United States
Environmental Protection
Agency

Office of
Emergency and
Remedial Response

EPA/ROD/R04-93/133
December 1992

EPA

Superfund Record of Decision:

Redwing Carriers/Saraland, AL

50272-101

REPORT DOCUMENTATION PAGE	1. REPORT NO. EPA/ROD/R04-93/133	2.	3. Recipient's Accession No.
4. Title and Subtitle SUPERFUND RECORD OF DECISION Redwing Carriers/Saraland, AL First Remedial Action - Final			5. Report Date 12/15/92
			6.
7. Author(s)			8. Performing Organization Rept. No.
9. Performing Organization Name and Address			10 Project Task/Work Unit No.
			11. Contract(C) or Grant(G) No. (C) (G)
12. Sponsoring Organization Name and Address U.S. Environmental Protection Agency 401 M Street, S.W. Washington, D.C. 20460			13. Type of Report & Period Covered 800/800
			14.

15. Supplementary Notes

PB94-964030

16. Abstract (Limit: 200 words)

The 5.1-acre Redwing Carriers/Saraland site is a former trucking terminal and current apartment complex located in Saraland, Mobile County, Alabama. Land use in the area is predominantly residential, with wetlands and woodlands situated near the site, and three layers of hydrogeologic units, including an alluvial and surficial aquifer, beneath the site. The estimated 160 people who reside onsite in the Saraland Apartment complex use wells located to the north of the site to obtain their drinking water supply, and although not currently utilized, the alluvial and surficial aquifers are a potential source of drinking water. There are one grass-covered and two concrete-lined drainage ditches onsite that eventually empty into the Norton Creek. From 1961 to 1971, Redwing Carriers operated a trucking company that transported substances such as asphalt, diesel fuel, chemicals, and pesticides from local plants and that used the site as a terminal for cleanup, repairing, and parking the fleet of trucks. Sometimes during the cleanup process, untreated substances were released sometimes directly into the ground. Many of the contaminants likely were diluted and washed away during storm events; however, many of them adhered to the asphalt, which was deposited later across the property during maintenance operations. In 1971, Redwing Carriers sold the property, which was converted into an apartment complex. In 1984, the State

(See Attached Page)

17. Document Analysis a. Descriptors

Record of Decision - Redwing Carriers/Saraland, AL
First Remedial Action - Final
Contaminated Media: soil, sediment, debris, sludge, gw
Key Contaminants: VOCs (benzene), metals (chromium)

b. Identifiers/Open-Ended Terms

c. COSATI Field/Group

18. Availability Statement	19. Security Class (This Report) None	21. No. of Pages 102
	20. Security Class (This Page) None	22. Price

(See ANSI-Z39.18) *See Instructions on Reverse* OPTIONAL FORM 272 (4-77) (Formerly NTIS-35) Department of Commerce

Abstract (Continued)

investigated complaints about a tar-like sludge oozing to the surface at numerous locations. In 1985, EPA studies detected high concentrations of 1,2,4-trichlorobenzene and naphthalene in the soil and in leachate coming from the sludge, which has been related to onsite ground water contamination. Subsequently, EPA required Redwing to remove any visible sludge detected on the surface of the site. This ROD addresses the first and final remedial action for the contaminated source material and ground water affecting the surficial and alluvial aquifers as a drinking water source. The primary contaminants of concern affecting the soil, sediment, debris, sludge, and ground water are VOCs, including benzene; and metals, including chromium.

The selected remedial action for this site includes temporarily relocating onsite residents during excavation; removing buildings or onsite structures as needed to facilitate excavation; excavating contaminated soil, sediment, and sludge until the remaining source material achieves excavation levels; staging and temporarily storing the excavated material onsite; treating the surface soil, sediment, and sludge offsite using thermal treatment, if necessary; dewatering and solidifying the subsurface soil offsite, if necessary, before disposing of the residuals in an offsite landfill; analyzing, treating, and discharging the water from the dewatering process in an appropriate manner; removing, sorting, and treating offsite, if necessary, all contaminated debris, including sidewalk slabs and pavement areas; backfilling excavated areas with clean material; extracting approximately 12,000,000 gallons of contaminated ground water from the surficial aquifer using extraction wells and french drains and treating it onsite using biological treatment and sand/activated carbon filtration, with a supplemental treatment step, if necessary, to remove contaminants not affected by biotreatment; discharging the treated ground water offsite to a POTW or onsite in nearby surface water; disposing of residual sludge and spent carbon offsite in an approved facility; allowing for natural attenuation of the alluvial ground water; and monitoring the surface soil, sludge seeps, and ground water in the alluvial aquifer to monitor the natural attenuation process. The estimated present worth cost for this remedial action is $7,002,562, which includes an estimated present worth O&M cost of $518,000.

PERFORMANCE STANDARDS OR GOALS:

Soil, sediment, and sludge cleanup goals and excavation levels are based on a human health risk from inhalation or ingestion and ground water protection with a cleanup level of 15 ug/l for lead. Chemical-specific goals include acetone 36 ug/kg; aldrin 4 ug/kg; alpha-BHC 0.5 ug/kg; benzo(a)anthracene 1,025 ug/kg; benzo(a)pyrene 94.9 ug/kg; benzo(b)fluoranthene 540 ug/kg; carbon tetrachloride 9,590 ug/kg; chloroform 70 ug/kg; chromium 47,000 ug/kg; chrysene 362 ug/kg; 4,4-DDT 566 ug/kg; dieldrin 0.1 ug/kg; gamma-BHC 3.2 ug/kg; methylene chloride 0.6 ug/kg; nickel 30,000 ug/kg; vanadium 156,000 ug/kg; and vernolate 55 ug/kg. Ground water cleanup goals are based on SDWA MCLs. Chemical-specific ground water cleanup goals include acetone 1,120 ug/l; aldrin 0.00317 ug/l; alpha-BHC 0.00855 ug/l; beryllium 4 ug/l; bis(2-ethylhexyl)phthalate 6 ug/l; carbon disulfide 47.6 ug/l; chloroform 100 ug/l; chromium 50 ug/l; 4,4-DDT 0.158 ug/l; dieldrin 0.00337 ug/l; gamma-BHC 0.2 ug/l; methylene chloride 5 ug/l; nickel 100 ug/l; vanadium 78.1 ug/l; and vernolate 11.2 ug/l.

RECORD OF DECISION
REDWING CARRIERS, INC. (SARALAND)
NPL SITE

DECEMBER 15, 1992

THE DECLARATION

Site Name and Location

The Redwing Carriers, Inc. (Saraland) Site (Redwing Site) is located in Mobile County, Alabama in the corporate limits of the City of Saraland. The 5.1 acre site is about eleven miles north of Mobile, Alabama. The Redwing Site is bounded to the east by U.S. Highway 43 and a skating rink. On the south it is bounded by a United Gas Pipe Line easement. A residential development is south of the pipe line easement. The Redwing Site is bounded on the north by a trailer park, and on the west by an undeveloped lot.

Statement of Basis and Purpose

This decision document presents the selected remedial action for the Redwing Site in Saraland, Mobile County, Alabama, which was chosen in accordance with the Comprehensive Environmental Response Compensation and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act (SARA), and, to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). This decision is based on the administrative record for this site.

The State of Alabama concurs with the selected remedy.

Assessment of the Site

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

Description of the Selected Remedy

The Major components of the remedy are:

- Excavation of sludge, sediments, and contaminated soils.
- Off-site treatment/disposal of contaminated soils, sediments and sludge.
- Regrading and backfill of excavations using clean, compacted fill material.
- Temporary and possibly permanent relocation of residents with the potential demolition of selected apartment units.
- On-site treatment of contaminated groundwater in the surficial aquifer. Monitoring and possible withdrawal and treatment of groundwater in the alluvial aquifer. Treated groundwater will be discharged to a Publicly Owned Treatment Works (POTW), or if unavailable, to a nearby surface water body.

SUMMARY OF REMEDIAL ALTERNATIVE SELECTION

REDWING CARRIERS, INC. (SARALAND)
SARALAND, ALABAMA

Prepared By

U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION IV
ATLANTA, GEORGIA

THE DECLARATION

Site Name and Location

The Redwing Carriers, Inc. (Saraland) Site (Redwing Site) is located in Mobile County, Alabama in the corporate limits of the City of Saraland. The 5.1 acre site is about eleven miles north of Mobile, Alabama. The Redwing Site is bounded to the east by U.S. Highway 43 and a skating rink. On the south it is bounded by a United Gas Pipe Line easement. A residential development is south of the pipe line easement. The Redwing Site is bounded on the north by a trailer park, and on the west by an undeveloped lot.

Statement of Basis and Purpose

This decision document presents the selected remedial action for the Redwing Site in Saraland, Mobile County, Alabama, which was chosen in accordance with the Comprehensive Environmental Response Compensation and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act (SARA), and, to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). This decision is based on the administrative record for this site.

The State of Alabama concurs with the selected remedy.

Assessment of the Site

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

Description of the Selected Remedy

The Major components of the remedy are:

- Excavation of sludge, sediments, and contaminated soils.
- Off-site treatment/disposal of contaminated soils, sediments and sludge.
- Regrading and backfill of excavations using clean, compacted fill material.
- Temporary and possibly permanent relocation of residents with the potential demolition of selected apartment units.
- On-site treatment of contaminated groundwater in the surficial aquifer. Monitoring and possible withdrawal and treatment of groundwater in the alluvial aquifer. Treated groundwater will be discharged to a Publicly Owned Treatment Works (POTW), or if unavailable, to a nearby surface water body.

This remedy is the only and final remedial action for the site. The function of this remedy is to reduce the risks associated with exposure to contaminated soils, sediments, and ground water.

The selected remedy will:

1. Prevent migration of contaminated groundwater.
2. Prevent human exposure to contaminated soils, sediments and sludge.
3. Permanently reduce the toxicity of the harmful constituents in all media.
4. Prevent migration of site contaminants via drainage pathways.

Statutory Determinations

The selected remedy is protective of human health and the environment, complies with Federal and State requirements that are legally applicable or relevant and appropriate to the remedial action, and is cost-effective. However, because treatment of the principal threats of the site was not found to be practicable, this remedy does not satisfy the statutory preference for treatment as a principal element.

Because this remedy will result in hazardous substances remaining on-site above health-based levels, a review will be conducted within five years after commencement of remedial action to ensure that the remedy continues to provide adequate protection of human health and the environment.

Patrick M Tobin

Patrick M. Tobin
Acting Regional Administrator

12-15-92
Date

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Decision Summary
Record of Decision
Redwing Carriers Inc. (Saraland)
Saraland, Alabama

1.0 SITE NAME, LOCATION AND DESCRIPTION

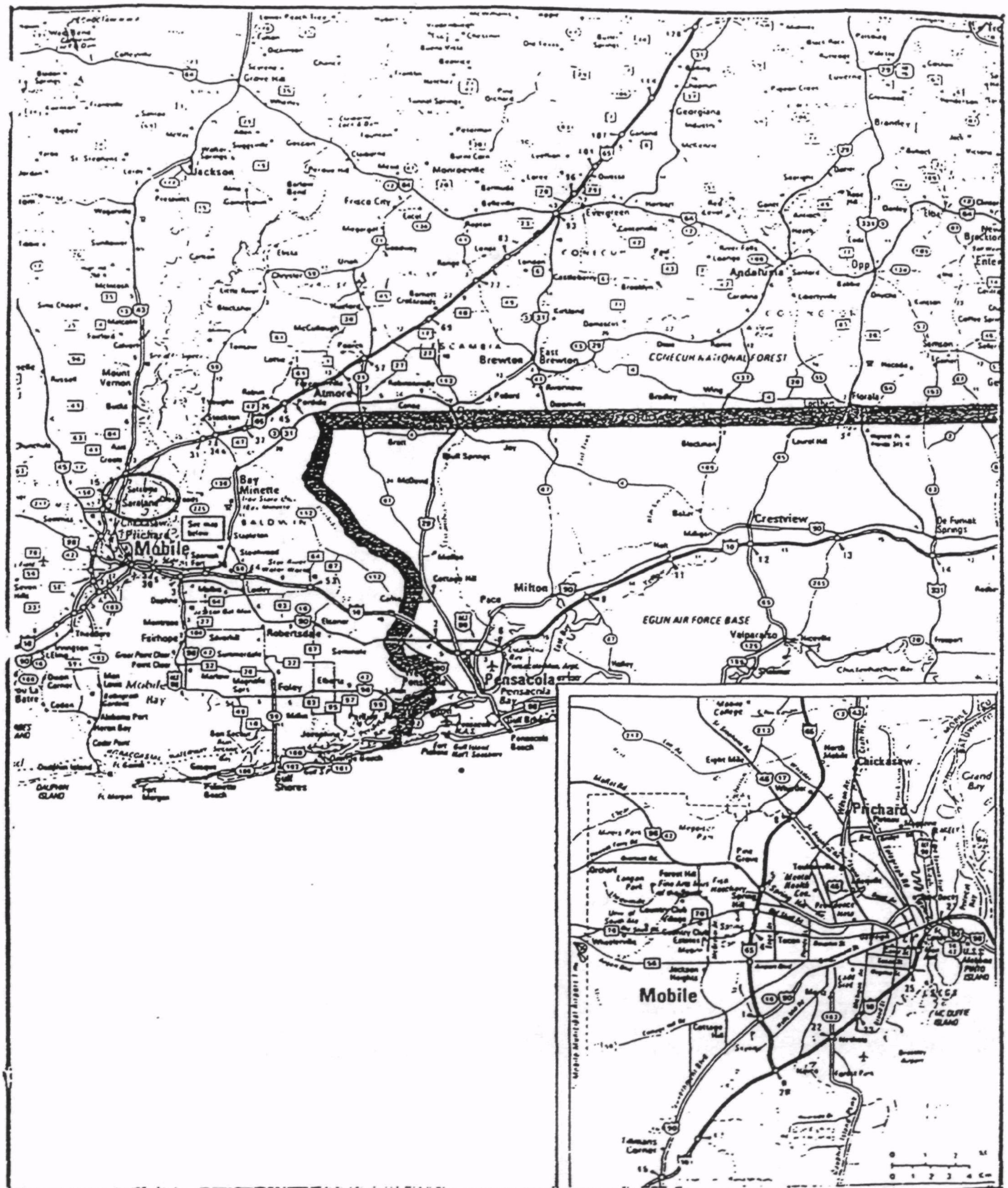
The Redwing Carriers, Inc. (Saraland) Site ("Redwing Site") comprises 5.1 acres and is located at 527 U.S. 43 in the City of Saraland, Mobile County, Alabama. Currently, thirteen (13) buildings which comprise the office and resident living units of the Saraland Apartment complex are built on the Redwing Site. The property is bounded to the north by Cook's Mobile Home Park (containing approximately 53 mobile homes), to the south by private residences on Craig Drive, to the west by a wooded area and private residences on Pierce Street, and to the east by an indoor roller skating rink and U.S. Highway 43. Figure 1 shows the location of the Redwing Site.

Concrete sidewalks are between and around the apartment buildings and along the north side of the office building. A paved drive and parking area surrounds the buildings' units and provides access from U.S. Highway 43 east of the complex. Two concrete lined drainage ditches run parallel to the southern and eastern property lines of the apartment complex. The southern ditch converges with the eastern ditch at the southeast corner of the Redwing Site. About 220 feet north of the southeast corner, the eastern ditch turns east and connects to a drainage ditch running parallel with U.S. Highway 43 at the entrance to the complex. A third drainage ditch runs along the northern property line. This ditch is unlined, but has a grass cover. This northern ditch also joins with the Highway 43 drainage ditch located at the complex entrance. A United Gas Pipe Line easement also parallels the northern side of this ditch. In the playground of the apartment complex are a slide and swing used by children.

Storm water runoff drains into ditches on the north, south and east borders of the property. This ditch system empties into a drainage ditch parallel to Highway 43 and leads to Norton Creek approximately 1/2 mile from the Redwing Site. Wetlands are located within a 3 mile radius.

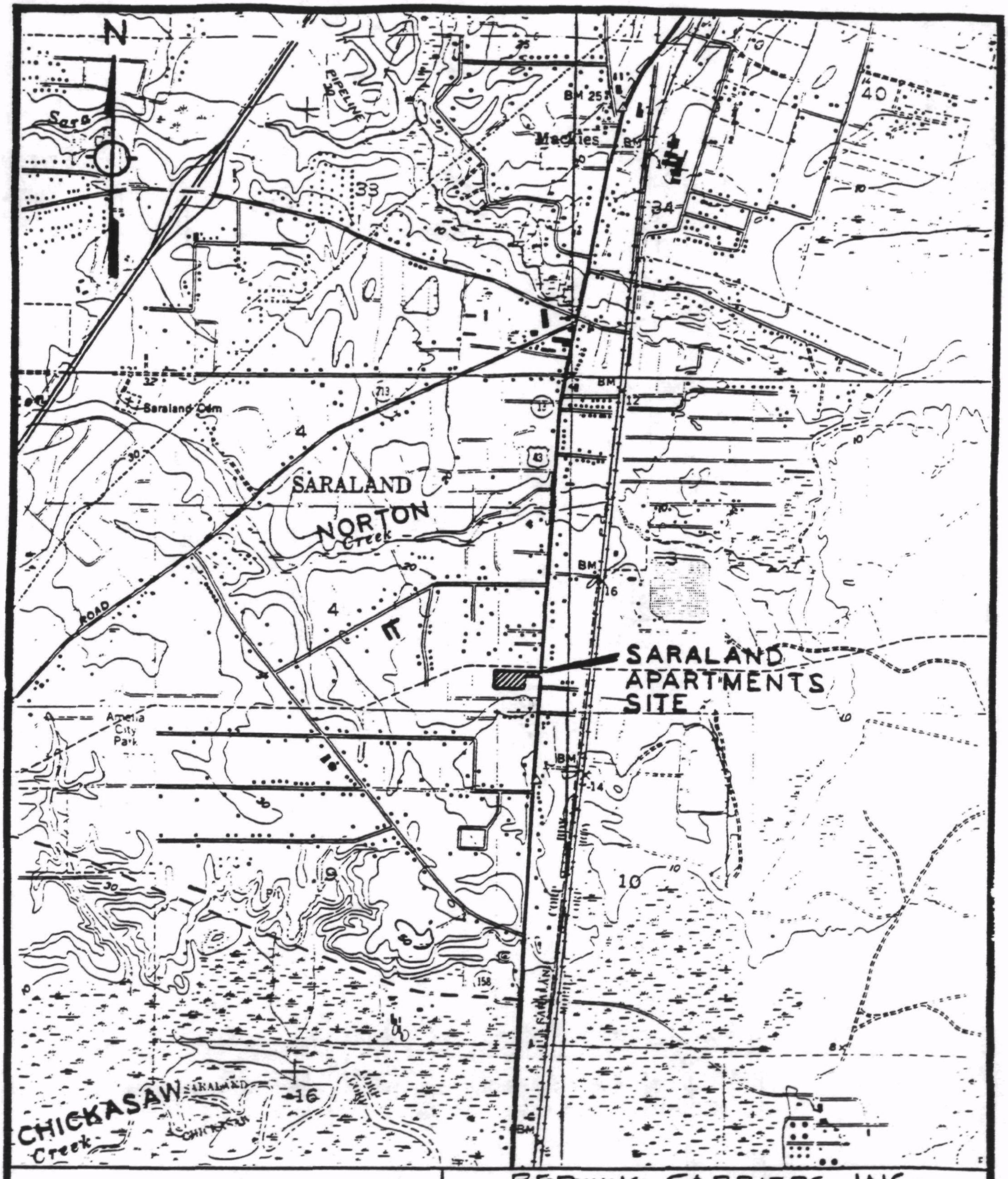
On-site Demographics

The Redwing Site's 60-unit apartment complex houses approximately 160 residents. Eighty to ninety of the residents are preschool-age or elementary school-age children who frequently play in the yard surrounding the apartments. Figures 2 and 3 are site maps which show the current layout of the property.



The WCM GROUP, Inc.	SARALAND, ALABAMA AREA MAP				
P.O. Box 3247 Humble, Texas 77347-3247 (713) 446-7070	DATE	SCALE	JOB NO.	REV.	DRAWN BY
	7/20/90	1" - 16 Mi			W DOUS FS

FIGURE - 1



The WCM GROUP, Inc. P.O. Box 3247 Humble, Texas 77347-3247 (713) 446-7070	REDWING CARRIERS, INC. SARALAND APARTMENT SITE		
	SARALAND, ALABAMA	JOB NO	
	DATE 4-27-92	SCALE 1:24000	DRAWN BY W. DOUGLAS

CHICKASAW, ALABAMA - 7.5 MIN. SERIES

FIGURE 2

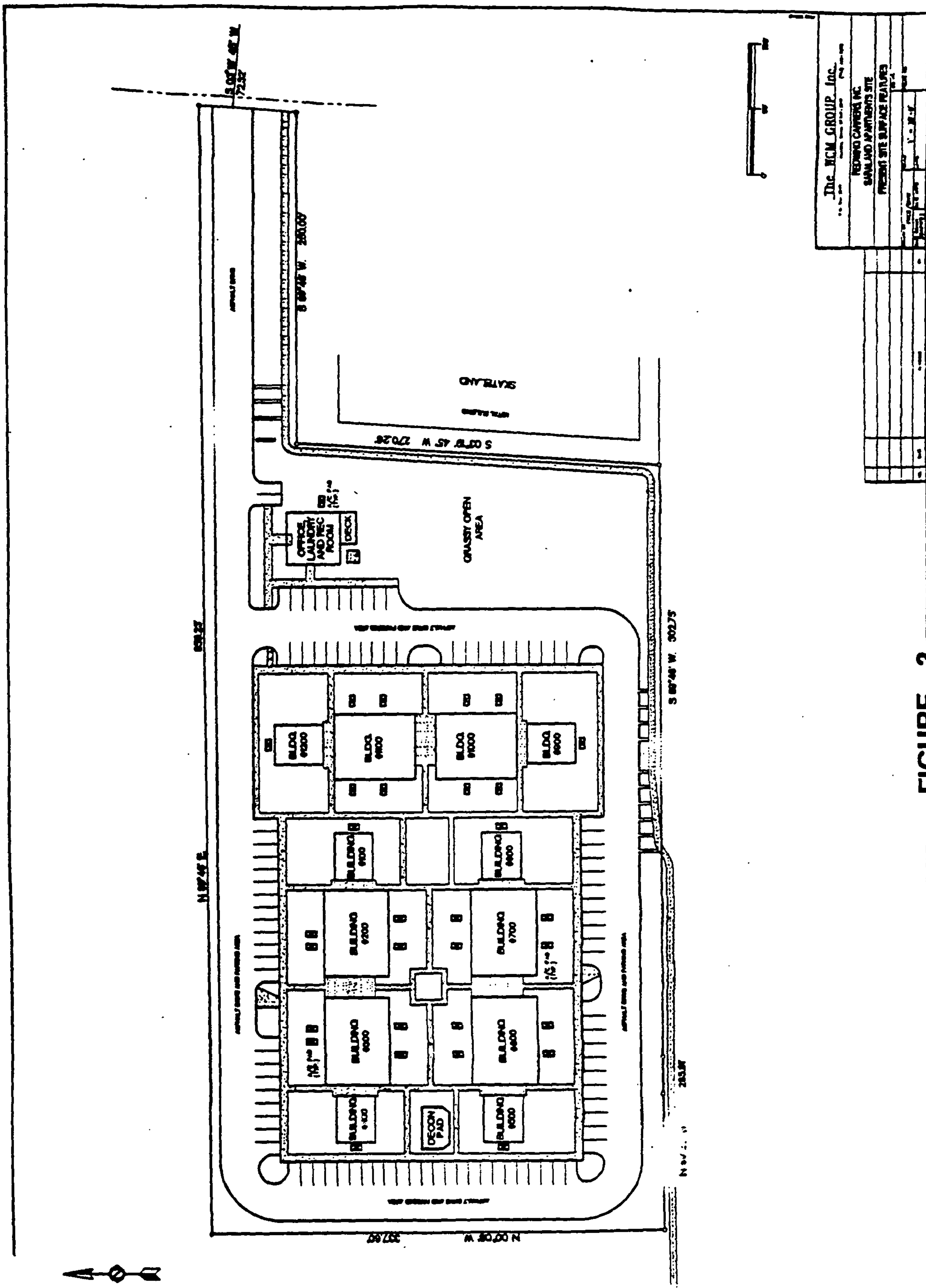

OFFICE LAUNDRY AND REC ROOM
DECK
GRASSY OPEN AREA
SKATELAND
DECON PAD

FIGURE - 3

2.0 SITE HISTORY AND ENFORCEMENT ACTIVITIES

From 1961 to 1971, Redwing Carriers, Inc. (Redwing), a trucking company, used the Redwing Site as a terminal for cleaning, repairing and parking its fleet of trucks. The firm transported a variety of substances, including asphalt, diesel fuel, chemicals and pesticides from local plants along U.S. Highway 43 North. During cleaning, untreated substances were released to the ground. Figure 4 depicts the general condition of the Redwing Site property layout during Redwing's operations.

