SNOHOMISH
HEALTH
DISTRICT

ENVIR MENTAL HEALTH DIVISION
3020 Rucker Avenue, Suite 104
Everett, WA 98201-3900
425.339.5250 FAX: 425.339.5254

Healthy Lifestyles, Healthy Communities

March 7, 2003

Mr. Jeff Kelley-Clarke
Solid Waste Management Division
Snohomish County Public Works
2930 Wetmore Avenue 5th Floor
Everett, Washington 98201

Subject: Site Hazard Assessment – Lake Goodwin Landfill, Frank Waters Road, Stanwood, Washington
Tax Parcel Number: Latitude: 48° 9' 34.27"
Longitude: 122° 18' 59.65"
Facility Site ID No.: 2710
Section: 17, Township: 31N, Range: 4E

Dear Mr. Kelley-Clark:

The Snohomish Health District has completed the Site Hazard Assessment (SHA) of the Lake Goodwin Landfill located on Frank Waters Road as required under the Model Toxics Control Act. This site's hazard ranking, an estimation of the potential threat to human health and/or the environment relative to all other Washington state sites assessed at this time, has been determined to be a 5, where 1 represents the highest relative risk and 5 represents the lowest risk.

For your information, Department of Ecology (Ecology) has published the results of this and other recently assessed sites in the *February 2003 Special Issue of the Site Register*. The site hazard ranking will be used in conjunction with other site-specific considerations in determining Ecology's priority for future actions.

Please contact me at 425.339.5250 if you have any questions relating to the SHA of your site. If you have any inquiries/comments about the site scoring/ranking process, please call Michael Spencer at 360.407.7195. For inquiries regarding any further activities at your site now that it is on Ecology's Hazardous Sites List, please call Maura O'Brien at 425.649.7000.

Sincerely,

Mike Young, R.S.
Environmental Health Specialist
Solid Waste and Toxics Section

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Enclosures

cc: Michael Spencer, Department of Ecology
Maura O'Brien, TCP - NWRO

WORKSHEET 1
SUMMARY SCORE SHEET

Site Name: **Lake Goodwin Landfill** **Facility Site ID No. 2710**

Location: Frank Waters Road, Stanwood, Washington

County: Snohomish, Section: 17, Township: 31N, Range: 4E.

Listing Date December, 2002 Latitude/longitude 48°9'34.27" 122°18'59.65"

Site Description **(Include management areas, compounds of concern, and quantities):**

The Lake Goodwin Landfill (AKA Warm Beach Landfill) is located west of Frank Waters Road in northwestern Snohomish County, about 5.5 miles south of Stanwood and about 1.5 miles northwest of Lake Goodwin. The area surrounding the landfill is mostly undeveloped forested land, or large acreage parcels with single homes. There are several high-density subdivisions within a two-mile radius of the landfill. Many homes utilize individual wells despite the public water systems, which now service part of the Lake Goodwin area. The landfill was developed in a former Snohomish County gravel pit and is still maintained by Snohomish County Public Works. Waste disposed at the landfill reportedly consisted of household garbage, demolition debris and some industrial waste. Records indicate that the site accepted some chemical contaminated materials (Non-Hazardous waste), tires and burned garbage up until the early 70's. The landfill ceased to accept waste in September of 1982. Final cover was placed on during 1983. The unlined waste mound covers approximately 11.5 acres, which is now capped with soil and vegetated with grass, clover and weeds. Monitoring wells were installed in October of 1990 and surround the landfill.

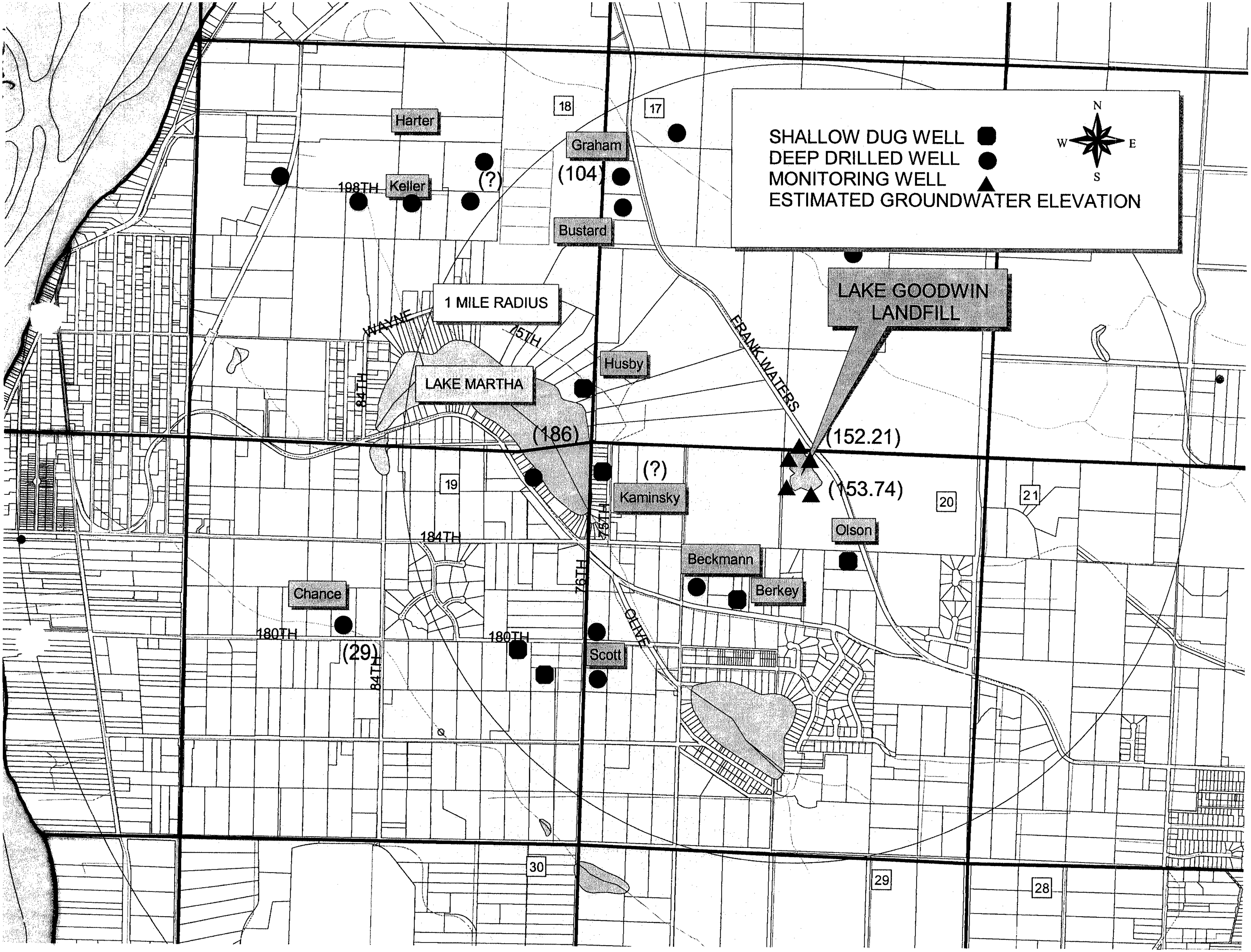
The geology of the area has been described as glacial fill deposits that may be thousands of feet deep. The landfill lies on an upland terrace known as the Tulalip Plateau. The plateau is part of many glacial formed features commonly found in the Puget Sound Lowlands. These features are thought to have formed as the result of pressure from ice, which was about 1000 meters deep and retreated some 14,000 years ago. The Tulalip Plateau is characterized by a smooth glacial till slope with a high point of 500 feet above sea level, located two miles southeast of the landfill, and descends to the west and northwest to sea level. The drainage in the area follows the descent of the till to the northwest, where glacial melt water carved drainage feathers trending northwest. For example, an unnamed creek north of the landfill drains a shallow valley northwest to the Puget Sound and drainage from the lakes south of the landfill also flows northwest to the Puget Sound.

