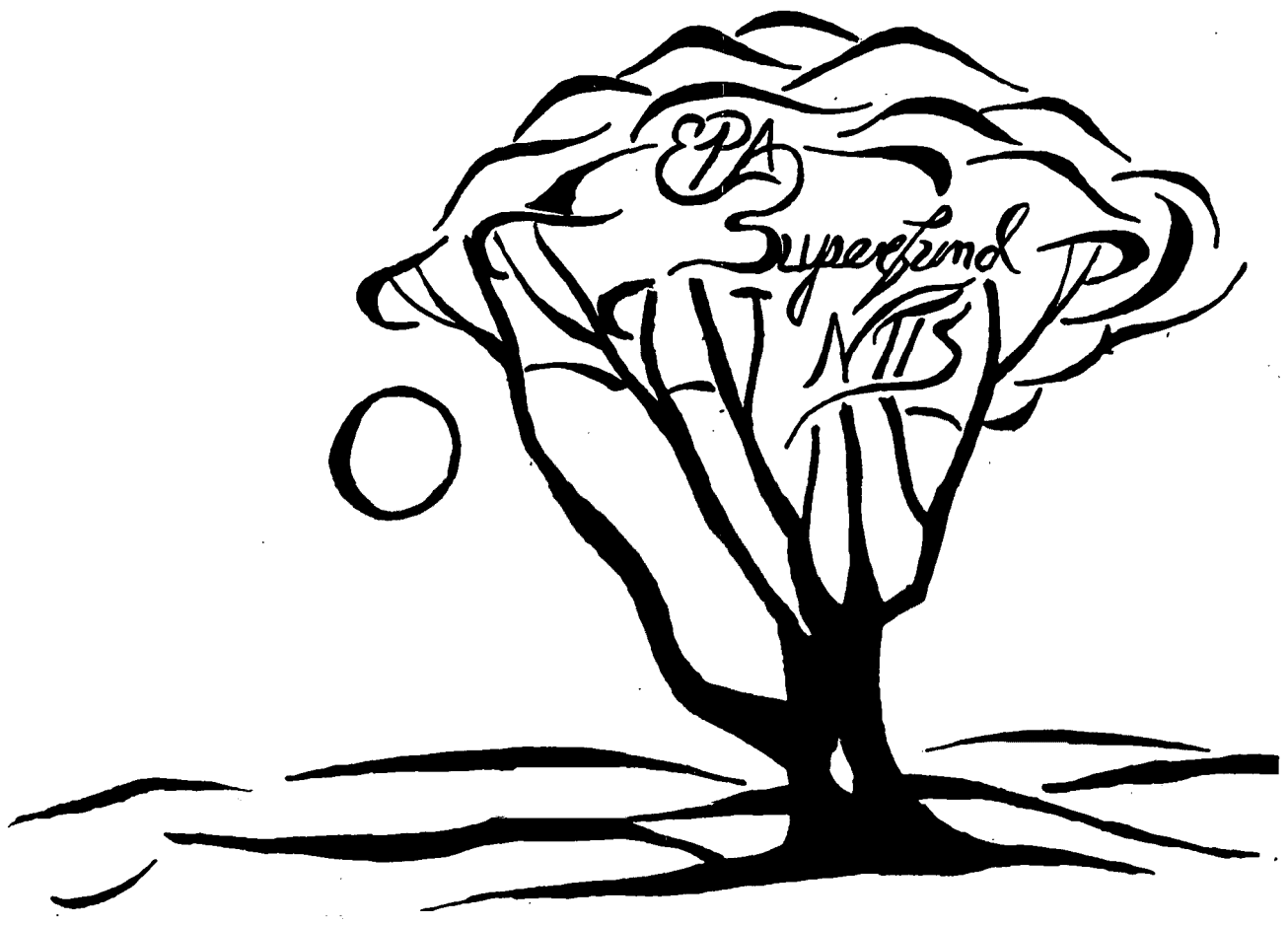
PB94-964051
EPA/ROD/R04-94/180
September 1994

EPA Superfund Record of Decision:

Davie Landfill Site,
Davie, FL,
8/11/1994



RECORD OF DECISION

SUMMARY OF REMEDIAL ALTERNATIVE SELECTION

DAVIE LANDFILL SITE

DAVIE, BROWARD COUNTY, FLORIDA

PREPARED BY

U. S. ENVIRONMENTAL PROTECTION AGENCY

REGION IV

ATLANTA, GEORGIA

RECORD OF DECISION
DECLARATION

SITE NAME AND LOCATION

Davie Landfill Site
Davie, Broward County, Florida

STATEMENT OF BASIS AND PURPOSE

This decision document (Record of Decision), presents the selected remedial action for the Davie Landfill Site, Davie, Broward County, Florida, developed in accordance with the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), 42 U.S.C. § 9601 et seq., and to the extent practicable, the National Contingency Plan (NCP), 40 CFR Part 300.

This decision is based on the administrative record for the Davie Landfill Site. The State of Florida, as represented by the Florida Department of Environmental Protection (FDEP), has reviewed the reports which are included in the administrative record for the Davie Landfill Site. In accordance with 40 CFR 300.430, as the support agency, FDEP has provided EPA with input on those reports. Based on comments received from FDEP, it is expected that written concurrence will be forthcoming; however, a letter formally recommending concurrence with the remedy has not yet been received.

ASSESSMENT OF THE SITE

Actual or threatened releases of hazardous substances from the Davie Landfill 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

This action is the second and final action planned for the Site. This action addresses ground water contamination at the Site and calls for the implementation of response measures which will protect human health and the environment.

The selected remedy relies on natural attenuation of vinyl chloride and antimony. A ground water monitoring program would be performed to ensure that attenuation is effective. Ground water would be monitored at wells along the perimeter of the landfill (compliance wells), as well as in residential wells near the Site, until levels of vinyl chloride and antimony reach cleanup goals or asymptotic levels. If contaminants are detected in residential wells in excess of cleanup goals, connections to the local public water supply will be provided to affected residents.

Attenuation of vinyl chloride is expected to take up to sixteen years. No estimate of the time required for antimony to attenuate could be made at this time; however, the levels of antimony detected are relatively low. Antimony is a metal and is expected to adhere to soil particles rather than move with the ground water. For these reasons natural attenuation of Antimony concentrations in ground water is expected to be effective.

The Site is being closed by Broward County under a permit with the State of Florida, in accordance with the Florida Administrative Code, Chapter 17-701, Solid Waste Management Facilities, and the monitoring required under this remedy is being addressed by the permit or other County and State actions.

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 threat at 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 may result in hazardous substances remaining onsite, a review was conducted within five years after commencement of the first remedial action and reviews will continue to be conducted at five-year intervals to ensure that the remedy continues to provide adequate protection of human health and the environment.

Patrick M Tobin for

JOHN H. HANKINSON, JR.
REGIONAL ADMINISTRATOR

August 11, 1994
DATE

TABLE OF CONTENTS

TABLE OF CONTENTS (continued)

TABLE OF CONTENTS (continued)

LIST OF TABLES

LIST OF TABLES (continued)

LIST OF FIGURES

1.0 SITE LOCATION AND DESCRIPTION

The Davie Landfill Site is located at 4001 S.W. 142nd Avenue in the Town of Davie, Broward County, Florida, approximately seven miles west of Ft. Lauderdale, Florida. The Site is situated between two major drainage canals. The North New River Canal is approximately 3.5 miles north of the Site and the South New River Canal (C-11) is approximately 0.25 miles south of the Site. The general location of the Site is illustrated in Figure 1-1.

The property surrounding the Site is located above the floodplain and is not classified as a wetland area. The 210-acre Site is comprised of a closed 68-acre trash landfill, a closed 48-acre sanitary landfill, and a pond (formally an 8-acres sludge lagoon). In addition, there are three onsite borrow pits which are now known as Lakes No. 1, 2, and 3. A dairy farm (Imagination Farms) borders the Site along the western, southern and most of the eastern boundaries. Camp Seminole of the South Florida Council of the Boy Scouts of America borders the Site along the northern boundary. The land use within three miles of the Site is a combination of commercial, residential, agricultural, and undeveloped land. See Figure 1-2, Site Map.

2.0 SITE HISTORY AND ENFORCEMENT ACTIVITIES

Operation of the Site began in 1964 with the start-up of the County's garbage incinerator and the opening of the trash landfill to accept trash, construction and demolition debris, and ash from the County's garbage incinerator. In November 1971, the sludge lagoon was created in a natural depression onsite to receive grease trap waste, septic tank waste, and treated municipal wastewater treatment plant sludges. In 1973, a water quality monitoring program was initiated by Broward County in cooperation with the U.S. Geological Survey (USGS). In June 1975, the incinerator was closed because particulate matter emissions failed to meet new air regulations. The sanitary landfill was opened in 1975 and operated until December 1987, when the entire Site was closed to all incoming waste.

The major source of contamination at this Site was the sludge lagoon. In 1975, the sludge lagoon received an estimated 2,500 tons of waste per month. In 1977, dikes were constructed around two sides of the sludge lagoon to increase the capacity of the lagoon to handle the volume of sludge disposal. Later, these dikes were raised to receive increased loads. By 1980, the volume of sludge placed in the lagoon had increased to approximately 7,100 tons per month.

In November 1981, concern regarding ground water contamination from the sludge lagoon resulted in EPA designating the Site as a hazardous waste site under CERCLA and prompted Broward County to cease all disposal operations at the lagoon.

FIGURE 1-1 GENERAL LOCATION MAP

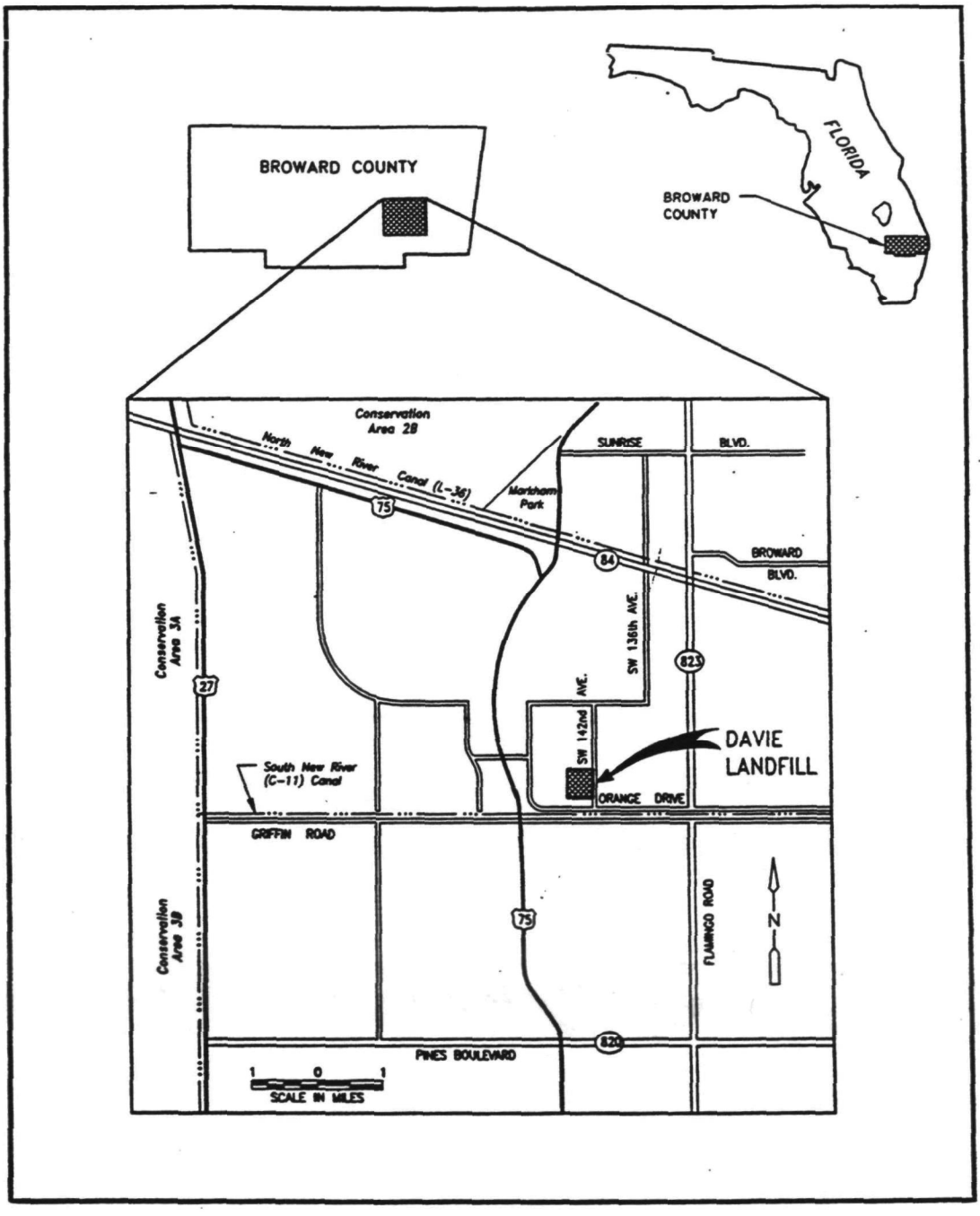
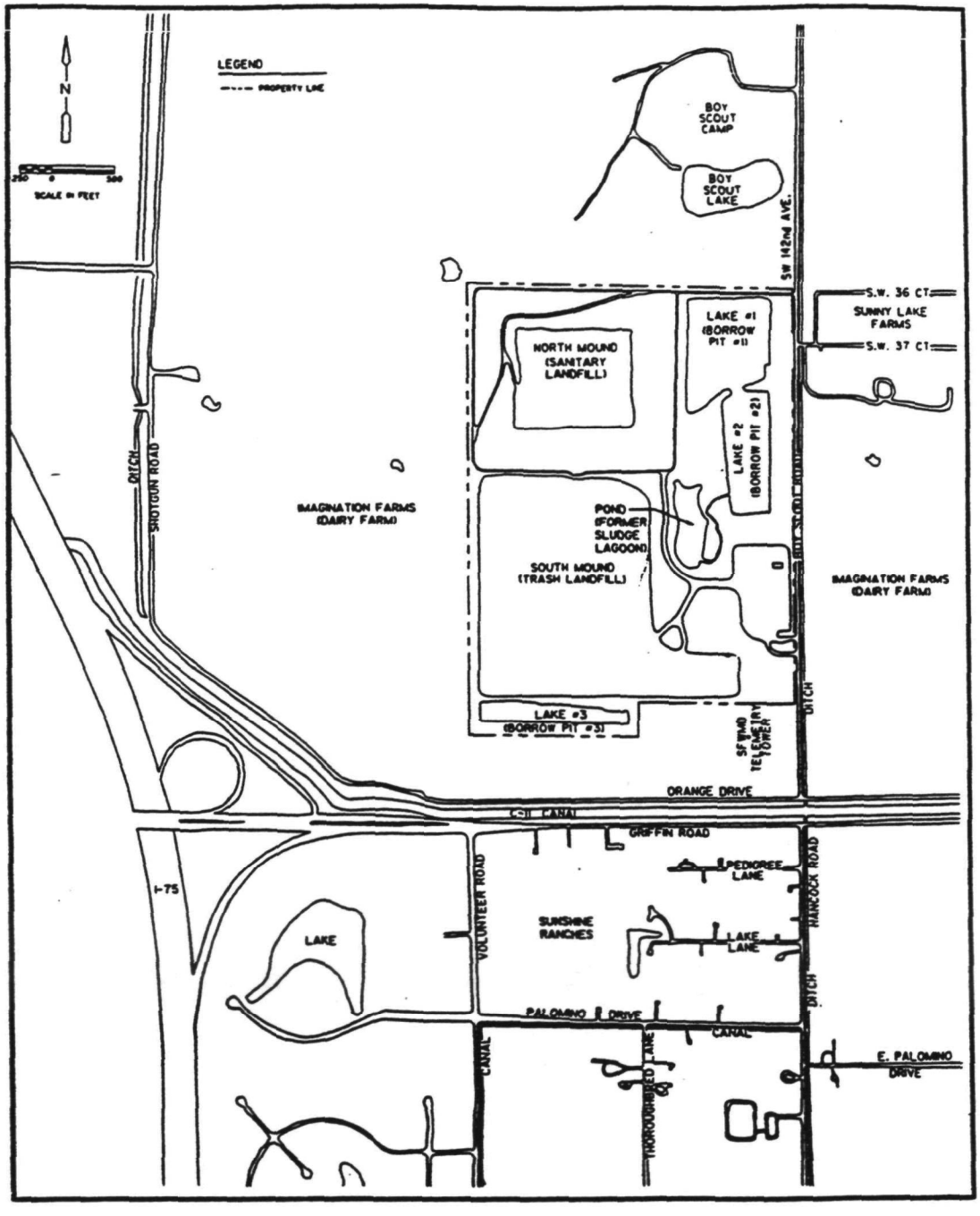


FIGURE 1-2 SITE MAP



In August 1982, EPA sampled the sludge in the lagoon and found high levels of total cyanides and total sulfides. Subsequent sampling, performed by EPA in 1983 and 1985, showed reduced concentrations of both contaminants. The Site was placed on EPA's National Priority List (NPL) as a superfund site in September 1983 due to concerns related to the sludge lagoon. On September 27, 1985, EPA issued a Record of Decision (ROD) regarding remediation of the sludge lagoon at the Site.

In 1988, Broward County Public Health Unit sampled private wells in the residential area south of the Site and found high levels of vinyl chloride. Broward County provided affected residents with bottled water and later municipal water service. Most residents continue to use their private wells for irrigation.

In 1989, the necessary remedial actions for the sludge lagoon clean up were performed by Broward County, pursuant to the ROD. The remedial activities included the stabilization of the sludge, relocation of the stabilized sludge to lined Cell No. 14 of the sanitary landfill and placement of a cap on Cell No. 14. The ROD addressed source control and indicated that a decision on additional action necessary to address ground water contamination would be made after an evaluation of the effects of the remedial action and further assessment of data from continued monitoring.

In 1992, EPA and Broward County entered into an Administrative Order by Consent (AOC), for the completion of the RI/FS process consistent with CERCLA and the NCP. The RI was finalized in January 1994. The FS was finalized in April 1994.

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 Site is located in a residential area, community relations activities have been focused on communication between the residents in the affected community and the government agencies conducting remedial activities at the Davie Landfill Site. Special attention has been directed toward keeping the community informed of all study results. Meetings were held with Town of Davie officials. In addition, an availability session was held with the community in February 1994 to inform residents of the results of the remedial investigation and risk assessment for the Site.

The Remedial Investigation Report, Baseline Risk Assessment Report, Feasibility Study Report, and Proposed Plan for the Davie Landfill Site were released to the public before May 9, 1994. These documents are incorporated in the Administrative Record for the Site. A copy of the Administrative Record, upon which the remedy is based, is located at the Broward County Public Library, 100 South Andrews Avenue, Ft. Lauderdale, Florida, and in the South Regional Campus of Broward County Community College, 7300 Pines Blvd., Pembroke Pines, Florida. In addition, the

Administrative Record and the Site (project) files are available for review at the EPA Region IV offices in Atlanta, GA. Notices of availability of these documents were published in the *Sun-Sentinel* on February 10 and 13, 1994 and May 8 and 11, 1994.

On May 19, 1994, EPA presented its preferred remedy for the Davie Landfill Site during a public meeting at the Town of Davie Community Hall, 6591 S.W. 45th Street, Davie, Florida. At this meeting, representatives of EPA answered questions about sampling at the Site and the remedial alternatives under consideration. A transcript of the meeting was prepared and is available at the information repositories.

A 30-day public comment period was held from May 9, 1994 through June 8, 1994. EPA's responses to comments which were received during the comment period are contained in Appendix A of this Record of Decision.

4.0 SCOPE AND ROLE OF ACTION

The work at Davie Landfill was organized into two operable units (OUs):

- OU1 for source control of contamination from the sludge lagoon; and
- OU2 for identification of any additional hot spots at the Site and remediation of ground water, as necessary.

EPA selected a remedy for OU1 in a ROD signed on September 27, 1985. That action was completed in 1989.

This ROD addresses the second remedial action for the Site. No additional hot spots were identified at the Site during the RI/FS for OU2. The function of this remedy is to reduce the risks associated with exposure to contaminated ground water. The ground water beneath the Site contains elevated levels of contaminants similar to that present in wastes and leachate at the Site. Although this water bearing zone is affected, the contamination is at very low levels and residents near the Site have been, and continue to be, connected to the public drinking water supply if the contamination begins to affect their private wells. The purpose of this proposed action is to prevent current or future exposure to contaminated ground water. OU2 will be the final response action for this Site.

5.0 SUMMARY OF SITE CHARACTERISTICS

5.1 Physiography and Topography

The Site exists on the western edge of the Atlantic Coastal Ridge in a transition area between the Everglades and the Atlantic Coastal Ridge. The Everglades region is

dominated by low lying marshes, sloughs, tree islands, and cypress forests. The Atlantic Coastal Ridge is characterized by higher topography and drained soils.

The topography in the vicinity of the Site is flat with the exception of two former beach dunes east and northeast of the Site, the C-11 Canal south of the Site, and the drainage ditch located east of the Site. Elevations in the vicinity of the Site range from 5 to 29 feet above National Geodetic Vertical Datum (NGVD) with the highest elevations located along the former beach dune ridges and the lowest elevations in the numerous canals and lakes in the area.

The topography at the Site is dominated by the two large landfill mounds in the northwest and the southwest corners of the Site as shown in Figure 1-2. The North Mound (sanitary landfill) rises to an elevation of 80 feet NGVD. The South Mound (trash landfill) rises to an elevation of approximately 60 feet NGVD. The lowest elevations at the Site exist in the pond (former sludge lagoon) and the borrow pit lakes in its eastern and southern portions.

5.2 Soils

Soils underlying the Site are predominantly classified by the Soil Conservation Service (SCS, 1984) as Udorthents. The SCS uses this term to describe soils that have been modified by spreading mixed limestone fragments, sand, and shell fill material over the natural surface for urban or recreational purposes. In a landfill setting, this fill material is typically excavated from borrow pits and spread over natural soil and solid waste.

The hydrologic properties of this soil type are highly variable and are dependent on the material, degree of compaction, and the slope and thickness of the layer. In areas where the Udorthents soils are poorly compacted, permeability is classified as rapid (6 to 20 inches/hour) and available water content is low. In addition, natural fertility and organic content are also low.