In 1971 Redwing sold the property to Harrington Inc. which in turn sold the property to Apartments, Inc. on December 22, 1971. On March 26, 1973, Apartments Inc. sold the property to Saraland Apartments Ltd. The Saraland Apartments were built on the Redwing Site in 1973.

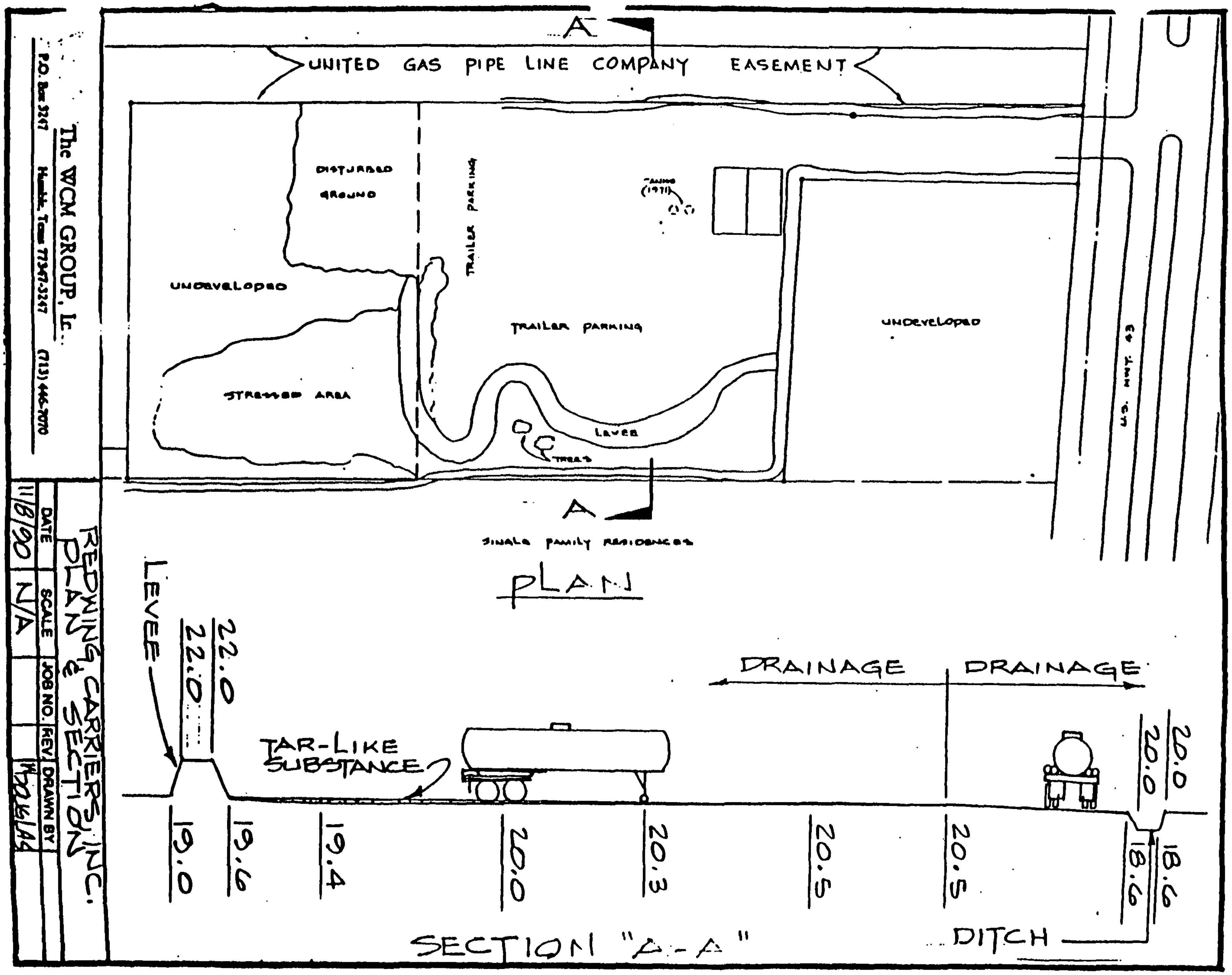
In 1984, The Alabama Department of Environmental Management (ADEM) investigated residents' complaints about a tar-like sludge oozing to the surface at numerous locations. In 1985, EPA conducted initial studies in which high concentrations of 1,2,4-trichlorobenzene and naphthalene were detected in the soil and in leachate coming from the sludge.

EPA sent notice letters to potentially responsible parties (PRPs) in 1985. EPA entered into an Administrative Order on Consent (AOC) on July 8, 1985 with Redwing. Under the order, Redwing was required and continues to periodically inspect the site and remove any visible sludge on the surface.

The Redwing Site was proposed for listing on the National Priorities List (NPL) in 1988 and finalized in February 1990. In June 1990, Redwing Carriers Inc. entered into an Administrative Order on Consent with EPA to conduct the Remedial Investigation/Feasibility Study (RI/FS) to determine the nature and extent of contamination at the site, to evaluate the associated risks, and to evaluate alternatives for eliminating those threats. Redwing, under EPA's oversight, began field activities for the first phase of the remedial investigation in January 1991. The RI/FS was completed in July of 1992.

3.0 HIGHLIGHTS OF COMMUNITY PARTICIPATION

All basic requirements for public participation under CERCLA sections 113(k)(2)(B)(i-v) and 117 were met in the remedy selection process. Because the local community has been very interested and involved in the Redwing Site status during the removal and the remedial activities at this site, community relations activities remained an important aspect throughout the RI/FS process.



UNITED GAS PIPE LINE COMPANY EASEMENT
A
DISTURBED GROUND
UNDEVELOPED
STRESSED AREA
TRAILER PARKING
TRAILER PARKING
LEVEE
TREES
UNDEVELOPED
U.S. HWY. 43
A
SINGLE FAMILY RESIDENCES
PLAN
LEVEE
22.0
22.0
TAR-LIKE SUBSTANCE
DRAINAGE
DRAINAGE
20.0
20.0
19.0
19.6
19.4
20.0
20.3
20.5
20.5
18.6
18.6
SECTION "A-A"
DITCH
The WCM GROUP, Inc.
P.O. Box 3247 Humble, Texas 77347-3247 (713) 446-7070
REDWING CARRIERS, INC.
PLAN & SECTION
DATE
SCALE
JOB NO.
REV.
DRAWN BY
11/8/90
N/A

FIGURE - 4

The community relations program at the Redwing Site was designed to maintain communication between the residents in the affected community and the government agencies conducting remedial activities at the Redwing Site. Frequent communication with on-site residents and local officials has been maintained as a priority. Special attention has been directed toward keeping the community informed of all study results. Meetings were held with Saraland city officials and EPA staff prior to the initiation of the RI/FS. Prior to approval of the RI/FS Workplan, EPA officials met with the community at an availability session in December 1990 to inform residents of EPA's intentions and to obtain input concerning sampling locations and health and safety procedures.

Once the first phase of the RI/FS was complete, EPA met with the community again in August 1991 to present the Preliminary Site Characterization Summary which detailed the results of the first phase of the investigation. EPA also discussed the rationale for the subsequent sampling investigation, Phase II. On August 11, 1992 after the finalization of the Remedial Investigation Report and the completion of the Draft Feasibility Study, EPA presented its preferred remedy for the Redwing Site during a public meeting at the Saraland Civic Center, 731 Mae Street, Saraland, Alabama. The 30-day public comment period began on August 1, 1992 and was extended through September 29, 1992 pursuant to requests from the public. A copy of the Administrative Record upon which the remedy was based, is located at the Saraland Public Library at 111 Saraland Loop, Saraland Alabama, 36571 and extra copies of the study were provided to a community group interested in commenting on the proposed plan. EPA's responses to comments which were received during the comment period are contained in Appendix A.

4.0 SCOPE AND ROLE OF RESPONSE ACTION

This remedy is the final remedial action for the site. The function of this remedy is to reduce the risks associated with exposure to contaminated soils, sediments, ground water and sludge.

The selected remedial alternative will address four conditions which pose a threat to human health and the environment:

- Contaminated groundwater in the surficial and alluvial aquifers (may potentially impact drinking water supplies).
- Ditch sediments along the northern, eastern and southern boundaries of the apartment complex property (may pose a direct contact threat to the public health).
- Sludge in the upper five feet of on-site soils (presents a

continuing direct contact threat to the public health).

- Sludge and contaminated subsurface soils (present a continuing source of contamination to the surficial aquifer).

Groundwater at the Redwing Site has been contaminated by the sludge and contaminated subsurface soils. Figure 5 shows the areas where the sludge/contaminated soil have been encountered. These areas correspond to the locations where the highest concentrations of contamination has been found in the surficial aquifer. This is the principal threat posed by conditions at the site.

Pathways of exposure include:

- Ingestion of contaminated soil, sediments, and sludge
- Dermal contact with contaminated soil/sediments/sludge and potential absorption of contaminants
- Ingestion of contaminated groundwater
- Inhalation of vapors from volatile constituents contained in the contaminated media.
- Migration of site related contaminants to off-site areas via drainage pathways.

The major components of the remedy are:

- Excavation of sludge, contaminated soils and sediments.
- Off-site materials treatment/disposal.
- Regrading and backfill of excavations using clean compacted fill material.
- Temporary and possibly permanent relocation of residents with the potential demolition of selected apartment units.
- On-site treatment of contaminated groundwater in the surficial aquifer. Monitoring, possible withdrawal and treatment of groundwater in the alluvial aquifer. Treated groundwater will be discharged to a Publicly Owned Treatment Works (POTW), or if unavailable, to a nearby surface water body.

5.0 SUMMARY OF SITE CHARACTERISTICS

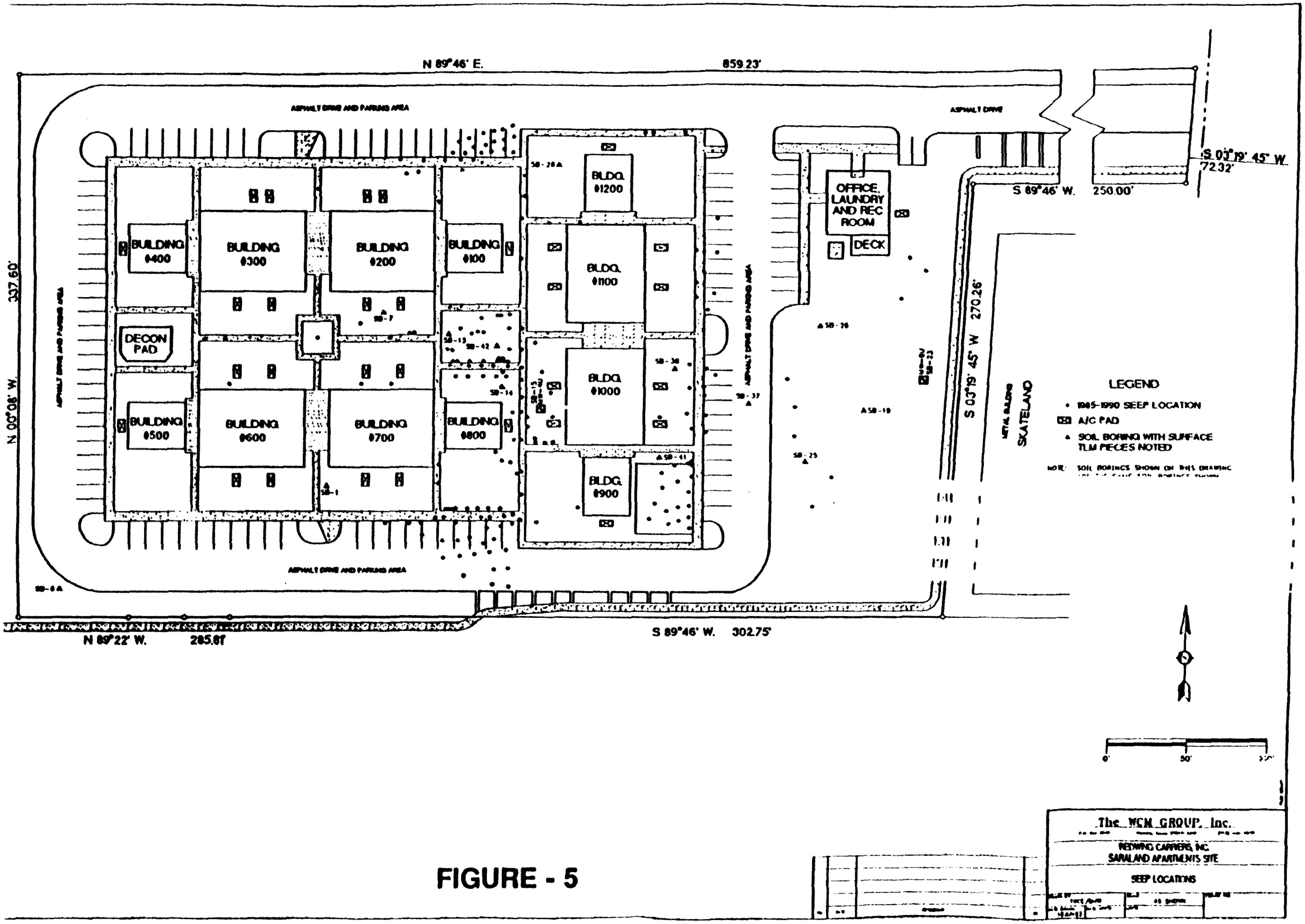

N 89°46' E.
859.23'
ASPHALT DRIVE AND PARKING AREA
ASPHALT DRIVE
S 03°19' 45" W
72.32'
S 89°46' W.
250.00'
BLDG. #1200
OFFICE, LAUNDRY AND REC ROOM
DECK
BUILDING #400
BUILDING #300
BUILDING #200
BUILDING #100
BLDG. #1100
337.60'
N 00°08' W.
DECON PAD
BLDG. #1000
BUILDING #500
BUILDING #600
BUILDING #700
BUILDING #800
BLDG. #900
S 03°19' 45" W
270.26'
SKATELAND
LEGEND
1985-1990 SEEP LOCATION
A/C PAD
SOIL BORING WITH SURFACE TLM PIECES NOTED
S 89°46' W.
302.75'
N 89°22' W.
285.81'
0'
50'
The WCM GROUP, Inc.
REDWING CARRIERS, INC.
SARALAND APARTMENTS SITE
SEEP LOCATIONS

FIGURE - 5

5.1 SITE GEOLOGY

The Redwing Site geology was determined from regional geological information and from site-specific data gathered during the Remedial Investigation. The Redwing Site is situated on fill soils overlying Holocene and possibly Pleistocene alluvium. Four generalized stratigraphic units have been defined as in Table 1 below.

TABLE 1 - GEOLOGICAL STRATA

Stratum	Approximate Depth Range (feet)	Description
I	0.0 - 6.0	Fill: Clayey to silty sand.
II	1.0 - 12.5	Clayey to silty sand with sandy clay and silt lenses.
III	4.0 - 29.5	Clay and sandy to silty clay with few silty sand lenses.
IV	8.0 - 40.0+	Sand and silty to clayey sand with occasional clay lenses.

Details regarding the regional and site geology are contained in the RI Report.

5.2 SITE HYDROGEOLOGY

The primary aquifer underlying the Redwing Site is a group of alluvial and terrace deposits ranging in thickness from a thin veneer to more than 150 feet and consisting of fine to coarse-grained sands, gravel, silts, sandy clay and organic material. The groundwater in the vicinity of the Redwing Site is approximately 10 feet below land surface. The Redwing Site is underlain by strata that comprise the Alluvial aquifer of Mobile County. Three distinct hydrogeologic units were identified from four strata underlying the Redwing Site. The designations assigned to these three units are as follows: (1) the Surficial Aquifer (upper sands); (2) a Low Permeability Unit and (3) the Alluvial Aquifer (lower sands). Groundwater in the aquifers beneath the Redwing Site have been classified as Class IIB for the surficial groundwater and Class IIA for the alluvial aquifer. Class IIB groundwater is a potential drinking water source although the groundwater may not be currently used as such. Class IIA groundwater is a current source of drinking water.

Watertable elevations indicate that groundwater flow within the Surficial Aquifer is toward the south. This southward flow coincides with the southward slope of the underlying Stratum III surface.

The low permeability hydrogeological unit is represented by Stratum III as was described in Table 1.

The third hydrogeologic unit encountered at the Redwing Site is defined by the lower sands designated as Stratum IV. Stratum IV has been designated the Alluvial Aquifer Unit. Groundwater in the Alluvial Aquifer is generally first encountered at depths 11 feet to 19 feet. Groundwater flow in the Alluvial Aquifer is in a westerly direction. This flow direction is almost perpendicular to the watertable groundwater flow in the surficial Aquifer.

5.3 AREA DRINKING WATER SOURCES

Drinking water for residents of Saraland is supplied by the City of Saraland Water Department, which obtains its water supply from wells located north of the Redwing Site. These three wells are located between 5000 and 7500 feet north of the Redwing Site. The depths range from 95 feet to 124 feet below ground surface. An additional well is located about 1400 feet southeast of the Redwing Site and extends to a depth of 98 feet. A well inventory survey was conducted to identify private wells within a one mile radius of the Redwing Site and identified 124 private wells in the area. Seventeen of the wells are currently being used. Two of the wells have their last documented use recorded as 1987. The uses range from drinking water to water for gardening. The wells range in depth from 15 to 140 feet. The complete results of the survey are contained in the Remedial Investigation report.

5.4 SUMMARY OF SITE CONTAMINATION

The Remedial Investigation was initiated in December 1990. The RI sampling, conducted in 1991 and 1992, focused on areas related to former terminal operations. Figure 6 shows a containment levee (thought to be the residuals disposal area) overlain by the current site features. During the truck washing operations, chemical residue and other contaminants were released from the trucks onto the ground and into the drainage ditches and levee areas on the property. Many of the contaminants were likely diluted and washed away during storm events, however, many of them adhered to the asphalt which was also deposited across the property during maintenance operations. The asphalt was contained primarily in the levee area with overflow going to the ditches. Many of the chemicals from the truck washing affixed themselves to the asphalt. This resulted in the sludge that we

FIGURE - 6

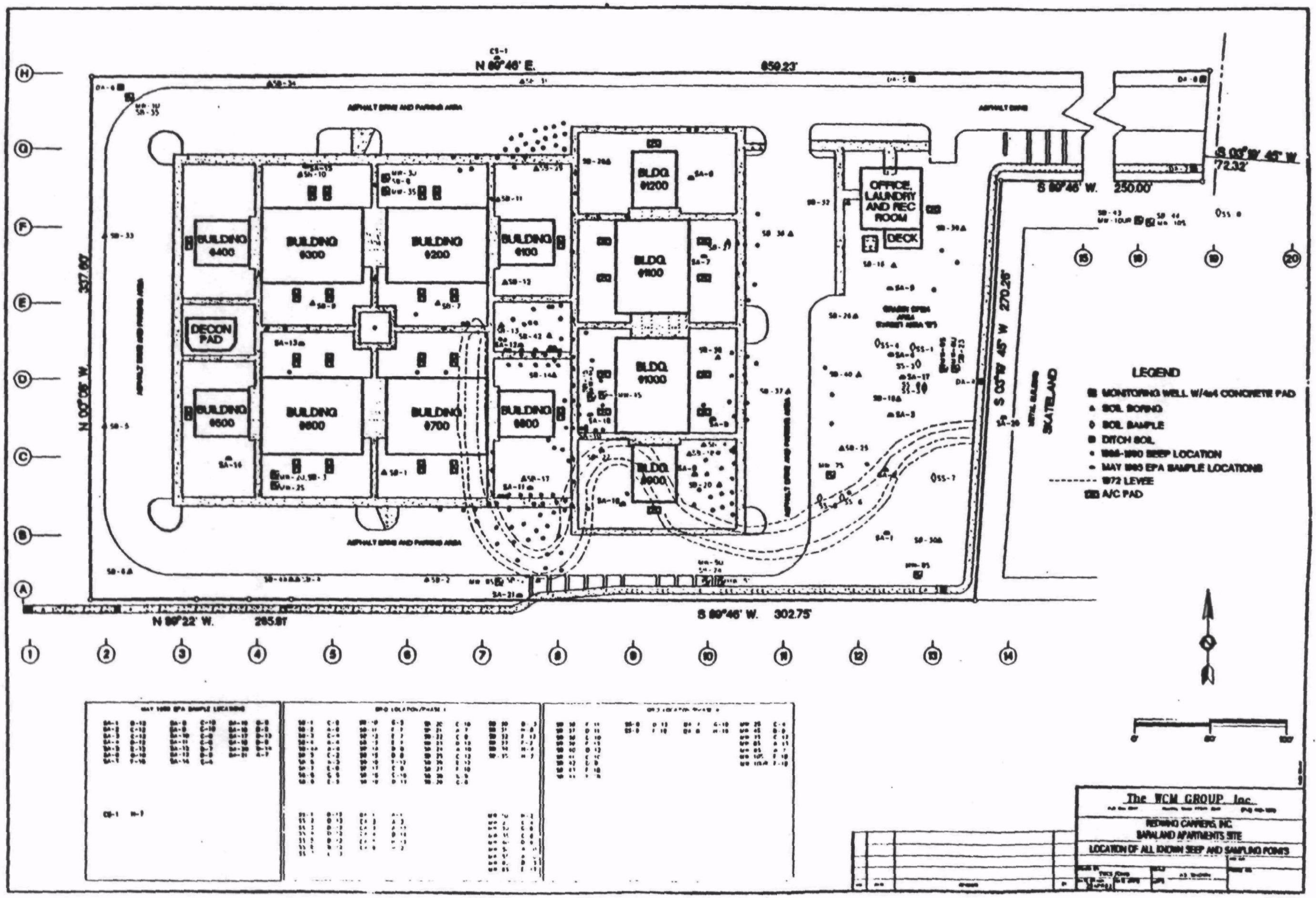


FIGURE - 6

currently encounter at the Redwing Site. Tables 2A and 2B contain the results from analysis of the sludge. The sludge is present at the Redwing Site in two forms: (1) surface seeps at 194 locations since 1985 (see Figures 5 and 6), and (2) sludge mixed with soil found in 15 samples across the Redwing Site. There is a direct relationship between constituents found in the soil and in the surficial groundwater.

5.4.1 CHEMICALS DETECTED DURING THE SITE INVESTIGATION

During the investigation, 39 soil borings were collected with a total of 123 separate soil samples being analyzed. The substances found most frequently at concentrations above cleanup levels fall into three major categories: 1) pesticides and herbicides; 2) Volatile organic compounds (VOCs) and 3) Polycyclic Aromatic Hydrocarbons (PAHs).

These substances were found in soils, ditch sediments, and groundwater across the Redwing Site. The highest levels of contamination were detected in the southern and eastern portions (the location of the former containment levee used by Redwing) and across areas of former terminal operations. Inorganic substances, which may occur in nature in significant levels, were also detected in soils, sludge and groundwater.