The glacial fill deposits include three important aquifers utilized by the community described as shallow, intermediate and deep. The deepest aquifer is thought to be about 200 feet under the landfill and flows west to the Puget Sound. This deep aquifer is within the Olympia Gravels unit of the Transitional Bed Formation. The intermediate aquifer is about 150 feet below the landfill and is monitored by wells installed by the county, which have been use to determine the groundwater flow direction is north-northwest. This intermediate aquifer is located within the Advance Outwash Formation, which is perched on top of the Transitional Bed Formation. The Advance Outwash Formation was formed when high-energy melt water from the advancing Vashon Glacier deposited sand and gravels. The Advance Outwash Formation has fine material at the bottom and more coarse material at the top. The Vashon Till Formation is above the Advanced Outwash Formation and is described as a dense low-permeable clay layer. The Vashon Till contains the shallow aquifer in gravel seams and weather till, which keeps water perched for several shallow dug wells in the area, but the shallow aquifer is not present at the landfill. The gravel pit was developed at the transition between the Advance Outwash Unit and the Vashon Till Formation.

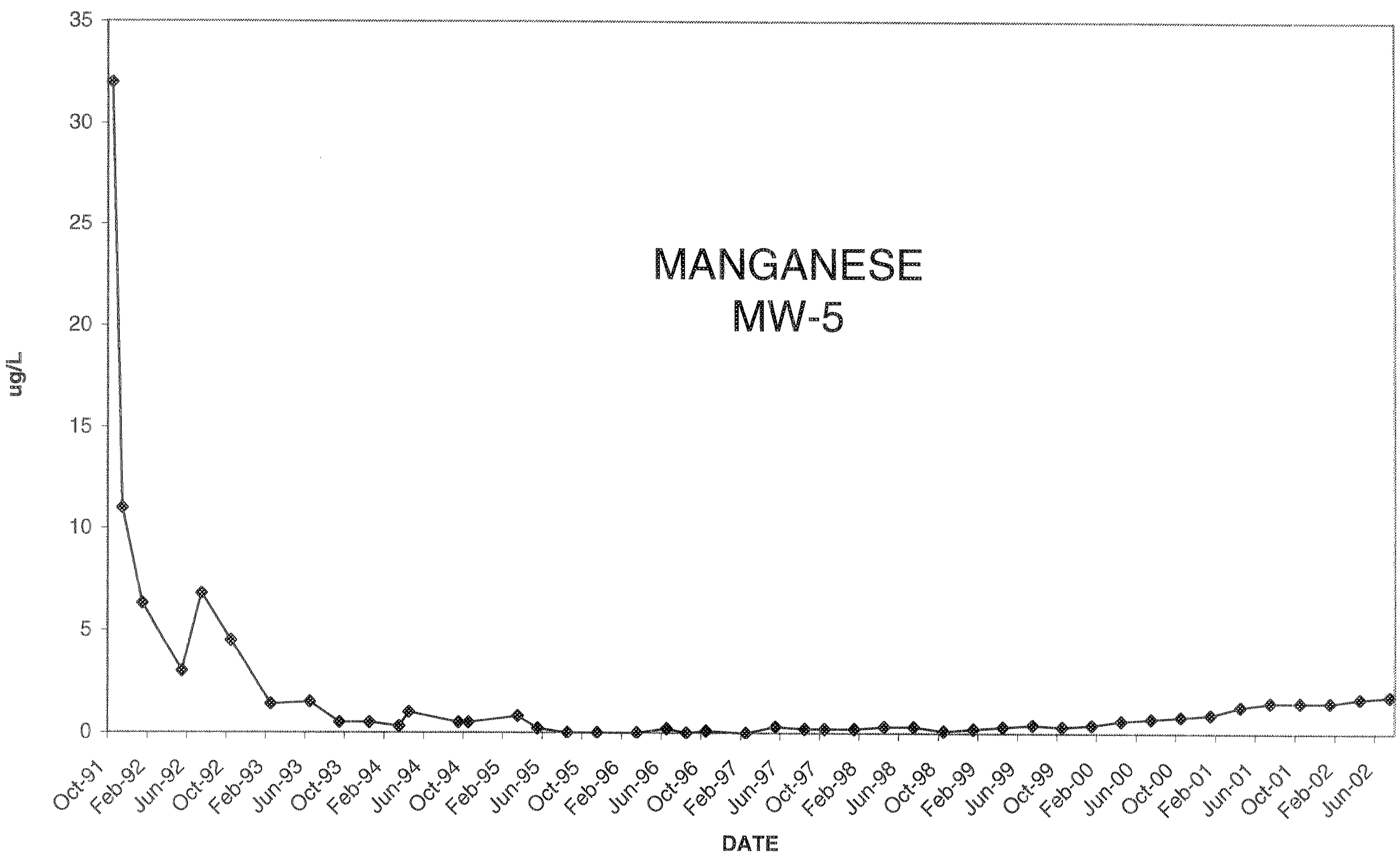
The attached map (Figure 1) shows the approximate locations of the monitoring wells and the surrounding residential wells north and west of the landfill. The map also shows the approximate elevation of the water in the wells. These elevations suggest that many of the shallow wells have not been developed in the same aquifer monitored by the county. The aquifer monitored by the county is at an elevation of 153' above sea level, which is below the elevation of nearby Lake Martha at 186'. Although the depths of the shallow wells near the lake are unknown, one may anticipate that the water levels in the wells are close to the lake elevation. Since the shallow aquifer is not present at the landfill, leachate is likely released to the intermediate aquifer, which flows north-northwest. Any leachate released from the landfill to the deep aquifer may be flowing under the lake in the deep aquifer, and under the shallow wells, to the west.

