disposed at the PGDP without treatment. We are not aware that specific WAC have been proposed or modified for the C-746-U landfill as a result of this and other recent proposals. We are also unaware of existing specific KPDES permit limitations for low-level wastewater discharges at the PGDP. U.S. Fish and Wildlife Service (Service) personnel have reviewed the information submitted and offer the following comments for consideration.

According to our records, the following federally listed endangered species are known to occur near the potential project impact areas:

Paducah Gaseous Diffusion Plant

Indiana bat	*Myotis sodalis*
orangefoot pimpleback	*Plethobasus cooperianus*
pink mucket	*Lampsilis abrupta*
ring pink	*Obovaria retusa*
fat pocketbook	*Potamilus capax*

Oak Ridge Reservation

gray bat	*Myotis grisescens*
pink mucket	*Lampsilis abrupta*

Qualified biologists should assess potential impacts and determine if the proposed project may affect the species. We recommend that you submit a copy of your assessment and finding to this office for review and concurrence. A finding of "may affect" could require the initiation of formal consultation procedures.

These constitute the comments of the U.S. Department of the Interior in accordance with provisions of the Endangered Species Act (87 Stat. 884, as amended: 16 U.S.C. 1531 et seq.). We appreciate the opportunity to comment. Should you have any questions or need further assistance, please contact Steve Alexander of my staff at 931/528-6481, ext. 210, or via e-mail at *steven_alexander@fws.gov*.

Sincerely,

Lee A. Barclay, Ph.D.
Field Supervisor

xc: Don Seaborg, DOE, Paducah
Wayne Davis, KDFWR, Frankfort
Jack Wilson, KDOW, Frankfort

Department of Energy

Oak Ridge Operations Office
P.O. Box 2001
Oak Ridge, Tennessee 37831—

January 23, 2002

Dr. Lee A. Barclay, Ph.D.
Field Supervisor
Fish and Wildlife Service
446 Neal Street
Cookville, Tennessee 38501

Dear Dr. Barclay:

ADDITIONAL INFORMAL CONSULTATION UNDER SECTION 7 OF THE ENDANGERED SPECIES ACT FOR THE PROPOSED WASTE DISPOSITION ACTIVITIES AT THE PADUCAH SITE, PADUCAH, KENTUCKY

Thank you for your prompt reply to my letter of August 16, 2001, concerning the proposed waste disposition activities at the Paducah Site, Paducah, Kentucky. As you requested, the Department of Energy (DOE) has prepared a Biological Assessment (BA) for the Paducah area federally listed species, *Myotis sodalis, Lampsilis arbrupta, Plethobasus cooperianus, Obovaria retusa,* and *Potamilis capax* identified in your letter. We have respectfully declined to perform a BA for the Oak Ridge area species listed in you letter since the portion of the proposed action that has not been previously addressed in National Environmental Policy Act (NEPA) documentation would only occur at the Paducah Site.

The enclosed BA is submitted for your review and concurrence. Based on the BA, DOE has determined that the proposed implementation of waste disposition activities at the Paducah Site is not likely to adversely affect the listed species. Results of the BA will be summarized in the text of the Environmental Assessment (EA) for the project, and the BA will be appended to the EA.

Following your review of the BA, please check the appropriate concurrence block and sign below. Please fax your comments to me at (865) 576-0746 as soon as possible, so that we may expeditiously complete the EA. If you need further information or wish to discuss the BA, please call me at (865) 576-0938. Thank you in advance for your prompt reply.

Sincerely,

James L. Elmore, Ph.D.
Alternate NEPA Compliance Officer

Enclosure

cc:
Gary Bodenstein, EM-98/PAD
David Tidwell, EM-98/PAD
Diane McDaniel, SAIC

Subject: **ADDITIONAL INFORMAL CONSULTATION UNDER SECTION 7 OF THE ENDANGERED SPECIES ACT FOR PROPOSED WASTE DISPOSITION ACTIVITIES AT THE PADUCAH SITE, PADUCAH, KENTUCKY**

☐ This Biological Assessment supports the conclusion that the implementation of waste disposition activities as described in the proposed action would not adversely impact federally listed protected species and/or habitat. With this BA, DOE has satisfied consultation requirements of Section 7 of the Endangered Species Act.

