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Evaluation of Groundwater Contamination at Roeder Avenue Landfill, Bellingham

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Evaluation of Groundwater Contamination at Roeder Avenue Landfill, Bellingham

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Abstract

The northwest perimeter of Roeder Avenue Landfill, a historic municipal dump located near the shoreline of Bellingham Bay, was monitored to determine if priority pollutants were migrating off-site through groundwater. The Washington Department of Ecology installed four monitoring wells and sampled them quarterly for one year (June 1994 - March 1995).

Of the priority pollutants examined, chromium was the only contaminant that consistently exceeded the Model Toxic Control Act (MTCA) cleanup level of 50 µg/L. The mean concentrations of chromium were 280 µg/L (MW1) and 68 µg/L (MW4). No volatiles or semivolatiles exceeded MTCA standards. In a 1992 groundwater study conducted on the southeast side of the landfill, some metals and organics were found above MTCA standards; however, chromium exceeded standards by a large margin. Both studies indicate that chromium is probably migrating off-site.

If time and resources allow, wells MW1 through MW4 should be visited once a year and maintained as viable monitoring wells. Also, water column samples for chromium should be collected from Bellingham Bay, just off the landfill, both on the southwest and the southeast side on a descending tide, to verify that chromium is not elevated in the marine environment. Subtidal sediments on the southeast side of the landfill in the Whatcom Waterway could be examined for chromium as part of the Whatcom Waterway cleanup that is underway.

Summary

Groundwater monitoring was conducted at four wells along the northeast edge of the Roeder Ave Landfill to determine if off-site migration of contaminants was occurring. Roeder Avenue Landfill is an abandoned dump located adjacent to the shoreline of Bellingham Bay on Georgia Pacific and Port of Bellingham property in Bellingham. Due to its location, the potential exists for leachate from the landfill to enter groundwater and migrate into the bay. The quantity or type of wastes disposed of at the landfill are unknown. To characterize groundwater quality and determine the potential impact to Bellingham Bay, Ecology installed four monitoring wells (Figure 1) on the northwest perimeter of the landfill. Ecology collected samples at the site quarterly from June 1994 to March 1995.

The results of this year-long effort indicated that, of the priority pollutants tested for, chromium is the only contaminant that consistently exceeded the Model Toxic Control Act (MTCA) cleanup level of 50 µg/L in wells MW1 and MW4. The mean concentrations of chromium were 280 µg/L (MW1) and 68 µg/L (MW4). Organics were infrequently detected at relatively low levels. These findings are consistent with previous monitoring conducted along the southeast portion of the site in 1992. No volatiles or semivolatiles exceeded MTCA standards. Conclusions and recommendations follow.

Conclusions

- Chromium is the only contaminant that consistently exceeded the Model Toxic Control Act (MTCA) cleanup level of 50 µg/L in wells MW1 and MW4. The mean concentrations of chromium were 280 µg/L (MW1) and 68 µg/L (MW4).

- Based on the analytical results, chromium, though exceeding MTCA standards at the concentrations found, would probably have little impact on the marine biota in Bellingham Bay due to dilution by seawater and the low likelihood that all of it is in the more toxic hexavalent form.

- Groundwater appears to flow from the northeast, across the landfill, and flow off-site both to the southeast into Whatcom Waterway and to the southwest in Bellingham Bay near I and J Street Waterway to either side of the GP treatment lagoon.

Recommendations

- Monitoring wells MW1 - MW4 should be visited and maintained on a yearly schedule.

- If time and resources allow, two to four water column samples for chromium should be taken from the bay as near as possible to the landfill on a low tide to verify chromium is not elevated in the marine environment due to the landfill. Subtidal sediments on the southeast side of the landfill in the Whatcom Waterway could be examined for chromium as part of the Whatcom Waterway cleanup that is underway.

Acknowledgments

We thank the many people who contributed to the success of this project.

- ◊ Lucille Pebles conceived and directed the project. She also assisted in sampling and reviewed drafts of this report.
- ◊ Denis Erickson led the design of the monitoring well configuration and, as licensed well driller, directed the installation of all wells.
- ◊ Art Larson and Bernie Strong worked long hours installing the wells.
- ◊ Karin Feddersen of Manchester Laboratory coordinated the chemicals analyses.
- ◊ Larry Goldstein and Dale Norton reviewed this report.
- ◊ Joan LeTourneau proofed and formatted this report.