Table 1 includes a list of all the chemicals detected in monitoring wells at this site. The table includes the maximum chemical analysis result for a specific parameter and the most recent test result for that parameter in the well, where the maximum concentration was detected. Table 1 also includes several different standards and the summary results of statistical testing. Nitrate, chromium, specific conductance, barium, cooper and sulfate were reported to be increasing in downgradient wells according to intra-well prediction limit testing with result reported by the county as Failure or Warning. It was noted that, while organic chemicals have been tested quarterly, semi-volatile organics and pesticides have only been tested once in each well. It should also be noted that the metal samples were filtered starting in 1993 and only dissolved results were reported after that date, which were consistently lower than the original total metal test results.

A geochemical survey was preformed as part of this assessment to provide additional evidence of groundwater impact from leachate and groundwater flow direction. The parameters used in the geochemical survey include common anions and cations, which are plotted as "Stiff Diagrams". The Stiff Diagrams are used as a method of graphically comparing the chemical "finger print" of several individual samples, see figure 4, 5 and 6. The shapes formed by the Stiff Diagrams quickly identify samples that have similar compositions and are particularly useful when used as map symbols to show the geographic location of different water facies.



SHALLOW DUG WELL
DEEP DRILLED WELL
MONITORING WELL
ESTIMATED GROUNDWATER ELEVATION
N
S
E
W
LAKE GOODWIN LANDFILL
1 MILE RADIUS
LAKE MARTHA
Harter
Keller
Graham
Bustard
Husby
Kaminsky
Olson
Beckmann
Berkey
Chance
Scott
(104)
(?)
(186)
(152.21)
(153.74)
(29)
18
17
19
20
21
29
28
30
198TH
WAYNE
75TH
84TH
FRANK WATERS
184TH
180TH
76TH
OLIVE


MANGANESE
MW-5
ug/L
35
30
25
20
15
10
5
0
Oct-91
Feb-92
Jun-92
Oct-92
Feb-93
Jun-93
Oct-93
Feb-94
Jun-94
Oct-94
Feb-95
Jun-95
Oct-95
Feb-96
Jun-96
Oct-96
Feb-97
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Oct-98
Feb-99
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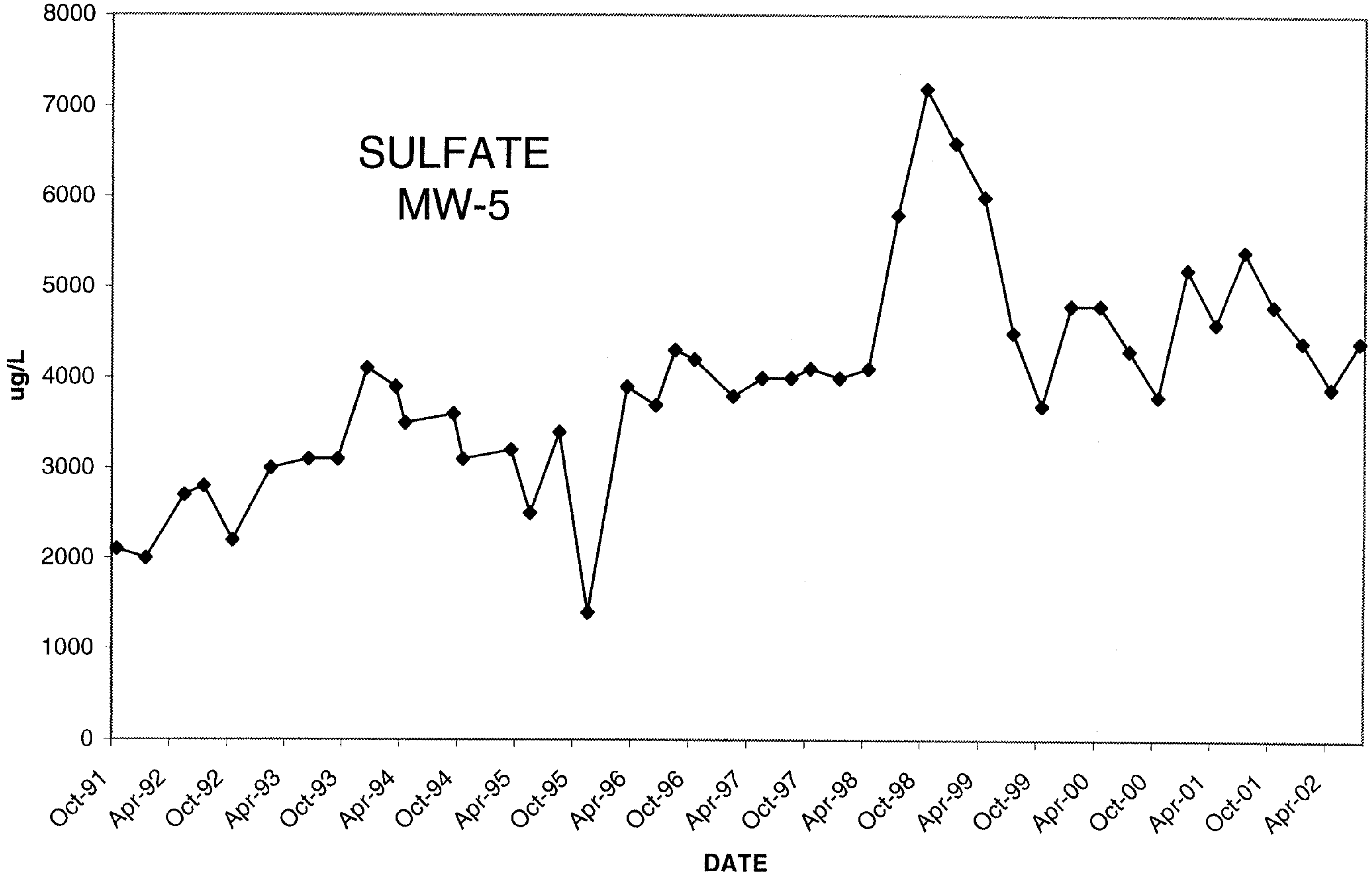
Feb-00
Jun-00
Oct-00
Feb-01
Jun-01
Oct-01
Feb-02
Jun-02
DATE

