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February 1995

EPA Superfund Record of Decision:

Murray-Ohio Dump (O.U. 1), Lawrenceburg, TN 6/17/1994

MURRAY OHIO DUMP NPL SITE
LAWRENCEBURG, TENNESSEE

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

RECORD OF DECISION
REMEDIAL DESIGN/REMEDIAL ACTION

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I. DECLARATION FOR THE RECORD OF DECISION

SITE NAME AND LOCATION

Murray Ohio Dump Site
Lawrenceburg, Lawrence County, Tennessee

STATEMENT OF BASIS AND PURPOSE

This decision document represents the selected remedial action for the Murray Ohio Dump Site developed in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA) and, to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP).

This decision is based on the contents of the administrative record for the Murray Ohio Dump site.

The State of Tennessee concurs on the selected remedy.

ASSESSMENT OF THE SITE

Actual or threatened releases from this Site, if not addressed by implementing the response action selected in this Record of Decision (ROD), may present an imminent or substantial endangerment to public health, welfare, or the environment.

DESCRIPTION OF THE REMEDY

This final remedy addresses remediation of ground-water/seep contamination and soil contamination by eliminating or reducing the risks posed by the Site, through treatment, engineering and institutional controls.

The major components of the selected remedy include:

- Constructing an enhanced single barrier cover system over the pre-1973 disposal area;

- Slope stabilization of the post-1973 disposal area with improvements on the existing cover;

- Constructing a durable surface cover over the 1973 disposal area;

- Constructing a single barrier cover system over the overland flow area;

- Deed restrictions and fencing around the disposal areas;

- Continued maintenance of the cover systems;

- Site monitoring; and

- Contingent construction of a seep collection and treatment system with discharge of treated effluent to Shoal Creek or a water treatment facility.

STATUTORY DETERMINATIONS

The selected remedy is protective of human health and the environment, complies with federal and State requirements that are applicable or relevant and appropriate to the remedial action and is cost-effective. This remedy utilizes permanent solutions and alternative treatment technologies to the maximum extent practicable, and satisfies the statutory preference for remedies that employ treatment that reduces toxicity, mobility and volume as a principal element. However, because treatment of the principle threats at the site was not found to be practicable, this remedy does not satisfy the statutory preference for treatment of all Site wastes as a principle element.

Because this remedy will result in hazardous substances remaining on-Site above health-based levels, a review will be conducted at least every five years beginning no later than five years from the date of commencement of construction of the remedial action to ensure that the remedy continues to provide adequate protection of human health and the environment. Reviews may be conducted on a more frequent bases as EPA deems necessary.

June 17, 1994
Date

Patrick M Tobin for
John H. Hankinson, Jr.
Regional Administrator

II. SITE DESCRIPTION, SITE HISTORY, AND SUMMARY OF ENFORCEMENT AND COMMUNITY RELATIONS

A. SITE LOCATION AND DESCRIPTION

The Murray Ohio Dump Site is located three miles southwest of the Lawrenceburg city limits in Lawrence County, Tennessee. It is within the boundaries of a tract of land owned and formerly operated by the City of Lawrenceburg as a sanitary landfill. The Site consists of two landfill areas, covering about 0.25 and 27 acres, respectively. Approximately eight acres of the larger landfill area were used for waste disposal. Figure 2-1 gives the general location of the Site.

Referring to Figure 4-2, the smaller, .25 acre area to the northwest is known as the 1973 disposal area. The western portion of the larger 27 acre landfill is known as the pre-1973 disposal area, with the eastern portion of this area being known as the post-1973 disposal area. An area not drawn on the figure, immediately to the north and downgradient of the larger area is known as the overland flow area since wastes flowed from the site over the surface to this area.

The Site occupies an elongated high spot running southeast to northwest. It is on the crest of a hill, 40 to 100 feet above the adjacent land. Steep slopes surround the landfill, especially north of the Site. In general, the natural soils that form the base of the landfill are well drained. The Site water table is approximately 40 to 50 feet below the land's surface and is Class II. Ground-water flow is easterly and northeasterly with interruption by karst features. The geologic units at the Murray Ohio Dump Site have been classified according to lithology, environment of deposition, and visual characteristics. The units are essentially flat-lying and increase in age with depth.

Figure 4-1 shows the several ephemeral streams located around the Site. Names of the major ones are Northeast Branch, Southeast Branch, and Southwest Branch. Most are on-Site flowing off-Site. All streams go into Shoal Creek (off-Site to the South) which is the major collection point in the area. Figure 4-1 also shows the five major seeps emanating from the northern side of the larger landfill unit and located along Northeast Branch.

The major recognized units at the Site are the Fort Payne Residuum, the Fort Payne Formation, Middle Paleozoic Shales, and the Ordovician Limestones. The Fort Payne Formation at the Site consists of an upper siliceous limestone unit and a shale unit. The Fort Payne is underlain by several thin shale and shaley limestone formations (Middle Paleozoic Shales) including, in descending order, the Maury Shale, the Chattanooga Shale, the Mannie Shale, the Fernvale Limestone and the Sequatchie Formation. The lowest geologic unit at the Site, the Ordovician Limestone, consists of undifferentiated limestones of the Maysville and Nashville groups and is composed primarily of fine- to coarse-grained calcarenite. Along Northeast Branch, a buff-colored, medium-grained calcareous sandstone predominates in the upper part of the unit.

The U.S. Bureau of the Census has estimated the 1994 population of Lawrenceburg at 10,708 persons and that of Lawrence County at 36,435 persons. Land immediately around the Site is considered residential and therefore any future use scenarios on or off-Site would involve residential exposure concentrations.

The city is mostly served by municipal potable water supply and sewer systems with a few private water supplies. Water for domestic and industrial use is withdrawn from Shoal Creek and Hope Spring, both points of which are approximately three miles upstream of the Murray Site. There are 11 domestic wells within a one-mile radius of the Site, 32 wells within a one- to two-mile radius of the Site, and 30 wells within a two- to three-mile radius of the Site.

B. SITE HISTORY AND ENFORCEMENT ACTIVITIES

Murray Ohio Manufacturing Company (Murray Ohio) began disposing of paint and plating sludge on-Site in 1963 and continued until December 1982. The smaller .25 acre landfill was used for a brief period during 1973 to 1974. Originally, the company placed its liquid wastes and sludges containing chromium, nickel and zinc in open trenches to facilitate dewatering. After the materials dewatered, the trenches were backfilled. Later, Murray Ohio changed its treatment process to produce dried filter cakes. Approximately 3,000 cubic yards of solid wastes were landfilled and covered between 1973 and 1982. The quantity of liquid wastes landfilled is unknown.

In March 1979, EPA conducted a site investigation at the landfill. Open trenches of metal plating sludges and paint wastes were observed, and samples were collected during the inspection. Analysis of the samples showed elevated concentrations of chromium and nickel in both the water and soil at the base of the slope below the landfill used by Murray Ohio.

In the summer of 1980, while still placing waste in the post-1973 area of the larger landfill, Murray Ohio graded parts of the Site and covered it with native soil to a thickness of two to ten feet. This cap was designed to minimize surface infiltration, control erosion, and isolate and contain the disposed wastes. Murray Ohio also constructed drainage ditches to intercept and divert surface water runoff from the landfill area.

In November 1981, the Tennessee Department of Environment and Conservation (TDEC) required that a ground-water monitoring system be installed at the Site to comply with Tennessee hazardous waste regulations. One well was installed uphill from the larger landfill and three wells were installed downhill in November 1981 and January 1982, respectively. Sampling from these wells began in September 1982. Murray ceased disposal at the Site in December 1982. Based on its Hazard Ranking System (HRS) score of 46.44, the Site was listed in September 1983 on EPA's National Priorities List (NPL).

At the direction of TDEC, early investigative work began in May 1984 for the Murray Ohio Dump Site. Beginning in June 1985, drilling of new wells and further sampling at the Site were conducted under a second phase of investigative work.

Until the summer of 1989, TDEC was responsible for oversight of the investigative work at the Murray Ohio Dump Site. After the State had preliminarily investigated and characterized the waste, EPA took over the lead oversight role via an Administrative Order on Consent (AOC). In this March 1990 AOC, Murray agreed to fund RI/FS activities for the Site.

The RI/FS, with oversight by EPA, was conducted from September 1990 to October 1993. Activities performed can be grouped into the following categories: planning and preparation, field activities (including sampling), laboratory analysis, data validation, evaluation and analysis, and report preparation. Specific objectives of the RI were:

- To further characterize wastes remaining at the Site;
- to define the set of Site-Specific contaminants attributable to the Site;
- to define the areal and vertical extent of any Site soil contamination;
- to identify site-related contamination in the sediments of Northeast Branch, Southeast Branch, and Southwest Branch and to evaluate potential for contaminants to migrate into Shoal Creek and other streams around the site;
- to define the ground-water flow regime beneath the Site and its relationship to Northeast Branch, Southeast Branch, Southwest Branch, Shoal Creek, and other streams around the Site;
- to define the extent of Site-related ground-water contamination;
- to define the extent of Site-related surface water contamination in Northeast Branch, Southeast Branch, and Southwest Branch, and to evaluate potential for contaminants to migrate into Shoal Creek and other streams around the site;
- to ascertain any Site-related air risks;
- to collect sufficient data to complete an accurate topographical Site map, including the location of all service buildings, fencelines, property boundaries and the like; and
- to produce a map showing the relationship of the Site to the residences, schools, churches and daycare centers within a one-half, one, two and three mile radius of the Site.

The following field sampling activities were undertaken as part of accomplishing these objectives:

Soil samples were collected from:

- The pre-1973 disposal area of the larger landfill;
- the post-1973 disposal area of the larger landfill;

- the smaller 1973 to 1974 disposal area;
- the area immediately downgradient to the southeast of the larger landfill; and
- the area immediately to the north and downgradient of the larger landfill, or, the "overland flow area".

Surface water and sediment samples were collected from:

- Northeast Branch upstream, downstream, and adjacent to the Site;
- Southwest Branch upstream, downstream and adjacent to the Site;
- Southeast Branch;
- the confluence of Southeast and Southwest Branches; and
- the confluence of Northeast Branch and Shoal Creek.

Ground-water seep and seep soil samples were collected along Northeast Branch at the point of contact between bedrock and overlying soils. Ground-water samples were collected both on-Site and on properties adjacent to the Site.

Murray Ohio retained Geraghty & Miller, Inc., to perform field activities and prepare documents relating to the RI/FS. EPA oversight work was conducted by Lee Wan & Associates and later by CDM. The RI is discussed in more detail in Section IV of this document.

C. COMMUNITY RELATIONS ACTIVITIES

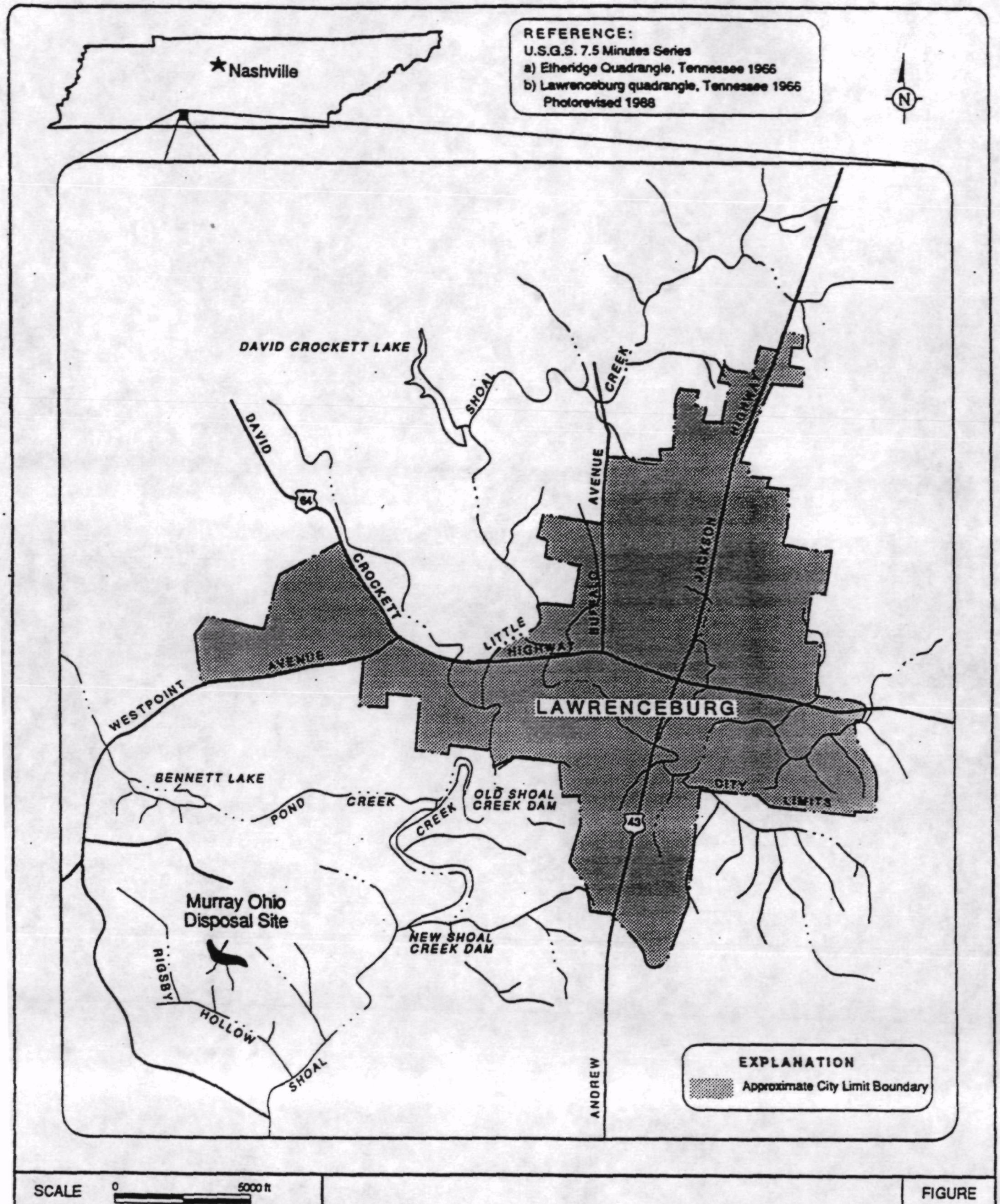
A Community Relations Plan for the Murray Ohio Dump Site was finalized in August 1990. This document lists contacts and interested parties throughout government and the local community. It also establishes communication pathways to assure timely dissemination of pertinent information.

Also in August 1990, EPA held a RI/FS kickoff meeting. Prior to this in June 1990, EPA conducted community interviews to assess public interest and concerns.

The RI and FS reports were finalized in February 1993 and February 1994, respectively. These reports and all other documents concerning the Site have been made available to the public in the Murray Ohio Dump NPL Site Information Repository in the Lawrenceburg Public Library on East Gaines Street in Lawrenceburg.

The Proposed Plan was sent out to the public on February 23, 1994, and a public meeting to discuss the Proposed Plan was held on March 8, 1994. This meeting was used to gain insight on public opinion concerning the remedial alternatives.

A public comment period was held on the Proposed Plan from February 26 to March 29, 1994. Comments received have been incoporated into the Responsiveness Summary (Appendix B) of this document.



Regional Location Map

Murray Ohio Disposal Site Lawrenceburg, Tennessee

FIGURE 2-1

III. SCOPE AND ROLE OF THE RESPONSE ACTION

The scope of this response action is to address remaining soil and ground water/seep concerns at the Site. As discussed previously in Section II of this document, actions were implemented in the summer of 1980 to grade parts of the Site and cover it with a layer of native soil. Drainage ditches were also constructed to intercept and divert surface water runoff from the landfill area. Also in place was a small ground-water monitoring well network, as required by TDEC prior to EPA's involvement.

During the development of the EPA RI, areas of concern were delineated for soil (contamination was mostly metals) in and immediately around the disposal areas. Of the most concern among these was the "overland flow area", an area to the north, immediately downgradient of the larger landfill where contamination had migrated via surface water runoff. It was also found during the RI that infiltration of precipitation through the wastes placed on-Site had caused downward migration of these contaminants into the upper aquifer beneath the Site. Further, these contaminants were found to exit the upper aquifer via various seeps found along Northeast Branch.

The FS determined that the most effective method of treating the contaminated ground water, which runs through highly fractured and solutionally enlarged conduits in the bedrock, is to block infiltration by augmenting the cap areas at the Site, allowing the remaining contaminants beneath the Site to exit via the seeps. Seeps will be monitored in a manner consistent with accepted karst monitoring practices quarterly up to twenty quarters or 5 years, in conjunction with the five-year-review process. (See Section VIII of this document for the monitoring plan.) Upon evaluating results of this monitoring program (at the time of the five-year-review), EPA will make a determination on whether or not to construct a seep collection and treatment system at the Site. If the seep system is required, discharge of the treated water would be to Shoal Creek.

This selected alternative for the Murray Ohio Dump Site will address all known concerns at the Site. It is intended to address the entire Site with regards to threats to human health and the environment posed by the Site, as indicated by the Risk Assessment included in the February 1993 RI report and revised by EPA in the February 1994 FS report. Findings of the Risk Assessment are summarized in Section V of this document.

This is the only ROD contemplated for this Site.

IV. SUMMARY OF SITE CHARACTERISTICS

A. CONTAMINANT CHARACTERISTICS

The primary contaminants of concern at the Site are chromium and nickel, of which chromium is mostly hexavalent. Sediment and soils are the probable repositories for most metals emitted into the environment. Inorganic molecules such as these have a high affinity for adsorption to soil and sediment under the right conditions. This, in turn, considerably restricts the molecule's mobility through the media. As a result, inorganics tend to not migrate substantially in soil and sediment except during erosion and heavy runoff periods and under certain soil pH conditions.

An important factor affecting adsorbance is pH of the soil or sediment. Inorganic adsorption is much higher at elevated pH levels. The redox potential (Eh) of a molecule also affects sorption and solutioning as it determines the oxidation state of a metal. Adsorption of metal cations increases with decreasing valence.

Nickel and chromium III are both expected to sorb well to soils and sediments, whereas chromium VI (also called hexavalent chromium) is a more water soluble contaminant due to the higher valence of chromium in this form. This is evidenced at Murray by the fact that more hex chromium was found in ground water and seep water whereas trivalent chromium was found more in soils and sediments.

B. AFFECTED MEDIA CHARACTERISTICS

For Site management purposes, the Murray Ohio Dump Site can be divided into specific affected media. The following discussion summarizes the characteristics of each media that are relevant to the identification, screening, and selection of remedial technologies and strategies. For more detailed information on sampling and results, refer to the Remedial Investigation Report on file in the Administrative Record for the Murray Ohio Dump NPL Site.

1. Soil

The EPA Remedial Investigation at the Site took surficial and deeper (below and including the existing clay cover) soil samples in the following areas:

- the pre-1973 disposal area of the larger landfill;

- the post-1973 disposal area of the larger landfill;
- the smaller 1973 to 1974 disposal area;
- the area immediately downgradient to the southeast of the larger landfill; and
- the area immediately to the north and downgradient of the larger landfill, or, the "overland flow area".

Deeper soil borings below the clay covers were found to contain unacceptable levels of chromium, lead, nickel and zinc. Soil borings with paint waste mixed in were found to contain elevated levels of toluene, xylenes, and ethylbenzene. Acetone, 2-butanone, methylene chloride, 4-methyl-2-pentanone, 2-methylnephthalene, and naphthalene were also detected in subsurface soils. Analytical breakdowns on subsurface soil samples can be found in Table 4-1.

Surficial soils in the overland flow area were found to contain unacceptable levels of nickel and chromium. Table 4-2 gives a breakdown on analytical results for each sample taken in the overland flow area and Table 4-3 shows results for other areas.

A geotechnical investigation was also performed on the clay cover and can be found in Appendix F of the Remedial Investigation report. Parameters such as cap thickness, hydraulic conductivity and compaction were tested. Based on the results of this investigation, EPA has concerns regarding the structural integrity and adequacy of long-term protection provided by the cover.