Prior to Site development, the dominant native soil type was classified as Hallandale fine sand. This soil type is still present on the undeveloped areas that surround the Site. Hallandale fine sand is a nearly level, poorly drained, and sandy soil found in the broad flats east of the Everglades and west of the Atlantic Coastal Ridge. It is underlain by limestone at a depth ranging from 7 to 20 inches. Permeability is moderate to moderately rapid throughout with water availability ranging from low to very low. Organic matter content and fertility are low.

5.3 Geology/Hydrogeology

The Site overlies and is open to the Biscayne aquifer, a water table system that has received sole source designation from EPA. In the area of the Site, the Biscayne aquifer is approximately 100 feet thick and is composed of two hydraulically

connected units. The upper unit is composed of approximately 15 feet of limestone and very fine grained quartz sand overlying about 35 feet of sand and sandstone. The total thickness of the upper unit is approximately 50 feet. The lower unit is composed of approximately 50 feet of sandstone with extensive solution cavities and vugs which are at least partially filled with very fine sand. The hydraulic conductivity of the upper unit is estimated to be 300 gallons per day per foot (gpd/ft). The hydraulic conductivity of the lower unit is estimated to be approximately 10,000 gpd/ft.

At a depth of approximately 200 feet below land surface, the base of the surficial aquifer system is reached. The lithologic unit that is of most importance in the confining sequence is the Miocene age Hawthorn Group. The predominance of clays and marls in the Hawthorn result in it being a confining unit between the Biscayne and Floridan aquifer systems.

In Broward County, the water available from the Floridan aquifer can not be utilized without some form of treatment due to high mineral content. In addition, the low permeability and extensive nature of the Hawthorn confining unit in the study area make the potential for chemical contaminants entering the Floridan aquifer remote. Therefore, the discussion of potentially affected aquifers will be limited to the Biscayne aquifer.

The regional ground water flow direction varies depending on the season and the elevation of the C-11 Canal. Regional ground water flow is generally from the northwest to the southeast. This regional pattern can be substantially altered by back-pumping of the C-11 Canal which is done typically during periods of high rainfall. The back-pumping of water from the C-11 Canal by the pumps at the S-9 control structure lowers the water level in the Canal and accentuates the southerly component of flow direction across the Site. During periods of high canal stage, ground water flow is away from the canal (to the north on the north side of the Canal and to the south on the south side of the Canal) and acts as a recharge mechanism for the aquifer.

5.4 Surface Water Hydrology

The Site is located in the C-11 drainage basin whose major features include the South (C-11) and North (L-36) New River Canals. The C-11 is approximately one-quarter of a mile south of the Site while the L-36 is located approximately 3 1/2 miles north of the Site. To the east of the Site along Boy Scout Road is a north-south trending drainage ditch that connects with the C-11 Canal (Figure 1-2). Approximate depth of this ditch is four feet. Another shallow ditch which also connects to the C-11 is present west of the Site along Shotgun Road. Neither of the ditches receive direct storm water runoff from the Site.

There is a perimeter berm around the Site sufficient to retain a 25-year, 72-hour storm onsite. All storm water from the Site is channeled to one of the onsite borrow pits/lakes or the pond (former sludge lagoon). A shallow ditch does separate the Site from the Boy Scout Camp. However, this ditch is dry most of the year and is on the north side of the perimeter berm which prevents landfill storm water runoff from entering this drainage ditch.

A Storm Water Management Plan (SWMP) for the landfill was prepared in December 1987 as part of the landfill closure design. The water management plan for the Site meets the South Florida Water Management District's (SFWMD's) criteria for the Site closure.

In accordance with SFWMD requirements, a dry retention area exists around the sanitary landfill. This retention area provides 1.4 inches of dry pretreatment volume, which exceeds the required 0.5 inch of dry pretreatment volume. The runoff contained in the retention area will pass through a 100-foot sand filter constructed as part of the landfill closure prior to discharging into Lake 1. Runoff in excess of 1.4 inches discharges into Lake 1 through an existing control structure constructed under the current SFWMD permit.

The Site is divided into two drainage areas. The northern area (81 percent of the Site) drains into two lakes, Lakes 1 and 2. The southwestern portion of the Site (19 percent of the Site) drains into Lake 3 which is not directly connected to the other two lakes. An overflow structure is located in the eastern berm along Lake 1 but has not been connected to the Boy Scout Road ditch. The control elevation of this structure is set at the 25-year storm stage, so that no overflow will occur until the water levels in the lakes exceed the 25-year storm stage. As part of the closure design, Lakes 1, 2, and the pond (former sludge lagoon) have been physically connected, thereby creating one water body. The overflow, when completed, will discharge into the ditch immediately east of Boy Scout Road through a proposed 36-inch culvert. This ditch connects into the C-11 Canal one-quarter mile south of the Site. Lake 3 has the capacity to retain a 25-year storm. No interconnect or outlet for Lake 3 currently exists.

The SFWMD allows 20 cubic feet per second per square mile (csm) or 6.5 cubic feet per second (cfs) offsite discharge from this Site for a 25-year design storm. The retention of the entire 25-year storm therefore exceeds the SFWMD's criteria. The design also includes a berm around the entire Site with a minimum crest elevation of 10.0 feet. The berm elevation was established so that the 25-year storm could be retained onsite, if required. The minimum building floor elevation within the Site is set at elevation 10.0 feet NGVD, thereby providing 25-year flood protection. The minimum road elevation is 10.0 feet NGVD. A No Discharge Permit application has been submitted to EPA under the National Pollution Discharge Elimination System (NPDES) program.

The side slopes of the landfill and the berms will have vegetation to prevent erosion from sheet flow. In areas where runoff is concentrated, inlets, drain pipes, and channels are being constructed as part of the closure plan to convey the runoff from the top of the landfill and down the side slopes into the retention areas.

5.5 Demography and Land Use

Broward County has an estimated population of 1,278,384, while the Town of Davie has an estimated population of 49,033 based on 1990 U.S. census results. Davie is located approximately 2.5 miles west of Fort Lauderdale, a major population center in the County. Cooper City, which is essentially surrounded by Davie on three sides, has a population of 22,108. Other population centers adjacent to Davie are Sunrise, Hollywood, Weston, Plantation, and unincorporated areas of Broward County.

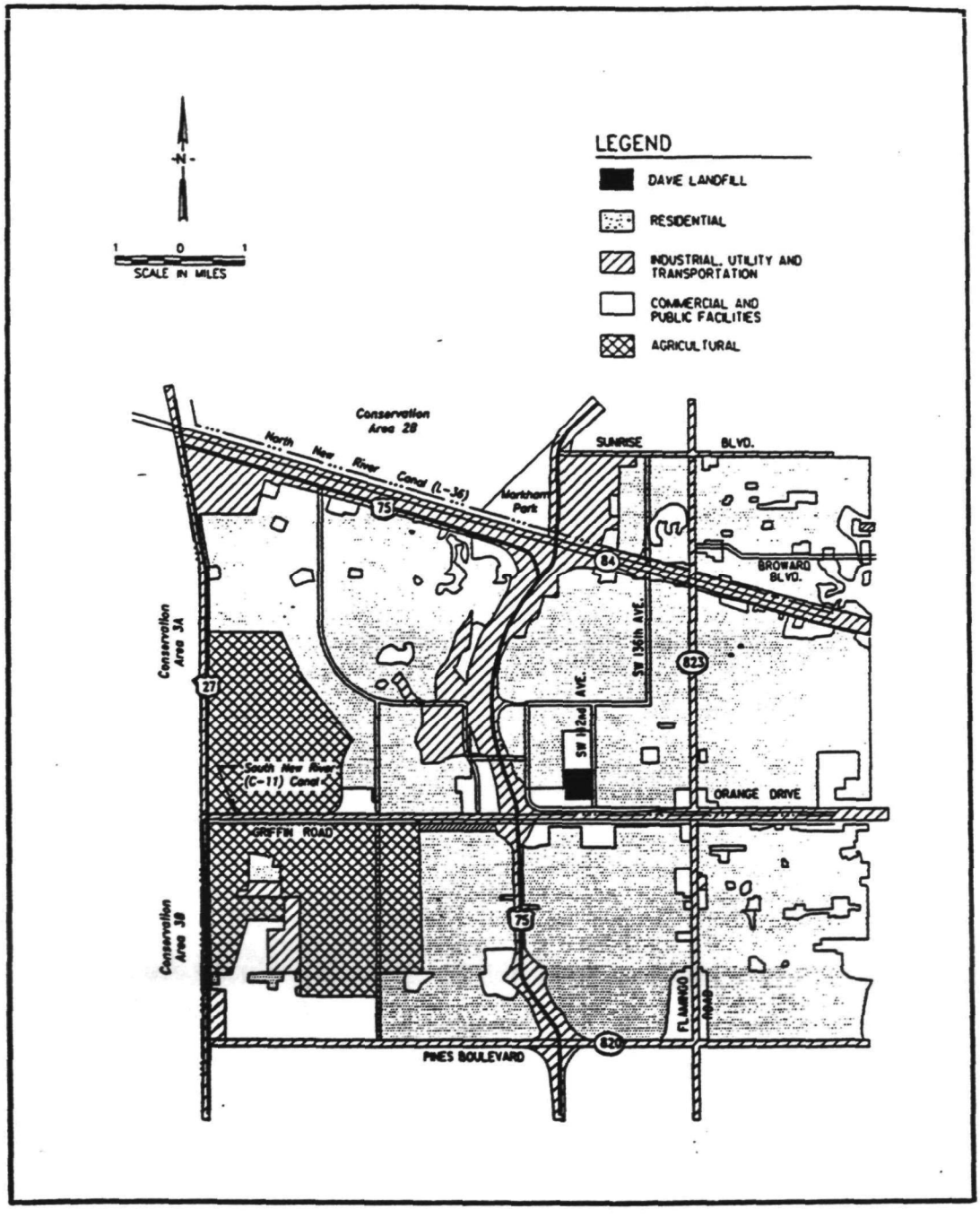
There are various land uses adjacent to the Site. To the north lies Camp Seminole of the South Florida Council of the Boy Scouts of America. Along the western, southern, and most of the eastern boundaries lies Imagination Farms, a dairy farm. To the northeast lies a single-family residential development, Sunny Lake Farms. A South Florida Water Management District (SFWMD) telemetry tower is located southeast of the Site along Boy Scout Road and adjacent to the C-11 Canal which is in the jurisdiction of the SFWMD. Just south of the C-11 Canal is the single family residential development, Sunshine Ranches. Surrounding area land uses as shown in the Broward County Land Use Plan prepared by the Broward County Planning Council (December 9, 1992) as shown in Figure 5-1.

Approximately half of the homes identified within a one-mile radius of the Site, in addition to Imagination Farms and the Boy Scout Camp, utilize private wells for domestic purposes (drinking, washing, irrigation, etc.) However, a number of these homes utilize bottled water for cooking and/or drinking purposes. Homes southwest of the Site are connected to a public water supply system, South Broward Utilities. In addition, a section of the Sunshine Ranches subdivision immediatley south of the Site is also connected to South Broward Utilities.

5.6 Ecological Survey

An ecological survey provided the basis for describing the primary ecological components of the Site. The purpose of this survey was to provide baseline information regarding major onsite habitats, vegetation types, and animal species prior to the initiation of closure activities at the Site. Due to past activities at the landfill, there was little remaining natural habitat at the Site. Major vegetation consisted largely of a stand of Brazilian Pepper and Australian Pine around the perimeter of the Site. Terrestrial features onsite (e.g., mounds, roads, parking areas) are influenced by past construction and present use. Aquatic features are, for the most part, also heavily influenced by past construction. For example, borrow pit

FIGURE 5-1 BROWARD COUNTY LAND USE PLAN



Lakes 1, 2, and 3 have unnatural straight-sided shapes, with steep banks and limited littoral zones. The pond (former sludge lagoon) is more natural in both overall shape and shoreline slope.

A relatively diverse and healthy biological community is present onsite. Ongoing closure activities have removed most existing vegetation for the purpose of replanting the Site with a diverse assembly of native species. These replantings will increase the habitat quality for local wildlife. The temporary loss of wildlife from construction activities and vegetation removal will probably be compensated rapidly by immigration of individuals from adjacent offsite locations. Species in addition to those presently onsite are expected to colonize onsite habitats as habitat diversity is increased. Plans to regrade (i.e., decrease the steepness of the slope) the shoreline edges of onsite lakes will increase littoral zone aquatic habitats. Littoral zones, or shallow water shorelines, play an important role in aquatic ecosystem function.

The initial biota survey of surface water bodies onsite was limited to shallow or near-shore areas accessible by foot. Shoreline vegetation consists of weedy species, including several types of grasses. A more comprehensive biota survey of deep waters was not justified based on the results of surface water and sediment sampling.

5.7 Summary of Site Contaminants

5.7.1 Substances Detected in Ground Water

5.7.1.1 Private Wells

Sixteen private homes south of the Site were sampled along with two wells at the Imagination Farms facility west of the Site and two wells at the Boy Scout Camp north of the Site for a total of 20 wells. The private well locations are shown on Figure 5-2. The results of the analyses for volatile organic compounds (VOCs), semi-volatile organic compounds, metals, and inorganic parameters are provided in Table 5-1, along with applicable federal and state primary and secondary drinking water standards. Primary drinking water standards are regulated and enforced by federal and state authorities to protect human health. Secondary drinking water standards are regulated by federal authorities but are not federally enforceable. Secondary drinking water standards are intended as guidelines for the states and address contaminants that affect aesthetic qualities related to public acceptance of drinking water (i.e., odor, taste, color, etc.).

One private well contained contamination that exceeded a primary drinking water standard (i.e., Maximum Contaminant Level (MCL)) for lead with a concentration of 45 ug/L (the primary MCL for lead is 15 ug/L). One well contained manganese at a concentration of 71.7 ug/L (the secondary standard for manganese is 50 ug/L). Another well contained aluminum at a concentration of 218 ug/L (the secondary

FIGURE 5-2: PRIVATE WELL SAMPLING LOCATIONS

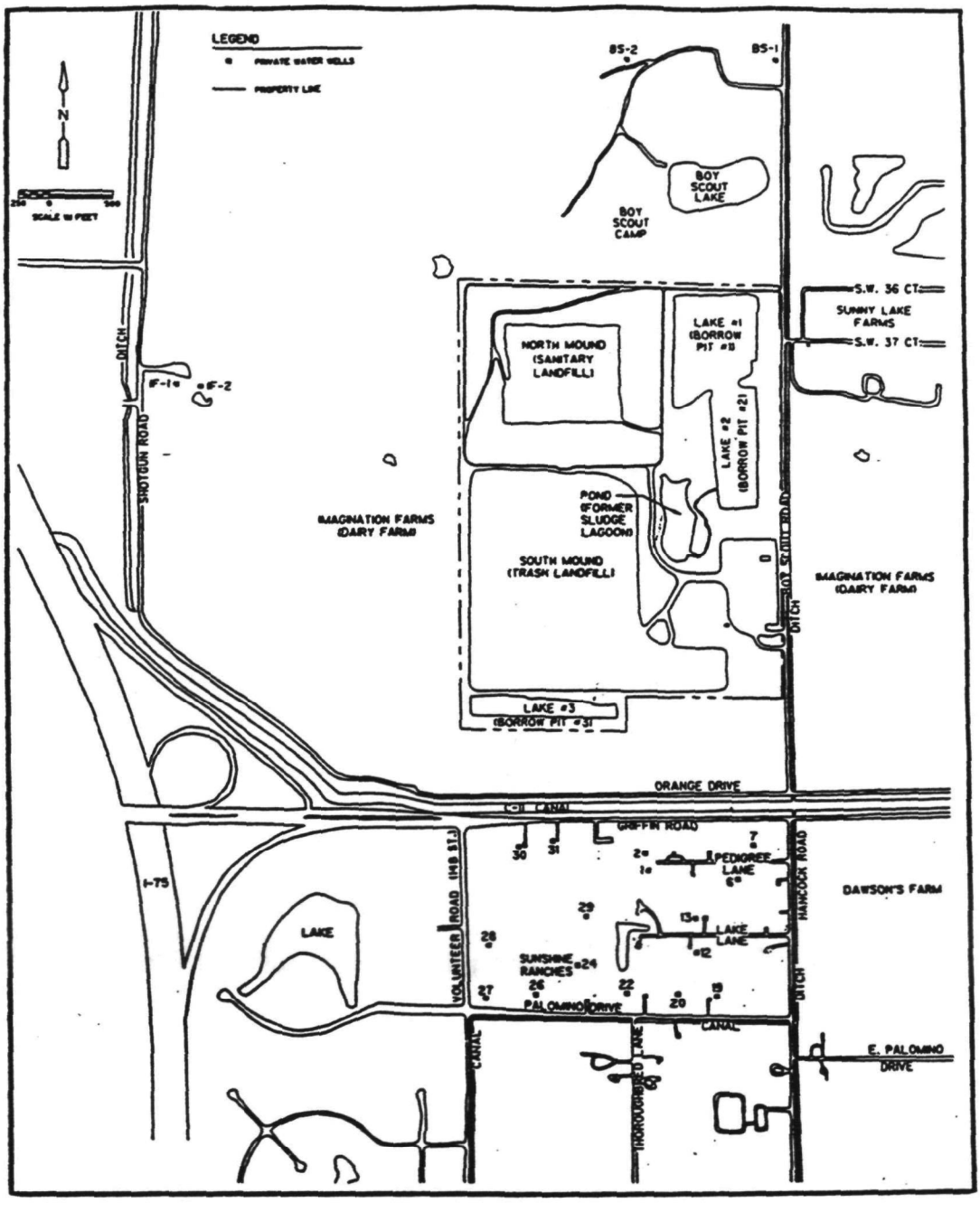


TABLE 5-1: CONTAMINANTS DETECTED IN PRIVATE WELL SAMPLING

Ground Water Analyte	Site-Related Samples		Background Sample (MW-22)		Ground Water Standards a) no standard, b) Secondary MCL, c) Primary MCL
	Frequency of Detection	Range of Detected Concentrations (µg/L)	Frequency of Detection	Range of Detected Concentrations (µg/L)	
METALS					
Aluminum	3/6	21.0 - 218	3/3	24.6-62	200 b)
Barium	6/6	18.4 - 76.0	3/3	15.8-31.2	2000 c)
Calcium	6/6	94,700 - 132,000	3/3	103,000-108,000	– a)
Cobalt	1/6	4.2	–	–	– a)
Cyanide	1/20	68	–	–	200 c)
Iron	20/20	110 - 17,300	3/3	3,110-11,600	300 b)
Lead	2/20	3.3 - 45	–	–	15 c)
Magnesium	6/6	6,075 - 10,500	3/3	5,310-8,900	– a)
Manganese	6/6	7.8 - 71.7	3/3	21.2-39.5	50 b)
Potassium	3/6	2,530 - 9,540	–	–	– a)
Sodium	6/6	18,450 - 97,700	3/3	9,790-40,700	160,000 c)
Vanadium	2/6	3.7 - 6.2	–	–	– a)
Zinc	9/20	19.4 - 190	3/3	22.4-39.4	5000 b)
SEMI-VOLATILES					
bis(2-ethylhexyl)phthalate	6/6	0.2 - 1.0	2/3	0.4-0.5	6 c)
1,4-Dichlorobenzene	2/6	0.3 - 0.4	–	–	75 c)
Di-n-butylphthalate	2/6	0.4 - 0.4	2/3	0.04-0.06	– a)
Pyrene	1/6	0.08	–	–	– a)
VOLATILE ORGANICS					
Chlorobenzene	1/20	7.0	–	–	100 c)
1,2-Dichloroethene	1/6	1.0	–	–	70 c)
INORGANIC PARAMETERS		(mg/L)		(mg/L)	(mg/L)
Alkalinity	20/20	160-460	3/3	250-290	– a)
BOD	1/20	2.2	2/3	2.2-4.4	– a)
Total Organic Carbon	20/20	13-32	3/3	22-32	– a)
COD	19/20	28-92	3/3	75-89	– a)
Chloride	20/20	23-200	3/3	18-68	250 b)
Fecal Coliform, col/100 mL	2/20	1-40	1/3	2	1 c)
Hardness	20/20	250-430	3/3	400-630	– a)
Nitrate	9/20	0.053-0.87	1/3	0.047	10 c)
Nitrite	4/20	0.011-0.025	–	–	1 c)
Ammonia, Nitrogen	20/20	0.23-9.3	3/3	0.27-0.99	– a)
Phenolics	1/20	0.014	–	–	– a)

TABLE 5-1: CONTAMINANTS DETECTED IN PRIVATE WELL SAMPLING (continued)

Ground Water Analyte	Site-Related Samples		Background Sample (MW-22)		Ground Water Standards a) no standard, b) Secondary MCL, c) Primary MCL
	Frequency of Detection	Range of Detected Concentrations (µg/L)	Frequency of Detection	Range of Detected Concentrations (µg/L)	
INORGANIC PARAMETERS (continued)		(mg/L)		(mg/L)	(mg/L)
Phosphorus	6/20	0.025-14	1/3	0.034	– a)
TDS	20/20	330-830	3/3	420-470	500 b)
Sulfate	16/20	5.9-52	2/3	6.4-12	250 b)
Turbidity, NTU	20/20	0.95-48	3/3	8-60	1 c)

– = There was no measurement above the detection limit.
µg/L = micrograms per liter
NA = Not Applicable

standard for aluminum is 200 ug/L). Based on the isolated exceedances noted in these wells, the metals detected appear to be reflective of contamination from plumbing rather than a ground water quality problems.

Iron was detected in excess of its secondary drinking water standard in every well except one. Concentrations ranged from 730 ug/L to 4400 ug/L. The secondary standard for iron is 300 ug/L. The only well which did not exceed the standard for iron had a concentration of 110 ug/L. Therefore, the high iron concentrations appear to be ambient to the area based on the high concentrations in almost all monitoring wells and private wells.

Concentrations of Total Dissolved Solids (TDS) ranged from 370 mg/L to 830 mg/L. Eight wells contained TDS in excess of ground water standards. The secondary ground water standard for TDS is 500 mg/L. Exceedances of TDS are considered Site related.

Of the remaining inorganic parameters, the only drinking water standards to be exceeded were fecal coliform and turbidity. Fecal coliform was detected in the two wells at Imagination Farms: one sample contained 1 col./100 ml. and the other contained 40 col./100 ml. The primary MCL for fecal coliform is a positive result (i.e., 1 col./100 ml.). The primary MCL for turbidity is 1 NTU. Turbidity exceeded 1 NTU in all wells except one. These exceedances are not considered Site related.

5.7.1.2 Ground Water

Thirteen new monitoring wells were installed as part of this investigation. The primary purpose for the additional wells was to better determine background/ ambient ground water quality. Ground water samples from these wells, along with 59 existing monitor wells, were collected and analyzed. The monitor well locations are shown on Figure 5-3. The results of the ground water monitor well analyses are summarized in Table 5-2.