Figure 2



SULFATE
MW-5
8000
7000
6000
5000
4000
3000
2000
1000
0
ug/L
Oct-91
Apr-92
Oct-92
Apr-93
Oct-93
Apr-94
Oct-94
Apr-95
Oct-95
Apr-96
Oct-96
Apr-97
Oct-97
Apr-98
Oct-98
Apr-99
Oct-99
Apr-00
Oct-00
Apr-01
Oct-01
Apr-02
DATE

TABLE 1

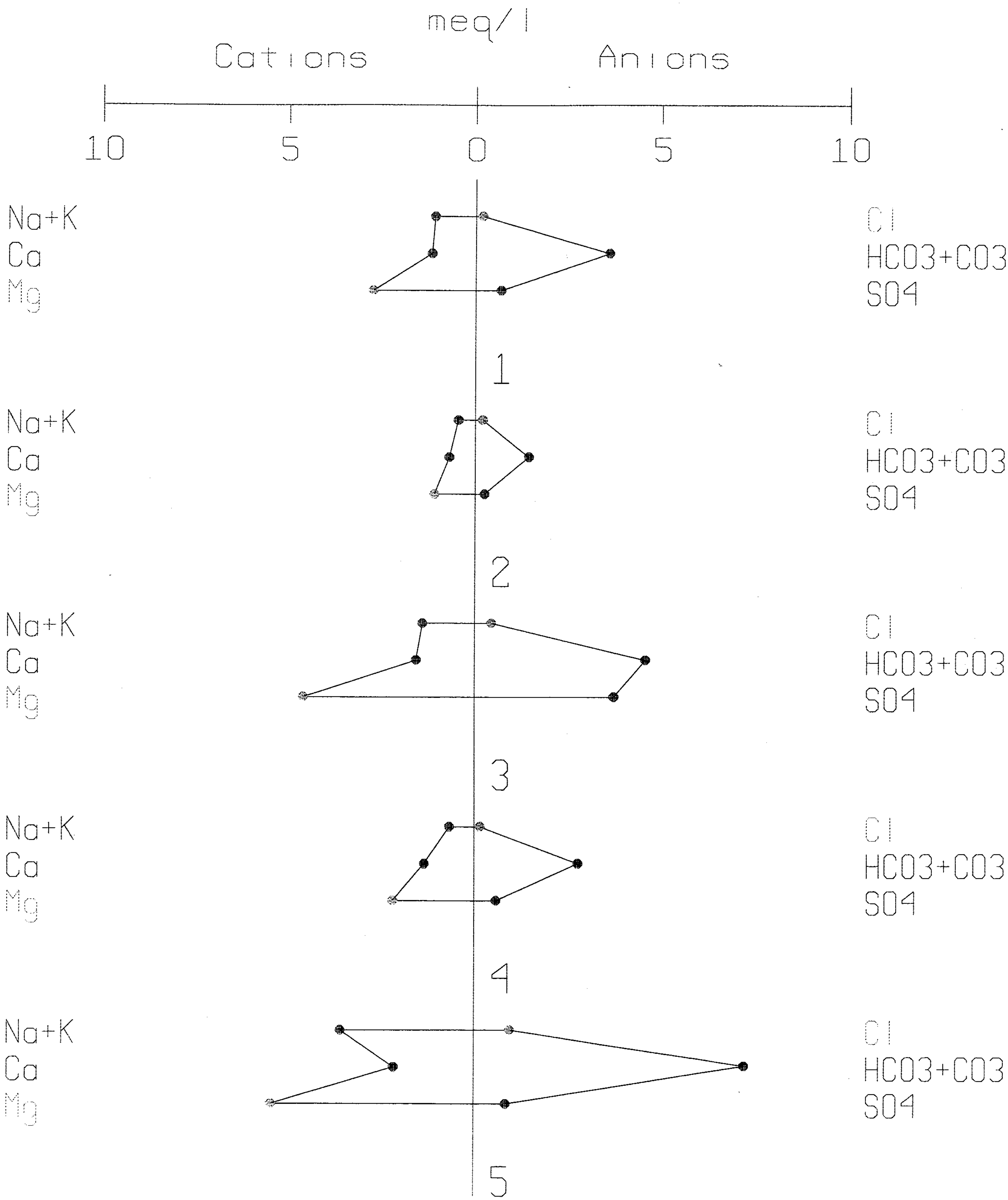
LAKE GOODWIN LANDFILL
GROUNDWATER MONITORING RESULT SUMMARY

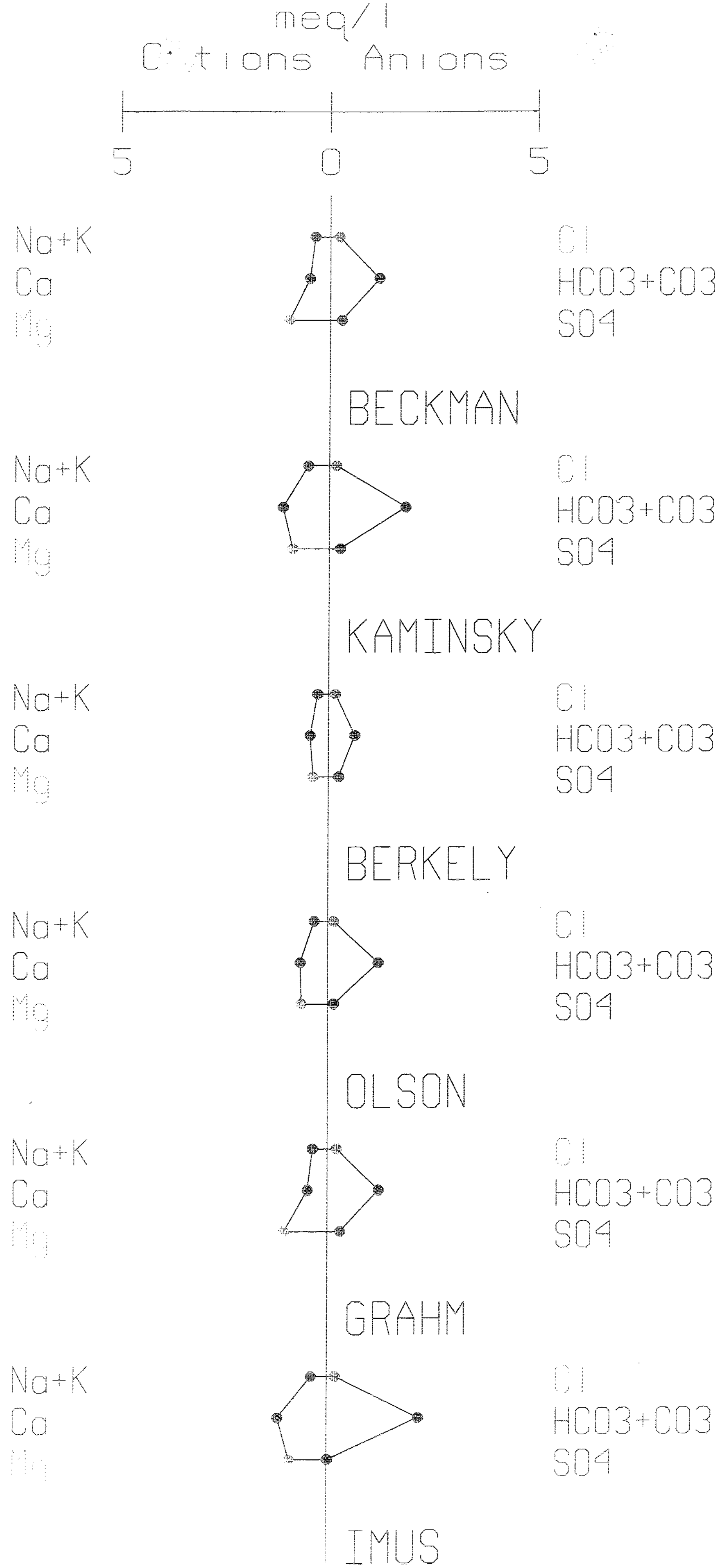
SHA

Chemical Parameters	Well	Maximum Result Reported 1990-2002		Date of Maximum Result	Latest Test Result		Date of Last Test Result	MTCA (Method A)	MTCA (Method B)	Ground Water Standard	Primary Drinking Water Standard	Secondary Drinking Water Standard
Acetone	LG-02	59.0	ug/L	12/27/90	ND	ug/L	10/9/02		800			
Antimony, Total (Sb)	LG-02	6.2	ug/l	6/20/91	6.200	ug/L	6/20/91		6.4			
Arsenic (As)	**LG-02**	**6.0**	**ug/L**	**9/13/94**	**4.000**	**ug/L**	**10/9/02**	**5**	**0.058**	0.05	10	
BARIUM (Ba)	LG-02	21.0	ug/L	8/5/97	8.00	ug/L	10/9/02			1000		
Benzene	**LG-01**	**0.9**	**ug/L**	**7/8/99**	**ND**	**ug/L**	**10/9/02**	**5**	**0.795**	1		
bis-(2-Ethylhexyl)phthalate	LG-05	1.0	ug/L	10/9/91	1.00	ug/L	10/9/91		6.25			
Cadmium (Cd)	LG-04	3.0	ug/L	5/24/95	ND	ug/L	10/9/02	5	8	10	5	
Carbon Disulfide	LG-02	23.0	ug/L	7/8/99	ND	ug/L	10/9/02		800			
Chloride (Cl)	LG-03	51000.0	ug/L	12/17/90	16000.00	ug/L	10/9/02			250		
Chromium (Cr)	**LG-03**	**98.0**	**ug/L***	10/21/92	ND	**ug/L**	**10/9/02**	**50**		50	100	
Coliform, Total	LG-01	1600	CFU/100	10/21/92	ND	CFU/1(	10/9/02			1	1	