Introduction

Roeder Avenue Landfill is a filled and closed landfill located near the shoreline of Bellingham Bay on Georgia Pacific and Port of Bellingham property in Bellingham. Records of the character or quantity of wastes disposed of at the landfill are unknown, though the landfill served for municipal garbage and demolition waste (Joe Razore, 1994).

The landfill was constructed by building dikes extending from the shoreline, pumping out the water and filling the reclaimed area with dredge material and solid waste (Joe Razore, 1994). After construction of the landfill, Georgia Pacific built a treatment lagoon to the southwest that extended out into the bay. Subsequent fill on two more sides has made the landfill landlocked with no borders on the shore of Bellingham Bay. Due to its location, the potential exists for leachate from the landfill to enter groundwater and migrate into the bay.

In 1992 several monitoring wells were installed on the southeast side of the landfill as part of a groundwater investigation at Bellingham Marine Industries (GeoEngineers 1992). Analytical results from these wells showed some metals and organics present above MTCA cleanup levels. Groundwater flow direction (southeast) indicates these chemicals could have migrated from the landfill northwest of the BMI site towards the southeast.

As part of the Bellingham Bay Action Program, marine sediments in the northeast corner of Bellingham Bay are being investigated to determine cleanup alternatives. As part of the cleanup operation a thorough understanding of on-going potential proximate sources of recontamination is critical to implementing any sediment cleanup action. As Roeder Avenue Landfill no longer lies on the shoreline, the major path of potential contamination is surface runoff or groundwater migration of leachate.

To characterize groundwater quality and determine the potential impact to Bellingham Bay, at the request of Washington Department of Ecology's Northwest Regional Office, the Environmental Investigations Program installed four monitoring wells (Figure 1) on the northwest perimeter of the landfill. Water from these wells was tested quarterly for one year (June 1994 to March 1995) to determine the degree to which environmental contaminants could be moving off-site.

Methods

Well Installation Procedures

Four wells were installed on the Port of Bellingham property on the northwest perimeter of the landfill (Figure 1). The approximate border of the landfill was defined from historical and aerial photos and interviews with the long-time owner Joe Razore, and the wells were sited on the periphery of the landfill. Due to its probable upgradient location from the landfill, MW3 was considered background and MW4 was installed to help delineate possible groundwater and leachate gradients. We installed the wells to characterize groundwater flow and to monitor any contaminants that leave the site. Water levels in existing monitoring wells on the southeast side of the landfill were measured and used to characterize groundwater flow to the south and southeast (GeoEngineers 1992).

The wells were installed using Ecology's 550 Dig-R-Mobile drill equipped with a 6-inch OD hollow-stem auger. Wells were constructed of flush-threaded, 1-1/4 inch, SCH 80 PVC casing with 10-foot, 0.010 slot, PVC screens. Monitoring well logs are included in Appendix A. Screens and casing were precleaned by the manufacturer and they were assembled without glue or solvents. All downhole equipment was pressure-washed with an on-site power washer between well installations to eliminate cross-contamination. Pressure washing water was discharged to the ground. Monterey silica sand was installed in the annular space surrounding the screen at least two feet above the top of well screen. Hydrated bentonite chips were installed in the annular space above the sand pack to provide a continuous seal. A tremmie tube was used to place the sand pack and bentonite chips below the water table. Concrete was placed from a depth of three feet to the surface to secure a six-inch outer protective casing. Wells were developed until the purge water was sediment free.

The relative elevation of the measuring point (top of PVC casing) of each well was determined using a surveying autolevel and rod. The elevations of the monitoring network were linked together with an autolevel the datum set to the mean lower low tide elevation in northern Bellingham Bay.

Soil Samples / Drill Cuttings

Soil samples were collected during the drilling at 2-1/2 foot intervals for the first 10 feet and at 5-foot intervals below 10 feet. Samples were obtained with 1-foot-long, split-spoon samplers. The split-spoon samplers were cleaned between samples using a Liquinox® wash and tap water rinse. Soil samples were described, logged, placed in glass containers, archived for possible future analysis and were not analyzed in this study. Soil cuttings from the auger were placed in 55 gallon drums and later tested for contamination and toxicity with bioassays. Results indicated that contaminant levels were below any concentrations that designate the soil as waste. This material has been properly disposed.