All of the ground water samples were analyzed for VOC parameters. The only VOC parameter that was detected at concentrations above its primary drinking water MCL was vinyl chloride. Vinyl chloride was detected at an estimated concentration of 3 ug/L in the sample collected from MW 13-50 and at estimated concentrations of 2 ug/L in the ground water samples collected from MW 13-25, MW 18-75, MW 19-27, and MW 19-67. The state of Florida MCL for vinyl chloride in ground water is 1 ug/L while the federal MCL is 2 ug/L. Because a plume of vinyl chloride was associated with the Site in the past and because the wells in which vinyl chloride was detected are downgradient of the Site, vinyl chloride contamination is considered Site related.

FIGURE 5-3 GROUND WATER MONITORING WELL LOCATIONS

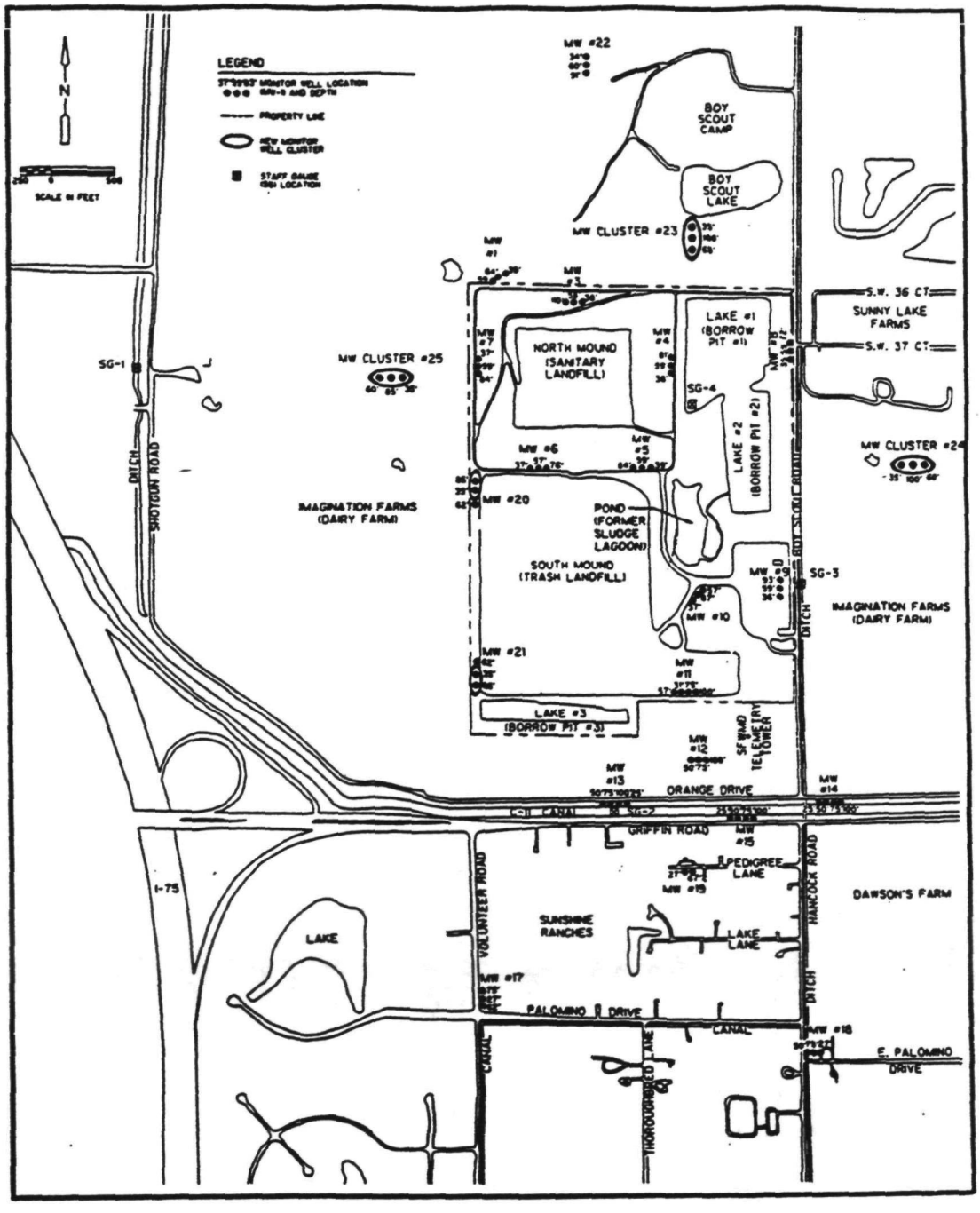


TABLE 5-2: CONTAMINANTS DETECTED IN GROUND WATER

Ground Water Analyte	Site-Related Samples		Background Sample (MW-22)		Ground Water Standards (ug/L) a) No Standard b) Secondary MCL c) Primary MCL
	Frequency of Detection	Range of Detected Concentrations (µg/L)	Frequency of Detection	Range of Detected Concentrations (µg/L)	
METALS					
Aluminum	18/19	21.8 - 3,720	3/3	24.6 - 62	200 b)
Antimony	3/19	15.0 - 19.1	–	–	6 c)
Arsenic	4/69	6.0 - 14	1/3	5.7	50 c)
Barium	19/19	24.6 - 172.5	3/3	15.8 - 31.2	2000 c)
Beryllium	3/19	1.0 - 1.1	–	–	4 c)
Calcium	19/19	9,700 - 233,000	3/3	103,000 - 108,000	– a)
Chromium	22/69	3.1 - 20	–	–	100 c)
Cobalt	2/19	3.8 - 304	–	–	– a)
Copper	3/69	4.3 - 33	–	–	1000 c)
Cyanide	14/69	10 - 67	–	–	200 c)
Iron	69/69	350 - 17,000	3/3	3,110 - 11,600	300 b)
Lead	4/69	4.8 - 7.3	–	–	15 c)
Magnesium	19/19	6,520 - 29,950	3/3	5,310 - 8,900	– a)
Manganese	19/19	11.5 -103	3/3	21.2 - 39.5	50 b)
Mercury	1/69	0.24	–	–	2 c)
Nickel	3/69	7.0 - 7.2	–	–	100 c)
Potassium	18/19	570 - 88,900	–	–	– a)
Sodium	19/19	15,800 - 191,000	3/3	9,790 - 40,700	160,000 c)
Thallium	1/19	5.0	–	–	
Vanadium	9/19	3.1 - 6.2	–	–	– a)
Zinc	68/69	13.0 - 296	3/3	22.4 - 39.4	5000 b)
SEMI-VOLATILES					
Acenaphthene	1/19	0.45	–	–	– a)
Anthracene	1/19	0.1	–	–	– a)
Bis(2-ethylhexyl)phthalate	19/19	0.1 - 2.0	2/3	0.4 - 0.5	6 c)
Butylbenzylphthalate	2/19	0.1 - 0.2	–	–	– a)
1,4-Dichlorobenzene	10/19	0.2 - 2.0	–	–	75 c)
Diethylphthalate	3/19	0.05 - 0.1	–	–	– a)
2,4-Dimethylphenol	1/19	0.3	–	–	– a)
Di-n-butylphthalate	14/19	0.06 - 0.6	2/3	0.04 - 0.06	– a)
Isophorone	1/19	0.08	–	–	– a)
2-Methylnaphthalene	1/19	1.0	–	–	– a)
4-Methylphenol	1/19	0.3	–	–	– a)
Pyrene	3/19	0.07 - 0.2	–	–	– a)

TABLE 5-2: CONTAMINANTS DETECTED IN GROUND WATER (continued)

Ground Water Analyte	Site-Related Samples		Background Sample (MW-22)		Ground Water Standards (µg/L) a) No Standard b) Secondary MCL c) Primary MCL
	Frequency of Detection	Range of Detected Concentrations (µg/L)	Frequency of Detection	Range of Detected Concentrations (µg/L)	
VOLATILE ORGANICS					
Acetone	8/69	5.0 - 5,600	2/3	6.0 - 16	– a)
2-Butanone	4/69	2.0 - 56.0	2/3	2.0	– a)
Carbon Disulfide	29/69	1.0 -140	2/3	4.0 - 5.0	– a)
Chlorobenzene	8/69	10.-14	–	–	100 c)
Chloroform	1/69	7.2	–	–	100 c)
1,2-Dichloroethene	7/19	1.0 - 3.0	–	–	70 c)
Vinyl Chloride	5/69	2.0 - 3.0	–	–	1 c)
PESTICIDES/PCBs					
4,4-DDD	1/69	0.025	–	–	– a)
4,4-DDT	2/69	0.044 - 0.071	–	–	– a)
INORGANIC PARAMETERS		(mg/L)		(mg/L)	(mg/L)
Alkalinity	69/69	180-900	3/3	250-290	– a)
BOD	52/69	1.6-30	2/3	2.2-4.4	– a)
Total Organic Carbon	69/69	11-93	3/3	22-32	– a)
COD	65/69	27-450	3/3	75-89	– a)
Chloride	69/69	8.5-320	3/3	18-68	250 b)
Fecal Coliform, col/100 mL	26/69	1-TNTC	1/3	2	1 c)
Hardness	69/69	130-630	3/3	400-630	– a)
Nitrate	13/69	0.013-0.96	1/3	0.047	10 c)
Nitrite	3/69	0.011-0.023	–	–	1 c)
Ammonia, Nitrogen	67/69	0.031-73	3/3	0.27-0.99	– a)
Phenolics	2/69	0.010-0.013	–	–	– a)
Phosphorus	42/69	0.011-2,200	1/3	0.034	– a)
TDS	69/69	250-1,700	3/3	420-470	500 b)
Sulfate	44/69	5.8-2500	2/3	6.4-12	250 b)
Turbidity, NTU	69/69	2.1-700	3/3	8-60	1 c)
pH, units	69/69	6.06-7.96	3/3	7.20-7.29	6.5-8.5 b)

– = There was no measurement above the detection limit.
µg/L = micrograms per liter
NA = Not Applicable
TNTC = Too Numerous To Count

With the exception of iron, only 8 of the 72 wells sampled contained metals which exceeded their respective drinking water standards. Sodium was detected in MW 11-31 at a concentration of 191 milligrams per liter (mg/L). The state primary drinking water MCL for sodium is 160 mg/L. Antimony was detected in wells MW 5-84, MW 11-57, and MW 18-27 at concentrations of 15 ug/L, 19.1 ug/L and 15.9, respectively. The primary drinking water MCL for antimony is 6 ug/L. Aluminum was detected in MW 13-50, MW 18-27, and MW 25-35 at concentrations of 3,720 ug/L, 379 ug/L, and 206 ug/L, respectively. The secondary drinking water standard for aluminum is 200 ug/L. Manganese was detected in MW 18-27, MW 18-50, and MW 18-75 at concentrations of 53 ug/L, 103 ug/L, and 74.4 ug/L, respectively. The secondary drinking water standard for manganese is 50 ug/L. Antimony is considered a Site related contaminant because ash in the trash landfill is a possible source. Sodium, aluminum, and manganese are not considered Site related contaminants due to the well locations and small number of exceedances.

Iron was detected in every sample analyzed in excess of the secondary drinking water MCL (300 ug/L). Iron concentrations ranged from 3110 ug/L to 11,600 ug/L in the background wells, (Well Cluster No. 22), to 17,000 ug/L at Well Cluster No. 4. The average iron concentration in the wells is 5,063 ug/L. High iron concentrations appear to be ambient to the area.

The primary drinking water MCL for fecal coliform is measured in bacteria colonies per 100 milliliters of sample (col./100 ml.). The MCL for fecal coliform is a positive result (i.e., 1 col./ 100 ml. or greater). Fecal coliform was detected in 27 wells across the Site area ranging in concentrations from 1 col./100 ml. to TNTC (too numerous to count). Fecal coliform bacteria was detected in the upgradient background wells located on the Boy Scout Camp (Well Cluster Nos. 22 and 23) as well as in the wells east and west of the Site (Well Cluster Nos. 24 and 25) and in wells downgradient of the Site south of the C-11 Canal (Well Cluster Nos. 15 and 18). A total of five clusters reported fecal coliform bacteria in all three wells. These clusters included MW-6, MW-8, MW-9, MW-12, and MW-23. Fecal coliform is not considered a Site related contaminant.

The primary drinking water MCL for turbidity is 1 NTU (Nephelometric Turbidity Unit). The MCL was exceeded in every sample collected. Turbidity values ranged from 2.1 NTU to 82 NTU except in sample MW-13-50, where turbidity was measured at 700 NTU. High turbidity is not considered a Site related problem.

Chlorides were detected in only two wells in excess of the secondary drinking water standard of 250 mg/L; MW 3-38 and MW 6-37 had chloride concentrations of 270 mg/L and 320 mg/L, respectively. These wells are located next to the north mound and exceedances are likely associated with the sanitary landfill.

TDS was detected in 45 well samples in concentrations exceeding the secondary drinking water standard. Concentrations in these wells ranged from 510 mg/L to 1,800 mg/L. The secondary standard for TDS is 500 mg/L. High TDS values are considered Site related.

Only one sulfate concentration exceeded the secondary drinking water standard of 250 mg/L. This concentration was detected at well MW 5-39 at a level of 2,500 mg/L. Sulfate is considered a Site related contaminant.

The secondary drinking water standard range for pH is 6.5 to 8.5 pH units. pH values below this range were measured in 11 samples from well clusters 7, 9, 12, 13, 15, and 19. The pH values from these samples ranged from 6.06 to 6.49. No pH values higher than 8.5 pH units were measured.

In summary, vinyl chloride and antimony are considered Site related contaminants which exceed primary drinking water standards. Neither contaminant was detected in a sufficient number of wells to define a plume. Chloride, TDS, and sulfate are considered Site related contaminants which exceed secondary drinking water standard. Only TDS was detected in a sufficient number of wells to define a plume. Chloride, TDS, and sulfate contamination may affect the aesthetic qualities of drinking water near the Site.

5.7.2 Substances Detected In Surface Water

Twenty-five surface water samples were collected from 15 locations. The surface water (SW) sample locations are shown on Figure 5-4. Three locations proposed for sampling in the Work Plan were dry and samples could not be collected (SW-1, SW-2, and SW-18). The analytical results for VOCs, semi-volatile organics, pesticides/PCBs, metals, and inorganics measured in the surface water bodies, are summarized in Table 5-3. Federal and state Water Quality Criteria (WQC) are provided in Table 5-3 for comparison with surface water contamination levels.

Iron was detected in all samples. Iron concentrations ranged from 39.1 ug/L at SW-10A to 8,920 ug/L at SW-8B. The sample from SW-8B was the only sample to exceed the state surface water standard of 1,000 ug/L for iron. High iron concentrations appear to be ambient to the area.

Beryllium was detected in two of the nine samples for which it was analyzed and was found at concentrations of 1.0 ug/L and 1.2 ug/L at SW-4A and SW-12A, respectively. These two samples exceeded the state surface water standard of 0.13 ug/L (annual average). SW-12A is a background sample from the C-11 canal, whereas, SW-4A was taken from the pond onsite.

FIGURE 5-4 SURFACE WATER, SEDIMENT, AND SOIL SAMPLING LOCATIONS

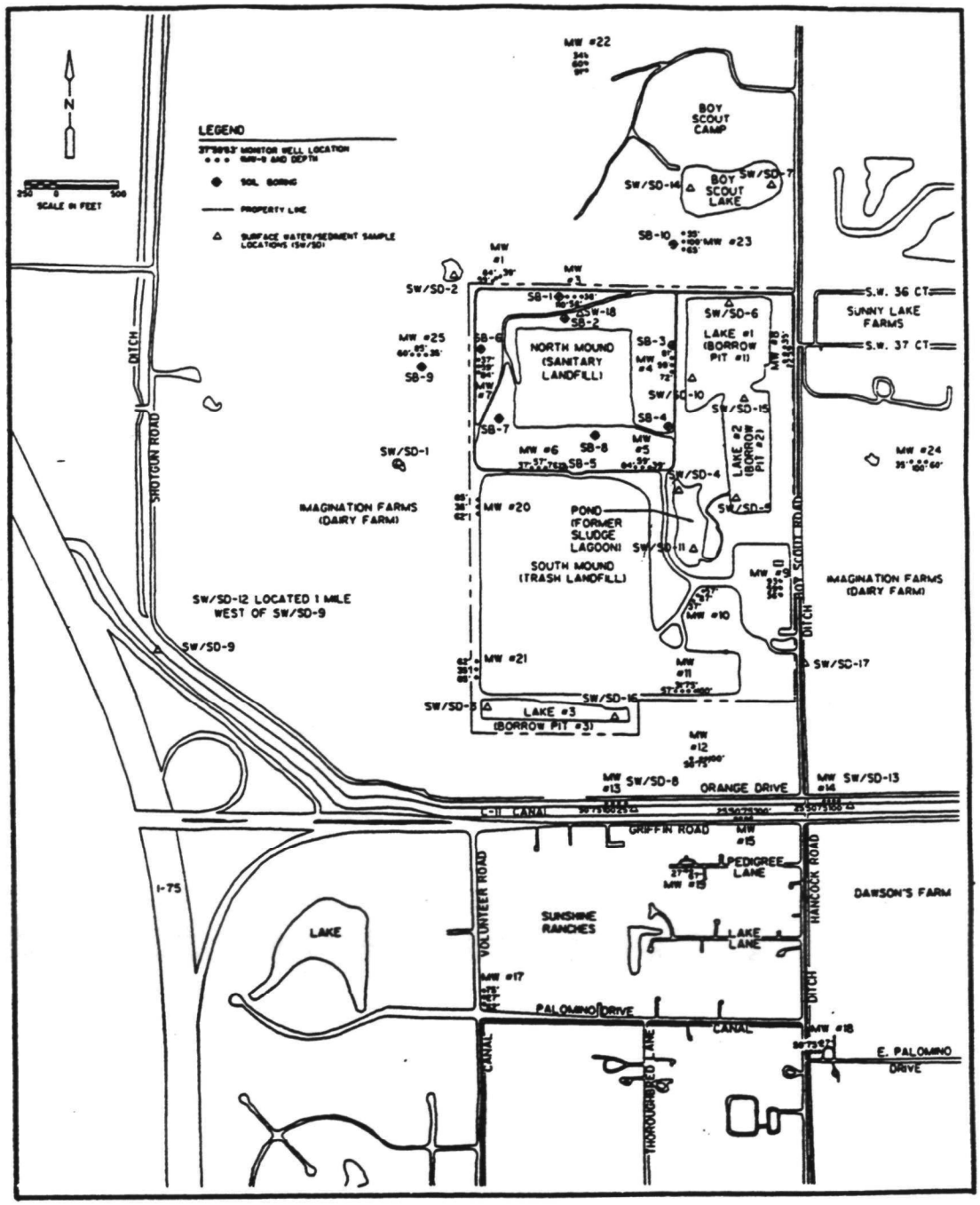


TABLE 5-3: CONTAMINANTS DETECTED IN SURFACE WATER

Surface Water Analyte	Site-Related Samples		Background Samples (SW-7A, SW-14A, SW-12A/B)		Freshwater Water Quality Criteria (ug/L)
	Frequency of Detection	Range of Detected Concentrations (µg/L)	Frequency of Detection	Range of Detected Concentrations (µg/L)	
VOLATILE ORGANICS					
Carbon Disulfide	2/21	1 - 7.5	1/4	21	2[d] a)
SEMI-VOLATILES					
bis(2-ethylhexyl)phthalate	4/6	0.1 - 0.7	2/3	0.2 - 0.3	3[e] b)
Di-n-butylphthalate	2/6	0.085 - 0.100	2/3	0.09 - 0.1	3[e] b)
METALS					
Aluminum	5/6	32.4 - 843	3/3	21.4 - 178	750/87 c)
Barium	6/6	10.8 - 62.1	3/3	4 - 32	NCA/50,000[f] a)
Beryllium	1/6	1.0	1/3	1.2	0.13(yr.avg) b)
Calcium	6/6	31,950 - 43,300	3/3	29,100 - 83,100	NCA
Copper	2/21	2.6 - 9.7	–	–	34.8[g] b)
Cyanide	1/21	11			5.2 b)
Iron	21/21	39.1 - 8920	4/4	50 - 371	1000 b)
Lead	2/21	3.9 - 5.4			15.9[g] b)
Magnesium	6/6	4,410 - 17,600	3/3	3,370 - 15,800	NCA
Manganese	6/6	1.2 - 16	3/3	7 - 10.6	NCA
Potassium	6/6	2,350 - 17,400	2/3	2,160 - 2,290	NCA
Sodium	6/6	24,300 - 74,200	3/3	9,610 - 69,700	NCA
Vanadium	5/6	3.4 - 20.7	1/3	4	NCA
Zinc	7/21	11.6 - 45.8	3/4	18.5 - 26.5	309[g] b)
PESTICIDES/PCBs					
alpha-BHC	1/21	0.012	–	–	NCA
delta-BHC	1/21	0.015	–	–	NCA
INORGANIC PARAMETERS		(mg/L)		(mg/L)	(mg/L)
Alkalinity	21/21	88-270	4/4	70-260	>20 b)
BOD	6/21	1.2-5.1	1/4	4.1	NCA
Total Organic Carbon	21/21	6.9-55	4/4	10-26	NCA
COD	15/21	21-170	2/4	87-130	NCA
Chloride	21/21	25-140	4/4	18-140	NCA
Fecal Coliform, col./100ml	17/21	1-410	4/4	4-94	NCA
Hardness	21/21	72-390	4/4	68-270	NCA
Nitrate	10/21	0.02-0.19	2/4	0.028-0.081	NCA
Nitrite	4/21	0.010-0.021	–	–	NCA
Ammonia, Nitrogen	21/21	0.011-5.8	2/4	0.014-0.18	0.02 b)
Phenolics	1/21	0.013	–	–	0.001 b)

TABLE 5-3: CONTAMINANTS DETECTED IN SURFACE WATER (continued)

Surface Water Analyte	Site-Related Samples		Background Samples (SW-7A, SW-14A, SW-12A/B)		Freshwater Water Quality Criteria (ug/L)
	Frequency of Detection	Range of Detected Concentrations (µg/L)	Frequency of Detection	Range of Detected Concentrations (µg/L)	
INORGANIC PARAMETERS		(mg/L)		(mg/L)	(mg/L)
Phosphorus	8/21	0.015-0.062	1/4	0.023	NCA
TDS	21/21	170-560	4/4	120-480	NCA
Sulfate	9/21	5.3-14	–	–	NCA
Turbidity, NTU	21/21	0.97-35	4/4	0.97-1.1	Background + 29
pH, units	21/21	6.74-8.65	3/3	7.61-8.41	Background + 1

NCA = No criteria available.
a) = Based on federal water quality criteria (40 CFR Part 131).
b) = Based on Florida Surface Water Standards (FAC, Chapter 17-302).
c) = Based on Region IV Waste Management Division Freshwater Quality Screening Values (November 16, 1992); acute/chronic.
[d] Based on undissociated H_2S.
[e] Based on phthalate esters.
[f] No WQC available; soluble barium concentration in freshwater would need to exceed 50 mg/L before toxicity to aquatic life is expected.
[g] Hardness-dependent criteria; value is based on a calculated average hardness of 354 mg/L $CaCO_3$ for ground water.