Copper (Cu)	LG-03	7.0	ug/L*	12/27/90	ND	ug/L	10/9/02		592	1000		
Di-n-Butylphthalate	LG-03	1.0	ug/L	12/27/90	ND	ug/L	6/20/91					
Ethylbenzene	LG-01	1.4	ug/L	7/8/99	ND	ug/L	10/9/02	700				
Iron (Fe)	LG-04	1800.0	ug/L	10/21/92	ND	ug/L	10/9/02					**300**
LEAD, (Pb)	**LG-03**	**10.0**	**ug/L***	**2/8/93**	ND	**ug/L**	**10/9/02**	**15**		50		
Manganese (Mn)	LG-05	320.0	ug/L	10/9/91	13.00	ug/L	10/9/02		2240			**50**
Methylene Chloride	LG-01	4.0	ug/L	10/21/92	ND	ug/L	10/9/02	5	5.83	5		
Nickel (Ni)	LG-05	40.0	ug/L	9/30/93	20.00	ug/L	10/9/02				100	
NITRATE-N (NO3)	**LG-05**	**30000.0**	**ug-N/L**	**10/23/01**	**14000.00**	**ug-N/L**	**10/9/02**		**1600**	10000	10000	
Zinc (Zn)	LG-02	3.3	ug/L	12/27/90	ND	ug/l	6/20/91		4800			
SELENIUM (Se)	LG-03	5.0	ug/L	10/21/97	ND	ug/L	10/9/02		80			
Specific Conductance	LG-03	11000^	umhos/cr	4/21/94	700.00	umhos/	10/9/02					**700**
Styrene	**LG-05**	**20.0**	**ug/L**	**11/26/91**	ND	ug/L	10/9/02		**1.46**			
SULFATE (SO4)	LG-03	98.0	ug/L*	6/4/96	41.00	ug/L	10/9/02					250000
Toluene	LG-01	3.2	ug/L	7/8/99	ND	ug/L	10/9/02	1000				

*Total Constituent

^Suspect outlier result


meq/l
Cations
Anions
10
5
0
5
10
Na+K
Ca
Mg
Cl
HCO3+CO3
SO4
1
2
3
4
5


meq/l
Cations Anions
5
0
5
Na+K
Ca
Mg
Cl
HCO3+CO3
SO4
BECKMAN
Na+K
Ca
Mg
Cl
HCO3+CO3
SO4
KAMINSKY
Na+K
Ca
Mg
Cl
HCO3+CO3
SO4
BERKELY
Na+K
Ca
Mg
Cl
HCO3+CO3
SO4
OLSON
Na+K
Ca
Mg
Cl
HCO3+CO3
SO4
GRAHM
Na+K
Ca
Cl
HCO3+CO3
SO4
IMUS

