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15. Supplementary Notes

16. Abstract (Limit: 200 words)

The Commencement Bay/Tacoma site is a 190-acre industrial/municipal landfill located in Pierce County, Tacoma, Washington. The landfill is operated by the City of Tacoma Refuse Utility and is surrounded primarily by residential development and open land, with some commercial and industrial development. Several utilities (i.e., sewer, water, and storm) pass through the site. An aquifer beneath the site provides drinking water to the Town of Fircrest and the City of Tacoma, both of which have wells near the landfill. The aquifer is also used by private individuals for their domestic water supply. Ground water flows predominatly to the southwest toward Leach Creek, which lies approximately 0.25 mile west of the landfill. Consequently, wetlands downstream of the landfill could potentially be exposed to contaminants in the surface water and ground water. The Tacoma landfill began operations in 1960, receiving only nonhazardous wastes including assorted municipal and industrial wastes, construction and demolition wastes, and bulk waste. To date, about 4 million tons of refuse have been deposited at the landfill to depths of 20 to 80 feet. Although the landfill does not accept hazardous wastes for disposal, it did receive wastes in the 1960s and 1970s that have since been designated as hazardous substances. In 1983, investigations by EPA revealed the presence of hazardous compounds in the ground water and soil near the landfill.
(See Attached Sheet)

17. Document Analysis a. Descriptors

Record of Decision
Commencement Bay/Tacoma, WA
First Remedial Action - Final
Contaminated Media: sw, soil
Key Contaminants: VOCs (benzene, toluene, xylenes), metals (chromium)

b. Identifiers/Open-Ended Terms

c. COSATI Field/Group

Availability Statement	19. Security Class (This Report) None	21. No. of Pages 121
	20. Security Class (This Page) None	22. Price

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

EPA/ROD/R10-88/016
Commencement Bay/Tacoma, WA
First Remedial Action - Final

16. ABSTRACT (continued)

Subsequent investigations indicated that the ground water is contaminated with VOCs. In response, the City of Tacoma connected affected residences to the public water system. In 1986, accumulation of landfill gas in a utility vault adjacent to the landfill resulted in a minor explosion. A field survey was initiated to evaluate the extent of offsite gas migration, and based on this survey a gas extraction system was constructed to extract, collect, and combust the gas. Gas samples collected at the landfill revealed high levels of VOCs. The primary contaminants affecting the ground water and surface water are VOCs including benzene, toluene, and xylenes.

The selected remedial action for this site includes: construction of a cap on the landfill with runoff directed to appropriate storm or sanitary sewers, and installation of a gas extraction system and gas probes to monitor methane gas production; installation of a ground water pump and treatment system with discharge of treated water to a local creek or the POTW and alternate water supply if needed; and ground water and surface water monitoring. The estimated present worth cost for this remedial action is between $21,015,000 and $23,418,000. The estimated O&M costs were not provided.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 10
1200 SIXTH AVENUE
SEATTLE, WASHINGTON

RECORD OF DECISION, DECISION SUMMARY, AND RESPONSIVENESS SUMMARY

FOR

FINAL REMEDIAL ACTION
COMMENCEMENT BAY - SOUTH TACOMA CHANNEL
TACOMA LANDFILL SITE
TACOMA, WASHINGTON
MARCH 1988

RECORD OF DECISION
REMEDIAL ALTERNATIVE SELECTION
FINAL REMEDIAL ACTION
COMMENCEMENT BAY - SOUTH TACOMA CHANNEL
TACOMA LANDFILL
TACOMA, WASHINGTON

RECORD OF DECISION

REMEDIAL ALTERNATIVE SELECTION

Site

Commencement Bay - South Tacoma Channel, Tacoma Landfill site - Tacoma, Pierce County, Washington.

Purpose

This decision document presents the selected final remedial action for the site, developed in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), and consistent with (where not precluded by SARA) the National Contingency Plan (NCP, 40 CFR Part 300). The State of Washington, in close consultation with EPA, has developed and concurred with the selected remedy. A copy of the state concurrence letter is attached as Appendix D.

Basis for Decision

The decision is based upon the administrative record for the site, as obtained from the files of the Washington State Department of Ecology and the U.S. Environmental Protection Agency (EPA). This record includes, but is not limited to, the following documents:

- Remedial Investigation Report for the Tacoma Landfill, Tacoma, Washington (December 1987)

- Feasibility Study of the Tacoma Landfill Site, Final Report (December 1987)

- Decision Summary of Remedial Alternative Selection

- Responsiveness Summary (attached as Appendix B)

- Staff summaries and documents--An index (Appendix C) identifies other items which are included in this administrative record.

Description

This record of decision (ROD) addresses source control of on-site contaminants through capping of the landfill and extraction of methane gas. Management of migration for off-site contaminants will be through a groundwater extraction and treatment system.

The remedial action is designed to:

- reduce the production of leachate by placing constraints on further site operations and by capping the landfill.

- eliminate off-site gas migration through the gas extraction system.

- prevent further migration of the contaminated plume via the groundwater extraction-treatment system.

- further protect public health and the environment via monitoring of groundwater, surface water, gas probes, and air emissions.

- provide an alternate water supply (Tacoma municipal water) to any residents deprived of their domestic supply due to demonstrated contamination from the landfill or due to the action of the extraction-treatment system.

Treatment will be sufficient to reduce contaminant levels in the groundwater to or below cleanup standards. Performance levels for the identified contaminants of concern are presented in Table 8. The methodology to be used to develop performance levels for the other contaminants in the groundwater is discussed in the Selected Remedial Alternative section of the ROD. Treatment should be permanent, and should effectively reduce the toxicity and mobility of the contaminants. Performance levels are not to be exceeded during the operational life of the remedial action. Treated water discharge shall at all times be consistent with federal laws and Washington State laws. Any treatment system which will produce air emissions will be designed to meet appropriate federal and state Air Toxics Guidelines and to use Best Available Control Technology (BACT) on the effluent air stream.

Containment of the plume will be confirmed by installation and periodic sampling of monitoring wells as well as continued, scheduled monitoring of private and public wells. Extraction will continue until water quality at the compliance boundary (defined by WAC 173-304 as the edge of the filled area) consistently meets or exceeds drinking water standards, or previously established and approved health-based criteria. In addition to meeting health-based criteria, potential impacts to public and private water supplies, and to Leach Creek must be considered in the decision to shut off the system.

Those residents who are deprived of domestic drinking water, either because their wells water quality shows demonstrated contamination from the landfill or because the quantity available has been reduced by the action of the extraction-treatment system, will be connected to city water supplies.

Source control measures are expected to reduce contaminant concentrations in the groundwater system. Source control measures consist of constructing a cap on the landfill and appropriate regrading to minimize infiltration and maximize run-off, ultimately reducing leachate volume and toxicity. Unlined areas of the landfill will be capped as soon as possible. WAC 173-304 defines the minimum requirements for a cap on a municipal landfill. A more stringent cap will be required unless further analysis of the cap, to be provided during remedial design, shows that a significant reduction in leachate volume or toxicity would not be achieved.

Increased run-off due to the construction of the cap will be routed off the landfill to reduce infiltration. The run-off collected from the landfill will be directed to the appropriate storm or sanitary sewers, consistent with local storm drainage ordinances or pre-treatment regulations. The storm drainage plan, prepared as part of the remedial design, will determine and minimize any impacts on downstream increases in peak flow.

The city of Tacoma (Tacoma) will implement a closure plan for the landfill consistent with Washington State Minimum Functional Standards for Landfill Closure (WAC 173-304), and as appropriate, Washington State Dangerous Waste Regulations (WAC 143-303).

Institutional controls will be implemented, consistent with the final design, to assure that the remedial action will continue to protect health and the environment. Tacoma, in cooperation with the town of Fircrest and Pierce County, will pursue the establishment of an ordinance, or other suitable methodology, to restrict drilling of water supply wells in an area from Tyler Street to Leach Creek, and from Center Street to approximately South 56th Street.

Declaration

Consistent with CERCLA, as amended by SARA, and the NCP, it is determined that the selected remedy as described above is protective of human health and the environment, attains Federal and State requirements which are applicable or relevant and appropriate, and is cost-effective. This remedy satisfies the preference expressed in SARA for treatment that reduces toxicity, mobility, or volume. Finally, it is determined that this remedy utilizes permanent solutions and alternative treatment technologies to the maximum extent practicable.

3-31-82
Date

Regional Administrator
Environmental Protection Agency
EPA - Region 10

DECISION SUMMARY
REMEDIAL ALTERNATIVE SELECTION
FINAL REMEDIAL ACTION
TACOMA LANDFILL
TACOMA, WASHINGTON

TABLE OF CONTENTS

		Page
I	SITE DESCRIPTION AND LOCATION	1
II	SITE HISTORY	3
	A. Landfill History and Operations	3
	B. Regulatory History - Previous Investigations	4
	C. The Remedial Investigation/Feasibility Study	5
III	SITE ENVIRONMENT	6
IV	NATURE AND EXTENT OF PROBLEM	9
	A. Extent of Gas Migration	9
	B. Contaminants Detected	13
	C. Extent of Groundwater Contamination	14
	D. Surface Water	16
	E. Future Impacts	17
	F. The Endangerment Assessment	19
V	ALTERNATIVES EVALUATION - FEASIBILITY STUDY	27
VI	SELECTED REMEDIAL ALTERNATIVE	35
	A. Description of the Selected Remedy	35
	B. Statutory Determinations	43
VII	ENFORCEMENT	49
VIII	COMMUNITY RELATIONS	50

APPENDICES

A. APPLICABLE AND APPROPRIATE REQUIREMENTS

B. RESPONSIVENESS SUMMARY

C. INDEX TO ADMINISTRATIVE RECORD

D. STATE CONCURRENCE LETTER

LIST OF TABLES

		following Page
Table 1	Summary of Organic Compounds Detected in Landfill Gas	11
Table 2	Threshold Limit Values for Landfill Gas Components	12
Table 3	Organic Waste Components Detected at the Landfill	14
Table 4	Metals Detected at the Landfill	14
Table 5	Travel Times to Reach Maximum and Threshold Concentrations, Close-in and Distant Wells	24
Table 6	Summary of Detailed Evaluation of Remedial Alternatives	32
Table 7	Section 121(b)(1)(A-G) Evaluation Factors	32
Table 8	Performance Standards for Treatment System/Discharge to Surface Water	37

LIST OF FIGURES

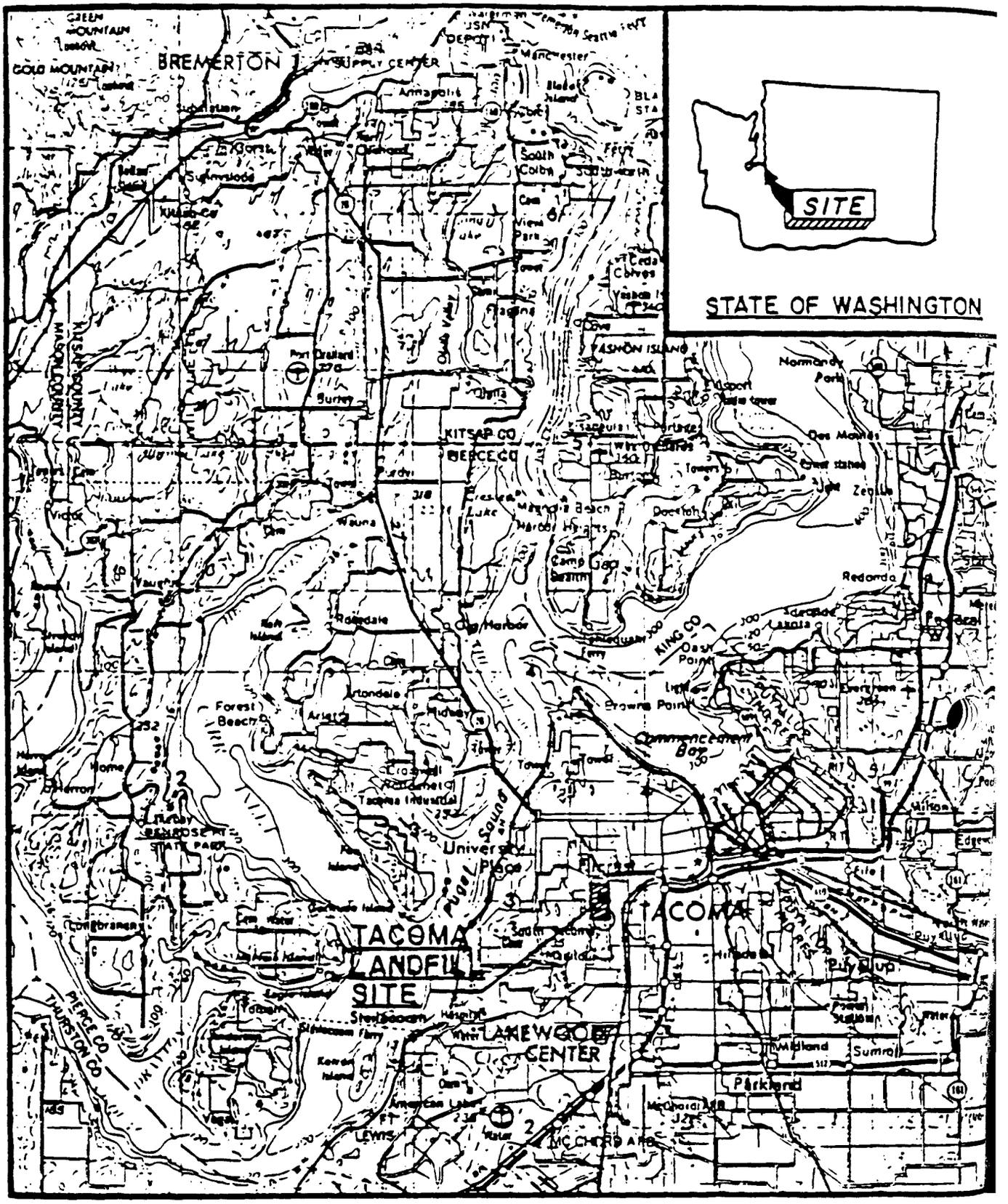
Figure 1	Site Location	1
Figure 2	Site Vicinity	1
Figure 3	Landfill Zoning	1
Figure 4	Leach Creek Drainage Basin	6
Figure 5	Landfill Site Cross Section and Lithology	7
Figure 6	Location of Private Wells/Extent of Contamination	8
Figure 7	Landfill Drainage Patterns	8
Figure 8	Landfill Gas Extraction System	9
Figure 9	Contaminant Distribution in Groundwater	15
Figure 10	Contaminant Distribution in Groundwater (continued)	15
Figure 11	Current and Predicted Contamination	18

I. SITE DESCRIPTION AND LOCATION

The Tacoma Landfill, operated by the City of Tacoma Refuse Utility, is located in Sections 12 and 13 of Township 20 North, Range 2 East, Pierce County, Washington. The landfill covers 190 acres and is bounded approximately by South 31st Street on the north, Tyler Street on the east, South 48th Street on the south, and Orchard Street on the west. Figures 1, 2 and 3 illustrate the location of the landfill, the vicinity surrounding the landfill, and the site itself. The landfill serves a population of approximately 212,000. To date, approximately 4.0 million tons of refuse have been deposited at the landfill since it opened in 1960. Currently about 600 tons per day of refuse are placed in the landfill.

The landfill does not accept hazardous wastes for disposal. However, the landfill received wastes in the 1960s and 1970s that have since been designated as hazardous substances under State and Federal law.

Figure 2 shows the general topography of the landfill and surrounding area. Drumlins (low, long ridges) abound in the general area and display a north-south axial configuration. Solid waste has been disposed of at the site between five drumlins. The landfill's western boundary is approximately one quarter mile from Leach Creek, but the landfill does not lie in the flood plain of that creek. The landfill is surrounded primarily by residential development and open land, with some commercial and industrial development. Land use for the area surrounding the landfill is shown on Figure 3. No use of natural resources other than groundwater is noted on land use inventories. Several utilities (sewer, water, and storm) pass through the site.