5.4.2 CHEMICALS DETECTED IN GROUNDWATER

Substances moving from soil and the sludge have contaminated groundwater in the surficial, or shallow, aquifer. Highest groundwater contaminant concentrations are under the eastern half of the Redwing Site, but the upper aquifer has been affected under most of the Redwing Site. Limited movement of contaminants to the alluvial (lower) aquifer has occurred, but at much lower levels.

Table 3 illustrates the migration of contaminants from the source areas to the surficial groundwater and alluvial sands. The groundwater in the alluvial aquifer was found to be contaminated in limited areas with some site related constituents. Table 4 illustrates the result of the alluvial aquifer sampling.

5.4.3 SURFACE WATER PATHWAY INVESTIGATION

Storm water which contacts surface soils, and sludge that has seeped to the surface, drains into on-site ditches resulting in a possible exposure pathway. The northern ditch is unlined but covered with grass. The southern and eastern ditches are now concrete-lined but were unlined when Redwing operated at the Redwing Site. Therefore, the study of the ditches extended to

TABLE 2A - RESULTS FROM ORGANIC CHEMICAL ANALYSIS OF SLUDGE		
COMPOUND	NO OF TIMES DETECTED	RANGE OF CONCENTRATIONS DETECTED μg/kg
1,1,1 TRICHLOROETHANE	1	3
1,2,4-TRICHLOROBENZENE	2	4,000 - 18,000
2-BUTANONE (MEK)	3	13 - 120
2-CYCLOHEXEN-1-OL	1	180
2-HEPTANONE	1	48
2-HEXANONE	2	11 - 27
2-METHYLNAPHTHALENE	3	2,600 - 5,200
2-PENTANONE, 4-HYDROXY-4-METHYL	8	1,900 - 100,000
2-PROPANOL	2	12 - 36
4-METHYL-2-PENTANONE	1	15
4,4'-DDD	3	0.1 - 6.8
4,4'-DDE	1	0.29
4,4'-DDT	4	0.48 - 11
ACENAPHTHENE	2	2,600 - 4,600
ACETONE	7	54 - 610
ALDRIN	1	0.86
ALPHA-BHC	1	1.1
ALPHA-CHLORDANE	12	762 - 19,100
ANTHRACENE	4	200 - 7,300
BENZENE	3	4 - 48
BENZO(A)ANTHRACENE	5	160 - 7,2[illegible]
BENZO(A)PYRENE	3	920 - 3,200
BENZO(B)FLUORANTHENE	5	280 - 7,200
BENZO(K)FLUORANTHENE	1	1,700
BENZO-(G,H,I)PERYLENE	2	610 - 880
BETA-BHC	1	6.4
BIS(2-ETHYLHEXYL)PHTHALATE	4	58 - 200
BUTYLATE	8	450 - 51,000
CACARBAMOTHOIC ACID,DIPROYL	1	4,900
CARBON DISULFIDE	3	5 - 24
CHLOROFORM	1	4

TABLE 2A - RESULTS FROM ORGANIC CHEMICAL ANALYSIS OF SLUDGE		
COMPOUND	NO OF TIMES DETECTED	RANGE OF CONCENTRATIONS DETECTED µg/kg
CHRYSENE	5	160 - 6,000
CYCLOATE	2	6.6 - 10
CYCLOHEXANE,DICHLORO	1	670
CYCLOHEXANOL,CHLORO	1	1,400
DELTA-BHC	1	0.23
DIBENZOFURAN	2	2,200 - 6,800
DIELDRIN	2	1.1 - 3.4
ENDRIN	2	3.3 - 11
ENDRIN KETONE	1	17
EPTC	4	39 - 1,900
ETHYLBENZENE	2	18 - 120
FLUORANTHENE	6	200 - 23,000
FLUORENE	4	2,300 - 12,000
GAMMA-BHC (LINDANE)	1	0.12
HEPTACHLOR EPOXIDE	1	1.7
INDENO(1,2,3-CD)PYRENE	2	710 - 1,300
METHOXYCHLOR	1	13
METHYLENE CHLORIDE	3	5 - 48
MOLINATE	2	18 - 21
NAPHTHALENE	2	3,900 - 13,000
NAPHTHALENE, 1-METHYL	1	9,900
NAPHTHALENE,2,3-DIMETHYL	1	5,600
PEBULATE	7	25 - 9,800
PHENANTHRENE	5	850 - 33,000
PYRENE	6	160 - 12,000
SULFER, MOL(S8)	6	1,600 - 100,000
TOLUENE	3	30 - 52
VERNOLATE	7	43 - 130,000
XYLENE	3	5 - 480

TABLE 2B - RESULTS FROM INORGANIC CHEMICAL ANALYSIS OF BLACK SLUDGE MATERIAL

CHEMICAL	NO OF TIMES DETECTED	RANGE OF CONCENTRATIONS INORGANIC CHEMICALS DETECTED (mg/kg)
ALUMINUM	12	762 - 19,100
ARSENIC	6	0.71 - 3.3
BARIUM	11	9.1 - 80.9
BERYLLIUM	2	0.39 - 0.63
CADMIUM	2	2.2 - 9.5
CALCIUM	12	59.1 - 27,100
CHROMIUM (III/VI)	11	2.7 - 51.9
COBALT	1	2.7
COPPER	11	1 - 23.7
IRON	12	204 - 9,150
LEAD	11	4.2 - 316
MAGNESIUM	12	11.1 - 361
MANGANESE	10	2.1 - 372
MERCURY	7	0.15 - 1.9
NICKEL	6	3 - 30.1
POTASSIUM	5	199 - 1,960
SELENIUM	3	0.62 - 1.6
SODIUM	12	169 - 12,900
VANADIUM	12	1.8 - 30.6
ZINC	12	2.2 - 97.7

TABLE 3 - REDWING SITE: SUMMARY OF CHEMICALS DETECTED DURING REMEDIAL INVESTIGATION

[a] - INDICATES TENTATIVELY IDENTIFIED COMPOUNDS [b] - INDICATES ORGANIC COMPOUND WHICH WAS ALSO DETECTED IN THE ALLUVIAL GROUNDWATER	RESULTS FROM CHEMICAL ANALYSIS OF SOILS IN THE VADOSE ZONE (0' - 2')	RESULTS FROM CHEMICAL ANALYSIS OF SOILS IN THE SATURATED ZONE (2'- 8')	RESULTS FROM CHEMICAL ANALYSIS OF SURFICIAL GROUNDWATER	RESULTS FROM CHEMICAL ANALYSIS OF ALLUVIAL SANDS
CHEMICALS	RANGE OF CONCENTRATIONS DETECTED(μg/kg)	RANGE OF CONCENTRATIONS DETECTED(μg/kg)	RANGE OF CONCENTRATIONS DETECTED (μg/l)	RANGE OF CONCENTRATIONS DETECTED (μg/kg)
1,1,1 TRICHLOROETHANE	ND	3	ND	ND
1,2-CYCLOHEHANEDIOL [a]	ND	ND	13	ND
1,2,4-TRICHLOROBENZENE	290 - 18,000	64 - 3,000	ND	ND
1,4 DICHLOROBENZENE	ND	190	ND	ND
2(3H)-FURANONE,DIHYDRO-4,5 [a]	ND	ND	79	ND
2-BUTANONE (MEK)	95	8 - 13	12 - 72	ND
2-CYCLOHEXEN-1-OL [a]	ND	180	8 - 12	ND
2-CYCLOHEXEN-1-ONE [a]	ND	ND	4.7	ND
2-HEPTANONE [a]	ND	14	ND	ND
2-HEXANONE	4 -64	5 - 29	4 - 16	ND
2-HEXANONE, 5-METHYL [a]	1,300 -2,200	ND	ND	210 - 750
2-METHYLNAPHTHALENE	4,300 - 4,700	44 - 2,600	ND	ND
2-METHYLPHENOL	ND	ND	120	ND
2-PENTANONE,4-HYDROXY 4-METHYL [a]	5,700 - 170,000	1,200 - 130,000	24	3,500 - 21,000
2-PROPANOL [ab]	190	12 - 13	ND	32 - 44
2,4-D	ND	9.2	14	8.2
2,4-DIMETHYLPHENOL	ND	ND	20	ND
2,4,5-T	20	ND	9.6	3.4
2,5 CYCLOHEXADIENE-1,4-DIONE [a]	ND	620	20	ND
4-METHLY-2-PENTANONE	15 - 19	8 - 27	16	ND
4-METHLYPHENOL	ND	77	12 - 790	ND

TABLE 3 - REDWING SITE: SUMMARY OF CHEMICALS DETECTED DURING REMEDIAL INVESTIGATION

* - INDICATES TENTATIVELY IDENTIFIED COMPOUNDS b - INDICATES ORGANIC COMPOUND WHICH WAS ALSO DETECTED IN THE ALLUVIAL GROUNDWATER	RESULTS FROM CHEMICAL ANALYSIS OF SOILS IN THE VADOSE ZONE (0' - 2')	RESULTS FROM CHEMICAL ANALYSIS OF SOILS IN THE SATURATED ZONE (2'- 8')	RESULTS FROM CHEMICAL ANALYSIS OF SURFICIAL GROUNDWATER	RESULTS FROM CHEMICAL ANALYSIS OF ALLUVIAL SANDS
CHEMICALS	RANGE OF CONCENTRATIONS DETECTED(µg/kg)	RANGE OF CONCENTRATIONS DETECTED(µg/kg)	RANGE OF CONCENTRATIONS DETECTED (µg/l)	RANGE OF CONCENTRATIONS DETECTED (µg/kg)
4,4'-DDD	12 - 65	.36 - 17	ND	ND
4,4'-DDE	2 - 5.8	3.8 - 5.8	ND	ND
4,4'-DDT [b]	16 - 74	1 - 25	0.86	4.5
ACENAPHTHENE	2,700	170 - 1,400	ND	ND
ACETONE [b]	3 - 230	30 - 270	550 - 4,400	25 240
ALDRIN	0.36 - 10	0.86 - 15	.011 - .47	2.6
ALPHA-BHC	1.1 - 4.7	2 - 3.2	0.044 - 0.15	ND
ALPHA-CHLORDANE	4.5 - 14	6.9 - 19	ND	210 - 750
ALUMINUM	(1,850 - 19,100)E'	(1,740 - 10,400)E'	(8.04 - 229)E'	(257 - 2,430) E'
ANTHRACENE	200 - 2,000	240 - 2,100	ND	ND
ARSENIC	1,400 - 3,600	1,300 - 3,500	4 - 22.6	(1.3 - 1.5) E'
BARIUM	10,800 - 80,900	9,100 - 56,200	231 - 1,100	(5.3 - 13.[illegible]
BENZENE	4	4	ND	ND
BENZO(A)ANTHRACENE	1,000 - 1,800	6,900	ND	ND
BENZO(A)PYRENE	920 -1,200	ND	ND	ND
BENZO(B)FLUORANTHENE	3000	7,400	ND	ND
BENZO(K)FLUORANTHENE	1,700	ND	ND	ND
BENZO-(G,H,I)PERYLENE	100 - 610	ND	ND	ND
BENZOIC ACID *	ND	ND	16 - 66	ND
BENZOIC ACID-DICHLORO *	ND	ND	5	ND
BERYLLIUM	630	260 - 300	3.9 - 9.5	430 - 440

TABLE 3 - REDWING SITE: SUMMARY OF CHEMICALS DETECTED DURING REMEDIAL INVESTIGATION				
[a] - INDICATES TENTATIVELY IDENTIFIED COMPOUNDS [b] - INDICATES ORGANIC COMPOUND WHICH WAS ALSO DETECTED IN THE ALLUVIAL GROUNDWATER	RESULTS FROM CHEMICAL ANALYSIS OF SOILS IN THE VADOSE ZONE (0' - 2')	RESULTS FROM CHEMICAL ANALYSIS OF SOILS IN THE SATURATED ZONE (2'- 8')	RESULTS FROM CHEMICAL ANALYSIS OF SURFICIAL GROUNDWATER	RESULTS FROM CHEMICAL ANALYSIS OF ALLUVIAL SANDS
CHEMICALS	RANGE OF CONCENTRATIONS DETECTED(μg/kg)	RANGE OF CONCENTRATIONS DETECTED(μg/kg)	RANGE OF CONCENTRATIONS DETECTED (μg/l)	RANGE OF CONCENTRATIONS DETECTED (μg/kg)
BETA - BHC	6.4 - 10	2 - 29	ND	ND
BICYCLO(2,2,1)HEPTAN-2-ONE [a]	ND	ND	23 - 100	ND
BIS(2-ETHYLHEXYL)PHTHALATE [b]	58 - 580	58 - 500	1 -85	85
BUTYLATE [b]	1.7 - 30,000	2.4 - 4,900	.35 - 15	ND
CADMIUM	2,200 - 9,500	ND	ND	ND
CALCIUM	(1,440 - 61,600)E[3]	(106 - 9,490)E[3]	(9.55 - 141)E[3]	(48.7 - 434)E[3]
CARBAMOTHIOIC ACID,DIPROPYL [a]	4,900	470	38 - 56	ND
CARBON TETRACHLORIDE	110,000	ND	ND	ND
CARBON DISULFIDE	5	4 - 9	9 - 5,500	ND
CHLOROBENZENE	19	ND	ND	ND
CHLOROFORM	100	250	2,900 - 27,000	ND
CHLOROPYRIFOS	ND	230	ND	ND
CHROMIUM (III/VI)	4,500 - 51,900	3,500 - 19,000	30 - 355	1,500 - 5,400
CHRYSENE	160 - 2,400	6,000	ND	ND
CINEOLE(VAN) [a]	780 - 7,700	ND	ND	ND
COBALT	1,900 - 2,700	1,500	17.4 - 74.9	2,800 - 10,400
COPPER	1,900 - 23,700	1,200 - 27,000	161	1,100 - 8,500
CYANIDE	ND	1,600	12.8 - 128	870
CYCLOATE [b]	6.6 - 10	3.4 - 390	1.9	ND
CYCLOHEXANE(DOT) [a]	7	ND	ND	ND
CYCLOHEXANECARABOXYLIC ACID [a]	ND	ND	32	ND

TABLE 3 - REDWING SITE: SUMMARY OF CHEMICALS DETECTED DURING REMEDIAL INVESTIGATION

[a] - INDICATES TENTATIVELY IDENTIFIED COMPOUNDS [b] - INDICATES ORGANIC COMPOUND WHICH WAS ALSO DETECTED IN THE ALLUVIAL GROUNDWATER	RESULTS FROM CHEMICAL ANALYSIS OF SOILS IN THE VADOSE ZONE (0' - 2')	RESULTS FROM CHEMICAL ANALYSIS OF SOILS IN THE SATURATED ZONE (2'- 8')	RESULTS FROM CHEMICAL ANALYSIS OF SURFICIAL GROUNDWATER	RESULTS FROM CHEMICAL ANALYSIS OF ALLUVIAL SANDS
CHEMICALS	RANGE OF CONCENTRATIONS DETECTED (µg/kg)	RANGE OF CONCENTRATIONS DETECTED (µg/kg)	RANGE OF CONCENTRATIONS DETECTED (µg/l)	RANGE OF CONCENTRATIONS DETECTED (µg/kg)
CYCLOHEXANE, DICHLORO [ab]	ND	200 - 850	7 - 24	ND
CYOLOHEXANOL, CHLORO [ab]	ND	340 - 2,500	13 - 140	ND
CYCLOPENTANECARBOXALDEHYDE [ab]	ND	ND	4 - 26	ND
CYCLOPENTANOL, 2-METHLY [a]	ND	ND	230	ND
DELTA-BHC [b]	ND	.23 - 15	0.04	ND
DI-N-BUTYL PHTHALATE	13	30	3 - 4	ND
DIBENZOFURAN	2,200	130 - 1,100	ND	ND
DICAMBA	100	ND	ND	ND
DICHLORPROP	220	ND	ND	ND
DIELDRIN	0.61 - 6.3	1.1 - 14	.012 - 1.1	1.9
DIETHYLPHTHALATE	ND	390	ND	ND
ENDOSULFAN SULFATE	ND	3.8 - 19	.02	ND
ENDOSULFAN 1	0.93	2	ND	ND
ENDRIN	1.1 - 11	1.7 - 18	.018 - 1.5	5
ENDRIN ALDEHYDE	ND	3.8	ND	ND
ENDRIN KETONE	2.5 - 17	3.8 - 15	ND	ND
EPTC [b]	5.9 - 490	1.7 - 800	.24 - 1.9	ND
ETHANONE, 1-(3-ETHYLOXIRANYL) [a]	ND	480	ND	ND
ETHYLBENZENE	4 - 87	ND	ND	ND
FLUORANTHENE	660 - 11,000	120 - 14,000	ND	ND
FLUORENE	3,800 - 10,000	170 - 2,300	ND	ND

TABLE 3 - REDWING SITE: SUMMARY OF CHEMICALS DETECTED DURING REMEDIAL INVESTIGATION				
a - INDICATES TENTATIVELY IDENTIFIED COMPOUNDS b - INDICATES ORGANIC COMPOUND WHICH WAS ALSO DETECTED IN THE ALLUVIAL GROUNDWATER	RESULTS FROM CHEMICAL ANALYSIS OF SOILS IN THE VADOSE ZONE (0' - 2')	RESULTS FROM CHEMICAL ANALYSIS OF SOILS IN THE SATURATED ZONE (2' - 8')	RESULTS FROM CHEMICAL ANALYSIS OF SURFICIAL GROUNDWATER	RESULTS FROM CHEMICAL ANALYSIS OF ALLUVIAL SANDS
CHEMICALS	RANGE OF CONCENTRATIONS DETECTED (μg/kg)	RANGE OF CONCENTRATIONS DETECTED (μg/kg)	RANGE OF CONCENTRATIONS DETECTED (μg/l)	RANGE OF CONCENTRATIONS DETECTED (μg/kg)
GAMMA-BHC (LINDANE)	2.5	.12 - 16	.01 - 0.7	7.7 - 7.8
GAMMA-CHLORDANE	2.1 - 9.9	2 - 9.6	ND	ND
HEPTACHLOR	1.4	1 - 15	0.018 - 0.51	3.4
HEPTACHLOR EPOXIDE	.58 - 5.3	.53 - 2	ND	ND
HEXADECANOIC ACID a	500	ND	ND	ND
HYDROCARBON COMPOUND a	ND	970	ND	ND
INDENO(1,2,3,-CD)PYRENE	710	ND	ND	ND
IRON	(760 - 11,900)E3	(2,080 - 15,400)E3	(8.63 - 937) E3	(385 - 3,600)E3
LEAD	(1.13 - 33.4)E3	(3.9 - 42.8)E3	3.4 - 162	760 - 3,000
MAGNESIUM	(100 - 2,150)E3	(56.3 - 568)E3	(4.73 - 45.6)E3	(40.3 - 348)E3
MANGANESE	(100 - 2,150)E3	(2.5 - 259)E3	(757 - 1,890)E3	(3.1 -9.4)E3
MERCURY	120 - 1,400	130 - 1,200	ND	ND
METHOXYCHLOR	44	.25 - 34	ND	ND
METHYLENE CHLORIDE	4 - 89	3 - 180	330 -650	ND
MOLINATE	21	18	0.14	ND
NAPHTHALENE	3,900	48 - 2,100	16	ND
NAPHTHALENE 1-METHYL a b	9,900	ND	ND	ND
NAPHTHALENE,2,3-DIMETHYL a	5,600	ND	36.2 - 301	ND
NICKEL	4,900 - 30,100	4,700 - 22,500	28.7 - 301	27,100
PEBULATE	1.6 - 9,800	7.7 - 1,300	0.61	ND
PHENANTHRENE	850 - 15,000	160 - 6,500	ND	ND

TABLE 3 - REDWING SITE: SUMMARY OF CHEMICALS DETECTED DURING REMEDIAL INVESTIGATION				
[a] - INDICATES TENTATIVELY IDENTIFIED COMPOUNDS [b] - INDICATES ORGANIC COMPOUND WHICH WAS ALSO DETECTED IN THE ALLUVIAL GROUNDWATER	RESULTS FROM CHEMICAL ANALYSIS OF SOILS IN THE VADOSE ZONE (0' - 2')	RESULTS FROM CHEMICAL ANALYSIS OF SOILS IN THE SATURATED ZONE (2'- 8')	RESULTS FROM CHEMICAL ANALYSIS OF SURFICIAL GROUNDWATER	RESULTS FROM CHEMICAL ANALYSIS OF ALLUVIAL SANDS
CHEMICALS	RANGE OF CONCENTRATIONS DETECTED (μg/kg)	RANGE OF CONCENTRATIONS DETECTED (μg/kg)	RANGE OF CONCENTRATIONS DETECTED (μg/l)	RANGE OF CONCENTRATIONS DETECTED (μg/kg)
PHENOL	ND	ND	520	ND
PHENOL-DIMETHYL [a]	ND	ND	61	ND
POTASSIUM	(206 - 334)E[3]	199,000	[illegible] - 25,500	254,000
PYRENE	160 - 8,400	1000 - 11,000	ND	ND
SELENIUM	710 - 1,600	890	3.7	ND
SODIUM	(37.1 - 3,600)E[3]	(55.2 - 5,430)E[3]	(37.8 - 2,370)E[3]	(44.6 - 89.6)E[3]
SULFUR,MOL(S8) [a b]	190 - 44,000	380 - 100,000	6 - 96	230 - 4000
TETRACHLOROETHANE	1,600	ND	ND	ND
TOLUENE	3 - 46	30	4	24
VANADIUM	8,400 - 49,900	5,700 - 31,900	16.5 - 580	4,700 - 8,400
VERNOLATE	2 - 26,000	49 - 8,400	1.1 - 140	ND
XYLENE	5 - 990	5	ND	ND
ZINC	1,340 - 97,700	4,300 - 207,000	187 - 739	2,700 - 51,100

TABLE 4 - REDWING SITE: SUMMARY OF ANALYSIS OF THE ALLUVIAL AQUIFER

CHEMICALS	RESULTS FROM CHEMICAL ANALYSIS OF ALLUVIAL GROUNDWATER		RESULTS FROM CHEMICAL ANALYSIS OF BACKGROUND ALLUVIAL GROUNDWATER	
	RANGE OF CONCENTRATIONS DETECTED (µg/l)	No. OF DETECTS	RANGE OF CONCENTRATIONS DETECTED (µg/l)	No. OF DETECTS
1,3-DIOXOLANE,2-ETHYL-4-MET *	100	1	ND	ND
2-PROPANOL *	6	1	ND	ND
4,4'-DDT	.01 - .08	2	ND	ND
ACETONE	12 - 180	8	180	1
ALUMINUM	6,350 - 42,000	11	3,780	1
ARSENIC	4 - 29.8	7	ND	ND
BARIUM	98.9 - 213	11	93.8	1
BERYLLIUM	1.3 - 5.2	3	ND	ND
BIS(2-ETHYLHEXYL)PHTHALATE	2 - 620	7	ND	ND
BUTYLATE	0.31 - 1	2	ND	ND
CALCIUM	13,000 - 44,800	11	11,500	1
CAPROLACATAM *	14 - 26	2	ND	ND
CHLORINATED HYDROCARBON COMP *	4 - 6.1	3	ND	ND
CHROMIUM (III/VI)	28.7 - 86.3	11	21.3	1
COBALT	6.5 - 33.3	6	5.2	1
COPPER	18.9 - 34.9	8	14.3	1
CYCLOATE	0.15	1	ND	ND
CYCLOHEXANE,DICHLORO *	16 - 51	4	ND	ND
CYCLOHEXANOLCHLORO *	180 - 260	4	ND	ND
CYCLOPENTANECARBOXALDEHYDE *	10 - 37	3	ND	ND
DELTA-BHC	.02	1	ND	ND
DI-N-OCTYL PHTHALATE	29	1	ND	ND
EPTC	0.12	1	ND	ND
IRON	8,850 - 166,000	11	7,380	1
LEAD	16.5 - 79.9	10	9	1
MAGNESIUM	2,830 - 9,640	11	2,400	1
MANGANESE	270 - 479	11	253	1
NAPHTHALENE 1-METHYL *	6	1	ND	ND
NICKEL	21.4 - 44.3	5	ND	ND
POTASSIUM	3,480 - 9,090	8	2,140	1
SODIUM	10,300 - 77,400	11	7,590	1
SULFUR,MOL(S8) *	30	1	ND	ND
VANADIUM	15.8 - 111	8	14.5	1
VERNOLATE	0.44 - 1.8	4	ND	ND
ZINC	67.4 - 324		55.3	

* - INDICATES TENTATIVELY IDENTIFIED COMPOUND

soils beneath the concrete liners. Contaminants found in the 8 ditch samples were similar to those detected in soils. Table 5 illustrates the contaminants found in the ditch sediments.