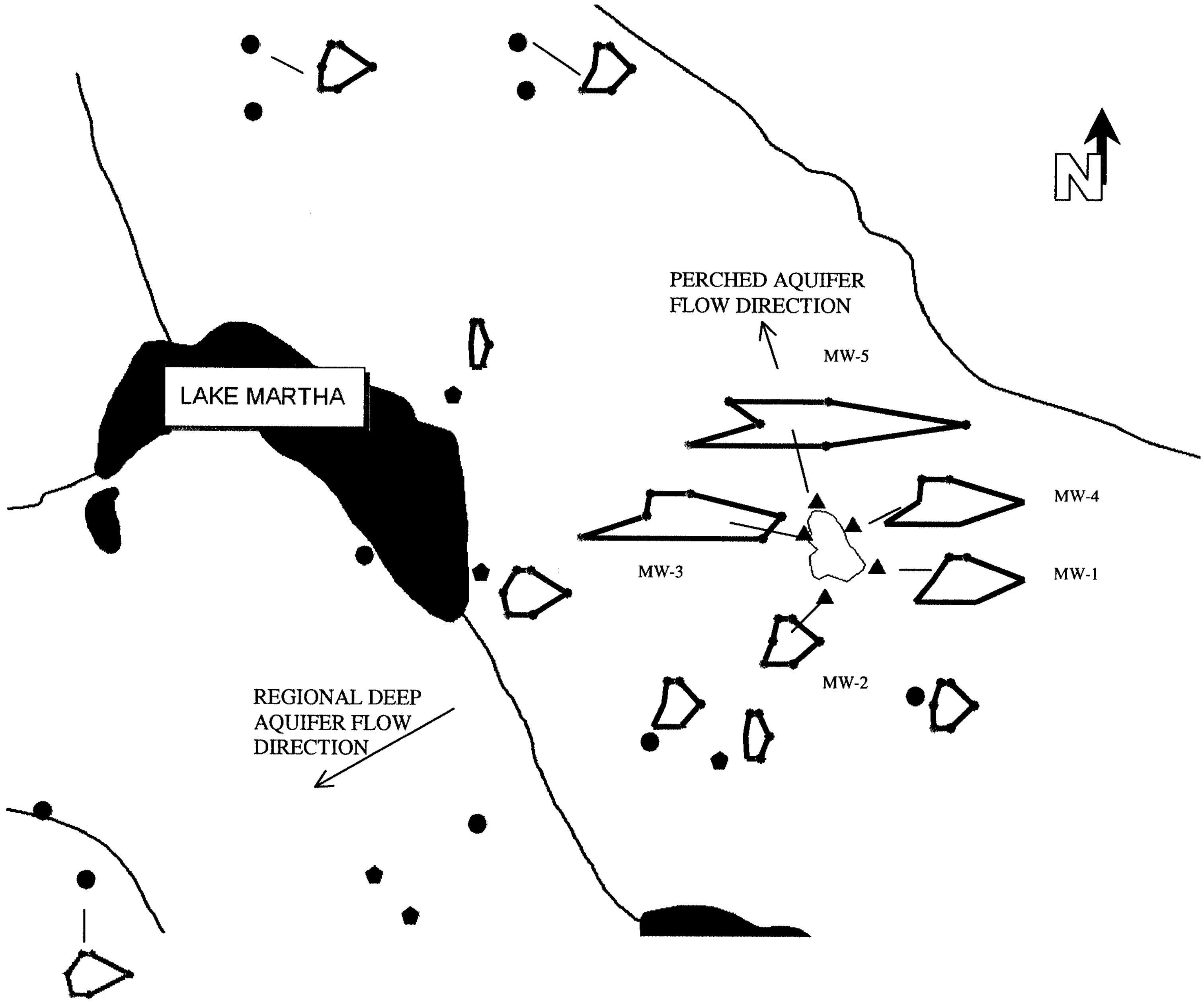
The size of the Stiff Diagram is directly related to the concentration of the ions present in the water. From the map showing the Stiff Diagrams (Figure 7), we can see that monitoring well 5 has the largest concentration of ions, and is likely the most leachate impacted well. MW5 was installed on the landfill property after the first four wells were installed to calculate the groundwater flow direction. The fifth well was needed to obtain samples directly downgradient of the landfill. The shape of the Stiff Diagrams is important to determine if off-site wells have any relationship to the impacted on-site monitoring wells. From the map there appears to be no clear relationship, but the Graham and Beckman well have a similar Ca/Mg ratio as MW5, MW3 and MW1. Graham and Beckman are deep wells that are likely downgradient of the landfill.

<u>Special Considerations</u> (Include limitations in site file data or data which cannot be accommodated in the model, but which are important in evaluating the risk associated with the site, or any other factor(s) over-riding a decision of no further action for the site):