N

0 1 2 4 8

SCALE : 1" = 4 MILES

FIGURE 1
SITE LOCATION M

TACOMA LANDFILL

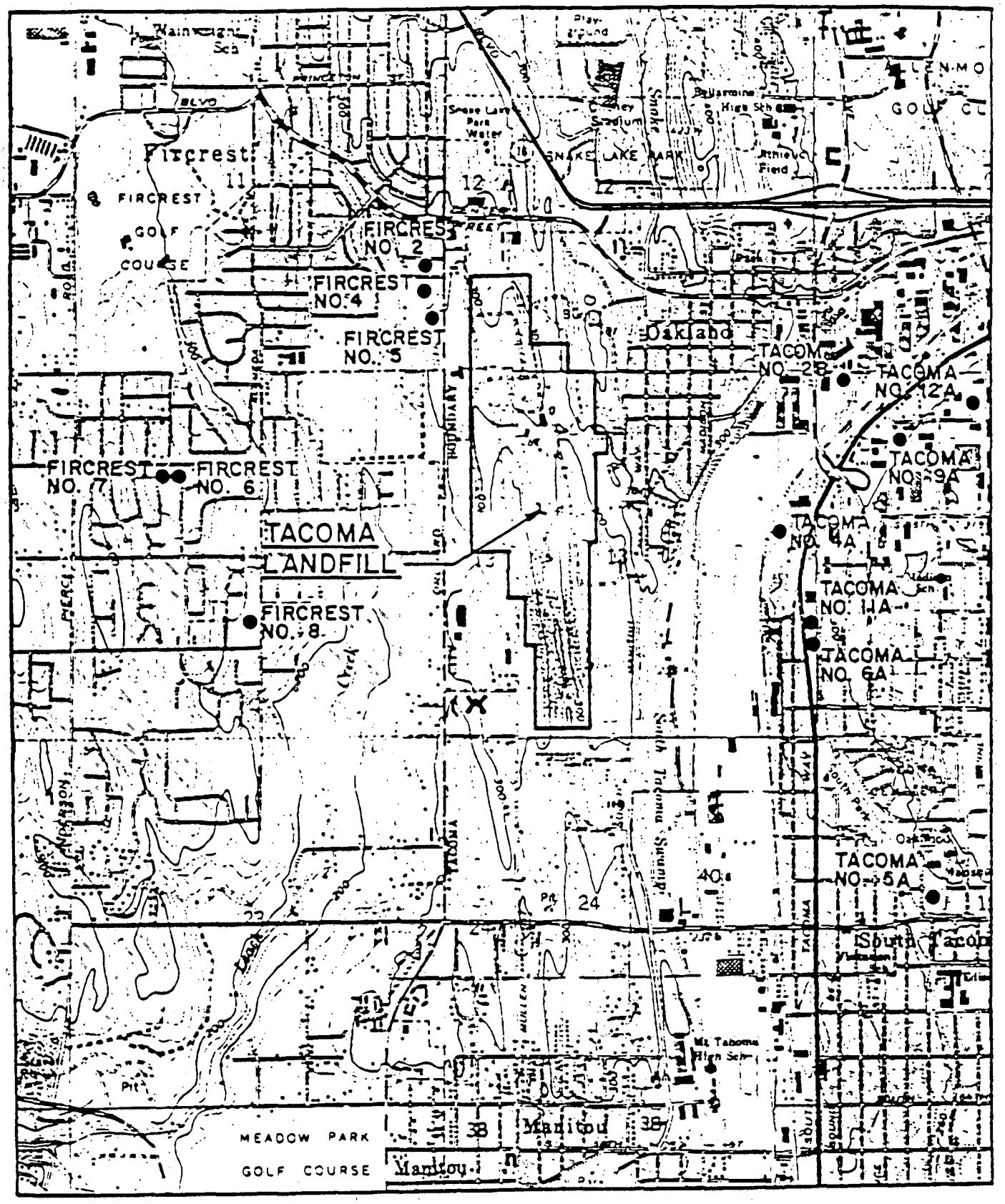


FIGURE 2
SITE VICINITY
PRODUCTION WELL LOCATIONS
TACOMA LANDFILL RI/FS

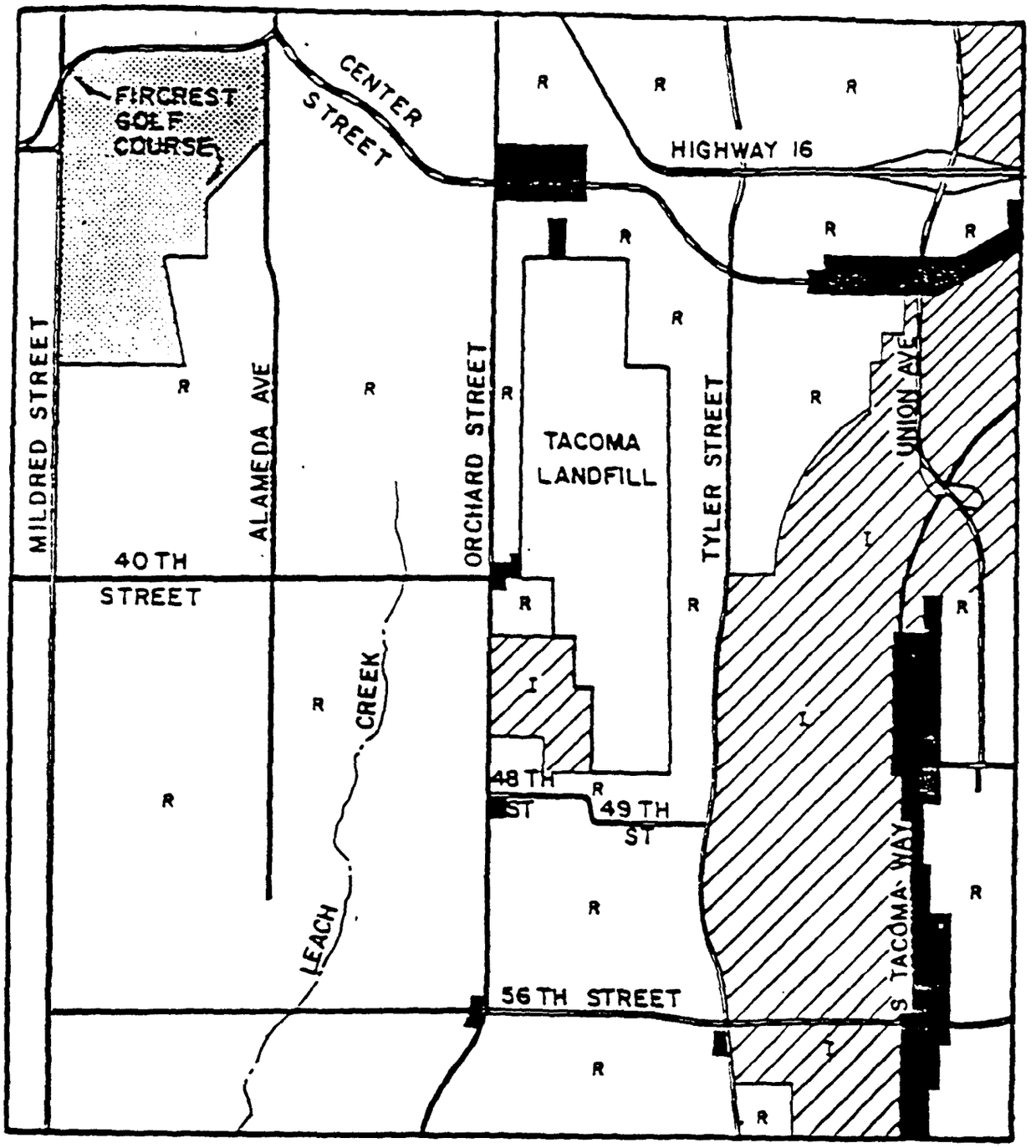


FIGURE 3
LANDFILL ZONING
TACOMA LANDFILL RI/FS

Apartments, undeveloped land, and commercial properties including a bowling alley, offices, building supply and paint stores, and gas stations are located north of the landfill. Immediately east of the landfill are apartment complexes, single family residences, and undeveloped land. The area further east between Tyler Street and South Tacoma Way is occupied by the Burlington Northern Railroad, industrial/commercial development, and an open area known as the South Tacoma Swamp. Between the west edge of the landfill and Orchard Street there are several apartment buildings and commercial establishments. West of Orchard Street and south of the landfill there is residential development and undeveloped land.

The landfill lies in the central portion of the Tacoma/Fircrest upland ground water system. A significant area for the central upland in the vicinity of the landfill is Leach Creek.

II. SITE HISTORY

A. Landfill History and Operations

The Tacoma Landfill began operations in 1960, and now serves a population of approximately 212,000. The wastes received and disposed at the landfill include garbage, rubbish, industrial wastes, construction and demolition wastes, street refuse, litter, and bulky waste. To date, approximately 4.0 million tons of refuse have been deposited at the landfill. Filled areas vary from 20 to 80 feet deep. Currently some 600 tons per day of refuse are placed in the landfill.

Most of the site has already been filled. The next section of the site to be filled is called the Central Area Pit. This section of the landfill covers approximately 18 acres and was developed during the summer and fall of 1987. A flexible membrane liner and leachate collection system were installed in the Central Area Pit. The liner and leachate collection system were designed primarily to maximize volume for waste disposal. To date, there has been no documentation received on the integrity of the liner.

Day to day operations of the landfill are regulated by the Tacoma-Pierce County Health Department (TPCHD) with oversight by the Washington Department of Ecology (Ecology); the operating permit is issued annually by TPCHD.

At the current rate, the 190-acre site has a remaining life expectancy of approximately four to five years if all the solid waste material is disposed without a significant reduction in volume. Tacoma has indicated it intends to implement programs to extend the life expectancy of the landfill.

There are many large and small industries in the Tacoma/Pierce County area which have disposed of wastes at the landfill. Memoranda reviewed during the preparation of the Description of Current Situation report and the RI indicate that some hazardous wastes were disposed of at the landfill. Investigations concerning the volumes, the chemical composition of the wastes, and the disposal locations are ongoing.

B. Regulatory History - Previous Investigations

In 1983 EPA conducted an investigation and detected hazardous compounds in samples of ground water and soils near the landfill. This led EPA to include the landfill on the National Priorities List of hazardous waste sites as part of the South Tacoma Channel site. Through a cooperative agreement with EPA, Ecology began an investigation into contamination at the site in 1984. On June 27, 1986, Tacoma assumed responsibility for conducting the remedial investigation and feasibility study under a Response Order on Consent issued by Ecology.

Since 1983 testing has been conducted at and around the Tacoma Landfill by EPA, Ecology, TPCHD, Tacoma, and others. The testing revealed that three private wells contained contaminants. The priority pollutant volatile organic compounds which were detected in the ground water samples were primarily chlorinated organics. Twenty-four volatile organic compounds were found in groundwater contaminated by the landfill.

Because of the concern about the public health effects of the contaminants, particularly vinyl chloride, the TPCHD recommended that Tacoma connect these affected residences to the Tacoma public water system. As a precautionary measure, Tacoma also connected two additional residences whose wells were near the area. Monitoring continues quarterly to ensure the clean water supply for potentially affected residents while appropriate cleanup actions are approved and carried out.

C. The Remedial Investigation/Feasibility Study (RI/FS)

The remedial investigation (RI), conducted by Tacoma's consultant, Black and Veatch, was performed in two phases. Phase 1 activities (July 1986 through January 1987) consisted primarily of field investigations to characterize both the hydrogeology of the site and the contaminants present in the various media at and surrounding the site. Phase 2, conducted from January through November 1987, was designed to fill in data gaps identified at the conclusion of Phase 1 and to provide the data necessary for the endangerment assessment and the feasibility study (FS).

Upon completion of the RI and and evaluation of the alternatives, the City, through their consultants (Black and Veatch), submitted a draft RI and FS report in September and October 1987 for agency review and approval. The final RI/FS reports were published December 1987. Public comment on the studies was completed in March 1988.

III. SITE ENVIRONMENT

The Tacoma Landfill site is located in the northern portion of the Chambers/Clover Creek drainage basin (see Figure 4). This area is part of the Puget Sound lowland. The study area is bounded by: the Tacoma channel to the east; Center Street to the north; 56th Street to the south; and Leach Creek to the west.

A moderate climate prevails. Winter temperatures are seldom below freezing and summer temperatures are rarely above 80°F. Approximately thirty-seven inches of rain fall in a normal year. Studies conducted in the Puget Sound region have indicated that approximately 30% of rainfall becomes groundwater.

The geology of the site consists of a series of glacial materials, mostly sand and gravel laid down over older alluvial silts and sands. The stratigraphic units (layers) described in the Remedial Investigation (Black and Veatch, 1987) from youngest to oldest (top down) are:

A. Vashon Till (dense gray, gravelly, silty, sand) (Qvt)
B. Vashon Advance Outwash (sands/gravels) (Qva)
C. Colvos Sand (dense sand/some gravel) (Qc)
D. Older Gravel (dense sandy gravel) (Qog)
E. Older Till (dense silty, gravelly sand) (Qot)
F. Older Outwash (dense silty, gravelly sand) (Qoa)
G. Older Sand (dense fine/medium sand) (Qos)
H. Older Lacustrine (lake bottom silts) (Qol/Qk)
I. Undifferentiated Quaternary Sediments (Qu)

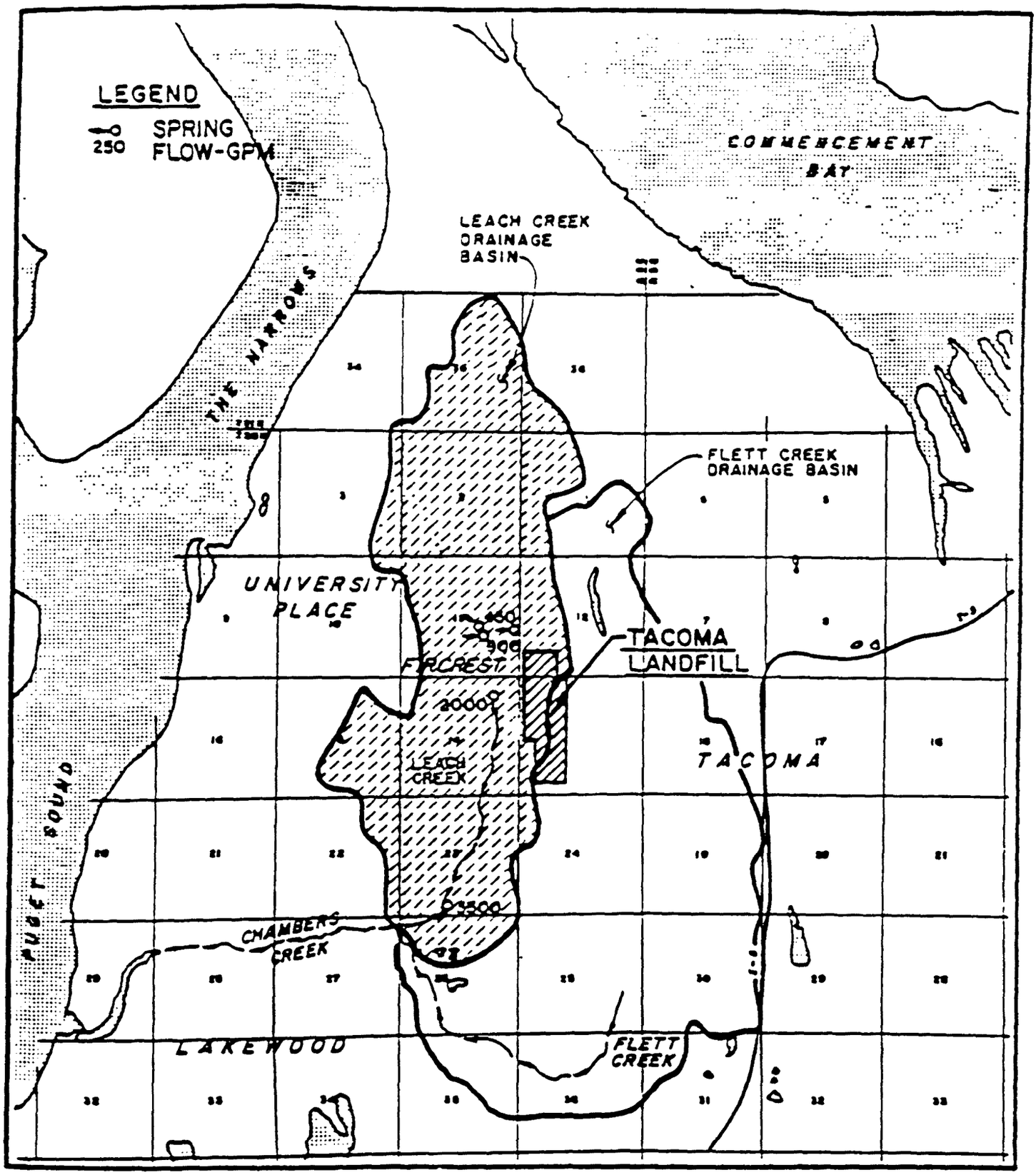


FIGURE ADAPTED FROM CLOVER/ CHAMBERS CREEK GEOHYDROLOGIC STUDY

FIGURE 4

LEACH CREEK DRAINAGE BASIN

TACOMA LANDFILL RI/FS

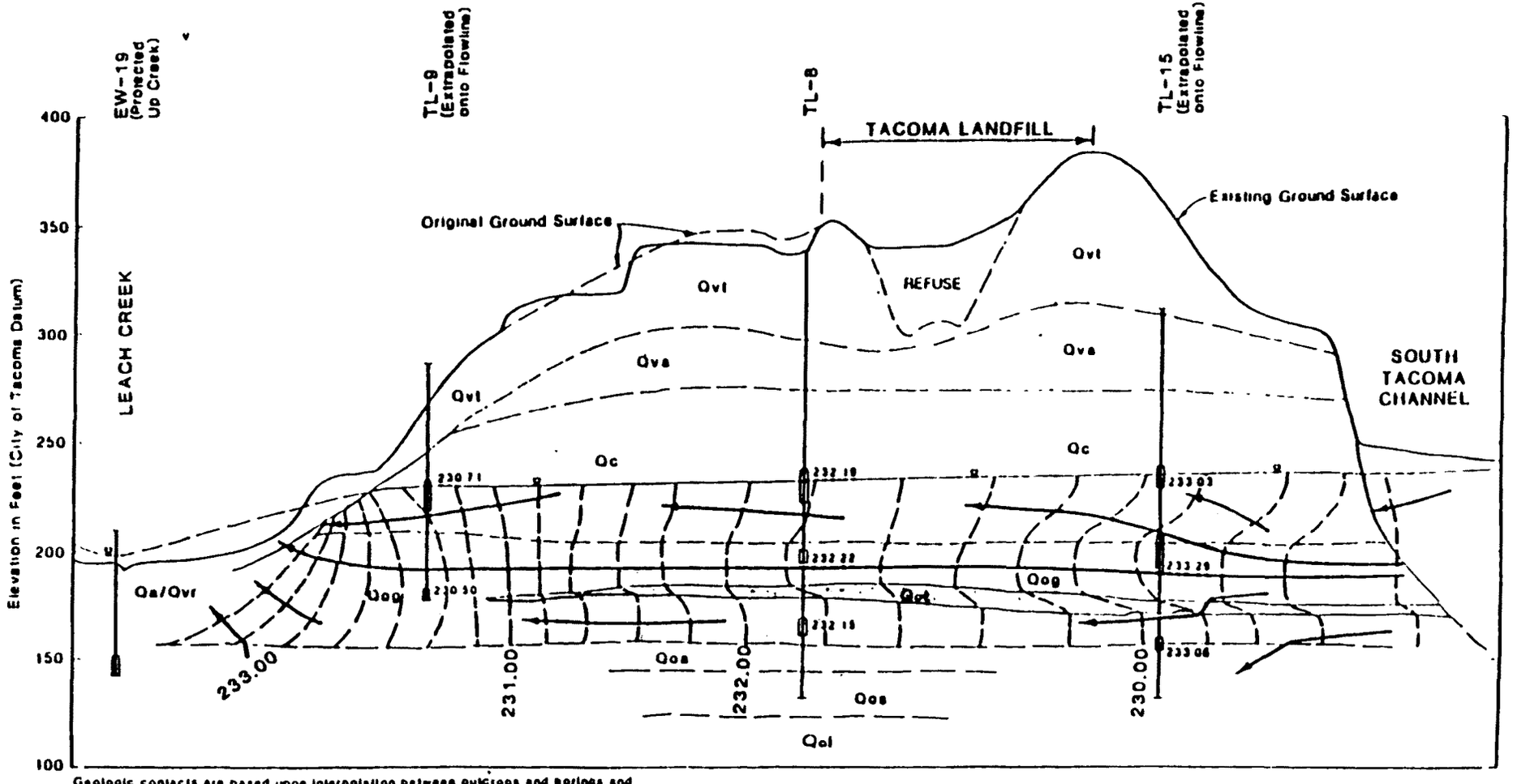
The affected aquifer is located between the lower zones of the Colvos Sand and the Older Lacustrine. The Older Lacustrine unit serves as the regional aquitard in the landfill area. A cross section through the area (Figure 5) shows the ridges, valleys, and the lithology (layers).