Fecal coliform were detected in 21 samples. Fecal coliform levels ranged from a low of 1 colony/100 ml. at four locations to a high of 410 colonies/100 ml. at SW-11A (the pond).

Ammonia nitrogen was detected in 23 samples ranging in concentration from 0.011 to 5.8 mg/L. Fifteen samples exceeded the surface water standard of 0.02 mg/L. Phenolics were detected in one sample, SW-6A in Lake 1, at a concentration of 13 ug/L. The state surface water standard for phenolics is 1 ug/L.

Turbidity of the samples ranged from 0.97 to 35 NTU. The state standard requires that the turbidity not be greater than 29 units above the background. One sample, SW-10B in Lake 1, is greater that 29 units above the background samples' turbidity.

Based on the contaminants detected, the most prevalent surface water contaminants are fecal coliform and ammonia nitrogen. These contaminants are as prevalent in offsite water bodies as in onsite water bodies. These are not considered Site related contaminants.

5.7.3 Substances Found In Sediments

Seventeen sediment samples were collected and analyzed in the sediment investigation. The sediment (SD) sampling locations are shown on Figure 5-4. The analytical results for VOCs, semi-volatile organics, pesticides/PCBs, metals, and inorganics detected in the sediments are summarized in Table 5-4. No applicable ARARs were identified to address contamination in sediments. The National Oceanic and Atmospheric Administration (NOAA) publishes sediment effect levels which are typically used as screening values for evaluation of ecological risk; those values are provided in Table 5-4 for comparison with onsite contamination levels.

Grain size analysis was performed on each sediment sample collected. The analyses represent the distributions of sediment grain size in the bottom of the surface water bodies where the samples were collected. The data indicates that approximately half of the sediment samples are predominantly of silt size and finer, while the other half falls into the fine to very fine grained sand size range.

In addition, six sediment samples were screened for dioxins using EPA Method 8270. Dioxin was not detected in any of the samples.

5.7.4 Substances Found In Soils

Ten soil samples were collected and analyzed as part of the soil investigation. The soil boring (SB) sampling locations are shown on Figure 5-4. The samples were collected from 0 to 2 ft depths from the surface. Table 5-5 provides a summary of VOCs, semi-volatile organics, pesticides/PCBs, metals, and other inorganic compounds detected in the soils. No applicable ARARs were identified to address contamination in soils.

TABLE 5.4: CONTAMINANTS DETECTED IN SEDIMENT

Sediment Analyte	Site-Related Samples		Background Samples (SD-1, SD-2, SD-7, SD-12, SD-14)		NOAA Biological Effect Levels (mg/kg)	
	Frequency of Detection	Range of Detected Concentrations (mg/kg)	Frequency of Detection	Range of Detected Concentrations (mg/kg)	ER-L	ER-M
VOLATILE ORGANICS						
Acetone	3/12	0.16 - 0.72	1/5	0.13	NELA	NELA
2-Butanone	1/12	0.39	1/5	0.045	NELA	NELA
Carbon Disulfide	1/12	0.092	1/5	9	NELA	NELA
Chlorobenzene	1/12	0.23	–	–	NELA	NELA
Toluene	1/12	0.011	–	–	NELA	NELA
SEMI-VOLATILES						
4-Methylphenol	1/4	0.025	–	–	NELA	NELA
bis(2-Ethylhexyl)phthalate	4/4	0.032 - 0.2	3/3	0.056 - 0.1	NELA	NELA
Benzo(b)fluoranthene	1/4	0.013	–	–	4 [a]	35 [a]
Benzo(k)fluoranthene	1/4	0.014	–	–	4 [a]	35 [a]
Butylbenzylphthalate	2/4	0.011-0.019	1/3	0.008	NELA	NELA
Di-n-butylphthalate	4/4	0.012 - 0.051	3/3	0.018 - 0.023	NELA	NELA
Fluoranthene	3/4	0.017-0.02	1/3	0.004	0.6	3.6
Phenanthrene	3/4	0.007-0.009	–	–	0.225	1.38
Pyrene	3/4	0.018 - 0.027	2/3	0.005	0.35	2.2
PESTICIDES						
4,4'-DDE	1/12	.001	–	–	0.002	0.015
METALS						
Aluminum	4/4	551 - 18,600	3/3	518 - 2,610	NELA	NELA
Arsenic	11/12	1.5 - 7.5	2/5	1.1 - 3.9	33	85
Barium	4/4	5.8 - 30	3/3	3.95 - 12.1	NELA	NELA
Beryllium	1/4	0.57	1/3	0.27	NELA	NELA
Cadmium	2/12	0.94 - 2	–	–	5	9
Calcium	4/4	19,800 - 197,000	3/3	12,000 - 103,000	NELA	NELA
Chromium	12/12	1.8 - 40.2	5/5	1.6 - 9.15	80	145
Cobalt	1/4	3.2	1/3	0.56	NELA	NELA
Copper	10/12	3.3 - 45	4/5	2.3 - 8.7	70	390
Cyanide						
Iron	12/12	2,010 - 28,000	5/5	756.5 - 5,830	20,000 [b]	40,000 [b]
Lead	12/12	2.6 - 44	5/5	2.3 - 22	35	110
Magnesium	4/4	229 - 1,630	3/3	318.5 - 588	NELA	NELA
Manganese	4/4	8.7 - 43.4	3/3	12.4 - 13.5	460 [b]	1,100 [b]
Mercury	5/12	0.072 - 0.17	–	–	0.15	1.3

TABLE 5.4: CONTAMINANTS DETECTED IN SEDIMENT (continued)

Sediment Analyte	Site-Related Samples		Background Samples (SD-1, SD-2, SD-7, SD-12, SD-14)		NOAA Biological Effect Levels (mg/kg)	
	Frequency of Detection	Range of Detected Concentrations (mg/kg)	Frequency of Detection	Range of Detected Concentrations (mg/kg)	ER-L	ER-M
METALS						
Nickel	8/12	5.5 - 13.7	3/5	1.2 - 2.5	30	50
Potassium	1/4	777	1/3	150	NELA	NELA
Silver	1/12	1.2	--	--	1	2.2
Sodium	4/4	103 - 456	3/3	68.45 - 339	NELA	NELA
Vanadium	4/4	3.1 - 77.2	3/3	1.55 - 17.1	NELA	NELA
Zinc	12/12	4.7 - 160	5/5	5.5 - 38	120	270

ER-L = NOAA effects range low.
ER-M = NOAA effects range median.
NELA = No effect level available.
[a] Based on total polynuclear aromatic hydrocarbons.
[b] OMOE (1990) Sediment Quality Guideline, low effect level and severe effect level.

TABLE 5-5: CONTAMINANTS DETECTED IN SOIL

Surface Soil Analyte	Site-Related Samples		Background Samples	
	Frequency of Detection	Range of Detected Concentrations (mg/kg)	Frequency of Detection	Range of Detected Concentrations (mg/kg)
METALS				
Aluminum	2/2	1,470 - 2,670	2/2	1,560 - 1,780
Antimony	1/2	9.2	–	–
Arsenic	2/8	1.0 - 4.9	1/2	1.2
Barium	2/2	24.0 - 24.1	2/2	1.4 - 3.3
Cadmium	2/8	0.4 - 0.5	–	–
Calcium	2/2	158,000 - 183,000	2/2	1,880 - 30,400
Chromium	8/8	6.5 - 8.8	2/2	4.9 - 5.1
Cobalt	2/2	0.4 - 0.6	1/2	0.8
Copper	6/8	2.6 - 55.8	–	–
Iron	8/8	460 - 2,130	2/2	543 - 989
Lead	7/8	1.4 - 9.1	2/2	1.4 - 1.5
Magnesium	2/2	1,140 - 1,190	2/2	65.4 - 131
Manganese	2/2	15.8 - 23.9	2/2	2.9 - 6.4
Mercury	5/8	0.03 - 0.2	–	–
Nickel	2/8	2.2 - 4.5	1/2	1.4
Potassium	2/2	182 - 248	1/2	70.9
Silver	2/8	1.0 - 2.4	1/2	0.44
Sodium	2/2	151 - 297	2/2	10.3 - 45.9
Vanadium	2/2	5.9 - 10.6	2/2	2.4 - 4.1
Zinc	7/8	4.6 - 47.6	2/2	2.2 - 3.7
VOLATILE ORGANICS				
Ethylbenzene	1/8	0.004	–	–
Xylenes	1/8	0.012	–	–
SEMI-VOLATILES				
Acenaphthene	1/2	0.027	–	–
Benzo(b)fluoranthene	2/2	0.007 - 0.015	–	–
Benzo(k)fluoranthene	1/2	0.012	–	–
Benzo(a)pyrene	1/2	0.011	–	–
bis(2-ethylhexyl)phthalate	2/2	0.081-0.22	2/2	0.01-0.04
Butylbenzylphthalate	2/2	0.012-0.016	2/2	0.007-0.011
Dibenzofuran	1/2	0.02	–	–

TABLE 5-5: CONTAMINANTS DETECTED IN SOIL (continued)

Surface Soil Analyte	Site-Related Samples		Background Samples	
	Frequency of Detection	Range of Detected Concentrations (mg/kg)	Frequency of Detection	Range of Detected Concentrations (mg/kg)
SEMI-VOLATILES				
1,2-Dichlorobenzene	1/2	0.014	–	–
1,4-Dichlorobenzene	1/2	0.062	–	–
Di-n-butylphthalate	2/2	0.035 - 0.059	2/2	0.027 - 0.032
Di-n-octylphthalate	1/2	0.15	–	–
Fluoranthene	2/2	0.008 - 0.01	1/2	0.004
Fluorene	1/2	0.035	–	–
2-Methylnaphthalene	1/2	0.1	–	–
Naphthalene	1/2	0.25	–	–
Phenanthrene	2/2	0.004 - 0.015	1/2	0.004
Pyrene	2/2	0.011 - 0.019	1/2	0.004
PESTICIDES/PCBs				
alpha-Chlordane	1/2	0.0033	–	–
gamma-Chlordane	1/2	0.003	–	–
4,4'-DDE	2/8	0.0014 - 0.0018	–	–

– = There was no measurement above the detection limit.
µg/L = micrograms per liter
NA = Not Applicable

6.0 SUMMARY OF SITE RISK

6.1 Risk Assessment Overview

CERCLA directs EPA to conduct a Baseline Risk Assessment (BRA) to determine whether a superfund site poses a current or potential threat to human health and the environment in the absence of any remedial action. The baseline risk assessment provides the basis for determining whether or not remedial action is necessary and the justification for performing remedial action.

The risk assessment is based on the data gathered in the *Remedial Investigation Report* (CDM,1993) and includes analyses of samples of ground water, surface water, sediment, and surface soil. Estimates of current risks are based on this investigation and in the absence of any site-specific remediation, future risk estimates are based on the assumption that current soil and ground water chemical concentrations will persist. Sections 6.2 through 6.6 address the risk assessment evaluation for human health. Section 6.7 describes the potential impacts on aquatic and terrestrial life associated with contamination at the Davie Landfill Site.

6.2 Contaminants of Potential Concern (COPCs) to Human Health

6.2.1 Screening Criteria

The chemicals measured in the various environmental media during the RI were evaluated for inclusion as chemicals of potential concern in the risk assessment by application of screening criteria. The screening criteria which resulted in elimination of chemicals included the following:

- Non-carcinogenic chemicals detected in a medium at a frequency of less than five percent may be deleted;
- Inorganic contaminant concentrations less than two times greater than the average detected value of the respective background sample may be deleted;
- Essential nutrients present at low concentrations (i.e., only slightly elevated above naturally occurring levels) and only toxic at very high doses may be deleted; and
- Non-carcinogenic chemicals that through an analysis of toxicity and concentration contribute less than one percent of the total risk may be deleted.

As a result of applying the above listed criteria, Table 6-1 lists the contaminants of potential concern (COPC) associated with the Davie Landfill Site. The chemicals listed in Table 6-1 are of greatest concern because of their toxicity, their relation to background concentrations, their prevalence onsite, and the likelihood of human exposure.

6.2.2 Contaminants of Potential Concern in Ground Water

Monitoring well cluster MW-22 (Figure 5-3) is upgradient of the Site and provided background ground water quality data. No inorganic chemicals could be eliminated from the ground water pathway based on the two times rule because all monitoring well data either exceeded two times the background levels or background levels were "non-detect". Five naturally occurring essential nutrients were eliminated because they were only slightly elevated above two times background levels; they are essential human nutrients; and they are toxic only at very high doses. Seventeen contaminants were eliminated by the concentration-toxicity screening.

Twenty chemicals reported in the downgradient and cross-gradient monitoring wells meet the COPC criteria (Table 6-1). These were evaluated in the quantitative risk assessment, but it should be noted that concentrations for a number of contaminants listed are below the drinking water standards or MCLs for these parameters.

6.2.3 Contaminants of Potential Concern in Soils

All analytical soil data were used in the identification of COPCs in soils. The background location used in the risk assessment was selected as a sampling site in which soil was undisturbed by either dairy farming or landfill activities. Three inorganics were eliminated based on a comparison to background levels. One inorganic was eliminated as an essential human nutrient that is only toxic at very high doses. Fourteen contaminants were eliminated through the concentration toxicity screening. Twenty chemicals reported in the soil meet the COPC criteria (Table 6-1). These were evaluated in the quantitative risk assessment.

6.2.4 Contaminants of Potential Concern in Surface Water

The surface water from Lakes 1 and 2 and the nature pond (former sludge lagoon) were evaluated together since these waterways are interconnected. The surface water from Lake 3 was evaluated separately, as was the surface water from the canals adjacent to the Site. Background surface water sample locations included SW-7 and SW-14 located at the Boy Scout lake and SW-12 located approximately 1.5 miles west of the landfill in the C-11 Canal.

TABLE 6-1: CONTAMINANTS OF POTENTIAL CONCERN

Contaminants	Ground Water	Soil	Surface Water (Lakes 1,2 & Pond)	Surface Water (Canals)	Sediment (Lake 1,2 & Pond)	Sediment (Lake 3)	Sediment (Canals)
INORGANICS							
Aluminum	X		X	X	X		
Antimony	X	X					
Arsenic	X	X					X
Barium	X	X		X	X		
Beryllium	X		X		X		
Cadmium		X			X		
Chromium (total)	X				X	X	X
Cobalt	X				X		
Copper		X	X	X	X		X
Cyanide	X			X			
Lead	X	X		X	X		X
Manganese	X	X			X		
Mercury		X			X	X	X
Nickel		X			X	X	X
Silver		X					
Thallium	X						
Vanadium		X	X	X	X		
Zinc		X			X		X
SEMI-VOLATILE ORGANICS							
Benzo(a)pyrene		X					
Benzo(b)fluoranthene		X			X		
Benzo(k)fluoranthene		X			X		
Bis(2-Ethylhexyl)phthalate	X	X	X	X	X		
1,4-Dichlorobenzene	X	X					X
Isophorone	X						

TABLE 6-1: CONTAMINANTS OF POTENTIAL CONCERN (continued)

Contaminants	Ground Water	Soil	Surface Water (Lakes 1,2 & Pond)	Surface Water (Canals)	Sediment (Lake 1,2 & Pond)	Sediment (Lake 3)	Sediment (Canals)
VOLATILE ORGANICS							
Acetone	X						
Carbon Disulfide	X		X				
Chloroform	X						
Vinyl Chloride	X						
PESTICIDES							
alpha-BHC (Lindane Isomer)			X				
delta-BHC (Lindane Isomer)			X				
alpha-Chlordane		X					
gamma-Chlordane		X					
4,4'-DDD	X						
4,4'-DDE		X					X
4,4'-DDT	X						

Lakes 1,2 and Nature Pond
Seven inorganics were eliminated based on the two times background rule. One naturally occurring essential nutrient was eliminated. One contaminant was eliminated based on the concentration toxicity screening. Eight contaminants reported in the surface water of Lakes 1 and 2 and the nature pond meet the COPC criteria (Table 6-1).

Lake 3
Only one contaminant (iron) was detected in the surface water of Lake 3, and it was eliminated from further consideration because it is an essential nutrients. Therefore, no contaminants reported in the surface water of Lake 3 meet the COPC criteria (Table 6-1).

Canals (i.e., C-11 and ditch on Boy Scout Road)
Five inorganics were eliminated based on the two times background rule. One naturally occurring essential nutrient was eliminated. No contaminants were eliminated based on the concentration toxicity screening. Seven contaminants reported in the surface water of the C-11 canal and the ditch on Boy Scout Road meet the COPC criteria (Table 6-1).

6.2.5 Contaminants of Potential Concern in Sediments

The sediments from Lakes 1 and 2 and the nature pond were evaluated together since these waterways are interconnected. The sediment from Lake 3 was evaluated separately, as was the sediment from the canals adjacent to the Site. Background sediment sample locations included SD-1 and SD-2 on Imagination Farms, SD-7 and SD-14 located at the Boy Scout lake, and SD-12 located approximately 1.5 miles west of the landfill in the C-11 Canal.

Lakes 1,2 and Nature Pond
One inorganic was eliminated based on the two times background rule. Five naturally occurring essential nutrients were eliminated. Ten contaminants were eliminated based on the concentration toxicity screening. Sixteen contaminants reported in the sediment of Lakes 1 and 2 and the nature pond meet the COPC criteria (Table 6-1).

Lake 3
Five inorganics were eliminated based on the two times background rule. No contaminants were eliminated based on the basis of being essential nutrients or due to the concentration toxicity screening. Three contaminants reported in the sediment of Lake 3 meet the COPC criteria (Table 6-1).

Canals (i.e., C-11 and ditch on Boy Scout Road)
Seven inorganics were eliminated based on the two times background rule. One naturally occurring essential nutrient was eliminated. Six contaminants were eliminated based on the concentration toxicity screening. Nine contaminants reported in the sediment of the C-11 canal and the ditch on Boy Scout Road meet the COPC criteria (Table 6-1).

6.3 Exposure Assessment

6.3.1 Introduction

The purpose of the exposure assessment is to estimate the magnitude of potential human exposure to the contaminants of potential concern at the Davie Landfill Site. Whether a contaminant is actually a concern to human health and the environment depends upon the likelihood of exposure, i.e. whether the exposure pathway is currently complete or could be complete in the future. A complete exposure pathway (a sequence of events leading to contact with a contaminant) is defined by the following four elements:

- a source and mechanism of release from the source;
- a transport medium (e.g., surface water, air) and mechanisms of migration through the medium;
- the presence or potential presence of a receptor at the exposure point; and
- a route of exposure (ingestion, inhalation, dermal absorption).

If all four elements are present, the pathway is considered complete.

6.3.2 Source, Mechanism of Release, and Transport

The source of contamination at the Site remains the trash and sanitary landfill mounds. The former sludge lagoon no longer appears to be a significant source of contamination. The two major constituent release and transport mechanisms potentially associated with the Site are as follows:

- The infiltration of precipitation through the landfill and the percolation of the resulting leachate into the ground water; and

- Release of leachate to surface waters, sediments, and soils through leachate seeps.

Because of the present landfill cover, the active landfill gas recovery system, and the minimal presence of VOCs in the contaminated media, exposure to constituents in air transport is not considered significant at the Site.

6.3.3 Potential Receptors and Routes of Exposure

Current
Currently, there are workers onsite conducting the closure of the landfill. There is, also, the possibility of trespassers gaining access to the Site by scaling the perimeter fence. These two populations could be exposed to surface soil, surface water, and sediments on the Site. Therefore, it was assumed that a hypothetical youth trespasser (age 7-16) and worker could be potentially exposed to the contaminants through dermal contact with and ingestion of contaminants in surface water, sediment, and surficial soils.

Future
Exposure to contaminated ground water was not evaluated for current residents living adjacent to the Site, since residents within areas of known contamination have been placed on municipal water. However, future residential exposure to ground water could occur if contaminated ground water spreads to new areas downgradient of the Site or if new wells are placed in contaminated ground water. In addition, area residents could potentially be exposed to surface water, surficial soils, and sediments if the landfill is opened as a park, which is the current plan for future land use at the Site. The future resident scenario was evaluated in order to evaluate these risks.

The County worker population can be receptors for contaminants in surface water and soils when onsite maintenance work is performed. The risk to these workers should be the same as that evaluated for the current worker.

6.3.4 Pathways

Table 6-2 outlines the potential pathways for both current and future use exposure scenarios. All possible pathways were first hypothesized and evaluated for completeness. The current pathways represent exposure pathways which could exist under current Site conditions while the future pathways represent exposure pathways which could exist, in the future, if the current exposure conditions change.

TABLE 6-2
POTENTIAL EXPOSURE PATHWAYS/ROUTES

Exposure Media	Scenario	Receptor	Exposure Pathways
Ground Water	Future	Resident (Child and Adult)	1.Ingestion of drinking water 2. Inhalation of VOCs released to indoor air 3. Dermal contact
Sediment	Current	Trespasser (Youth, 7-16) Adult Worker	1. Incidental ingestion 2. Dermal contact
Surface Water	Current	Trespasser (Youth, 7-16) Adult Worker	1. Incidental ingestion 2. Dermal contact
Surface Soils	Current	Trespasser (Youth, 7-16) Adult Worker	1. Incidental ingestion 2. Dermal contact
	Future	Resident (Child and Adult)	1. Dermal contact 2. Incidental ingestion

6.3.5 Exposure Point Concentrations and Dose Assumptions

The 95 percent upper confidence limit (UCL) on the arithmetic mean was calculated and used as the exposure concentration of contaminants of potential concern in each-media evaluated, unless it exceeded the maximum concentration. Where this occurred, the maximum concentration was used as the exposure point concentration for that contaminant. Exposures point concentrations are summarized in Section 6.4, Tables 6-3 through 6-6.