A ditch sample collected below the concrete liner in the eastern ditch contained the highest number of compounds at the highest concentrations. Lower concentrations were found in downstream ditch areas.

Site ditches provide only temporary habitats for aquatic plants and animals. Two water species, the arrowhead plant and mosquitofish, were observed after heavy rain. The mosquitofish would likely move downstream as ditch water dried up. Since contaminants in ditch sediments can move downstream and could have moved in the past, EPA used data from on-site ditch sediments to predict effects on plant and animal life in downstream surface water bodies. The analysis of these data indicates that the highest concentrations are presently separated from the ditch by the concrete liner and that measurable levels are not presently moving off-site.

5.4.4 AIR PATHWAY INVESTIGATION

A sample of sludge was collected and the vapor from the headspace analyzed at temperatures 25°C and 45°C (77 and 113 degrees fahrenheit, respectively). Two volatiles were detected at the high temperature and one semivolatile at the low temperature. Additionally, air modeling was conducted using assumptions which were more conservative than the above headspace analysis. This was done to predict risk that might be posed if people were breathing those contaminants in the air. Modeling and air monitoring results indicated that exposure, above Federal/State standards, to chemicals in the air was not likely to occur.

5.5 FATE AND TRANSPORT

An evaluation of the potential for transport and likely fate of compounds detected during the remedial investigation consisted of analysis of the relationships among the various media at the Redwing Site. This evaluation also entailed a review of the physical and chemical data for each constituent in all potentially affected media. To estimate concentrations for media and locations where no samples were collected or over time frames for which data is not available, estimates were made of concentrations using environmental fate and transport models.

Exposure pathways for modeling were (1) a source and mechanism of chemical release; (2) an environmental transport medium; (3) a point of potential exposure and (4) an exposure route. The media evaluated for both present and potential future exposure were (a) groundwater (alluvial and surficial); (b) soils and seeps of sludge; (c) air and (d) surface water and sediments.

Contaminants have been found primarily in the eastern portion of the Redwing Site and in the location of the former levee. The contaminants are affiliated with the sludge and the soil that is

TABLE 5 - REDWING SITE: ORGANIC AND INORGANIC CONSTITUENTS DETECTED IN DITCH SEDIMENTS			
[a] - INDICATES TENTATIVELY IDENTIFIED COMPOUNDS (TICs) [b] - INDICATES ORGANIC COMPOUND WHICH WAS ALSO DETECTED IN THE ALLUVIAL GROUNDWATER	RESULTS OF ANALYSIS FROM BACKGROUND SOILS	RESULTS OF ANALYSIS FROM DITCH SEDIMENTS	
CHEMICALS	RANGE OF CONCENTRATIONS DETECTED (μg/kg)	RANGE OF CONCENTRATIONS DETECTED (μg/kg)	No. of Detects
ORGANICS			
1,1,1-TRICHLOROETHANE	ND	8	1
2-BUTANONE (MEK)	8	17 - 65	2
2-CYCLOHEXEN-1-OL [a]	ND	140	1
2-METHYLNAPHTHALENE	ND	2,200	1
2-PENTANONE,4-HYDROXY 4-METHYL [a]	ND	9,000 - 78,000	6
4,4'-DDD	ND	0.34	1
4,4'-DDE	.47 - .61	0.23	1
4,4'-DDT [b]	ND	0.32	1
ACENAPHTHENE	ND	2,400 - 2,700	2
ACETONE [b]	5 - 67	33 - 160	4
ALDRIN	ND	0.67 - 200	3
ALPHA-BHC	ND	0.16	1
ALPHA-CHLORDANE	.38 - 1.8	0.67 - 12	3
ANTHRACENE	ND	1,300	1
BENZO(A)ANTHRACENE	180	1,300	1
BENZO(B)FLUORANTHENE	300	1,300	1
BETA - BHC	ND	4.8	1
BIS(2-ETHYLHEXYL)PHTHALATE [b]	79 - 180	140 - 160	2
BUTYLATE [b]	ND	120	1
CHRYSENE	93	1,300	1
CYCLOHEXANE,DICHLORO [a][b]	ND	180	1
CYCLOHEXANOLCHLORO [ab]	ND	1,800	1
DELTA-BHC [b]	ND	18	1
DIBENZOFURAN	ND	1,500 - 1,800	2
DIELDRIN	0.57	0.16	1
ENDOSULFAN I	ND	0.93	1
ENDRIN	ND	0.52	1
ENDRIN KETONE	ND	3.9	1
ENDRIN ALDEHYDE	ND	3.9	1
ETHYLBENZENE	ND	18	1
ETHYNE, FLUORO-[a]	ND	7	1

TABLE 5 - REDWING SITE: ORGANIC AND INORGANIC CONSTITUENTS DETECTED IN DITCH SEDIMENTS

ª - INDICATES TENTATIVELY IDENTIFIED COMPOUNDS (TICs) ᵇ - INDICATES ORGANIC COMPOUND WHICH WAS ALSO DETECTED IN THE ALLUVIAL GROUNDWATER	RESULTS OF ANALYSIS FROM BACKGROUND SOILS	RESULTS OF ANALYSIS FROM DITCH SEDIMENTS	
CHEMICALS	RANGE OF CONCENTRATIONS DETECTED (µg/kg)	RANGE OF CONCENTRATIONS DETECTED (µg/kg)	No. of Detects
FLUORANTHENE	310	4,900 - 7,700	2
FLUORENE	ND	2,500 - 2,800	2
GAMMA-BHC (LINDANE)	ND	0.087 - 54	2
GAMMA-CHLORDANE	.42 - 1.3	0.78 - 18	2
HEPTACHLOR	ND	0.69	1
HEPTACHLOR EPOXIDE	ND	1.5	1
METHOXYCHLOR	ND	2.5	1
METHYLENE CHLORIDE	2 - 10	7 - 31	2
NAPHTHALENE	ND	5,200	1
NAPTHALENE, -TRIMETHYL-	ND	9,300	1
NAPHTHALENE, 2,3-DIMETHYL ª	ND	13,000	1
PEBULATE	ND	16 - 71	2
PHENANTHRENE	97	8,700 - 11,000	2
PYRENE	240	3,300 - 4,800	2
SULFUR, MOL(S8) ª ᵇ	ND	180 - 52,000	3
VERNOLATE	ND	290 - 2,600	2
XYLENE	ND	17 - 25	2
INORGANICS			
ALUMINUM	254 - 4,140	1,350 - 10,700	8
ARSENIC	ND	1.2 - 2.8	2
BARIUM	7.6 - 42.1	11.5 - 32.2	6
CALCIUM	38.3 - 1,360	338 - 6,460	8
CHROMIUM (III/VI)	1.4 - 8.2	4.9 - 24.3	5
COBALT	8.9	1.8 - 2.5	2
COPPER	1.1 - 4.2	2.3 - 4.3	5
IRON	322 - 9,520	2,950 - 28,900	4
LEAD	3.8 - 9.8	8.2 - 17.3	5
MAGNESIUM	28.5 - 820	74.1 - 149	5
MANGANESE	1.9 - 107	7.3 - 20	5
MERCURY	ND	0.33 - 3.1	2
NICKEL	7	6.1	1
POTASSIUM	25.8 - 396	250	1

TABLE 5 - REDWING SITE: ORGANIC AND INORGANIC CONSTITUENTS DETECTED IN DITCH SEDIMENTS			
* - INDICATES TENTATIVELY IDENTIFIED COMPOUNDS (TICs) b - INDICATES ORGANIC COMPOUND WHICH WAS ALSO DETECTED IN THE ALLUVIAL GROUNDWATER	RESULTS OF ANALYSIS FROM BACKGROUND SOILS	RESULTS OF ANALYSIS FROM DITCH SEDIMENTS	
CHEMICALS	RANGE OF CONCENTRATIONS DETECTED (µg/kg)	RANGE OF CONCENTRATIONS DETECTED (µg/kg)	No. of Detects
SODIUM	40.9 - 46.3	41 - 3,500	5
VANADIUM	6 - 17	9.4 - 29.2	4
ZINC	1.9 - 31.9	17.7 - 30.6	2

commingled with the sludge. This combination shall be referred to as the "source material". Various classes of compounds were distributed across areas of the former terminal operations. Volatile organic compounds (VOCs) and aromatic compounds are generally less persistent in surficial soil and surface water. The VOCs are most persistent in groundwater. The semivolatile compounds detected at the Redwing Site are found to be insoluble in the groundwater with the exception of the phenols. Some of the Polycyclic Aromatic Hydrocarbons (PAHs) are very persistent and tend to bioaccumulate in the environment although no significant concentrations were found in the groundwater at the Redwing Site.

Pesticides and herbicides detected at the Redwing Site are chlorinated hydrocarbons such as aldrin and carbamate compounds such as butylate. These compounds are not easily water soluble; however, they are persistent and tend to remain in groundwater and soil once transport has taken place.

Inorganic chemicals are widespread naturally in the environment and occur in varying concentrations. Inorganic chemicals in aqueous form tend to be transported easily into groundwater and surface water. Several inorganic chemicals were detected in the groundwater at the Redwing Site.

The groundwater at the Redwing Site has been impacted by contaminants coming from the source material. The highest concentrations of contaminants in the groundwater occur in the eastern half of the apartment complex but the surficial groundwater has been impacted under almost the entire site.

The storm water from the Redwing Site contacts surface soils and sludge seeps. The contaminated sediments in the unlined northern ditch are also a current vehicle for transport of chemicals of concern.

5.6 SOURCE AREAS OF CONTAMINATION

The results of the remedial investigation identified eight areas of the Redwing Site as the source of the groundwater contamination. Those areas are shown on Figures 7 and 8. The bulk of the sludge was detected in the eastern area of the Redwing Site. This coincides with the area of highest concentrations of groundwater contamination. The source material (i.e. sludge commingled with soil) was also concentrated in the central area of the Redwing Site, the northwest area near building 1200 and in two areas near the southwest corner of the Redwing Site.

Table 6 shows the estimated volumes of source material which were evaluated from the data collected during the RI.

TABLE 6 - AREAS AND VOLUME ESTIMATES FOR SOURCE MATERIAL (INCLUDES SLUDGE) *

SOURCE AREA	SQUARE FEET	SLUDGE THICKNESS (FT)	SLUDGE VOLUME (CU. YDS)	SOURCE MATERIAL THICKNESS (FT)	SOURCE MATERIAL VOLUME (CU. YDS)
E-1	5,800	2.0	433	5	1,080
E-2	1,500	0.5	29	5	285
E-3	4,760	2.4	423	6	1,060
C-1	9,180	1.2	408	6	2,040
C-2	730	2.5	68	6	162
N-1	3,240	1.5	180	3.5	420
SW-1	640	2.0	47	5	119
SW-2	680	1.0	25	5	126
TOTALS	26,610	n/a	1,613	n/a	5,292

* Source material includes black sludge and influenced soils.

6.0 SUMMARY OF SITE RISKS

CERCLA directs that the EPA protect human health and the environment from current and future exposure to hazardous

FIGURE - 7

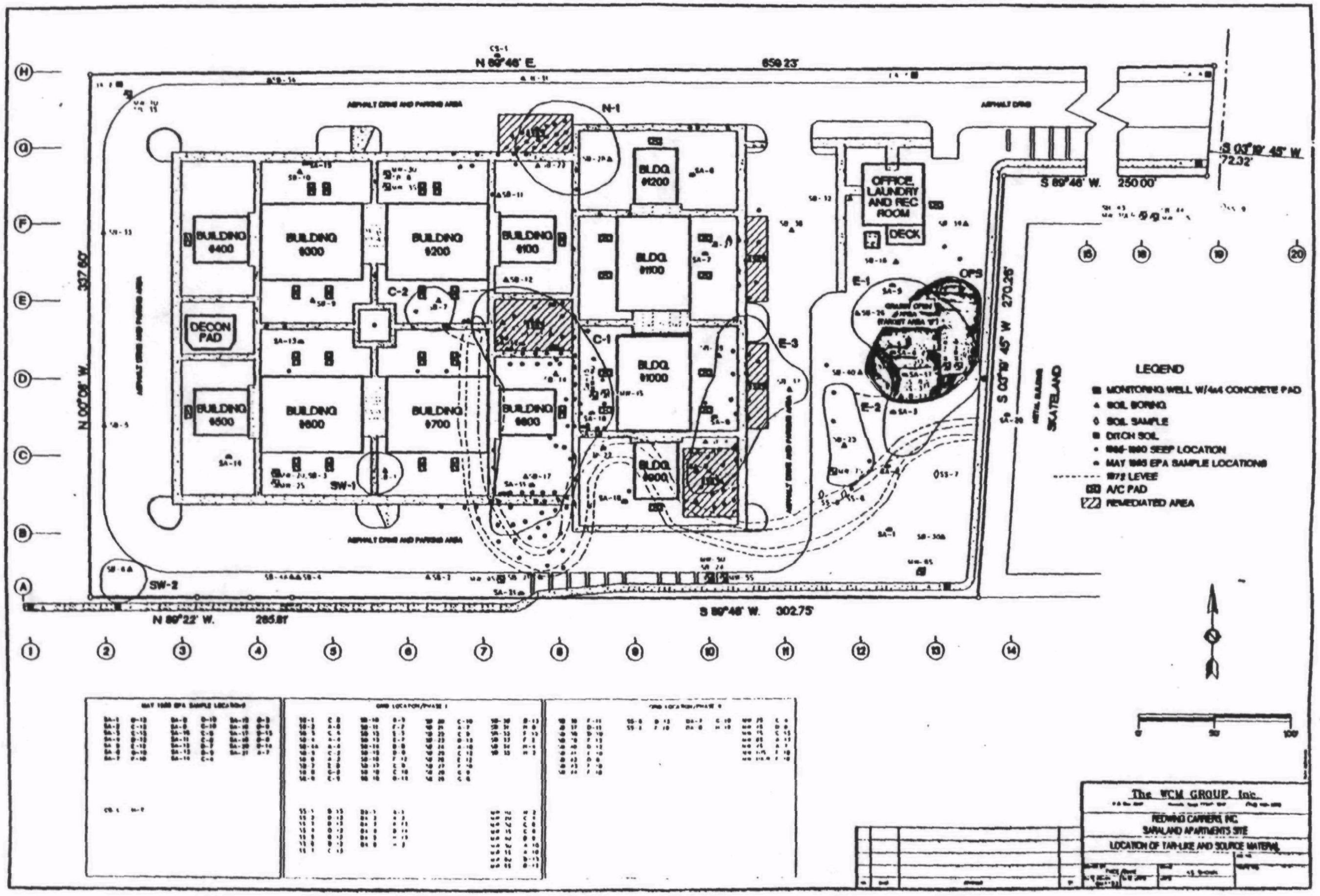


FIGURE - 7

FIGURE - 8

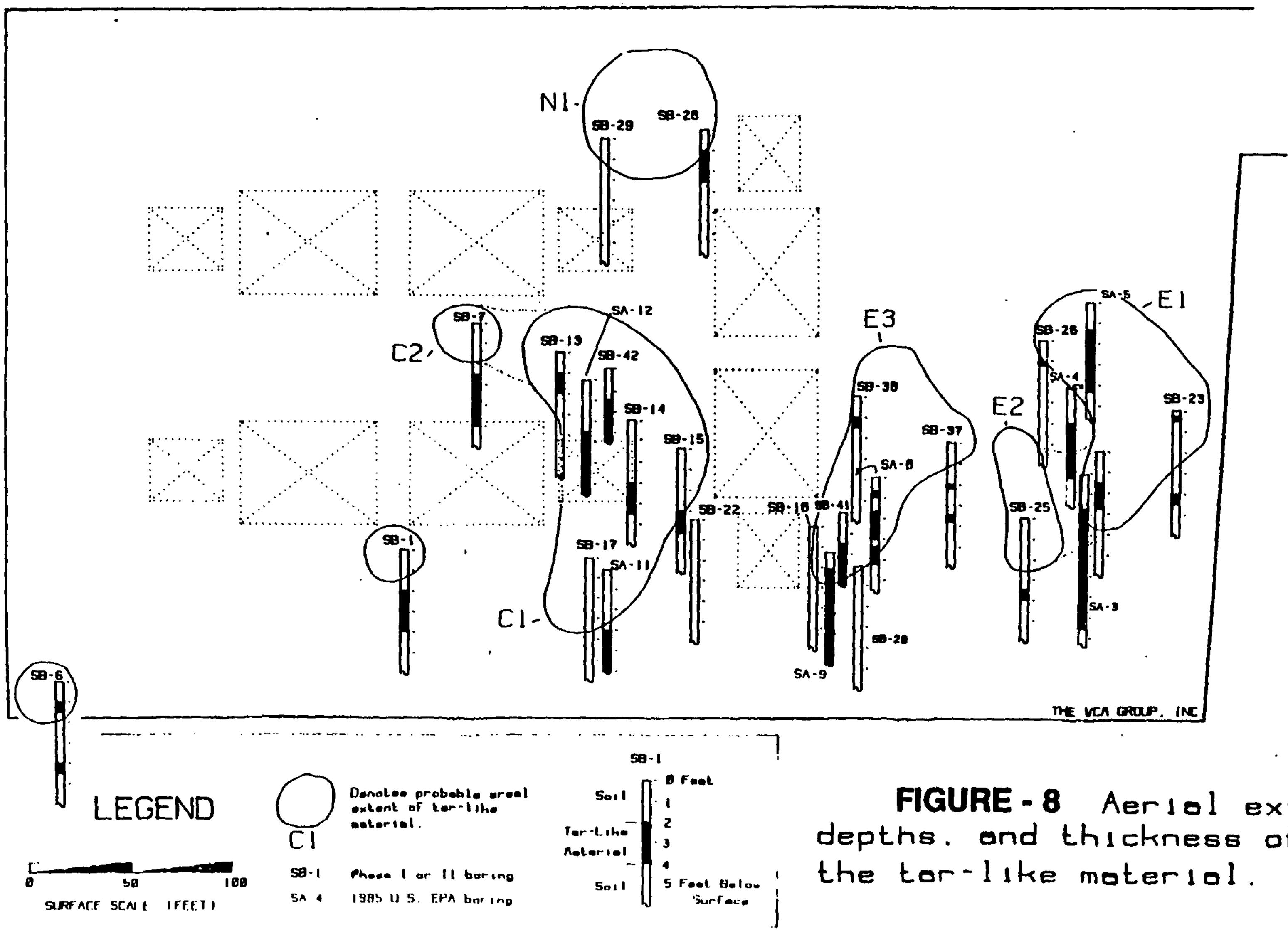


FIGURE - 8 Aerial extent, depths, and thickness of the tar-like material.

BLANK PAGE

substances at Superfund sites. In order to assess the current and future risks for th· ·edwing Site, a baseline risk assessment (BRA) was conducted as : .: of the Remedial Investigation. The BRA consists of a human ealth and environmental assessment of current and potential exposures at the Redwing Site.

As defined by the 1990 National Oil and Hazardous Substances Pollution Contingency Plan (NCP), the BRA:

> "characterize[s] the current and potential threats to human health and the environment that may be posed by contaminants migrating to ground water or surface water, releasing to air, leaching through soil, remaining in the soil, and bioaccumulating in the food chain."

40 C.F.R 300.430(d)(1). The BRA is organized into two major components, the Hum Health Risk Assessment and the Environmental Evalu on. The risk assessment processes are evaluated within ea component.

6.1 CONTAMINANTS OF CONCERN

Tables 7A and 7B provide a comprehensive list of the contaminants identified as chemicals of potential concern (COCs) at the site in their various media. Chemicals provided in Tables 8A and 8B are the contaminants which the baseline risk assessment (BRA) indicated might pose a current or future significant risk. The criteria for a significant risk was a carcinogenic risk level within or above the acceptable risk range (i.e., 10E-4 to 10E-6), or a hazard quotient greater than unity (1). Tables 8A and B also provide the reasonable maximum exposure (RME) concentrations which were used in the BRA.

The exposure point concentrations are based on the 95% upper confidence limit (UCL) of the arithmetic average. The soil UCLs are based on samples taken from the top 1 foot (12 inches) of soils or sediments.

6.2 EXPOSURE ASSESSMENT

The exposure assessment is the identification of populations that may be exposed to the constituent and the determination of the potential magnitude and duration of their exposures. A quantitative exposure assessment is the estimation of the magnitude, duration and frequency of exposure to various environmental media including both current and potential future exposures.

TABLE - 7A

CHEMICALS OF POTENTIAL CONCERN FOR SOILS, DITCH SEDIMENTS, AND TAR-LIKE MATERIAL

1,1,1-TRICHLOROETHANE	CYANIDE
1,2,4-TRICHLOROBENZENE	DI-N-BUTYLPHTHALATE
1,4-DICHLOROBENZENE	DI-N-OCTYL PHTHALATE
2,4-D	DIBENZ(A,H)ANTHRACENE
2,4,5-T	DICAMBA
2-BUTANONE (MEK)	DIELDRIN
4,4'-DDD	DIETHYLPHTHALATE
4,4'-DDE	ENDOSULFAN I
4,4'-DDT	ENDRIN
4-METHYL-2-PENTANONE	EPTC
4-METHYLPHENOL	ETHYLBENZENE
ACENAPHTHENE	FLUORANTHENE
ACETONE	FLUORENE
ALDRIN	GAMMA-BHC (LINDANE)
ALPHA-BHC	GAMMA-CHLORDANE
ALPHA-CHLORDANE	HEPTACHLOR
ANTHRACENE	HEPTACHLOR EPOXIDE
BENZALDEHYDE	INDENO(1,2,3-CD)PYRENE
BENZENE	LEAD
BENZO(A)ANTHRACENE	MANGANESE
BENZO(A)PYRENE	MERCURY
BENZO(B)FLUORANTHENE	METHOXYCHLOR
BENZO(G,H,I)PERYLENE	METHYLENE CHLORIDE
BENZO(K)FLUORANTHENE	MOLINATE
BETA-BHC	NAPHTHALENE
BIS(2-ETHYLHEXYL)PHTHALATE	PEBULATE
BUTYLATE	PHENOL
CADMIUM	PYRENE
CARBON DISULFIDE	SELENIUM
CARBON TETRACHLORIDE	TETRACHLOROETHENE
CHLOROBENZENE	TOLUENE
CHLOROFORM	VERNOLATE
CHLORPYRIFOS	XYLENE
CHROMIUM (III/VI)	ZINC
CHRYSENE	

TABLE - 7B

CHEMICALS OF POTENTIAL CONCERN IN GROUNDWATER

Chemical	Detected in Alluvial Aquifer	Detected in Surficial Water Table Unit
2,4-D		*
2,4-Dimethylphenol		*
2,4,5-T		*
2-Butanone		*
4,4'-DDT	*	*
4-Methyl-2-Pentanone		*
4-Methylphenol		*
Acetone	*	*
Aldrin		*
Alpha-BHC		*
Arsenic	*	*
Barium	*	*
Benzoic Acid		*
Beryllium	*	*
Bis(2-ethylhexyl)phthalate	*	*
Butylate	*	*
Caprolactum	*	
Carbon Disulfide		*
Chloroform		*
Chromium (III/VI)	*	*
Copper	*	*
Cyanide	*	*
Di-n-butylphthalate		*
Di-n-octylphthalate	*	
Dieldrin		*
Endrin		*
EPTC	*	*
Gamma-BHC		*
Heptachlor		*
Iron	*	*
Lead	*	*
Manganese	*	*

TABLE - 7B

CHEMICALS OF POTENTIAL CONCERN IN GROUNDWATER

Chemical	Detected in Alluvial Aquifer	Detected in Surficial Water Table Unit
Methylene Chloride		*
Molinate		*
Naphthalene		*
Nickel	*	*
Pebulate		*
Phenol		*
Selenium		*
Toluene		*
Vanadium	*	*
Vernolate	*	*
Zinc	*	*
* Detected in corresponding medium		

TABLE 8A - SURFACE SOIL AND SEDIMENTS RME CONCENTRATIONS

CONTAMINANTS OF CONCERN	CONCENTRATION RANGE (μg/kg)	RME CONCENTRATIONS (μg/kg)
BENZO (A) PYRENE	73 - 3,200	671
BENZO (B) FLUORANTHENE	230 - 7,400	3,170
BENZO (A) ANTHRACENE	67 - 7,200	2,880
CARBON TETRACHLORIDE	110,000	25,600
CHRYSENE	93 - 3,800	2,660

TABLE 8B - GROUNDWATER RME CONCENTRATIONS

CONTAMINANTS OF CONCERN	CONCENTRATION RANGE (ug/l)	RME CONCENTRATIONS (μg/kg)
4,4'-DDT	0.96	0.223
ACETONE	10,000 - 2,100,000	1,520
ALDRIN	0.11 - 0.47	0.121
ALPHA-BHC	0.044 - 0.15	0.0595
ARSENIC	4,000 - 29,800	15
BERYLLIUM	1.3 - 9.5	5.18
BIS(2-ETHYLHEXYL)PHTHALATE	2 - 620	206
CARBON DISULFIDE	9 - 5,500	1,220
CHLOROFORM	2,900 - 27,000	7,740
CHROMIUM	6.2 - 355	156
LEAD	2.4 - 162	69.1
METHYLENE CHLORIDE	330 - 650	204
NICKEL	28.7 - 301	151
VANADIUM	6.6 - 580	272
VERNOLATE	1.1 - 140	35.5

The exposure assessment was conducted in three steps: (1) identification of exposure pathways, (2) estimation of environmental concentrations and (3) selection of exposure assumptions and estimation of human intake. Included was an evaluation of possible exposure doses to people currently living at the Redwing Site and potential future exposure doses due to groundwater.