Water, infiltrating through the landfill, picks up various contaminants. Where the Vashon Till is not present beneath the waste, contaminants move with the water through the unsaturated zone and into the aquifer. It is also possible for low solubility, pure phase fluids, called dense, non-aqueous phase liquids (DNAPLs), such as chlorinated hydrocarbons to enter the aquifer. Evidence of this has not been shown, nor has it been disproven. The water table lies within the Colvos Sand unit, about 70 feet below the bottom of the landfill.

The predominant flow direction of the water table aquifer is southwesterly toward Leach Creek. However, during periods of heavy water use by Tacoma city wells (summer and early fall), the groundwater flow direction is reversed. Also, depending on local conditions, groundwater and contaminant movement may be downward or upward.

The Older Alluvium reportedly forms the confining layer. Leach Creek is the closest discharge point of the aquifer. Additional information from future activities will clarify the ground water flow conditions near the creek and elsewhere around the site.

The aquifer is part of the Chambers/Clover Creek Ground Water Management Area. The TPCHD is petitioning EPA for a Sole Source Aquifer designation for



Geologic contacts are based upon interpolation between outcrops and borings and represent our interpretation of subsurface conditions based on currently available data

Figure prepared by Hart Crowser, Inc.

Notes. 1. Water table elevations are from 12/4/86. Potentials at lower levels are calculated from average vertical gradients over seven (7) sets of water level measurements (Table 4-2) and therefore represent anticipated average conditions.

2 Flowlines are drawn qualitatively assuming a moderate degree of anisotropy.

TL-8 Well Number

Well Location

Water Table 12/4/86

Screen Section

233.00 Equipotential Line

Water Table Elevation in Feet

Groundwater Flow

Horizontal Scale in Feet
0 400 800

0 50 100
Vertical Scale in Feet
Vertical Exaggeration x 8

FIGURE 5
SITE CROSS SECTION AND LITHOLOGY

TACOMA LANDFILL RI/FS

this aquifer. The Town of Fircrest and the City of Tacoma both operate wells near the landfill (see Figure 2). In addition, the aquifer is also used by private individuals for domestic water supply (see Figure 6).

Wetlands downstream of the landfill on Chambers Creek could potentially be exposed to contaminants in the surface water and ground water. None of the five endangered species identified in the State of Washington is common to the area surrounding the landfill.

The topographical lowpoint in the landfill is currently at the north end of the Central Area Pit. Some runoff from surrounding areas drains and discharges to the sanitary sewer. Drainage from the north and along Mullen Street is directed towards a pond situated between the bowling alley parking lot and northern landfill property on Mullen Street. Drainage from the west side of the site is directed toward a catch basin and discharges to the Leach Creek retention basin. The south end of the site drains to the south and is not collected. Drainage patterns are shown in Figure 7.

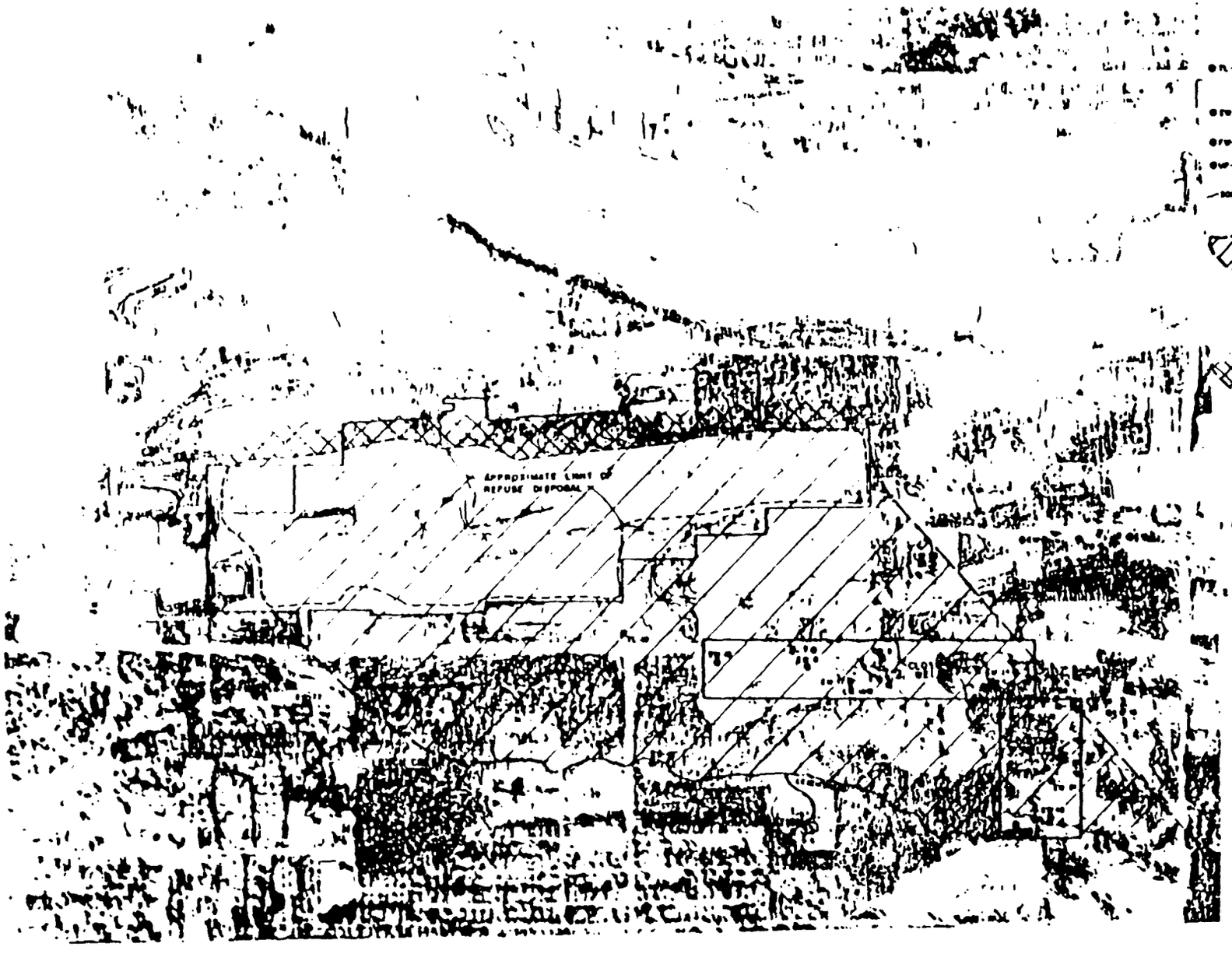


FIGURE 6
LOCATION OF PRIVATE WELLS
EXTENT OF CONTAMINATION

TACOMA LANDFILL RI/FS

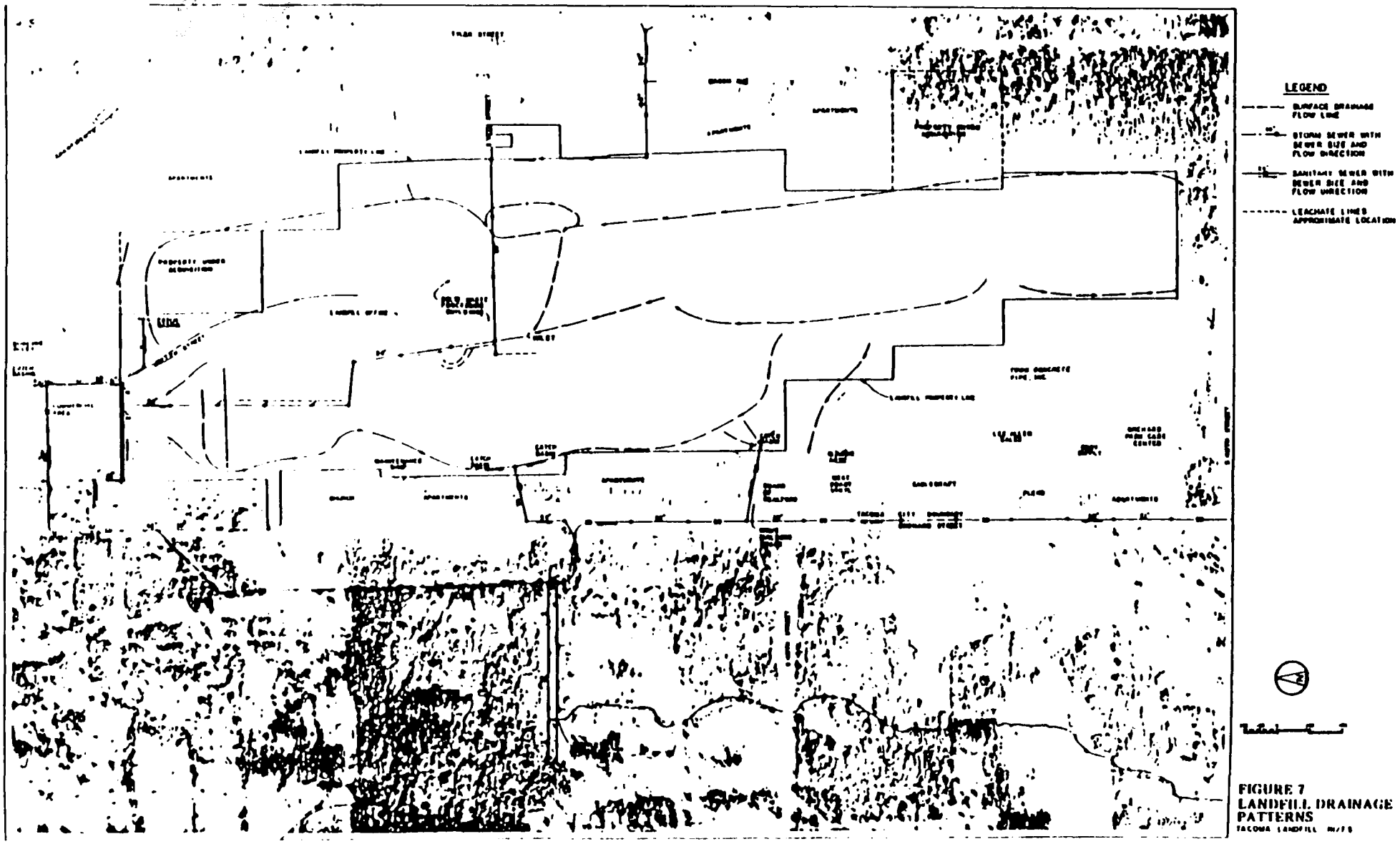


FIGURE 7
LANDFILL DRAINAGE PATTERNS
TACOMA LANDFILL 9/78

IV. NATURE AND EXTENT OF PROBLEM

A. Extent of Gas Migration

In May 1986, accumulation of landfill gas in a utility vault at the Town Concrete Pipe Company (located immediately adjacent to and west of the landfill) resulted in a small explosion. Tacoma had already hired a consultant (Mandeville Associates) to address problems of gas production and migration at the landfill and was able to immediately initiate a field survey to evaluate the extent of gas migration off-site. Based on this survey, the consultant designed and constructed a gas extraction system to extract, collect and combust the gas. The field survey showed the biggest problem to be southwest of the site and this initial effort concentrated on controlling gas from migrating into businesses in this area.

The current landfill gas system consists of 128 extraction wells, collection piping, 77 gas probe locations, and the motor blower/flare station where contaminants are incinerated. The system layout is shown on Figure 8.

Tacoma has conducted a two-stage gas monitoring program to monitor the effectiveness of the extraction system. Figure 8 shows the locations of 66 probes installed around the landfill. Each of these probes consists of two to five probes able to monitor gas at depths from 6 to 70 feet. These probes are checked twice a week and seem to indicate that the shallower gas is being controlled by the extraction system.

LEGEND

FIGURE 8
LANDFILL GAS
EXTRACTION SYSTEM

The gas found deeper than about 35-40 feet is not being controlled as well. As a result of this information, Tacoma is installing approximately 74 new, deep extraction wells around the landfill. This work began on January 27, 1988.

The City has also been conducting an off-site monitoring program beginning in May, 1986. From May 1986 until August 1987, this program focused on businesses and apartments to the south and west of the site, where both ambient and point source measurements were taken. Beginning in August 1987, the current off-site monitoring system began. This consists of monitoring utility vaults in residential areas (shown on Figure 8), and routine ambient and point source monitoring in some businesses and vacant apartments. The data from this effort shows that methane is still escaping the landfill and finding its way to the surface in off-site locations. The utility vault data shows several areas around the landfill to be of particular concern.

The Minimum Function Standards require that the concentrations in off-site structures be below 100 parts per million (ppm) by volume of hydrocarbon in ambient air. From November 1986 through October 1987, the readings of ambient air in off-site structures were below the limit; however, some point sources monitored such as foundation cracks and closed vaults on occasion have shown readings above 100 ppm. Readings above the limit were found in the ambient air in one building west of the landfill near 40th Street (Classic Auto) in November 1987. The City installed four additional gas extraction wells in this area in December 1987. No readings were detected in the building after the first well was connected to the system on December 15, 1987.

Ecology has requested that additional gas probes be placed in the neighborhoods of concern. The existing probes are well within the influence of the gas extraction wells and do not represent ambient conditions further off-site. Methane concentrations in utility vaults can also be misleading. Gas concentrations fluctuate a great deal with changing atmospheric conditions. Therefore, it is possible that landfill gas could be found in a house without observing it in the vault. Additional gas probes are needed to better determine the performance of the gas extraction system.

A total of 42 landfill gas samples were collected at 26 locations around the landfill. The gas samples collected from gas wells and probes were analyzed for priority pollutant volatile organic compounds (VOC). The analytical results are summarized in Table 1. The methane concentration was analyzed for five of the Phase 1 samples and was field measured for seven of the Phase 2 samples. These results are presented below:

Sample No.	Methane (ppm)	Sample No.	Methane (ppm)
Phase 1		Phase 2	
GS-001	540,000	GS-213	370,000
GS-002	430,000	GS-214	480,000
GS-002DUP	430,000	GS-215	610,000
GS-003	560,000	GS-218	560,000
GS-004	240,000	GS-219	200,000
		GS-220	200,000
		GS-221	200,000

TABLE 1
SUMMARY OF PRIORITY POLLUTANT VOLATILE
ORGANIC COMPOUNDS DETECTED IN LANDFILL GAS SAMPLES
Concentrations in ug/ml

Date	Benzene	Chloro-benzene	Chloro-ethane	1,1-Di-chloro-ethene	1,2-Di chloro-ethene	1,1-Di-chloro-ethene	Trans-1,2-Di chloro-ethene
06/25/86	2600	1500	1400	TR	5000	5000	2500
06/25/86	700	5000	10000	5000	5000	5000	TR
06/25/86	3200	1250	300	1250	1250	1250	500
06/25/86	2400	980	2500	1250	1250	1250	130
06/25/86	2900	950	2500	1250	1250	1250	1250
06/25/86	1800	1400	12000	5000	5000	5000	700
06/25/86	1800	5000	6300	5000	5000	17000	12000
06/25/86	3000	1100	12000	5000	5000	5000	5000
06/25/86	1300	1600	10000	5000	5000	5000	5000
06/25/86	1800	5000	TR	900	TR	TR	23000
06/25/86	2000	1200	TR	5000	5000	1000	16000
06/25/86	4800	800	1400	3700	12000	TR	120000
08/26/86	35.5U	71U	35.5U	35.5U	35.5U	35.5U	35.5U
08/26/86	2200	25U	450	1600	25U	45	1200
11/13/86	4800J	100U	2300J	3300J	100U	100U	35000J
12/09/86	2100	100U	9300	2000	1600	100	20000
12/09/86	1400	100U	1000	2200	1500	100	19000
02/12/87	2600J	1000U	2000U	1000U	1000U	1000U	8600J
02/10/87	3400	500U	12000	1400B	500U	500U	7700
02/10/87	840J	100U	200U	10000	10000	10000	600J
02/10/87	1200	1000U	1800J	600J	10000	10000	2600
02/12/87	2600	1000U	1200	1500B	10000	10000	3000
02/12/87	4800	1000U	2200	1500	1900	520J	38000
02/10/87	2400	1000U	1300J	800J	10000	10000	9400
02/10/87	2600	1000U	1800J	1500	10000	580J	56000
02/10/87	2600	1000U	2000U	1000U	10000	10000	4600
02/10/87	3200J	1000U	2000U	1000U	10000	10000	10000

TABLE 1 (cont)
SUMMARY OF PRIORITY POLLUTANT VOLATILE
ORGANIC COMPOUNDS DETECTED IN LANDFILL GAS SAMPLES
Concentrations in ug/ml

Sample Locations	Ethyl Benzene	Methy-lene Chloride	Tetra-chloro-ethene	Toluene	1,1,1-Tri-chloro-ethane	Tri-chloro-ethene
GW-01	68000	1700B	1300	6100	5000	1100
GP-28	4300	2500B	TR	1600	5000	TR
GP-45	18000	TRB	300	11000	1250	1250
GP-32	8100	200B	TR	530	1250	1250
GP-32	8000	300B	TR	630	1250	1250
GP-33D	39000	TRB	TR	3300	5000	5000
GP-33S	21700	73000	25000	89000	900	3800
GP-25D	30000	5000	TR	1400	5000	5000
GP-25S	36000	TRB	5000	5000	5000	5000
GP-06D	50000	2000B	20000	860000	5000	13000
GP-06S	77000	2500B	4700	210000	5000	5800
FS-01	28000	33000B	24000	84000	TR	25000
GP-13	TRB	250B	35.5U	130B	35.5U	35.5U
GP-14	1200	1600B	2000	26000	900	1100
GP-TL-08A	37000J	500U	3200J	110000J	100U	6700J
FLARE	18000*	30000*	10000	97000*	1400	10000
FLARE	19000*	50000*	10000	10000*	1300	5800
GW-22	8800BJ	100UJ	600BJ	9800BJ	1000U	600BJ
GW-12	5600B	2400000B	320000B	550000B	5800	9300
GW-28 EAST	500000B	1000UJ	200J	46000B	1000U	200J
GW-28 SW	90000B	1000UJ	600J	360000B	1000U	800J
GW-64	1500B	110000B	2200	140000B	560J	26000B
GW-1A	1600000B	1000UJ	12000	1500000B	200J	12000
GW-6A	570000B	1000UJ	3200	1200000B	1000U	3400
GW-6D	590000B	1000UJ	8400	1300000B	1000U	8400
GW-45	120000B	3600B	1000B	86000B	1000U	1000U
GW-45(Dup)	120000BJ	2800BJ	1400J	84000BJ	1000U	800J

The landfill gas contains significant concentrations of VOCs and has been proposed as a possible migration pathway for these compounds to the groundwater, particularly when groundwater contamination is found upgradient.