The exposure point concentrations for each of the contaminants of potential concern and the exposure assumptions for each pathway were used to estimate the chronic daily intakes for the potentially complete pathways. EPA guidance was used to determine parameters needed to calculate chronic daily intakes. The guidance addresses assumptions with regard to drinking water ingestion, inhalation of VOCs while showering, incidental ingestion of soil, dermal contact with soil, incidental water ingestion while wading, and dermal adsorption while wading.

6.4 Toxicity Assessment

The purpose of the toxicity assessment is to assign toxicity values (criteria) to each contaminant evaluated in the risk assessment. The toxicity values are used in conjunction with the estimated doses to which a human could be exposed to evaluate the potential human health risk associated with each contaminant. In evaluating

potential health risks, both carcinogenic and non-carcinogenic health effects were considered.

Cancer slope factors (CSFs) are developed by EPA under the assumption that the risk of cancer from a given chemical is linearly related to dose. CSFs are developed from laboratory animal studies or human epidemiology studies and classified according to route of administration. The CSF is expressed as $(mg/kg/day)^{-1}$ and when multiplied by the lifetime average daily dose expressed as mg/kg/day will provide an estimate of the probability that the dose will cause cancer during the lifetime of the exposed individual. This increased cancer risk is expressed by terms such as $1x10^{-6}$.. This is a hypothetical estimate of the upper limit of risk based on very conservative or health protective assumptions and statistical evaluations of data from animal experiments or from epidemiological studies. To state that a chemical exposure causes a $1x10^{-6}$ added upper limit risk of cancer means that if 1,000,000 people are exposed one additional incident of cancer is expected to occur. The calculations and assumptions yield an upper limit estimate which assures that no more than one case is expected and, in fact, there may be no additional cases of cancer. USEPA policy has established that an upper limit cancer risk falling below or within the range of $1x10^{-6}$ to $1x10^{-4}$ is acceptable.

The toxicity criteria used to evaluate potential non-carcinogenic health effects are reference doses (RfDs). The RfD is expressed as mg/kg/day and represents that dose that has been determined by experimental animal tests or by human observation to not cause adverse health effects, even if the dose is continued for a lifetime. The procedure used to estimate this dose incorporates safety or uncertainty factors that assume it will not over-estimate this safe dose. If the estimated exposure to a chemical expressed as mg/kg/day is less than the RfD, the exposure is not expected to cause any non-carcinogenic effects, even if the exposure is continued for a lifetime. In other words, if the estimated dose divided by the RfD is less than 1.0, there is no concern for adverse non-carcinogenic effects.

Exposure Point Concentrations and Toxicity Potency Factors used to calculate Human Health Risks are summarized in Tables 6-3 through 6-6.

6.5 Risk Characterization

To evaluate the estimated cancer risks, a risk level lower than $1x10^{-6}$ is considered a minimal or de minimis risk. The risk range of $1x10^{-6}$ to $1x10^{-4}$ is an acceptable risk range and would not be expected to require a response action. A risk level greater than $1x10^{-4}$ would be evaluated further and a remedial action to decrease the estimated risk considered.

TABLE 6-3: CONTAMINANTS OF POTENTIAL CONCERN IN GROUND WATER AND TOXICITY ASSESSMENT

Media and Chemical	Exposure Point Concentrations			Toxicity	
	Frequency of Detection	Exposure Pt. Conc.[1]	Background	CSF [3] 1/(mg/kg/day)	RfD [2] mg/kg/day
Ground water		µg/L	µg/L		
INORGANICS: Aluminum	18/19	500	24.6 - 62	NC	NC
Antimony	3/19	10.2	ND	NC	.0004
Arsenic	4/69	5.0	5.7	1.75	.0003
Barium	19/19	79.2	15.8 - 31.2	NC	.07
Beryllium	3/19	0.67	ND	4.3	.005
Chromium (total)[4]	22/69	7.5	ND	NC	.005
Cobalt	2/19	9.5	ND	NC	NC
Cyanide	14/69	9.2	ND	NC	.02
Lead	4/69	2.6	ND	NTV	NTV
Manganese	19/19	43.1	21.2 - 39.5	NC	.005
Thallium	1/19	2.8	ND	NC	NTV
VOLATILE ORGANICS: Acetone	8/69	48.9	6.0-16	NC	.1
Carbon Disulfide	29/69	12.6	4.0-5.0	NC	.1
Chlorobenzene	8/69	3.6	ND	NC	.02
Chloroform	1/69	3.5	ND	.0061	.01
Vinyl Chloride	5/69	3.0	ND	1.9	NC
SEMI-VOLATILES: bis(2-ethylhexyl)phthalate	19/19	1.4	0.4-0.5	.014	.02
1,4-Dichlorobenzene	10/19	2.0	ND	.024	.3
Isophorone	1/19	0.08	ND	.00095	.2
PESTICIDES/PCBs: 4,4-DDD	1/69	0.025	ND	.24	.003
4,4-DDT	2/69	0.05	ND	.34	.0005

1 Exposure Point Concentration defined as the 95% upper confidence chemical concentration or the maximum detected concentration, whichever is less.

2 Reference doses (RfDs) have been developed by EPA for indicating the potential for adverse health effects from exposure to chemicals exhibiting non-carcinogenic effects. Adapted from USEPA IRIS, 1993 and USEPA Health Effects Summary Table, OERR 9200.6-303 (1992).

3 Cancer potency factors (CPFs) have been developed for estimating excess lifetime cancer risks associated with exposure to potentially carcinogenic chemicals. Adapted from USEPA IRIS, 1993 and USEPA Health Effects Summary Table, OERR 9200.6-303 (1992), unless otherwise noted.

4 Exposure Point Concentration for total Chromium; toxicity for Chromium VI.

ND = Not Detected
NC = Not of Concern
NTV = No Toxicity Data Available

TABLE 6-4: CONTAMINANTS OF POTENTIAL CONCERN IN SOIL AND TOXICITY ASSESSMENT

Media and Chemical	Exposure Point Concentrations			Toxicity	
	Frequency of Detection	Exposure Pt. Conc.[1]	Background	CSF [3] 1/(mg/kg/day)	RfD [2] mg/kg/day
SOIL		mg/kg	mg/kg		
INORGANICS: Antimony	1/2	9.2	ND	NC	.0004
Arsenic	2/8	2.3	1.2	1.75	.0003
Barium	2/2	24.1	1.4-3.3	NC	.07
Cadmium	2/8	0.36	ND	NC	.001
Copper	6/8	55.8	ND	NC	NC
Lead	7/8	9.1	1.4-1.5	NTV	NTV
Manganese	2/2	23.9	2.9-6.4	NC	.14
Mercury	5/8	0.13	ND	NC	.0003
Nickel	2/8	2.9	1.4	NC	.02
Silver	2/8	1.3	0.44	NC	.005
Vanadium	2/2	10.6	2.4-4.1	NC	.007
Zinc	7/8	47.6	2.2-3.7	NC	.3
SEMI-VOLATILES: Benzo(b)fluoranthene	2/2	0.015	ND	.73	NC
Benzo(k)fluoranthene	1/2	0.012	ND	.73	NC
Benzo(a)pyrene	1/2	0.011	ND	7.3	NC
1,4-Dichlorobenzene	1/2	0.062	ND	.024	.3
PESTICIDES/PCBs: alpha-Chlordane	1/2	0.0033	ND	1.3	.00006
gamma-Chlordane	1/2	0.003	ND	1.3	.00006
4,4'-DDE	2/8	0.0018	ND	.34	.0007

1 Exposure Point Concentration defined as the 95% upper confidence chemical concentration ot the maximum detected concentration, whichever is less.

2 Reference doses (RfDs) have been developed by EPA for indicating the potential for adverse health effects from exposure to chemicals exhibiting non-carcinogenic effects. Adapted from USEPA IRIS, 1993 and USEPA Health Effects Summary Table, OERR 9200.6-303 (1992).

3 Cancer potency factors (CPFs) have been developed for estimating excess lifetime cancer risks associated with exposure to potentially carcinogenic chemicals. Adapted from USEPA IRIS, 1993 and USEPA Health Effects Summary Table, OERR 9200.6-303 (1992). unless otherwise noted.

ND = Not Detected
NC = Not of Concern
NTV = No Toxicity Data Available

TABLE 6-5: CONTAMINANTS OF POTENTIAL CONCERN IN SURFACE WATER AND TOXICITY ASSESSMENT

Media and Chemical	Exposure Point Concentrations			Toxicity	
	Frequency of Detection	Exposure Pt. Conc.[1]	Background	CSF [3] 1/(mg/kg/day)	RfD [2] mg/kg/day
SURFACE WATER (LAKE 1, 2, and POND)		mg/kg	mg/kg		
INORGANICS: Aluminum	3/3	505	21.4-178	NC	NC
Beryllium	1/3	1.05	1.2	4.2	.005
Copper	1/10	2.6	ND	NC	NC
Vanadium	3/3	20.7	4	NC	.3
VOLATILE ORGANICS: Carbon Disulfide	2/10	5.3	21	NC	.1
SEMI-VOLATILES Bis(2-ethylhexyl)phthalate	3/3	0.7	0.2-0.3	.014	.02
PESTICIDES/PCBs alpha-BHC	1/10	0.012	ND	6.3	NC
delta-BHC	1/10	0.015	ND	NC	NC
SURFACE WATER (C-11 CANAL, BOY SCOUT RD DITCH)		µg/l	µg/l		
INORGANICS: Aluminum	2/3	105	21.4-178		
Barium	3/3	62.1	4.32		
Copper	1/7	9.7	ND		
Cyanide	1/7	7.6	ND		
Lead	2/7	4.6	ND		
Vanadium	2/3	15.4	4		
SEMI-VOLATILES: bis(2-ethylhexyl)phthalate	1/3	3.0	0.2-0.3		

1 Reasonable Maximum Exposure defined as the 95% upper confidence chemical concentration or the maximum detected concentration, whichever is less.

2 Reference doses (RfDs) have been developed by EPA for indicating the potential for adverse health effects from exposure to chemicals exhibiting non-carcinogenic effects. Adapted from USEPA IRIS, 1993 and USEPA Health Effects Summary Table, OERR 9200.6-303 (1992).

3 Cancer potency factors (CPFs) have been developed for estimating excess lifetime cancer risks associated with exposure to potentially carcinogenic chemicals. Adapted from USEPA IRIS, 1993 and USEPA Health Effects Summary Table, OERR 9200.6-303 (1992), unless otherwise noted.

ND = Not Detected
NC = Not of Concern
NTV = No Toxicity Data Available

TABLE 6-6: CONTAMINANTS OF POTENTIAL CONCERN IN SEDIMENT AND TOXICITY ASSESSMENT

Media and Chemical	Exposure Point Concentrations			Toxicity	
	Frequency of Detection	Exposure Pt. Conc.[1]	Background	CSF [3] 1/(mg/kg/day)	RfD [2] mg/kg/day
SEDIMENT (LAKE 1, 2, and POND)		mg/kg	mg/kg		
INORGANICS: Aluminum	2/2	18,600	518-2,610	NC	NC
Barium	2/2	30	3.95-12.1	NC	.07
Beryllium	1/2	0.57	0.27	4.2	.005
Cadmium	2/6	2.0	ND	NC	.001
Chromium (total)[4]	6/6	38.3	1.6-9.15	NC	.005
Cobalt	1/2	3.2	0.56	NC	NC
Copper	5/6	29	2.3-8.7	NC	NC
Lead	6/6	44	2.3-22	NTV	NTV
Manganese	2/2	43.4	12.4-13.5	NC	.14
Mercury	3/6	0.17	ND	NC	.0003
Nickel	5/6	13.7	1.2-2.5	NC	.02
Vanadium	2/2	77.2	1.55-17.1	NC	.007
Zinc	6/6	160	5.5-38	NC	.3
SEMI-VOLATILES Bis(2-ethylhexyl)phthalate	2/2	0.2	0.056-0.1	.014	.02
Benzo(b)fluoranthene	1/2	0.013	ND	.73	NC
Benzo(k)fluoranthene	1/2	0.014	ND	.73	NC
SEDIMENT (LAKE 3)		mg/kg	mg/kg		
INORGANICS: Chromium (total)[4]	2/2	33	1.6-9.15	NC	.005
Mercury	1/2	0.072	ND	NC	.0003
Nickel	2/2	8.6	1.2-2.5	NC	.02
SEDIMENT (C-11 CANAL AND BOY SCOUT RD DITCH		mg/kg	mg/kg		
INORGANICS: Arsenic	4/4	7.5	1.1-3.9	1.75	.0003
Chromium (total)[4]	4/4	36	1.6-9.15	NC	.0001

TABLE 6-6: CONTAMINANTS OF POTENTIAL CONCERN IN SEDIMENT AND TOXICITY ASSESSMENT (continued)

Media and Chemical	Exposure Point Concentrations			Toxicity	
	Frequency of Detection	Exposure Pt. Conc.[1]	Background	CSF [3] 1/(mg/kg/day)	RfD [2] mg/kg/day
SEDIMENT (C-11 CANAL AND BOY SCOUT RD DITCH)		mg/kg	mg/kg		
Copper	3/4	45	2.3-8.7	NC	NC
Lead	4/4	29	2.3-22	NTV	NTV
Mercury	1/4	0.17	ND	NC	.0003
Nickel	1/4	10	1.2-2.5	NC	.02
Zinc	4/4	100	5.5-38	NC	.3
SEMI-VOLATILES Di-n-butylphthalate	2/2	.024	0.018-0.023	NC	.1
PESTICIDES/PCBs 4,4'-DDE	1/4	.001	ND	.34	.0007

1 Exposure Point Concentration defined as the 95% upper confidence chemical concentration, or the maximum concentration detected, whichever is less.

2 Reference doses (RfDs) have been developed by EPA for indicating the potential for adverse health effects from exposure to chemicals exhibiting non-carcinogenic effects. Adapted from USEPA IRIS, 1993 and USEPA Health Effects Summary Table, OERR 9200.6-303 (1992).

3 Cancer potency factors (CPFs) have been developed for estimating excess lifetime cancer risks associated with exposure to potentially carcinogenic chemicals. Adapted from USEPA IRIS, 1993 and USEPA Health Effects Summary Table, OERR 9200.6-303 (1992). unless otherwise noted.

4 Exposure point concentration for total Chromium; toxicity for Chromium VI.

ND = Not Detected
NC = Not of Concern
NTV = No Toxicity Data Available

A hazard quotient (HQ) of less than unity (1.0) indicates that the exposures are not expected to cause adverse health effects. An HQ greater than one (1.0) requires further evaluation. For example, although the hazard quotients of the contaminants present are added and exceed 1.0, further evaluation may show that their toxicities are not additive because each contaminant affects different target organs. When the total effect is evaluated on an effect and target organ basis the hazard index of the separate chemicals may be at acceptable levels.

Carcinogenic risks and non-carcinogenic hazards were evaluated for potential exposures to media-specific contaminants of potential concern in surface soil, surface water, sediment and ground water. Receptor populations were workers, trespassers and area residents that could, theoretically, use the ground water for a household water source.

Estimated potential exposure to contaminants of concern in surface water, surface soil and surface sediments are within EPA's acceptable carcinogenic risk range or non-carcinogenic hazard.

Estimated potential added cancer risks and non-carcinogenic hazards from the use of contaminated ground water for household use are outside EPA's acceptable range. The estimated cancer risk exceedances are related to vinyl chloride and arsenic concentrations. The arsenic concentration is well below the MCL. The maximum vinyl chloride concentrations in downgradient wells exceeds the primary drinking water MCL by 1 to 2 ug/L. The estimated non-carcinogen risk exceedance is related to antimony concentrations. Antimony was measured at 15 to 19 ug/L while the primary drinking water MCL is 6 ug/L. A summary of the risks is provided in Table 6-7.

TABLE 6-7: SUMMARY OF UNACCEPTABLE RISK THROUGH GROUND WATER INGESTION [a]

Chemical	Lifetime Excess Cancer Risk	Hazard Quotient Child (1-6 years)	Hazard Quotient Adult
Antimony		2.0	0.7
Arsenic	1×10^{-4}	1.0	0.5
Beryllium	4×10^{-5}		
Chloroform	4×10^{-6}		
Chromium	N/A	0.1	
Manganese	N/A	0.6	0.2
Vinyl Chloride	1×10^{-4}		
1,4-Dichlorobenzene	1×10^{-6}		
TOTAL	3×10^{-4}	4.0	2.0

[a] Calculations based on exposure assumptions and point concentrations

6.6 Identification of Uncertainties

Uncertainty is inherent in the risk assessment process. Each of the three components of risk assessment (data evaluation, exposure assumptions, and toxicity criteria) contribute uncertainties. For example, the assumption that ground water and soil concentrations will remain constant over time highly overestimates the lifetime exposure. Contaminants dissolve in rainwater and migrate from the soil, degrade as a result of biological action (organics), are dispersed and diluted in ground water, and otherwise are subject to a variety of attenuation processes. In addition, for a risk to exist, both significant exposure to the pollutants of concern and toxicity at these predicted exposure levels must exist. The toxicological uncertainties primarily relate to the methodology by which carcinogenic and noncarcinogenic criteria (i.e., cancer slope factors and reference doses) are developed. In general, the methodology currently used to develop cancer slope factors and reference doses is very conservative, and likely results in an overestimation of human toxicity and resultant risk.

The use of conservative assumptions throughout the risk assessment process are believed to result in an over-estimate of human health risk. Therefore, actual risk may be lower than the estimates presented here but are unlikely to be greater.

6.7 Ecological Evaluation

6.7.1 Overview

The risk to the environment is determined through the assessment of potentially adverse effects to ecosystems and populations resulting from Site-related contamination using qualitative methods. Ground water, soil, surface water, and sediments throughout the landfill area were sampled to determine the extent of contamination, as described in Section 5. Ground water discharge to surface water at the canal is presumed to occur at the Site; therefore, ground water data was used to address ecological concerns. Contaminants detected in each media are listed in Table 5-1 through 5-5.

6.7.2 Contaminants of Potential Concern

All organic parameters detected above method detection limits were considered to be contaminants of potential concern to ecological life. Inorganics at concentrations greater than two times the mean background concentration were considered contaminants of potential concern. Since all inorganic parameters detected in ground water exceeded twice the mean background values, all inorganic parameters were considered to be chemicals of potential concern. In soils, three contaminants (aluminum, chromium, and cobalt) were eliminated as contaminants of potential concern based on background screening. For Lakes 1 and 2 and the pond, inorganic

parameters in surface water eliminated based on background screening included barium, calcium, iron, magnesium, manganese, sodium, and zinc. For Lake 3, iron in surface water was eliminated based on background screening. No inorganic parameters in the surface water of the C-11 Canal and the Boy Scout Road Ditch were eliminated based on background screening. Arsenic in sediments of Lakes 1 and 2 and the pond was eliminated based on background screening. For sediment in Lake 3, arsenic, copper, iron, lead, and zinc were eliminated based on background screening. In the C-11 Canal and Boy Scout Road Ditch, aluminum, barium, calcium, magnesium, manganese, sodium, and vanadium were eliminated based on background screening. The remaining inorganic parameters were carried through the ecological risk assessment as contaminants of potential concern.

6.7.3 Exposure Assessment

Davie Landfill is a disturbed site impacted by past and present human activities. Habitat losses undoubtedly occurred when the Site was originally developed and as construction and maintenance activities continued. With the creation of Lakes 1, 2, and 3 and the remediation of the former sludge lagoon, available aquatic habitats were increased. However, Lakes 1, 2, and 3 provided limited shallow water habitat because the edges of the lakes dropped off sharply into deep water. During closure of the landfill, the shores of the lakes are being regraded to provide a more natural shoreline, suitable for aquatic life and accessible to terrestrial wildlife. In addition, dairy cows from adjacent properties have impacted the shoreline habitats at the Site. Construction of a new fence around the Site as part of the landfill closure plan is expected to alleviate the habitat destruction caused by the dairy cows.

Two species may be a potential concern at this Site. The bald eagle (*Haliaeetus leucocephalus*), a federal endangered species, is known to use areas near the Site, especially the Everglades area to the west. In addition, a species of special concern to the state, the eastern burrowing owl (*Athene cunicularia*), has been reported on the Site. A list of federally listed threatened and endangered species and category 1 and 2 candidates for federal listing in Broward County is provided in Table 6-8. None of the species on this list were identified onsite during the ecological characterization conducted as part of the remedial investigation. Lists of observed (January 1993) and reported fauna at the Davie Landfill are provided in Table 6-9.

The target receptors were divided into two main categories: terrestrial and aquatic. Since clean soils have been placed over the Site and former leachate seeps redirected by the low-permeability cover, exposure of terrestrial wildlife through ingestion of contaminated soils and vegetation and uptake of soil contaminants by plant roots are no longer deemed a viable pathways. Thus, no risk is expected for these terrestrial receptors. The threat to burrowing animals is not expected to be significant because the landfill cover is approximately two-feet thick.