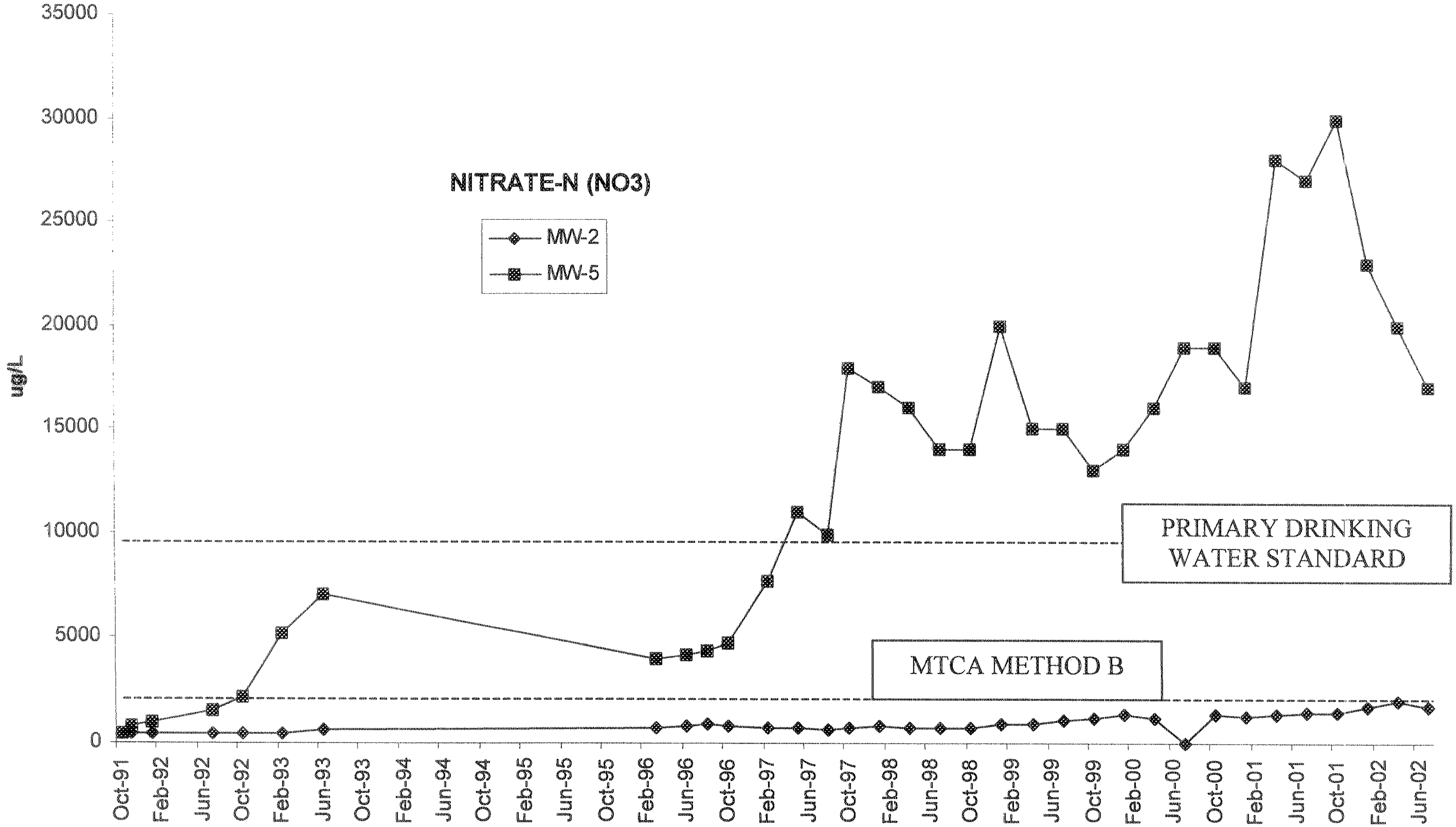
A decision of "No Further Action" cannot be made for this site at this time because evidence from this investigation suggests that leachate continues to impact the ground water. Despite the closure activity, there continues to be some impact to the groundwater downgradient of the landfill. There is significant evidence of groundwater impact from leachate at the monitoring wells, which have reported the detection of many different chemical parameters. Although the chemical concentrations of some of these parameters have gone down over the years, such as manganese (Figure 2), other chemicals, such as sulfate (Figure 3), are increasing in concentration. For example, nitrate has been increasing to a point where it has exceeded both the primary drinking water standard, and the method B MTCA standard, see figure 8. While nitrate has not been a traditional MTCA chemical of concern, its presents and the other leachate indication chemicals provides evidence for over-riding a decision of no further action at the site. Some of the chemical parameters analyzed for as part of the groundwater-monitoring program, such as chromium, have Model Toxic Control Act (MTCA) cleanup standards, which have been exceeded at least once over the years. There is reason to believe that the MTCA standards may continue to be exceeded by some parameters periodically.

Surface water and air routes were not scored because the contamination was only documented in the subsurface groundwater and the landfill cap has no gas collection system. The high permeability of the Advanced Outwash Formation, where landfill was developed, accounts for the lack of any surface water, or leachate, being observed near the landfill. There was no evidence that the creek in the area was being impacted by the landfill. Surface water samples were collected in the unnamed creek north of the landfill by a Snohomish County Public Works Surface Water Management investigator. This investigation was made on December 02, 2002 as a request of the Health District to address the possibility that this creek is intercepting leachate via groundwater. A report found during the file review indicated that the creek is draining the intermediate aquifer in the Advance Outwash Formation (source 1). Field analysis of surface water using leachate detection chemical parameters could not distinguish an anomaly in the creek. The field parameters measured included pH, conductivity, turbidity, temperature, and dissolved oxygen.

LAKE GOODWIN LANDFILL
SITE HAZARD ASSESSMENT
STIFF PATTERN GEOCHEMICAL SURVEY



LAKE GOODWIN LANDFILL
MONITORING WELL RESULTS



ROUTE SCORES:

Surface Water/Human Health:	N/A	Surface Water/Environ. :	N/A
Air/Human Health:	N/A	Air/Environmental:	N/A
Ground Water/Human Health:	26.6		

OVERALL RANK: 5

WORKSHEET 2
ROUTE DOCUMENTATION

1. SURFACE WATER ROUTE – Not Scored

List substance to be considered for scoring: N/A

Explain basis for choice of substance(s) to be used in scoring. N/A

List the management units to be considered in scoring: N/A

Explain basis for choice of unit used in scoring: N/A

2. AIR ROUTE – Not Scored

List substance to be considered for scoring: N/A

Explain basis for choice of substance(s) to be used in scoring. N/A

List the management units to be considered in scoring: Source: (1)

Explain basis for choice of unit used in scoring: N/A

3. GROUND WATER ROUTE

List substance to be considered for scoring:

Groundwater	Max.Result ug/l	Max. Background	Cleanup Standard
Nitrate	30000	2100	1600*
Arsenic	6	6	5
Chromium (Total)	98	34	50
Benzene	0.9	ND	5
Lead	10	ND	15
Styrene	20	ND	1.46*

*Method B

Explain basis for choice of substance(s) to be used in scoring.

The substances listed above were reported by Snohomish County Public works as part of the ground water monitoring program and were taken from table 1 of worksheet 1.

Although arsenic was found above MTCA standards, it will not be used to rank the site, because it was also found in the background well. Benzene, Lead, and Styrene were found to be above the MTCA cleanup standard once, and then not detected above the standard again.

Chromium was found above MTCA, and chromium was reported at levels above the background well. The highest total chromium metal level reported was from an analysis of water collected in 1992 at MW-3, which is an on-site downgradient monitoring well. Since then, two other total chromium metal analyses and 35 dissolved chromium metals analyses were performed on samples collected from monitoring well 3. Only one detectable concentration of chromium was reported in monitoring well 3 since 1992. The background well MW-2 has reported detectable chromium more frequently than monitoring well 3, and more recently one sample was above the normal prediction limit of 6 ug/L. Despite the fact that the levels of chromium are currently below the MTCA standards, it will be used to rank the site.