The American Congress of Governmental Industrial Hygienists has issued threshold limit values (TLVs) on airborne concentrations of various substances. These limits are intended as guidelines in the control of potential health hazards. The time-weighted average (TWA) TLV concentration for a normal 8-hour workday and a 40-hour workweek is the concentration which nearly all workers might be exposed to without adverse effect. The compounds detected in landfill gas samples that exceeded 15 percent of the TWA values are given in Table 2. Two of the TWA's were exceeded (toluene and vinyl chloride). The detected concentrations listed in Tables 1 and 2 are from samples collected inside the respective gas well or probe and are not representative of ambient air concentrations.

EPA's ISCST (Industrial Source Complex Short-Term) dispersion model was used to predict the potential landfill air quality impacts. Toluene was generally detected at higher concentrations than other VOCs in the landfill gas samples and had the highest mass flow rate both in and out of the flares during the flare test; therefore, it was selected as the pollutant to be assessed by the air quality analysis.

The worst case analysis predicted the highest toluene concentration (using a one hour averaging time) to be slightly greater than 2 ppb. The Draft New Source Guidelines for Toxic Air Contaminants (Sept. 1986) for the State of Washington indicate a 14 ppb toluene to be the acceptable ambient

TABLE 2

THRESHOLD LIMIT VALUES FOR LANDFILL GAS COMPOUNDS

Compound (CAS Number)	Sample No.	Highest Value Detected ug/m3	TWA(1) ppm	TWA(1) ug/m3
Benzene (71-43-2)	GS-012, GS-217	6,800	10	30,000
1,1-Dichloroethene (75-35-4)	GS-007	17,000	5	20,000
Trans-1,2-Dichloroethene (540-59-0)	GS-012	120,000	200	790,000
Ethylbenzene (100-41-4)	GS-011	77,000 (2)	100	435,000
Methylene Chloride (75-09-2)	GS-007	73,000	100	350,000
Toluene (108-88-3)	GS-010	860,000	100	375,000
Vinyl Chloride (75-01-4)	GS-217	124,000	5	10,000
2-Hexanone (591-78-6)	GS-011	8,200	5	20,000
Total Xylenes (1330-20-7)	GS-011	170,000	100	435,000
1,2-Dichloroethane (107-06-2)	GS-012	12,000	10	40,000

(1)TWA - Time Weighted Average, Reference 34.

(2)A value of 160,000 ug/m^3 was detected for ethylbenzene in sample GS-217; however, ethylbenzene was also detected in the laboratory reagent blank.

level; therefore, it would appear that as long as the current gas collection system remains functional, ambient air concentrations of VOCs should remain well below ambient air standards.

B. Contaminants Detected

Groundwater, surface water, leachate, sanitary sewer, subsurface soil, sediment and landfill gas samples were collected during the RI sampling program. The prevalent contaminants detected during the sampling program were volatile organic compounds followed by semivolatile organic compounds and metals.

Twenty-four volatile organic chemicals were found in the groundwater. Of the twenty-four chemicals, the following seven indicator chemicals were identified in the Endangerment Assessment in the RI as being of most concern because of their toxicity, frequency of occurrence, and primary targets (human population):

- vinyl chloride
- benzene
- 1,2-dichloroethane
- methylene chloride
- 1,1-dichloroethane
- chloroethane
- toluene

In addition, review of the Endangerment Assessment by EPA and Ecology resulted in the inclusion of three additional indicator chemicals listed below:

- o xylenes
- o 1,1,1-trichloroethane
- o ethyl benzene.

The rationale for inclusion of these chemicals is discussed further in the Endangerment Assessment section of this document.

Twenty three private drinking water wells were sampled during the sampling program. For the three wells where contamination exceeded drinking water standards, the City of Tacoma connected the residents to City water. As the plume spreads, it is predicted more private wells would become contaminated at levels above public health standards unless actions are taken to restrict the movement of the plume.

A list of hazardous organic compounds (priority pollutant and hazardous substance list compounds) detected in groundwater samples analyzed during the RI is given in Table 3. Table 4 provides the list of priority pollutant metals detected at the landfill.

C. Extent of Ground Water Contamination

The contaminant pathway of primary concern near the landfill is the ground water. The town of Fircrest supplies water to its residents from six ells located west of the landfill. Three of these wells are only

TABLE 3

ORGANIC WASTE COMPONENTS DETECTED AT THE TACOMA LANDFILL

Waste Component	Subsurface Soil	Ground-water	Surface Water	Sanitary Sewer and Leachate	Sediment	Gas[a]
Volatile Organic Compounds						
Tetrachloroethene	X	X		X	X	X
Trans-1,2-Dichloroethene	X	X		X		
Trichloroethene	X	X		X	X	X
1,1-Dichloroethene		X		X	X	X
Vinyl Chloride		X		X		X
1,1,1-Trichloroethane		X				X
1,1-Dichloroethane		X		X		X
1,2 Dichloroethane		X				X
Chloroethane		X		X		X
Benzene		X		X	X	X
Ethylbenzene		X	X	X		X
Chlorobenzene		X		X		X
Toluene	X	X	X	X	X	X
Xylene (Total)	X	X		X		X
2-Butanone	X	X		X	X	X
2 Hexanone				X		X
1,2,-Dichloropropane		X		X		X
Trans-1,3-Dichloropropene		X				X
Styrene						X
Carbon Disulfide						X
Chloroform		X	X	X		
Chloromethane						X
Bromo-dichloromethane						
Methylene Chloride	X	X		X	X	X
Acetone	X	X		X	X	X
4-Methyl-2-pentanone		X		X		
SemiVolatile Organic Compounds[b]						
Hexachlorobenzene		X				
PNAs		X			X	
Phenol		X		X		
Pthalate Esters		X			X	
1,4-Dichlorobenzene				X		
N-Nitro-Sodi-phenylamene				X		
Benzyl Alcohol				X		
Benzoic Acid				X		
4-Methy Phenol				X		
Isophorone					X	

[a] Samples not analyzed for semivolatile compounds

[b] Only trace amounts of semivolatile compounds were detected in ground water samples.

TABLE 4

METALS DETECTED AT TACOMA LANDFILL

	Subsurface Soil	Ground-water	Surface Water	San. Sewer & leachate	Sediment	Gas
Arsenic	X	X	X	X	X	NA
Cadmium		X	X	X	X	NA
Chromium	X	X	X	X	X	NA
Copper	X	X	X	X	X	NA
Mercury	X	X	X	X	X	NA
Nickel	X	X	X	X	X	NA
Lead	X	X	X	X	X	NA
Zinc	X	X	X	X	X	NA
Iron	X	X	X	X	X	NA
Aluminum	X	NA	X	NA	X	NA
Manganese	X	X	X	X	X	NA

NA= not applicable

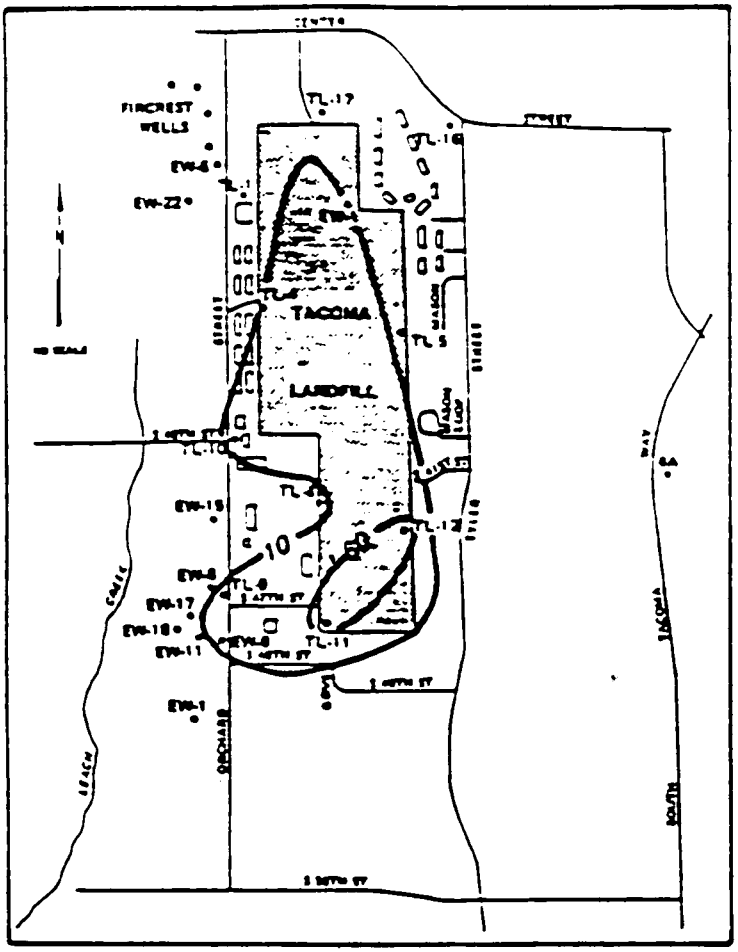
approximately 0.2 mile from the edge of the landfill. The City of Tacoma operates nine wells to the east of the landfill to supplement summer peak demands on their surface water supply (see Figure 2). In addition, twenty-six known domestic wells are located near the landfill (see Figure 6).

Volatile organic compounds have been detected in 20 monitoring wells installed around the perimeter of the landfill during the RI and in six of the private wells. The highest contaminant concentrations and greatest numbers of compounds were generally found near the water table in the southern portion of the landfill. Water samples from monitoring wells TL-4, TL-8a, TL-11a, and TL-12 illustrate this occurrence. However, the highest concentration of vinyl chloride detected to date on the site was drawn from a deeper portion of the aquifer at monitoring well TL-10b.

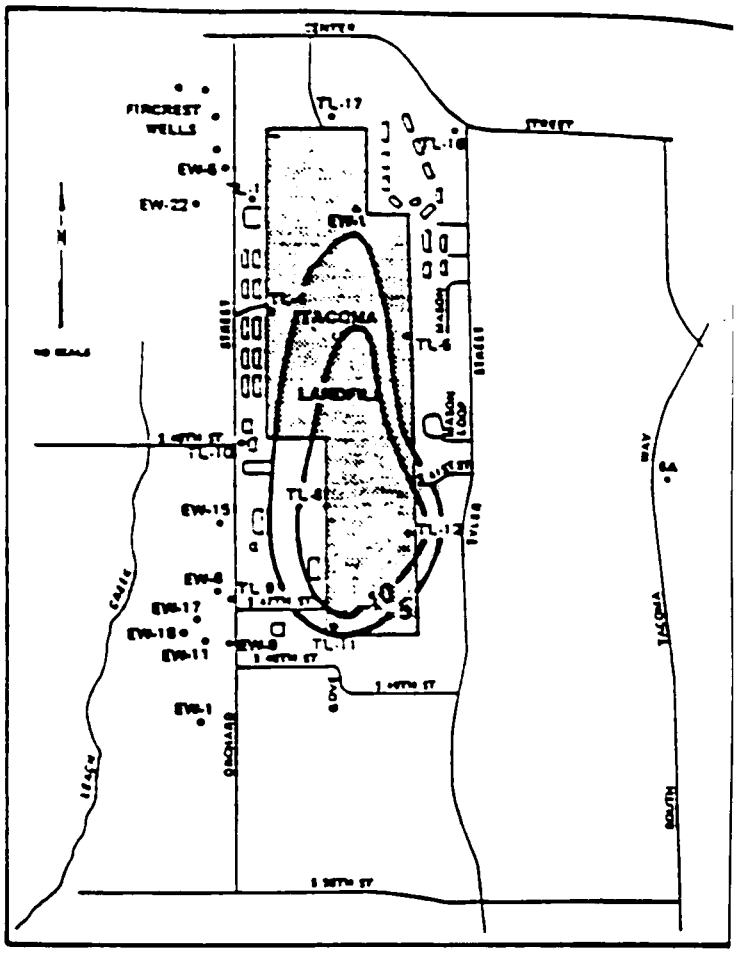
Contour maps included in the RI report show the projected distribution of seven of the contaminants of concern in the aquifer associated with the Tacoma Landfill Site:

	Contaminant	Maximum Concentration
a.	Vinyl chloride	80 ug/l
b.	Benzene	19ug/l
c.	1,2-dichloroethane (DCE)	20 ug/l
d.	Methylene chloride	1300 ug/l
e.	1,1-dichloroethane (DCA)	42 ug/l
f.	Chloroethane	55 ug/l
h.	Toluene	60 ug/l