☐ This Biological Assessment does not support the conclusion that the implementation of waste disposition activities as described in the proposed action would not adversely impact federally listed protected species and/or habitat. DOE has not satisfied consultation requirements of Section 7 of the Endangered Species Act.

Signature

Date

United States Department of the Interior

FISH AND WILDLIFE SERVICE
446 Neal Street
Cookeville, TN 38501

September 20, 2002

Mr. James L. Elmore, Ph.D.
U.S. Department of Energy
Oak Ridge Operations Office
P.O. Box 2001
Oak Ridge, Tennessee 37831

Dear Dr. Elmore:

Thank you for your letter and enclosure of August 21, 2002, transmitting additional information for the Environmental Assessment (EA) for Waste Disposition Activities at the Paducah Site (DOE/EA-1339) in McCracken County, Kentucky. A conference call regarding this proposal was held between representatives of the Department of Energy (DOE) and U.S. Fish and Wildlife Service on August 16, 2002. All of this information is supplemental to the pre-decisional draft EA received on May 17, 2002, and the Biological Assessment (BA) prepared for this proposal received on January 24, 2002. U.S. Fish and Wildlife Service (Service) personnel have reviewed the information submitted and offer the following comments for consideration.

The BA and supporting information are adequate and support the conclusion of not likely to adversely affect, with which we concur. In view of this, we believe that the requirements of Section 7 of the Endangered Species Act (Act) have been fulfilled and that no further consultation is needed at this time. However, obligations under Section 7 of the Act must be reconsidered if: (1) new information reveals that the proposed action may affect listed species in a manner or to an extent not previously considered, (2) the proposed action is subsequently modified to include activities which were not considered in this biological assessment, or (3) new species are listed or critical habitat designated that might be affected by the proposed action.

Provided that best available control technologies for inorganic and organic priority pollutants are implemented for the on-site treatment and discharge(s) of project wastewater to Bayou Creek and Little Bayou Creek, existing warmwater aquatic habitat water quality criteria are not exceeded in Bayou Creek and Little Bayou Creek as a result of the proposed discharge(s), and the proposed discharge(s) are included in existing modeling performed by the Kentucky Division of Water for Total Maximum Daily Load development for Bayou Creek and Little Bayou Creek, we believe that the EA is adequate.

These constitute the comments of the U.S. Department of the Interior in accordance with provisions of the Endangered Species Act (87 Stat. 884, as amended: 16 U.S.C. 1531 et seq.), the Migratory Bird Treaty Act (16 U.S.C. 703-711), the Fish and Wildlife Coordination Act (16 U.S.C. 661 et seq.), and the National Environmental Policy Act (42 U.S.C. 4321-4347; 83 Stat. 852). We appreciate the opportunity to comment. Should you have any questions or need further assistance, please contact Steve Alexander of my staff at 931/528-6481, ext. 210, or via e-mail at *steven_alexander@fws.gov*.

Sincerely,

Lee A. Barclay

Lee A. Barclay, Ph.D.
Field Supervisor

xc: Jeff Pratt, KDOW, Frankfort
Mike Guffy, KDWM, Frankfort
Wayne Davis, KDFWR, Frankfort
Laila Lienesch, FWS, Frankfort

APPENDIX F

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

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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

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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.

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APPENDIX G

ANALYSIS OF ACCIDENT IMPACTS TO HUMANS

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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:

$$\begin{aligned}\text{AST} = &\left(\text{Total solid isotopic activity}\right) \times 5\% \text{ Boxes Damaged} \times 1\% \text{ Re leased as powder} \\ &\times 6 \times 10^{-4} \text{ suspended in air} \\ &+ (\text{Total liquid isotopic activity}) \times 5\% \text{ Boxes Damaged} \times 10\% \text{ Re leased} \\ &\times 1 \times 10^{-4} \text{ suspended in air} \\ &= 3 \times 10^{-7} \times \left(\text{Total solid isotopic activity}\right) + 5 \times 10^{-7} \times (\text{Total liquid activity})\end{aligned}$$

$$\text{AST} = 2.4 \times 10^{-3} \text{ Ci U}$$

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:

$$LST = (Total\ isotopic\ activity) \times 5\%\ Boxes\ Damaged$$
$$= 8\ Ci\ U$$

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 $\times$ 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)

$$\text{Dose} = AST \times \chi/Q \times \text{Breathing Rate} \times DCF$$
$$= 2.4 \times 10^{-3}\ Ci\ U \times 1.8 \times 10^{-3}\ s/m^3 \times 3.33 \times 10^{-4}\ m^3/s \times 2.64\ 10^{6}\ rem/Ci\ U$$
$$= 3.8 \times 10^{-3}\ \text{rem or } 3.8\ \text{mrem}$$