2. Surface Water and Sediments

Surface water and sediment samples were collected as part of the RI from:
- Northeast Branch upstream, downstream, and adjacent to the Site;
- Southwest Branch upstream, downstream, and adjacent to the Site;
- Southeast Branch;
- the confluence of Southeast and Southwest Branches; and
- the confluence of Northeast Branch and Shoal Creek.

Sampling locations are shown in Figure 4-1 of this document.

In surface water, chromium and nickel were detected at elevated concentrations near the head of Northeast Branch. Concentration levels decline in the downstream direction and are equal to background concentration before Northeast Branch enters Shoal Creek. No other streams around the Site contained significant concentrations of any contaminants.

In sediments, contaminant concentrations tend to follow trends in surface water, i.e., elevated concentrations of chromium and nickel were detected at the head of Northeast Branch, declining towards background at the confluence with Shoal Creek. No other significant concentrations of contaminants were detected in sediments in other streams around the Site.

3. Ground-water Seep and Seep Soils

Ground-water seep and seep soil samples were collected along Northeast Branch at the point of contact between bedrock and the overlying soils. Locations can be found in Figure 4-1 of this document or in the RI report.

Work was supervised by TDEC and then EPA on several occasions from 1984 to 1990 when seeps were found to be flowing. Results from these investigations confirmed impact above acceptable levels along Northeast Branch.

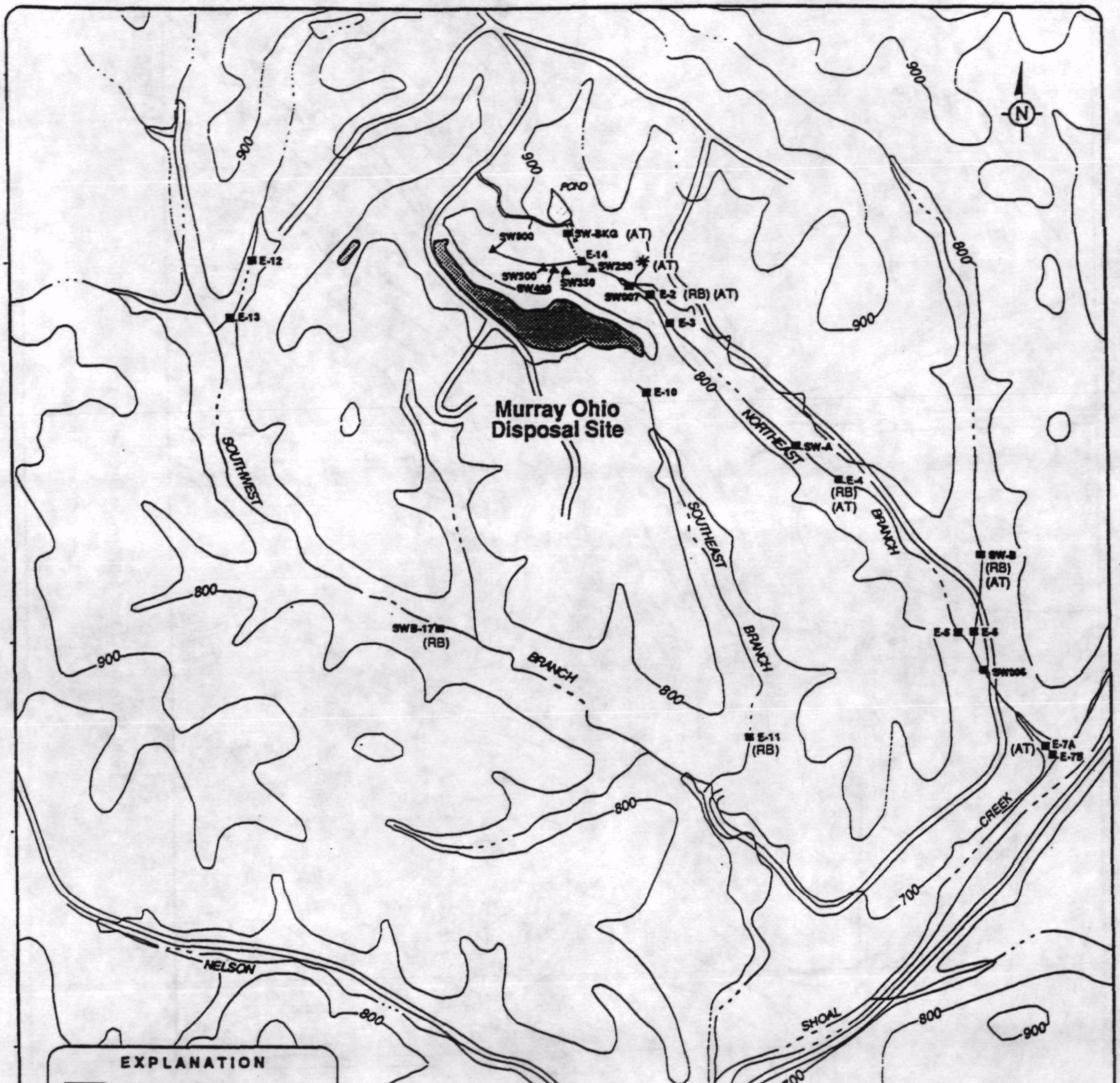
Seep soils were sampled concurrently with running seeps. Samples showed impacts for chromium, nickel, lead and zinc. One organic compound, trichloroethene, was found at elevated levels in seep soils. For more detailed analytical results, refer to Table 4-4 of this document.

4. Ground water

Ground water was sampled on-Site in November - December of 1990 as part of the EPA RI. Samples were taken from 14 wells and were drawn mostly from the upper aquifer, the Fort Payne Formation. Samples were also collected from other underlying zones. Ground-water contamination was found in the Fort Payne Formation, but not the lower aquifer. Impacts for chromium, nickel, cadmium and lead were noted in the Fort Payne. For a breakdown on the exceedances at each sampling location, refer to Figure 4-2, which shows ground-water sampling locations, and Table 4-5 which gives analytical results for each contaminant at each location.

Referring to the February 1993 RI report, the on-Site square footage associated with ground-water exceeding Maximum Contaminant Levels (MCLs) is estimated to be 444,800 square feet. The corresponding contaminated pore volume is estimated to be 37,765,024 gallons, or 4,948,800 cubic feet.

Ground water was also sampled at off-Site residential locations by TDEC and Murray Ohio over a three year period from 1987 to 1990. Figure 4-3 shows locations where wells and springs were sampled. All results were well below drinking water standards.

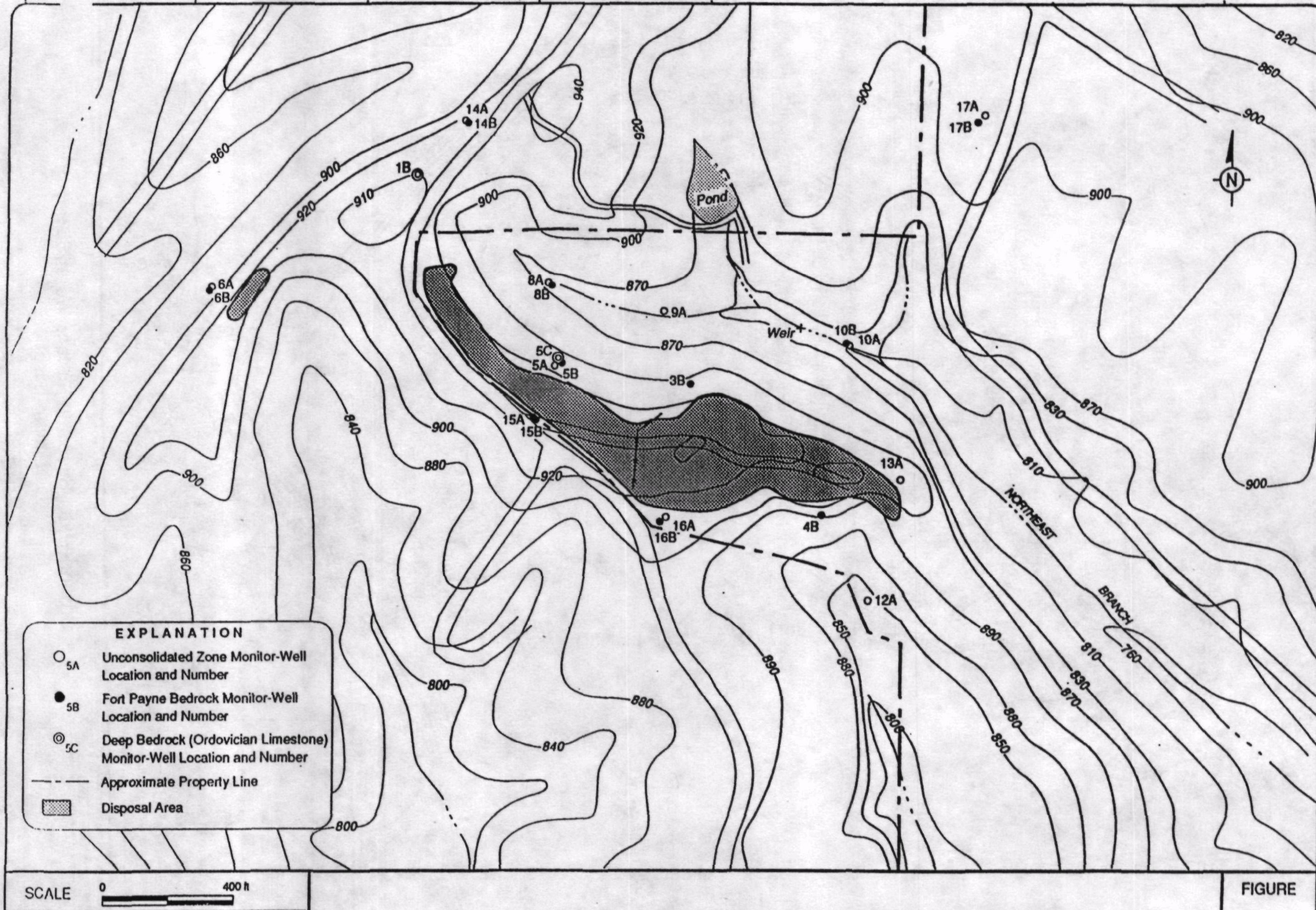


SCALE 0 1000 ft

FIGURE 4-1

Ground-Water Seep and Surface-Water/Sediment Sampling Locations

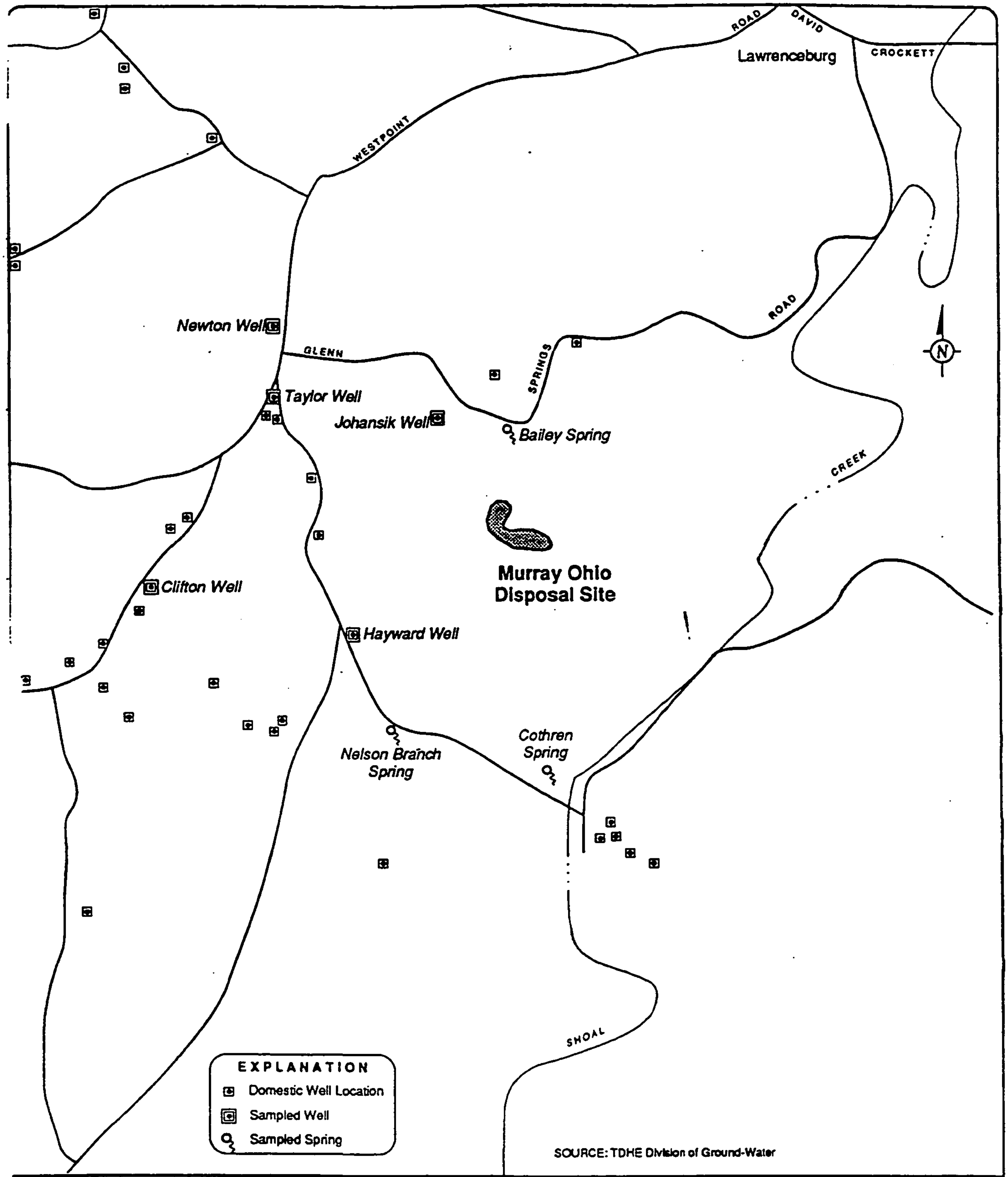
Murray Ohio Disposal Site Lawrenceburg, Tennessee



1990 Ground-Water Sampling Points

Murray Ohio Disposal Site Lawrenceburg, Tennessee

FIGURE 4-2



Domestic Water Supplies Sampled by TDHE and Murray Ohio

Murray Ohio Disposal Site Lawrenceburg, Tennessee

FIGURE 4-3

Table 4-1 Occurrence of Contaminants Detected in Subsurface Soils, Murray Ohio Disposal Site, Lawrenceburg, Tennessee.

Contaminants	Frequency of Detection	Range	Arithmetic Mean Total	Arithmetic Mean Detects	UCL	Site** Background
INORGANICS						
Aluminum	1/2	8,300 - 8,300	8,300	8,300	NA	(50,000)
Arsenic	1/2	6 - 6	6	6	NA	(6.5)
Barium	1/2	13 - 13	13	13	NA	(500)
Cadmium	16/51	0.083 - 13	0.7	1.7	1.1	(NA)
Chromium (total)	50/51	1.1 - 1,000	88	90	130	15
Chromium VI	4/37	0.95 - 1.6	0.25	1.2	0.35	--
Cobalt	1/2	4.8 - 4.8	2.4	4.8	18	(10)
Cyanide	3/18	0.28 - 3.8	0.37	1.6	0.73	--
Copper	1/2	21 - 21	10.5	21	77	(10)
Iron	50/51	260 - 32,000	15,000	15,000	17,000	16,850
Lead	24/51	3.9 - 800	31	62	58	42
Nickel	49/51	8.5 - 880	150	154	190	(5)
Vanadium	1/2	34 - 34	17	34	120	(30)
Zinc	49/51	30 - 1,100	110	119	150	180
VOCs						
Acetone	1/4	0.37 - 0.37	0.15	0.37	0.32	--
2-Butanone	4/4	0.82 - 0.98	0.4	0.4	0.9	--
Ethylbenzene	7/18	0.003 - 890	80	206	170	--
4-Methyl-2-pentanone	2/4	5.7 - 6.8	3.1	5.7	7.4	--
Methylene chloride	1/4	0.18 - 0.18	0.061	0.18	0.16	--
Toluene	7/18	0.049 - 5,800	500	1,300	1,100	--
Xylenes	7/18	0.021 - 4,700	430	1,100	920	--

Table 4-2 Overland Flow and Former Ponded Areas Analytical Results

Murray Ohio Disposal Site Lawrenceburg, Tennessee

Sample Identification	Date Sampled	Total Cr (mg/kg)	Hexavalent Cr (mg/kg)	Nickel (mg/kg)
Overland Flow Area				
OF-1	5/11/93	16	0.20 U	24
OF-2	5/11/93	1,090	0.20 U	3,040
OF-3	5/11/93	26	0.20 U	83
OF-4	5/11/93	23	0.20 U	52
OF-5	5/11/93	356	0.20 U	2,980
OF-6	5/11/93	278	0.20 U	552
OF-7	5/11/93	12	0.20 U	19
OF-8	5/11/93	17	0.20 U	54
OF-9	5/11/93	19	0.20 U	12
OF-10	5/11/93	11	0.20 U	21
OF-11	5/11/93	42	0.20 U	1,110
OF-12	5/11/93	202	0.20 U	313
OF-13	5/11/93	156	0.20 U	285
OF-14	5/11/93	302	0.20 U	661
OF-15	5/11/93	436	0.20 U	765
OF-16	5/11/93	30	0.20 U	24
OF-17	5/11/93	523	0.20 U	1,470
OF-18	5/11/93	511	1.8	546
OF-19	5/11/93	361	0.20 U	2,130
OF-20	5/11/93	82	0.20 U	202
OF-21	5/11/93	3,730	0.20 U	3,650
OF-22	5/11/93	112	0.20 U	935
OF-23	5/12/93	1,280	1.4	900
OF-24	5/12/93	377	0.20 U	893
OF-25	5/12/93	1,250	0.70	1,280
OF-26	5/12/93	194	0.20 U	918
OF-27	5/12/93	212	1.7	134
OF-28	5/12/93	547	0.20 U	110
OF-29	5/12/93	162	0.20 U	641
OF-30	5/12/93	213	0.20 U	428
OF-31	5/12/93	520	0.20 U	1,560
OF-32	5/12/93	22	0.20 U	18
OF-33	5/12/93	4,830	0.20 U	6,910
OF-34	5/12/93	54	0.20 U	151
OF-35	5/12/93	19	0.20 U	592
OF-36	5/12/93	165	0.20 U	1,110
OF-37	5/12/93	19	0.20 U	244
OF-38	5/12/93	124	0.20 U	160
OF-39	5/12/93	25	0.20 U	52
Deep Sample #1 (OF-5)	5/13/93	1,080	5.7	942
Deep Sample #2 (OF-30)	5/13/93	53	0.86	79
Former Ponded Area				
PA-1	5/12/93	15	0.20 U	27
PA-2	5/13/93	14	0.20 U	40
PA-3	5/13/93	42	0.20 U	98
PA-4	5/13/93	69	0.20 U	26
PA-5	5/13/93	25	0.20 U	96
PA-6	5/13/93	11	0.20 U	18
PA-7	5/13/93	23	0.20 U	67
Background				
BG-1	5/12/93	10	0.20 U	10
BG-2	5/12/93	25	0.20 U	13
BG-3	5/12/93	10	0.20 U	6

U - The parameter was analyzed for, but was not detected.
The associated numerical value is the sample quantitation limit.

Table 4-3 Occurrence of Contaminants in Surficial Soils, Murray Ohio Disposal Site, Lawrenceburg, Tennessee.