Exposure pathways at the Redwing Site were defined in terms of the following elements: (1) a source and mechanism of chemical release into the environment, (2) an environmental transport medium, (3) a point of potential human exposure and (4) an exposure route (e.g., ingestion of drinking water).

The media considered for both present and potential future exposure are: (1) groundwater (alluvial and surficial), (2) soils and seeps of sludge (tar-like material), (3) air, and (4) on-site ditch sediments.

Chemical concentrations used in the exposure assessment were based on sampling data collected during the remedial investigation. The exposure dose was calculated using the 95% upper confidence limit (UCL) of the arithmetic mean of the concentration unless this was greater than the maximum concentration detected, in which case the maximum observed value was used. Whenever possible, actual sampling data were used. When sampling data was not available, environmental fate and transport modeling was used to estimate concentrations based on the sampling data. Calculated chemical concentrations for the exposure assessment used all detected concentrations of a chemical plus half the quantification limit for each sample in which that chemical was not detected. Only chemicals that were detected in at least one sample from the Redwing Site were included in these calculations. These data are summarized in Tables XI-1 through XI-8 of Appendix XI of the RI Report for all COCs. Table 8A & 8B of this section provide a summary of the more significant contaminants and their respective RME concentrations.

Based on sampling results and Site layout, four areas of possible current exposure were identified as (1) the eastern portion of the Redwing Site (Target Area E), (2) the western portion of the Redwing Site not covered by apartment buildings or pavement (Grassy Area), (3) the Northern Ditch and (4) the apartments' living quarters. The Redwing Site was divided into these four areas for fate and transport modeling and calculations of human intake. The receptors considered for the exposure assessment included an adult, a 9-year-old child (the average of a child ages 6 through 12 years) and a 4-year-old child (the average of a child ages 6 months through 6 years).

When site-specific data were not available, the exposure assumptions used in the risk assessment were based on standard methodology. Tables 9 through 13, which were originally presented in the RI Report as Table 6-8 and Tables 6-10 through 6-13, identify assumptions used in the risk assessment are provided in the following pages. In the tables and as presented in the RI Report, the contaminated sludge is referred to as "tar-like material."

6.2.1 EXPOSURE PATHWAYS

Groundwater: The surficial groundwater is a potential drinking water source. For the City of Saraland, the alluvial aquifer is a current and potential future drinking water source. Presently, three municipal wells located within 1.5 miles of the Redwing Site receive water from the alluvial aquifer. Although no wells are located on the Redwing Site, there are several private wells located within a one-mile radius of the Redwing Site. These wells were installed at various depths and contact the surficial as well as the alluvial aquifer. Remedial Investigation sampling data revealed contamination in on-site groundwaters, however, no Site related contaminants were detected in off-site wells. The potential future exposure associated with a well installed on the Redwing Site was evaluated. The evaluation addressed potential future exposure to groundwater from both the surficial and alluvial aquifer as a result of ingestion and showering.

Soils: Exposure to soils and seeps at the Redwing Site may occur through incidental ingestion, dermal contact or inhalation of vapors and particulates. Actual exposure at the Redwing Site has not been measured, therefore, conservative default estimates were used. Possible exposure to soils and seeps was estimated by proportionally dividing exposure (time of contact and ingestion mass) among the three outdoor areas (Target Area E, Grassy Area and Northern Ditch) and seeps for relative contribution of risk.
Seeps (Sludge): The ongoing removal of seeps by Redwing has not been incorporated into the BRA. The maximum seep area was estimated using historical data in conjunction with ground-level and aerial photographs from the period prior to the current seep inspection and removal program. Additional seep analyses were conducted which estimates exposure of sludge (tar-like material) seeps found at the Redwing Site. Methodology assumptions used to estimate the total seep area and the resulting risk estimates are presented in Appendix XVII of the BRA.

This analysis resulted in a total seep area of 540 ft^2 or 0.34% of the potential exposure area (sum of Target Area E and Grassy Area less the area of apartments and Northern ditch). The population potentially exposed to the seeps are residents of Saraland Apartments consisting of approximately 96 adults and 64 children. The estimate of seep constituent concentrations include all samples of sludge regardless of depth.

TABLE - 9

EXPOSURE ASSUMPTIONS FOR U/BK MODEL

Exposure Assumption	U/BK Default[1]	Saraland Modification
Air Data		
Concentration (μg Pb/m^3)	0.20[2]	NM
Lung Absorption	32.0%	NM
Breathing Rate (m^3/d)	4.5	8
Diet Data		
Intake (μg Pb/day)	6.38	NM
Water Data		
Amount Ingested (liters/day)	0.48	1.3
Soil/Dust Data		
Percent of soil and dust that is soil	45%	NM
Amount ingested (mg/day)	100	200
Soil contribution to house dust	28%	NM

1 Average for children ages 0 to 6 years old.
2 Mean concentration in urban air (USEPA 1990b).
NM - Not modified.

TABLE 10

SUMMARY OF USEPA ASSUMPTIONS

Exposure Assumptions	RAGS (USEPA 1989b)/1991a)	Exposure Factors Handbook (USEPA 1989a)	New Interim Region IV Guidance (USEPA 1992)
Ingestion of water			
o Amount ingested per day			
-adult	2 liters		
-9-year-old		1.5 liters	
-4-year-old		1.3 liters	
o Years exposed (adult)	30 years		
Showering			
o Breathing rate		0.6 m³/hr	
o Years exposed (adult)	30 years		
Soil and tar-like material ingestion			
o Amount ingested			
- Adult	100 mg/day		
- 9-year-old	100 mg/day		
- 4-year-old	200 mg/day		
o Days/year exposed			
- adult and children	350 d/year		
Dermal contact with soil (all areas)			
o Adherence factor			
- soil			0.2 mg/cm²
- tar-like material			1.0 mg/cm²
o Days/year exposed			
- adult and children	350 d/year		
Dermal Absorption			
o Organics			1.0%
o Inorganics			0.1%
Vapor inhalation indoors			
o Days/year exposed indoors			
- adult and children	350 d/year		

TABLE 11

SUMMARY OF NON-USEPA ASSUMPTIONS

Exposure Assumption	RAGS (USEPA 1989b)	Hypothetical Values Used in Saraland Risk Assessment	Rationale for Non-USEPA Assumptions
Showering			Adjust for additional indoor air exposure (e.g., dishwasher) due to volatilization from water
o Time exposed adult	7(12) min per day average (worst) case	36 min/day	
o Years exposed (children)	NA	6/5.5 years	Number of years for each age group
Incidental ingestion of soil and dermal contact (all areas)			
o Years exposed-adult	30 years- 90th percentile at one residence	9.6 years	95% UCL for residence at Saraland Apartments. Children exposed over total age period.
Dermal contact with soil (all areas)			
o Surface area			Assumed face and 2/3 upper limbs for adult, and face, 2/3 upper limbs and 1/2 lower limbs for children (ICRP 1984)
- adult		2756 cm^2	
- 9-year old		3655 cm^2	
- 4-year old		2522 cm^2	
Inhalation of particulates			
o Contact time	Dependent on duration of exposure	8 hr/day	Assumed to be the reasonable maximum exposure time outdoors
Inhalation of vapors			
o Outdoor-contact time	Dependent on duration of exposure	8 hr/day	Assumed to be the reasonable maximum exposure time outdoors
o Indoor-contact time	Dependent on duration of exposure	16 hr/day	Assumed to be the reasonable maximum exposure time indoors

TABLE 12

GENERIC EXPOSURE ASSUMPTIONS[1]

Assumptions	Adult	9-Year-[2] Old Child	4-Year-[3] Old Child
Days per Lifetime	25,550	25,550	25,550
Years of Exposure[4]	9.6[4]	6[5]	5.5[5]
Body Weight (kg)	70	31	14.5
Breathing Rate (m^3/hr)	0.833	0.625[6]	0.333[6]
Total Body Surface Area (cm^2)[6]	16,900	10,425	7,195
Surface Area of Lower Limbs (cm^2) (37.5%)	6,337.5	3,909.4	2,698.1
Hands (cm^2) (5.2%)	8[illegible]8	542.1	374.1
Upper Limbs (cm^2) (18.8%)	3,177.2	1,959.5	1,352.7
Head and Neck (cm^2) (7.8%)	1,318.2	813.2	561.2

Notes:

1 USEPA 1989a
2 Average of a child ages 6 to 12 years.
3 Average of a child ages 6 months to 6 years.
4 Upper 95th percentile value for residents currently residing at the Saraland Apartments. For hypothetical groundwater exposure scenarios, 30 years (USEPA upper 95th percentile for U.S. residence at a location) will be used.
5 Based on adult residence time of 9.6 years, child could theoretically reside at Saraland Apartments for entire time period within this age group.
6 ICRP 1984.

TABLE 13

SPECIFIC EXPOSURE SCENARIO ASSUMPTIONS FOR THE RME RECEPTOR

Exposure Scenario Assumptions	Adult	9-Year-Old Child	4-Year-Old Child	Reference
HYPOTHETICAL FUTURE EXPOSURE: Assumes future installation of water supply wells				
INGESTION OF WATER, ALLUVIAL AQUIFER				
Amount ingested (l/day)	2	1.5	1.3	USEPA 1989a 1989b
Number of contacts total (days/yr * yrs exposed)[1]	10500	2100	1925	USEPA 1989b/1991a
INGESTION OF WATER, SURFICIAL WATER TABLE UNIT (ON-SITE AND OFF-SITE)				
Amount of water ingested (l/day)	2	1.5	1.3	USEPA 1989a
Number of contacts total (days/yr * yrs exposed)[1]	10500	2100	1925	USEPA 1989b/1991a
SHOWERING, ALLUVIAL AQUIFER				
Breathing Rate (m^3/hr)	0.6	0.6	0.6	USEPA 1989b
Time Exposed (hr/day)	0.6[2]	0.4[3]	0.4[3]	ENVIRON
Number of contacts total (days/yr*yrs exposed)[1]	10500	2100	1925	USEPA 1989a/1991a
SHOWERING, SURFICIAL WATER TABLE UNIT (ON-SITE AND OFF-SITE)				
Breathing Rate (m^3/hr)	0.6	0.6	0.6	USEPA 1989b
Time Exposed (hr/day)	0.6[2]	0.4[3]	0.4[3]	ENVIRON
Number of contacts total (days/yr * yrs exposed)[1]	10500	2100	1925	USEPA 1989a/1991a
CURRENT EXPOSURE				
INGESTION OF SOIL, Eastern sector				
Amount ingested (kg/day)	0.0001	0.0001	0.0002	USEPA 1989b
Total time of ingestion (days/yr * yrs exposed)	3360	2100	1925	USEPA 1991a/ ENVIRON
Days exposed per year	350	350	350	USEPA 1991a
Fraction of time in Eastern sector	49.83%	72.83%	55.83%	ENVIRON
INGESTION OF SOIL, Western/Central sector				
Amount ingested (kg/day)	0.0001	0.0001	0.0002	USEPA 1989b
Total time of ingestion (days/yr * yrs exposed)	3360	2100	1925	USEPA 1991a/ ENVIRON
Fraction of time in Western/Central sector	49.83%	18.83%	38.83%	ENVIRON
INGESTION OF TAR-LIKE MATERIAL				
Amount ingested (kg/day)	0.0001	0.0001	0.0002	USEPA 1989b
Ingestion time (days/yr * yrs exposed)	3360	2100	1925	USEPA 1991a/ ENVIRON
Fraction of time exposed to seeps of tar-like material	0.34%	0.34%	0.34%	ENVIRON

TABLE 13

SPECIFIC EXPOSURE SCENARIO ASSUMPTIONS FOR THE RME RECEPTOR

Exposure Scenario Assumptions	Adult	9-Year-Old Child	4-Year-Old Child	Reference
INGESTION OF SEDIMENTS, NORTHERN DITCH				
Amount ingested (kg/day)	0.0001	0.0001	0.0002	USEPA 1989b
Total time of ingestion (days/yr * yrs exposed)	3360	2100	1925	USEPA 1991a/ ENVIRON
Fraction of time in ditch	0%	8%	5%	ENVIRON
DERMAL, SOIL, Eastern sector				
Number contacts total (days/yr * yrs exposed)	3360	2100	1925	USEPA 1991a/ ENVIRON
Days exposed per year	350	350	350	USEPA 1991a
Soil to skin adherence factor (kg/cm^2)	2.00E-07	2.00E-07	2.00E-07	USEPA 1992
Dermal absorption (%)				
Compound Class Specific				
organics	1%	1%	1%	USEPA 1992
inorganics	0.1%	0.1%	0.1%	USEPA 1992
Surface area of contact (cm^2)	2756	3655	2522	
for Adult = Face + 2/3 Upper limbs				USEPA 1989a
for NINE and FOUR = Face + 2/3 Upper limbs + 1/2 Lower limbs				ENVIRON
Fraction of time in Eastern sector	49.83%	72.83%	55.83%	ENVIRON
DERMAL, SOIL, Western/Central sector				
Number contacts total (days/yr * yrs exposed)	3360	2100	1925	USEPA 1991a/ ENVIRON
Soil to skin adherence factor (kg/cm^2)	2.00E-07	2.00E-07	2.00E-07	USEPA 1992
Dermal absorption (%)				
Compound Class Specific (see above)				USEPA 1992
Surface area of contact (cm^2)	2756	3655	2522	USEPA 1989a
Fraction of time in Western/Central sector	49.83%	18.83%	38.83%	ENVIRON
DERMAL, TAR-LIKE MATERIAL				
Number contacts total (days/yr * yrs exposed)	3360	2100	1925	USEPA 1991a/ ENVIRON
Soil to skin adherence factor (kg/cm^2)	1.00E-06	1.00E-06	1.00E-06	USEPA 1992
Dermal absorption (%)				
Compound Class Specific (see above)				USEPA 1992
Surface area of contact (cm^2)	2756	3655	2522	ICRP 1984/ ENVIRON
Fraction of time exposed to seeps of tar-like material	0.34%	0.34%	0.34%	ENVIRON

TABLE 13

SPECIFIC EXPOSURE SCENARIO ASSUMPTIONS FOR THE RME RECEPTOR

Exposure Scenario Assumptions	Adult	9-Year-Old Child	4-Year-Old Child	Reference
DERMAL, SEDIMENT, NORTHERN DITCH				
Number contacts total (days/yr * yrs exposed)	3360	2100	1925	USEPA 1991a/ ENVIRON
Soil to skin adherence factor (kg/cm²)	2.00E-07	2.00E-07	2.00E-07	USEPA 1992
Dermal absorption (%)				
Compound Class Specific (see above)				USEPA 1992
Surface area of contact (cm²)	2756	3655	2522	ENVIRON
Fraction of time in ditch	0%	8%	5%	ENVIRON
INHALATION - PARTICULATES, Eastern sector				
Contact time (hr/day)	2	2	2	ENVIRON
Number contacts total (days/yr * yrs exposed)	3360	2100	1925	USEPA 1991a/ ENVIRON
Fraction of time in Eastern sector	49.83%	72.83%	55.83%	ENVIRON
INHALATION - VAPORS, Eastern sector				
Contact time (hr/day)	2	2	2	ENVIRON
Number contacts total (days/yr * yrs exposed)	3360	2100	1925	USEPA 1991a/ ENVIRON
Fraction of time in Eastern sector	49.83%	72.83%	55.83%	ENVIRON
INHALATION - VAPORS, Western/Central sector				
Contact time (hr/day)	2	2	2	ENVIRON
Number contacts total (days/yr * yrs exposed)	3360	2100	1925	USEPA 1991a/ ENVIRON
Fraction of time in Western/Central sector	49.83%	18.83%	38.83%	ENVIRON
INHALATION - VAPORS, TAR-LIKE MATERIAL				
Contact time (hr/day)	2	2	2	ENVIRON
Number contacts total (day/yr * yrs exposed)	3360	2100	1925	USEPA 1991a/ ENVIRON
Fraction of time exposed to seeps of tar-like material	0.34%	0.34%	0.34%	ENVIRON
INHALATION - VAPORS, INDOORS				
Contact time (hr/day)	22	22	22	ENVIRON
Number contacts total (days/yr * yrs exposed)	3360	2100	1925	USEPA 1991a/ ENVIRON
Fraction of time indoors	100%	100%	100%	ENVIRON

1 Based on default USEPA value for length of residence, 350 days per year; 30 years (adult), 6 years (9 year old) and 5.5 years (4 year old).

2 Based on inhalation during 15 minute daily shower and additional exposure to other volatiles for 20 minutes per day.

3 Based on inhalation during 24 minute bath.

Air: Although exposures have not been measured, exposure to constituents through inhalation of vapor and particulates ispossible. Possible exposures to vapors in the grassy area, indoors, target area E and the sludge have been evaluated via mathematical modeling. Indoor exposure may occur from the inhalation of vapor that may diffuse through concrete foundation cracks or utility openings. In addition, outdoor ambient air concentrations can contribute to indoor air concentrations. Total indoor air concentrations were estimated from the sum of modeled indoor and outdoor ambient air concentrations.

6.3 TOXICITY ASSESSMENT: DOSE RESPONSE EVALUATION

The toxicity assessment evaluates the adverse effects on humans due to exposure to the chemicals of concern. The dose-response evaluation is the characterization of the relationship between the dose received and the resulting effect. The toxicity values are then derived from quantitative dose-response relationships. These values are used to predict the incidence or probability of an adverse effect occurring relative to a dose. Toxicity values are used during risk characterization to estimate the possibility of an adverse effect occurring under a given set of circumstances.

Scientists have developed several mathematical models to extrapolate low-dose carcinogenic risks to humans based on carcinogenicity observed at high doses typically used in experimental animal studies. These models provide an estimate of the upper limit on lifetime cancer risk per unit dose, Carcinogenic Slope Factor (CSF). The mathematical model used by EPA to generate CSFs is a linearized multistage model.

Non-carcinogenic risks for long-term exposures are characterized by the chronic reference dose (RfD) for ingestion, or reference concentration (RfC) for inhalation which is similar in concept to an "acceptable daily intake." The RfD or RfC represents an estimate of daily exposure that is not expected to result in an increased risk of adverse health effects. Initially, the threshold dose is identified by determining the no-observed-effect level (NOEL), or, if a NOEL is not available, the lowest-observed-effect level (LOEL) from observations of people or experimental animals.

Toxicity values developed by EPA (RfDs, RfCs, and CSFs) have been used to characterize risk for all compounds except Lead and PAHs. Lead and PAHs are discussed below. Table 14, summarizes utilized toxicity values from Appendix XII of the RI report.