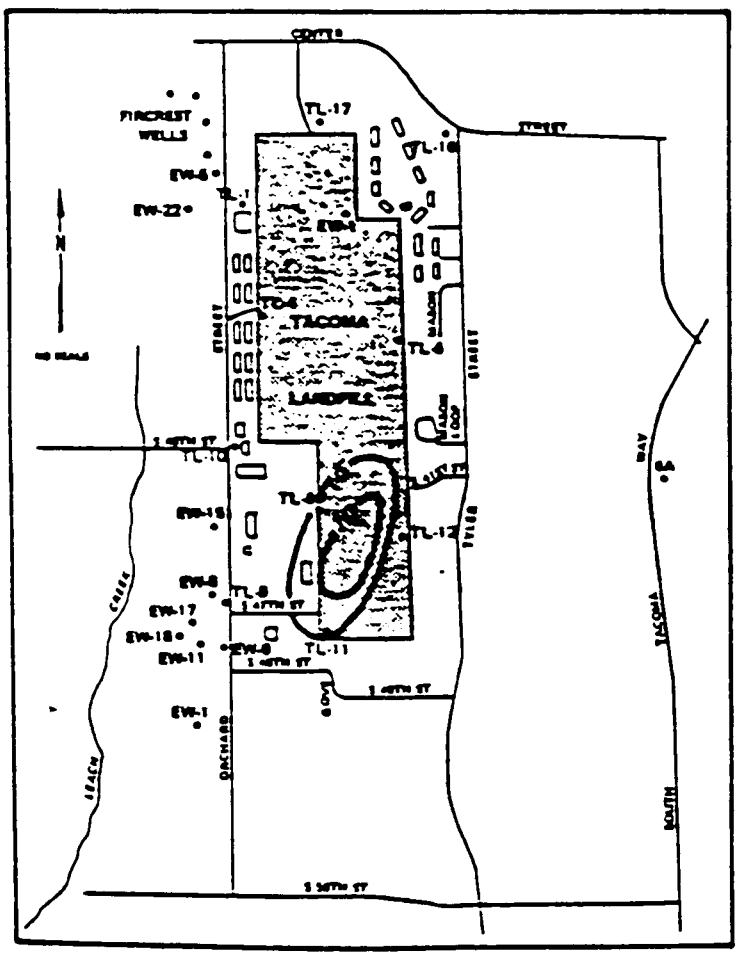
CONTAMINANT DISTRIBUTION IN GROUNDWATER



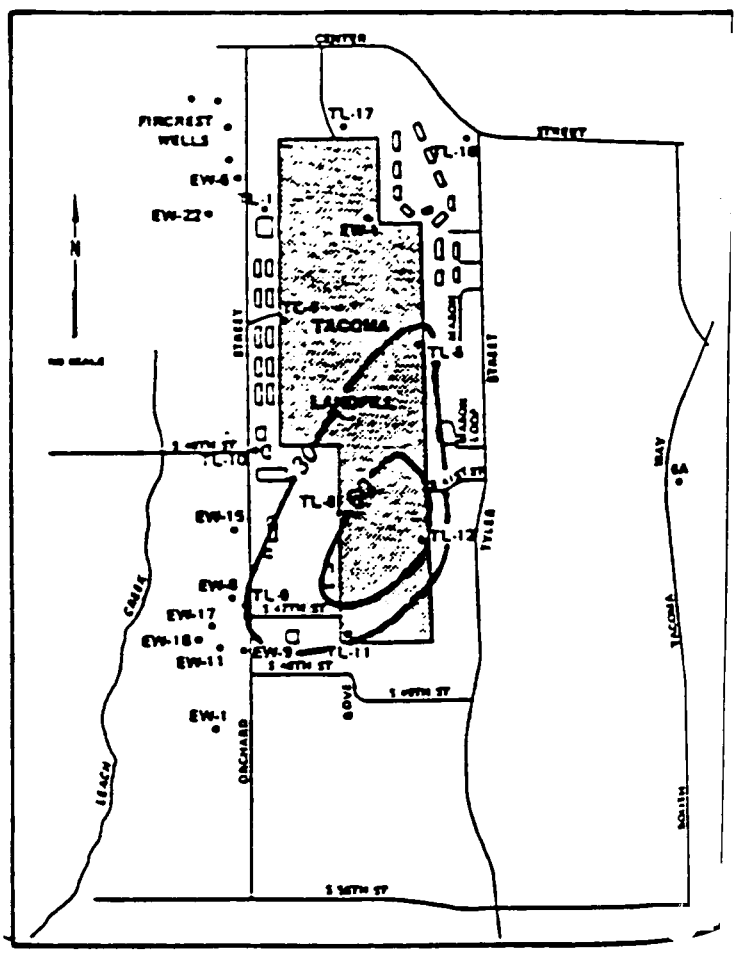
VINYL CHLORIDE



BENZENE



1,2–DICHLOROETHANE

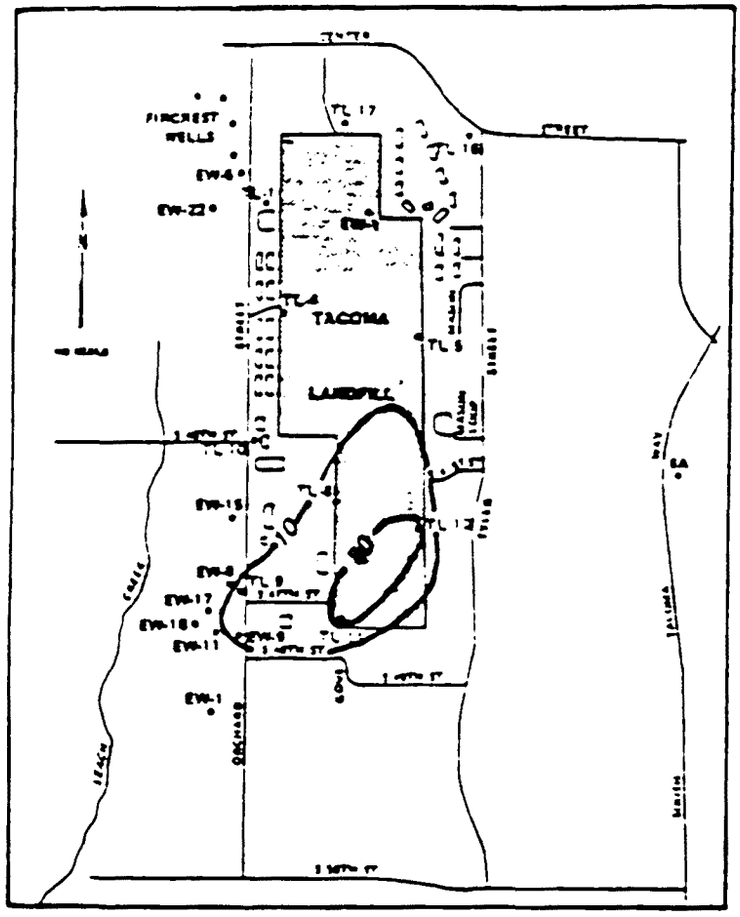


METHYLENE CHLORIDE

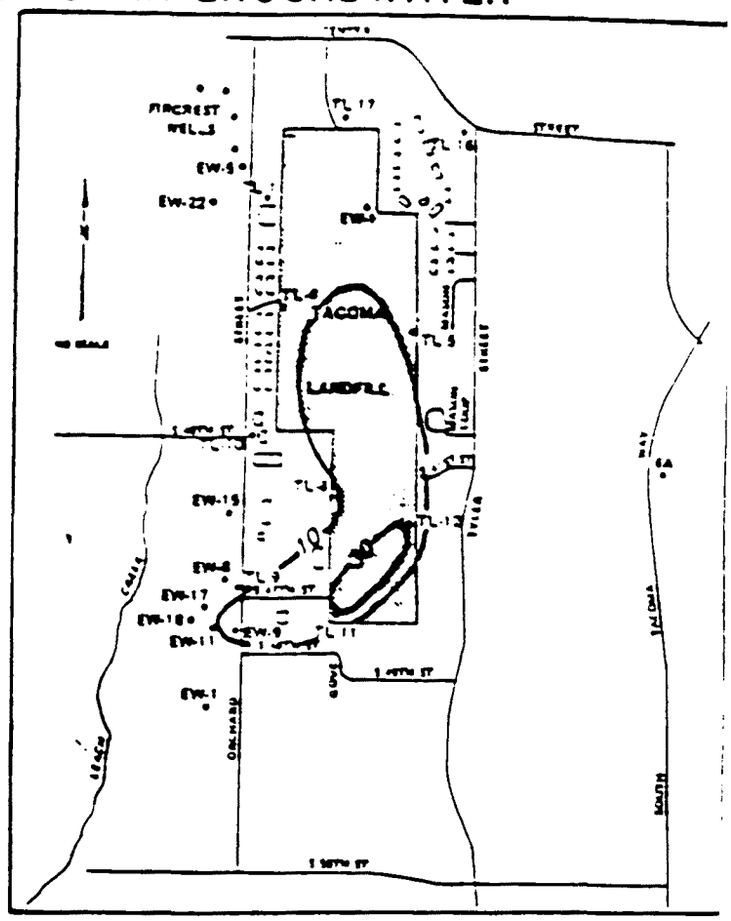
CONCENTRATION CONTOURS IN UG/L

FIGURE 9
CONTAMINANT DISTRIBUTION
IN GROUNDWATER

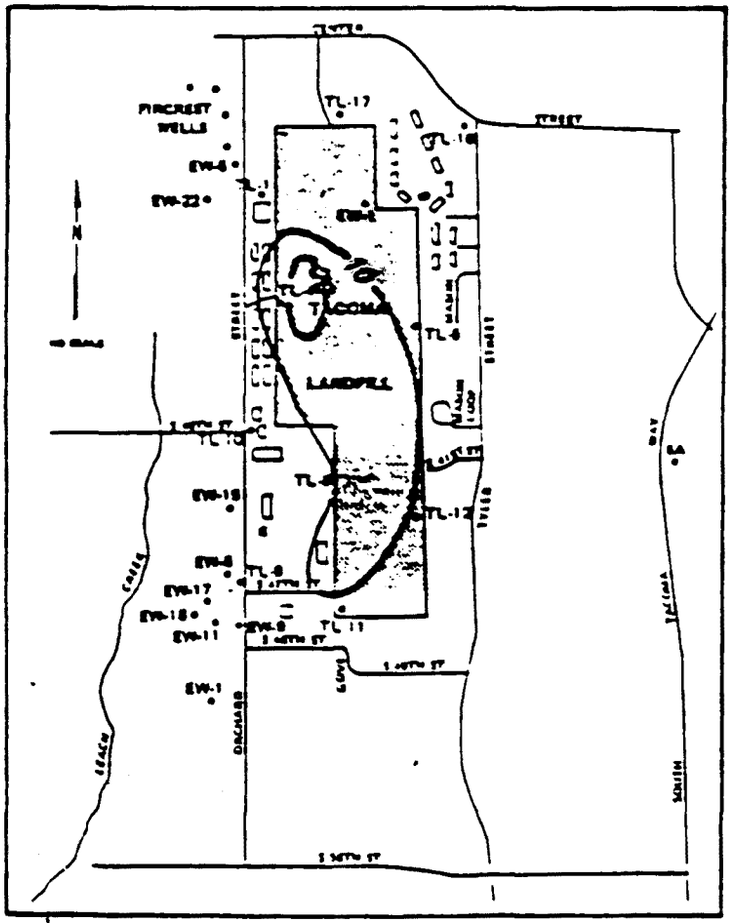
CONTAMINANT DISTRIBUTION IN GROUNDWATER



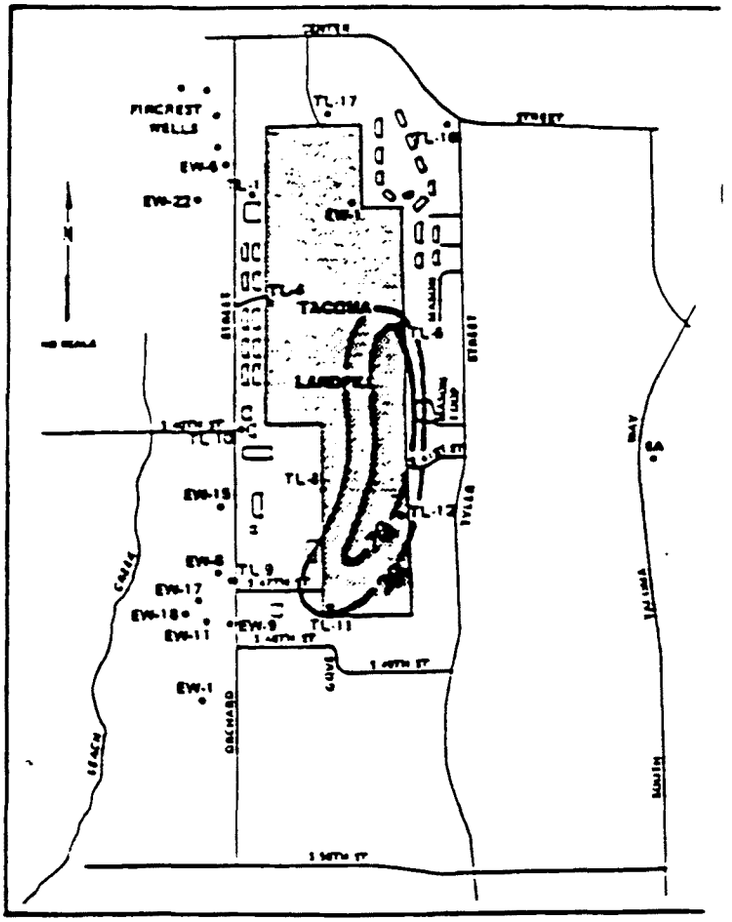
1,1-DICHLOROETHANE



CHLOROETHANE



TOLUENE



TCE

CONCENTRATION CONTOURS IN UG/L

FIGURE 10
CONTAMINANT DISTRIB
IN GROUNDWATER (CO

The contour maps are presented here as Figures 9 and 10 to show the general pattern in which each contaminant has spread in the aquifer.

Priority pollutant semivolatile, base, neutral, and acid extractable compounds were detected in trace amounts in a few of the ground water samples collected at the site. Priority pollutant metals occasionally exceeded maximum contaminant levels (MCLs) established pursuant to the federal Safe Drinking Water Act.

1,1,1-trichloroethane was also found in measurable amounts in wells along 53rd Street West. Routine sampling of these wells has been on an annual basis and it is possible that the landfill is not the only source of contamination. This is in the process of being evaluated.

D. Surface Water

Surface water testing throughout the study area, in general, did not show a significant problem which could be attributed directly to the landfill. At this time most of the surface water is being controlled on-site. There are three notable exceptions to surface water control:

1. The retention pond to the north has been contaminated with toluene. This chemical has also been detected in nearby monitoring well TL-17.

2. Nearby off-site storm sewers receive runoff which discharges to surface water (Leach and Flett Creeks) without retention or pre-treatment.

3. Storm water from the landfill is being conducted to the sanitary sewer.

Leachate was surfacing on the working face that now comprises the east side of the Central Area. The leachate is now being conducted directly to the sanitary sewer through a buried toe drain.

Sediment samples taken from nearby storm sewer outlets show elevated values for metals. However the RI was inconclusive citing other potential sources in addition to the landfill. Surface water (storm water runoff) will be addressed as part of the selected remedy.

E. Future Impacts

As part of the RI/FS, modeling was performed to project future contaminant migration. Contamination has been verified in private wells southwest of the landfill in the direction of Leach Creek.

Tentative flow paths were then plotted based on the mapping of ground water levels over several months. Contaminant flow velocities and dispersion ratios were then estimated and a simplified groundwater contaminant transport model named Plume (Van der Heijde 1983) was run.

Receptor groups were assigned based on location of known contamination and the assumed aquifer discharge. Wells closest to Orchard Street were designated near. Wells downgradient from the near wells were called far. Leach Creek was assumed to be the far boundary. The Fircrest wells were not

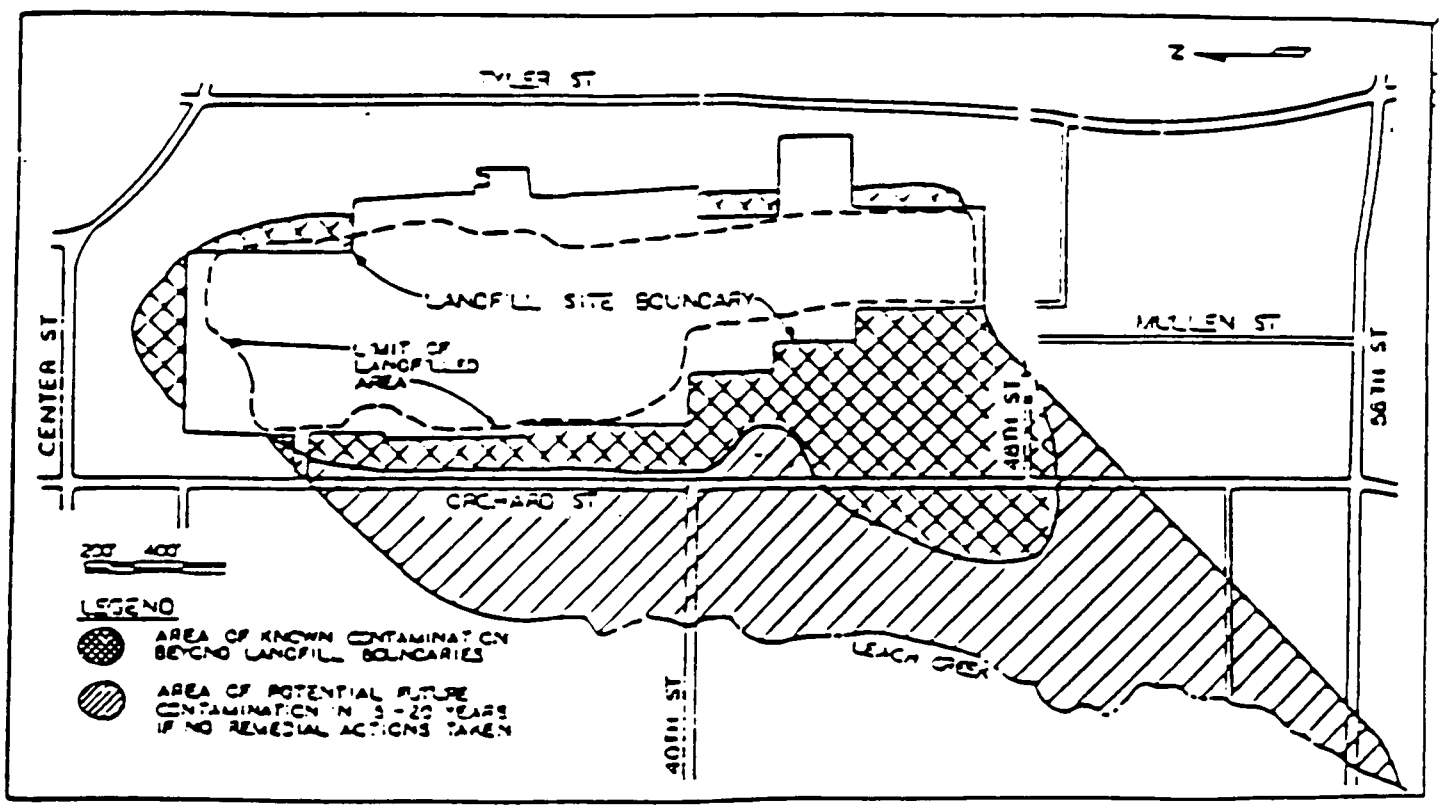
included in the model because the flow path analysis did not show them in the line of contamination. However, the flow path analysis was based on current usage rates and pumping conditions of both Fircrest and the Tacoma wellfield, and did not take into account any future changes to these conditions. The Feasibility Study (FS) did not include flow path analysis under differing usage rates and pumping conditions. Therefore, the model is appropriate for prediction of future migration only as far as the assumptions remain valid.

The studies showed that the main plume of groundwater contamination may reach 1200 feet southwest of the landfill. To the west and southeast it may reach 200 feet and to the northeast about 800 feet. Figure 11 shows this plume and how far it would spread if unchecked, and if the model assumptions are correct. The modeling that helped predict the plume's spread assumed tha pumping of the Fircrest and City of Tacoma (6a) wells will stay the same. These wells are about 500 and 3500 feet from the site, respectively.

The model predicted that for the next 100 years the aquifer between the landfill and Leach Creek would contain unacceptable levels of contaminants. Table 5 lists the estimated maximum predicted off-site concentrations for the seven indicator chemicals in the RI, and the estimated times to reach maximum concentrations at the close in and distant wells.