Contaminants	Frequency Detects / Total	Range of Detects Min - Max	Arithmetic Mean Total	Arithmetic Mean Detects	UCL	Background* Mean
Inorganics						
Aluminum	4 / 4	7,600 - 9,700	8,500	8,500	9,600	(50,000)
Arsenic	4 / 4	4.9 - 8.0	6.1	6.1	7.7	(6.5)
Barium	4 / 4	54 - 200	130	130	220	(500)
Calcium	4 / 4	1,600 - 24,000	9,300	9,300	21,000	(2,300)
Chromium	8 / 9	13.0 - 145	35	39	62	12
Cobalt	4 / 4	14 - 24	19	19	24	(10)
Iron	9 / 9	14,000 - 123,000	29,000	29,000	51,000	10,300
Lead	5 / 9	8.9 - 94	17	28	35	(15)
Magnesium	4 / 4	430 - 2,100	1,000	1,000	1,900	(1,500)
Manganese	4 / 4	820 - 3,000	1,800	1,800	2,900	335
Nickel	9 / 9	13 - 278	65	65	120	6
Potassium	4 / 4	540 - 990	780	780	1,000	(6,800)
Vanadium	4 / 4	20 - 34	26	26	33	(30)
Zinc	9 / 9	24 - 71	46	46	55	13
Pesticides						
Endosulfan I	1 / 4	0.0029 - 0.0029	0.002	0.003	0.0026	-

Concentrations are given in milligrams per kilogram (mg/kg).
List includes all contaminants which were detected at least once.

*	Concentrations in parentheses are regional background means reported by CDM (Appendix A); other values are from boring 17A, 0 to 5 feet sampling interval (Geraghty & Miller, 1990).
-	Not detected in background samples.
Mean	Arithmetic average of the total number of samples, using one-half the detection limit for non-detects.
UCL	95 percent upper confidence limit (one-tailed normal distribution) on the arithmetic mean.

Table 4-4 Occurrence of Contaminants in Water and Soil from Ground-Water Seeps, Murray Ohio Disposal Site, Lawrenceburg, Tennessee.

Contaminants	Frequency of Detection	Range	Arithmetic Mean Total	Arithmetic Mean Detects	UCL
		SEEP WATER			
INORGANICS					
METALS					
Cadmium	4/6	0.0003 - 0.0007	0.00035	0.0007	0.00054
Chromium (total)	6/6	0.01 - 1.4	0.56	0.56	1
Chromium VI	3/5	0.03 - 1.5	0.55	0.91	1.3
Iron	2/6	0.08 - 0.49	0.11	29	0.27
Magnesium	5/6	3.5 - 11	5.9	6.7	9.2
Manganese	6/6	0.05 - 1.2	0.45	0.45	0.81
Nickel	5/6	0.06 - 2.9	0.99	1.2	1.9
Zinc	1/6	0.1 - 0.1	0.034	0.1	0.063
ANIONS					
Bicarbonate	3/5	210 - 340	190	290	330
Carbonate	3/5	0.2 - 0.4	0.29	3	0.46
Chloride	5/5	7 - 35	15	15	26
Cyanide	1/6	0.005 - 0.005	0.0029	0.005	0.0038
Nitrate-N	5/5	0.2 - 2.9	0.8	0.8	1.9
Sulfate	5/5	28 - 130	77	77	130

Table 4-4 Occurrence of Contaminants in Water and Soil from Ground-Water Seeps, Murray Ohio Disposal Site, Lawrenceburg, Tennessee.

Contaminants	Frequency of Detection	Range	Arithmetic Mean Total	Arithmetic Mean Detects	UCL
CATIONS					
Calcium	6/6	29 - 140	75	75	120
Potassium	5/6	0.65 - 1.1	0.7	0.78	0.92
Sodium	6/6	8.6 - 44	24	24	37
ORGANICS					
1,2-Dichloroethene	2/2	0.013 - 0.015	0.014	0.014	0.02
Toluene	2/5	0.006 - 0.008	0.0043	0.007	0.0067
Trichloroethene	2/2	0.13 - 0.14	0.13	0.13	0.16
			SEEP SOIL		
INORGANICS					
METALS					
Aluminum	1/1	12,000 - 12,000	12,000	12,000	--
Arsenic	1/1	5 - 5	5	5	--
Barium	1/1	130 - 130	130	130	--
Beryllium	1/1	0.74 - 0.74	0.74	0.74	--
Chromium (total)	6/6	120 - 1,100	500	500	830
Cobalt	1/1	50 - 50	50	50	--
Copper	1/1	56 - 56	56	56	--
Iron	6/6	1,200 - 12,000	4,300	4,300	7,700
Lead	2/6	6.8 - 80	17	43	42

Table 4-4 Occurrence of Contaminants in Water and Soil from Ground-Water Seeps, Murray Ohio Disposal Site, Lawrenceburg, Tennessee.

Contaminants	Frequency of Detection	Range	Arithmetic Mean Total	Arithmetic Mean Detects	UCL
Magnesium	6/6	47 - 600	180	180	350
Manganese	6/6	420 - 3,100	1,000	1,000	1,900
Mercury	1/1	0.27 - 0.27	0.27	0.27	--
Nickel	6/6	42 - 780	440	440	670
Selenium	1/1	0.4 - 0.4	0.4	0.4	--
Silver	1/1	0.045 - 0.045	0.045	0.045	--
Vanadium	1/1	14 - 14	14	14	--
Zinc	6/6	19 - 100	44	44	70
ANIONS					
Cyanide	1/1	0.43 - 0.43	0.43	0.43	--
CATIONS					
Calcium	6/6	460 - 2,200	1,300	1,300	1,800
Potassium	6/6	64 - 490	180	180	310
Sodium	2/2	21 - 36	29	29	76
ORGANICS					
Trichloroethene	2/2	0.13 - 0.21	0.17	0.17	0.44

All surface-water concentrations are in milligrams per liter (mg/L) and surficial soil concentrations are in milligrams per kilogram (mg/kg).

UCL Upper 95 percent confidence limit on the arithmetic mean.

-- No data available.

Table 4-5 Ground Water — Summary of Analytical Results

Murray Ohio Disposal Site Lawrenceburg, Tennessee

Sample Location:	MW-1B	MW-3B	MW-4B	MW-5A	MW-5B	MW-5B	MW-5C	MW-5C	MW-6A	MW-6B
Sample ID:	1B-2	3B-2	4B-2	5A-2	5B-2	5B-2-F*	5C-2	5C-2-F*	6A-2	6B-2
Date Sampled:	12/6/90	12/7/90	12/7/90	12/2/90	12/5/90	12/1,5/90	12/5/90	12/2,5/90	12/2,3/90	12/6/90
Monitored Zone:	OL	FPF	FPF	FPR	FPF	FPF	OL	OL	FPR	FPF
Constituent										
Cadmium	0.0014	0.0052	0.0028	—	0.0016	0.0002 J	0.0002 U	0.0002 U	0.0004	0.0002
Calcium	36 U	68	67	—	66	70	270	170	9.5 U	110
Chromium	0.01 U	0.01	0.01 U	—	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.48
Chromium, hexavalent	0.01 U	0.18	0.01 U	—	0.01 U	0.01 U	—	0.01 U	0.01 U	0.43
Iron	1.8 U	0.9 U	0.03 U	—	0.46 U	0.17 U	0.60 U	0.23 U	0.15 U	0.09 U
Lead	0.036	0.057 J	0.004 UJ	—	0.004 U	0.004 U	0.004 UJ	0.004 UJ	0.004 U	0.001 J
Magnesium	7.7	26	7.7	—	22	24	57	40	2.8	24
Manganese	0.04	0.10	0.03	—	0.07	0.04	0.06	0.02	0.06	0.09
Nickel	0.05 U	0.05 U	0.05 U	—	0.05 U	0.05 U	0.05 U	0.05 U	0.05	0.05 U
Potassium	3.2	5.0	2.0	—	2.7	1.7	6.2	4.2	0.60 U	2.0
Sodium	40	25 J	1.2 UJ	—	12 J	12 J	120 J	98 J	1.4 UJ	24
Zinc	0.16 UJ	0.06 UJ	0.10 UJ	—	0.02 U	0.02 U	0.04 U	0.02 U	0.02 U	0.19 UJ
Cyanide (total)	0.005 UJ	—	0.005 U	—	0.006	0.005	0.005 U	0.005 U	0.005 U	0.007 J
Chloride	3.6 U	—	11 U	—	—	—	38 U	40 U	12 U	33 U
Nitrate	1.0 U	—	0.1 U	—	—	—	0.1 U	0.1 U	0.1 U	1.0 U
Sulfate	1.0 U	—	1.4 J	—	—	—	1,400 J	1,128 J	17	119
Sulfide	0.2 U	—	0.2 U	—	0.2 UJ	0.2 UJ	0.2 UJ	—	0.2 UJ	0.2 U
Alkalinity (total)	151	—	164	—	164 J	160 J	138	156	50	220
Carbonate	1 U	—	0.3	—	0.2	1 U	0.3	0.5	1 U	0.3
Bicarbonate	151	—	164	—	164	3.0 U	138	155	50	220
Hydroxide	1.0 U	—	1.0 U	—	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
BOD	20 U	—	6	—	5	—	—	—	9	1 U
COD	797 J	—	8 U	—	99 UJ	—	54 UJ	—	7 U	20 UJ
CO2 Free	91 U	—	0.3	—	21	0.1	11	9.4	7.4	29
pH (Lab) (pH units)	6.52	—	7.21	—	7.20	7.66	7.40	7.52	7.13	7.18
pH (Field) (pH units)	6.28	—	—	—	—	—	7.19	—	6.45	7.09
Benzene (ppb)	1 U	1 U	1 U	5	1 U	—	1 U	—	1 U	1 U
Toluene (ppb)	50 U	11 U	6 U	5 U	12 U	—	79	—	5 U	5 U
Ethylbenzene (ppb)	1 U	1 U	1 U	1 U	1 U	—	1 U	—	1 U	1 U
Xylenes (ppb)	2 U	2 U	2 U	2 U	2 U	—	2 U	—	2 U	2 U

NOTE: All concentrations reported in parts per million unless noted otherwise.
ppb - parts per billion
OL - Ordovician Limestone
FPF - Fort Payne Formation
FPR - Fort Payne Residuum
— Parameter not analyzed for in this sample.
* Filtered Sample

U - The parameter was analyzed for, but was not detected. The associated numerical value is the sample quantitation limit.
J - The associated numerical value is an estimated quantity.
UJ - The parameter was analyzed for, but was not detected. The sample quantitation limit is an estimated quantity.

Table 4-5 Ground Water — Summary of Analytical Results

Murray Ohio Disposal Site Lawrenceburg, Tennessee

Sample Location:		MW-8A	MW-8B	MW-8B	MW-9A	MW-9A	MW-10A	MW-10B	MW-12A	MW-13A	MW-13A
Sample ID:		8A-2	8B-2	8B-2-F*	9A-2	9A-2-F*	10A-2	10B-2	12A-2	13A-2	13A-2-F*
Date Sampled:		11/30;12/3,4/90	11/30/90	11/30/90	11/30;12/3,4/90	12/3,4/90	12/3,4/90	12/3,4/90	12/6/90	12/2,3/90	12/3,4/90
Monitored Zone:		FPR	FPF	FPF	FPR	FPR	FPR	FPF	FPR	FPR	FPR
Constituent											
Cadmium		0.0006	0.0002 U	0.0002 UJ	0.0002 U	0.0005	0.0021	0.0002 U	0.0030	0.0002 U	0.0006
Calcium		19 U	123	106	8.3 U	34 U	9.8 U	820	20 U	54 U	36 U
Chromium		0.04	2.2	2.1	0.01 U	0.01 U	0.01 U	0.02	0.01 U	0.01 U	0.01 U
Chromium, hexavalent		0.09	2.5	2.6	0.14	—	0.01 U	0.04	0.01 U	0.01 U	0.01 U
Iron		1.2 U	0.06 U	0.03 U	0.19 U	0.11 U	2.5	1.1 U	0.69 U	0.36 U	0.03 U
Lead		0.046 J	0.004 U	0.004 U	0.004 U	0.004 U	0.010	0.005 J	0.004 UJ	0.004 U	0.004 U
Magnesium		3.5	32	32	2.6	11	2.0	2.6	2.1	11	5.3
Manganese		1.8	0.04	0.03	0.06	0.05	1.0	0.02	0.97	0.08	0.05
Nickel		0.57	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.06	0.05 U	0.05 U
Potassium		1.4	3.5	3.6	1.1	1.5	2.3	6.0	0.78	1.1	0.68
Sodium		7.8J	53	51	3.3 UJ	5.8 J	0.2 UJ	18 J	0.2 U	2.3 UJ	1.4 UJ
Zinc		0.12 U	0.22 U	0.02 U	0.02 U	0.07 U	0.03 U	0.02 U	0.14 UJ	0.02 U	0.02 U
Cyanide (total)		0.005	0.005 U	0.005 U	0.005 U	—	0.005 U	—	0.005 U	0.005 U	—
Chloride		—	33 U	33 U	—	—	—	—	2.6 U	1.5 U	2.1 U
Nitrate		—	1.4 U	1.4 U	—	—	—	—	0.1 U	0.1 U	0.1 U
Sulfate		—	243	171	—	—	—	—	9.4 J	10 U	10 U
Sulfide		0.2 U	0.2 U	0.2 UJ	0.2 U	—	0.2 U	—	0.2 U	0.2 UJ	0.2 UJ
Alkalinity (total)		28 U	193	193	76	—	22 U	6,580	56	98	112
Carbonate		1 U	0.4	0.6	1 U	—	1 U	5,617	1 U	0.1	0.1
Bicarbonate		28 U	193	192	76	—	22 U	32 U	56	98	112
Hydroxide		1.0 U	1.0 U	1.0 U	1.0 U	—	1.0 U	931	1.0 U	1.0 U	1.0 U
BOD		4 U	13	—	4 U	—	4 U	—	1 U	1 U	—
COD		70 UJ	82 U	—	95 UJ	—	7 UJ	—	7 U	24 U	—
CO2 Free		22 U	0.4	0.6	39	—	11 U	1.0 U	1.0 U	33	20
pH (Lab)	(pH units)	6.41	7.38	7.50	6.59	—	6.62	12.27	7.26	6.77	7.04
pH (Field)	(pH units)	5.60	6.94	—	—	—	—	—	6.71	6.43	—
Benzene	(ppb)	1 U	1 U	—	1 U	—	1 U	1 U	1 U	1 U	—
Toluene	(ppb)	5 U	5 U	—	5 U	—	5 U	9 U	5 U	6 U	—
Ethylbenzene	(ppb)	1 U	1 U	—	1 U	—	1 U	1 U	1 U	1 U	—
Xylenes	(ppb)	2 U	2 U	—	2 U	—	2 U	2 U	2 U	2 U	—

NOTE: All concentrations reported in parts per million unless noted otherwise.
ppb - parts per billion
OL - Ordovician Limestone
FPF - Fort Payne Formation
FPR - Fort Payne Residuum
— Parameter not analyzed for in this sample.
* Filtered Sample

U - The parameter was analyzed for, but was not detected. The associated numerical value is the sample quantitation limit.
J - The associated numerical value is an estimated quantity.
UJ - The parameter was analyzed for, but was not detected. The sample quantitation limit is an estimated quantity.

Table 4-5 Ground Water — Summary of Analytical Results

Murray Ohio Disposal Site Lawrenceburg, Tennessee

Sample Location:		MW-14A	MW-14B	MW-14B	MW-15A	MW-15B	MW-16A	MW-16B	MW-17A	MW-17A	MW-17B
Sample ID:		14A-2	14B-2	14B-2-D†	15A-2	15B-2	16A-2	16B-2	17A-2	17A-2-F*	17B-2
Date Sampled:		12/2,3/90	12/6/90	12/6/90	12/4/90	12/2,3/90	12/1/90	12/2,3/90	12/3,4/90	12/5/90	12/5/90
Monitored Zone:		FPR	FPF	FPF	FPR	FPF	FPR	FPF	FPR	FPR	FPF
Constituent											
Cadmium		0.0003	0.0004	0.0006	—	0.0002	0.0085	0.0008	0.0029	0.0003	0.0065
Calcium		55 U	52 U	54 U	—	63 U	84	95	6.3 U	41 U	340
Chromium		0.01 U	0.01 U	0.01 U	—	0.01 U	0.03	0.01 U	0.01 U	0.01 U	0.01 U
Chromium, hexavalent		0.01 U	0.01 U	0.01 U	—	0.01 U	0.01 U	0.01 U	0.01 U	—	0.01 U
Iron		0.39 U	0.03 U	0.03 U	—	0.15 U	2.0 U	0.53 U	3.9	0.03 U	1.90 U
Lead		0.004 U	0.004 UJ	0.004 UJ	—	0.004 U	0.004	0.004 UJ	0.018	0.004 U	0.004 UR
Magnesium		6.6	7.4	7.4	—	1.7	11	47	5.4	3.2	123
Manganese		0.25	0.01 U	0.02	—	0.01 U	7.3	0.04	4.6	0.01 U	0.24
Nickel		0.05 U	0.05 U	0.05 U	—	0.05 U	2.5	0.05 U	0.13	0.05 U	0.05 U
Potassium		1.1	0.77	0.60 U	—	2.3	6.2	30	1.6	0.93	5.7
Sodium		0.2 UJ	0.6 U	0.2 U	—	20 J	70 J	340 J	2.3 UJ	8.2 J	580 J
Zinc		0.02 U	0.02 UJ	0.02 UJ	—	0.02 U	0.54 U	0.02 U	0.42 U	0.02 U	0.02 U
Cyanide (total)		0.005 U	0.005 U	0.005 U	—	0.005 U	0.005 U	0.01 U	0.005 U	—	—
Chloride		1.5 U	1.5 U	1.0 U	—	73	51	10	—	—	—
Nitrate		0.1 U	0.1 U	0.1 U	—	0.1 U	0.1 U	41	—	—	—
Sulfate		10 U	11 UJ	7.6 UJ	—	10 U	280 J	709	—	—	—
Sulfide		0.2 UJ	0.2 U	0.2 U	—	0.2 UJ	0.2 UJ	0.2 UJ	0.2 U	—	—
Alkalinity (total)		148	151	149	—	100	108	108	136	—	—
Carbonate		0.2	0.4	0.9	—	62 U	1 U	1 U	0.3	—	—
Bicarbonate		148	151	148	—	23 U	108	1 U	136	—	—
Hydroxide		1.0 U	1.0 U	1.0 U	—	14 U	1.0 U	3.88	1.0 U	—	—
BOD		9	1 U	1 U	—	2	3	—	4	—	—
COD		26 U	7 U	7 U	—	243 U	133 UJ	126 U	7 UJ	—	—
CO2 Free		20	9.7	4.5	—	1.0 U	49	1.0 U	10	—	—
pH (Lab)	(pH units)	7.16	7.49	7.80	—	10.48	6.64	11.88	7.43	—	—
pH (Field)	(pH units)	7.47	7.92	—	—	—	6.51	—	7.39	—	—
Benzene	(ppb)	1 U	1 U	1 U	1 U	1 U	3	1 U	1 U	—	1 U
Toluene	(ppb)	5 U	6 U	7 U	5 U	9 U	8 U	5 U	5 U	—	5 U
Ethylbenzene	(ppb)	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	—	1 U
Xylenes	(ppb)	2 U	2 U	2 U	2 U	2 U	5	2 U	2 U	—	2 U

NOTE: All concentrations reported in parts per million unless noted otherwise.
ppb - parts per billion
OL - Ordovician Limestone
FPF - Fort Payne Formation
FPR - Fort Payne Residuum
— Parameter not analyzed for in this sample.
* Filtered Sample † Duplicate Sample

U - The parameter was analyzed for, but was not detected. The associated numerical value is the sample quantitation limit.
J - The associated numerical value is an estimated quantity.
UJ - The parameter was analyzed for, but was not detected. The sample quantitation limit is an estimated quantity.
R - The data are unusable (compound may or may not be present). Resampling and reanalysis is necessary for verification.

V. SUMMARY OF SITE RISKS

Surficial on-site soils and surface water of the streams around the site and Shoal Creek were considered to have current, potentially complete exposure pathways. Future potentially complete exposure pathways include surficial and subsurface soils, surface water of the streams around the Site (including Shoal Creek), and ground water. The risk assessment was performed as part of the RI for the matrices listed above and can be found in the RI report with an EPA addendum in the FS report.