For polynuclear aromatic hydrocarbons (PAHs), a CSF has been onlyestablished for benzo(a)pyrene (BaP). Therefore, a Region IV interim guidance document has recently adopted a toxicity

TABLE - 14

REFERENCE DOSES, REFERENCE CONCENTRATIONS AND CANCER SLOPE FACTORS

	NON-CARCINOGENIC				CARCINOGENIC			
CHEMICAL	Inhal. RfC (mg/kg/day)	Inhal. RfC SOURCE	Oral RfD (mg/kg/day)	Oral RfD SOURCE	Inhal. CSF 1/(mg/kg/day)	Inhal. CSF SOURCE	Oral CSF 1/(mg/kg/day)	Oral CSF SOURCE
Acenaphthene	NA		6.00×10^{-2}	HEAST/IRIS 1991	NA		NA	
Acetone	NA		1.00×10^{-1}	HEAST/IRIS 1991	NA		NA	
Aldrin	NA		3.00×10^{-5}	HEAST/IRIS 1991	1.70×10^{1}	HEAST/IRIS 1991	1.70×10^{1}	HEAST/IRIS 1991
Anthracene	NA		3.00×10^{-1}	HEAST/IRIS 1991	NA		NA	
Benz(a)anthracene[1]	NA		NA		6.10×10^{-1}	HEAST 1991 (BaP TEF)	5.80×10^{-1}	HEAST 1991 (BaP TEF)
Benz(a)pyrene	NA		NA		6.10	HEAST 1991	5.80	HEAST 1991
Benzaldehyde	NA		1.00×10^{-1}	HEAST 1991	NA		NA	
Benzene	NA		NA		2.90×10^{-2}	HEAST/IRIS 1991	2.90×10^{-2}	HEAST/IRIS 1991
Benzo(b)fluoranthene[1]	NA		NA		6.10×10^{-1}	HEAST 1991 (BaP TEF)	5.80×10^{-1}	HEAST 1991 (BaP TEF)
Benzo(ghi)perylene	NA		3.00×10^{-2}	HEAST/IRIS 1991	NA		NA	
Benzo(k)fluoranthene[1]	NA		NA		6.10×10^{-1}	HEAST 1991 (BaP TEF)	5.80×10^{-1}	HEAST 1991 (BaP TEF)
Benzoic Acid	NA		4.00	HEAST 1991	NA		NA	
Bis(2-ethylhexyl)phthalate (BEHP)	NA		2.00×10^{-2}	HEAST/IRIS 1991	NA		1.40×10^{-2}	HEAST/IRIS 1991
Butylate	NA		5.00×10^{-2}	HEAST/IRIS 1991	NA		NA	
Caprolactam	NA		5.00×10^{-1}	HEAST 1991	NA		NA	
Carbon disulfide	2.86×10^{-3}	HEAST 1991	1.00×10^{-1}	HEAST/IRIS 1991	NA		NA	
Carbon tetrachloride = Tetrachloromethane	NA		7.00×10^{-4}	HEAST/IRIS 1991	1.30×10^{-1}	HEAST/IRIS 1991	1.30×10^{-1}	HEAST/IRIS 1991

TABLE - 14

REFERENCE DOSES, REFERENCE CONCENTRATIONS AND CANCER SLOPE FACTORS

CHEMICAL	NON-CARCINOGENIC				CARCINOGENIC			
	Inhal. RfC (mg/kg/day)	Inhal. RfC SOURCE	Oral RfD (mg/kg/day)	Oral RfD SOURCE	Inhal. CSF 1/(mg/kg/day)	Inhal. CSF SOURCE	Oral CSF 1/(mg/kg/day)	Oral CSF SOURCE
Chlordane (alpha)	NA		6.00×10^{-5}	HEAST/IRIS 1991	1.30	HEAST/IRIS 1991	1.30	HEAST/IRIS 19
Chlordane (gamma)	NA		6.00×10^{-5}	HEAST/IRIS 1991	1.30	HEAST/IRIS 1991	1.30	HEAST/IRIS 19
Chlorobenzene = Monochlorobenzene	5.00×10^{-3}	HEAST 1991	2.00×10^{-2}	HEAST/IRIS 1991	NA		NA	
Chloroform = Trichloromethane	NA		1.00×10^{-2}	HEAST/IRIS 1991	8.10×10^{-2}	HEAST/IRIS 1991	6.10×10^{-3}	HEAST/IRIS 19
Chlorpyrifos	NA		3.00×10^{-3}	HEAST 1991	NA		NA	
Chrysene[1]	NA		NA		6.10×10^{-2}	HEAST 1991 (BaP TEF)	5.80×10^{-2}	HEAST 1991 (BaP TEF)
Cresol (p-) (4-Methyl Phenol)	NA		5.00×10^{-2}	HEAST 1991	NA		NA	
2,4-D (2,4-Dichlorophenoxyacetic acid)	NA		1.00×10^{-2}	HEAST 1991	NA		NA	
Di-n-butyl phthalate	NA		1.00	HEAST/IRIS 1991	NA		NA	
Di-n-octyl phthalate	NA		2.00×10^{-2}	HEAST 1991	NA		NA	
Dibenz(a,h)anthracene[1]	NA		NA		6.10	HEAST 1991 (BaP TEF)	5.80	HEAST 1991 (BaP TEF)
Dicamba	NA		3.00×10^{-2}	IRIS 1991	NA		NA	
Dichlorobenzene (1,4-) = p-Dichlorobenzene	2.00×10^{-1}	HEAST 1991	NA		NA		2.40×10^{-2}	HEAST 1991
Dichlorodiphenyl dichloroethane (p,p'-) (DDD)	NA		NA		NA		2.40×10^{-1}	HEAST/IRIS 1991
Dichlorodiphenyl dichloroethylene (p-p') (DDE)	NA		NA		NA		3.40×10^{-1}	HEAST/IRIS 1991

TABLE - 14

REFERENCE DOSES, REFERENCE CONCENTRATIONS AND CANCER SLOPE FACTORS

	NON-CARCINOGENIC				CARCINOGENIC			
CHEMICAL	Inhal. RfC (mg/kg/day)	Inhal. RfC SOURCE	Oral RfD (mg/kg/day)	Oral RfD SOURCE	Inhal. CSF 1/(mg/kg/day)	Inhal. CSF SOURCE	Oral CSF 1/(mg/kg/day)	Oral CSF SOURCE
Dichlorodiphenyltrichloroethane (p,p'-) (DDT)	NA		5.00×10^{-4}	HEAST/IRIS 1991	3.40×10^{-1}	HEAST/IRIS 1991	3.40×10^{-1}	HEAST/IRIS 1991
Diethylphthalate	NA		8.00×10^{-1}	HEAST 1991	NA		NA	
Dieldrin	NA		5.00×10^{-5}	HEAST/IRIS 1991	1.60×10^{1}	HEAST/IRIS 1991	1.60×10^{1}	HEAST/IRIS 1991
Dimethylphenol (2,4-)	NA		2.00×10^{-2}	HEAST 1991	NA		NA	
Endosulfan	NA		5.00×10^{-5}	HEAST/IRIS 1991	NA		NA	
Endosulfan II[2]	NA		5.00×10^{-5}	HEAST/IRIS 1991	NA		NA	
Endrin and metabolites	NA		3.00×10^{-4}	HEAST/IRIS 1991	NA		NA	
Ethyl (S-) dipropylthiocarbamate (EPTC)	NA		2.50×10^{-2}	HEAST/IRIS 1991	NA		NA	
Ethylbenzene	2.86×10^{-1}	HEAST/IRIS 1991	1.00×10^{-1}	HEAST/IRIS 1991	NA		NA	
Fluoranthene	NA		4.00×10^{-2}	HEAST/IRIS 1991	NA		NA	
Fluorene	NA		4.00×10^{-2}	HEAST/IRIS 1991	NA		NA	
Heptachlor	NA		5.00×10^{-4}	HEAST/IRIS 1991	4.50	HEAST/IRIS 1991	4.50	HEAST/IRIS 1991
Heptachlor epoxide	NA		1.30×10^{-5}	HEAST/IRIS 1991	9.10	HEAST/IRIS 1991	9.10	HEAST/IRIS 1991
Hexachlorocyclohexane, alpha isomer	NA		0.00		6.30	HEAST/IRIS 1991	6.30	HEAST/IRIS 1991
Hexachlorocyclohexane, beta isomer (beta-HCH)	NA		0.00		1.80	HEAST/IRIS 1991	1.80	HEAST/IRIS 1991
Hexachlorocyclohexane, gamma (see Lindane)	NA		3.00×10^{-4}	HEAST/IRIS 1991	NA		1.30	HEAST 1991

TABLE - 14

REFERENCE DOSES, REFERENCE CONCENTRATIONS AND CANCER SLOPE FACTORS

CHEMICAL	NON-CARCINOGENIC				CARCINOGENIC			
	Inhal. RfC (mg/kg/day)	Inhal. RfC SOURCE	Oral RfD (mg/kg/day)	Oral RfD SOURCE	Inhal. CSF 1/(mg/kg/day)	Inhal. CSF SOURCE	Oral CSF 1/(mg/kg/day)	Oral CSF SOURCE
Indeno(1,2,3)pyrene[1]	NA		0.00		6.10×10^{-1}	HEAST 1991 (BaP TEF)	5.80×10^{-1}	HEAST 1991 (BaP TEF)
Methoxychlor	NA		5.00×10^{-3}	HEAST/IRIS 1991	NA		NA	
Methyl ethyl ketone (MEK) = 2-butanone	9.00×10^{-2}	HEAST 1991	5.00×10^{-2}	HEAST 1991	NA		NA	
Methyl isobutyl ketone	2.00×10^{-1}	HEAST 1991	5.00×10^{-1}	HEAST 1991	NA		NA	
Methylene chloride = Dichloromethane	8.60×10^{-1}	HEAST 1991	6.00×10^{-2}	HEAST/IRIS 1991	1.65×10^{-3}	HEAST 1991	7.50×10^{-3}	HEAST 1991
Molinate	NA		2.00×10^{-3}	HEAST/IRIS 1991	NA		NA	
Naphthalene	NA		4.00×10^{-3}	HEAST 1991	NA		NA	
Pebulate	NA		5.00×10^{-2}	HEAST 1991	NA		NA	
Phenol	NA		6.00×10^{-1}	HEAST/IRIS 1991	NA		NA	
Pyrene	NA		3.00×10^{-2}	HEAST/IRIS 1991	NA		NA	
2,4,5-T	NA		1.00×10^{-2}	HEAST/IRIS 1991	NA		NA	
Tetrachloroethylene = Perchloroethylene	NA		1.00×10^{-2}	HEAST/IRIS 1991	1.82×10^{-3}	HEAST 1991	5.10×10^{-2}	HEAST 1991
Toluene = Toluol	5.71×10^{-1}	HEAST 1991	2.00×10^{-1}	HEAST/IRIS 1991	NA		NA	
Trichlorobenzene (1,2,4-)	3.00×10^{-3}	HEAST 1991	1.31×10^{-3}	HEAST 1991	NA		NA	
Trichloroethane (1,1,1-)	3.00×10^{-1}	HEAST 1991	9.00×10^{-2}	HEAST 1991	NA		NA	
Vernolate	NA		1.00×10^{-3}	HEAST 1991	NA		NA	
Xylenes	8.60×10^{-2}	HEAST 1991	2.00	HEAST/IRIS 1991	NA		NA	

TABLE - 14

REFERENCE DOSES, REFERENCE CONCENTRATIONS AND CANCER SLOPE FACTORS

	NON-CARCINOGENIC				CARCINOGENIC			
CHEMICAL	Inhal. RfC (mg/kg/day)	Inhal. RfC SOURCE	Oral RfD (mg/kg/day)	Oral RfD SOURCE	Inhal. CSF 1/(mg/kg/day)	Inhal. CSF SOURCE	Oral CSF 1/(mg/kg/day)	Oral CSF SOURCE
Arsenic	NA		3.00×10^{-4}	IRIS 1991	5.00×10^{1}	HEAST 1991	1.75	IRIS 1991
Barium	NA		7.00×10^{-2}	IRIS 1991	NA		NA	
Beryllium	NA		5.00×10^{-3}	IRIS 1991	8.40	IRIS 1991	4.30	IRIS 1991
Cadmium dusts & salts (as Cd)	NA		5.00×10^{-4}	HEAST/IRIS 1991	6.30	IRIS 1991	NA	
Chromium (III)	5.70×10^{-7}	HEAST 1991	1.00	HEAST 1991	NA		NA	
Chromium (VI)	5.70×10^{-7}	HEAST 1991	5.00×10^{-3}	IRIS 1991	4.20×10^{1}	IRIS 1991	NA	
Copper	NA		1.00	IRIS 1991	NA		NA	
Cyanides (as CN)	NA		2.00×10^{-2}	HEAST 1991	NA		NA	
Manganese	1.14×10^{-4}	IRIS 1991	1.00×10^{-1}	IRIS 1991	NA		NA	
Mercury - Inorganic	8.57×10^{-5}	HEAST 1991	3.00×10^{-4}	HEAST 1991	NA		NA	
Nickel	NA		2.00×10^{-2}	HEAST 1991	8.40×10^{-1}	HEAST 1991	NA	
Selenium	NA		5.00×10^{-3}	IRIS 1991	NA		NA	
Vanadium	NA		7.00×10^{-3}	HEAST 1991	NA		NA	
Zinc and compounds	NA		2.00×10^{-1}	HEAST 1991	NA		NA	

[1] Cancer slope factors have been adjusted using toxicity equivalency factor (TEF) methodology as cited in *New Interim Region IV Guidance*, February 1992 memo from USEPA Region IV.
[2] HEAST 1991 and IRIS 1991 provide references for Endosulfan only. These values were also used for Endosulfan II.

equivalency factor (TEF) methodology for carcinogenic PAHs based on the relative potency of each compound to the potency of BaP. The oral CSF for BaP is 5.8 $(mg/kg\text{-}day)^{-1}$. Therefore, compounds with a TEF of 0.1 were evaluated using oral CSFs of 0.58 $(mg/kg\text{-}day)^{-1}$. This TEF approach was used for inhalation, dermal and oral exposure pathways (see Table 15).

TABLE 15 - TOXICITY EQUIVALENCY FACTORS (TEFs) FOR POLYNUCLEAR AROMATIC HYDROCARBONS (PAHs)

Compound	TEF
Benzo(a)anthracene	0.1
Benzo(b)fluoranthene	0.1
Benzo(k)fluoranthene	0.1
Chrysene	0.01
Dibenzo(a,h)anthracene	1.0
Indeno(1,2,3-c,d)pyrene	0.1

For Lead, the RfD or CSF currently does not exist, nor are values likely to be developed in the foreseeable future due to difficulty of detecting effects of very low levels of lead exposure. The Uptake/Biokinetic (U/BK) model, developed by Harley and Kneip (USEPA 1991b), has been used by the USEPA Office of Air Quality Planning and Standards to set the National Ambient Air Quality Standards (NAAQS) for lead. Also, the Environmental Criteria and Assessment Office (ECOA) has distributed the U/BK model as a method for establishing soil cleanup levels for lead. Accordingly, the U/BK model was used in the Risk Assessment for this site as the most appropriate method currently available to estimate the potential risks associated with exposure to lead.

6.4 RISK CHARACTERIZATION

Human health risks are characterized for potential carcinogenic and noncarcinogenic effects by combining exposure and toxicity information. Excessive lifetime cancer risks are determined by multiplying the estimated daily intake level with the cancer potency factor. These risks are probabilities that are generally expressed in scientific notation (e.g., 1×10^{-6}). An excess lifetime cancer risk of $1x10^{-6}$ indicates that, as a plausible upper bound, an individual has a one in one million additional (above their normal risk) chance of developing cancer as a result of site-related exposure to a carcinogen over a 70-year lifetime under the assumed specific exposure conditions at a site.

The Agency considers individual excess cancer risks in the range of $1x10^{-4}$ to $1x10^{-6}$ as protective; however the $1x10^{-6}$ risk level is generally used as the point of departure for setting cleanup levels at Superfund sites. The point of departure risk level of $1x10^{-6}$ expresses EPA's preference for remedial actions that result in risks at the more protective end of the risk range.

Potential concern for noncarcinogenic effects of a single contaminant in a single medium is expressed as the hazard quotient (HQ) (or the ratio of the estimated intake derived from the contaminant concentration in a given medium to the contaminants's reference dose). A HQ which exceeds one (1) indicates that the daily intake from a scenario exceeds the chemical's reference dose. By adding the HQs for all contaminants within a medium or across all media to which a given population may reasonably be exposed, the Hazard Index (HI) can be generated. The HI provides a useful reference point for gauging the potential significance of multiple contaminant exposures within a single medium or across media. An HI which exceeds unity indicates there may be a concern for potential health effects resulting from the cumulative exposure to multiple contaminants within a single medium or across media. Tables 16 and 17 provide a summary of specific carcinogenic and noncarcinogenic risks respectively. The future potential exposure to the surficial and/or alluvial aquifer were the only pathways which represent an unacceptable risk.

6.5 UNCERTAINTY ANALYSIS

Throughout the risk assessment process, uncertainties associated with evaluation of chemical toxicity and potential exposures arise. For example, uncertainties arise in derivation of toxicity values for reference doses (RfDs) and carcinogenic slope factors (CSFs), estimation of exposure point concentrations, fate and transport modeling, exposure assumptions and ecological toxicity data. Because of the conservative nature of the risk assessment process, risks estimated in this assessment are likely to be overestimates of the true risk associated with potential exposure at the Redwing Site.

Because of the uncertainty in the calculation of the total area occupied by seeps, three different estimations of seep area were conducted in the risk assessment. This was done to quantify the range of possible exposure and the resulting risks at the Redwing Site. These calculations are presented in the RME scenario (Section 6.2.3.4) of the RI Report and in Appendix XVII of the Report.

Since 1985, a seep inspection and removal program has been implemented at the Redwing Site. As a result, seeps have not been observed to increase in size beyond approximately 2 inches in diameter. However, the risk assessment was conducted to evaluate risks associated under the conditions that would occur at the Redwing Site if the removal actions were not occurring.

TABLE 16 - SUMMARY OF PATHWAY SPECIFIC CARCINOGENIC RISKS

EXPOSURE SCENARIO	ADULT CANCER RISK	9 YEAR OLD CANCER RISK	4 YEAR OLD CANCER RISK	SUM OF 9 AND 4 YEAR OLD CANCER RISK
ALLUVIAL AQUIFER				
ingestion of water	$5x10^{-4}$	$2x10^{-4}$	$3x10^{-4}$	$8x10^{-4}$
inhalation during showering	$9x10^{-8}$	$3x10^{-8}$	$6x10^{-8}$	$1x10^{-7}$
SURFICIAL AQUIFER				
ingestion of water	$1x10^{-3}$	$4x10^{-4}$	$7x10^{-4}$	$2x10^{-3}$
inhalation during showering	$4x10^{-3}$	$1x10^{-3}$	$2x10^{-3}$	$6x10^{-3}$
TARGET AREA E				
ingestion of soil	$4x10^{-7}$	$8x10^{-7}$	$2x10^{-6}$	$3x10^{-6}$
dermal contact (w/soil)	$2x10^{-8}$	$6x10^{-8}$	$6x10^{-8}$	$1x10^{-7}$
inhalation (vapors)	$3x10^{-6}$	$4x10^{-6}$	$3x10^{-6}$	$7x10^{-6}$
inhalation (particulates)	$5x10^{-8}$	$8x10^{-8}$	$7x10^{-8}$	$1x10^{-7}$
GRASSY AREA				
ingestion of soil	$1x10^{-7}$	$7x10^{-8}$	$5x10^{-7}$	$6x10^{-7}$
dermal contact (w/soil)	$7x10^{-9}$	$5X10^{-9}$	$1X10^{-8}$	$2X10^{-8}$
inhalation (vapor)	$4X10^{-9}$	$1X10^{-9}$	$3X10^{-9}$	$5X10^{-9}$
INDOOR EXPOSURE				
inhalation of vapor (includes seeps)	$1X10^{-5}$	$2X10^{-5}$	$2X10^{-5}$	$3X10^{-5}$
inhalation of vapor (excludes seeps)	$1X10^{-7}$	$1X10^{-7}$	$1X10^{-7}$	$2X10^{-7}$
DITCH				
ingestion of sediments	0	$8X10^{-8}$	$2X10^{-7}$	$3X10^{-7}$
dermal contact with sediments	0	$6X10^{-9}$	$5X10^{-9}$	$1X10^{-8}$
EXPOSURE TO SEEPS OF BLACK SLUDGE				
ingestion of sludge	$5x10^{-9}$	$7x10^{-9}$	$3x10^{-8}$	$4x10^{-8}$
dermal contact with sludge	$1x10^{-9}$	$3x10^{-9}$	[illegible]$x10^{-9}$	$6x10^{-9}$
inhalation of vapors	$1x10^{-6}$	$1x10^{-6}$	$1x10^{-6}$	$3x10^{-6}$
TOTAL CURRENT EXPOSURE [Includes risks from eastern+western/central+indoor+ditch+seeps.]	**$2x10^{-5}$**	**$2x10^{-5}$**	**$2x10^{-5}$**	**$5x10^{-5}$**
TOTAL POTENTIAL EXPOSURE				
Includes currents exposure + exposure to the alluvial aquifer.	**$6x10^{-4}$**	**$2x10^{-4}$**	**$4x10^{-4}$**	**$9x10^{-4}$**
Includes current exposure + exposure to the surficial groundwater.	**$5x10^{-3}$**	**$2x10^{-3}$**	**$3x10^{-3}$**	**$8x10^{-3}$**

TABLE 17 - SUMMARY OF PATHWAY SPECIFIC TOTAL HAZARD INDICES (NON-CARCINOGENIC RISKS)			
EXPOSURE SCENARIO	ADULT	NINE-YEAR-OLD	FOUR-YEAR-OLD
ALLUVIAL AQUIFER			
Ingestion of water	$2X10^{0}$	$4X10^{0}$	$8X10^{0}$
Inhalation during showering	0	0	0
SURFICIAL AQUIFER			
ingestion of water	$3X10^{1}$	$5X10^{1}$	$9X10^{1}$
Inhalation during showering	$8X10^{0}$	$1X10^{1}$	$3X10^{1}$
TARGET AREA E			
ingestion of soil	$4X10^{-2}$	$1X10^{-1}$	$5X10^{-1}$
dermal contact (w/soil)	$2X10^{-3}$	$8X10^{-3}$	$9X10^{-3}$
inhalation (vapors)	$1X10^{-3}$	$2X10^{-3}$	$2X10^{-3}$
inhalation (particulates)	$3X10^{-2}$	$8X10^{-2}$	$7X10^{-2}$
GRASSY AREA			
ingestion of soil	$3X10^{-3}$	$2X10^{-3}$	$2X10^{-2}$
dermal contact (w/soil)	$9X10^{-5}$	$1X10^{-4}$	$3X10^{-4}$
inhalation (vapor)	$2X10^{-4}$	$1X10^{-4}$	$2X10^{-4}$
INDOOR EXPOSURE			
inhalation of vapor (includes seeps)	$3X10^{-2}$	$5X10^{-2}$	$8X10^{-2}$
inhalation of vapor (excludes seeps)	$5X10^{-3}$	$8X10^{-3}$	$9X10^{-3}$
NORTHERN DITCH			
ingestion of sediments	0	$7X10^{-3}$	$2X10^{-2}$
dermal contact with sediments	0	$3X10^{-4}$	$3X10^{-4}$
EXPOSURE TO SEEPS OF SLUDGE			
ingestion of sludge	$1X10^{-4}$	$3X10^{-4}$	$1X10^{-3}$
dermal contact with sludge	$2X10^{-5}$	$6X10^{-5}$	$9X10^{-5}$
inhalation of vapors	$2X10^{-3}$	$4X10^{-3}$	$4X10^{-3}$
TOTAL CURRENT EXPOSURE [Includes risks from eastern+western/central+indoor+ditch+seeps.]	**$1x10^{-1}$**	**$3x10^{-1}$**	**$7x10^{-1}$**
TOTAL POTENTIAL EXPOSURE			
Includes currents exposure + exposure to the alluvial aquifer.	**$3X10^{0}$**	**$5X10^{0}$**	**$9X10^{0}$**
Includes current exposure + exposure to the surficial groundwater.	**$4X10^{1}$**	**$6X10^{1}$**	**$1X10^{2}$**

An alte. .tive seep analysis was conducted assuming a maximum possibl. eep area of 10,400 ft². This is 20 times greater than the area used in the RME scenario. Using the alternative seep analysis, HIs for the 9 and 4-year-old children exceed 1. The alternative seep area also increased carcinogenic risks under the current exposure scenario by an order of magnitude.

6.6 HUMAN HEALTH SUMMARY

EPA evaluated present and possible future exposure from 1) surficial and alluvial groundwater, 2) soils and seeps of sludge, 3) air and (4) site surface water and sediments. The risk assessment indicates that contaminant levels in surface soil, sediments and sludge seeps are not high enough to pose a significant health threat via current exposure. Furthermore, there is no current exposure to people from groundwater or subsurface soil contamination. However, CO could pose a future health risk if the surficial aquifer were u as a source of potable water or if contamination moves int e alluvial aquifer. Additionally, COCs may pose a hea risk if the PAHs detected under the concrete liner become ex ed because of the removal of the liner, or if similar contamination is found elsewhere along the drainage pathway. The COCs in the northern ditch do not currently present a significant human health threat.

6.7 ENVIRONMENTAL EVALUATION

The environmental evaluation examined the potential for adverse ecological impacts as a result of the presence of the chemicals at the Redwing Site. The evaluation was conducted in four steps: (1) identification of the presence of critical habitats and species of concern, (2) identification of chemicals of potential concern, (3) estimation of acute and chronic toxicity and exposure concentrations, and (4) comparison of toxicity threshold estimates and exposure estimates.

The ecological risk assessment primarily addressed risk to on-site receptors. The Redwing Site is mostly a non-vegetated, non-aquatic habitat in an urban/residential area and does not provide any special or unique habitats. Therefore, it is unlikely to attract or support endangered or threatened species. Terrestrial (land) plants are limited to mowed grass and a few bushes and trees. Animals likely to be found at the Redwing Site are song or field birds, small rodents, frogs, and possibly reptiles. Although Redwing Site contaminants might have harmful effects on some plants and animals, the source area is presently covered with soil making direct exposure unlikely. Wildlife would probably avoid the tar seeps. Therefore, the source material does not appear to pose an environmental risk.