FIGURE 11

CURRENT AND PREDICTED CONTAMINATION



F. Endangerment Assessment

An endangerment assessment was conducted at the Tacoma Landfill to estimate the magnitude and probability of actual or potential harm to public health or the environment caused by the threatened or actual release of hazardous substances. The assessment presented in the RI addressed the potential human health and environmental effects associated with the Tacoma Landfill site in the absence of the any remedial action (i.e., the no action alternative).

The no action alternative is the baseline where no corrective actions take place under Superfund. In the case of the Tacoma Landfill, however, certain corrective actions will take place regardless of the actions taken pursuant to the Superfund site cleanup. These corrective actions must be conducted to meet the requirements of the Washington State Minimum Functional Standards for landfills (WAC 173-304). These actions include: developing an operating and closure plan for the landfill, installation of a cap, installation of a liner and leachate collection for ongoing disposal activities, and installation, operation and maintenance of a methane gas extraction system.

The future operation and maintenance of the landfill gas extraction system and planned refuse processing operations will restrict development of the landfill. Therefore, the endangerment assessment for the no action alternative assumes site access will continue to be restricted in the future. Although several pathways of exposure can be postulated for the site (surface runoff, inhalation of vapors and entrained dust), the primary pathway of concern for this site is groundwater. Since access to the site will be

restricted, the importance of the air pathway will be reduced. The methane gas collection system will also act to minimize the inhalation exposure route. The target receptors are the private and public well owners within the path of contaminant plume. Also of concern is the possibility of heavy metals and organics reaching Leach Creek, and ultimately Puget Sound, either by surface or groundwater routes.

Health Evaluation

The public health evaluation identifies potential threats to human health in the absence of remedial action at the site. This evaluation process includes a hazard assessment, dose/response assessment, exposure assessment and risk characterization.

Twenty-four volatile organic chemicals were detected in the groundwater. Of these, seven were selected as contaminants of concern in the Endangerment Assessment of the RI due to their frequency of occurrence, concentrations found, and primary targets (human population):

- vinyl chloride
- benzene
- 1,2-dichloroethane
- methylene chloride
- 1,1-dichloroethane
- chloroethane
- toluene

However, based on EPA and Ecology's review of the Endangerment Assessment, the following three additional organic chemicals have been added to the list of contaminants of concern:

- o xylenes
- o 1,1,1-trichloroethane
- o ethyl benzene.

This new list of ten organic contaminants of concern were separated into classes of potential carcinogens and noncarcinogens. Vinyl chloride, benzene, 1,2-dichloroethane, and methylene chloride were selected as indicator potential carcinogens. Both vinyl chloride and benzene are classified as human carcinogens by the EPA. Methylene chloride is a B2, probable human carcinogen, based on inadequate data in humans and increased incidence in rats and mice. It is present both on and off-site at considerably less frequencies of occurrence.. 1,2-dichloroethane, despite being found even less frequently than methylene chloride, is ranked as an EPA B2 carcinogen and is included for that reason.

Chosen as noncarcinogen indicator chemicals of concern were 1,1-dichloroethane, chloroethane, toluene, xylenes, 1,1,1-trichloroethane, and ethyl benzene. The three chlorinated ethanes were encountered relatively frequently in the samples, although 1,1-dichloroethane occurs much less frequently than the others. In general, the toxicity and bioconcentration potential of the chlorinated ethanes increases with increased concentration. All but the 1,1,1-isomer are extremely soluble in water. Toxicity concerns

from their ingestion at significant levels in drinking water lie chiefly in the areas of chronic liver damage and overall central nervous system depression.

Toluene and xylenes were selected largely because of their high frequencies of occurrence, chemical similarities, and potential ecological risk. Toluene was the most commonly detected chemical in water samples off-site, and was roughly equivalent to xylene as fourth most common on-site. Ethyl benzene was included as a chemical of concern because of its relatively frequent occurrence among the more minor chemicals, its leachability, and its tendency to biodegrade relatively slowly in groundwater.

The Endangerment Assessment of the RI calculated the excess lifetime cancer risks from ingestion of carcinogens in groundwater if no alternate water supply is provided, and an estimate of risk if there is short term exposure to the indicator chemicals. Because so many chemicals, both carcinogens and noncarcinogens, are present in the groundwater, the possibilities of additivity and synergism cannot be ignored. However, the Endangerment Assessment of the RI was largely modeled on the concept of the predominant risk being due to the ingestion of water containing vinyl chloride

The calculation of carcinogenic risk, assuming no alternate water supply is provided, is based on a 70 kg adult consuming 2 liters of contaminated groundwater for 70 years. The increased risk of cancer if a 70 kg adult consumes 2 liters of vinyl chloride contaminated groundwater (at a concentration of 70 ug/L) for 70 years is about 5 in one thousand.

Carcinogenic risks have been calculated for the short term exposure scenario, that a carcinogen migrates to a residential well the day after a "carcinogen free" sample is collected. It is estimated it will take approximately four months from the start of exposure until contamination is detected in the next quarterly sample and before an alternate water supply can be provided. The short term concentration was estimated based on sampling results for the residential wells in which contamination has been detected. The average daily intake was then calculated to account for the four month exposure. The estimated excess cancer risk associated with this short term exposure is less than one in a million.

The population at risk within the predicted plume is divided into three areas: the area within City boundaries, the area within the Town of Fircrest boundaries, and the unincorporated area within Pierce County. Approximately half of the predicted contaminant plume is east of Orchard Street within the Tacoma City limits. There are approximately 26 residences within the projected plume, if contamination continues to flow predominately toward the southwest. Groundwater sampling and hydrogeological investigations conducted during the RI indicate that the plume has reached the existing wells closest to the landfill. Those with close-in wells in which contaminants have been detected have been connected to City water.

There are still three close-in wells not hooked up to City water in which contaminants have not been detected. No contaminants have been detected in the distant wells, and based on the contaminant transport modeling, it will be several years before the wells in this group will be impacted as a result of contaminant migration from the landfill.

Table 5 lists the estimated landfill source concentrations for the seven indicator chemicals listed in the RI and the estimated times to reach maximum concentrations at the close-in and distant wells. The close-in wells would be expected to be maximally impacted by vinyl chloride beginning about 10 to 15 years from now while benzene would not be expected to peak until about 55 to 60 years hence. The distant wells would be expected to reach maximum benzene concentrations in about 85 to 90 years.

There is a possibility that if water from Leach Creek was used in the future as a drinking water supply, exposure to vinyl chloride and/or benzene at levels exceeding their MCLs could occur. There are existing water rights for domestic use of Leach Creek.

Some potential exists for human exposure to contaminants by using private well water for livestock and to water vegetables, etc. However, since the contaminant concentrations of the groundwater being used to water livestock and irrigate crops would be the same as detected in the private wells, it would be highly unlikely that a significant exposure would result from this pathway.

Environmental Evaluation

The Endangerment Assessment in the RI did not compare the levels of organics and metals in the groundwater to ambient Water Quality Criteria (WQC) for the protection of aquatic life. Metals and organic compounds in the groundwater which are above federal or state WQC are of environmental concern. Maximum concentrations detected in either on-site or off-site

TABLE 5

TRAVEL TIMES TO REACH MAXIMUM AND THRESHOLD CONCENTRATIONS, CLOSE-IN AND DISTANT WELLS

Indicator Chemical	Maximum Predicted Offsite Conc. ug/L	Time from Present to Approach Max. Concentration, Yrs. Close-In Wells	Time from Present to Approach Max. Concentration, Yrs. Distant Wells	Threshold Conc. ug/L	Time From Present to Back Below Threshold Yrs
Vinyl Chloride(1)	60-70	10-15	25-30	2	>100
Benzene(1)	8-10	55-60	85-90	5	>100
1,2-Dichloroethane(1)	4-5	45-50	75-80	5	NA
Methylene Chloride(1)	150-160	5-10	20-30	36, 5	>100
1,1-Dichloroethane(2)	80	35-40	65-70	271, 27	NA, >100
Chloroethane(2)	30	5-10	20-25	(Very High)	NA
Toluene(2)	30	55-60	85-90	2000	NA

NOTES:

(1) Maximum concentrations for carcinogens are maximum 70 years average.

(2) Maximum concentrations for noncarcinogens are maximum 90 days average.

groundwater for cadmium, chromium, copper, nickel and zinc, all exceeded ambient WQC for the protection of aquatic life. An overview of the VOCs which were identified as potentially harmful to the environment are listed in Table 3.

Flett and Leach Creeks support anadromous salmonid runs, which will be at risk if toxic compounds are present in the creeks during critical phases (e.g., smolting) in their growth cycles. Heavy metals, as well as certain of the organics such as xylene may also pose problems for the health of the downstream wetlands ecosystem as the Leach Creek drainage ultimately enters Puget Sound. This would most markedly impact highly vulnerable organisms such as larval fishes, but parts of the commercially important benthos (shellfish) could also become adversely affected.

Conclusions

Based on a review of the endangerment assessment and data presented in the RI report, the following conclusions were made concerning risk to human health and the environment from contaminants associated with the Tacoma Landfill site:

- Concentrations of several indicator chemicals frequently exceed MCLs in the groundwater. Drinking the water from contaminated wells poses the most significant risk to human health, especially in terms of chemicals in the aggregate.

- Under the no action alternative, some contaminant concentrations in the groundwater plume are predicted to exceed ambient WQC when the plume discharges to Leach Creek. These levels could pose a risk to aquatic biota, especially since the Leach and Flett Creeks wetland area enters Puget Sound.

- Based on EPA and Ecology's review of the Endangerment Assessment in the RI, the agencies agreed that it would be appropriate, for the protection of public health, to establish health-based levels for a larger number of compounds than the seven indicator chemicals selected during the risk assessment. Accordingly, xylenes, 1,1,1-trichloroethane and ethyl benzene have been added to the list of contaminants of concern.

- Depending on the discharge location, performance levels for the selected remedy will be based on MCLs, Water Quality Criteria, or pre-treatment standards. In the absence of established standards or Water Quality Criteria, EPA Region 10 has conducted a risk assessment of the compounds. These are listed in Table 8 of the Selected Remedy portion of this document. The most stringent number will be used for the performance levels for the treatment system if the cleaned water is discharged to surface water. For the other volatile organic chemicals and metals found in the groundwater, EPA and Ecology have identified a methodology for establishing performance levels. This methodology is detailed in the Selected Remedial Alternative section of this document (Section VI).

V. SUMMARY OF ALTERNATIVES EVALUATION

A. Identification and Screening of Remedial Technologies

In order to develop a complete listing of potential remedial technologies, general response actions corresponding to each contaminant pathway were identified.

The general response actions fall into the following seven primary categories:

- o No action
- o Institutional controls
- o Containment
- o Removal
- o On-site treatment/discharge
- o Off-site treatment/disposal
- o Other management options.

Forty potential remedial technologies for controlling contaminant migration were screened. Thirty-one potential remedial technologies were identified for the groundwater pathway and nine potential remedial technologies were identified for the gas migration/air quality pathway. The potential remedial technologies were categorized according to the appropriate general response action. A screening process was applied to these to identify unsatisfactory technologies. Screening criteria were effectiveness, implementability, and cost.

The technologies that were not screened out were assembled into preliminary remedial action alternatives. These alternatives were designed to meet the categories identified by the National Contingency Plan (NCP). Screening criteria contained in the NCP and Superfund Amendments and Reauthorization Act of 1986 (SARA) were overlapped in this process. An initial screening was performed on sixteen separate alternatives. The preliminary remedial action alternatives were screened again in order to eliminate alternatives that adversely impact public health and the environment, or that are more expensive than other alternatives which provide the same degree of remediation. This initial screening of remedial action alternatives produced six remedial alternatives that were subjected to detailed development and analysis.

For ease in presenting the alternatives to the public, alternatives 2, 4, 8, and 12 as numbered in the FS report (Black & Veatch 1987) were combined since they represented just one technical category (i.e., pump, treat, and discharge). The alternatives then became no action, alternative water supply/landfill cap, and pump, treat, and discharge with landfill cap. Four treatment options are included in the last alternative (see Table 6). Information packages available to the public contained these three alternatives, which were also presented at a public meeting on February 11, 1988.

B. Methodology for Detailed Evaluation of Remedial Alternatives

The detailed evaluation in the FS discusses cost-effectiveness of an alternative in terms of technical, environmental and public health, and

institutional concerns. Requirements of the NCP were met by evaluating each alternative with respect to the following criteria:

- o Technical Feasibility
- o Public Health Impacts
- o Environmental Impacts
- o Institutional Requirements
- o Cost Analysis.

This analysis facilitates the comparison of similar components among the alternatives for the same criteria.

Technical Feasibility

The technical evaluation considered the performance, reliability, implementability, and safety factors of the remedial actions. Performance of each alternative was based on the alternative's expected effectiveness and its useful life. Key considerations in evaluating reliability included operation and maintenance (O&M) requirements and the demonstrated performance of the technologies at similar sites. While SARA requirements do not include demonstrated performance, the six final remedial alternatives evaluated against this criteria were known technologies. For implementability, both the constructability and the time required to achieve a given level of response were considered. Constructability addresses whether the alternative can be constructed on the site and the impact of external conditions on the construction. The time it takes to implement an alternative and the time to

achieve beneficial results that attain or exceed relevant or applicable standards were also considered. The safety evaluation considers short-term and long-term threats to the safety of nearby residents and to persons working on-site. Major risks to consider are exposure to hazardous substances, fire, and explosion due to activities conducted during implementation of the remedial action.

Public Health Impacts

The public health evaluation of alternatives assesses the extent to which each alternative mitigates long or short-term exposure to any residual contamination and protects public health during and after completion of the remedial action. In evaluating both long and short-term public health impacts, two primary areas were considered. Evaluation of short-term impacts considered health effects on workers during construction of the remedial action and on the public for the interim period prior to remedial action implementation. Long-term impacts were judged based on chronic intake of the contaminant over a lifetime.

Environmental Impacts

Each remedial alternative was evaluated for beneficial and adverse environmental impacts for the long and short-term. Criteria for evaluating beneficial effects were final environmental conditions, improvements in the

biological environment, and improvements in resources people use. Criteria for evaluating adverse effects were the expected effect of the remedial action and the measures taken in the event inevitable or irreversible effects occur.

Institutional Requirements

Institutional requirements are divided into three categories: community concerns, conformance with Applicable or Relevant and Appropriate Requirements (ARARs), and permitting requirements. Community concerns addresses the public's acceptance of the selected remedial action alternatives. The remedial action alternatives developed in the FS should address all legally applicable or relevant and appropriate standards, requirements, criteria, or limitations to be consistent with SARA. Institutional constraints are those mechanisms available to ensure administrative control over activities at the site (zoning, permits, ordinances, etc.).

Cost Analysis

Detailed cost analysis of alternatives involves estimating the expenditures required to complete each measure in terms of capital costs, and annual operation and maintenance costs for a 30-year period. Once these values were determined and a present worth calculated for each alternative, a comparative evaluation was made. The cost estimates presented in the FS section were based on conceptual designs prepared for the alternatives (i.e., without detailed engineering data). These estimates were accurate between +50 percent and -30 percent in 1987 dollars.

Rating Alternatives

A rating system is used to evaluate alternatives, and the terms high, moderate, and low are assigned to each. A high rating indicates that the alternative promotes the intent of the criterion and/or meets or exceeds the remedial objectives. A moderate rating indicates that the alternative only partially promotes the intent of the criterion; however, the alternative does remediate the problem to an acceptable extent even though it does not meet all the remedial objectives. A low rating indicates that the alternative does not promote the criterion and/or does not meet the remedial objectives.

An evaluation of each alternative is contained in Tables 6 and 7. These evaluations are based on numerical ratings of each criterion contained in the FS (Black & Veatch 1987). A criterion was subdivided into one or a few factors, which were rated from 1 to 5. To establish the criterion numerical rate, numerals assigned to each factor within the criterion were averaged. For this report, ratings were assigned as follows:

Numerical Rating	New Criterion Rating
$\leq$2.00	High
2.01-3.99	Moderate
$\geq$4.00	Low

TABLE 6

SUMMARY OF DETAILED EVALUATION OF REMEDIAL ALTERNATIVES

No.	Alternative (No. in FS)	Cost ($1,000)		Criterion				
		Capital	Present Worth	Public Health Impacts	Environmental Impacts	Technical Feasibility	Institutional Requirements	Community Concerns
1	No Action (1)	--	--	Low	Low	N/A	Low	Low
2	Alternative Water Supply/ Landfill Cap (3)	16,423	18,376	High	Moderate	High	High	High
3	Pump, Treatment, and Discharge with Landfill Cap							
	a. Off-site Treatment at Sewage Treatment Plant (2)	17,932	23,418	High	High	Moderate	High	High
	b. On-site Treatment (Air Stripping and Carbon Adsorption (4)	19,532	22,717	High	High	Moderate	High	High
	c. On-site Treatment Carbon Adsorption (8)	19,266	23,417	High	High	Moderate	High	High
	d. On-site Treatment (Air Stripping) (12)	18,971	21,015	High	High	Moderate	High	High

TABLE 7

SECTION 121(b) (1) (A-G) FACTORS

	Alternative					
Criterion	1	2	3a	3b	3c	3d
Compliance with ARARs	Low	Moderate	High	High	High	High
Reduction of Toxicity, Mobility, Volume	Low	Moderate	High	High	High	High
Short-Term Effectiveness	Low	High	Moderate	Moderate	Moderate	Moderate
Long-Term Effectiveness	Low	Moderate	High	High	High	High
Implementability	N/A	High	Moderate	Moderate	Moderate	Moderate
Cost (See Table 6)						
Community Acceptance	Low	Moderate	High	High	High	High
State Acceptance	Low	Moderate	High	High	High	Moderate
Overall Protection of Human Health and the Environment	Low	Moderate	High	High	High	High

C. Results of Detailed Evaluation of Remedial Alternatives

This section presents a summary of the detailed evaluation of the remedial alternatives in terms of costs, public health impacts, environmental impacts, technical feasibility, institutional requirements, and community concerns. A summary of these items is presented in Table 6 according to 1985 RI/FS Guidance Factors (EPA 1985) and an evaluation of the remedial alternatives according to the Section 121(b)(1)(A-G) factors is shown in Table 7.