MIW/MUW Consequence:

$$\text{Consequence} = \text{Dose} \times \text{Fatality rate}$$
$$= 3.8 \times 10^{-3}\ \text{rem} \times 1\ \text{person} \times 4 \times 10^{-4}\ \text{LCF per person-rem}$$
$$= 1.5 \times 10^{-6}\ \text{LCF}$$

MIW/MUW Risk = 1.5×10^{-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
= 2.4×10^{-3} Ci U × 8.8×10^{-5} s/m^3 × 3.33×10^{-4} m^3/s × 2.64 10^6 rem/Ci U
= 1.9×10^{-4} rem or 0.19 mrem

MEI Consequence:

Consequence = Δοσε × Fatality rate
= 1.9×10^{-4} rem × 1 person × 5×10^{-4} LCF per person-rem
= 9.5×10^{-8} LCF

MEI Risk = 9.5×10^{-10} expected fatalities

Population:

Dose = AST × 0.64 person-rem/Ci U
= 2.4×10^{-3} Ci U × 0.64 person-rem/Ci U
= 1.5×10^{-3} person-rem

Population Consequence:

Consequence = Dose×Fatality rate
= 1.5×10^{-3} person-rem × 5×10^{-4} LCF per person-rem
= 7.5×10^{-7} LCF

Population Risk = 7.5×10^{-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 × (1/4.7×10^{11} L/24 h) × 2 L/24 h × 2.6 10^5 rem/Ci
= 9×10^{-6} rem or 0.009 mrem

MEI Consequence = 9×10^{-6} rem × 1 person × 5×10^{-4} LCF per person-rem
= 4.5×10^{-9} LCF

MEI Risk = 4.5×10^{-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.

$$AST = (Total\ toxic\ metal\ mass) \times 5\%\ Boxes\ Damaged \times 1\%\ \mathrm{Re}leased\ as\ \ powder$$
$$\times 6 \times 10^{-4}\ suspended\ in\ air$$
$$= 3 \times 10^{-7} \times (Total\ toxic\ metal\ mass)$$
$$AST = 45\ g\ Cr$$

Assuming an 1- hour exposure period, the MIW and MUW would be exposed to a toxic metal concentration of:

$$Concentration = \frac{45\ g\ Cr}{3600\ s} \times \chi / Q = 1.24 \times 10^{-2}\ g\ Cr/s \times 1.8 \times 10^{-3}\ s/m^3$$
$$= 2.2 \times 10^{-5}\ g\ Cr/m^3\ or\ 0.02\ mg\ Cr/m^3$$

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 × χ/Q × Breathing Rate×DCF
= 0.041 Ci U × 3×10^{-2} s/m^3 × 3.33×10^{-4} m^3/s × 2.64 10^6 rem/Ci U
= 1.1 rem

Consequence = 1.1 rem × 1 person × 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 × χ/Q×Breathing Rate×DCF
= 0.041 Ci U × 3.4×10^{-4} s/m^3 × 3.33×10^{-4} m^3/s × 2.64 10^6 rem/Ci U
= 1.2×10^{-2} rem or 12 mrem

Consequence = 1.2×10^{-2} rem × 1 person × 5×10^{-4} LCF per person-rem
= 6×10^{-6} LCF

MEI Risk = 1.1×10^{-9} expected fatalities

Population:

Dose = AST × 0.64 person-rem/Ci U
= 0.041 Ci U × 0.64 person-rem/Ci U
= 2.6×10^{-2} person-rem