TABLE 6-8: FEDERALLY LISTED THREATENED AND ENDANGERED SPECIES AND CATEGORY 1 AND 2 CANDIDATES FOR FEDERAL LISTING IN BROWARD COUNTY

Scientific Name	Common Name	Status
Amphibians and Reptiles		
Alligator mississippiensis	American alligator	T(S/A)
Caretta caretta caretta	Atlantic loggerhead turtle	T
Chelonia mydas mydas	Atlantic green turtle	E
Dermochelys coriacea	Leatherback turtle	E
Drymarchon corais couperi	Eastern indigo snake	T
Eretmochelys imbricata imbricata	Atlantic hawksbill turtle	E
Gopherus polyphemus	Gopher tortoise	C2
Lepidochelys kempi	Atlantic ridley turtle	E
Ophisaurus compressus	Island glass lizard	C2
Pituophis melanoleucus mugitus	Florida pine snake	C2
Pseudobranchus striatus lustricolus	Gulf hammock dwarf siren	C2
Rana areolata aesopus	Florida Crawfish frog	C2
Sceloporus woodi	Florida scrub lizard	C2
Birds		
Ammodramus maritima	Cape Sable seaside sparrow	E
Charadrius melodus	Piping plover	T
Dendroica kirtlandii	Kirtland's warbler	E
Falco peregrinus tundrius	Arctic peregrine falcon	T
Falco sparverius paulus	Southeastern American kestrel	C2
Haliaeetus leucocephalus	Bald eagle	E
Lanius ludovicianus migrans	Migrant loggerhead shrike	C2
Mycteria americana	Wood stork	E
Rostrhamus sociabilis	Snail kite	E
Sterna dougallii	Roseate tern	T
Vermivora bachmanii	Bachman's warbler	E
Mammals		
Blarina carolinensis (=brevicauda) shermani	Sherman's short-tailed shrew	C2
Eumops glaucinus floridanus	Florida mastiff bat	C1
Neofiber alleni	Round-tailed muskrat	C2
Peromyscus (= Podomys) floridanus	Florida mouse	C2
Plecotus rafinesquii	Southeastern big-eared bat	C2
Trichechus manatus latirostris	West Indian manatee	E
Ursus americanus floridanus	Florida black bear	C2
Plants		
	Family Arecaceae	
Roystonea elata	Florida royal palm	C1
Jacquemontia reclinata	Beach jacquemontia	PE

TABLE 6-9: OBSERVED (JANUARY 1993) AND REPORTED FAUNA, BROWARD COUNTY LANDFILL, DAVIE, FLORIDA

COMMON NAME	SCIENTIFIC NAME	COMMENTS
INVERTEBRATES		
Aphids	Order *Homoptera*, family *Aphididae*	OBSERVED
Beetles (Ladybugs, Ground Beetles, Weevils)	Order *Coleptera*, families *Coccinellidae*, *Carabidae*, *Curculionidae*	OBSERVED (adults)
Butterflies (Zebra, Zebra Swallowtail, three unidentified species)	Order *Lepidoptera*	OBSERVED (adults and one species unidentified larvae)
Cicadas (unidentified species)	Order *Homoptera*, family *Cicadidae*	OBSERVED (adults)
Damselflies (Narrow-winged) (several unidentified species)	Order *Odonata*, family *Coenagrionidae*	OBSERVED (adults)
Dragonflies (several unidentified species)	Order *Odonata*, various families	OBSERVED (adults)
Fire Ants	*Solenopsis geminata*	OBSERVED (adults, pupae, mounds)
Flies (House, Crane, Mosquito, unidentified species)	Order *Diptera*, families *Muscidae*, *Tipulidae*, *Culicidae*, etc.	OBSERVED (adults)
Grasshoppers (several unidentified species)	Order *Orthoptera*	OBSERVED
Honey Bees	*Apis mellifera*	OBSERVED
Leafhoppers (unidentified species)	Order *Homoptera*, family *Cicadellidae*	OBSERVED
Moths (two unidentified species)	Order *Lepidoptera*	OBSERVED (adults and one species unidentified larvae)
Snails (aquatic)	Class *Gastropoda*	OBSERVED
Spiders (Argiope, Orb Weaver, unidentified species)	Order *Araneae*, family *Aranicidae*, etc.	OBSERVED (adults and webs)
Spittlebugs (unidentified species)	Order *Homoptera*, family *Cercopidae*	OBSERVED
Green Stinkbugs	*Acrosternum hilare*	OBSERVED
Wasps (three unidentified species)	*Vespula sp.*	OBSERVED (adults and nests)
Water Striders (unidentified species)	Order *Hemiptera*, family *Gerridae*	OBSERVED (adults)

TABLE 6-9: OBSERVED (JANUARY 1993) AND REPORTED FAUNA, BROWARD COUNTY LANDFILL, DAVIE, FLORIDA (continued)

COMMON NAME	SCIENTIFIC NAME	COMMENTS
FISH		
Largemouth Bass	*Micropterus salmoides*	REPORTED
Least Killifish (presumptive)	*Heterandria formosa* (possibly *Fundulus sp.*)	OBSERVED (one immature specimen)
Mosquitofish	*Gambusia holbrooki*	OBSERVED
AMPHIBIANS		
Frogs (unidentified)	*Rana sp.* (possibly *R. utricularia*)	OBSERVED (adults)
Southern Leopard Frogs	*Rana utricularia*	OBSERVED (adults, immature and mature larvae, eggs)
REPTILES		
Cuban Brown Anoles	*Anolis sagrei sagrei*	OBSERVED (adults and immature)
Florida Water Snakes	*Nerodia fasciata pictiventris*	OBSERVED (three adults)
Green Anole	*Anolis carolinensis*	OBSERVED (single adult)
Southeastern Five-lined Skink	*Eumeces inexpectatus*	OBSERVED (single adult)
Turtles (presumptive Musk, Mud, or Cooter species)	*Sternotherus odoratus, Kinosternon bauri, K. subrubrum,* or *Chrysemys floridana*	OBSERVED (snouts protruding from water only)
BIRDS		
American Kestrel	*Falco sparverius*	OBSERVED
Bald Eagle	*Haliaeetus leucocephalus*	REPORTED
Barn Owl	*Tyto alba*	REPORTED
Black Vulture	*Coragyps atratus*	OBSERVED
Cattle Egret	*Bubulcus ibis*	OBSERVED
Common Gallinule (Moorhen)	*Gallinula chloropus*	OBSERVED
Common Ground Dove	*Columbina passerina*	OBSERVED
Common Tern	*Sterna hirundo*	OBSERVED
Eastern Burrowing Owl	*Athene cunicularia*	REPORTED
Great Blue Heron (Common and White Phase)	*Ardea herodias*	OBSERVED
Great Egret	*Casmerodius albus*	OBSERVED
Great Horned Owl	*Bubo virginianus*	REPORTED

TABLE 6-9: OBSERVED (JANUARY 1993) AND REPORTED FAUNA, BROWARD COUNTY LANDFILL, DAVIE, FLORIDA (continued)

COMMON NAME	SCIENTIFIC NAME	COMMENTS
Killdeer	*Charadrius vociferus*	OBSERVED
Little Blue Heron	*Egretta caerulea*	OBSERVED
Monk Parakeet (presumptive)	*Myiopsitta monachus*	OBSERVED
Mourning Dove	*Zenaida macroura*	OBSERVED
Perching Birds (various species)	Order *Passeriformes*	HEARD (unidentified calls)
Ring-necked Duck	*Aythya collaris*	OBSERVED
Sparrows (unidentified)	Family *Emberizidae*	OBSERVED
Turkey Vulture	*Cathartes aura*	OBSERVED
MAMMALS		
Mustelid (unidentified)	Family *Mustelidae*	OBSERVED (tracks only)
Raccoon	*Procyon lotor*	REPORTED (tracks observed)
Rodent (unidentified)	Order *Rodentia*	OBSERVED (burrows only)

A qualitative exposure assessment was used for aquatic biota living in the water column (aquatic community) and those living in or on the bottom sediments (benthic community).

The exposure point concentration is the concentration of a contaminant to which an ecological receptor is expected to be exposed. The average exposure point concentration was calculated as the arithmetic mean of the contaminant concentrations. Undetected values were not incorporated into the calculation of average concentrations. The average and maximum concentrations for ground water, surface water, and sediment contaminants were used in the risk characterization.

6.7.4 Toxicity Assessment

6.7.4.1 Ground Water/Surface Water

As a means of characterizing aquatic toxicity, the EPA has developed water quality criteria (WQC) for the protection of 95 percent of all aquatic life where sufficient data are available. The Region IV Waste Management Division has established screening levels for surface water at hazardous waste sites, primarily based upon the Ambient Water Quality Criteria. Exceedance of these screening levels might indicate a potential for adverse ecological effects (depending upon factors such as frequency of detection, degree of exceedance, etc.), thus indicating a need for more site-specific ecological investigations, such as toxicity testing. In addition, Florida Department of Environmental Protection (FDEP) has established its own water quality criteria, which vary depending on use classification for the surface water body. Class III criteria were established to protect recreation and the propagation and maintenance of a healthy, well-balanced population of fish and wildlife. For those contaminants that did not have established WQC, acute and chronic toxicity values were based on a percentage of median lethal concentrations for various organisms obtained from available literature.

6.7.4.2 Sediments

The toxicity of contaminants to aquatic biota living in or near the bottom sediments (benthic community) can be assessed by comparing sediment contaminant concentrations to sediment biological effect ranges published by the National Oceanic and Atmospheric Administration (NOAA). The NOAA sediment effects range values were developed to determine concentrations of contaminants which may result in adverse ecological effects. These values are based upon available sediment data collected primarily in marine and estuarine environments throughout the United States. The Effects Range-Low (ER-L) values represent the lower tenth percentile of the range of concentrations in which effects were observed or predicted. The Effects Range-Median (ER-M) values represent the 50th percentile concentrations.

For iron and manganese the Ontario Ministry of the Environment (OMOE) sediment quality guidelines were used to determine risks. In the OMOE guidelines, the Lowest Effect Level is the level of sediment contamination that can be tolerated by the majority of benthic organisms. The Severe Effects Level is the level of sediment contamination at which pronounced disturbance of the sediment dwelling community is expected.

For organic non-polar chemicals lacking biological effects levels, an alternative approach was applied using the Equilibrium Partitioning (EP) Approach to evaluate the potential for adverse effects associated with exposure to impacted sediments.

6.7.5 Risk Characterization

6.7.5.1 Ground Water/Surface Water

Comparison of the concentrations of contaminants of potential concern with federal Water Quality Criteria (WQC), regional screening values, and state water quality standards, was used to assess the likelihood of adverse effects of ground water and surface water to aquatic life:

- Numerous contaminants in ground water (presuming ground water discharges to surface water) exceeded federal WQC, regional screening values, and state water quality standards. As impacted ground water migrates downgradient toward a surface water discharge point, a significant loss of VOCs is expected through volatilization, retardation, and degradation. Inorganics are expected to adsorb to sediment and organic materials within the aquifer such that their surface water concentrations also will be reduced. Therefore, it is conservative to assume that aquatic life will be effected by ground water contamination.

- Concentrations of carbon disulfide, bis(2-ethylhexyl)phthalate, and aluminum, in surface water of Lakes 1 and 2 and the pond, exceed WQC for these contaminants. It should be noted that the maximum detected concentrations of carbon disulfide and bis(2-ethylhexyl)phthalate in Lakes 1 and 2 and the pond do not exceed two times the average background concentration, so their presence may not be Site-related.

- In the C-11 Canal and the Boy Scout Road Ditch, the maximum detected concentration of bis(2-ethylhexyl)phthalate, aluminum, cyanide, and iron equaled or exceeded federal, regional, and/or state chronic WQC.

Water quality criteria were not available for all detected contaminants; therefore, the contribution of all the contaminants of potential concern could not be evaluated. Despite the absence of some criteria, the results show a limited potential for both

chronic and acute adverse effects to occur to aquatic life inhabiting Lakes 1 and 2, the pond, the C-11 Canal, and the Boy Scout Road ditch.

6.7.5.2 Sediment

To assess potential adverse effects on benthic organisms from exposure to potentially toxic sediment, contaminants of potential concern identified in sediments were compared with available NOAA sediment biological effect ranges, Ontario Ministry of the Environment (OMOE) sediment quality guidelines, and Equilibrium Partitioning concentrations:

- All sediment contaminant concentrations in all waterbodies fell below the ER-M levels. In Lakes 1 and 2 and the pond, maximum detected concentrations of lead, mercury, silver, and zinc exceeded the ER-L value but not the ER-M value, indicating a low potential for ecological effects.

- There were no exceedances of the biological effects levels for contaminants detected in Lake 3.

- The maximum detected concentration of mercury in sediments of the C-11 Canal and the Boy Scout Road ditch exceed the ER-L value for this constituent but not the ER-M value, indicating a low potential for ecological effects. The maximum detected concentration of iron exceeded the OMOE Lowest Effect Level. The detected concentration of butylbenzylphthalate exceeded the calculated sediment concentration (based upon equilibrium partitioning).

Sediment biological effects levels were not available for all the detected contaminants; therefore, the contribution of all the contaminants of potential concern could not be evaluated. These results suggest, based on available data, that a slight potential exists for adverse effects to occur to benthic and aquatic life inhabiting Lakes 1 and 2, the pond, the C-11 Canal, and the Boy Scout Road ditch.

6.7.6 Uncertainty Analysis

The main sources of uncertainty associated with this ecological evaluation can be attributed to the following:

- Environmental chemistry and sample analysis,

- Exposure Assumptions, and

- Toxicity criteria.

While environmental parameter estimation and exposure assumptions provide uncertainty, the primary sources of uncertainty are the interpretation and application of available toxicological data.

7.0 DESCRIPTION OF ALTERNATIVES

7.1 Performance Standards

Estimated potential human exposure to Site contaminants in surface water, surface soil, and surface sediments do not result in unacceptable cancer or non cancer risks at the Davie Landfill Site. However, the estimated potential cancer and non-cancer risks from exposure to ground water are above EPA's cleanup target cancer risk range and an HQ above 1. Closure of the landfill and completion of the cover system is expected to reduce contamination from the landfill and potential risks to human health. Contaminants in ground water at levels above ARARs are listed in Table 7-1.

There is a low potential risk associated with exposure of aquatic life to contamination in surface water and sediments in onsite water bodies. Closure of the landfill and completion of the cover system is expected to reduce contamination from the landfill and potential risks to ecological life.

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

The Feasibility Study Report evaluated possible alternatives for remediation of conditions at the Davie Landfill Site. A total of three (3) alternatives have been established for detailed analysis consideration. These alternatives were selected to provide a range of remedial actions for the Site.

TABLE 7-1: SUMMARY OF REMEDIAL ACTION PERFORMANCE STANDARDS (Ground water)

Contaminant	Concentrations Detected (µg/l)		Background (µg/l)	Performance Standard (µg/l)
	Mean	Max		
Vinyl Chloride	2.2	3	ND	1 [a]
Antimony	16.7	19.1	ND	6 [b]

a - State of Florida Primary Drinking Water Level
b - Safe Drinking Water Act Maximum Contaminant Level (MCL).

7.2 Alternative No. 1: No Action

The no action alternative was developed as required by the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), the regulation implementing the Superfund law. It is used as a baseline for comparing other alternatives. Under this alternative, EPA would take no action to minimize the impact ground water contamination has on the area. There is no cost associated with this alternative because no additional activities would be conducted.

However, at Davie Landfill, a number of County and State actions are being executed at the Site which should reduce contamination in the ground water. Broward County is in the process of closing the landfill in accordance with the requirements of FDEP closure permit number SF06-143540. Closure is expected to eliminate the source of contamination at the Site. The permit is subject to 15 general conditions and 25 specific conditions including the following:

- monitoring ground water at the Site for twenty years,
- providing written proof that the Site is zoned for parks and recreation, and
- providing public potable water and sewer to the park.

Natural attenuation of the contaminants in ground water is anticipated after closure of the landfill is complete. Broward County estimates that over $14 million have been invested or committed for closure of the landfill in accordance with the permit. Approximately $1.3 million of that total is associated with ground water monitoring, zoning the Site, and potable water and sewer extension to the Site.

In addition to the actions required under the permit, the State Health Department monitors residential wells near the Site for contamination and urges residents with wells affected by contamination from the Site to connect to a public water supply using funds provided by the State of Florida Water Quality Assurance Trust Fund.

Because this alternative would result in contaminants remaining onsite, CERCLA requires that the Site be reviewed every five years. If indicated by the review, remedial actions would be implemented at that time to address the contaminated ground water.

7.3 Alternative No. 2 - Natural Attenuation With Ground Water Monitoring

This remedial alternative involves action aimed at limiting exposure, and primarily consists of the following: (1) natural attenuation of vinyl chloride and antimony; (2) ground water monitoring; and (3) provision of alternative water to residences with contaminated wells. These remedial activities are expected to limit contact with

contaminated ground water in the vicinity of the Davie Landfill Site and includes utilization of a comprehensive ground water monitoring plan to periodically evaluate the quality of the ground water emanating from the Site.

A literature search was conducted during the FS to determine the length of time for natural attenuation to decrease concentrations of vinyl chloride to below the MCL of 1 ug/L. Based on that search it was determined that vinyl chloride has a half-life ranging from 8 weeks to 95 months. The highest concentration of vinyl chloride detected at Davie Landfill was 3 ug/L; therefore, calculations indicate that a maximum of 16 years may be required to reduce vinyl chloride concentrations to 0.75 ug/L, which is below the MCL.

No estimation of the time required for antimony to attenuate could be made because antimony is a metal, is present in low concentrations in the ground water samples, and is expected to adhere to soil particles rather than move with the ground water. The suspected source for antimony is the incinerator ash buried in the trash landfill. There is no direct exposure pathway to the ash or soil to which the antimony may adhere. That is why the ash and soil do not need to be remediated. Natural attenuation by adherence to soil is expected to be effective for antimony.

A ground water monitoring program would be performed to ensure that attenuation is effective. Ground water would be monitored at wells along the perimeter of the landfill (compliance wells), as well as in residential wells near the Site, until levels of vinyl chloride and antimony reach performance standards (see Table 7-1). If vinyl chloride is detected in residential wells at concentrations above 1 ug/L at least three times, then a source for alternative water will be provided to affected residences. Monitoring will continue for at least one year after the concentrations in all monitoring wells decrease below the performance standards. Should any concentrations above performance standards be detected within this post-remediation monitoring period, actions would be taken to verify the contaminant levels, and if verified, additional control measures may be evaluated.

The Site is being closed by Broward County under a permit with the State of Florida, in accordance with the Florida Administrative Code, Chapter 17-701, Solid Waste Management Facilities. The monitoring required under this remedy is being conducted by Broward County in accordance with the FDEP closure permit. Provision of public water to private well users with wells affected by Site-related contamination is being provided through the State of Florida Water Quality Assurance Trust Fund. The County is to provide EPA with quarterly reports which include any ground water monitoring results for that period, residential well monitoring results, and any provisions made to extend the public water supply.

Because all monitoring costs are included in County and State actions described previously, no additional costs are anticipated for this action unless Broward County

fails to perform the actions required by the permit. Ground water monitoring, zoning the Site, and potable water and sewer extension to the Site are estimated at $1.3 million. In addition, EPA estimates that up to $100,000 may be required over the next sixteen years to provide public water to affected residents if the State Trust Fund cannot be accessed.

7.4 Alternative No. 3 - Ground Water Treatment

This alternative includes ground water extraction, physical/chemical treatment of the extracted water, and discharge to surface water. A National Pollutant Discharge Elimination System (NPDES) permit would be required to discharge treated ground water to a surface water body located offsite. A ground water monitoring program would be necessary to ensure that the ground water treatment system is effective and that contaminants do not migrate.

A ground water model was used to determine the time required to circulate clean ground water through the contamination zone and reduce contaminant levels below cleanup goals. The model indicates it would take 12 years to reduce vinyl chloride levels below cleanup goals and 146 years to reduce antimony levels. For the purposes of the cost analysis a maximum of 30 years of extraction and treatment was assumed. During the remedial design (RD), treatability studies may be conducted, if required, to determine the effectiveness of treatment on the extracted ground water. Due to the existing low concentrations at the Site, extraction alone, through dilution, may reduce contaminant concentrations to below discharge standards. Filtration to remove the high iron content would likely be the only treatment that would be necessary to meet surface water discharge standards. Final treatment methods would be determined during the remedial design for the system. Any wastes generated during the treatment process would be disposed of at a regulated facility. The actual number of extraction wells required would be determined during the RD. For the purposes of this analysis, three extraction wells were considered appropriate.

The estimated capital cost for a three well, 150 gpm extraction system is $2,490,000. Operation and Maintenance costs for thirty years of operation are estimated at $3,460,000. The total present worth cost of this remedy is estimated at $5,950,000.

8.0 SUMMARY OF THE COMPARATIVE ANALYSIS OF ALTERNATIVES

8.1 Statutory Balancing Criteria

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. § 9621, and in the NCP, 40 CFR § 300.430. The major objective of the feasibility study (FS) was to develop, screen, and evaluate alternatives for the remediation of the Davie Landfill Site. A wide variety of alternatives and

technologies were identified as candidates to remediate the contamination at the Davie Landfill 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 relevant and appropriate requirements (ARARS);
- 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;
- 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 into the ROD.

The following analysis is a summary of the evaluation of alternatives for remediating the Davie Landfill Superfund Site under each of the criteria. A comparison is made between each of the alternatives for achievement of a specific criterion.

8.2 Threshold Criteria

8.2.1 Overall Protection of Human Health and the Environment

All of the alternatives, including No Action, should provide some degree of protection for human health and the environment. Alternatives 1 and 2 include ground water monitoring and natural attenuation to meet clean-up goals and public water is provided to residents to protect human health. Alternative 3 would provide protection of human health and the environment through active remediation of the ground water.

8.2.2 Compliance With ARARs

The remedial action for the Davie Landfill Site, under Section 121(d) of CERCLA, must comply with federal and state environmental laws that either are 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 and 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 human 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.

Location-specific ARARs are restrictions placed on the concentration of hazardous substances or the conduct of activities solely on the basis of location. Examples of location-specific ARARs include state and federal requirements to protect floodplains, critical habitats, and wetlands, and solid and hazardous waste facility siting criteria. Table 8-1 summarizes the potential location-specific ARARs for the Davie Landfill Site.

Action-specific ARARs are technology- or activity-based requirements or limitations on actions taken with respect to hazardous wastes. These requirements are triggered by the particular remedial activities that are selected to accomplish a remedy. Since there are usually several alternative actions for any remedial site, various

requirements can be ARARs. Table 8-2 lists potential action-specific ARARs and TBCs for the selected and contingency ground water remedy for the Davie Landfill Site.

Chemical-specific ARARs are specific numerical quantity restrictions on individually-listed contaminants in specific media. Examples of chemical-specific ARARs include the MCLs specified under the Safe Drinking Water Act as well as the ambient water quality criteria that are enumerated under the Clean Water Act. Because there are usually numerous contaminants of potential concern for any remedial site, various numerical quantity requirements can be ARARs. Table 8-3 lists potential chemical-specific ARARs for the Davie Landfill Site.

All alternatives will meet their respective ARARs. The ARARs that apply to this Site include chemical, action, and location-specific ARARs. Alternatives 1 and 2 would comply with all ARARS (i.e., federal and state Maximum Contaminant Levels (MCLs)) through monitoring and natural attenuation. The point of compliance would be determined through the FDEP closure permit. Alternative 3 would meet all ARARS (i.e., federal and state MCLs and surface water discharge requirements, RCRA Subpart G, NPDES permitting requirements, etc.) through active ground water remediation.

Long-term monitoring is required in all alternatives. Additional statistical analysis of data will further substantiate the presence/absence of contaminants in ground water. This long-term monitoring will provide the data necessary for a statistical determination of constituent concentrations in ground water. If it becomes apparent that MCLs will not be met through attenuation, EPA, in consultation with FDEP, will re-evaluate the effectiveness of the remedy.

8.3 Primary Balancing Criteria

8.3.1 Long-Term Effectiveness and Permanence

Alternative 3 provides the highest degree of long-term effectiveness and permanence because this alternative uses treatment technologies to reduce hazards posed by the contaminants in the ground water at the Landfill Site. Calculations indicate that vinyl chloride concentrations could be reduced to cleanup levels (Table 7-1) after 12 years of ground water extraction; Antimony concentrations are expected to take up to 146 years of ground water extraction before cleanup levels are attained.