Site ditches provide only temporary habitats for aquatic plants and animals. Two aquatic species, the arrowhead plant and the mosquitofish, were observed in the concrete-lined ditches following heavy rainfall. The mosquitofish would likely move downstream as water in the ditch dries up. Since contaminants in unlined ditch sediments could move downstream and those in the lined ditch could have moved in the past, data from on-site ditch sediments were used to predict effects on plant and animal life in downstream surface water bodies. The analysis indicated that the highest contaminant concentrations were found under the concrete liner in the ditch and measurable levels of contaminants are not presently moving off site. Dilution factors were applied to the maximum detected ditch sediment concentrations to determine possible sediment contaminant levels downstream in Norton Creek resulting from any past migration. Comparison of these levels with toxicity information indicated that possible past migration of sediment contaminants downstream into Norton Creek would have little effect on the aquatic biota.

For specific information on EPA's environmental and human health evaluations, refer to the Baseline Risk Assessment portion of the RI Report.

6.7.1 UNCERTAINTY ANALYSIS

The major uncertainties associated with the environmental evaluation are the extrapolation of soil/ditch sediment concentrations to actual exposures. In addition the extrapolation of laboratory toxicity data on pure compounds or specific complexes to the Redwing Site, where the actual environmental forms are unknown, adds to the uncertainty.

6.8 RISK ASSESSMENT SUMMARY

The health risk posed at this site is primarily from the future use of the groundwater in both the surficial and alluvial aquifer as a potable source. This is due to the presence of contaminants presently at concentrations above EPA's Maximum Containment Levels for drinking water. Surface soils and sediments are subject to contamination from the continual leaching of contaminants from the sludge which percolates to the surface.

With regard to environmental risks, there are no permanent on-site aquatic habitats and the only on-site surface water bodies are intermittent ditches. The highest sediment contaminant levels are under the lined ditch and therefore not presently available to migrate along the surface water pathway. Dilution factors, with respect to possible effects on aquatic biota on surface water bodies downstream, show that there would be no adverse effect on aquatic biota from sediment contaminant levels.

6.9 CHEMICALS OF CONCERN AND CLEANUP LEVELS

The chemicals of potential concern were determined during the risk assessment. All constituents detected at the Redwing Site were initially considered as chemicals of potential concern. The results of the risk assessment have provided a basis for narrowing that list to those constituents in the soils which pose a threat via the direct contact (ingestion and inhalation) route and via the migration pathway to groundwater. The chemicals determined for the remedial investigation to be of potential concern to human health and the environment and their respective protective cleanup levels for soils and sediments are presented in Tables 18 and 19. Additionally, Table 20 lists protective groundwater concentrations. These allowable post-remediation concentrations are based upon the current groundwater protection standard (MCL) or where such standards are not available, the number is based on the results of the risk assessment which constitute health-based cleanup goals.

6.10 CONCLUSION

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

TABLE 18 - CLEANUP LEVELS FOR SUBSURFACE SOIL

CONTAMINANTS OF CONCERN	CONCENTRATION RANGE (μg/kg)	CLEANUP LEVEL * (μg/kg)
4,4'-DDT **	0.48 - 140	566
ACETONE	3 - 2,300	36
ALDRIN	0.67 - 200	4
ALPHA-BHC	0.1 - 4.7	0.5
CHLOROFORM	4 - 46,000	70
CHROMIUM	2,800 - 52,900	47,000
DIELDRIN	0.57 - 6.3	0.1
GAMMA-BHC (LINDANE)	2.5 - 54	3.2
METHYLENE CHLORIDE	3 - 89	0.6

TABLE 18 - CLEANUP LEVELS FOR SUBSURFACE SOIL

CONTAMINANTS OF CONCERN	CONCENTRATION RANGE (µg/kg)	CLEANUP LEVEL * (µg/kg)
NICKEL	3,000 - 36,500	30,000
VANADIUM **	1,800 - 50,200	156,000
VERNOLATE	2 - 130,000	55

* Cleanup levels are based on groundwater protection. If lead is detected in subsurface soils not already cited for remediation because cleanup levels above are exceeded, and the concentration of lead is above 54,000 µg/kg, then groundwater and soil characterization will be conducted to determine if soil cleanup is required for the protection of groundwater at 15µg/l, the current action level for lead in groundwater.

** Concentrations of these site related contaminants were detected above cleanup levels in groundwater during the remedial investigation but not in the subsurface soils. Their current existence in subsurface soils above cleanup levels must be verified.

TABLE 19 - CLEANUP LEVELS FOR SURFACE SOIL AND SEDIMENTS

CONTAMINANTS OF CONCERN	CONCENTRATION RANGE (µg/kg)	CLEANUP LEVEL (µg/kg) *
BENZO (A) PYRENE	73 - 3,200	94.9
BENZO (B) FLUORANTHENE	230 - 7,400	540
BENZO (A) ANTHRACENE	67 - 7,200	1,025
CARBON TETRACHLORIDE	110,000	9,590
CHRYSENE	93 - 3,800	362

* Based on risk from inhalation or ingestion

TABLE 20 - CLEANUP LEVELS FOR GROUNDWATER

CONTAMINANTS OF CONCERN	CONCENTRATION RANGE (µg/l)	CLEANUP LEVEL (µg/l) *
4,4'-DDT	0.86	0.158
ACETONE	10,000 - 2,100,000	1,120
ALDRIN	0.11 - 0.47	0.00317
ALPHA-BHC	0.044 - 0.15	0.00855
BERYLLIUM	1.3 - 9.5	4.00
BIS(2-ETHYLHEXYL)PHTHALATE	2 - 710	6.00
CARBON DISULFIDE	9 - 5,500	47.6
CHLOROFORM	2,900 - 27,000	100
CHROMIUM	6.2 - 355	50
DIELDRIN	0.012 - 1.1	.00337
GAMMA - BHC (LINDANE)	0.01 - 0.7	0.2
METHYLENE CHLORIDE	330 - 650	5
NICKEL	28.7 - 301	100
VANADIUM	6.6 - 580	78.1
VERNOLATE	1.1 - 140	11.2

* Based on MCL or Risk Assessment

7.0 DESCRIPTION OF ALTERNATIVES

The Feasibility Study Report evaluated possible alternatives for remediation of conditions at the Redwing Site. A total of six (6) alternatives have been established for detailed analysis consideration. These alternatives were selected to provide a range of remedial actions for the Redwing Site.

1.	No Action
2.	Continuing Response Action
3.	Collection of Source Material and Off-Site Treatment Disposal; Extraction of Groundwater with On-Site Treatment and Off-Site Disposal to a POTW
4.	RCRA Cap
5.	Concrete Cap
6.	Collection of Source Material and On-Site Treatment Disposal; Extraction of Groundwater with On-Site Treatment and Off-Site Disposal to a POTW

7.1 ALTERNATIVE No. 1 - No Action

The no action alternative is carried through the screening process as required by the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). This alternative is used as a baseline for comparison with other developed alternatives. Under this alternative the seep inspection and removal program currently being conducted by Redwing under a removal order would cease. Sludge seeps would be allowed to emerge unchecked and the EPA would not take further action to minimize the impact that soil contamination would have on the groundwater. Contaminants in the soil would continue to leach into the groundwater. Levels of contamination would continue to exceed groundwater protection standards. The overall remedial action levels would not be achieved by utilizing this alternative. There is no cost associated with this alternative since no actions would be conducted.

7.2 ALTERNATIVE No. 2 - Inspection and Seep Removal with Groundwater Monitoring

This alternative consists of inspection for and removal of surfaced seeps of sludge along with monitoring surficial and alluvial groundwater quality and movement. This alternative contains some of the elements currently being conducted under an Administrative Order by Redwing Carriers, Inc. Groundwater remediation is not addressed by this alternative. Under this alternative, institutional controls and natural attenuation of the contamination within the surficial and alluvial groundwater would be the mechanism to prevent exposure and groundwater remediation respectively. The estimated costs for this alternative is $558,000 for the thirty (30) years of implementation. However, the timeframe for natural attenuation to occur has not been determined.

7.3 ALTERNATIVE No. 3 - Excavation of Source Material, Extraction of Surficial Groundwater with Off-Site Treatment and Disposal of each. Groundwater Monitoring of the Alluvial Aquifer.

This alternative involves excavation and transportation of soil and sludge (i.e. source material) to an off-site treatment and disposal facility. Additionally, extraction and disposal of contaminated surficial groundwater would be required. Groundwater monitoring of the alluvial aquifer would be implemented to assure attenuation of the contaminant levels. Source material and groundwater pre-treatment may be required prior to disposal. This may require thermal and biological treatment of soils and groundwater, respectively. Excavated subsurface soils may require dewatering and stabilization prior to land disposal. This water will be analyzed and treated/disposed of in an appropriate manner. Excavation may be accomplished with or without the removal of buildings or structures in areas requiring excavation. Currently, there is no evidence that contamination exists under the buildings. However, if contamination is found during the remedial design appropriate action, which may involve the demolition of some buildings, will be undertaken. EPA will consult the public before taking this action.

The areas of soil and sludge would be excavated. Residents would be temporarily relocated during the period of excavation. Source materials would be moved to a staging area on-site prior to being hauled off-site. Some of the excavated soils will be removed from the saturated zone and will require dewatering. Sidewalk slabs and pavement areas may be contaminated and thus require removal. Excavated areas would be backfilled with clean material. The excavated material would be sorted and characterized to determine if treatment is required before land disposal. If treatment is required it will be conducted off-site at an approved facility. All excavated soil, source material, sludge, and contaminated debris will be disposed of off-site at an approved facility. It is estimated that the excavation and removal would be accomplished in 18 months.

Alternative 3 also includes extraction and active treatment of the surficial groundwater. Under this alternative contaminated groundwater would be extracted, treated on-site and discharged to the POTW or to a nearby surface water body if appropriate limits can be met. The alluvial groundwater will be monitored to insure that chemicals of concern decrease to cleanup levels. If natural attenuation does not progress at a rate to meet cleanup levels within the timeframe of active treatment to the surficial aquifer, the remedial design will be modified to include active treatment of alluvial as well as surficial groundwater.

An installed network of extraction wells and french drains will extract contaminated groundwater from the surficial aquifer for on-site treatment. The treatment system will use a biotreatment process and sand/activated carbon filtration to treat more heavily contaminated groundwater. After concentrations decrease the system may be adjusted to reduce the rate of extraction or to a point where only the filtration system is required. The groundwater may also contain contaminants which may not be effectively treated using a biotreatment process. These contaminants may require a supplemental treatment step. Residual constituents in the biotreatment sludges or spent carbon would be disposed of off-site at an approved facility.

It is predicted that 12 million gallons of surficial groundwater must be treated to reduce concentrations to cleanup levels. The groundwater cleanup time frame is estimated to be 7 years. The time may be shortened by putting nutrients into the surficial aquifer to enhance biodegradation.

This alternative would provide overall protection for any present or future uses of the property. The estimated implementation timeframe for this alternative is seven (7) years. The estimated cost for this alternative is $7,002,562.

7.4 ALTERNATIVE No. 4 - RCRA Cap, Extraction of Surficial Groundwater for On-site Treatment, and Groundwater Monitoring for the Alluvial Aquifer.

This alternative involves placement of a RCRA cap over the eastern half of the apartment complex, extraction and on-site treatment of the surficial groundwater and monitoring of the alluvial aquifer. Construction of the RCRA cap will require the demolition of approximately six buildings and the capped area would be fenced. As part of this alternative, the contaminated surficial groundwater will be extracted in order to prevent further migration of contamination. Groundwater will be treated on-site and subsequently discharged. The integrity of the cap would be maintained indefinitely with monitoring of the surficial and alluvial aquifer. Surficial groundwater extraction and treatment is expected to reduce contaminant concentrations below cleanup levels within eleven (11) years. The estimated cost for this alternative is $3,870,460.

7.5 ALTERNATIVE No. 5 - Concrete Cap, Extraction and Off-Site Treatment and Disposal of Surficial Groundwater and Monitoring of the Alluvial Aquifer.

This alterative consists of the placement of a concrete cap over sections of the eastern half open grassy areas of the Redwing Site, surficial groundwater extraction with off-site treatment and disposal and monitoring of the groundwater in the alluvial aquifer.

The concrete cap would be constructed without the demolition of any apartment buildings. The cap could be placed around the existing apartment units which are in source areas of contamination. The cap would be constructed such that its integrity can be maintained and upward movement of subsurface sludge would be inhibited.

The cap would be designed with sufficient thickness and joint impermeability to control seeps of sludge and potential vapor emissions. The cap would be designed and constructed above grade over the current ground surface of the Redwing Site such that it would eliminate migration of sludge around the edges of the cap. The capped area would remain accessible for use by the apartment residents. To maintain the existing functional use of the Redwing Site, recreational-use improvements would be incorporated into the cap design.

The contaminated surficial groundwater would be extracted and treated on-site, as necessary, for disposal to the POTW. Implementation of groundwater monitoring of the alluvial aquifer and maintenance of the cap would be required. The estimated timeframe for remediation of the surficial groundwater is ten (10) years. Natural attenuation would be the mechanism for remediation of the alluvial groundwater. The cap would be maintained indefinitely. The estimated cost of this alternative is $2,233,751.

7.6 ALTERNATIVE No 6 - Excavation of Source Material and Surficial Groundwater with On-Site Treatment/Disposal. Groundwater Monitoring of the Alluvial Aquifer.

This alternative combines source material excavation with on-site treatment of source material and surficial groundwater. Temporary relocation for approximately 2 years would be required during excavati[illegible] and treatment of the source material. Currently, the[illegible]s no evidence that contamination exists under the buildings. [illegible]wever, if contamination is found during the remedial design appropriate action, which may involve the demolition of some buildings, will be undertaken. EPA will consult the public before taking this action.

The following primary on-site treatment processes will be implemented: 1) soil washing/flushing, 2) filtration, and 3) biotreatment. The excavated source material will be stockpiled and washed with a compatible washing agent as a volume reducing treatment step. The washed soil would be then dewatered and analyzed before backfilling into the excavation. The spent wash solution and soil fines would be pumped through a filtration system to further separate and concentrate the dissolved and suspended constituents. The filtrate may be reused as wash solution. The filtered constituents will then be sent to the biotreatment unit. The biotreatment process will be designed to create a favorable environment for microorganisms which are capable of degrading the compounds of concern at the Redwing Site.

In addition to the soil washing, other technologies (ex-situ soil flushing, gravity separation and ex-situ bioremediation) may also be used in addition to or instead of ex-situ soil washing, if during the remedial design these technologies are effective in reducing soil contaminant concentrations and are determined to be cost effective.

Alternative 6 also includes extraction and active treatment of surficial groundwater. Under this alternative, contaminated groundwater would be extracted, treated on-site and discharged to the POTW or to a nearby surface waterbody if appropriate limits can be met. The alluvial groundwater will be monitored to insure that chemicals of concern decrease to cleanup levels. If natural attenuation does not progress at a rate to meet cleanup levels within the timeframe of active treatment to the surficial aquifer, the remedial design will be modified to include active treatment of alluvial as well as surficial groundwater.

An installed network of extraction wells and french drains will extract contaminated groundwater from the surficial aquifer for on-site treatment. The treatment system will use a biotreatment process and sand/activated carbon filtration to treat more heavily contaminated groundwater. After concentrations decrease the system may be adjusted to reduce the rate of extraction or to a point where only the filtration system is required. The groundwater may also contain contaminants which may not be effectively treated using a biotreatment process. These contaminants may require a supplemental treatment step. Residual constituents in the biotreatment sludges or spent carbon would be treated prior to disposal.

It is predicted that 12 million gallons of surficial groundwater must be treated to reduce concentrations to cleanup levels. The groundwater cleanup time frame is estimated to be 7.1 years. The time may be shortened by putting nutrients into the surficial aquifer to enhance biodegradation.

The estimated timeframe for treatment of the source material and groundwater is 2 and 7 years respectively. The estimated cost of this alternative is $6,168,452.

7.7 ARARS AND TBCS

The remedial action for the Redwing Site, under CERCLA Section 121 (d), must comply with federal and state environmental laws that are either applicable or relevant and appropriate (ARARs). Applicable requirements are those standards, criteria or limitations promulgated under federal or state law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location or other circumstance at a CERCLA site. Relevant and appropriate requirements are those that, while not applicable, still address problems or situations sufficiently similar to those encountered at the site that their use is well suited to the particular site. To-Be-Considered Criteria (TBCs) are non-promulgated advisories and guidance that are not legally binding but should be considered in determining the necessary level of cleanup for protection of health or the environment.

While TBCs do not have the status of ARARS, EPA's approach to determining if a remedial action is protective of human health and the environment involves consideration of TBCs along with ARARs.

The affected groundwater in the aquifers beneath the Redwing Site have been classified as Class IIB for the surficial groundwater and Class IIA for the alluvial aquifer. Class IIB groundwater is a potential drinking water source although the groundwater may not be currently used as such. Class IIA groundwater is a current source of drinking water. It is EPA's policy that groundwater resources be protected and restored to their beneficial uses. The six remedial alternatives with the exception of alternative one (no action) have components which may to some degree promote the beneficial use of the aquifers. A complete definition for groundwater classification is provided in the Guidelines for Ground-water Classification under the EPA Ground Water Protection Strategy, Final Draft, December 1986.

The action level for lead in groundwater (15µg) is the only TBC that has been identified at this time. The potential action specific, chemical specific and State ARARs are presented in Tables 21A, B and C.

TABLE 21A - ACTION-SPECIFIC FEDERAL ARARS FOR THE REDWING SITE		
CLEAN WATER ACT - 33 U. S. C. 1251-1376		
R & A	40 CFR Part 122, 125 - National Pollutant Discharge Elimination System	Requires permits for the discharge of pollutants for any point source into waters of the United States.
A	40 CFR Part 403 - National Pretreatment Standards	Sets standards to control pollutants which pass through or interfere with treatment processes in public treatment works or which may contaminate sewage sludge.
RESOURCE CONSERVATION AND RECOVERY ACT - 42 U.S.C. 6901-6987		
R & A	40 CFR Part 257 - Criteria for Classification of Solid Waste Disposal Facilities and Practices	Establishes criteria for use in determining which solid waste disposal facilities and practices pose a reasonable probability of adverse effects on public health or the environment.
R & A	40 CFR Part 262 - Standards Applicable to Generators of Hazardous Waste	Establishes standards for generators of hazardous wastes.
A	40 CFR Part 263 - Standards Applicable to Transportation of Hazardous Waste	Establishes standards which apply to transporters of hazardous waste within the U.S. if the transportation requires a manifest under 40 CFR PaRt 262.
R & A	40 CFR Part 264 - Standards for Owners and Operators of Hazardous Waste Treatment, Storage and Disposal (TSD) Facilities	Establishes minimum national standards which define the acceptable management of hazardous wastes for owners and operators of facilities which treat, store or dispose of hazardous wastes.
A	40 CFR Part 268 - Land Disposal	Identifies hazardous wastes that are restricted from land disposal and describes those circumstances under which an otherwise prohibited waste may be land disposed.

TABLE 21A - ACTION-SPECIFIC FEDERAL ARARS FOR THE REDWING SITE		
SAFE DRINKING WATER ACT		
A	40 CFR Parts 144 - 147 - Underground Injection Control Regulations	Provides for protection of underground sources of drinking water
HAZARDOUS MATERIALS TRANSPORTATION ACT - 49 U.S. C 1801-1813		
A	40 CFR Parts 107, 171-177 - Hazardous Materials Transportation Regulations	Regulates transportation of hazardous materials.

A = APPLICABLE REQUIREMENTS WHICH WERE PROMULGATED UNDER FEDERAL LAW TO SPECIFICALLY ADDRESS A HAZARDOUS SUBSTANCE, POLLUTANT, CONTAMINANT, REMEDIAL ACTION LOCATION OR OTHER CIRCUMSTANCE AT THE REDWING SITE.

R & A = RELEVANT AND APPROPRIATE REQUIREMENTS WHICH WHILE THEY ARE NOT "APPLICABLE" TO A HAZARDOUS SUBSTANCE, POLLUTANT, CONTAMINANT, REMEDIAL ACTION, LOCATION, OR OTHER CIRCUMSTANCE AT THE REDWING SITE, ADDRESS PROBLEMS OR SITUATIONS SUFFICIENTLY SIMILAR TO THOSE ENCOUNTERED AT THE REDWING SITE THAT THEIR USE IS WELL SUITED TO THE SITE.

TABLE 21B - CHEMICAL-SPECIFIC FEDERAL ARARS FOR THE REDWING SITE		
CLEAN WATER ACT - 33 U. S. C. 1251-1376		
R & A	40 CFR Part 131 - Ambient Water Quality Criteria requirements	Suggested ambient standards for the protection of human health and aquatic life.
A	40 CFR Part 403 - National Pretreatment Standards	Sets standards to control pollutants which pass through or interfere with treatment processes in publicly-owned treatment works or which may contaminate sewage sludge.
RESOURCE CONSERVATION AND RECOVERY ACT - 42 U.S.C. 6901-6987		
R & A	40 CFR Part 261 - Identification and Listing of Hazardous Wastes	Defines those solid wastes which are subject to regulation as hazardous wastes under 40 CFR Parts 263-265 and Parts 124, 270, and 271.

TABLE 21B - CHEMICAL-SPECIFIC FEDERAL ARARS FOR THE REDWING SITE		
R & A	40 CFR Part 262 - Standards Applicable to Generators of Hazardous Waste	Establishes standards for generators of hazardous waste.
CLEAN AIR ACT - 42 USC Section 7401 - 7642		
R & A	40 CFR Part 50 - National Primary and Secondary Ambient Air Quality Standards	Establishes standards for ambient air quality to protect public health and welfare.
SAFE DRINKING WATER ACT - 40 USC Section 300		
R & A	40 CFR Part 141 - National Primary Drinking Water Standards	Establishes maximum contaminant levels (MCLs) which are health-based standards for public water systems.
R & A	PL No. 99-339 100 Stat.462 (1986) - Maximum Contaminant Level Goals (MCLGs)	Establishes drinking water quality goals set at levels of no known or anticipated adverse health effects with an adequate margin of safety.

A = APPLICABLE REQUIREMENTS WHICH WERE PROMULGATED UNDER FEDERAL LAW TO SPECIFICALLY ADDRESS A HAZARDOUS SUBSTANCE, POLLUTANT, CONTAMINANT, REMEDIAL ACTION LOCATION OR OTHER CIRCUMSTANCE AT THE REDWING SITE.

R & A = RELEVANT AND APPROPRIATE REQUIREMENTS WHICH WHILE THEY ARE NOT "APPLICABLE" TO A HAZARDOUS SUBSTANCE, POLLUTANT, CONTAMINANT, REMEDIAL ACTION, LOCATION, OR OTHER CIRCUMSTANCE AT THE REDWING SITE, ADDRESS PROBLEMS OR SITUATIONS SUFFICIENTLY SIMILAR TO THOSE ENCOUNTERED AT THE REDWING SITE THAT THEIR USE IS WELL SUITED TO THE SITE.

TABLE 21C -STATE OF ALABAMA ARARS FOR THE REDWING SITE		
REGULATION	**APPLICABLE OR RELEVANT AND APPROPRIATE**	**BASIS FOR DETERMINATION**
Alabama Water Pollution Control Act code of Alabama, Title 22, Chapter 22 - Water Improvement Commission)	APPLICABLE REQUIREMENT WHICH WAS PROMULGATED BY THE STATE OF ALABAMA TO SPECIFICALLY ADDRESS A HAZARDOUS SUBSTANCE, POLLUTANT, CONTAMINANT, REMEDIAL ACTION LOCATION OR OTHER CIRCUMSTANCE AT THE REDWING SITE.	Establishes standards for limits of pollution and quality of water.