A. SELECTION OF CONTAMINANTS OF POTENTIAL CONCERN

The hazard identification involved the selection of contaminants of potential concern (COPCs), detected contaminants which have inherent toxic or carcinogenic effects that are likely to pose the greatest concern with respect to the protection of public health and the environment. Selected contaminants of concern which were found to drive the Risk Assessment (or account for approximately 90% of the risk) at the Murray Site include:

* Nickel
* Chromium III
* Chromium VI

Delineation of all COPCs for each media can be found in Table 5-1 of this document. Monitoring data from the RI report were used to calculate exposure concentrations for the exposure scenarios described below.

B. EXPOSURE ASSESSMENT

The objective of the exposure assessment is to estimate the type and magnitude of exposures to the chemicals of potential concern that are present at or migrating from the Site. The results of the exposure assessment are combined with chemical-specific toxicity and carcinogenicity information to characterize potential risks.

Populations at greatest risk of health effects are those who would potentially use on-Site ground water and children who would play in surficial soils in the overland flow area on-Site. The primary routes of exposure to contaminants in the ground water are ingestion of the water, inhalation of volatiles and dermal absorption. The primary route of exposure for children playing in surficial soils of the overland flow area is ingestion.

Exposure Point Concentrations

Exposure point concentrations were calculated for ground water, surface water, sediment, ground-water seeps and surficial soils. The reasonable maximum exposure (RME) point concentration was calculated after testing the data's distribution. The 95% Upper Confidence Limit (UCL) on the arithmetic mean was calculated for each COC in each area. The RME was the lower of the 95% UCL or the maximum detected concentration.

Table 5-2 of this document contains the exposure point concentrations, or the UCLs, for each of the driving contaminants in each media tested. Ground water, surface water and sediment, seep soil and water, soil (surficial and subsurface) and surface water data from the RI Report were used to derive exposure point concentrations. The RI Report contains data for samples taken for the contaminants of concern for the time frames and locations discussed for each media in Section III of this document.

Some of the analytical results are reported as "non-detects", meaning the actual concentration of the contaminant analyzed for is between zero and the detection limit. The risk assessment calculations were based on assuming that all non-detect samples were contaminated at a concentration equal to the detection limit. This makes the risk assessment more conservative.

Exposure Dose Calculations

Average daily exposure doses (ExDs) were calculated for each exposure pathway using standard assumptions in EPA Risk Assessment guidance. Exposure scenarios and calculations with assumptions will be summarized below. For cancer effects, doses were averaged over a lifetime (70 years); doses for non-cancer effects were averaged over the exposure period (U.S. EPA 1989a).

Current Exposure

1. Wading

Current wading exposure doses (WExDs) for a child (6 to 15 years of age) to surface water and sediment in Northeast, Southeast, and Southwest Branches and on-Site ground-water seeps were calculated using the following assumptions:

a. a 38-kg body weight (U.S. EPA, 1989c);

b. a skin surface area of 4,100 sq. cm in contact with affected media (i.e., hands, feet, lower arms, and lower legs);

c. a sediment or soil adherence rate of 1.0 mg/cm^2 (U.S. EPA, 1992b);

d. an incidental sediment ingestion rate of 50 mg/day or one-half the rate for soil (U.S. EPA 1991a);

e. standard EPA bioavailability adjustment factors and permeability constants for dermal absorption of contaminants from water and soils, respectively;

f. an exposure frequency of 50 days/year for 10 years, which is similar to EPA Region IV's recommended exposure frequency of 45 days/year of swimming (U.S. EPA, 1991b);

g. an exposure duration of 2.6 hours per day wading in the branches, which equals the standard default value for swimming, and one hour per day playing in the seeps; and

h. an averaging period for children and adults of 25,550 days for cancer risk (365 days for 70 years) and 3,650 days (365 days for 10 years) for hazard quotients.

Example calculations for this scenario are shown in Table 5.3. For a child trespasser exposed to surface water and sediment, the excess lifetime cancer risk (ELCR) was found to be 1 x 10^-9. The hazard index (HI) was found to be 0.3. For a child trespasser exposed to water and soil in ground-water seeps, the ELCR was 1 x 10 ^-6 and the HI was 0.3 here as well. All computed risk values for the wading scenario are within EPA guidelines.

2. Swimming

Using a similar approach to that described for wading, calculations were made for swimming exposure in Northeast, Southeast and Southwest Branches. Numerical results of calculations will be revealed in the **Risk Characterization** portion of this section. All swimming exposures were found to be acceptable.

3. Fish Ingestion

While it is unlikely that fish would be caught and consumed from the branches, calculations were performed for them, as opposed to

Shoal Creek (a more likely scenario since it is a larger stream) to obtain a more concentrated, conservative scenario. Exposure doses were calculated for consumption of fish caught locally in Shoal Creek based on data from Northeast, Southeast, and Southwest Branches and the following assumptions:

a. hypothetical concentrations of contaminants in the fish were calculated using the 95% UCL concentrations detected from the three branches times the fish bioconcentration factor (BCF); and

b. ingestion of an average of 54 grams of fish per day (U.S. EPA, 1991a).

Body weight and averaging times were the same for the other scenarios previously presented.

4. Soils

Surficial soil exposure doses were estimated for children (6 to 15 years of age) trespassing on the Site. Specific guidance is not currently available for this non-residential type of scenario. Thus, exposure doses were calculated based on body weights and averaging times presented previously and the following assumptions:

a. a breathing rate of 2 cubic meters/hour which assumes moderate activity (U.S. EPA, 1989c);

b. a dust adherence of 1 mg/cm^2 (U.S. EPA, 1992b);

c. a skin surface area of 3,100 cm^2 (hands, face and arms, U.S. EPA, 1989c);

d. a soil ingestion rate of 100 mg/day (U.S. EPA, 1989a); and

e. an exposure frequency of 50 days/year for 10 years.

<u>Future Exposure</u>

Data from both the unconsolidated and Fort Payne bedrock zones of the upper aquifer were used to estimate exposure to ground-water contaminants and soil data to a depth of 16 feet. Exposure scenarios assumed a future resident and included ingestion of ground water, inhalation of VOCs during domestic use of the water, dermal contact with ground water while bathing and ingestion of soil. As with Current Exposures, results of calculations are presented in the Risk Characterization portion of this section.

1. Potable Ground Water

Average daily drinking-water exposure doses for future ingestion of ground water from a hypothetical potable well installed at the disposal site were calculated based on the body weights and averaging times previously presented and the following assumptions:

a. ingestion of 2 liters of water/day for 30 years (U.S. EPA 1989a); and

b. the ground water in the potable well is from both the unconsolidated as well as the Fort Payne bedrock zones.

2. Showering

Exposure doses for inhalation of VOCs released from tap water during indoor activities (showering, dishwashing) are based on models presented in Foster and Chrostowski (1987) and McKone (1987). McKone's study indicated that inhalation exposure in the shower was approximately equal to inhalation exposure from all other household sources. Inhalation exposure while in the shower was based on the Foster and Chrostowski model. The shower exposure dose for each contaminant was doubled to derive a total household inhalation exposure dose estimate. Assumptions used are similar to those previously presented.

3. Soil Exposure Due to Residential Construction

Future residential development of the Site would require excavation and regrading; thus, all soil data to a depth of 16 feet were selected to represent future surficial soil concentrations. Ingestion was the only exposure pathway considered for future residents in the excavation/construction scenario. This is consistent with current EPA guidance (1991d). Dermal and inhalation pathways were considered minor because lawns and the generally undisturbed nature of residential property limit these exposure routes. Furthermore, VOCs would not persist in surficial soil, and inorganics are not well absorbed across the skin. Therefore, the standard soil ingestion assumptions should provide a reasonably conservative estimate of future residential exposure to soil.

Exposure of a future resident considered exposure as a child and adult over a 30-year residence time. Body weights and soil ingestion rates differ with age; therefore, an age-adjusted soil ingestion factor of 114 mg-yr/kg-day and an exposure frequency of 350 days per year were used to calculate exposure (U.S. EPA, 1991 a and d).

4. Soil Exposure for a Child Resident in Overland Flow and Formerly Ponded Areas

This portion of the Risk Assessment was performed by EPA after the previously presented parts since additional sampling of the Overland Flow and Formerly Ponded areas was required subsequent to the RI. Additional sampling was required due to very high soil concentrations found in these areas. Calculations for this scenario are presented in the EPA addendum to the FS.

This scenario assumed a future child resident playing in the Overland Flow and Formerly Ponded Areas and ingesting, dermally absorbing and/or inhaling soil contaminants. EPA's Regional Toxicologist performed this portion of the Risk Assessment and assumed all current EPA values for exposure in these three avenues. Refer to this part of the FS for all information on these values and assumptions. Exposure point concentrations can be found in Table 5.2 herein.

Exposure to Lead

The current approach to assessing the toxicity of lead is based on potential effects seen in children as predicted by the Uptake Biokinetic Model for lead. The model estimates blood lead levels which are then compared to the acceptable level of 10 micrograms/deciliter.

This model is a program that estimates total lead uptake [micrograms (ug) lead/day] in humans which results from diet, inhalation and ingestion of soil, dust, water, painting, and placental transport to the fetus. The current program calculates lead uptake and blood lead levels for the most sensitive subpopulation, children aged 0 to 6 years. This would be a hypothetical future exposure scenario where children in this age group visit the Site or are on-Site residents. Table 5.4 summarizes the results from this model.

C. TOXICITY ASSESSMENT

Under current EPA guidelines, the likelihood of carcinogenic and non-carcinogenic effects due to exposure to Site chemicals are considered separately. Criteria for evaluating the potential of Site chemicals to cause these two types of adverse effects are described below.

Criteria for Non-Carcinogenic Effects

The Reference Dose (RfD) is an estimate of the highest human intake of a chemical, expressed as mg/kg/day, that does not cause adverse effects when exposure is long-term (lifetime). RfD values are based on animal or human toxicity studies from which a no-observed-adverse-effect level (NOAEL) is experimentally determined. The NOAEL is the highest dose at which there was no statistically or biologically significant adverse effect observed. The RfD is derived by dividing the NOAEL from the selected study by an uncertainty factor. The uncertainty factor consists of multiples of 10 to account for specific areas of uncertainty in the available data.

The dose calculated from the exposure assessment is compared to the RfD to determine whether adverse effects might occur. If predicted exposure concentrations are below the level of the RfD, no adverse health effects are expected according to current EPA guidelines.

The oral RfD for nickel is 2×10^{-2}mg/kg/day, which is calculated using an uncertainty factor of 300. Total Chromium and Chromium VI have RfDs of 1×10^{0} and 5×10^{-3}, respectively, with corresponding 1000 and 500 uncertainty factors.

Nickel's chronic RfD was derived from a rat subchronic study in which the subjects exhibited substantial weight loss. Chromium's RfDs were based on NOAELs. Dermal RfDs were developed by adjusting oral RfDs by the oral absorption factors presented in ATSDR's toxicological profiles.

Criteria for Carcinogenic Effects

EPA uses a weight-of-evidence system to convey how likely a chemical is to be a human carcinogen, based on epidemiological studies, animal studies, and other supportive data. The classification system of EPA for characterization of the overall weight of evidence of carcinogenicity includes: Group A - Human Carcinogen; Group B - Probable Human Carcinogen; Group C - Possible Human Carcinogen; Group D - Not Classifiable as to Human Carcinogencity; Group E - Evidence of Non-Carcinogenicity for Humans. Group B is subdivided into two groups: Group B1 - limited human evidence for carcinogenicity; and Group B2 - sufficient data in animals, but inadequate or no evidence in humans.

EPA's weight-of-evidence classification for nickel is B2 and is based on effects from exposure to refinery dust. The use of this chemical's carcinogenic toxicity value in this analysis is therefore conservative. The classification for Chromium VI is also B2.

For chemicals with carcinogenic effects, EPA calculates the cancer risk associated with a given dose by multiplying the dose from a given route of exposure by a cancer potency factor or potency slope. EPA derives potency factors from the upper 95% confidence limit of the slope of the extrapolated dose-response curve, which shows the relationship between a given dose and the associated tumor incidence. As a result, the predicted cancer risk is an upper-bound estimate of the potential risk associated with exposure. The inhalation CSFs for Nickel and Chromium VI are 8.4×10^{-1} and 4.1×10^{-1}, respectively. There are currently no oral CSFs for any of the COPCs.

D. RISK CHARACTERIZATION

The risks for each of the scenarios presented in the exposure assessment are be quantified in this section and can be found in Table 5.5. The table summarizes all of the added lifetime risks for each scenario, with the exception of the "Soil Exposure for a Child Resident in Overland Flow and Formerly Ponded Areas". With the exception of this scenario, the HI for a future resident is at 4.0, above the EPA allowable limit of 1.0. This risk for a future resident is mostly all due to ground water ingestion. Potable ground water for future potential residents presents a scenario which will require remediation.

Tables 5.6 and 5.7, respectively, give the cancer and non-cancer risks associated with the Overland Flow Area. Cancer risks are acceptable, however, the hazard index for a future child resident playing in soils in the area is 2.28. This area will require remediation to bring nickel levels down to permissible concentrations in the soil, as nickel is the contaminant mainly responsible for the unacceptable HI.

E. ENVIRONMENTAL RISKS

Endangered Species and Critical Habitats

The Tennessee Department of Environment and Conservation (TDEC) has identified a critical habitat for the slackwater darter (Etheostoma boschundi) in both Lawrence and Wayne Counties, however, this critical habitat does not occur downstream of the Site. In addition, the U.S. Department of Interior, Fish and Wildlife Service has expressed concern for the federally-listed endangered gray bat (Myotis grisescens) for the area around Lawrenceburg. A gray bat was collected in the Lawrenceburg on April 28, 1969, by Tennessee Valley Authority researchers.

No priority hibernation, maternity, or bachelor caves for the gray bat have been identified in either Lawrence County Tennessee or adjacent Giles County. There is, however, one priority cave (Ice Cave) and another cave (Lay Cave) documented to be used by the gray bat for hibernation purposes. Each of these caves is approximately 35 to 40 kilometers (22 to 25 miles) from the Site. Given that foraging ranges for the gray bat are from an average of 11 kilometers (6.8 miles) to a maximum of 17 to 20 kilometers (10.5 to 12 miles) from a roost cave (La Val et. al.), it is highly unlikely that gray bats potentially occupying Ice Cave or Lay Cave would frequent the Site.

A cave used by bats, other than gray bats, is known to exist around the Murray Ohio Dump Site. The cave is approximately 400 meters (1/4 mile) down the gravel road past the background monitoring wells (MW-17A and MW-17B). Gray bats will not cohabitate with other bat species in the same cave; therefore, the presence of other bat species precludes use of this cave at this time by gray bats.

A threatened or endangered species survey was conducted by CDM/FPC for EPA in November 1991 as part of the RI and found no threatened or endangered species. A copy of this report can be found in Appendix B of the RI report.

Aquatic Effects

Northeast Branch receives most of the Site runoff before entering Shoal Creek. Northeast Branch is a shallow (6 to 12 inches deep) seasonal stream which is not expected to support a complex aquatic ecosystem. Southeast Branch and Southwest Branch are even more shallow and seasonal than Northeast Branch. Figure 4.1 shows the location of these streams in relation to the Site. Surface water and sediment samples were collected from these streams by Geraghty & Miller, Inc. and CDM/FPC as part of the RI. Additional samples were collected by EPA's Environmental Services Division (ESD).

Samples revealed elevated levels of nickel, hexavalent chromium (mostly in water) and total chromium (mostly in sediment). These levels were at their highest at the head of Northeast Branch adjacent to the landfill and decreased to background at the confluence with Shoal Creek. Chemistry samples from Southeast Branch and Southwest Branch revealed no unacceptable levels.

Chromium was the primary contaminant detected. Its toxicity to biota is significantly influenced by abiotic variables such as Ph, temperature, and hardness of water and biological factors such as species, life stage and sensitive populations. Chronic (28 to 84 days) lethal concentrations for 50 percent of the population tested (LC_{50}s) for freshwater organisms most sensitive to chromium VI have been reported from 0.2 to 0.5 mg/l (Eisler 1986). The maximum and average concentrations detected in Northeast Branch exceeded the chronic criterion for chromium VI, but did not exceed the criterion for chromium III. Again, concentrations are diluted to background at the entrance to Shoal Creek.

The National Oceanic and Atmospheric Administration (NOAA) has established values for screening sediment contaminant concentrations with respect to potential biological effects. These values are not standards or criteria. NOAA Effects Range-Low (ER-L) and Effects Range-Median (ER-M) values were used for comparison with the detected levels of contaminants in sediment. ER-L values are concentrations equivalent to the lower 10 percentile of NOAA screened available data and indicate the low end of the range of concentrations in which adverse biological effects were observed or predicted in sensitive species and/or sensitive life stages. ER-M values are the 50th percentile concentrations in ranges of screened data; above these concentrations, adverse effects were observed or predicted for most species tested.

Nickel exceeded the ER-M value at Northeast Branch locations nearest the Site. The maximum sediment concentration of nickel detected in Southeast Branch of 64 mg/kg exceeded the sediment background level (30 mg/kg) as well as the NOAA ER-M value of 50 mg/kg. Chromium exceeded the ER-L value but not the ER-M value.

Biological testing was conducted by ESD to assess current ambient conditions and ecological integrity of the tributaries draining the Site and feeding into Shoal Creek. These tests were designed for a tiered approach and included habitat assessment, surface-water and sediment toxicity testing and benthic macroinvertebrate biosurvey. This study is contained in Appendix A of the RI report.

Data for surface water and sediment chromium and nickel concentrations, acute toxicity tests, and benthic macroinvertebrate survey indicate that the Site exerts an impact on the upper reaches of Northeast Branch. However, the impact to the aquatic community is restricted in areal extent. There is no indication of metal contamination or aquatic toxicity where Northeast Branch drains into Shoal Creek. The toxicity of water diminishes and disappears as Northeast Branch reaches Shoal Creek. Some places along Southeast Branch show toxicity to biota. Although toxicity samples were not collected from Southwest Branch in the proximity of the Site drainage, current data (i.e., habitat assessment, bioassessment score) indicate that the Site exhibits no impact to this branch.

Elevated levels of nickel and chromium detected in surface water and sediment of Northeast Branch (and sporadically along Southeast Branch) decreased to acceptable levels as the tributary approached Shoal Creek. There is no indication of elevated contaminant concentration in Southwest Branch. Chromium and nickel may be migrating from the Site to Northeast Branch and Southeast Branch from erosion and ground-water transport. Concentrations of chromium and nickel may be affecting biota in Northeast Branch and Southeast Branch, but are not likely affecting populations in Shoal Creek.

Terrestrial Effects

The results of the CDM/FPC terrestrial habitat survey are presented in Appendix B of the RI report. In summary, the only significant contaminants posing risk were chromium and nickel. The current landfill cover does lessen threats to the terrestrial environment, but not to an acceptable level. The chance of exposure to contaminants is increased in the 1973 area due to inadequate cover thickness. Likewise, high levels of nickel and chromium in the surficial soils of the overland flow and formerly ponded areas present a threat to terrestrial receptors.

F. UNCERTAINTIES

All estimates of risk are based upon numerous assumptions with uncertainties. In addition to limitations associated with Site-specific chemical data, other assumptions and uncertainties that affect the accuracy of the Site-specific risk characterizations result from the extrapolation of potential adverse human health effects from animal studies, the extrapolation of effects observed at high-dose to low-dose effects, the modelling of dose response effects, and route-to-route extrapolation.

The use of acceptable levels (established standards, criteria and guidelines) and unit cancer risk values which are derived from animal studies introduces uncertainty into the risk estimates. In addition, the exposure assumptions used in estimating individual dose levels are often surrounded by uncertainties. As such, these estimates should not stand alone from the various assumptions and uncertainties upon which they are based. In developing numerical indices of risk, an attempt is made to evaluate the effect of the assumptions and limitations on the numerical estimates.