Groundwater Sampling

Samples were collected from MW1, MW2, MW3, and MW4 on four occasions: June, September, and December 1994 and March 1995 (Figure 1). Prior to sampling, static water level measurements were obtained from eight monitoring wells; wells MW1-MW4 and four monitoring wells to the southeast of the landfill were installed for another study. All water levels were measured within one hour with an electronic water level indicator. The meter's probe was rinsed with deionized water after each use. Before sampling, a minimum of three well volumes were purged from wells MW1-MW4 with a centrifugal pump. Purge water was discharged to storm drains or to the ground near each well.

Samples were collected with decontaminated teflon bailers and placed in appropriately cleaned containers. Each sample for dissolved metals were filtered in the field through a new, in-line, 0.45 µm polycarbonate membrane filter and preserved with 1 ml of nitric acid to a pH < 2. Samples collected for volatile organics were filled to the brim, free of headspace and preserved with two drops of 1:1 hydrochloric acid. All samples were stored in coolers with ice. Chain-of-custody procedures were followed in accordance with Manchester Laboratory protocol (Ecology, 1994).

Before sampling, the bailers were cleaned with a Liquinox® wash and sequentially rinsed with hot tap water, 10% nitric acid, distilled/deionized water, and pesticide-analysis grade acetone. After cleaning, the bailers were air-dried and wrapped in aluminum foil.

Quality Assurance Samples

Quality control (QC) samples collected in the field consisted of a blind duplicate and two rinsate blanks. A blind duplicate sample was collected from well MW1 in December 1994. Duplicate samples are two sets of samples collected from a well simultaneously and submitted to the laboratory with different identification. Two rinsate blanks were collected over the year by pouring organic free water through a decontaminated bailer. In addition to quality control samples collected in the field, laboratory quality control samples consisted of matrix spikes, matrix spike duplicates and surrogate compound recoveries.

In general the quality of the data is acceptable for use. All analyses were performed by Manchester Laboratory. The quality assurance review and laboratory reporting sheets are presented in Appendix B.

Duplicate samples collected at MW1 provide an estimate of combined sampling and laboratory precision. The numeric comparison of duplicate results is expressed as the relative percent difference (RPD). RPDs are the ratio of the difference and the mean of the duplicate results expressed as a percentage. The RPDs for the following parameters are chromium (20%), zinc (96%), bis(2ethylhexyl)phthalate (58%), TDS (6%), and TOC (55%). Most matrix spike and spike duplicate recoveries were within acceptable QC limits of ±25% for water sample analysis.

Results and Discussion

Field Observations

Table 1 lists field observation data for each of the wells sampled. Stabilized field measurements for pH, temperature, and specific conductance for the four wells ranged as follows: pH from 6.6 to 7.0 standard units over the year. Temperatures were generally higher in June (14.8 - 16.4 °C) and lower in March (11.8 - 12.9 °C). Specific conductance fluctuated over the year and among wells. Specific conductance ranged from an average of 670 μmhos in MW3 to 4,070 μmhos in MW2. Specific conductance values were higher for those wells closer to Bellingham Bay as compared to well MW3, which is farther inland. Purge water from wells MW1, MW2, and MW4 was varying shades of olive green. We have no explanation for this.

In addition to the sampled wells, water levels were measured in four other wells south of the landfill. These wells were selected to help define the groundwater flow direction. All water levels were measured within one hour of each other. Water levels above mean sea level ranged from a mean of 3.10 (MW4) to 6.56 (MW3) feet (Table 2). Groundwater flow direction is to the southwest, toward Bellingham Bay (Figure 2).

Analytical Results

Tables 1 and 3 summarize all laboratory results. The following analyses were conducted on monitoring well MW1 through MW4. All four wells were tested for most priority pollutants and for selected conventional parameters including volatile organics (VOAs), semivolatile organics (BNA), chlorinated organics (PCB), metals, nitrate/nitrite, total dissolved solids (TDS), and total organic carbon (TOC). The laboratory reporting sheets are presented in Appendix B.