Natural attenuation, as provided in Alternatives 1 and 2, also would be considered effective from a long-term standpoint. Calculations indicate that vinyl chloride concentrations could be reduced to cleanup levels (Table 7-1) through natural attenuation in up to 16 years. No estimate of the time required for antimony to attenuate could be made at this time; however, the levels of antimony detected are

TABLE 8-1: POTENTIAL LOCATION SPECIFIC ARARS AND TCBs

Standard Requirement Criteria or Limitation	Citation	Description	Comment
FEDERAL			
Resource Conservation and Recovery Act (RCRA), as amended	42 USC 6901		
RCRA Location Standards	40 CFR 264.18(b)	A treatment, storage, or disposal (TSD) facility must be designed, constructed, operated, and maintained to avoid washout on a 100-year floodplain.	If solids are generated during treatment, the potential disposal facility could be located within the 100-year floodplain. Requirement is relevant and appropriate.
Endangered Species Act	16 USC 1531	Requires action to conserve endangered species or threatened species, including consultation with the Department of Interior.	
Clean Water Act	33 USC Section 1251		
Dredge and Fill Requirements (Section 404)	40 CFR 230	Requires permit for discharge of dredged or fill material into aquatic environment.	No alternative will be developed that would discharge dredged or fill material into an aquatic environment.
Rivers and Harbors Act of 1899 (Section 10 Permit)	33 USC Section 403	Requires permit for structures or work in or affecting navigable waters.	No alternative involves work that would affect a navigable waterway.
Wilderness Act	16 USC 1311	Area must be administered to leave it un-impaired as wilderness and will preserve it as a wilderness.	No wilderness areas exist onsite or adjacent to the site.
National Wildlife Refuge System	16 USC 668 50 CFR 27	Restricts activities within National Wildlife Refuges.	No wildlife refuge area exist onsite or adjacent to the site.

TABLE 8-2: POTENTIAL ACTION SPECIFIC ARARS AND TCBs

Standard Requirement Criteria or Limitation	Citation	Description	Comment
FEDERAL			
Resource Conservation and Recovery Act (RCRA), as amended	42 USC 6901, 6905, 6912, 6924, 6925		
Classification of Hazardous Waste	40 CFR 261	Federal requirements for classification and identification of hazardous wastes.	If solids are generated through groundwater treatment, it is a potential ARAR.
Requirements for Storage, Treatment, and Disposal of Hazardous Waste	40 CFR 264 40 CFR 265	Regulates storage, treatment, disposal, and operation of hazardous wastes.	If solids are generated through groundwater treatment, it is a potential ARAR.
RCRA Land Disposal Restrictions	40 CFR Part 268	Provides for proper disposal of regulated contaminants found in sludge.	Potentially an ARAR if metals removal is part of selected remedy.
Requirements for Generation, Storage, Transportation and Disposal of Hazardous Waste	40 CFR 263 40 CFR 264	Regulates storage, transportation, and operation of hazardous waste generators.	May be an ARAR if metals precipitation is part of selected remedy due to sludge products.
Clean Water Act (CWA)	33 USC Section 1251-1376		
Ambient Water Quality Criteria (AWQC)	40 CFR Part 131	Sets criteria for water quality based on toxicity to aquatic organisms and human health.	The AWQC for organic and inorganic contaminants are potentially relevant and appropriate if discharge of treated groundwater is required.
Best Available Treatment (BAT) Technology	40 CFR 122	Use of best available technology economically achievable is required to control discharge of toxic pollutants to POTW.	Potentially applicable if treated groundwater is discharged to a publicly owned treatment works (POTW).
National Pollutant Discharge Elimination System (NPDES) Permit Regulations	40 CFR 122 Subpart C	Use of best available technology economically achievable for toxic pollutants discharged to surface waters.	Potentially applicable if treated effluent is discharged to surface water.
Discharge must be consistent with the requirements of a Water Quality Management Plan approved by EPA	40 CFR 122	Discharge must comply with EPA-approved Water Quality Management Plan.	Potentially applicable if groundwater is discharged to surface water.
Discharge must not increase contaminant concentrations in offsite surface water.	Section 121 (d)(2)(B)(iii)	Selected remedial action must establish a standard of control to maintain surface water quality.	Potentially applicable if groundwater is discharged to surface water.

TABLE 8-2: POTENTIAL ACTION SPECIFIC ARARS AND TCBs (continued)

Standard Requirement Criteria or Limitation	Citation	Description	Comment
Clean Air Act			
National Primary and Secondary Ambient Air Quality Standards	40 CFR Part 50	Sets primary and secondary air standards at levels to protect public health and public welfare.	May be relevant or appropriate if onsite treatment units are part of remedial action.
National Emissions Standards for Hazardous Air Pollutants (NESHAPs)	40 CFR Part 61	Provides emissions standard for hazardous air pollutants for which no ambient air quality standard exists.	May be relevant or appropriate if onsite treatment units are part of remedial action.
Air Use Approval	40 CFR 60 (Subpart A)	Requires notification and performance testing by owner or operator.	May be relevant or appropriate if onsite treatment units are part of remedial action.
Occupational Safety and Health Administration	29 CFR 1910 Part 120	Provides safety rules for handling specific chemicals for site workers during remedial activities.	Health and safety requirements are applicable to all potential remedial actions.
STATE			
Discharge to Surface Water/POTW Florida Water Quality Standards			
Florida Groundwater Quality Standards	FAC 17-520	Establishes groundwater standards.	May be applicable should groundwater discharge (i.e., reinjection) be selected.
Florida Surface Water Quality Criteria	FAC 17-302.530	Establishes surface water quality standards and guidelines for allowable levels of metals and PAHs (toxic organics) in surface water used for recreation and propagation and maintenance of a healthy, well-balanced population of fish and wildlife.	May be applicable should surface water discharge be selected.
Surface Water Improvement and Management Act (SWIM)	FAC 17-43	Regulates surface water discharges and discharges to a POTW.	May be an ARAR should treatment and discharge to surface water be selected.
Florida Wetlands Application Regulations	FAC 17-611	Establishes that no wastes are to be discharged to any waters of the state without being given the treatment necessary to protect the beneficial use of such waters.	No wetlands exist near the site.

TABLE 8-2: POTENTIAL ACTION SPECIFIC ARARS AND TCBs (continued)

Standard Requirement Criteria or Limitation	Citation	Description	Comment
Florida Underground Injection Control Regulations	FAC 17-28	Governs the construction of injection wells so that injected fluids remain in the injected zone and that unapproved interchange between aquifers is prohibited.	Applicable should injection be selected.
FDEP Air Pollution Control Regulations	FAC Chapter 17-2	Establishes air quality standards within the state.	May be an ARAR if treatment of offgases from onsite treatment unit is required during remediation.
Local City of Sunrise	FAC 15-92	Establishes POTW discharge limits.	May be applicable should POTW discharge be selected.

TABLE 8-3: POTENTIAL CHEMICAL SPECIFIC ARARS AND TCBs

Standard Requirement Criteria or Limitation	Citation	Description	Comment
FEDERAL			
Safe Drinking Water Act	40 USC Section 300		
National Primary Drinking Water Standards	40 CFR Part 141	Establishes health-based standards for public water systems (maximum contaminant levels).	The MCLs for organic and inorganic contaminants are applicable to the groundwater contaminated by the site since it is a potential drinking water source.
Maximum Contaminant Level Goals	Publication L. Nº 99-399, 100 Stat. 642 (1986)	Establishes drinking water quality goals set at levels of no known or anticipated adverse health effects.	Proposed MCLGs for organic and inorganic contaminants are applicable to the groundwater potentially used for drinking water.
Clean Water Act	33 USC Section 1251-1376		
Ambient Water Quality Criteria	40 CFR Part 131	Sets criteria for water quality based on toxicity to aquatic organisms and human health.	The AWQC for organic and inorganic contaminants are applicable to the site.
Resource Conservation and Recovery Act (RCRA), as amended	42 USC 6905, 6912, 6924, 6925		
RCRA Groundwater Protection	40 CFR Part 264	Provides for groundwater protection standards, general monitoring requirements, and technical requirements.	The RCRA groundwater monitoring requirements are relevant and appropriate for groundwater at the site.
STATE (FDEP REQUIREMENTS)			
Florida Drinking Water Standards	FAC 17-550	Establishes drinking water standards for public water systems in Florida.	Applicable to groundwater at the site.
Florida Groundwater Regulations	FAC 17-520, 17-522	Establishes groundwater quality standards.	Applicable to groundwater at the site.

relatively low. Antimony is a metal and is expected to adhere to soil particles rather than move with the ground water. For these reasons natural attenuation is expected to be effective for antimony. Because these remedies may result in contaminants remaining onsite, a 5-year review would be necessary to verify that the remedies included in these alternatives remain protective.

8.3.2 Reduction of Toxicity, Mobility, or Volume Through Treatment

Coupled with the source containment alternative (OU1 ROD), completed in 1989, Alternative 2 will result in permanent remediation of the ground water and will pose no continued risk to the surrounding public or the environment upon completion. Alternative 2 will rely on natural attenuation and dilution to reduce the toxicity, mobility, and volume of ground water contaminants at the Site and attain ARARs within 16 years (Section 7.3). Because Alternatives 1 and 2 do not involve any construction, they will not generate any waste residuals.

Alternative 3 provides for active ground water remediation through extraction and discharge to surface water with some treatment to meet discharge standards. In Alternative 3, toxicity, mobility, and volume of contaminated ground water are reduced through remediation. Alternatives 1 and 2 do not provide for ground water treatment, but rather attenuation of contaminants over time. Alternative 3 best satisfies CERCLA's statutory preference for treatment and use of treatment to reduce toxicity, mobility, and volume of contaminants.

8.3.3 Short-Term Effectiveness

Alternatives 1 and 2, which require no construction, are expected to have the greatest short-term effectiveness because implementation presents no risk to workers, community, and the environment. Alternative 3 also is effective in the short-term. The installation of ground water extraction wells may impose risks through disturbing the soil and ground water, however, this is not expected to pose any short-term environmental or public health hazards.

8.3.4 Implementability

The implementability of an alternative is based on technical feasibility and the availability of services and materials. Alternative 1 would be the simplest to implement. Materials, services, and capabilities are readily available for maintenance of the landfill cover system and monitoring through the FDEP closure permit. Periodic maintenance of the cover should provide reliability in the future. The ground water monitoring program would determine the effectiveness of attenuation of the contaminants in ground water. Alternative 2 would be only slightly less simple to implement than Alternative 1, because it requires EPA to remain involved with the Site for a period of time to ensure that contaminant levels meet ARARs, it does not require construction and the obtaining of permits. Alternative 3 is the most

difficult to implement, and includes ground water extraction, treatment and discharge to surface water. A National Pollutant Discharge Elimination System (NPDES) permit is required for discharges offsite. Treatability testing may be required to define the design parameters for these processes.

8.3.5 Cost

Alternatives 1 and 2 have no present worth cost because EPA would not require any additional actions beyond those required for landfill closure. If Broward County stopped performing work under the State of Florida Permit, the cost for Alternative 2 would increase to approximately $1.3 million. If the State trust fund is not accessed to provide public water to affected residents, the cost for Alternative 2 could increase by another $100,000. Alternative 3 has an estimated present worth cost of $5,950,000, including O&M costs. The present worth value represents the total cost of the remediation expressed in today's dollars. These estimates are based on a 5% interest rate.

TABLE 8-4: COMPARISON OF COSTS

Alternative	Present-worth Cost	Capital Cost	Operation and Maintenance Cost
1. No–Action	$ 0	$ 0	$ 0
2. Natural Attenuation and Ground water Monitoring	$ 0	$ 0	$ 0
(cost if no FDEP permit)	($1,400,000)	($ 100,000)	($1,300,00)
3. Ground water Treatment	$ 5,950,000	$ 2,490,000	$ 3,460,000

8.4 Modifying Criteria

8.4.1 State Acceptance

The State of Florida, as represented by the Florida Department of Environmental Protection (FDEP), has been the support agency during the Remedial Investigation and Feasibility Study (RI/FS) process for the Davie Landfill Site. In accordance with 40 C.F.R. § 300.430, FDEP as the support agency, has provided input during this process by reviewing and providing comments to EPA on all major documents in the Administrative Record. Based upon comments received from FDEP, it is expected that written concurrence will be forthcoming; however, a letter formally recommending concurrence with EPA's selected remedy has not yet been received.

8.4.2 Community Acceptance

Based on comments expressed at the May 19, 1994, public meeting and receipt of 6 written comments during the comment period, it appears that the Davie community generally agrees with Alternative 2 as the selected remedy. Specific responses to issues raised by the community can be found in Appendix A, The Responsiveness Summary.

9.0 SUMMARY OF SELECTED REMEDY

Based upon the comparison of alternatives in the feasibility study (FS) and upon consideration of the requirements of CERCLA, the NCP, the detailed analysis of alternatives and public and state comments, EPA has selected Alternative 2 for this Site. The selected alternative for the Davie Landfill Site is consistent with the requirements of Section 121 of CERCLA and the NCP. Based on the information available at this time, the selected alternative represents the best balance among the criteria used to evaluate remedies. The selected alternative will reduce the mobility, toxicity, and volume of contaminated ground water at the Site. In addition, the selected alternative is protective of human health and the environment, will attain all federal and state ARARs, is cost-effective and utilizes permanent solutions to the maximum extent practicable.

9.1 Ground Water Remediation

9.1.1 Major Components of Ground Water Remediation

The major components of the selected remedy (Alternative #2) which address ground water remediation are as follows:

- natural attenuation of vinyl chloride and antimony,
- ground water monitoring to confirm natural attenuation,
- monitoring of residential wells to determine the impact upon such private wells, and
- public water supply connections for residents that have been affected by contamination in excess of the levels above performance standards.

Implementation of Alternative 2 in conjuction with the OU1 and the landfill closure will protect human health and the environment. Completion of the landfill closure under the FDEP permit is expected to eliminate the only remaining source of contamination in the ground water, surface soils, surface water, and sediments. The FDEP permit also requires that the Site be zoned for parks and recreation and that public water and sewer be provided to park facilities. Because ground water samples

taken from the landfill property showed no significant amounts of contamination, no further deed restrictions or ground water use restrictions are considered necessary on the landfill property.

A reduction in the concentration of contaminants in ground water should be achieved within a reasonable timeframe given the low levels of contamination, low likelihood of exposure, and the relatively long timeframe required for extraction and treatment of ground water. Contaminated ground water is not being used for drinking water in the vicinity of the Site. Residential areas adjacent to the Site are monitored and provisions have been made to provide public water to residents with wells found to have contaminated ground water. Ground water use controls will continue to be implemented to ensure that ground water is not used before levels protective of human health and the environment are reached.

The purpose of the selected remedy is to ensure that contaminant levels reach ARARs. Should contaminant levels approach asymptotic levels before reaching ARARs, EPA, in consultation with FDEP, will re-evaluate the effectiveness of the selected remedy. Because this remedy will result in hazardous substances remaining in the ground water above health-based levels for a time exceeding five years, a review will continue to be conducted every five years after commencement of the OU1 remedial action to ensure that the remedy continues to provide adequate protection of human health and the environment. No additional capital costs are associated with this remedy, provided Broward County continues to perform under the state closure permit.

9.1.2 Performance Standards

Ground water will be monitored until the following maximum concentration levels are attained.

Contaminant	Concentration
vinyl chloride	1 ug/L
antimony	6 ug/L

A literature search was conducted and calculations were performed during the FS that indicate the natural attenuation of vinyl chloride will achieve ARARs in 16 years. No estimation of the time required for antimony to attenuate could be made because antimony readily binds to soil and is unlikely to move with the ground water and thereby contaminate the ground water. Because the levels of antimony detected are relatively low, antimony is a metal, and antimony is expected to adhere to soil particles rather than move with the ground water, natural attenuation is expected to be an effective remedy for antimony to reach ARARs. The major federal and state ARARs and TBCs for this alternative can be found in Tables 8-1, 8-2, and 8-3 of this ROD.

9.1.3 Compliance Testing

A ground water compliance program will be developed to monitor the progress of the ground water restoration. Ground water samples will be collected from existing monitoring wells. These samples will provide confirmation that levels of vinyl chloride and antimony are continuing to decline and that contamination has not continued to migrate or contaminate other nearby residential wells.

Ground water samples will be collected from the monitoring wells and analyzed for vinyl chloride and antimony levels in accordance with the approved FDEP ground water monitoring plan until ARARs are reached. If levels are exceeded or contaminant levels approach asymptotic levels before achieving ARARs, EPA, in consultation with FDEP, will reevaluate the effectiveness of the remedy and the need for further action. Irregardless, monitoring will continue until ARARs are met. Post remediation monitoring will be conducted for a minimum of one year to confirm that the performance standards have been attained.

10.0 STATUTORY DETERMINATION

Under Section 121 of CERCLA, 42 U.S.C. § 9621, EPA must select remedies that are protective of human health and the environment, comply with applicable or relevant and appropriate requirements (unless a statutory waiver is justified), are cost effective, and utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. In addition, CERCLA includes a preference for remedies that employ treatment that permanently and significantly reduce the volume, toxicity, or mobility of hazardous wastes as their principal element. The following sections discuss how the selected remedy meets these statutory requirements.

10.1 Protection of Human Health and the Environment

The selected remedy provides protection of human health and the environment by eliminating, reducing, and controlling risk through engineering controls and/or institutional controls and ground water treatment, if required, as delineated through the performance standards described in Section 9.0 - SUMMARY OF SELECTED REMEDY. The carcinogenic risk due to vinyl chloride and the non-carcinogenic risk due to antimony will be reduced to acceptable levels (i.e., cancer risk between $1x10^{-6}$ and $1x10^{-4}$ and Hazard Index less than or equal to 1) once performance standards are achieved.

Ground water monitoring will be implemented in accordance with performance standards described in Section 9.0 - SUMMARY OF SELECTED REMEDY to ensure that no exposure through ingestion of contaminated ground water occurs. Active remediation will not be implemented for ground water. Residents found to have

contaminated wells will be placed on public water. Implementation of this remedy will not pose unacceptable short-term risks or cross media impact.

10.2 Attainment of the Applicable or Relevant and Appropriate Requirements (ARARs)

Remedial actions performed under Section 121 of CERCLA, 42 U.S.C. § 9621, must comply with all applicable or relevant and appropriate requirements (ARARs). All alternatives considered for the Site were evaluated on the basis of the degree to which they complied with these requirements. The selected remedy was found to meet or exceed ARARs identified in Tables 8-1, 8-2, and 8-3. The following is a short narrative explaining the attainment of pertinent ARARs.

Chemical-Specific ARARs
Ground water performance standards identified as primary drinking water MCLs are the remedial action goals set out in this ROD. If it becomes apparent that MCLs will not be met due to attenuation, EPA, in consultation with FDEP, will re-evaluate the effectiveness of this remedy. Performance standards are consistent with ARARs identified in Table 8-3.

Action-Specific ARARs
Performance standards are consistent with ARARs identified in Table 8-2.

Location-Specific ARARs
Performance standards are consistent with ARARs identified in Table 8-1.

The selected remedy is protective of species listed as endangered or threatened under the Endangered Species Act. Requirements of the Interagency Section 7 Consultation Process, 50 CFR Part 402, will be met. The Department of the Interior, Fish & Wildlife Service, will be consulted during the remedial design to assure that endangered or threatened species are not adversely impacted by implementation of this remedy.

Waivers
Waivers are not anticipated at this Site at this time. Should contaminants reach asymptotic levels prior to reaching performance standards, a waiver may be considered provided affected residential areas are provided with public water.

Other Guidance To Be Considered
Other Guidance To Be Considered (TBCs) include health-based advisories and guidance. TBCs have been utilized in estimating incremental cancer risk numbers for remedial activities at the Site and in determining RCRA applications to contaminated media.

10.3 Cost Effectiveness

After evaluating all of the alternatives which satisfy the two threshold criteria, protection of human health and the environment and attainment of ARARs, EPA has concluded that the selected remedy, Alternative 2, affords the highest level of overall effectiveness proportional to its cost. Section 300.430(f)(1)(ii)(D) of the NCP also requires EPA to evaluate three out of five balancing criteria to determine overall effectiveness: long-term effectiveness and permanence; reduction of toxicity, mobility, or volume through treatment; and short-term effectiveness. Overall effectiveness is then compared to cost to ensure that the remedy is cost-effective. The selected remedy provides for overall effectiveness in proportion to its cost.

The selected remedy has a low present worth, capital, and operation and maintenance cost compared to more exotic remedies, while satisfying the criteria for long-term effectiveness and permanence and short-term effectiveness. This alternative would not reduce toxicity, mobility, or volume through treatment; however, the reduction of toxicity, mobility, or volume through this action would be monitored until ARARs are attained.

The estimated present worth cost for the selected remedy is $0. Should Broward County fail to perform the work required under the FDEP landfill closure permit and fail to access the State of Florida Water Quality Assurance Trust Fund to provide a source of public water to affected residents, then the estimated total present worth cost for the selected remedy will be $1,400,000.

The $ 6 million cost increase for Alternative 3 is not warranted since Alternatives 1 and 2 will protect human health and the environment. EPA believes the selected remedy, Alternative 2, will eliminate the risks to human health at no additional capital or O&M cost to the PRPs while satisfying residents' desires to maintain EPA involvement and also satisfying statutory requirements for EPA to remain involved.

10.4 Utilization of Permanent Solutions to the Maximum Extent Practicable

EPA and the State of Florida have determined that the selected remedy represents the maximum extent to which permanent solutions and treatment technologies can be utilized in a cost-effective manner for the final remediation at the Davie Landfill Site. Of those alternatives that are protective of human health and the environment and comply with ARARs, EPA and the State have determined that Alternative 2 provides the best balance of trade-offs in terms of long-term effectiveness and permanence, reduction in toxicity, mobility, or volume achieved through treatment, short-term effectiveness, implementability, and cost, while also considering the statutory preference for treatment as a principal element and consideration of state and community acceptance. The selected remedy will not satisfy the statutory preference for treatment. However, the selected remedy does provide for long-term

effectiveness and permanence, is easily implemented, reduces toxicity, mobility or, volume, and is cost effective.

The Davie community is concerned about water quality around the Site. Many members of the community would like to be furnished with a source for public water regardless of whether their wells are contaminated or not. However, the community generally agrees with the selected remedy.