Nitrate has been found to exceed the MTCA (Method B) cleanup standard of 1600 ug/L. Nitrate has also exceeded the drinking water standard and the groundwater quality standard, both of which are 10,000 ug/L. In addition nitrate was also found at more than ten times above of the background samples. Nitrate has shown a statistical increased in concentration over time based on a calculated prediction limit, which is based on a site wide standard deviation.

List the management units to be considered in scoring: Source: (2)
The landfill cap is the management unit most likely to keep contaminates from moving into the ground water.

Explain basis for choice of unit used in scoring: Source (2)
The landfill cap is maintained, but there is no liner and no leachate collection system.

WORKSHEET 6
GROUND WATER ROUTE

1.0 SUBSTANCE CHARACTERISTICS

1.1 Human Toxicity

Substance	Drinking Water Standard (ug/l)	Val.	Acute Toxicity (mg/kg-bw)	Val.	Chronic Toxicity (mg/kg/day)	Val.	Carcinogenicity WOE	CPF	Val.
Nitrate	10000	2	ND	ND	0.1	3	ND	ND	ND
Chromium	100	6	ND	ND	1	1	ND	ND	ND

Source: 24
Highest Value: 2
2 Bonus Points? ____
Final Toxicity Value: 6

1.2 Mobility (Use numbers to refer to above listed substances)

Cations/Anions	*K*	*Value*
Chromium	>1	3

Source: 15 Value: ____

OR

Solubility (mg/l)	*mg/l*	*Value*
Nitrate NO3	53000	3

Source: ____ Value: 3

1.3 Substance Quantity — Source: 2 Value: 1

Explain basis: UNKNOWN QUANTITIES

2.0 MIGRATION POTENTIAL

2.1 Containment — Source: 1 Value: 5
Explain basis:
No liner - 3
Maintained Engineered cover - 0
No leachate collection -2
No liquids present -0

2.2 Net Precipitation: 16.9" Net P. for Everett (N-A) = Sum P. - PET — Source: 10 Value: 2

2.3 Subsurface Hydraulic Conductivity: Advanced Outwash — Source: 1 Value: 4

2.4 Vertical Depth to Ground Water: 0' Release — Source: 1 Value: 8

WORKSHEET 6
GROUND WATER ROUTE

3.0 TARGETS

3.1 Ground Water Usage:	Private wells in area. with no alternative source		Source: 16	Value: 5
3.2 Distance to Nearest Drinking Water Well:		988 feet	Source: 3	Value: 4
3.3 Population Served within 2 Miles:		Square root of 7336 = 86	Source: 9,6	Value: 86
3.4 Area Irrigated by (Groundwater) Wells within 2 miles:		325 ac .75*Square root of 325 =13.5	Source: 6	Value: 14

4.0 RELEASE

Explain basis for scoring a release to ground water: Source: 2 Value: 5

There is ample evidence of leachate impacting the groundwater.

See references for Sources Used in Scoring

Ground Water Route - Human Health Pathway

GW = (SUB X 40/208) X {(MIG X 25/17) + REL + (TAR X 30/165)} / 24 = **26.56**

GW = Pathway Score For Ground Water-Human Health =
SUB = (Human Toxicity + Mobility + 3) X (Containment + 1) + Substance Quantity = 73
MIG = Depth to Aquifer + Net Precipitation + Hydraulic Conductivity = 14
REL = Release to the Ground Water = 5
TAR = Aquifer Use + Well Distance + Population Served + Area Irrigated = 109

Site Scoring

Pathway	Route Score	Quintile
SW-HH	0	1
Air-HH	0	1
GW-HH	26.6	2
SW-En	0	1
Air-En	0	1

Priority Scores

$\frac{H^2+1M+L}{8} =$ (4+1+1)/8= 0.875

$\frac{H^2+2L}{7} =$ (1+1)/7= 0.28571429

Quintile Values as of August 28, 2001

Human Health Pathway Scores

Quintile No.	Surface Wate	Air	Ground Water
5	>26.8	>33.5	>55.0
4	20.1-26.6	22.0-33.5	43.9-55.0
3	13.9-20.0	14.3-21.9	35.5-43.8
2	7.2-13.8	8.1-14.2	26.5-35.4
1	<7.2	<8.1	<26.5

Environmental Pathway Scores

Quintile No.	Surface Water	Air
5	>49.1	>31.3
4	33.5-49.1	23.7-31.3
3	23.3-33.4	15.6-23.6
2	10.4-23.5	0.1-15.2
1	<10.4	<0.1

Human Health Priority	Environment Priority 5	4	3	2	1	**NA**
5	1	1	1	1	1	1
4	1	2	2	2	3	2
3	1	2	3	4	4	3
2	2	3	4	4	5	3
1	2	3	4	5	5	**5**
NA	3	4	5	5	5	NFA

REFERENCES

1. Hydrogeologic Study Lake Goodwin Landfill Snohomish County, WA Converse Consultants NW Project # 89-35228-10 July 8, 1991

2. Snohomish Health District, Site Hazard Assessment for Bryant Landfill.

3. Aerial photograph from Snohomish County Public Works, Section 17 T31N, R4E .

4. Washington Department of Ecology, WARM Scoring Manual, April 1992.

5. Washington Department of Ecology, Toxicology Database for Use in Washington Ranking Method Scoring, January 1992.

6. Washington Department of Ecology, water Rights Information System (WRIS), November 4, 1992.

7. NOAA Atlas 2 Volume IX- Washington Precipitation Frequency Atlas of the Western United States, 1973.

8. U.S.G.S. Topo. Map, Stanwood Quad., 7.5 Min. Series Photorev. 1973. and Geologic map 1:24,000 by Minard 1985

9. Washington Department of Health, Public Water System List, April 26, 1993.

10. Washington Climate for Snohomish Co., National Weather Service Forecast Office, 1931-1960.

11. Ground-Water Resources of Snohomish County Washington. Geologic Survey Water-Supply Paper 1135. Newcomb, R. C., 1952.

12. General Chemistry, eighth edition; Holtzclaw Robinson, Pub. D.C. Heath and Company Lexington, Mass. P599-600.

13. Snohomish Health District Permits.

14. Washington Department of Ecology, Cleanup Levels and Risk Calculations under the Model Toxics Control Act Cleanup Regulation CLARK. Version 3.1 Publication No. 94-145 Updated November 2001

15. LISTING OF SUPPLIED IONIC MOBILITIES WITH FULL ION NAMES FOR THE PROGRAM. www.med.unsw.edu.au/PHBSoft/mobility

16. Map of Water System Plan Seven Lakes Water Association Nov. 4, 1994.