Table 1 reviews metals and conventional results from wells MW1 through MW4. Of the priority pollutant metals tested, chromium is the only contaminant that consistently exceeded the MTCA cleanup level of 50 μg/L. The mean concentrations of chromium were 280 μg/L in MW1 and 68 μg/L in MW4. Of the other priority pollutant metals measured, only copper, zinc, lead, mercury, and nickel were present above detection limits. Copper and zinc were measured in each well at concentrations ranging from 3.7 to 14 μg/L and 8.2 to 33 μg/L, respectively. The chromium value at the background well (MW-3) was undetected at 5 μg/L.

Chromium levels also exceeded MTCA standards in two of the wells to the southeast of the landfill (MW8, MW12) and ranged from 60 to 1,100 μg/L. (GeoEngineers 1992). Thus, the data from the current study and the GeoEngineer study indicate that chromium is probably migrating off-site from both sides of the landfill. With regard to potential toxicity to the bay, one consideration is that all chromium levels found are below the acute salt water criteria for hexavalent chromium (1,100 μg/L) (EPA 1986). It is unlikely all the chromium is in the hexavalent form and there is some evidence that the hexavalent form is reduced to the trivalent form in sea water (Jenkins 1982). The criteria for trivalent is 10x higher (less stringent). The chronic hexavalent criteria is the same as the MTCA level.

Results for select conventional parameters are shown in Table 1. Relative to concentrations in MW3, which we considered background, elevated concentrations of TDS and TOC were detected in wells MW1, MW2, and MW4. The mean concentration of TDS ranged from 432 mg/L (MW3) to 3,240 mg/L (MW2). The high TDS and associated high conductivity in these wells are consistent with the close proximity to saltwater. These elevated values could also be caused by the dissolved material from the landfill. Mean concentrations of TOC ranged from 9 mg/L (MW3) to 96 mg/L (MW1). In June 1994 nitrate/nitrite was detected in MW1 and MW2 at 0.04 and 0.03 mg/L, respectively.

Results for volatile and semivolatile organics are summarized in Table 3. No volatiles or semivolatiles exceeded MTCA standards. Acetone was detected in MW1 in June 1994 at 280 µg/L. We conclude, due to the lack of any repeated high measurements in following samples, that this high concentration is due to acetone used in bailer decontamination procedures. Several organics were detected, but at concentrations near or below the quantification limits. Many of the organics detected in the samples are common laboratory chemicals and were detected in several of the laboratory blanks. In June 1994, PCB 1260 was detected in MW4 at 0.38 µg/L, slightly above the MTCA standard of 0.1 µg/L. In subsequent sampling PCB 1260 was not detected at a quantification limit of 0.031 µg/L. Because of our inability to find PCB 1260 again we conclude the original detection to be erroneous.