Consequence = 2.6×10^{-2} person-rem × 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 $= 3.8 \times 10^{-4}$ Ci U $\times 3 \times 10^{-2}$ s/m^3 $\times 3.33 \times 10^{-4}$ m^3/s $\times 2.64\ 10^6$ rem/Ci U
$= 0.01$ rem or 10 mrem

Consequence $= 0.01$ rem $\times$ 1 person $\times 4 \times 10^{-4}$ LCF per person-rem
$= 4.0 \times 10^{-6}$ LCF

MUW Risk $= 1.7 \times 10^{-8}$ expected fatalities

MEI 1580 m from release:

Dose $= 3.8 \times 10^{-4}$ Ci U $\times 3.4 \times 10^{-4}$ s/m^3 $\times 3.33 \times 10^{-4}$ m^3/s $\times 2.64\ 10^6$ rem/Ci U
$= 1.1 \times 10^{-4}$ rem or 0.11 mrem

Consequence $= 1.1 \times 10^{-4}$ rem $\times$ 1 person $\times 5 \times 10^{-4}$ LCF per person-rem
$= 5.5 \times 10^{-8}$ LCF

MEI Risk $= 2.4 \times 10^{-10}$ expected fatalities

Population:

Dose $= 3.8 \times 10^{-4}$ Ci U $\times$ 0.64 person-rem/Ci U
$= 2.4 \times 10^{-4}$ person-rem

Consequence $= 2.4 \times 10^{-4}$ person-rem $\times 5 \times 10^{-4}$ LCF per person-rem
$= 1.2 \times 10^{-7}$ LCF

Population Risk $= 5.2 \times 10^{-10}$ 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 $= 8.2 \times 10^5$ 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.

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APPENDIX H

TRANSPORTATION ACCIDENT ANALYSIS

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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

Risk Group	Annual impacts		Total for 10-year life cycle	
	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

Risk Group	Annual impacts		Total for 10-year life cycle	
	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

Risk Group	Annual impacts		Total for 10-year life cycle	
	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		Total for 10-year life cycle	
	Dose (person-rem)	LCF	Dose (person-rem)	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		Total for 10-year life cycle	
	Dose (person-rem)	LCF	Dose (person-rem)	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		Total for 10-year life cycle	
	Dose (person-rem)	LCF	Dose (person-rem)	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		Total for 10-year life cycle	
	Dose (person-rem)	LCF	Dose (person-rem)	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)	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		Latent fatalities from emissions[b]
	Accidents	Fatalities	
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

Risk Group	Annual impacts		Total for 10-year life cycle	
	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

Risk group	Annual impacts		Total for 10-year life cycle	
	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: Dose (person-rem)	Annual impacts: LCF	Total for 10-year life cycle: Dose (person-rem)	Total for 10-year life cycle: 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: Dose (person-rem)	Annual impacts: LCF	Total for 10-year life cycle: Dose (person-rem)	Total for 10-year life cycle: 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: Dose (person-rem)	Annual impacts: LCF	Total for 10-year life cycle: Dose (person-rem)	Total for 10-year life cycle: 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: Dose (person-rem)	Annual impacts: LCF	Total for 10-year life cycle: Dose (person-rem)	Total for 10-year life cycle: 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.

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APPENDIX I

ANALYSIS OF WASTE TREATMENT FACILITY AIRBORNE CHEMICAL RELEASES

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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 °C (77 °F). 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

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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)

Therefore,

$$C = [(1{,}834{,}160) \times (10)] \div [(245) \times (2.58)]$$

$$= 29{,}000 \text{ ppm}$$

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:

$$C = [M \times ARF \times RF)] \div [V \times F]$$

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,

$$C = |(4.086x10^7) \times (2x10^{-3}) \times (0.3)| \div [(245) \times (1.0)]$$
$$= 100 \text{ ppm} = 100 \text{ mg/m}^3$$

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

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APPENDIX J

ANALYSIS OF ON-SITE TREATMENT OF LLW AND TRU WASTE

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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		Population LCF[c]
	MEI[b] (mrem)	Population (person-rem)	
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

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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

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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.

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APPENDIX L

PUBLIC COMMENT RESPONSE TABLE

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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.

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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.

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		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.

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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.

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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.

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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.

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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.

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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.

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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.

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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.

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		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. Recommendation: 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.

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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. <u>Recommendation:</u> 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.