Non-cost Evaluation

As shown in Table 6, Alternatives 2, 3a, 3b, 3c, and 3d all had four high ratings and one moderate rating. Therefore, they would be judged comparable alternatives under this system of rating criteria. However, evaluating alternatives using guidance from Section 121(b)(1)(A-G) factors reveals some differences (Table 7). The (A-G) factors are used to assess alternative remedial actions for permanent solutions and to assess alternative treatment technologies that yield a permanent and significant decrease in the toxicity, mobility, or volume of the hazardous substance, pollutant, or contaminant. Alternatives 3a, 3b, and 3c, have six high ratings and two moderate ratings. Alternative 3d has five high ratings and three moderate ratings. Alternative 2 has only two high ratings and six moderate ratings. It is clear that Alternatives 3a through 3c would be considered superior to to the other alternatives.

Cost Summary and Sensitivity Analysis

Cost estimates prepared for each alternative involved approximation, assumptions, estimations, interpretations, and engineering judgment. To provide some indication of sensitivity of the costs to changes in key parameters, a sensitivity analysis was performed.

The cost of closing the landfill is the major cost for all the alternatives under consideration, and is the same for each. The treatment process cost could be the most variable because alternatives would not yield the same influent concentrations. To evaluate the impact that changes in concentration would have on carbon adsorption treatment costs, concentrations of two and three times the predicted value were analyzed. The carbon adsorption unit cost was chosen for analysis on the basis of its potential impact on overall treatment cost estimates of Alternatives 3b and 3c. When the concentration of contaminants in the waste stream is doubled, the carbon usage (cost) will increase by approximately 1.5 times. The total cost for Alternative 3b would increase 3.8 percent while the total cost for Alternative 3c would increase 6.8 percent. For the case when the contaminant concentrations are tripled, the carbon cost will approximately double. The total cost for Alternative 3b would increase 7.3 percent while the total cost for Alternative 3c would increase 9.7 percent.

VI. SELECTED REMEDIAL ALTERNATIVE (No. 3)

A. Description of Selected Remedy

The selected remedy includes a landfill cap and gas extraction system to control the source, and a ground water extraction and treatment system to control migration of the plume. All extracted water will be treated to specific performance standards, monitored to ensure compliance and will be properly discharged. The Tacoma water supply system will be expanded to assure sufficient water is available should any water supply (public or private) become contaminated from the landfill. The remedy also includes a closure schedule for operation of the landfill.

The remedy is designed to:

- Prevent further migration of the plume via the ground water extraction-treatment system.

- Reduce the production of leachate by placing constraints on site operations and by properly grading and capping the landfill.

- Eliminate off-site gas migration through the gas extraction system.

- Further protect public health and the environment via monitoring of groundwater, surface water, gas probes, air emissions, and provision of alternate water supplies where necessary.

Management of Migration

Migration control will be achieved through a ground water extraction and treatment system, and a system or method to confirm performance. Activities necessary to develop those systems shall be conducted during remedial design. Wells for this system will be placed within and, if necessary, downgradient to contain the plume. Containment is defined as controlling the plume and preventing the spread of contamination. The goal of the containment system is to prevent any further degradation of existing water quality beyond the boundaries of the existing plume. The extraction wells should be designed to achieve this objective. The existence of the gradient reversal due to pumping by the city of Tacoma wellfield, local effects from pumping the Fircrest wells, or monitoring results at the landfill may result in the need for extraction wells at locations other than those identified in the feasibility study. Minimum flows as required by WAC 173-512 shall be maintained in Leach and Flett Creeks.

The treatment process shall be permanent and shall effectively reduce the toxicity, mobility, and volume of contaminants. It shall also employ all known, available, and reasonable methods to treat the contaminated ground water, and to prevent the spread of contamination. Discharge of treated ground water may be to either Leach Creek, Flett Creek, or the sanitary sewer.

If the discharge is to either Leach Creek or Flett Creek, the effluent must meet or exceed maximum contaminant levels (MCLs) developed pursuant to the Safe Drinking Water Act or meet the chronic fresh water criteria as set forth in EPA's Quality Criteria for Water, 1986 (EPA 440/5-86-001), whichever

is more stringent. Both of these creeks have existing water rights on them, although they are closed to further appropriation by WAC 173-512. In addition, both creeks support anadromous salmonid runs.

Most of the contaminants found at the Tacoma Landfill do not currently have MCLs. For the VOCs listed in Table 3, and for metals in the groundwater, which EPA and Ecology have not established treatment levels, a methodology for determining the appropriate discharge limits has been established. If no MCL has been established for a contaminant, the ambient water quality criteria (WQC) for protection of human health for water and fish ingestion will be used. If the value for protection of fish (the chronic fresh water criteria) is lower than the value for protection of human health, the lower value will be applied. If there are no WQC at all, then additional guidance documents, such as Health Advisories from EPA's Office of Drinking Water or any appropriate toxicological profiles, will be used to develop treatment levels. These treatment levels must be reviewed and approved by both Ecology and EPA prior to their use. This methodology will be used to set performance levels for any other contaminants identified in the groundwater and traceable to the landfill.

For six of the volatile organic compounds listed in Table 8, appropriate treatment levels have been identified. These are based on Safe Drinking Water Act MCLs or ambient WQC. In the absence of an MCL or ambient WQC, EPA Region 10 conducted a risk assessment of the chemical and provided an appropriate treatment goal for the protection of public health, welfare and the environment. These goals are listed in column three of Table 8 and will be used as performance goals for the treatment system. In addition, the effluent

TABLE 8

PERFORMANCE LEVELS FOR TREATMENT SYSTEM

DISCHARGE TO SURFACE WATER

TACOMA LANDFILL

(ug/L)

Constituent	Safe Drinking Water Act MCL	Water Quality Criteria: Water and Fish(1)	Water Quality Criteria: Chronic(2) Fresh water	EPA Reg. 10 Risk(3) Assess.
Benzene	5	0.66*	53	
Chloroethane				20
1,1-dichloroethane				20
1,2-dichloroethane	5	0.94*	20,000	
Ethyl benzene		1,400	320	
Methylene chloride				5*
Toluene		14	175	
1,1,1-trichloroethane	200	18,400		
Vinyl chloride	2			
Xylenes				10

(1) EPA Quality Criteria for Water, 1986 EPA 440/5-86-001, for water and fish ingestion by humans.

(2) Chronic fresh water criteria for protection of aquatic life. Where no values for chronic exposure were available, the acute values were divided by 100.

(3) Based on EPA Region 10 Risk Assessment.

* Values presented for carcinogens are at the 10^{-6} risk level.

must meet water quality standards as set forth in 173-201 (Water Quality Standards for Waters of the State of Washington).

If the option of discharge to the sanitary sewer is chosen, it must be consistent with discharge limitations as defined by WAC 173-216 (State Waste Discharge Program) and must meet pre-treatment regulations (City of Tacoma Code, Chapter 12.08), as revised for operation of the secondary sewage treatment plant.

Any treatment system which results in contaminant air emissions shall be designed to address appropriate ambient air quality values as determined by Ecology's Draft New Source Review Guidelines for Toxic Air Contaminants, (September 1986, or as revised). In addition, the Puget Sound Air Pollution Control Authority (PSAPCA) has made the determination that all new sources shall use Best Available Control Technology (BACT). This also will be a requirement of the treatment system design. BACT may involve a different technology for different contaminants.

The extraction and treatment system can be shut off when water quality within the plume, outside the compliance boundary (defined by WAC 173-304 as the edge of the filled area), consistently meets or exceeds drinking water standards, or previously established and approved health-based criteria. In addition to meeting health-based criteria, potential impacts to public and private water supplies and to Leach Creek must be considered in the decision to shut off the system. Ecology and EPA will reevaluate the implemented system every five years to assure that it is working properly and to propose any modifications that could facilitate the cleanup of the groundwater.

Source Control

Source control measures consist of constructing a cap on the landfill to minimize infiltration and maximize run-off. Unlined areas of the landfill will be capped as soon as possible. WAC 173-304 defines the minimum requirements for a cap on a municipal landfill. A more stringent cap will be required unless further analysis of the cap, to be provided during remedial design, shows that a significant reduction in leachate volume or toxicity would not be achieved.

Increased run-off due to the construction of the cap will be routed off the landfill to reduce infiltration. The slope of the cap and construction of drainage structures will be consistent with WAC 173-304. The run-off collected from the landfill will be directed to the appropriate storm or sanitary sewers, consistent with local storm drainage ordinances or pre-treatment regulations. The storm drainage plan, prepared as part of the remedial design, will determine and minimize any downstream increases in peak flow.

The Minimum Functional Standards (MFS) (WAC 173-304) prohibit filling in unlined areas after November 1989. These standards contain specific liner requirements which will apply to all municipal landfills by this date. Compliance with Minimum Functional Standards is determined by TPCHD, in accordance with Ecology review. Insufficient information has been received by Ecology and TPCHD to evaluate compliance of the liner installation with Minimum Functional Standard requirements. If the liner is determined not to be in compliance, a variance will be required from TPCHD to operate the Central Area Pit.

In the interim, the City has identified several unlined areas which need to be filled to meet minimum slope requirements in WAC 173-304. Additional filling in these areas will be kept to the minimum required to meet the final grade requirements of the Minimum Functional Standards. The City plans to develop an unfilled area of the landfill (North Borrow Pit) for future waste disposal. Filling of this or other previously unused areas will require a liner consistent with WAC 173-304.

Should a variance be needed and granted, the Central Area Pit will be brought up to final grade in accordance with the Operations and Closure Plan to minimize leachate production. Leachate head wells will be installed in the waste in the Central Area to assure that the leachate head requirements of WAC 173-304 are being met. Ecology and EPA will identify and approve of the appropriate number of leachate head wells during the Remedial Design phase.

MFS requires operating landfills to submit an operating plan by October 1987. A schedule for closure of the landfill under WAC 173-304 is considered part of the remedial action at this site. The schedule, developed as part of the required Operations and Closure Plan, will address various waste reduction measures and develop contingency plans if these measures do not produce the expected results. The contingency plans will include specific dates for beginning the process to site another municipal solid waste disposal facility to serve the City of Tacoma. Waste reduction measures to be considered include, but are not limited to:

- increased recycling including a program to exclude hazardous waste from the landfill

- incineration of the light fraction of shredded waste at the Tacoma City Light Cogeneration plant

- pyrolysis of the heavy fraction of shredded waste at an on-site facility

Several utilities pass through the site. The Operations and Closure Plan will provide for rerouting these utilities around the site or developing a testing and maintenance program that will ensure their long-term integrity without interfering with the selected remedy.

The production of methane gas at the landfill is being addressed through the installation of a gas extraction system and is being monitored using a series of gas probes installed around the landfill. The gas collected by the extraction system is burned by the combusters which meet PSAPCA's BACT requirements. Any future expansion of this system will be required to comply with these requirements. Additional gas probes will be installed in the surrounding neighborhoods to verify that the extraction system is preventing off-site gas migration. If significant concentrations of gas are found in the soils off-site, further gas extraction wells may have to be installed to collect and control these methane sources.

Because landfill gas is warmer than the ambient air, condensate collects in the gas collection line. This condensate is currently allowed to drain back into the landfill Condensate from the flare station is collected and discharged to the sanitary sewer. As part of the remedial design, the

quantity and quality of these condensates will be determined. If significant concentrations or volume of condensates are found, the condensate shall be collected and treated appropriately. Source monitoring of the gas burners and the treatment plant system will be required.

Monitoring

Ground water monitoring wells shall be installed in locations appropriate, for obtaining the following information:

- o determine if the ground water extraction system is preventing the spread of the contaminant plume
- o determine the extent of plume migration to the east of the site
- o identify any potential impacts to Leach Creek and the Fircrest well system
- o ensure there is no dense phase plume migrating away from the site in the deepest zones of the aquifer.

Ecology and EPA will review and approve of the number and location of the groundwater monitoring wells during the Remedial Design phase of the cleanup program.

Leach Creek will be monitored for both water quality and quantity. Other surface waters acting as receiving waters for either the groundwater

extraction system or the surface drainage system will be monitored for water quality. Effluent from the treatment system will also be monitored to assure that discharge limitations are not exceeded. The nature and extent of the monitoring program, including bioassays, will be developed during the Remedial Design phase of the cleanup program.

At a minimum, the private wells in the path of the plume will continue to be monitored on a quarterly basis. Fircrest wells will be sampled monthly. Any well, public or private, which becomes contaminated due to the landfill will be replaced and water will be supplied from existing City of Tacoma water supply systems. If EPA and Ecology make a determination that any well is in danger of exceeding an MCL, or a contaminant level based on an EPA risk assessment, connection to Tacoma's municipal water supply will be required. Aesthetic quality will also be a consideration in making this determination.

Tacoma, in cooperation with the Town of Fircrest, and Pierce County, will pursue the establishment of an ordinance, or other suitable methodology, to restrict drilling of water supply wells in an area from Tyler Street to Leach Creek; and from Center Street to approximately South 56th Street.

B. Statutory Determinations

The selected remedy meets all statutory requirements for the overall protection of human health and the environment. The groundwater extraction system will remove contaminated groundwater migrating from the landfill and prevent contamination from spreading in the aquifer. The movement of contamination to nearby Leach Creek should be prevented by groundwater

pumping. Treatment of the extracted water will be designed to reduce the toxicity, mobility and volume of contaminants and prevent them from returning to the groundwater or surface water environment. Nearby residents affected by contaminated groundwater, or by low water volume or flow as a result of the operation of the extraction-treatment system, will be connected to Tacoma's municipal water system.

The selected remedy must also meet all Applicable or Relevant and Appropriate Requirements (ARARs) and should address those items listed in the To Be Considered category. These are listed and their application is briefly described in Attachment A.

The laws and regulations of concern include but are not limited to the following:

1. Resource Conservation and Recovery Act (RCRA; 42 USC 6901), RCRA regulations (40 CFR 261 to 280), Washington State Dangerous Waste Regulations (WAC 173-303 and 70.105 RCW), and Washington State Minimal Functional Standards for Solid Waste Handling (WAC 173-304 and 70.95 RCW).

   Groundwater protection requirements of RCRA and Washington State Dangerous Waste Regulations will be attained by installation of the landfill cap to minimize leachate production, and operation of the groundwater extraction wells to remove contaminated groundwater. The selected remedy prevents further spread of groundwater contamination and

constitutes a Corrective Action Program as specified in 40 CFR 264.100 and WAC 173-303-645(11). Closure of the Tacoma Landfill to State Minimum Functional Standards will be evaluated to ensure consistency with RCRA landfill closure standards.

2. Safe Drinking Water Act (42 USC 300), and Primary Drinking Water Standards (40 CFR 141).

Groundwater will meet maximum contamination levels (MCLs) and appropriate health-based standards as the contaminated plume is removed and leachate generation is minimized. The selected remedy will prevent exposing the public to contaminated drinking water by monitoring residential wells for MCLs and connecting the house to Tacoma's municipal water supply when conditions require it. Any affected public water supplies also will be connected to city water. Therefore, by monitoring, providing an alternate drinking water supply, and restricting groundwater use (until the aquifer no longer exceeds these levels) in the area, the selected remedy will meet the requirements of these regulations.

3. Clean Air Act (72 USC 7401).

If an airstripping system is used, concentrations of contaminants in the air stripper off-gases will be required to meet the requirements of the Clean Air Act. The flares for the methane gas extraction system must also meet the requirements of the Clean Air Act.

4. Clean Water Act (33 USC 1251), National Pollution Discharge Elimination System (NPDES; 40 CFR 122), NPDES Permit Program (WAC 173-220), and Water Pollution Control Act (RCW 90-48).

The selected remedy treats the extracted water to meet MCLs, health-based standards, or Water Quality Criteria prior to discharge. Therefore, there will be no adverse impact on surface waters resulting from discharge of treated groundwater, and the requirements of these regulations will be attained. The landfill cap will reduce leachate generation and therefore reduce the impact on groundwater. Storm drainage will be collected and discharged either to existing storm sewers or to surface waters. Contaminated storm water runoff will meet pre-treatment regulations and will be discharged to the sanitary sewer. Groundwater extraction and treatment will further reduce the contaminant plume. Other substantive aspects of the NPDES Permit System will be met during the design phase, although no permit is actually required.

Although on-site remedial work does not require a permit, the substantive requirements of any applicable permit will be met. Federal, state, or local permits which are required for off-site activities will be obtained.

5. Rules and Regulations of the State Board of Health Regarding Public Water Systems (WAC 248-54).

The selected remedy provides standards for connection to an alternative drinking water supply for all residents who require these supplies in conformance with these regulations.

6. Protection of Withdrawal Facilities Associated with Groundwater Rights (WAC 173-150).

This regulation protects water rights both in terms of water quality and quantity. Groundwater quality will reach levels less than MCLs; therefore the selected remedy complies with that portion of the regulation. The other portion of the regulation requires that surrounding wells not be deprived of their water supply due to other groundwater removal actions. Alternative water supplies will be made available to all residents affected by groundwater removal actions to meet the requirements of this regulation.

7. Minimum Functional Standards for Landfills (WAC 173-314 and 70.95 RCW).

The technology to be applied to remediate the landfill at a minimum will meet the Washington state standards for ongoing landfill operations, closure, capping, leachate containment, and methane control.

8. Hazardous Waste Cleanup Act (70.105B RCW).

The selected remedy will be the cleanup standards established by this act.

The selected remedy meets the SARA preference for permanent solutions to the maximum extent practicable. Treatment technologies are used as a principal element of the remedy and they will effectively reduce the toxicity, mobility, and volume of the contaminants permanently. Connection of residents, as required, to the Tacoma municipal water water supply is also considered a long-term solution.