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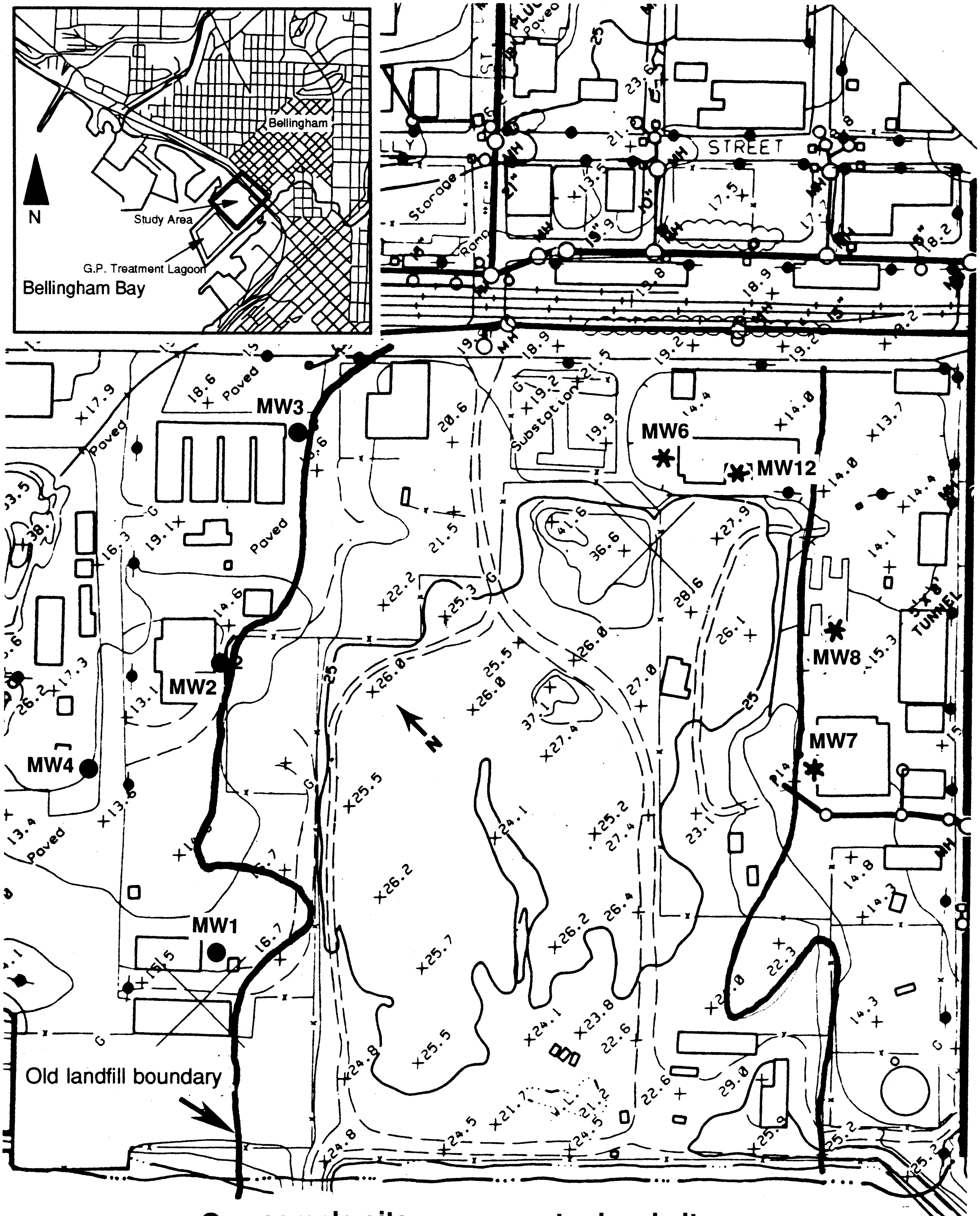
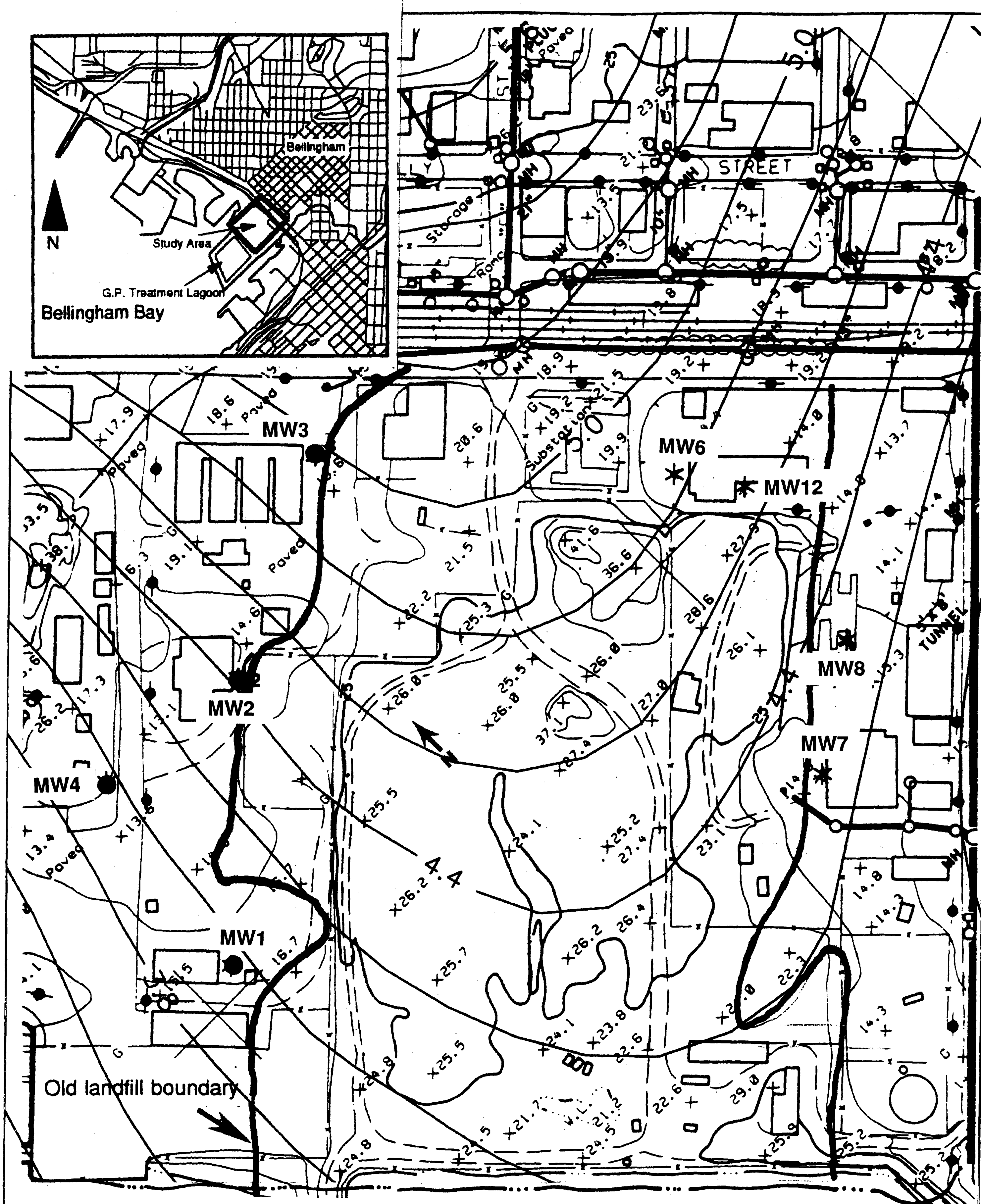