The uncertainty factors which are incorporated into the risk estimates are believed to be conservative. As such, when they are considered collectively, exposure and subsequently risk may be overestimated. On the other hand, these risk calculations were based on present conditions at the Site, including present concentrations of contaminants in the various Site media. Additional risk could occur should the concentrations increase in any of the Site media.

G. CONCLUSIONS

Hazard Indices were unacceptable for a future resident ingesting ground water at the Site and for a child playing in and ingesting soils from the Overland Flow Area. These His were 4.0 and 2.3, respectively and were due almost entirely to nickel, chromium and hexavalent chromium. All other scenarios presented in the Exposure Assessment and Risk Characterization portions of this section were found to be acceptable for cancer as well as non-cancer risks. A summary of the cancer as well as non-cancer risk numbers for each scenario can be found in Tables 5.5, 5.6 and 5.7.

Recommended remediation numbers are to those ground-water ARARs specified in Section VII of this document and the following surficial soil numbers for the driving contaminants, as calculated by EPA's Regional toxicologist:

Nickel	-	1,498 ppm
Chromium(6)	-	374 ppm
Total Chromium	-	74,881 ppm

Off-Site soils meet the approved action delineation levels for Nickel, Chromium(6), and Total Chromium.

Data for surface water and sediment chromium and nickel concentrations, acute toxicity tests, and benthic macroinvertebrate survey indicate that the Site exerts an impact on the upper reaches of Northeast Branch. No other streams around the Site show impacts with the exception of some mild impacts to Southeast Branch. No further ecological sampling in the tiered approach is necessary at this time. High metal concentrations in the surficial soils of the overland Flow Area, in addition to presenting a human health risk, could pose risks to the terrestrial environment.

Actual or threatened releases of hazardous substances from this Site, if not addressed by implementing the response actions in this ROD, may present an imminent and substantial endangerment to public health, welfare and the environment.

Table 5.1 Contaminants of Potential Concern, Murray Ohio Disposal Site, Lawrenceburg Tennessee.

Contaminants	Ground Water: Unconsolidated Zone	Ground Water: Fort Payne Bedrock Zone	Surface Water	Sediment	Ground-Water Seeps: Seep Water	Ground-Water Seeps: Seep Soil	Soil: 0-6 feet	Soil: 0-16 feet
INORGANICS								
Arsenic							(x)	(x)
Barium			x	x		x	(x)	(x)
Beryllium						x		
Cadmium	x				x			x
Chromium	x	x	x	x	x	x	x	x
Cobalt				x		x	x	x
Copper						x		
Cyanide	x	x			x	x		x
Iron							x	x
Lead	x	x	x			x	x	x
Manganese			x	x	x	x	x	x
Mercury						x		
Nickel	x		x	x	x	x	x	x
Nitrate			x		x			
Vanadium						(x)	(x)	(x)
Zinc			x	x	x	x	x	x
ORGANICS								
VOCs								
Acetone								x
Benzene	x							
2-Butanone								x
1,2-Dichloroethene	<u>x</u>	<u>x</u>			x			
Ethylbenzene								x
4-Methyl-2-pentanone								x
Toluene		x			x			x
Trichloroethene	<u>x</u>	<u>x</u>			x	x		
Xylenes	x							x

Footnotes appear on page 2.

Table 5.1. Contaminants of potential concern, Murray Ohio Disposal Site, Lawrenceburg Tennessee.

Contaminants	Ground Water				Ground-Water Seeps		Soil	
	Unconsolidated Zone	Fort Payne Bedrock Zone	Surface Water	Sediment	Seep Water	Seep Soil	0-6 feet	0-16 feet
Semi-VOCs								
Fluoranthene				x				
Pyrene				x				
PESTICIDES								
gamma-BHC			x					
Endosulfan I							x	x

x Contaminant of concern.

(x) Retained in exposure calculations, but not likely a contaminant of concern based on background concentrations.

x Constituent is included as a COC because it was detected in a ground-water seep.

TABLE 5.2
EXPOSURE POINT CONCENTRATIONS FOR DRIVING COCS BY MEDIA

GROUND WATER

Unconsolidated Zone

Contaminant	UCL (mg/l)
Chromium (total)	0.022
Chromium VI	0.068
Nickel	0.99

Fort Payne Bedrock Zone

Contaminant	UCL (mg/l)
Chromium (total)	0.76
Chromium VI	0.97
Nickel	----

Unconsolidated and Fort Payne Bedrock Zones

Contaminant	UCL (mg/l)
Chromium (total)	0.39
Chromium VI	0.48
Nickel	0.46

SUBSURFACE SOILS

Contaminant	UCL (mg/kg)
Chromium (total)	93
Nickel	180

SURFICIAL SOILS EXCLUDING OVERLAND FLOW AND FORMERLY PONDED AREAS

Contaminant	UCL (mg/kg)
Chromium	62
Nickel	120

SURFICIAL SOILS FROM OVERLAND FLOW AREA

Contaminant	UCL (mg/kg)
Total Chromium	1290
Chromium VI	0.358
Nickel	3390

SURFICIAL SOILS FROM FORMERLY PONDED AREAS

Contaminant	UCL (mg/kg)
Total Chromium	70.1
Chromium VI	NA
Nickel	96

TABLE 5.2 (continued)
EXPOSURE POINT CONCENTRATIONS FOR DRIVING COCS BY MEDIA

SURFACE WATER

Contaminant	UCL (mg/l)
Chromium	0.041
Nickel	0.047

SEEP WATER

Contaminant	UCL (mg/l)
Chromium (total)	1.0
Chromium VI	1.3
Nickel	1.9

SEEP SOIL

Contaminant	UCL (mg/kg)
Chromium (total)	830
Nickel	670

SEDIMENT

Contaminant	UCL (mg/kg)
Chromium (total)	110
Nickel	580

Table 5.3 Equations and Example Calculations, Current Wading Exposure Doses to Surface Water, Sediments, and Ground-Water Seeps, Murray Ohio Disposal Site, Lawrenceburg, Tennessee.

Equation Definitions

$$WExD = \frac{C_{SED} \times [(IR) + (SSA \times SA \times BAF)] \times EF}{BW \times AP \times UC1} \quad \text{sediment}$$

$$WExD = \frac{C_{SW} \times SSA \times PC \times ED \times EF}{BW \times AP \times UC2} \quad \text{surface water}$$

where:

WExD Average daily wading exposure dose (mg/kg/day).
AP Averaging period (25,550 days/lifetime [70 years] for carcinogens; 3,650 days [10 years] for non-cancer effects) (USEPA, 1989a; 1991a,c).
BAF Bioavailability adjustment factor (unitless) (Table 7-11).
BW Body weight (38-kg) (USEPA, 1989c).
C_{sed} Constituent concentration in sediment (mg/kg).
C_{sw} Constituent concentration in surface water (mg/L).
ED Exposure duration (2.6 hours/day for streams and 1 hour per day for seeps) (USEPA, 1991a).
EF Exposure frequency (50 days/year x 10 years).
IR Ingestion rate (50 mg/day).
PC Permeability constant (cm/hr) (Table 7-11).
SA Sediment adherence (1 mg/cm^2/day) (USEPA, 1992b).
SSA Skin surface area in contact with affected media (4,100 cm^2 - child) (USEPA, 1989c).
UC1 Unit conversion (1,000,000 mg/kg).
UC2 Unit conversion (1,000 cm^3/L).
mg/kg Milligrams/kilogram.
mg/L Milligrams/liter.
cm/hr Centimeters/hour.

Example calculations (Total chromium in Seeps)

$$WExD_{sd} = \frac{830 \text{ mg/kg} \times [(50 \text{ mg/day}) + (4{,}100 \text{ cm}^2 \times 1 \text{ mg/cm}^2\text{/day} \times 0.2)] \times 500 \text{ days}}{38 \text{ kg} \times 3{,}650 \text{ days} \times 1{,}000{,}000 \text{ mg/kg}}$$

$$= 2.6E\text{-}03 \text{ mg/kg/day (soil)}$$

$$WExD_{sw} = \frac{1 \text{ mg/L} \times 4{,}100 \text{ cm}^2 \times 0.001 \text{ cm/hr} \times 1 \text{ hr/day} \times 500 \text{ days}}{38 \text{ kg} \times 3{,}650 \text{ days} \times 1{,}000 \text{ cm}^3\text{/L}}$$

$$= 1.5E\text{-}05 \text{ mg/kg/day (water)}$$

Table 5.4 Blood Lead Levels in Children (Aged 0 to 6), Murray Ohio Disposal Site, Lawrenceburg, Tennessee.

Source Area	Medium	Lead Concentration	Blood Lead Levels[a] Geometric Mean µg/dL	Percent Below 10 µg/dL
Unconsolidated Zone and Bedrock Zone	Ground Water	16 µg/L	2.47*	100*
Surficial Sol	Soil/Dust	35 mg/kg		
	Air[b]	0.0026 µg/m³		

a Calculated using the USEPA Lead5 model (USEPA, 1991e).
b Calculated value. C_{AIR} = SPM mg/m³ x C_s mg/kg x 10^{-6} kg/mg x 10^3 µg/mg; where SPM is the fraction of suspended particulate matter in mg/m³ from soil (Federal Register, 1988).
* Sum of all the sources together.
µg/dL Micrograms per deciliter.
µg/L Micrograms per liter.
µg/m³ Micrograms per cubic meter.
mg/kg Milligrams per kilogram.

Table 5.5 Total Site Risk
Murray Ohio Disposal Site Lawrenceburg, Tennessee.

	Cancer Effects		Non-Cancer Effects	
	Adult	Child	Adult	Child
Current Risks				
Wading				
Branches	NA	1×10^{-9}	NA	0.27
Ground-Water Seeps	NA	1×10^{-6}	NA	0.33
Swimming	NA	NA	0.1	0.1
Fish Ingestion	NA	NA	0.3	0.5
Surficial Soil	NA	1×10^{-6}	NA	0.25
Total	**NA**	**2×10^{-6}**	**0.4**	**1**
Future Residential Risks				
Ground Water				
Ingestion	5×10^{-7}	NC	3.8	NC
Inhalation	4×10^{-7}	NC	0.0009	NC
Dermal Contact	1×10^{-8}	NC	0.1	NC
Soil	2×10^{-5}	*	0.39	*
Total	**2×10^{-5}**		**4**	

NA Not applicable.
NC Not calculated. future exposure based on 30-year residency.
* Included in adult risk estimate.

Table 5.6 **Excess Lifetime Cancer Risk Associated with Exposure to Surface Soil Under Future Exposure Scenarios**

Overflow Area Soils				
Chemicals	**Child Ingestion LECR**	**Child Dermal LECR**	**Child Inhalation LECR**	
Total Chromium	**NC**	**NC**	**NC**	
Chromium (6)	**NC**	**NC**	**2.78E-09**	
Nickel	**NC**	**NC**	**5.39E-07**	
Totals	**NC**	**NC**	**5.42E-07**	5.39E-07

Table 5.7 **Hazard Indices Associated with Exposure to Surface Soils Under Future Exposure Scenarios**

Overflow Area Soils				
Chemicals	**Child Ingestion Dose/RfD Ratio**	**Child Dermal Dose/RfD Ratio**	**Child Inhalation Dose/RfC Ratio**	
Total Chromium	0.01720000	0.00002726	NC	
Chromium (6)	0.00095467	0.00000151	NC	
Nickel	2.26000000	0.00358210	NC	
Totals	2.27815467	0.00361088	NC	2.282

*NC - Not calculated due to some of the components in the mathematical formula being zero.

VI. DESCRIPTION OF REMEDIAL ALTERNATIVES

In the previous section of this document, several risk scenarios were developed. The two unacceptable ones were that of a future resident ingesting ground water from beneath the Site and that of a child resident ingesting soils from the Overland Flow Area.

A total of eight alternatives were evaluated for remediating ground water and soil at the Site. With the exception of Alternative 1 which involves no action, the other seven alternatives involve different degrees of capping at the Site, some in conjunction with seep collection and treatment or ground-water extraction and treatment. The alternatives are as follows:

Alternative 1: No Action

The National Contingency Plan requires the development of a no action alternative as a basis for comparison of alternatives. Therefore, Remedial Alternative 1 consists of implementing no remedial action at the Site, including no restriction on future installation of potable ground-water wells, deed restrictions, or institutional controls such as fencing. Maintaining the existing cover system would be discontinued.

There is no present worth cost or implementation time associated with this remedial alternative since no action would be taken and the Site would remain in its present condition.

Alternative 2: Current Site Conditions with Remediation Performed to Date, Upgrades, and Continued Maintenance of Containment Systems

Remedial Alternative 2 includes current Site conditions with remediation performed to date and upgrades to promote and continue maintenance of the containment systems. The existing cover system would be maintained over the pre- and post-1973 disposal areas and a durable cover would be constructed over the 1973 disposal area. Deed restrictions are currently in place for the property to restrict the use of ground water and land use.

1. Landfill Contents

Landfill contents would be maintained under Remedial Alternative 2 by maintaining the existing cover system over the pre- and post-1973 disposal areas and constructing a durable surface cover over the 1973 disposal area. The durable surface cover would provide a road surface for vehicular access to the City of

Lawrenceburg Sanitary Landfill. Infiltration of precipitation through the landfill contents would be reduced by installing and maintaining the cover systems. Restrictions would be noted in the deed for the Murray Ohio Dump Site.

Slope stabilization of the eastern lobe of the post-1973 disposal area would reduce erosion and prevent slope failure of the final cover. A concrete retaining wall approximately 10 feet high would be constructed against the almost vertical slope. The wall foundation would be installed above the existing grade to prevent disturbance of the waste. Slope stabilization would occur prior to cover system construction.

The existing barrier cover systems over the pre-and post-1973 disposal areas would continue to be maintained. The vegetative cover on these areas would be mowed regularly on-schedule and granular lime would continue to be applied (to maintain the Ph of the soil at 7 or above) to promote vegetative growth, mainly crown vetch.

A durable surface cover would be constructed over the 1973 disposal area. An access road for the active portions of the City of Lawrenceburg Sanitary Landfill currently passes over this former disposal area. The durable surface cover would consist of a fiber-reinforced concrete cover installed over the existing access road and would be approximately six inches thick. This would prevent further erosion of the existing clay cover, protect the clay cover from vehicular damage, and allow continued access to the City landfill.

2. Ground Water

Deed restrictions and the Conservation Easement and Restrictive Covenant for the Site would restrict future development of ground-water supply wells. These would remain in effect for no less than 30 years. After 30 years, prohibitions on specific activities may be terminated upon showing that the prohibition is no longer necessary to protect humans, animals, or the environment from exposure to contaminants.

No action would be performed on seeps to collect contaminated ground water.

3. Surface Water

No action would be performed for surface water.

4. Costs and Time to Implementation

The present worth cost of Alternative 2 is $370,000. Although no exact implementation times are available, EPA estimates the time required to implement each remedy, from shortest to longest, by alternative number, is as follows:

#1 < #2 < #3 <#6 <#8 <#4 <#7 <#5

Therefore, Alternative #2 has a fast implementation time.

Because this alternative would result in contaminants remaining on-Site, CERCLA requires that the Site be reviewed every five years. If justified by the review, remedial actions would be implemented at that time to remove or treat contamination.

Remedial Alternative 3: More Elaborate Upgrades with Storm-water Management Controls and Additional Institutional Controls and Deed Restrictions

Remedial Alternative 3 represents more elaborate upgrades to the current containment systems. As with Alternative 2, the existing cover system over the pre-and post-1973 disposal areas would be maintained and a durable cover system would be constructed over the 1973 disposal area. The additional cover component in this alternative involves construction of a single barrier cover system over the Overland Flow Area. Storm-water management controls would be implemented to reduce run-off and infiltration of precipitation through the landfill contents. Additional institutional controls and deed restrictions would also be employed.

1. Landfill Contents

Remedial Alternative 3 includes maintaining the cover systems, construction of a durable surface cover on the 1973 disposal area, and construction of a single barrier cover system on the Overland Flow Area. Maintenance of the existing covers would involve mowing and lime application. Mobility of the contaminants of concern would also be reduced by implementing storm-water management controls. These controls include regrading and revegetation of the pre-1973 disposal area and slope stabilization of the post-1973 disposal area. Slope stabilization of the eastern portion of the post-1973 disposal area would be performed as described under Alternative 2.

Regrading and revegetation of the pre-1973 disposal area would reduce transport of contaminants of concern in two ways. First, it would eliminate the ponding that currently is increasing infiltration into the area. Secondly, it would direct storm water away from the Overland Flow Area, where it is transporting constituents into Northeast Branch. The single barrier cover system to be constructed over the Overland Flow Area would reduce leaching of the contaminants of concern via infiltration of precipitation through this area. A durable surface cover would be constructed over the 1973 disposal area, as described in Alternative 2.

Access restrictions in the form of a perimeter fence around the disposal areas would be constructed to limit access to the landfill contents and restrict the direct contact exposure pathway of would-be trespassers. Previously described deed restrictions would also be implemented.

2. Ground Water

Deed restrictions would prohibit installation of ground-water supply wells at the Site and adjacent properties. Additionally, Site monitoring would be performed at selected wells in the existing monitor well network at the Site to gauge ground-water contaminant concentrations. Periodic monitoring under this alternative would also be performed to confirm the continued stability of aquifer characteristics. Samples from each well would be analyzed for TAL metals, TCLs, semi-volatiles, and general water quality parameters. No action would be performed on the seeps to collect contaminated ground water.

3. Surface Water

No action would be performed for surface water under this alternative.

4. Costs and Time to Implementation

The present worth cost of Alternative 3 is $1,700,000. Although no exact implementation times are available, EPA estimates the time required to implement each remedy, from shortest to longest, by alternative number, is as follows:

#1 < #2 < #3 <#6 <#8 <#4 <#7 <#5

Therefore, Alternative #3 has a moderately fast implementation time.

Because this alternative would result in contaminants remaining on-Site, CERCLA requires that the Site be reviewed every five years. If justified by the review, remedial actions would be implemented at that time to remove or treat contamination.

Remedial Alternative 4: Alternative 3 Plus a Subsurface Drain System for Collecting Ground-Water Seeps, Treatment and Surface-Water Monitoring

Remedial Alternative 4 involves collection and on-Site treatment of the ground-water seep discharges to improve water quality in the upper reaches of Northeast Branch coupled with maintaining the cover systems. The collected water would be discharged to Shoal Creek under an NPDES permit after being treated by chromium reduction, metals precipitation, coagulation/flocculation, and gravity clarification.

1. Landfill Contents

Remedial Alternative 4 includes maintaining the cover systems, construction of a durable surface cover, and construction of a single barrier cover system as a containment response for the landfill contents. These containment options for landfill contents, storm-water management controls, and maintenance procedures are the same as under Remedial Alternative 3.

2. Ground Water

Remedial Alternative 4 involves collection and on-Site treatment of ground water and the five seeps along Northeast Branch. Ground water and the seeps would be collected in a subsurface trench and piped to a collection point for on-Site treatment. A trench drain would be installed to collect both the seep discharge and contributing ground water from the Site that is baseflow to Northeast Branch. Collected seep and ground-water discharge would flow to a sump at the lowest collection point and then be pumped to a treatment system located in the vicinity of the headwaters.

Treatment of the ground-water and seep discharge would be accomplished on-Site through chromium reduction, metals precipitation, coagulation/flocculation and gravity clarification. After exiting the treatment train, the treated ground-water and seep discharge would be pumped to a sludge thickening tank to settle precipitated material and then piped to a gravity clarifier for additional particulate and solids removal. The settled sludge would then be collected in a sludge accumulation tank and transported off-Site for disposal. Prior to surface water discharge through a transfer pump, the treated ground water and seep discharge would flow through a polishing filter to remove any residuals and the flow rate would be equalized in an accumulation tank.

Improvements to the existing roadway at the Site would be required to permit tanker truck access for treatment reagent and residual transport. Approximately 18,000 square feet of wooded area would have to be cleared, grubbed and regraded to make room for the treatment system compound and truck turn-around area.