TABLE 21C -STATE OF ALABAMA ARARS FOR THE REDWING SITE		
Alabama National Pollutant Discharge Elimination System Permit Regulations (Alabama Administrative Code, Department of Environmental Management, Water Division, Water Quality Program, Chapter 335-6-6 NPDES; adopted October 19, 1979; amended January 24, 1989)	*APPLICABLE REQUIREMENT WHICH WAS PROMULGATED BY THE STATE OF ALABAMA TO SPECIFICALLY ADDRESS A HAZARDOUS SUBSTANCE, POLLUTANT, CONTAMINANT, REMEDIAL ACTION LOCATION OR OTHER CIRCUMSTANCE AT THE REDWING SITE.*	State administered permit program comparable to the National permitting system.
Alabama Primary Drinking Water Standards (Alabama Administrative Code, Department of Environmental Management, Water Division - Water supply Program, Chapter 335-7-2-Primary Drinking Water Standards; Adopted January 4, 1989)	*APPLICABLE REQUIREMENT WHICH PROMULGATED BY THE STATE OF ALABAMA TO SPECIFICALLY ADDRESS HAZARDOUS SUBSTANCE, POLLUTANT, CONTAMINANT, REMEDIAL ACTION LOCATION OR OTHER CIRCUMSTANCE AT THE REDWING SITE.*	Applicable to water systems required to monitor for various contaminants.
Maximum Concentration of Constituents for Groundwater Protection (Alabama Administrative Code, Department of Environmental Management, Hazardous Waste Program, Chapter 335-14-5.06-Releases from Solid Waste Management Units; adopted June 8,m 1983; amended January 25, 1992)	*RELEVANT AND APPROPRIATE REQUIREMENT WHICH WHILE IT IS NOT "APPLICABLE" TO A HAZARDOUS SUBSTANCE, POLLUTANT, CONTAMINANT, REMEDIAL ACTION, LOCATION, OR OTHER CIRCUMSTANCE AT THE REDWING SITE, ADDRESS PROBLEMS OR SITUATIONS SUFFICIENTLY SIMILAR TO THOSE ENCOUNTERED AT THE REDWING SITE THAT THEIR USE IS WELL SUITED TO THE SITE.*	Applies to owners/operators of facilities that transport, store, or dispose of hazardous waste.

8.0 SUMMARY OF COMPARATIVE ANALYSIS OF ALTERNATIVES

This section of the ROD provides the basis for determining which alternative provides the best balance with respect to the statutory balancing criteria in Section 121 of CERCLA, 42 U.S.C. Section 9621, and in the NCP, 40 C.F.R, Section 300.430. The major objective of the FS was to develop, screen and evaluate alternatives for the remediation of the Redwing Site. A wide variety of alternatives and technologies were identified as candidates to remediate the contamination at the Redwing Site. These were screened based on their feasibility with respect to the contaminants present and the site characteristics. After the initial screening, the remaining alternatives/technologies were combined into potential remedial alternatives and evaluated in detail. The remedial alternative was selected from the screening process using the following nine evaluation criteria:

- Overall protection of human health and the environment;
- Compliance with applicable and/or relevant Federal or State public health or environmental standards;
- Long-term effectiveness and permanence;
- Reduction of toxicity, mobility or volume of hazardous substances or contaminants;
- Short-term effectiveness or the impacts a remedy might have on the community, workers or the environment during the course of implementation;
- Implementability, that is, the administrative or technical capacity to carry out the alternative;
- Cost-effectiveness considering costs for construction, operation, and maintenance of the alternative over the life of the project, including additional costs should it fail;
- Acceptance by the State and
- Acceptance by the Community.

The NCP categorizes the nine criteria into three groups:

(1) Threshold Criteria - overall protection of human health and the environment and compliance with ARARs (or invoking a waiver) are threshold criteria that must be satisfied in order for an alternative to be eligible for selection;

(2) Primary Balancing Criteria - long-term effectiveness and permanence; reduction of toxicity, mobility or volume; short-term effectiveness; implementability and cost are primary balancing factors used to weigh major trade-offs among alternative hazardous waste management strategies; and

(3) Modifying Criteria - state and community acceptance are modifying criteria that are formally taken into account after public comments are received on the proposed plan and incorporated in the ROD.

The selected alternative must meet the threshold criteria and comply with all ARARs or be granted a waiver for compliance with ARARs. Any alternative that does not satisfy both of these requirements is not eligible for selection. The Primary Balancing Criteria is the technical criteria upon which the detailed analysis of alternatives is primarily based. The final two criteria, known as Modifying Criteria, assess the public's and the state agency's acceptance of the alternative. Based on these final two criteria, EPA may modify aspects of a specific alternative.

The following analysis is a summary of the evaluation of alternatives for remediating the Redwing Carriers Inc., (Saraland) Superfund Site under each of the criteria. A comparison is made between each of the alternatives for achievement of a specific criterion.

8.1 THRESHOLD CRITERIA

Overall Protection of Human Health and the Environment

Each of the alternatives with the exception of Alternative 1 and 2 would provide protection of human health and the environment by minimizing or controlling the risk associated with the contaminated soils through institutional controls and treatment or containment. Alternative 2 would rely on an ongoing maintenance endeavor to achieve satisfactory protection from direct contact with the source material, but is ineffective for protection of groundwater. Therefore, cleanup levels for groundwater would not be achieved with Alternative 2. The containment alternatives 4 and 5 would rely on continued maintenance to achieve satisfactory protection. These two alternatives provide overall protection by isolating the source material from potential direct contact, ingestion or inhalation. The surficial groundwater pump and treat action may eventually achieve the remedial objective for the surficial groundwater, however, the source material would remain. Therefore, overall protection may not be achieved with alternatives 4 and 5. Those alternatives involving excavation, (Alternatives 3 and 6), would minimize the majority of the risk by removing and treating the principal source of the soil and groundwater contamination. Alternatives 3 and 6 would provide the best overall protection because of removal and treatment of contaminated soils and groundwater.

Compliance with ARARs

Each of the remaining alternatives (alternatives 3, 4, 5 and 6) could comply with all Federal or State ARARs or justify a waiver. Chemical specific ARARs for groundwater would be met through compliance with the groundwater protection standards (ie., MCLs).

8.2 PRIMARY BALANCING CRITERIA

Long-Term Effectiveness and Permanence

The long-term effectiveness is demonstrated by treatment of contaminated soils and groundwater using proven technologies thus eliminating potential exposure and long term maintenance.

Alternatives 3, 4, 5 and 6 would provide long-term effectiveness through limiting the migration of contamination or treatment of the contaminated soils at the Redwing Site. For alternatives 4 and 5, long-term effectiveness relies on proper cap maintenance and continued extraction and treatment of groundwater. Implementation would require restricted use of the affected groundwater until the remedial cleanup goals are achieved. In Alternative 4, the contaminants are contained on-site in a RCRA landfill while Alternative 5 uses a concrete cap to prevent infiltration of rainwater into the contaminated soils. The long-term effectiveness of Alternative 4 and 5 is satisfactory since continuous inspection and monitoring would be required while allowing for the use of the property as an apartment complex. Alternatives 3 and 6 provide the best level of long-term effectiveness because treatment would be utilized to permanently remediate the soils and groundwater.

Reduction of Toxicity, Mobility or Volume Through Treatment

Alternatives 4 and 5 would isolate the contamination from the environment thus minimizing the forces which drive contaminant mobility. However, toxicity and volume would not be affected by Alternative 4 or 5. Alternatives 3 and 6 would reduce the mobility, toxicity, and volume of contaminants which are above acceptable risk levels.

Short-Term Effectiveness

Alternatives 3, 4, 5 and 6 will require varying amounts of time to implement. None are immediately implementable or effective. Threshold toxicity criteria would not be exceeded by implementing Alternatives 3 and 6. Health risks to remedial workers is unlikely since appropriate monitoring and engineering controls will be applied. Of the alternatives evaluated, Alternatives 3 and 6 are most effective because contaminated soils and groundwater would be removed and treated. However Alternative 6 would require a longer implementation time period because of the requirement for on-site treatment, thus reducing its short term effectiveness.

Implementability

Alternatives 3, 4, 5 and 6 are equally implementable but may require the temporary/permanent relocation of on-site residents to allow for excavation and construction. Alternative 4 may require permanent demolition of the on-site buildings located in the capped area. Complexities in the implementation of alternatives 3, 4 and 6 exist because remediation impacts on the apartment complex residents. Alternative 5 (Concrete Cap) design would be complex to allow for the continued use of the property as a pleasant living environment.

Cost

All of the alternatives which involve on-site treatment components have higher capital and present worth costs. However, the cost associated with Alternatives 3 and 6 (excavation with on-site/off-site treatment) would not extend into the operation and maintenance period except for a limited time to achieve the groundwater cleanup goals. Alternatives 4, and 5 would require expenditure of funds for an indefinite period of time.

Cost Summary

Since no action would be taken under alternative 1, no additional costs would be incurred. The other alternatives range in cost as shown below. Temporary relocation costs are not included in cost estimates for alternatives 3 and 6. Capital costs include direct and indirect costs. Operation and Maintenance costs are present worth dollars based on 5% discount rate. Implementation present worth is the sum of capital costs and the present worth of the total Operation and Maintenance expenditures.

Alternative	Capital Cost	O&M Costs	Present Worth Costs
2	$ 76,000	$ 482,000	$ 558,000
3	$6,484,763	$ 518,000	$7,002,562
4	$2,065,755	$1,805,000	$3,870,000
5	$1,811,017	$ 423,000	$2,233,751
6	$5,951,165	$ 217,000	$6,168,000

8.3 MODIFYING CRITERIA

State Acceptance

The State of Alabama has concurred with the selection of Alternative 3 to remediate the Redwing Site. The State of Alabama expressed concern that the originally proposed

Alternative 6 would not be the appropriate option for the Redwing Site. EPA took the state agency's concern into account and reevaluated the preferred alternative.

Community Acceptance

At the August 11, 1992 public meeting the primary concern expressed by the community was that the sludge and contaminated materials be removed from the Redwing Site. Implementation of an off-site option (Alternative 3) will provide a protective remedial alternative and satisfy the primary community concern.

9.0 THE 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 and groundwater remedy for this site. The risk associated with this site has been calculated at 10^{-6} at the completion of this remedy. This is determined to be protective of human health and the environment. The total present worth cost of the selected remedy, Alternative #3, is estimated at $7,002,562.

A. Source Control

Source control remediation will address the contaminated soils, sludges and sediments at the Site. Source control shall include excavation of soils, sludges and sediments, staging, dewatering, characterization, and transportation to an approved disposal facility.

A.1. The major components of source control to be implemented include:

Soils, sludges and related materials shall be excavated at the Redwing Site and staged on-site for off-site disposal. Excavation shall occur in all areas of site related contamination above cleanup levels. The concrete liners in the southern and eastern ditches shall be removed and excavation shall occur along past and present drainage pathways from the Redwing Site. Excavation shall continue until the remaining soils and sediments material achieve the levels specified in the tables below.

In order to comply with ARARs, source material may require pre-treatment prior to disposal. This may require thermal treatment of soils. Excavated subsurface soils may require dewatering and stabilization prior to land disposal. The water from the saturated soils must be analyzed and treated/disposed of in an appropriate manner.

Excavation may be accomplished with or without the removal of buildings or structures. While the areas of soil and sludge (i.e. source material) are excavated residents will be temporarily relocated. Source materials will be excavated and moved to a staging area on-site prior to being hauled off-site. Some of the excavated soils will be removed from the saturated zone and will require dewatering. Sidewalk slabs and pavement areas may be contaminated and thus require removal. Excavated areas will be backfilled with clean material. The excavated material will be sorted and characterized to determine if treatment is required before land disposal. If treatment is required it will be conducted off-site at an approved facility. All excavated soil, source material, sludge, and contaminated debris will be disposed of off-site at an approved facility.

Excavation of the surface soils and along the drainage pathways shall continue until the levels identified in the table below are met.

TABLE 22A SURFACE SOIL AND SEDIMENT EXCAVATION LEVELS

CONTAMINANT	EXCAVATION LEVEL (µg/kg)
BENZO (A) PYRENE	94.9
BENZO (B) FLUORANTHENE	540
BENZO (A) ANTHRACENE	1,025
CARBON TETRACHLORIDE	9,590
CHRYSENE	362

Excavation of materials shall occur in the subsurface soils contaminated with chemical concentrations above the levels identified in the table below:

TABLE 22B SUBSURFACE SOIL EXCAVATION LEVELS	
CONTAMINANT	EXCAVATION LEVEL (µg/kg)
4,4'-DDT	566
ACETONE	36
ALDRIN	4
ALPHA-BHC	0.5
CHLOROFORM	70
CHROMIUM	47,000
DIELDRIN	0.1
GAMMA-BHC (LINDANE)	3.2
METHYLENE CHLORIDE	0.6
NICKEL	30,000
VANADIUM	156,000
VERNOLATE	55

* If lead is detected in subsurface soils not already cited for remediation because the cleanup levels above have been exceeded, and the concentration of lead is greater than 54,000µg/kg; then groundwater and soil characterization will be conducted to determine if soil cleanup is required for the protection of groundwater at 15µg/l, the current action level for lead in groundwater.

A.2 Treatment of excavated material

The excavated material will be sorted and characterized for RCRA hazardous waste characteristics, to determine if thermal or other treatment is required before land disposal. If treatment is required it will be conducted off-site at an approved facility.

A.3. Performance Standards

The performance standards for this component of the selected remedy include, but are not limited to, the following excavation and treatment standards:

a. Excavation Standards:

Excavation shall continue until the remaining soil and material achieve the concentration levels identified in Table 22A and 22B of the previous section. All excavation shall comply with ARARs, including, but not limited to OSHA and state standards. Testing methods approved by EPA shall be used to determine if the concentration levels have been achieved.

b. Treatment Standards:

All excavated soils, sludges and related materials will disposed of at an appropriate approved facility. Pre-treatment may be required prior disposal. Treatment will be conducted at an approved facility.

B. Groundwater Remediation

Groundwater remediation will address the contaminated groundwater at the Redwing Site. Contaminated surficial groundwater will be extracted, treated on-site and discharged to the POTW or to a nearby surface waterbody if the POTW is unavailable and if appropriate limits can be met. The alluvial groundwater will be monitored to insure that chemicals of concern decrease to cleanup levels. If natural attenuation does not progress at a rate to meet cleanup levels within the timeframe of the active treatment of the surficial groundwater, the remedial design will be modified to include active treatment of the alluvial aquifer as well as surficial groundwater.

B.1. The major components of groundwater remediation to be implemented include:

Extraction and active treatment of the surficial groundwater. The major component of groundwater remediation to be implemented at the Redwing Site is installation of a network of extraction wells and french drains to extract contaminated groundwater from the surficial aquifer for on-site treatment with discharge to a POTW or to a nearby surface waterbody if appropriate limits can be met.

B.2. Extraction, Treatment, and Discharge of Contaminated Groundwater

The treatment system will use a biotreatment process and sand/activated carbon filtration to treat heavily contaminated groundwater. After concentrations decrease (estimated at 1,000,000 gallons), the system may be adjusted to reduce the rate of extraction or where only the filtration system is required. The groundwater may also contain contaminants which will not be effectively treated using a biotreatment process. These contaminants may require a supplemental treatment step as identified during the remedial design. Residual constituents in the biotreatment sludges or spent carbon will be disposed of at an approved facility.

It is predicted that approximately 12 million gallons of surficial groundwater must be treated to reduce concentrations to cleanup levels which are specified in Table 20 of this ROD and repeated in Section B.3 below. The groundwater cleanup time frame is estimated to be 7 years. The time may be shortened by putting nutrients into the surficial aquifer to enhance biodegradation.

B.3. Performance Standards

Groundwater shall meet the clean-up levels specified in the table below at the wells in the surficial and alluvial aquifers at the Redwing Site.

a. Extraction Standards:

Groundwater will be extracted from the surficial aquifer in a manner to be determined during the remedial design.

b. Treatment Standards:

Groundwater shall be treated until the cleanup levels identified below are attained at the wells designated by EPA as compliance points:

CONTAMINANTS OF CONCERN	**GROUNDWATER CLEANUP LEVEL (µg/l) ***
4,4'-DDT	0.158
ACETONE	1,120
ALDRIN	0.00317

CONTAMINANTS OF CONCERN	GROUNDWATER CLEANUP LEVEL (µg/l) *
ALPHA-BHC	0.00855
BERYLLIUM	4.00
BIS(2-ETHYLHEXYL)PHTHALATE	6.00
CARBON DISULFIDE	47.6
CHLOROFORM	100
CHROMIUM	50
DIELDRIN	.00337
GAMMA - BHC (LINDANE)	0.2
METHYLENE CHLORIDE	5
NICKEL	100
VANADIUM	78.1
VERNOLATE	11.2

* Based on MCL or Risk Assessment

c. Discharge Standards:

Discharges for the groundwater treatment system shall comply with all ARARs, including, but not limited to, POTW pretreatment requirements, substantive requirements of the NPDES permitting program under the Clean Water Act, 33 U.S.C Section 1251 et seq., and all effluent limits established by EPA.

d. Design Standards:

The design, construction and operation of the groundwater treatment system shall be conducted in accordance will all ARARs, including the RCRA requirements set forth in 40 C.F.R. Part 264 (Subpart F).

C. Compliance Monitoring

Groundwater monitoring shall be conducted at this site on a monthly basis at wells designated by EPA as compliance points.

After demonstration of compliance with Performance Standards, the Site including soil and groundwater shall continue to be monitored quarterly for five years. Inspection of surface soils for sludge seeps shall occur not less than monthly during the summer months of the year. If monitoring indicates that the Performance Standards set forth in Paragraph B.3 are being exceeded at any time after pumping has been discontinued, extraction and treatment of the groundwater will recommence until the Performance Standards are once again achieved. If monitoring of the remaining soil indicates Performance Standards set forth in Paragraph A.3 have been exceeded, the effectiveness of the source control component will be re-evaluated.

10.0 STATUTORY DETERMINATIONS

The selected remedy satisfies the requirement of CERCLA section 121 to protect human health and the environment by eliminating and by reducing risks posed through each pathway and population through treatment. The remedy ensures adequate protection of human health and the environment. The site risk will be reduced to the 10^{-6} risk range for carcinogens, and a Hazard Index for non-carcinogens of less than one.

No short-term risks or cross-media impacts will be caused by implementation of the remedy. The selected remedy satisfies the requirement of CERCLA section 121 to comply with ARARS.

The selected remedy provides overall effectiveness proportionate to its costs (i.e., is cost-effective). The selected remedy satisfies the requirement of CERCLA section 121 to utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable.

The selected remedy provides the best balance of tradeoffs among the alternatives with respect to the evaluation criteria. Those criteria that were most critical in the selection decision (i.e., those criteria that distinguish the alternatives most) are: Overall protection of human health and the environment, compliance with ARARs; reduction of toxicity, mobility and volume through treatment; long term effectiveness and permanence; state and community acceptance.

11.0 DOCUMENTATION OF SIGNIFICANT CHANGES

Significant changes from the Proposed Plan must be documented in accordance with CERCLA section 117(b). Although the changes from the originally proposed remedial alternative are significant they could have been reasonably anticipated by the public based on the alternatives and other information available in the proposed plan and the supporting analysis and information in the administrative record. Therefore, no additional public comment on the revised remedial alternative will be offered.

The State of Alabama indicated grave concern about the on-site treatment aspect of Alternative 6. This was due to the density of the population in close proximity to the on-site treatment of contaminated soils. The Region evaluated the State's concerns with great scrutiny and agreed that the selection of Alternative 3 provided for a better balance between the preference for on-site treatment, and the concerns for the overall negative effect on the community. Alternative 3 has therefore been selected as the final remedial alternative for the Redwing Site.

The soil clean-up levels protective of ground water generated by Redwing Carriers Inc., in the Draft Feasibility Study Report and subsequently put-forth in the Proposed Plan, were reviewed and revised. Redwing used the SUMMERS model to generate the levels and one correction was necessary for each compound. Redwing incorrectly calculated the octanol/water partitioning coefficient (Koc) because they used an equation that is specific to only certain compounds. EPA recalculated the soil clean-up levels using compound specific Koc values from the EPA publication entitled Basics of Pump-and-Treat Ground Water Remediation Technology. Table 18 reflects the results of these calculations.

Redwing did not use a site specific partitioning coefficient to determine the soil cleanup level for lead. It was determined that site specific values should be used. EPA performed a statistical analysis of site specific soil/water partitioning coefficients (Kd's) generated for the site rather than use the Kd that was used before. The cleanup level which was obtained for lead using this site specific Kd can been specified as an action level for further characterization of soil and groundwater in areas where cleanup levels for other constituents of concern have not been exceeded.

Although some of the cleanup levels contained in the Draft Feasibility Study were computed incorrectly they were calculated to achieve the remediation goals which would result in acceptable exposure levels that are protective of human health and the environment. The result of EPA's recalculation of the cleanup levels was that some of the levels became higher while others became lower, however, the final remediation goal remains the same. **In the case of the subsurface soil cleanup levels, protection of the groundwater as a potential drinking water source is the final remediation goal.** A comparison of the cleanup levels from the Draft Feasibility Study and EPA's recalculated values, is presented below:

SOIL CLEAN-UP LEVELS PROTECTIVE OF GROUND WATER
(all cleanup levels are in units of ug/kg)

Compound	Proposed Plan Cleanup Level	ROD Cleanup Level
DDT	131	566
Acetone	295	36
Aldrin	0.860	4
A-BHC	0.402	0.5
Chloroform	419	70
Chromium	85,800	47,000
Dieldrin	0.0959	0.1
G-BHC (Lindane)	9.40	3.2
Methylene Chloride	9.05	0.6
Nickel	30,300	30,000
Vanadium	157,000	156,000
Vernolate	56.0	55.0

APPENDIX B:CONCURRENCE LETTERS

ADEM

ALABAMA
DEPARTMENT OF ENVIRONMENTAL MANAGEMENT

Leigh Pegues, Director

1751 Cong. W. L. Dickinson Drive
Montgomery, AL 36130
(205) 271-7700
FAX 271-7950
270-5612

Field Offices:

110 Vulcan Road
Birmingham, AL 35209
(205) 942-6168
FAX 941-1603

P.O. Box 953
Decatur, AL 35602
(205) 353-1713
FAX 340-9359

2204 Perimeter Road
Mobile, AL 36615
(205) 450-3400
FAX 479-2593

Guy Hunt
Governor

November 30, 1992

Mr. Kenneth A. Lucas, RPM
U.S. EPA, SSRB
345 Courtland St. N.E.
Atlanta, GA 30365

Re: Redwing Carriers/Sarland Apartments NPL Site
Record of Decision

Dear Mr. Lucas:

The Alabama Department of Environmental Management (ADEM), Special Projects, received the second draft Record of Decision (ROD) for the Redwing Carriers/Saraland Apartments NPL Site on November 6, 1992, for review and requested concurrence.

This office appreciates the EPA's consideration of STATE concerns expressed in correspondence and at our September 29, 1992 meeting, with you and Mr. Arthur Collins, here in Montgomery.

The STATE concurs with this ROD, but has reservations that the selected remedy could be onerous to implement. We reiterate the position that protection of human health and the environment could be accomplished with a less extensive and disruptive alternative.

Confirmation of the presence or absence of source material beneath buildings can be ascertained by use of recently developed sensing equipment used in the oil industry and discussed with you.

It is suggested that the clean-up level for Methylene Chloride in subsurface soil and surficial groundwater may be at or below detection limits.

In Section 7.3, page 63, 2nd paragraph, thermal pre-treatment of source material and groundwater is not understood. We see similar language in the draft Scope of Work, received Wednesday, November 25, 1992. Applicable air emission standards would have to be met in the use of any thermal device.

Section 9.0 B., page 80, Groundwater Remediation, calls for discharge of treated water to be discharged to the POTW or to a nearby surface waterbody. Except for rain events, the closest waterbody is Norton Creek, 1/2 mile from the site.

Please be advised that concurrence with this ROD does not bind the STATE contractually to matching requirements in the event of Fund Lead remediation. If this Lead is followed, the department would approach the Legislature to request funds to meet the fiscal matching requirements concerning this Site.

If there are questions, call this office at (205)260-2787 or 260-2786.

Sincerely,

Daniel E. Cooper, Chief
Special Projects

/JEM/jdb