● = sample site ⚹ = water level site

Figure 1. Monitoring well locations.



● = sample site ✳ = water level site

Figure 2. Water level elevation.

Table 1. Metals and conventionals in water found above detection limits in monitoring wells at Roeder Ave. All metals values $\mu g/l$.

Station	MW1				MW2				MW3				MW4				MTCA
Date	6/6/94	9/22/94	12/12/94	3/28/95	6/6/94	9/22/94	12/12/94	3/28/95	6/6/94	9/22/94	12/12/94	3/28/95	6/6/94	9/22/94	12/12/94	3/28/95	Std
Lab No.	238060	388040	508020	138010	238061	388041	508021	138011	238062	388042	508022	138012	238063	388043	508023	138013	
Antimony	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	*
Arsenic	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	5
Berylium	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	*
Cadmium	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	5
Chromium	250	310	230	320	10 P	6.5 P	7.6 P	7.3 P	—	—	—	—	57	68	65	84	50
Copper	4.3 P	5.1 P	3.7 P	5.7 P	6.2 P	5 P	—	—	7.6 P	—	—	—	—	4.4 P	—	14 P	*
Lead	—	—	1.3 P	—	—	—	—	—	1.9 P	—	—	—	—	—	—	—	5
Mercury	—	0.07 P	—	—	—	0.07 P	—	—	—	—	—	—	—	0.05 P	—	—	2
Nickel	—	—	—	—	—	—	—	—	11 P	—	—	—	—	—	—	32 P	*
Selenium	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	*
Silver	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	*
Thallium	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	*
Zinc	9.4 P	33 P	12 P	10 P	20 P	14 P	8.2 P	16 P	27 P	12 P	—	15 P	20 P	20 P	15 P	13 P	*
Temp °C	15	M	13	11.8	16.4	M	13.5	11.8	14.8	M	14	12.9	15.3	M	13.5	12.5	*
Conductivity (μmhos)	3550	3100	3500	3600	6600	5500	1540	2630	850	700	600	520	3950	2680	3800	2700	*
pH (standard units)	6.8	7	7	6.7	7	7	7	7	6.6	7	6.8	6.6	6.9	6.9	6.8	6.7	*
TOC (mg/L)	109	120	62.2	94.6	31.7	35	26.4	27	18.3	11.8	5.2	2.1	40	41.3	39.2	34.8	*
TDS (mg/L)	2720	2933	2600	2550	4130	4212	2100	2520	624	637	321	146	2300	1913	1740	1460	*
NO2/NO3-N (mg/L)	0.043 E	//	//	//	0.027	//	//	//	—	//	//	//	—	//	//	//	*

P = Metal found above detection limit but below quantification limit.
* = No MTCA standard.
— = Not found above detection limits
[box] =exceeds standard
M = Missing data due to equipment malfunction.
E = Estimate
// = Not examined

Table 2. Water levels (ft.) in wells above mean sea level.