The same sampling actions as those in Alternative 3 would be employed for ground water, i.e., sampling and analysis would be performed at selected wells in the existing monitoring well network at the Site to gauge ground-water contaminant concentrations and mobility, as well as aquifer characteristics.

3. Surface Water

Sampling would be conducted on a quarterly basis at SW-007. Sampling would be for TAL metals. This would mark improvements to water quality of Northeast Branch after implementation of containment measures at the Site.

4. Costs and Time to Implementation

The present worth cost of Alternative 4 is $4,500,000. Although no exact implementation times are available, EPA estimates the time required to implement each remedy, from shortest to longest, by alternative number, is as follows:

#1 < #2 < #3 <#6 <#8 <#4 <#7 <#5

Therefore, Alternative #4 has an implementation time on the slow side.

Because this alternative would result in contaminants remaining on-Site, CERCLA requires that the Site be reviewed every five years. If justified by the review, remedial actions would be implemented at that time to remove or treat contamination.

<u>Remedial Alternative 5: Alternative 3 Plus a Vertical Ground-water Extraction Well Network, Treatment of Ground Water, and Surface-Water Monitoring</u>

This alternative involves ground-water collection and on-Site treatment as a means of restoring the ground water for potential use as drinking water and reducing contaminant transport to seeps and Northeast Branch. Treatment methods used and sludge disposal and water discharge options are identical to those described under Remedial Alternative 4 for ground water and seeps.

1. Landfill Contents

Remedial Alternative 5 includes maintaining the cover systems, construction of a durable surface cover, and construction of a single barrier cover system as a containment response for the landfill contents. These containment options for landfill contents, maintenance procedures and storm-water management controls are the same as those described for Alternatives 3 and 4.

2. Ground Water

Remedial Alternative 5 includes collection and on-Site treatment of ground water for potential use as drinking water and addressing the seeps and contaminant transport to Northeast Branch. Ground-water collection would be accomplished using vertical extraction wells. Once operating effectively, these wells would prevent contaminated ground water from moving beyond the landfill boundary and potentially impacting Northeast Branch.

A target constant extraction flow rate of 45 gallons per minute is estimated (18 wells at approximately 2.5 gallons per minute per well). A high degree of uncertainty exists for the estimated well yields because these yields are based on measurements of the in-situ hydraulic conductivity.

Treatment and discharge of the ground water would be accomplished using the treatment methods described for the ground water and seeps under Remedial Alternative 4.

Improvements to the existing roadway at the Site would be required to permit tanker truck access for treatment reagent and residual transport. Approximately 18,000 square feet of wooded area would have to be cleared, grubbed and regraded to make room for the treatment system compound and truck turn-around area.

3. Surface Water

Sampling would be conducted on a quarterly basis at SW-007. Sampling would be for TAL metals. This would mark improvements to water quality of Northeast Branch after implementation of containment measures at the Site.

4. Costs and Time to Implementation

The present worth cost of Alternative 5 is $7,200,000. Although no exact implementation times are available, EPA estimates the time required to implement each remedy, from shortest to longest, by alternative number, is as follows:

#1 < #2 < #3 <#6 <#8 <#4 <#7 <#5

Alternative #5 has the slowest implementation time of all of the alternatives.

Because this alternative would result in contaminants remaining on-Site, CERCLA requires that the Site be reviewed every five years. If justified by the review, remedial actions would be implemented at that time to remove or treat contamination.

Remedial Alternative 6: Alternative 3 Plus Major Enhancement of the Existing Cover Over the Pre-1973 Disposal Area

Remedial Alternative 6 involves the same containment options described in Remedial Alternative 3 with major enhancement of the existing cover system over the pre-1973 disposal area. This area appears to be a source of contaminants entering Northeast Branch. Additional institutional controls and deed restrictions would be instituted to reduce the potential for direct contact with landfill contents and restrict the future use options of the Site and adjacent properties.

1. Landfill Contents

This alternative includes maintaining cover systems over the disposal areas, upgrading the stormwater management controls, construction of an enhanced single barrier cover system over the pre-1973 disposal area, construction of a single barrier cover system over the Overland Flow Area, and construction of a durable surface cover over the 1973 disposal area.

For suitable construction of the enhanced single barrier cover system, the pre-1973 disposal area would be regraded to provide a minimum slope of approximately 5 percent for positive surface-water run-off. Approximately 8,300 cubic yards of fill material would be imported from a borrow source adjacent to the Site so that disturbance of the existing cover and the wastes would not be necessary. Upgrading to an enhanced single barrier cover system over this disposal area would provide further protection to human health and the environment by blocking potential exposure pathways and reducing infiltration into the landfill contents.

As described in Remedial Alternative 3, a durable surface cover and a single barrier cover system would be constructed over the 1973 disposal area and the Overland Flow Area, respectively. The single barrier cover system on the Overland Flow Area would prevent direct transfer of contaminants from surface soils to Northeast Branch during precipitation events. This cover would also limit contaminant migration to ground water by limiting infiltration of precipitation. Once the cover systems have been placed, the soil cover and disturbed areas would be vegetated to provide erosion control and limit surface-water infiltration. Routine inspection and maintenance of the cover systems on the disposal areas would be conducted to maintain the integrity of the cover systems. Installation of additional fencing around the perimeter of the Site would limit direct contact with landfill contents and would prohibit vehicular access over the disposal areas.

Slope stabilization of the post-1973 disposal area would be implemented to reduce erosion of the slope and sedimentation into Northeast Branch, as described in previous Remedial Alternatives. Access restrictions and deed restrictions described in previous Remedial Alternatives would be maintained to reduce the potential of direct contact with landfill contents and restrict future use options of the property.

2. Ground Water

Remedial Alternative 6 employs Site monitoring and deed restrictions for addressing the potential risks to human health associated with ground water at the Site. Sampling and analysis would be performed at selected wells in the existing monitoring well network at the Site to gauge ground-water contaminant concentrations, as previously described. Periodic ground-water monitoring would be performed to confirm the continued stability of aquifer characteristics. Deed restrictions described for the previous remedial alternatives would be implemented.

3. Surface Water

Remedial Alternative 6 involves installation of chain-link fencing around the seep areas. This would prohibit direct contact with seeps, thus restricting access and exposure to humans and animals. Sampling would be conducted on a quarterly basis at SW-007, SW-BKG and SW-A. Surface water sampling would be for TAL metals. This would mark improvements to water quality of Northeast Branch after implementation of containment measures at the Site.

4. Costs and Time to Implementation

The present worth cost of Alternative 6 is $2,000,000. Although no exact implementation times are available, EPA estimates the time required to implement each remedy, from shortest to longest, by alternative number, is as follows:

#1 < #2 < #3 <#6 <#8 <#4 <#7 <#5

Alternative #6 has a moderate implementation time.

Because this alternative would result in contaminants remaining on-Site, CERCLA requires that the Site be reviewed every five years. If justified by the review, remedial actions would be implemented at that time to remove or treat contamination.

Remedial Alternative 7: Containment and Surface Water Options in Alternative 6 Plus a Seep Collection and Treatment Contingency Measure and Cover Improvements on the Post-1973 Disposal Area

Remedial Alternative 7 involves the same containment options and sampling for surface water as Alternative 6 plus additional improvements on the post-1973 disposal area, however, a contingent option for seeps is also included. At EPA's discression, as part of a five-year-review for the Site, if ground-water, seep water, and surface water quality in Northeast Branch are not observed to improve after construction of the cover systems, the seep collection, treatment and discharge contingency would be implemented.

1. Landfill Contents

This alternative includes maintaining cover systems over the disposal areas, upgrading the stormwater management controls, construction of an enhanced single barrier cover system over the pre-1973 disposal area, construction of a single barrier cover system over the Overland Flow Area, and construction of a durable surface cover over the 1973 disposal area. In addition, improvements would be constructed on the post-1973 disposal area to bring it up to RCRA standards.

For suitable construction of the enhanced single barrier cover system, the pre-1973 disposal area would be regraded to provide a minimum slope of approximately 5 percent for positive surface-water run-off. Approximately 8,300 cubic yards of fill material would be imported from a borrow source adjacent to the Site so that disturbance of the existing cover and the wastes would not be necessary. Upgrading to an enhanced single barrier cover system over this disposal area would provide further protection to human health and the environment by blocking potential exposure pathways and reducing infiltration into the landfill contents.

As described in Remedial Alternative 3, a durable surface cover and a single barrier cover system would be constructed over the 1973 disposal area and the Overland Flow Area, respectively. The single barrier cover system on the Overland Flow Area would prevent direct transfer of contaminants from surface soils to Northeast Branch during precipitation events. This cover would also limit contaminant migration to ground water by limiting infiltration of precipitation. Once the cover systems have been placed, the soil cover and disturbed areas would be vegetated to provide erosion control and limit surface-water infiltration. Routine inspection and maintenance of the cover systems on the disposal areas would be conducted to maintain the integrity of the cover systems. Installation of additional fencing around the perimeter of the Site would limit direct contact with landfill contents and would prohibit vehicular access over the disposal areas.

Slope stabilization of the post-1973 disposal area would be implemented to reduce erosion of the slope and sedimentation into Northeast Branch, as described in previous Remedial Alternatives. Access restrictions and deed restrictions described in previous Remedial Alternatives would be maintained to reduce the potential of direct contact with landfill contents and restrict future use options of the property.

2. Ground Water

Remedial Alternative 7 employs Site monitoring and deed restrictions as remedial actions for addressing the potential risks to human health associated with ground water at the Site. Sampling and analysis would be performed at selected wells in the existing monitoring well network at the Site to gauge ground-water contaminant concentrations, as previously described. Periodic ground-water monitoring would be performed to confirm the continued stability of aquifer characteristics. Deed restrictions described for the previous remedial alternatives would be implemented.

In addition, Remedial Alternative 7 involves the same collection of ground water and the five seeps along Northeast Branch, as outlined in Alternative 4. If the seep remedial measures are required, on-Site and off-Site treatment options are available. Ground water and the seeps would be collected in a subsurface trench and piped to a collection point for on-Site treatment. A trench drain would be installed to collect both the seep discharge and contributing ground water from the Site that is baseflow to Northeast Branch. Collected seep and ground-water discharge would flow to a sump at the lowest collection point and then be pumped to a treatment system located in the vicinity of the headwaters of Northeast Branch.

Treatment of the ground-water and seep discharge would be accomplished through chromium reduction, metals precipitation, coagulation/flocculation and gravity clarification. After exiting the treatment train, the treated ground-water and seep discharge would be pumped to a sludge thickening tank to settle precipitated material and then piped to a gravity clarifier for additional particulate and solids removal. The settled sludge would then be collected in a sludge accumulation tank and transported off-Site for disposal. Prior to surface water discharge through a transfer pump, the treated ground water and seep discharge would flow through a polishing filter to remove any residuals and the flow rate would be equalized in an accumulation tank.

In the event of on-Site seep treatment, improvements to the existing roadway at the Site would be required to permit tanker truck access for treatment reagent and residual transport. Approximately 18,000 square feet of wooded area would have to be cleared, grubbed and regraded to make room for the treatment system compound and truck turn-around area.

3. Surface Water

Remedial Alternative 7 involves installation of chain-link fencing around the seep areas. This would prohibit direct contact with seeps, thus restricting access and exposure to humans and animals. Surface water sampling would be conducted on a quarterly basis at SW-007, SW-BKG and SW-A. Sampling would be for TAL metals. This would mark improvements to water quality of Northeast Branch after implementation of containment measures at the Site.

4. Costs and Time to Implementation

The present worth base cost of Alternative 7 is $3,416,000. An additional $2,100,000 would be added to this cost if the seep contingency were invoked and treatment occurred on-Site. Likewise, if the seep contingency were required and treatment was off-Site, an additional $7,900,000 would be added to the base cost. Although no exact implementation times are available, EPA estimates the time required to implement each remedy, from shortest to longest, by alternative number, is as follows:

#1 < #2 < #3 <#6 <#8 <#4 <#7 <#5

Alternative #7 will take longer than most of the other remedies to implement.

Because this alternative would result in contaminants remaining on-Site, CERCLA requires that the Site be reviewed every five years. If justified by the review, remedial actions would be implemented at that time to remove or treat contamination.

<u>Remedial Alternative 8: Alternative 7 Plus Containment Upgrades to the Pre-1973 Disposal Area, the Overland Flow Area, and the 1973 Disposal Area</u>

Alternative 8, double barrier containment with contingent seep controls, is the most rigorous alternative. It is composed of the same remedial measures as Alternative 7, except for the following upgraded components: a) The Pre-1973 disposal area would be covered with a new double barrier cover system instead of an enhanced single barrier cover system; b) The Overland Flow area would be covered with a new double barrier cover system instead of a new single barrier cover system; and c) The 1973 disposal area would be covered with an enhanced single barrier cover system instead of a durable surface cover.

1. Landfill Contents

Refer to this portion of Alternative 7, as it is identical. The only additions are those listed in the preceding paragraph. The same durable road surface would be required to be constructed and inspection and maintenance requirements would be the same as for Alternative 7.

2. Ground Water

Refer to this portion of Alternative 7, as it is exactly identical.

3. Surface Water

Refer to this portion of Alternative 7, as it is exactly identical.

4. Costs and Time to Implementation

The present worth base cost of Alternative 8 is $3,516,000. An additional $2,100,000 would be added to this cost if the seep contingency were invoked and treatment occurred on-Site. Likewise, if the seep contingency were required and treatment was off-Site, an additional $7,900,000 would be added to the base cost. Although no exact implementation times are available, EPA estimates the time required to implement each remedy, from shortest to longest, by alternative number, is as follows:

#1 < #2 < #3 < #6 < #8 < #4 < #7 < #5

This estimation assumes high efficiency of the cover systems once implemented and in estimating a relative time does not assume that the seep contingency will be necessary. Alternative #8 will therefore have a moderate implementation time.

Because this alternative would result in contaminants remaining on-Site, CERCLA requires that the Site be reviewed every five years. If justified by the review, remedial actions would be implemented at that time to remove or treat contamination.

VII. COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES

A detailed comparative analysis was performed on the eight remedial alternatives developed during the FS and the modifications submitted during the public comment period using the nine evaluation criteria set forth in the NCP. The advantages and disadvantages of each alternative were evaluated in order to identify the alternative with the best balance among the nine criteria.

Threshold Criteria:

A. OVERALL PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT

This criterion addresses whether or not an alternative provides adequate protection and describes how risks are eliminated, reduced, or controlled through treatment and engineering or institutional controls.

Alternatives 7 and 8 are the most desirable and are estimated to reduce seep and ground water levels of contaminants to Ambient Water Quality Criteria (AWQC) and Maximum Contaminant Levels (MCLs) for nickel, chromium and hexavalent chromium within a reasonable time frame. Both of these alternatives also eliminate the risk due to a child ingesting soils in the Overland Flow Area. Alternative 7 is estimated to achieve the same results as Alternative 8, however, Alternative 8 costs more.

Due to the lack of a seep control contingency, EPA is not confident that Alternative 6 will meet acceptable levels of the signature contaminants in ground water. If the cap systems were to function ideally and prevent all infiltration, the system would naturally cleanse itself via the seeps and meet these levels, however, there is no guarantee of this. Alternative 6 does, however, eliminate the risk due to a child ingesting soil in the Overland Flow Area. If Alternative 6 were to achieve health-based levels it would most likely do so in the same amount of time it would take Alternatives 7 or 8 to do so in the event that their seep contingencies were not necessary.

Alternative 5, which involves removing the ground water via vertical extraction wells and treating it would be protective of human health and the environment if effective. It is not thought, however, that this remedy will be effective due to the inherent uncertainty (because the soil zone dye traces have been ineffective) associated with well installation in this karst hydrogeologic setting. If Alternative 5 were implemented and effective, it would take the longest of all remedies to achieve protection. Alternative 5 does, however, eliminate the risk due to a child ingesting soil in the Overland Flow Area.

While Alternative 4 does have a seep contingency, the cap systems, identical to those in Alternative 5, are not as protective as those of Alternatives 6 through 8. EPA is not confident that all health based levels of contaminants in the ground water beneath the Site will be met, however, the risk due to a child ingesting soil from the Overland Flow Area is eliminated by this alternative. Relative to the others, this alternative has a moderate time to achieve its goals. Construction time would be on the long side compared to the other alternatives.

Alternative 3, which involves various upgrades to the cap systems is not thought to be protective of human health and the environment for ground water/seeps since it neither has the conservative cover of higher numbered alternatives nor the seep collection contingency. It should, however, be protective of a child ingesting soil in the Overland Flow Area. Alternative 3 is estimated to take a moderate time to both construct as well as achieve its goals once construction is complete.

Alternative 2 is not estimated to be protective for ground water/seeps or a child ingesting soil since the cover systems outlined are less conservative than Alternative 3 and do not even include the Overland Flow Area. Since its goals are not high, its implementation time and time to achieve its goals are quite rapid.

Alternative 1 is not estimated to be protective of human health and the environment since it does not eliminate, reduce, or control risks by treating contamination in the environment.

B. COMPLIANCE WITH APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARS)

This criterion addresses whether or not an alternative will meet all ARARs or provide grounds for invoking a waiver. Each alternative was evaluated for compliance with ARARs, including chemical-specific, action-specific, and location-specific ARARs. For a complete discussion of all ARARs and "To be considered" (TBC) criteria, refer to Section IX of this document.

Alternatives 1 and 2 do not comply with Maximum Contaminant Levels (MCLs) and Maximum Contaminant Level Goals (MCLGs) set forth in the Safe Drinking Water Act (SDWA), 40 CFR Part 141, Subparts B, F, and G, nor do they comply with the Ambient Water Quality Criteria (AWQC) set forth in 40 CFR Part 403, Sections 303 and 304 of the Clean Water Act (CWA). They also do not comply with the Resource Conservation and Recovery Act (RCRA) Subtitle C, 40 CFR Part 265.310; which regulates landfill closure and post-closure activities.

Alternative 3 will not meet AWQCs or RCRA Subtitle C and EPA is not confident that it will meet MCLs. Alternative 4 will meet AWQCs, but will not comply with RCRA Subtitle C and will probably not comply with MCLs either.

If effective, Alternative 5 would comply with MCLs and AWQC, however, due to the karst hydrogeologic setting at the Site, EPA doubts the effectiveness of a ground-water extraction scenario. The cap scenario for this alternative will still not comply with RCRA Subtitle C for the Post-1973 disposal area.

Alternative 6 will not meet AWQCs. There is no way to predict with certainty until the caps are in place and ground-water monitoring occurs if it will meet MCLs, but EPA is not confident that these levels will be achieved by the proposed cap augmentations.

Alternatives 7 and 8 will meet AWQCs and EPA feels confident that they will meet MCLs. They also comply with RCRA Subtitle C. Alternatives 7 and 8 comply with all ARARs that are known at this time.

Primary Balancing Criteria:

C. LONG-TERM EFFECTIVENESS AND PERMANENCE

This refers to the ability of an alternative to maintain reliable protection of human health and the environment, over time, once cleanup objectives are met.

Since their caps are more conservative and they employ seep contingencies to take up where the caps may not be effective, Alternatives 7 and 8 are the most effective in the long term.

Alternatives 5 and 6 can be considered only partial for long-term effectiveness since Alternative 5 is not thought to be a technology which will work to extract ground water at the Site and Alternative 6 has no seep collection to account for cap systems which might not totally prevent all infiltration.

EPA does not feel confident about the long-term effectiveness of Alternative 4 since even though it has a seep contingency, its cover system scenario is not conservative enough for the long-term.

Alternatives 2 and 3 can also only be considered partial for long-term effectiveness since EPA doubts that either of these will achieve health based levels in ground water and seeps. Alternative 2 also does not outline any cover for placement on the Overland Flow Area.

By its nature, Alternative 1 is not at all long-term effective.

D. REDUCTION OF TOXICITY, MOBILITY OR VOLUME THROUGH TREATMENT

This is the anticipated performance of the treatment technologies an alternative may employ. The degree of reduction of toxicity, mobility or volume through treatment varies depending on the capping and ground-water/seep collection scenarios in an alternative.