The selected remedy meets all objectives of remedial action in that it provides a safe water supply and therefore protects public health, provides a permanent solution with moderately frequent maintenance, protects the environment to the maximum extent practicable, and reduces toxicity, mobility, or volume as a principle element of treatment. The selected remedy meets the requirement of cost-effectiveness.

VII. ENFORCEMENT

On June 27, 1986, Tacoma assumed responsibility for conducting the RI/FS under a Response Order on Consent issued by Ecology. The remedial action is anticipated to be accomplished voluntarily by the responsible parties. EPA and Ecology intend to start a negotiation period after the signing of the Record of Decision and will ensure that the remedial action proceeds. Finally, EPA and Ecology are still considering the possibility of identifying additional parties who may be potentially responsible for conditions at the site. Other than the June 27, 1986 Consent Order, there has never been any enforcement action taken by the regulatory agencies (i.e., EPA or Ecology) regarding the Tacoma Landfill site. If the responsible parties decline to implement the selected remedy as described in the Record of Decision, however, EPA and Ecology will seek appropriate enforcement action.

VIII COMMUNITY RELATIONS

Community relations activities conducted at the Tacoma Landfill site to date include the following:

- In 1983, the Tacoma landfill was included as part of the South Tacoma Channel site on the National Priorities List under Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA).

- In May 1985, Ecology and Black & Veatch began Remedial Investigation (RI) Phase I.

- In December 1985, Ecology and Black & Veatch began implementing the RI Project Work Plan and Sampling Plan Phase I.

- In 1985, a community relations plan was developed by Black & Veatch and Hall and Associates for Ecology.

- From May 1985 to the present, the City of Tacoma maintained correspondence with interested local residents and well owners by providing notification of quarterly sampling and outlining analytical results.

- In May 1986, the City of Tacoma issued a fact sheet discussing management of methane gas at the landfill.

- On May 13, 1986, U.S. EPA, in cooperation with the City of Tacoma and Ecology, conducted a public meeting to discuss well water quality of private wells surrounding the landfill.

- In July 1986, the City of Tacoma issued a press release and letter to residents discussing background and scope of the RI.

- In July 1986, the City of Tacoma and Ecology signed a consent agreement establishing guidelines for the RI/FS.

- In August 1986, the City of Tacoma began sampling 13 private wells located near the landfill.

- In February 1987, the Phase I Sampling Plan, Phase II Sampling Plan and Phase I RI Report were completed and made available to the public through Tacoma City and County libraries.

- On April 16, 1987, Ecology, in cooperation with the City of Tacoma and EPA , conducted a public meeting and provided a fact sheet discussing progress of the RI/FS.

- In January, 1988 a public notice was published in the Tacoma News Tribune announcing the availability of the RI and FS Reports and a public meeting to be held February 11, 1988.

- On February 11,1988, Ecology, in cooperation with EPA and the City of Tacoma, conducted a public meeting to discuss alternatives for cleaning up the groundwater and controlling methane gas at the landfill, including the agencies' preferred plan.

- From February 4 through March 4, 1988, public comments on the RI/FS were accepted and documented.

- In February and March 1988 the the Responsiveness Summary and Record of Decision were written.

APPENDIX A

APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

A. FEDERAL LAWS AND REGULATIONS

- Resource Conservation and Recovery Act (RCRA) (42 USC 6901), Subtitle C:

  - Protection of groundwater (40 CFR 264, Subpart F) Closure and post-closure of landfills (40 CFR 264, Subpart G) [Note: These are administered by Ecology under Dangerous Waste Regulations, WAC 173-303]

- Safe Drinking Water Act (SWDW) (42 USC 300):

  - Drinking Water Standards (40 CFR 141). Enforceable Maximum Contaminant Levels (MCLs), Which are relevant and appropriate at this site. [NOTE: This is administered by the Department of Social and Health Services under WAC 248-54-175 for public water supplies]

- Clean Water Act (CWA) (33 USC 1251):

  - National Pollutant Discharge Elimination System (NPDES) (40 CFR

122) [Note: NPDES program is administered by Ecology under WAC 173-220]

- Water Quality Criteria (EPA440/5-86-001).

o Clean Air Act (CAA) (72 USC 7401):

- National Emission Standards for Hazardous Air Pollutants (NESHAPS) [Note: NESHAPS Program is administered by Ecology and Puget Sound Air Pollution Control Agency under WAC 173-403].

o OSHA 29 CFR 1910:

- governs worker safety at hazardous waste sites

B. WASHINGTON STATE LAWS AND REGULATIONS

- Dangerous Waste Regulations, WAC 173-303: established standards for handling and disposal of hazardous waste.

- Minimum Functional Standards for Solid Waste Handling, 70.95 RCW and WAC 173-304: requirements for operation and closure of solid waste disposal facilities.

- Hazardous Waste Cleanup, Chapter 70.105B RCW: standards for the cleanup of hazardous waste sites.

- Water Quality Standards for Waters of the State of Washington, WAC 173-201: Standards for discharge to Flett Creek, or Leach Creek, or surface waters of the state.

- Submission of Plans and Reports for Construction of Wastewater Facilities, WAC 173-240: standards for the design, operation and maintenance of waste water treatment systems.

- National Pollutant Discharge Elimination System Permit Program, WAC 173-220: Discharge limitations if treated water is discharged into surface waters.

- Underground Injection Control Program, WAC 173-218: discharge standards for reinjection of treated water into the ground.

- State Waste Discharge Permit Program, WAC 173-216: Standards for the discharge to the sanitary sewer or groundwater (except by injection).

- Washington Clear Air Act, RCW 70.94: applicable for discharging pollutants into the atmosphere from a new source.

- General Regulations for Air Pollution Sources, WAC 173-400.

- Implementation of Regulations for Air Contaminant Sources, WAC 173-403.

- Emission Standards and Controls for Sources Emitting Volatile Organic Compounds, WAC 173-490.

- Instream Resources Protection Program - Chambers-Clover Creeks Basin, WAC 173-512: governs minimum water flow and levels requirements.

- Protection Associated with Groundwater Rights, WAC 173-150-100: applicable to activities that would degrade water quality.

- Minimum Standards for Construction and Maintenance of Water Wells, WAC 173-160: governs design of extraction and monitoring wells.

- Water Well Construction Act, RCW 18.104: provides for the regulation of water well construction.

- Water Pollution Control Act, RCW 90.48: standards for the protection of surface water and groundwater.

- Management of Waters of the State, RCW 90.54.020: provides for the protection of state water quality.

TO BE CONSIDERED

- Ecology New Source Review Guidelines for Toxic Air Contaminants in the State of Washington, September 1986.

- EPA Policy Statement - Groundwater Protection Strategy.

- Washington Department of Ecology Final Cleanup Policy: (Technical memorandum dated July 10, 1984) used for guidance in establishing cleanup levels.

- State Water Code, RCW 90.03 and Water Rights, RCW 90.14: establishes water rights permits necessary for water withdrawals, including groundwater extraction.

- State Environmental Policy Act (SEPA), WAC 197-11: covers all actions which may have significant environmental impact.

- State Protection of Upper Aquifer Zones, WAC 173-154: restricts activities that would impair senior groundwater rights, including water level lowering and water quality degradation.

- Protection of Withdrawal Facilities Associated with Groundwater Rights, WAC 173-150: restricts activities that would impair senior groundwater rights, including water levels lowering and water quality degradation.

- City of Tacoma Code, Chapter 12.08: pre-treatment regulations which govern discharge to the sanitary sewer.

- Pierce County Storm Drainage Ordinance 86-60: provides guidelines for the report criteria, analysis and design of public and private storm drainage systems.

APPENDIX B

RESPONSIVENESS SUMMARY

This community relations responsiveness summary is divided into the following sections:

Section 1.0 Overview. This section reviews the U.S. Environmental Protection Agency s (EPA) preferred alternative for corrective action, and likely public reaction to this alternative.

Section 2.0 Background on Community Involvement and Concerns. This section provides a brief history of community interest and concerns raised during remedial planning activities at the Tacoma Landfill site.

Section 3.0 Summary of Major Comments Received During the Public Comment Period and Agency Responses to the Comments. Both written and oral comments are categorized by relevant topics. EPA's responses to these major comments are also provided.

Section 4.0 Remaining Concerns. This section describes remaining community concerns that EPA and Ecology should consider in conducting the remedial design and remedial action at the Tacoma Landfill site.

Community relations activities conducted during remedial response activities at the Tacoma Landfill site are listed in Attachment A to this summary.

1.0 OVERVIEW

The City of Tacoma, under a Response Order on Consent issued by the Washington State Department of Ecology, completed a Remedial Investigation/Feasibility Study (RI/FS) for the Tacoma Landfill site, located south of Tacoma, Washington. From 1960 through the 1980s, the landfill has received refuse and garbage from the city's collection service. Hazardous materials were part of the refuse. Contaminants were discovered in nearby drinking water wells at levels high enough to cause public health concerns. The cleanup alternative recommended by Ecology to EPA, was to intercept the advance of contaminants by extracting the contaminated water, treating it, and discharging the cleaned water. This alternative is described in more detail in the Feasibility Study (Chapter 4; Black & Veatch 1987) and in the Selected Remedial Alternative section of the Record of Decision (Section VI).

In this summary, concerns of the local community about problems at the site, the recommended cleanup alternative, and the study process itself are described. Public comment also indicates that residents hope the cleanup will be as quick and thorough as possible, and not raise additional problems through its implementation. Only one potentially responsible party, the City of Tacoma, has been identified to date although an investigation to identify others has been initiated. The identified responsible parties will share cleanup costs. Residents are concerned about the funding to perform the cleanup and any adverse impact upon refuse collection rates.

2.0 BACKGROUND ON COMMUNITY INVOLVEMENT AND CONCERNS

Community interest in the Tacoma Landfill began as early as 1968 when local residents complained of poor water quality in their private wells. This condition continued throughout the 1970s. The residents are currently concerned about leachate from the landfill contaminating their private wells, and methane gas entering their homes.

Early in the Remedial Investigation/Feasibility Study (RI/FS) process (1985), Hall and Associates interviewed local residents and government officials and compiled a list of community concerns regarding the landfill. The following is a compilation of community concerns in 1985:

- Lack of interest and unwillingness to provide water testing by the public health agency.

- Lack of candor by government officials, particularly relating to contamination of wells in University Place during the late 1970s.

- Quality of drinking water.

- Health of small children in the neighborhood and recent miscarriages.

- Cost of replacing private wells and connecting residences to the city's water system.

- Inconvenience associated with using bottled water

- Need to be kept informed of landfill related activities.

The City of Tacoma and Ecology developed a community relations plan in an effort to keep the public informed of RI/FS activities. The City of Tacoma has addressed public concerns by holding meetings with residents to discuss RI/FS activities and public health concerns. Attachment A summarizes the community relations activities conducted at the South Tacoma Landfill. The following is a record of those activities:

1) In 1968, the City of Tacoma Department of Public Works began receiving complaints of contamination of the Home Builder's Association well, located at South 40th and Orchard Streets.

Actions: The City of Tacoma conducted a chemical analysis of the well water. Results revealed the water contained a high iron content, was discolored, and had a slight odor. The city installed a leachate collection system comprised of a gravel drain and dike. The dike diverted leachate flow to the drain that discharged to a perforated manhole connected to the city sewer system. An additional cover placed over the fill promoted surface water drainage, inhibited infiltration of water, and reduced leachate production. The Home Builder's Association was eventually connected to the city's water system.

2) In the late 1970s, wells owned by the University Place Water Company located west of the landfill, were found to contain elevated levels of iron and manganese. Residents complained of unappealing water taste, color, and odor.

Actions: An investigation conducted by Ecology indicated that well water contamination could have resulted from surface water or groundwater from the landfill, or from water migration through material containing high levels of iron and manganese. Residents served by these wells were eventually connected to the city's water system and these wells have not yet been abandoned in accordance with State requirements.

3) In 1985, prior to the RI, groundwater samples were collected from wells near the landfill and analyzed for U.S. EPA priority pollutant volatile organic compounds. Four private wells located in the vicinity of the landfill were found to contain priority pollutant volatile organic compounds.

Actions: In June 1985, vinyl chloride was detected in the Shaughnessy's well and they were connected to the city's water system. Vinyl chloride was detected in the Donaldson's well and they were connected to the city's water system in June 1986. Although vinyl chloride was not detected in the remaining two wells (those of the Higgins/Knipher and Miller residences), the city supplied these residences with bottled water for drinking. The Higgins/Knipher and Miller residences were later connected to the city's water system in October and December 1986, respectively. In 1987, the Meyer and Phillips residences were connected to the city's water system because vinyl chloride contaminated their wells.

4) Early in 1986, local citizens were becoming concerned about the quality of water from their private wells.

Actions: Ecology, in cooperation with the City of Tacoma and EPA, conducted a public meeting on May 13, 1986 to discuss affects of potential leachate migration to private wells. The meeting was open exclusively to private well owners. Twenty citizens and ten city, state, and federal representatives attended. At this time, Black & Veatch was still acting as a consultant for Ecology. A description and history of the site was outlined, the affects of methane gas migration were discussed, and an agenda and fact sheet were distributed.

5) In May 1986, local residents voiced concern about lateral methane gas migration at the City of Tacoma municipal landfill.

Actions: The city hired a consultant (Mandeville Associates) to investigate gas production and the extent of off-site migration prior to the release incident. The city conducted field surveys using portable explosimeters and found methane gas had migrated beyond the landfill boundaries. As a result of these findings, a gas extraction system comprised of 128 gas extraction wells with gas probes at 66 locations was installed. Initial efforts focused on controlling gas in businesses located southwest of the site. A flare station with permanent flares was installed in November 1986. The city implemented a gas monitoring program for structures surrounding the landfill. Both ambient and point sources were measured.

6) As early as 1983, local residents were voicing concerns about potential groundwater contamination from leachate migrating from the landfill.

Actions: In June 1986, the City of Tacoma, under the direction of Ecology, assumed responsibility for conducting an RI/FS. Quarterly groundwater monitoring activities were established to identify hazardous contaminants. The city continued contact with specific residents by notifying them of sampling dates and reporting analytical results. Public involvement in landfill issues is maintained by Ecology conducting public meetings and providing fact sheets on recent landfill activities and studies.

7) As the RI progressed in 1987, local citizens continued to voice concerns and questions.

Actions: Ecology, in cooperation with the City of Tacoma and EPA, conducted a public meeting on April 16, 1987 to discuss the progress of the RI/FS. Groundwater well monitoring procedures and analytic results were addressed. At that time, three to four residences had been connected to the city's water supply. Methane gas migration and monitoring were discussed. Dr. Branchflower, a consultant to the City of Tacoma, discussed risk assessment at the landfill site. Black & Veatch, acting as consultants to the city, provided graphical representation of well locations and migration pathways. An agenda and fact sheet were distributed.

8) After the RI/FS was made public in February 1988, citizens had concerns and unanswered questions.

Actions: On February 11, 1988, Ecology, in cooperation with EPA and the City of Tacoma, conducted a public meeting to discuss remedial alternatives for cleaning up leachate and methane gas at the landfill. Questions relating to the RI/FS were answered and public comments were recorded.

3.0 SUMMARY OF MAJOR COMMENTS RECEIVED DURING THE PUBLIC COMMENT PERIOD AND AGENCY RESPONSES TO THE COMMENTS

The public comment period was open from February 4 through March 4, 1988. Ecology held a public meeting in Tacoma on February 11, 1988 to explain the study and the remedial alternatives. Formal comments received at that meeting concerned providing an alternate water supply, coordinating planning, evaluating alternative design options, and implementing new landfill operations including recycling and ash disposal. The last comment is considered beyond the scope of the FS.

Comments from members of the public, primarily Tacoma area residents, regarding the FS report are summarized below. Questions were addressed to U.S. EPA, Ecology, the Tacoma-Pierce County Health Department (TPCHD), and City of Tacoma representatives and their consultants.

FORMAL COMMENTS

Four participants from the public presented formal comments during the public hearing. Those comments are summarized below.

1) Provision of an alternative water supply for residents whose wells have been contaminated regardless of the chosen alternative was a concern of one participant.

Response: The preferred alternative includes provision of an alternate, unthreatened water supply (municipal water) to any resident whose water supply is adversely impacted as further describes in the ROD by contamination emanating from the landfill.

2) One comment addressed the need to incorporate long-term planning in future studies. The speaker noted that seven years ago, many of today's problems connected with the landfill were not known and not planned for. Another comment addressed the need for more coordination in the planning process between the consultants and agencies connected with landfill studies.

Response: Long term planning of the landfill operation is conducted at the local level with assistance and review by the state. Selection of the preferred alternative under CERCLA/SARA included analysis of long-term needs. Long-term planning is part of the studies. Ecology a EPA agree that more coordination is needed and have incorporated this into ongoing community relation activities.

3) Several design options were offered by one participant who felt that they should have been considered during the evaluation of remedial alternatives. These options are as follows:

- An aeration facility to remove volatile material from the groundwater.
- A system of wells completely encircling the landfill to intercept and retrieve contaminated groundwater.

- Incorporation of removable pumps and sequencing pumping to optimize groundwater retrieval.

- Discharge of treated groundwater to the Simpson pulp mill or other use of treated groundwater as a water supply.

- Use of extracted methane to produce electricity.

Response: Ecology and EPA will take note of these suggestions and they will be evaluated during the Remedial Design phase as appropriate.

4) A comment was received concerning the potential threat to public health caused by heat generation from spontaneous combustion of materials in the proposed sealed landfill. Such conditions might lead to an explosion that would endanger nearby apartments and their inhabitants, and taxpayers would be obligated to pay for the damage.

Response: The landfill will be continuously monitored so that spontaneous combustion problems should not occur. Should a problem occur, the landfill has a contingency plan and an emergency response plan in place.