	Dept. of Ecology				GeoEngineers			
Station	MW1	MW2	MW3	MW4	MW6	MW7	MW8	MW12
Date								
6/7/94	3.24	3.76	6.23	2.82	4.49	4.58	3.38	4.29
9/21/94	2.74	3.27	5.39	2.43	4.18	4.02	2.87	3.86
2/13/94	3.90	4.50	7.07	3.49	4.98	5.22	3.96	4.67
3/28/95	4.25	4.83	7.56	3.66	4.98	5.22	4.11	4.75
Mean	3.53	4.09	6.56	3.10	4.66	4.76	3.58	4.39

All water levels taken within 1 hour on each day.
To convert datum to top of MW4 well casing subtract 8.235 ft.

Table 3. Organics in water found above detection limits in monitoring wells at Roeder Ave. All values $\mu g/l$.

Station	MW1				MW2				MW3				MW4				MTCA
Date	6/6/94	9/22/94	12/12/94	3/28/95	6/6/94	9/22/94	12/12/94	3/28/95	6/6/94	9/22/94	12/12/94	3/28/95	6/6/94	9/22/94	12/12/94	3/28/95	Std
Lab No.	238060	388040	508020	138010	238061	388041	508021	138011	238062	388042	508022	138012	238063	388043	508023	138013	
Volatiles																	
Acetone	280	—	—	—	1.8 J	—	—	—	—	—	—	—	1.8 J	—	—	—	*
Benzene	0.19 J	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	5
Chloroform	—	0.49 J	—	0.42 J	0.13 J	—	—	—	—	—	—	—	—	—	—	—	*
Carbon disulfide	—	—	—	—	1.4	—	—	—	—	—	—	—	—	—	—	—	*
p-Isopropyltoluene	—	—	—	—	1.9	—	—	—	—	—	—	—	—	—	—	—	*
Dichloroethane	—	—	—	—	—	—	—	—	—	—	—	—	0.12 J	—	—	—	5
Dichlorofluoromethane	—	—	—	—	—	—	—	—	—	—	3.4 J	—	—	—	—	—	*
Semivolatiles																	
Benzoic acid	1.8 J	//	—	//	1.7 J	//	—	//	—	//	—	//	—	//	—	//	*
Phenanthrene	0.3	//	—	//	—	//	—	//	—	//	—	//	—	//	—	//	*
4-Methylphenol	0.38	//	—	//	0.15 J	//	—	//	—	//	0.072 J	//	—	//	—	//	*
Pyrene	0.32	//	—	//	—	//	—	//	—	//	—	//	0.094 J	//	—	//	*
Fluoranthene	0.24 J	//	—	//	—	//	—	//	—	//	—	//	0.059 J	//	—	//	*
Di-n-butylphthalate	—	//	—	//	0.25 J	//	—	//	—	//	—	//	—	//	—	//	*
Retene	—	//	—	//	—	//	—	//	0.1 J	//	0.092 J	//	—	//	—	//	*
Bis(2ethylhexyl)phthalate	—	//	0.53	//	—	//	4.2	//	—	//	0.5	//	—	//	0.19 J	//	*
3B-Coprostanol	—	//	0.82 J	//	—	//	—	//	—	//	—	//	—	//	—	//	*
Diethylphthalate	—	//	0.19 J	//	—	//	0.15 J	//	—	//	—	//	—	//	0.16 J	//	*
butylbenzylphthalate	—	//	—	//	—	//	—	//	—	//	—	//	—	//	0.061 J	//	*
Chlorinated organics																	
PCB 1260	—	//	—	//	—	//	—	//	—	//	—	//	0.38	//	—	—[2]	0.1

J = Value is an estimate.

-- = Not found above quantification limits.

// = Not analyzed.

Outline=above standard

* = No MTCA standard.

[2]Additional sample with low levels of detection found no PCBs