The cap systems placed over the Site in several of the alternatives will act to prevent infiltration of precipitation through the landfill areas, thus keeping leachate from coming out the sides of the landfills in ground-water seeps, particularly along Northeast Branch. The caps placed over the landfill areas will act to contain the plume in this order of effectiveness: 8 & 7, 6 & 4 , 5, 3, 2.

Alternatives 4,5,7 and 8 all utilize the same type of treatment for ground-water/seeps, once collection is complete. The chromium reduction and metals precipitation process is a well-established method for removing the metal contaminants, such as those at the Murray Site, from water. This is a reliable treatment process which will adapt well to varying influent concentrations.

E. SHORT-TERM EFFECTIVENESS

This involves the period of time required to achieve protection and any adverse impacts on human health and the environment that may be posed during the construction and implementation period until cleanup objectives are achieved. The following factors were used to evaluate the short-term effectiveness of each alternative: protection of the community during remedial actions, protection of workers during remedial actions, environmental impacts from implementation of alternatives, and the time until remedial action objectives are met.

With respect to protection of the community, Alternatives 2 - 8 will not pose additional risk to the community, although there may be some slight inconveniences in some cases. Likewise, Alternative 1 poses no risk to the community over what already exists.

Alternatives 7 and 8 are more effective and protective to the community in the short-term than are Alternatives 4 and 6. Following these would be Alternatives 3 and 5 with only partial effectiveness. Last for short term effectiveness would be Alternatives 2 and 1, respectively.

Risks to workers for all of the alternatives can be minimized with safe working practices. Alternatives 4, 7 and 8 may involve more risk than the others since placement of the seep collection system involves blasting the rock outcrops along Northeast Branch with explosives.

With respect to environmental impacts, the ground-water plume will be contained in the order of effectiveness cited in the previous section, **"Reduction of Toxicity, Mobility and Volume"**. Alternatives 4, 7 and 8 will impact the environment in a greater way than the other alternatives due to the blasting of the banks around Northeast Branch. The environment of this shallow ephemeral stream would be significantly altered and would require rejuvenation when seep collection systems were finally in-place.

Assuming that seep contingencies are not needed, Alternatives 7 and 8 will achieve the best degree of protection in the same time frame as Alternatives 6 and 4 will achieve a lesser degree of protection. In approximately the same time frame, Alternatives 5, 3 and 2 will achieve only partial protection. Should the seep contingency be required for Alternatives 4, 7 and 8, this will add to their implementation times by approximately one and one-half years.

F. IMPLEMENTABILITY

This is the technical and administrative feasibility of an alternative, including the availability of goods and services needed to implement the solution. Alternatives 1 through 8 will be feasible, both technically and administratively. Required services and materials generally are available, and the technologies used for all alternatives rely on standardized construction methods and demonstrated technologies.

Alternative 1 would be the most implementable, as it involves no remedial activities. Alternative 2 and then 3 would be considered the next most implementable since they involve only some upgrades to the existing cap systems. Because of its better-developed cap systems, Alternative 6 is slightly more difficult to implement, but still not as difficult as Alternative 4 since Alternative 4 involves installing a seep collection system. Alternative 5, with ground-water extraction wells falls somewhere between 4 and 6 for implementability concerns. Alternatives 7 and 8 would be the most difficult to implement since they have the most advanced cap systems and possible construction of seep collection systems.

The ease of implementability is, however, not largely different from the easiest action (Alternative 2) to the most advanced (Alternative 8).

G. COST

Cost includes capital costs as well as operation and maintenance costs and is presented in present value. This evaluation examines the estimated costs for implementing the remedial alternatives. The estimated present-worth value of each alternative is as follows:

Alternative 1:	$0
Alternative 2:	$370,000
Alternative 3:	$1,700,000
Alternative 4:	$4,500,000
Alternative 5:	$7,200,000
Alternative 6:	$2,000,000
Alternative 7:	$3,416,400
(with seep treatment on-Site, add:)	$2,100,000
(with seep treatment off-Site, add:)	$7,900,000
Alternative 8:	$3,516,400
(with seep treatment on-Site, add:)	$2,100,000
(with seep treatment off-Site, add:)	$7,900,000

Modifying Criteria:

H. STATE ACCEPTANCE

This indicates whether, based on review of the RI report, FS Report, and Proposed Plan, U.S. EPA and TDEC agree on the preferred alternative. EPA and TDEC are in agreement on the selected alternative. Please refer to Appendix A of this document which contains a letter of concurrence from TDEC.

I. COMMUNITY ACCEPTANCE

This indicates the public support of a given alternative. This criterion is addressed in the Responsiveness Summary, Appendix B, to this document. The community accepts the selected remedy.

VIII. SELECTED REMEDY

Based upon consideration of the requirements of CERCLA, the NCP, the detailed analysis of alternatives and public and State comments, EPA has selected a source control/ground-water remedy for this Site. At the completion of this remedy, the risk associated with this Site has been calculated at 10^{-6} which is determined to be protective of human health and the environment. The total present worth base cost of the selected remedy, Alternative #7, is estimated at $3,416,400. Additional present-worth costs of $2,100,000 and $7,900,000 are estimated if seep control is required and treatment is on- and off-Site, respectively.

A. SOURCE CONTROL

Source control remediation will address the contaminated soils and sludges at the Site.

The selected remedy includes maintaining the cover system over disposal areas, upgrading the storm-water management controls, construction of an enhanced single barrier cover system over the pre-1973 disposal area, construction of a single barrier cover system over the Overland Flow Area, and construction of a durable surface cover over the 1973 disposal area. Slope Stabilization and cap improvements would be implemented for the post-1973 disposal area.

For suitable construction of the enhanced single barrier cover system, the pre-1973 disposal area would be regraded to provide a minimum slope of approximately 5 percent for positive surface-water run-off. Approximately 8,300 cubic yards of fill material would be imported from a borrow source adjacent to the Site so that disturbance of the existing cover and the wastes would not be necessary. Upgrading to an enhanced single barrier cover system over this disposal area would provide further protection to human health and the environment by blocking potential exposure pathways and reducing infiltration into the landfill contents.

A durable surface cover and a single barrier cover system would be constructed over the 1973 disposal area and the overland flow area, respectively. The single barrier cover system on the Overland Flow Area would prevent direct transfer of constituents from surface soils to Northeast Branch during precipitation events and would also block the unacceptable future child ingestion of soil scenario. Both covers would limit contaminant migration to ground water by limiting infiltration of precipitation. Once the cover systems have been placed, the soil cover and disturbed areas would be vegetated to provide erosion control and limit surface-water infiltration. Routine inspection and maintenance of the cover systems on the disposal areas would be conducted to maintain the integrity of the cover systems. Installation of additional fencing around the perimeter of the Site would limit direct contact with the landfill contents and would prohibit vehicular access over the disposal areas.

Slope stabilization of the post-1973 disposal area would be implemented to reduce erosion of the slope and sedimentation into Northeast Branch. The cover system on this area would be upgraded to comply with RCRA Subtitle C standards. Following source control remediation, access restrictions and deed restrictions (in the form of record notices placed on the site) would be maintained to reduce the potential of direct contact with landfill contents and restrict future use options of the property.

Performance Standards

1. Capping Standards

To insure protectiveness of human health and the environment, EPA's Regional Toxicologist has calculated the following allowable surficial soil concentrations for the Overland Flow and Formerly Ponded Areas. Concentrations shall not exceed these numbers once the cover system is in-place:

Total Chromium:	74,881 ppm
Hexavalent Chromium:	374 ppm
Nickel:	1,498 ppm

As stated in Section IX of this document, the regulations in the Resource Conservation and Recovery Act (RCRA) Section 265.310, Closure and Post-Closure Care, also provide standards for all of the cover systems to be constructed at this Site.

2. Other Standards

Section IX of this document lists all other Applicable or Relevant and Appropriate Requirements (ARARs) pertaining to this remedial action at the Murray Ohio Site.

B. GROUND-WATER REMEDIATION

Capping is expected to reduce infiltration, thereby allowing natural attenuation processes to act in reducing contaminant levels toward levels stated in Section IX of this document under ARARs. If the capping and natural attenuation measures of the selected remedy are not effective in bringing ground water to acceptable levels, ground-water seep collection and treatment measures will be employed. Ground water and the seeps would be collected in a subsurface trench and piped to a collection point for on-Site treatment. A trench drain would be installed to collect both the seep discharge and contributing ground water from the Murray Site that is baseflow to Northeast Branch. The trench would be approximately four feet wide, with a 6-inch perforated PVC pipe laid at the bottom of the trench. The trench would be filled with gravel, covered with a 6-mil polyethylene sheet, a minimum of one foot of soil, and revegetated. The trench depth may vary from approximately 30 feet at SW-800 to close to land surface at SW-250. The collected seep and ground-water discharge would gravity flow to a sump at the lowest collection point and then be pumped to a treatment system either on- or off-Site.

Treatment of the water would be accomplished through chromium reduction, metals precipitation, coagulation/flocculation, and gravity clarification. Discharge of treated effluent would be to Shoal Creek.

Performance Standards

1. Monitoring Locations and Parameters for Triggering Seep Collection and Treatment Measures

Parameters:	Full TCL/TAL list
Locations:	- all ground-water monitoring wells used in the RI - all seeps used in the RI - surface water at SW-BKG and points SW007 and SW-A in Northeast Branch

2. Treatment Standards

If the seep contingency is necessary, ground water and seeps shall be treated at least until the following maximum concentration levels are attained at the wells, ground-water seeps and surface water stations designated by EPA as compliance points:

Chromium:	.1 ppm
Hexavalent Chromium:	.1 ppm

Nickel: .1 ppm

3. Discharge Standards

Discharges from the ground water and seep treatment system shall comply with all ARARs, including, but not limited to, requirements of the National Pollutant Discharge Elimination System (NPDES) permitting program under the Clean Water Act, 33 U.S.C. {1251 et seq.} and all effluent limits established by EPA, as well as Tennessee Surface Water Quality Standards.

4. Design Standards

The design, construction and operation of the treatment system shall be conducted in accordance with all ARARs. Design will also be performed in an effort to minimize all environmental impacts to terrestrial and aquatic habitats in the area.

5. Other Standards

Section IX of this document lists all other Applicable or Relevant and Appropriate Requirements (ARARs) pertaining to this remedial action at the Murray Ohio Site.

C. COMPLIANCE TESTING AND MONITORING

No later than five years from the date of commencement of remedial construction, a five year review will be completed for the Murray Ohio Site since waste remains on-Site. Five year reviews regularly occur after the first five-year-review at intervals of no greater than five years.

Quarterly monitoring will be performed beginning with the date of source-control construction completion for the parameters and locations listed above for **"Performance Standards, Monitoring Locations and Parameters for Triggering Seep Collection and Treatment Measures"**. At the time of the first or any five-year-review, EPA will evaluate quarterly monitoring performed to that point and all ARARs in part IX of this document to determine if the source-control component and natural attenuation are functioning in an effective enough fashion to reduce levels of contaminants to acceptable levels. Based upon this evaluation, EPA may require employing the seep contingency measures in this remedy.

If EPA determines that the seep measures in this remedy are required, the constructed system's effectiveness will be evaluated by EPA based on the same parameters and locations used to previously determine the need for the seep measures.

Should a five-year-review reveal any other inadequacies for the source-control component, such as the **"Capping Standards"** under **"Source Control"** in this section being exceeded, EPA will re-evaluate the effectiveness of the source control component and may make recommendations to improve its capabilities.

Any significant alteration of the environment in and around Northeast Branch due to seep collection and treatment measures (if necessary) will be repaired by methods such as dredging, filling, planting vegetation to prevent erosion, etc..

IX. STATUTORY DETERMINATIONS

Under its legal authorities, EPA's primary responsibility at Superfund sites is to undertake remedial actions that achieve adequate protection of human health and the environment. In addition, Section 121 of CERCLA establishes several other statutory requirements and preferences. These specify that when complete, the selected remedial action for this Site must comply with applicable or relevant and appropriate environmental standards established under federal and State environmental laws unless a statutory waiver is justified. The selected remedy must also be cost-effective and utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. Finally, the statute includes a preference for remedies that employ treatment that permanently and significantly reduces the volume, toxicity or mobility of hazardous wastes as their principle element. The following sections discuss how the selected remedy meets these statutory requirements.

A. PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT

The selected remedy protects human health and the environment by preventing infiltration of water into the waste. This, together with natural attenuation, prevents migration of any contaminated ground water in the plume beneath the surface or in leachate seeps. The selected remedy also contains measures for collecting and treating seeps should monitoring outlined in Section VIII of this document reveal that the cap systems are not functioning effectively. Discharge of the treated water would be to Shoal Creek at concentrations protective of human health and the environment.

Institutional controls and monitoring will insure that the public is not affected by Site-related contaminants at a future time.

Implementation of Alternative #7 will not pose any unacceptable short-term risks or cross-media impacts to the Site, the workers, or the community. If seep collection and treatment measures are required, the environment around Northeast Branch may be altered temporarily, but will be restored.

B. ATTAINMENT OF APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENT OF ENVIRONMENTAL LAWS

The selected remedy of source control via improving the cover systems, possible seep collection with on-site treatment and discharge to Shoal Creek will comply with all applicable or relevant and appropriate chemical, action, and location-specific requirements (ARARs). The ARARs are presented below. Sludges generated from on-site contingent treatment of seeps will be transported off-Site for disposal. Discharge of contingent treatment system effluent off-site to Shoal Creek will require an NPDES permit. Contingent treatment may require off-site instead of on-site treatment.

Action-Specific ARARs:

* Surface Discharge Standards for Treated Effluent, 50 FR 30784; 40 CFR 122.44(a), (i); 40 CFR 131; TWQCB 1200-4-5.02 &.03. Pertinent State water quality standards must be complied with for discharge. These standards may be in addition to or more stringent than standards in the federal Clean Water Act. Applicable since direct discharge of treatment system effluent is a component of the selected remedy.

* Test Methods for Waste Constituents in Treated Effluent, 40 CFR 136. Approved test methods for waste constituents to be monitored must be followed. Detailed requirements for analytical procedures and quality control are provided. Potentially applicable since direct discharge of treatment system effluent is a component of the selected remedy.

* Fugitive Dust Emissions Standards for Excavation and Grading, TDHE 1200-3-8-.01. Fugitive dust emissions for particulates shall not exceed 5 minutes per hour or 20 minutes per day as to produce a visible emission beyond the property line. Potentially applicable since construction activities, including earth moving activities, may release particulate matter into the atmosphere.

* Resource Conservation and Recovery Act (RCRA), 40 CFR, Section 265.310, Closure and Post-Closure Care. Applicable for the post-1973 disposal area since RCRA regulated waste was disposed in this area and relevant and appropriate for the remainder of the Site

* Tennessee Regulations for Non-Specific Earth Moving Activities, TDHE 1200-1-7-.04-(2)-(i). Meet Subtitle 9 requirements and develop an erosion and sedimentation control plan. Applicable since earth moving activities are part of the selected remedy.

* TDHE 1200-1-7-.04-(7)-(b), Tennessee Ground-water Monitoring Requirements. Maintaining the quality of ground water through monitoring requirements. Potentially applicable since treatment technologies to be used in the selected remedy include treatment of ground water/seep water.

* Tennessee Landfill Requirements, TDHE 1200-1-7-.04-(8) & TDHE 1200-1-7-.04-(8)-(c)-3-(i) & (iii). The cover system shall consist of at least 36 inches of compacted soil with a minimum of 12 inches of soil which will support the growth of suitable vegetation. Applicable since the disposal areas have been used as industrial waste landfills.

* Tennessee Closure and Post-Closure Requirements, TDHE 1200-1-11-05 (14)(e). Provide long-term minimization of migration of liquid; function with minimum maintenance; promote drainage and minimize erosion/ accommodate settling and subsidence; and have a permeability of less than or equal to the permeability of a bottom liner system or natural subsoils present. Post closure requirements include ground-water monitoring. Applicable to the larger landfill since F006 waste was disposed of in this area after 1980 and relevant and appropriate to the other areas because they contain the same or similar waste.

<u>Location-Specific ARARs:</u>

* National Archaeological and Historical Preservation Act, 16 U.S.C., Section 469; 36 CFR Part 65. Action to recover and preserve artifacts. Potentially applicable based on May 27, 1993, correspondence from TDEC Division of Archaeology. Prehistoric and historic archaeological resources are potentially located in the project area. Action to recover and preserve artifacts located in the undisturbed areas of the site may therefore be required.

<u>Chemical-Specific ARARs:</u>

* Safe Drinking Water Act (40 CFR Part 141). Subparts B and G provide maximum concentration levels (MCLs) allowable for drinking water, i.e., ground water and ground-water seeps at and around the Site. Relevant and Appropriate to ground water beneath and seeps emanating from the Site.

* EPA Ambient Water Quality Criteria (AWQC), Clean Water Act, 40 CFR 403. AWQC are identified in Section 121(d)(2)(A) of CERCLA, as amended by SARA to be ARARs. Gives chemical-specific concentration-based standards for surface water bodies. AWQC are developed as guidance for the States to develop ambient surface water quality standards that will be fully protective of human health and the environment. As such, AWQC are relevant and appropriate to the selected remedial action. Discharge of the treated effluent from the site must not result in ambient surface water concentrations that exceed chemical-specific AWQC.

* Tennessee Water Quality Criteria (1200-4). Gives chemical-specific concentration-based standards for protection of human health and the environment in surface water bodies. Applicable to streams around the site.

Other Criteria To-Be-Considered:

* Covers for Uncontrolled Hazardous Waste Sites, EPA/540/2-85/002. Provides guidance for cover design, gas and infiltration control, cost estimation, and construction.

* Secondary Drinking Water Standards, 40 CFR 143. Sets forth nonenforceable guidelines to states.

* EPA Ambient Water Quality Criteria Guidance (EPA 440/5-80-068, 077, 041).

C. COST-EFFECTIVENESS

The selected remedy is cost-effective because it has been determined to provide overall effectiveness proportional to its costs, the net present worth value being $3,416,400 plus $2,100,000 if seep measures are required and treatment is on-Site or plus $7,900,000 if treatment is off-Site. The only other alternative which would meet all ARARs for the Site was Alternative #8 which is less cost-effective. In addition to not meeting ARARs for the Site, the other alternatives are only partially protective.

D. UTILIZATION OF PERMANENT SOLUTIONS AND ALTERNATIVE TREATMENT TECHNOLOGIES (OR RESOURCE RECOVERY TECHNOLOGIES) TO THE MAXIMUM EXTENT PRACTICABLE

EPA and the State of Tennessee have determined that the selected remedy represents the maximum extent to which permanent solutions and treatment technologies can be utilized in a cost-effective manner for the Murray Ohio Dump Site. Of those alternatives that are protective of human health and the environment and comply with ARARs, EPA and TDEC have determined that the selected remedy provides the best balance of tradeoffs in terms of long-term effectiveness and permanence, reduction of toxicity, mobility, or volume achieved through treatment, short-term effectiveness, implementability, and cost, also considering the statutory preference for treatment as a principle element and community input.

The selected remedy will be easy to implement technically since it relies on standard construction methods and treatment methods which have been used extensively in a wide range of applications. Of Alternatives #7 and #8, which are equally protective, Alternative #7 (the selected remedy) is more cost-effective.

E. PREFERENCE FOR TREATMENT AS A PRINCIPLE ELEMENT

If treatment is found necessary, the remedy provides for reducing contaminants in ground water to acceptable levels via metals precipitation, coagulation, flocculation and filtration. The selected remedy also contains provisions for five-year-reviews. These provisions insure that the remedy will be evaluated at intervals of no less than five years starting from the date of construction commencement and, if it is not meeting the standards set forth in this Record of Decision, will be upgraded to meet them.