10.5 Preference for Treatment as a Principal Element

The statutory preference for treatment is not satisfied by the selected remedy; however, natural attenuation is a cost effective method to address the residual threat to ground water posed by the existing contaminants, vinyl chloride and antimony. Based on the ground water contaminants present and their low concentrations, relative to the drinking water quality standards, the scattered occurences of contamination which prevented the identification of the plume, the low mobility of antimony, and the fact that the primary source of the contamination at the Site, the sludge lagoon, has been remediated, EPA concluded that it was impracticable to treat the ground water effectively. The remedial objectives of the selected remedy address the health and environmental threats at the Site: ingestion of contaminated ground water.

11.0 DOCUMENTATION OF SIGNIFICANT CHANGES

There have been no significant changes in the selected remedy, Alternative 2, from the preferred remedy described in the proposed plan.

APPENDIX A - RESPONSIVENESS SUMMARY

RESPONSIVENESS SUMMARY
OPERABLE UNIT 2
DAVIE LANDFILL SUPERFUND SITE
DAVIE, BROWARD COUNTY, FLORIDA

Introduction

This responsiveness summary for the Davie Landfill Superfund Site documents for the public record concerns and issues raised during the comment period on the proposed plan for operable unit 2 (OU2). EPA's responses to these concerns and issues are included.

Overview of Comment Period

The proposed plan for operable unit 2 (OU2) at the Davie Landfill Superfund Site was issued on May 6, 1994. The thirty–day public comment period for the proposed plan began May 9, 1994, and ended June 8, 1994. Six written comments, some with multiple concerns, were received during that comment period. A public meeting was held on May 19, 1994 at the Town of Davie Community Hall, at 6591 S.W. 45th Street, Davie, Florida. Several comments were received and addressed during that meeting. A transcript of the meeting was prepared and is available at the information repositories near the Site.

Concerns Raised During the Comment Period

Private Well User Concerns:

1. Several citizens expressed concern about ground water quality near the Site and their general desire to be placed on public water. Residents feel that Broward County has polluted the aquifer which most adjacent residents access for drinking water through private wells. They want Broward County to pay for extending public water lines and for residential connections. Several residents indicated that they thought Broward County should pay their water bills.

   Response: Contaminants detected were found in very small quantities at sporadic locations. The proposed remedy includes monitoring of monitoring wells and residential wells downgradient of the Site until concentrations of vinyl chloride and antimony reach ARARS (i.e., primary drinking water standards). If contaminant levels reach asymptotic levels before reaching ARARs, EPA, in consultation with FDEP, will re–evaluate the effectiveness of the selected remedy. The remedy also requires Broward County to provide residents with contaminated wells connections to public water. The remedy does not require Broward County to provide access to public water to residents not affected by contamination.

Broward County's Public Health Unit has performed the residential monitoring at the Site since 1988, and will continue to monitor residential wells downgradient of the areas placed on public water. Broward County is responsible for ensuring that monitoring of residential areas is conducted, whether through the Public Health Unit or another county office.

Currently, public water supply connections are being paid for through the State of Florida Water Quality Assurance Trust Fund. If the trust fund cannot be accessed to pay for public water connections for affected residents, Broward County will be required to pay for the connections.

The remedy does not require Broward County to pay for residential water uses of affected residents; the county only is required to provide an alternate source of water to affected residents.

2. Several residents who live northeast of the Site expressed concern that a leachate force main from the landfill was routed through their neighborhood. The residents are concerned that the line will leak and contaminate their private wells. They are concerned that no one monitors their wells. They insist that Broward County agreed to provide public water to their homes when the leachate line was installed, but that Broward County never installed public water lines. They do not trust Broward County officials to look out for their welfare.

Response: The leachate collection line was constructed in 1992 with HDPE pipe as a modification to the FDEP permit for the closure of the landfill. The pipe was installed in 500 ft lengths with fusion welds. This type of pipe is typically used to convey leachate because it is chemically resistant to contaminants found in leachate; it is strong enough to bear the overburden loads typically imposed at landfills; and it is flexible enough to withstand uneven settlements without breaking. The pipe lengths are long to reduce the number of connections required and the pipes are fusion welded to reduce the possibility of leakage. The pipe was hydrostatically tested (i.e., tested with high pressure water) prior to being put in service and the pressure at the beginning and end of the line is checked twice per week to determine if there have been any unexplained pressure drops. Broward County officials have said that no decrease in pressure or volume, which might indicate a leak, has been observed since the pipeline has been in operation.

The Broward County Public Health Unit has monitored at least one resident on 37th Court and has not found contamination. The Health Unit has agreed to monitor a few homes in the area for a short period of time in order to alleviate residential concerns.

Broward County agreed to provide $175,000 towards the installation of public water supply lines to the residential area northeast of the Site when the pipeline was being installed. Town of Davie officials have developed plans which they estimate will require more than $175,000 to implement. The Town currently is evaluating ways to finance the shortfall.

3. Two residents who live northeast of the Site asked that their wells be tested.

   Response: EPA forwarded those requests to the Broward County Public Health Unit. The director of the Public Health Unit indicated that those wells would be sampled, if possible, when sampling in that area was performed.

4. A citizen asked that more sampling be done southeast of the Site.

   Response: Broward Counties Public Health Unit will continue to monitor residential areas southeast of the Site. This area has been monitored since 1988. EPA determined that enough data currently exists to make a decision regarding remediation at the Site, but monitoring will continue to be performed in the residential area southeast of the Site.

5. A resident asked about orange pipes that used to be on 36th Court. The resident indicated that crews used to periodically take samples from the pipes, but the pipes no longer are visible or are being sampled.

   Response: The orange pipes were not installed as part of the leachate force main or any landfill activities. EPA has been unable to locate any information regarding the orange pipes.

6. A citizen asked if Broward County was going to reimburse residents south of the Site who hooked up to public water at their own expense.

   Response: EPA can require that Broward County provide an alternate water source to private well owners impacted by contamination from the Site. EPA does not have the authority to require Broward County to reimburse residents for past damages.

7. A citizen expressed concern about public water supply wells being affected by contamination, specifically the "Ivanhoe" well field.

   Response: The nearest public water well field is in Cooper City, 2 miles southeast of the Site. There are several clusters of monitoring wells between the Site and the well field. The local water authorities analyze the water daily. If the Site were affecting water quality at the public water well field, there would be indications from monitoring wells. The Ivanhoe well field is several miles

west of the Site, is upgradient of the Site, and therefore, should not be affected by contamination.

Landfill Closure Concerns:

8. A citizen expressed concern about the facility becoming a park.

   Response: Based on the Risk Assessment performed by EPA, the soils, surface water, and sediments at the closed landfill are not hazardous to the public. Therefore, EPA is not restricting access to the landfill. The Site has been zoned for Parks and Recreation. Continuing concerns regarding the use of the Site for a Park should be directed toward Broward County and Town of Davie officials.

9. A citizen asked why organic matter was dumped onsite along the shoreline of Lake No. 3.

   Response: The closure plan for the landfill requires that topsoil and grass cover the slopes and shoreline leading to the Lakes to reduce erosion, thereby maintaining the integrity of the closure system. The topsoil and grass should improve the habitat for terrestrial wildlife at the Site.

Natural Resource Concerns:

10. One comment stated that the proposed plan did not go far enough in predicting the damage to natural resources.

    Response: Seventy-two (72) ground water monitoring wells were sampled, twenty (20) private wells were sampled, 25 surface water samples were taken, 17 sediment samples were taken, and 10 soil samples were taken. Natural Resource Trustees for the state and federal government were asked to comment on the location and number of samples prior to beginning field activities at the Site. Until this comment was received, there was no indication from any group reviewing the reports that the Remedial Investigation/Feasibility Study (RI/FS) at the Site was lacking in any area. Based on the results of the RI, EPA does not feel that a more detailed investigation is warranted at this Site.

RI/FS Concerns:

11. A citizen asked if we sampled in the C-11 canal.

    Response: Yes. Sediments and surface water were sampled at 4 locations in the C-11 canal. Nine contaminants of potential concern were found in the

sediment and seven contaminants were found in the surface water. More information on the contaminants of potential concern can be found in Tables 3–5 and 3–8 of the Baseline Risk Assessment or in Tables 6–5 and 6–6 of the Record of Decision (ROD). The effects of the contaminants of concern in sediment and surface water on human health and the environment were evaluated in the Baseline Risk Assessment and were found to be below a level which would harm human health or the environment.

12. One comment stated that an insufficient number of samples was taken in the C–11 canal and that the full impact on biota from the existence and transport of contaminants within C–11 has not been determined yet by either bioassay or toxicological studies. This comment also stated that background sample locations SD–9 and SD–12 were not truly background. The citizen questioned the impact of Site contaminants on the Everglades.

Response: Sediments and surface water were sampled at 4 locations in the C–11 canal. EPA and state and federal trustees reviewed the work plan which described those locations and determined that this number of samples was adequate to characterize the surface water chemistry near the landfill. Site–specific ecological testing, such as the bioassays and toxicological testing mentioned, often are recommended if Site contaminant concentrations exceed the screening values or literature information for the appropriate media. However, additional factors, such as the number of samples and the number of contaminants exceeding screening values, the degree of exceedance, factors affecting bioavailability, etc., are considered in making the decision to conduct such testing. Based on the results of the RI, EPA determined that no further testing was necessary.

C–11 Canal sampling location SD–9 was not used as a background location (Section 2.1, page 2–14 of the Baseline Risk Assessment). SD–12 was used as a background location. SD–12 was collected 2.5 miles west of the Site and 3.5 miles east of the pumping station. Because of the distance between the pump station and the sample location, it is unlikely that these sediment samples could be affected by backpumping of the canal. Similarly, it is unlikely that Site–related contaminants have impacted the Everglade region west of the Site. Therefore, SD–12 is considered representative of ambient sediment chemistry.

13. One comment questioned why the detection limit for vinyl chloride was 10 ug/L when the MCL is 1 ug/L.

Response: The detection limit for vinyl chloride should have been less than or equal to 1 ug/L. The 10 ug/L value in the groundwater samples is a quantification level. Above 10 ug/L the analyses can be accurately quantified. Below 10 ug/L the analyses can be estimated. Any detection of vinyl chloride

below 10 ug/L was reported as an estimate and was labeled with a J. The minimum instrument detection level was 1.3 ug/L.

Because there is a substantial data base regarding vinyl chloride in this area based on testing methods with detection limits of 1 ug/L, EPA did not feel that it was necessary to resample with lower detection limits in order to determine the extent of contamination. The sampling results gathered in the RI agreed with other results taken in this area. This means that the locations where vinyl chloride was detected in the RI are the same locations where vinyl chloride has been detected in previous sampling events. In addition, the levels of vinyl chloride estimated in the RI are in the same range as the levels detected in previous sampling events.

The Florida Department of Health and Rehabilitative Services (HRS) provides quarterly groundwater testing for residences in the area surrounding the Site. The detection limit in the test method used by HRS is 1 ug/L. The County also tests groundwater quarterly using a method with a detection limit of 1 ug/L.

14. One comment stated that secondary drinking water standards were violated for iron, sodium, aluminum, and manganese.

Response: A 1991 study performed by the U.S. Geological Survey, in cooperation with the Florida Department of Environmental Regulation, Major-Ion and Selected Trace-Metal Chemistry of the Biscayne Aquifer, Southeast Florida, reports iron concentrations in the Biscayne Aquifer in South Florida for 182 samples that range from below detection limits (BDL) to 21,000 ug/L. The iron reported in the RI was well within the range of naturally occurring iron reported by the USGS (350 ug/L to 17,000 ug/L). Iron is ubiquitous in the ground water in South Florida.

Less than 5% of the ground water samples contained exceedances for sodium, aluminum and manganese. The sodium and manganese analyses fell within the range of background values for the Biscayne Aquifer as reported by the 1991 USGS Study. The exceedances do not define a plume and occur scattered throughout the sampling area. The risk assessment performed for this Site indicated that none of these contaminants are considered to contribute significantly to the calculated human health risk.

15. One comment stated that the detection limit for Antimony (15 ug/L) was higher than the MCL (6 mg/L), therefore the contamination at the Site due to antimony may be more extensive than indicated in the RI.

Response: Antimony was not identified as a contaminant of concern at this Site prior to the RI, and therefore, the detection limit was not of great concern

prior to the investigation. The 15 ug/L value in the groundwater samples is a quantification level. Above 15 ug/L the analyses can be accurately quantified. Below 15 ug/L the analyses can be estimated. Any detection of antimony below 15 ug/L would have been reported as an estimate and labeled with a "J". The minimum instrument detection level was approximately 2 ug/L.

Twenty–five percent of the samples were tested for antimony. No estimated values were reported. Three wells analyzed positive for antimony at 15 to 19 ug/L. Antimony is expected to readily bind to the soil; therefore, antimony is not expected to migrate into the groundwater and contaminate the groundwater.

16. One comment stated that antimony was detected in 8 out of 8 sediment samples above the biological Effects Range–Low concentration, mercury was detected in 9 out of 22 sediment samples above the biological Effects Range–Low (ER–L) concentration, and silver was detected in 2 out of 22 sediment samples above the biological Effects Range Low (ER–L) concentration. The commentor implied that a more extensive response was required to address this contamination.

Response: It appears that the commentor misinterpreted the results of the RI. Table E5.4 in Appendix E of the RI provides a summary of metals detected in sediments near the Site. When a contaminant is tested for but not detected it is reported with a "<" symbol or a "U" qualifier and a number. The number represents the ***quantitation limit*** (i.e., the detection limit above which the reported values are considered accurate). Below that number the concentration can be ***estimated*** but not determined with the required degree of accuracy. Any detections below the quantitation limit would have been reported as an estimated value and labeled with a "J". The lowest level that can be estimated is referred to as the instrument detection limit. The instrument detection limit is typically 10–15% of the quantitation limit.

The NOAA Sediment Effects Range Low (ER–L) and Effects Range Median (ER–M) concentrations are used as ***screening values*** to determine if more detailed studies are required. Concentrations above the ER–L, but well below the ER–M, indicate a low potential for detrimental effects. Based on the limited exceedances at the Site, EPA determined that additional studies were not warranted.

Based on Table E5.4 of the RI, antimony was not detected in any sediment samples, either as an estimated value or above the quantitation limit. Quantitation limits vary from sample to sample depending on the presence of other contaminants in the sample and the concentration of those contaminants. This is because the presence of other contaminants makes it more difficult to segregate out the exact amount present of any particular contaminant below the

quantitation limit. The ***quantitation limit*** for antimony in sediment ranged from 2.6 – 6.6 mg/kg in 7 samples and was 23.3 mg/kg in 1 sample; these quantitation limits were above the NOAA Effects Range–Low (ER–L) concentration of 2 mg/kg but below the Effects Range–Median (ER–M) concentration of 25 mg/kg.

Mercury was detected in 5/17 sediment samples at concentrations ranging from 0.072–0.17 mg/kg. Four of the samples (at 0.17 mg/kg) slightly exceed the ER–L for mercury of 0.15 mg/kg but are below the ER–M of 1.3 mg/kg. Sample SD–9, located somewhat upstream from the landfill, was the only sample from the C–11 canal in which mercury was detected. If the landfill were the source of the mercury, one might have expected to find detections of mercury in canal sediment samples SD–8 and SD–13, which are downgradient from the landfill. Therefore, EPA believes the mercury contamination in the C–11 canal sample is not Site related.

Silver was detected in 1/6 sediment samples. Silver was detected at 1.2 mg/kg, which is slightly above the Effects Range–Low (ER–L) concentration of 1 mg/kg but below the Effects Range–Median (ER–M) concentration of 2.2 mg/kg.

17. One comment expressed concern that the Boy Scout Lake and other recreational water bodies may be affected by contaminated sediments through runoff pathways.

Response: Surface water runoff is contained onsite by an extensive storm water management system. The Boy Scout Lake should not be impacted by runoff from the Site, because a perimeter berm prevents water from flowing offsite. If storm water exceeds the retention capacity of onsite structures, it will be released, in a controlled manner via an existing underground culvert, to the canals adjacent to the Site.

Onsite lake sediments contain higher contaminant levels than the Boy Scout Lake and these lakes have direct contact with onsite runoff. The risk assessment conducted as part of the RI/FS indicates that the sediments in onsite lakes do not pose a significant human health threat, and only pose a low risk to aquatic life.

18. Broward County does not agree that vinyl chloride and antimony concentrations are site related. The county contends that septic tanks may account for or contribute to the detection of vinyl chloride, and that the fact that the Davie Landfill Site and surrounding area was a bombing range for the U.S. Army during World War II may account for the presence of antimony.

Response: Since 1988, Broward County has reported exceedances of drinking water standards for vinyl chloride in well clusters MW-11, MW-12, MW-13, MW-15, MW-19, and MW-20. All of these well clusters, except for MW-20, are located downgradient of the landfill and all of these well clusters, except for MW-19, are located upgradient from the residential area (Sunshine Ranches). Vinyl chloride also was detected in other onsite wells at or below drinking water standards.

The residential wells where vinyl chloride was detected were downgradient of the landfill. If residential septic systems were another source of vinyl chloride contamination, then Broward County's Public Health Unit should be detecting vinyl chloride more often in wells located downgradient, not upgradient, from the septic tanks. The health unit has reported vinyl chloride in a few wells downgradient of the landfill; however, in most residential wells sampled near the Site, vinyl chloride was not detected.

Antimony was detected in two wells on the Site and one well off the Site. The trash landfill contains ash from the former incinerator and ash can be a source for antimony. Prior to this comment, EPA was not aware that the landfill and surrounding area had been used as a bombing range during World War II. However, if the source for antimony was from activity during World War II, EPA would expect to detect antimony more extensively on and off the Site.

Risk Assessment Concerns:

19. Broward County does not agree with the major assumptions driving the risk at the Site, specifically the future resident scenario.

Response: The future resident scenario was evaluated to determine the worst case of possible exposure. The risk was evaluated based on exposure to each contaminated media: ground water, surface soil, surface water, and sediment. The risk assessment concluded that surface soil, surface water, and sediment at the Site do not contribute significantly to the risk to future residents; however, the ground water is a significant source of concern.

The county contends that the Site has been zoned for parks and recreation, that the landfill will never become a residential area, and that public water will be supplied to the Site for any park facilities as stipulated in the FDEP Closure Permit. However, residential areas surround the Site and EPA contends that the future resident scenario is applicable to current residents living adjacent to the Site because most residents have private wells which tap into the contaminated aquifer and because most residents will have access to surface soils, surface water, and sediments at the Site when it is opened as a park.

Concerns About The Remedy Selected:

20. A citizen commented that an insufficient number of alternatives were analyzed.

Response: General response actions for ground water remediation under the National Contingency Plan (NCP) include no action, institutional controls, and several extraction, treatment, containment, and disposal options. A preliminary screening of technologies was conducted in the FS on the basis of effectiveness, technical implementability, and cost. The most viable options were evaluated as alternatives.

21. A citizen commented that more emphasis needs to be put on Broward County being the responsible entity. The citizen did not believe that monitoring was enough of an action at the Site.

Response: Broward County is the only responsible party at the Site. Broward County has assumed responsibility for all past and present remedial activities at the Site and always has been identified as the responsible party for the Site.

This Site was originally placed on the National Priorities List (NPL) due to contamination from the former sludge lagoon. The sludge lagoon remediation was performed in 1989 and is referred to as operable unit 1 (OU1). The ground water at the Site is being addressed as operable unit 2 (OU2).

It has been five years since Broward County remediated the major source of contamination at the Site (i.e., OU1). Closure of the landfill essentially is complete through a FDEP permit, thereby eliminating the source of the low level contamination. The Broward County Public Health Unit has monitored the ground water since 1989, and, as verified in the RI for OU2, only low levels of contamination remain in the ground water. As the levels of contamination decrease, the cost effectiveness of removing and treating the ground water also decreases. Based on a literature search and calculations done during the FS (pages 4–7 and 4–13 of the FS), vinyl chloride will attenuate in less than or equal to 16 years and cost nothing, whereas, extraction and treatment of vinyl chloride would take approximately 12 years and $ 6,000,000.

The residential area being impacted by contamination was provided by the Broward County Public Health Unit with access to a public water source in 1988. In the 6 years since those residents were provided access to public water, two homes southeast of those residents were found to have drinking water violations for vinyl chloride. Those residents then were provided access to public water through a state water quality trust fund.

Based on the RI/FS and residential well monitoring results, the continued effects of contamination on residential areas are considered limited. The private wells users near the Site will continue to be monitored until the levels of vinyl chloride and antimony reach ARARs and Broward County will be responsible for providing affected residents with access to a public water source, either through the state trust fund or through county funds.

22. Another comment indicated a preference for a remedy which removes or reduces harmful contaminants at the Site.

Response: Ground water extraction, treatment, and surface water discharge was considered as a possible alternative at this Site. Due to the low levels of contamination at the Site, extraction of vinyl chloride would take approximately 12 years as opposed to the 16 years estimated for natural attenuation. Antimony would be even more difficult to extract and will likely adhere to soil particles rather than be removed through ground water extraction. Because current contaminant levels in the ground water already meet most surface water standards, except for iron, the extracted ground water probably would not require extensive treatment. Therefore, extraction of the ground water would involve pumping ground water to surface water with little required treatment.

Because natural attenuation will achieve the same cleanup standards in only a slightly longer time period than would ground water extraction, EPA has determined that it is more appropriate to allow the contaminants to attenuate at this Site.

23. Broward County commented that residential monitoring is now and will continue to be monitored by the State Public Health Department. Broward County stated that monitoring will not be provided by the Broward County Office of Integrated Waste Management and is not included in the Water Quality Management Plan for the Davie Landfill. In addition, Broward County stated that if public water needs to be provided, it is intended that the primary source of funding for the supply of water will be through the State of Florida Water Quality Assurance Trust Fund.

Response: As the only responsible party for remediation of the Davie Landfill Site, Broward County will be held responsible for the execution of all activities required in the selected remedy. Broward County will be held responsible for monitoring the landfill and residential areas until contaminant levels reach ARARs. Broward County will be held responsible for providing public water to residents affected by contamination from the Site. EPA will not object to the county using other resources to assist in the execution of the work, but, Broward County always will be held responsible if those resources fail to perform as required.

Condition #11 of the FDEP Closure Permit for the Davie Landfill, as modified on September 1, 1988, requires that the county "continue the random groundwater monitoring of the private residents' water supplies which are affected by the landfill plume for its forward movement/recession until the Corrective Actions For Ground Water Contamination Cases (CAFGWCC) has been resolved in writing by the Department." The permit further requires that Broward County "continue to provide bottled water to those residents whose private water supplies are determined to be affected by this plume." The permit states that this "determination shall be done in writing by the Broward County Public Health Unit."

If Broward County fails to perform any component of EPA's selected remedy, EPA will pursue additional enforcement activities, or EPA will take over execution of the work and pursue cost recovery actions against Broward County.