X. SIGNIFICANT CHANGES TO ALTERNATIVE 7

During the public comment period on the Proposed Plan, EPA received comments from Geraghty & Miller, Inc. on behalf of Murray Ohio Manufacturing Co. These comments proposed changes to the monitoring program for determining the necessity of seep control and collection measures after cap repairs are completed. Geraghty & Miller also expressed concern that the construction work required to install the seep collection system would destroy the natural environment of the upper reaches of Northeast Branch.

EPA feels that some of Geraghty & Miller's ideas are of merit and worth incorporating into the ROD as changes since the Proposed Plan.

Deviations made from the Proposed Plan as a result of Geraghty & Miller's March 29, 1994, comments include changing the monitoring period for determining if the seep measures are necessary and adding in measures to insure that Northeast Branch is protected in the event that the seep construction occurs.

In the Feasibility Study, EPA had originally stated that a monitoring period of one year (4 quarters) from the date of construction would be necessary to determine if seep collection and treatment measures would be necessary. Geraghty & Miller proposed five years (20 quarters) of seep collection as a period for determining if the additional construction should take place. EPA feels that the 20 quarters is quite excessive while one year may or may not be enough to make this determination. As a result, EPA has incorporated measures into the ROD which would make the evaluation for seep measures part of the five-year-review process. As stated previously, the first five-year-review can occur at any time before five years from the date of construction commencement with successive five year reviews occurring at five year intervals thereafter. In this way, data can be evaluated quarterly as it is generated, thus allowing for a more appropriate time (chosen by EPA) to make the determination for or against additional construction for seep controls.

Locations stated in Section VIII of this ROD are as stated in the FS and will still be used as sampling points. A full TCL/TAL scan will be run at each point. EPA still agrees with and will use Geraghty & Miller's sampling methodology, health and safety measures and data validation procedures presented in the March 29, 1994, submittal.

EPA is also concerned with possible damage to the Northeast Branch environs, which is exactly the area which the remedy seeks to protect. The five-year-review measures outlined in the previous paragraph should eliminate making a decision on a firm date when concentrations may well be declining towards and near reaching acceptable levels. The seep contingency portion of the selected remedy will only be invoked if after quarterly monitoring in what EPA deems a reasonable time frame, it appears that levels of contaminants are not close to reaching acceptable levels.

Measures for restoring Northeast Branch and its surroundings have also been incorporated into the ROD for the event that the seep construction is necessary.

Please see Appendix B to this document which is the Responsiveness Summary to the Proposed Plan. The Responsiveness Summary contains greater details on Geraghty & Miller's proposed modifications as well as EPA's responses to each issue raised.

Appendix A

Letters from Support Agencies

STATE OF TENNESSEE
DEPARTMENT OF ENVIRONMENT AND CONSERVATION
NASHVILLE ENVIRONMENTAL FIELD OFFICE
537 BRICK CHURCH PARK DRIVE
NASHVILLE, TENNESSEE 37243-1550

May 10, 1994

Ms. Patricia C. Fremont
Remedial Project Manager
Kentucky/Tennessee Remedial Section
United States Environmental Protection Agency
Region IV
345 Courtland Street, N. E.
Atlanta, Georgia 30365

Re: Murray Ohio Dump NPL Site, Lawrenceburg, Tennessee. (DSF site # 50-502)

Subject: Review of the Draft Record of Decision and Responsiveness Summary

Dear Ms. Fremont:

Division of Superfund personnel have reviewed the Draft Record of Decision and Responsiveness Summary for the Murray Ohio Dump NPL Site. The major components of the selected remedy include:

* Constructing an enhanced single barrier cover system over the pre-1973 disposal area;
* Slope stabilization of the post-1973 disposal area with improvements on the existing cover;
* Constructing a durable surface cover over the 1973 disposal area;
* Constructing a single barrier cover system over the overland flow area;
* Deed restrictions and fencing around the disposal areas;
* Continued maintenance of the cover systems;
* Site monitoring; and
* Contingent construction of a seep collection and treatment system with discharge of treated effluent to Shoal Creek or a water treatment facility.

We feel that the selected remedy adequately addresses State concerns and is appropriate for this site based on the existing known conditions.

Sincerely,

Clinton W. Willer
Director
Division of Superfund

xc: Nashville Field Office

Appendix B

Responsiveness Summary

APPENDIX B

MURRAY OHIO DUMP NPL SITE

RESPONSIVENESS SUMMARY

A. OVERVIEW

When the public comment period began, EPA had selected a preferred alternative for the Murray Ohio Dump Site in Lawrenceburg, Tennessee. EPA's preferred alternative addressed the soil and ground-water/seep contamination problems at the Site. The preferred alternative involved placing different types of caps over the various Site areas, maintenance and monitoring, and contingent seep collection, treatment and discharge if necessary. If seep measures were employed, treated seep/ground water would be returned to Shoal Creek.

Judging from the comments received during the public comment period, the residents and city officials of Lawrenceburg and the Tennessee Department of Environment and Conservation (TDEC) would support the cap enhancements and contingent seep measures. In a letter dated March 29, 1994, the PRPs had some concerns about the monitoring interval from which data would be taken to evaluate the need for seep measures. As written in Section X of the ROD and below, EPA has modified the ROD somewhat since some of these suggestions are practical. The PRPs were also concerned that the seep measures, if constructed, would destroy the upper reaches of Northeast Branch. EPA agrees that this is precisely the environment that the selected remedy plans to protect and has also made allowances for this, as in Section X and below.

These sections follow:

* Background on Community Involvement
* Summary of Comments Received During the Public Comment Period and Agency Responses
    - Part I: Summary and Response to Local Community Concerns
    - Part II: Comprehensive Response to Specified

Legal and Technical Questions

- * Remaining Concerns
- * Attachment: Community Relations Activities at Murray Ohio Dump

B. BACKGROUND ON COMMUNITY INVOLVEMENT

A core group of citizens whose property is closest to the Murray Ohio Dump site has always been, and continues to be, extremely concerned about the site. Several of these citizens have written letters to TDEC concerning animals that have died on their property, the condition of ground water, and other general inquiries about the Site.

In contrast, other citizens are aware of the Site, but have not expressed undue concern. Furthermore, there is little official documentation of community concern regarding the Site. Local officials could remember no verbal complaints or questions about the Site and the Site has not been an issue in city elections.

During interviews, residents and local officials expressed concern for private wells in the area, even though all of the citizens who use well water have access to city water. The homeowners with well water, however, do not want city water because of the expense and the fluoride in the water.

Although everyone interviewed knew about the Site's existence, no one except a few close neighbors considered the Site to be a problem. These neighbors reported that in the past they had to make repeated calls to TDEC before well water testing occurred. They were extremely concerned since learning that Murray Ohio's contractor would be conducting water sampling from then on. They said they would not feel confident that the results they received would be correct.

City and County officials wanted to be kept informed about Site findings, as did the Site's neighbors.

The major concerns expressed during the remedial planning activities at the Murray Ohio Dump Site focused on the possible health effects from contamination at the Site. These concerns and how EPA addressed them are described below:

1. Several citizens living nearest to the Site expressed

concerns about using their well water. Citizens questioned Murray Ohio's contractor performing tests on their wells.

EPA Response: EPA informed citizens of past sampling events performed by TDEC which had revealed no impacts to residential wells in the area. Citizens were reassured that EPA would be overseeing Murray's contractor in the field as well as evaluating all sampling results.

2. Citizens noted that there had been several fish kills near the Site. Eight cows on a nearby farm had to be killed after coming down with a disease, which their owner attributed to the Site. One citizen noted that he stopped hunting in the area after killing a raccoon whose teeth were rotting and who appeared to be under-nourished. No one expressed any human health concerns about the Site.

   EPA Response: EPA stated that all the water and sediments of all streams in the area would be sampled to determine the cause of the fish kills. EPA thanked the citizens for sharing the incidents concerning cattle and raccoons and said that this information would be taken into account when designing the studies and evaluating results.

3. Local citizens were concerned about the effect the Site was having on property values.

   EPA Response: EPA sympathized and said that it hoped that remedial activities at the Site would help bring the property values up.

C. SUMMARY OF COMMENTS RECEIVED DURING THE PUBLIC COMMENT PERIOD AND AGENCY RESPONSES

The public comment period on the proposed plan for the Murray Ohio Dump Site was held from February 26, 1994, to March 29, 1994. EPA held a public meeting on March 8, 1994, to present the proposed plan to the public. Comments received during this time are summarized below. Part I of this section addresses those community concerns and comments that are non-technical in nature. Responses to specific legal and technical questions are provided in Part II.

Part I - Summary and Response to Local Community Concerns

Comments Made During the March 8, 1994, EPA Public Meeting

For the detailed transcript of the public meeting, please consult the administrative record for the Murray Ohio NPL Site.

1. A citizen wanted to know how deep the contaminants went down into the soil and ground water. This same citizen also wanted to know what the concentration of chromium in the Cothren Spring was.

EPA Response: EPA stated that the original trenches for disposing of waste had been dug 8 to 12 feet deep, but that contamination had migrated downward into the ground water. EPA's hydrologist explained that the contamination flowed down through the Fort Payne soil layer and limestone layer (ranging from 10 to 80 feet) after which it flowed to Northeast Branch.

EPA responded that the data taken in TDEC's off-Site private well surveys revealed that in 1990, the chromium level in the Cothren Spring was .001 parts per million (ppm), as compared to the ground-water protection standard of 0.1 ppm and that nickel was below the detection limit. In 1991 sampling, both chromium and nickel were below the detection limit. In 1992, chromium was .001 ppm again and nickel was below the detection limit. Citizens were advised to consult the information repository in the Lawrence County Library for additional information or for answers to questions that they thought of after the public meeting.

2. A citizen was concerned that a spring on his property had not been sampled. He felt that his location was one close to the vicinity of the Site and should not have been overlooked.

EPA Response: Several large and small scale maps were shown to Mr. Cothren on the overhead projector for the purpose of discerning exactly where the spring he was referring to was located. In the end, EPA was able to discern approximately where it was located. EPA encouraged Mr. Cothren to send in a comment during the public comment period requesting that his spring be sampled and to attach a marked copy of the map handout given to him in the meeting. Mr. Cothren was also told that more detailed technical information on sampling points and results could be found in the Site Information Repository located in the Lawrence County Library. Mr. Cothren was told that his spring could be sampled either by EPA or TDEC. Jerry Archer of Geraghty & Miller stated that he believed the reason the spring was not previously sampled was that it issued from the lower, uncontaminated aquifer.

3. A citizen mentioned concern that fractures beneath the surface could carry contaminants far off in various directions. This citizen was also concerned that contaminated leachate beneath the Site would remain there after capping.

EPA Response: EPA stated that monitoring points would be placed around and off the Site to determine if contamination was migrating via fractures and where. EPA stated that any contaminated leachate had probably exited the aquifer via seeps into Northeast Branch.

4. A gentleman and his son stood up with questions concerning locations of the off-Site ground-water monitoring points on the maps shown on the overhead and given in handouts. They wanted to know how the proposed cover systems worked and how water flowed where it did beneath the ground. The son was the person who had previously stood up with concerns about his spring being contaminated.

EPA Response: EPA and Geraghty & Miller clarified locations of these points to the gentleman's satisfaction. EPA explained that the caps were meant to divert precipitation, etc.. from infiltrating down into the waste and carrying out leachate via ground-water seeps. EPA also explained that underground water flowed via pressure differences and therefore ended up in Northeast Branch. EPA and Geraghty & Miller again explained that his spring came from a formation below that of the contaminated one and that impermeable layers of rock between the two formations would cause contaminated ground water to flow out as seeps into Northeast Branch.

5. The same gentleman and his son had more questions concerning the hydrogeologic characterization of the Site. They related a point where Northeast Branch went underground and pointed to it on a map, questioning if EPA had accounted for this.

EPA Response: EPA stated that monitor well 10A covered the area where Northeast Branch went underground. EPA also explained that Northeast Branch and the other streams in the vicinity of the Site were seasonal streams and that sampling was therefore performed at different times of the year to get a complete picture of the contamination.

6. A question was asked regarding the half-lives of chromium and nickel, i.e., if they would break down into anything else in the future.

EPA Response: EPA's toxicologist stated that since chromium and nickel were elements, they could not be broken down any further. EPA stated that the solution was dilution - lowering the concentrations to acceptable values - and also explained due to various parameters such as Ph and soil properties, that it was very difficult to say with any certainty how long the dilution process would take.

7. A question arose concerning the City Landfill which is adjacent to the Murray Ohio Site and the dumping of waste by Murray Ohio Mfg. at this Site.

EPA Response: EPA explained that the small stream, Southeast Branch, that runs between the two Sites was sampled as part of the RI. Results were evaluated and the remedy will address any problems in the Southeast Branch. EPA also stated that its Site Assessment section was currently evaluating the City Landfill and offered to give the citizen a contact to whom he could ask questions about the City Landfill.

8. Another citizen voiced concern about children possibly playing in the downwash area of the City Landfill and seeps from it.

EPA Response: EPA requested that the citizen send in a written comment and again said it would give the citizen a toll free number after the meeting where he could call and report this to Site Assessment.

Part II: Comprehensive Response to Specified Legal and Technical Questions

Comments Made By PRPs in the March 29, 1994, Letter to EPA

The only legal and technical questions received were those in the March 29, 1994, letter to EPA from Geraghty & Miller, Inc., on behalf of Murray Ohio Mfg. This letter can be found in the administrative record for the Murray Ohio Site. Following is a summary of the major questions and concerns raised in this letter and EPA's responses. EPA has attempted to address each issue in the order found in the letter; however, some skips may exist where questions cross-reference others, or two questions in different places in the letter relate directly to one another.

In general, the PRPs agreed with EPA's selected remedy for the Site but had the following concerns, listed with EPA's responses:

1. The PRPs stated that construction work required to construct

the contingent seep collection and treatment system would destroy the upper reaches of Northeast Branch. The PRPs also proposed modifying the monitoring period for determining the necessity of the seep measures from 4 quarters (one year) to 20 quarters (5 years).

EPA Response: EPA felt that 20 quarters was excessive and instead included a compromise in Section X of the ROD. This consisted of making the evaluation for the seep measures part of the five-year review process. The first five-year review can occur at any time before five years from the date of construction commencement with successive five-year reviews at intervals of no longer than five years thereafter. In this way, data can be evaluated quarterly as it is generated, thus allowing for a more appropriate time (chosen by EPA) to make the determination for or against additional construction for seep controls.

EPA is also concerned with possible damage to the Northeast Branch environs, which is exactly the area which the remedy seeks to protect. The five-year review measures should eliminate making a decision on a firm date when concentrations may well be declining towards and near reaching acceptable levels. The seep contingency portion of the selected remedy will only be invoked if after quarterly monitoring in what EPA deems a reasonable time frame, it appears that levels of contaminants are not close to reaching acceptable levels.

Measures for restoring Northeast Branch and its surroundings have also been incorporated into Section VIII of the ROD for the event that the seep construction is necessary.

2. The PRPs asserted that without the seep contingency measures, Maximum Contaminant Levels (MCLs) and Ambient Water Quality Criteria (AWQC) would be eventually achieved over time.

EPA Response: Perhaps these levels would be achieved eventually over some period in geologic time, but maybe not in a time frame which EPA deems reasonable for protecting human health and the environment. This is why the contingent seep control and collection measures are included.

3. The PRPs asserted that implementation of the seep contingency could harm the health and safety of the community during operation of an on-Site treatment system.

EPA Response: EPA agrees that there are some risks associated with these measures, but these risks are very slight indeed, if proper management measures are taken.

4. The PRPs asserted in Section 2.0 of their letter that RCRA closure requirements are not applicable to the entire Post-1973 area of the landfill, but only to the unit or area of contamination (AOC) which received waste after 1980. They also asserted that all technical standards set forth in various RCRA guidance manuals for landfill closure need not be rigidly followed.

EPA Response: RCRA defines the "unit" differently than CERCLA. This is a CERCLA facility and for CERCLA purposes, a landfill is considered to be one "unit". Therefore, RCRA regulations set forth in Section IX of this document are applicable to the post-1973 area of the landfill and relevant and appropriate to all other areas.

EPA agrees that technical guidance documents are "To be considered" or TBC materials and has stated this in Section IX of the ROD. These TBC technical guidance manuals were only used in the Feasibility Study for the purpose of a general, worst-case estimate for comparing the cost of the various remedies with an upgraded cap required for the Post-1973 area of the landfill. No attempt was made to give exact design numbers.

5. The PRP asserts in Section 2.3.5 of the letter that the existing cover over the post-1973 disposal area currently meets all requirements of RCRA Subtitle C.

EPA Response: There are several reasons why this cover does not meet RCRA Subtitle C requirements. First, it does not comply with the provisions in 40 CFR, 265.310 (a)(1) and (a)(3) which state that, "the final cover must be designed and constructed to provide long term minimization of migration liquids through the closed landfill" and "...promote drainage and minimize erosion of abrasion of the cover." EPA has on various trips out to the Site observed the post-1973 area of the cover to be hummocky and cracked in spots, a condition which certainly does not minimize migration of liquids through the landfill. This area of the landfill also has a slope which is too steep and will result in erosion of the cover, if the grade is not decreased. For the above-mentioned reasons, the cover also will not comply with 265.310(a)(4), which states, "...accommodate settling and subsidence so that the cover's integrity is maintained".

6. The PRP asserts in Section 2.4 that the existing cover over the post-1973 disposal area meets RCRA Subtitle D requirements.

EPA Response: RCRA Subtitle C is the ARAR which applies here. Subtitle D is not an issue.

7. Geraghty & Miller was dissatisfied with the level of detail provided by EPA in the FS for the estimation of additional costs to the PRP to perform cap improvements for Alternative #7 (the selected remedy) and Alternative #8. Both of these alternatives involved improvements to the post-1973 area of the cap beyond what Geraghty & Miller had included in the FS.

EPA Response: When EPA took back the FS after two drafts by Geraghty & Miller, a general estimate of the cost of the additional work required for compliance with ARARs was needed to prepare any PRPs signing on to pay for Remedial Design/Remedial Action for a worst-case scenario and to provide the public with sufficient information to allow for informed public comment. Estimates were made as per practical experience and the TBC guidance, "Covers for Uncontrolled Hazardous Waste Sites", EPA/540/2-85/002. To reiterate, the additional figure of $1,216,400 is a worst-case scenario for cost estimation purposes only. No attempt was made to give any exact design numbers or parameters. These will be obtained during Remedial Design.

D. REMAINING CONCERNS

EPA is unaware of any remaining concerns.

ATTACHMENT A - COMMUNITY RELATIONS ACTIVITIES AT MURRAY OHIO DUMP SUPERFUND SITE

Community relations activities conducted for the Murray Ohio Dump Site have included:

* Distribution of an RI/FS kickoff fact sheet (August 1990)
* Community interviews (June 1990)
* An RI/FS kickoff public meeting (August 1990)
* Distribution of a proposed plan fact sheet (February 1994)
* A proposed plan public meeting in Lawrenceburg to record comments by the public, including potentially responsible parties (March 1994)
* Phone calls to various members of the community throughout the RI/FS to address their various concerns

Appendix C

Risk Assessment Certification

RISK ASSESSMENT CERTIFICATION

The Region IV risk assessment staff has reviewed the PRP-generated risk assessment for the ***Murray Ohio Disposal NPL Site, Lawrenceburg, TN*** for compliance with current Agency health risk guidance and policy. Comments were conveyed to the Potential Responsible Parties (PRP) through the Remedial Project Manager and changes/corrections have been incorporated into a revised risk assessment document. An addition to this BRA was developed by EPA as a supplemental Baseline Risk Assessment provided in appendix C of the FS report. In accordance with the requirement of OSWER Directive No. 9835.15 (8/28/90), it has been determined that the final risk assessment including the EPA supplement as summarized in the Record of Decision conservatively conveys the upperbound cancer and the systemic toxicity human health risk posed through all reasonably likely current and future exposure scenarios and the ecological risks by contaminants identified at this site. Therefore, it is acceptable to the Agency.

Elmer W. Akin

ELMER W. AKIN, CHIEF
OFFICE OF HEALTH ASSESSMENT

6/6/94
DATE