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INVESTIGATION OF GROUNDWATER IMPACTS AT CONSTRUCTION AND DEMOLITION WASTE LANDFILLS

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INVESTIGATION OF GROUNDWATER IMPACTS AT CONSTRUCTION AND DEMOLITION WASTE LANDFILLS

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Abstract

The purpose of this study was to determine if unlined construction and demolition waste landfills are impacting groundwater quality and if impacts were found, to evaluate the degree of contamination. The results are intended to help determine the most appropriate regulations needed for these disposal sites.

Two large Wisconsin construction and demolition landfills were selected for the study based on their hydrogeologic environment, relatively long site histories and site accessibility. Five groundwater monitoring wells were installed at each site, and sampled for two years. The samples were tested and analyzed for a number of parameters, including 49 volatile organic compounds. Existing data from a number of other small construction and demolition landfills in Wisconsin was also evaluated.

The results of the study indicate groundwater impacts at both sites. The Wisconsin Public Health- and Welfare Standards for groundwater were frequently exceeded for sulfate, chloride, and manganese. Hardness, and a few other parameters were elevated.

Introduction

Across the country, municipal solid waste (MSW) landfills have become increasingly expensive as an option for waste disposal. As costs rise, concern has grown about using valuable landfill space for materials that are presumed to have a lower potential for contaminating groundwater. One option is to create landfills with different designs for different types of waste. Consequently, landfills accepting construction and demolition (C/D) waste would have less stringent design and regulations. However, there has been very limited study on the potential environmental impacts from these landfills. The purpose of this study is to address the potential for groundwater impacts at C/D waste landfills.

Disposal of C/D waste and its potential impact to groundwater quality has been of concern in Wisconsin because many areas of the State depend on groundwater for potable water supplies. New regulations have allowed for the establishment of small C/D waste landfills that have much less stringent environmental controls than are required for MSW landfills. Wisconsin regulations specific to small C/D waste landfills became effective in 1988. Small C/D waste sites are currently permitted for a capacity of up to 50,000 cubic yards and are not required to meet a number of the criteria for MSW or industrial waste landfills. Although some locational criteria apply and groundwater monitoring is required, a liner and other environmental controls are not required.

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Connelly et al.,(1991) reported that many states specifically regulate C/D waste and require locational criteria and groundwater monitoring Often the requirements are similar to those for MSW landfills.

This paper discusses C/D waste characterization and generation, as well as some of the past research done on C/D landfills. It also reports and discusses the results from a two year study conducted by the Wisconsin Department of Natural Resources (WDNR) on two C/D landfills. Finally, we make a number of recommendations.

Waste Characterization and Generation

The Wisconsin state statutes (Administrative Code NR 500.03(31)) define demolition waste as "The solid waste resulting from the construction, demolition or razing of buildings, roads and other structures. Demolition and construction material typically consists of concrete, bricks, bituminous concrete, wood, glass, masonry, roofing, siding and plaster, alone or in combinations. It does not include asbestos, waste paints, solvents, sealers, adhesives, or similar materials." A survey of other states revealed that definitions in other states tend to be similar (Connelly, et al., 1991).

The actual make-up of C/D waste can vary greatly in different parts of the country and over time, due to the economy. According to studies of C/D waste streams in various communities in New York (O'Leary and Walsh, 1992) and around Houston, Texas (Norstrom, et al., 1991), the majority of the materials are composed of broken concrete, bricks, stones, asphalt, wood and brush. Other components that make up a smaller portion of the waste stream are metals, roofing, plaster materials, and paper. Concrete, asphalt, bricks, and rocks were estimated to constitute 50% (by weight) and wood 25% of the C/D waste in the New York communities.

The Franklin Associates, Ltd. (1992) estimated C/D debris generation in Wisconsin to be 1,054,000 tons per year (tpy) in 1990. Of this, 527,000 tpy are concrete and asphalt (50%), 263,500 tpy is wood (25%), and 263,500 tpy is other material (25%). 75% of the C/D debris is landfilled and the remaining 25% is recycled. C/D debris is classified as non-municipal waste and comprises 17 % of the estimated 6,312,450 tpy generated. Municipal solid waste generation in Wisconsin is estimated to be 3,352,460 tpy.

Historic Information

• *Contamination Potential*
Various studies of C/D waste suggest that it may not be as inert as previously thought, but no extensive research has been conducted to determine the actual groundwater contamination resulting from C/D landfills. Norstrom, et al., (1991) examined the properties of leachate at three C/D landfills in the Houston area. They found that levels of contaminants were within the lower half of the range of contaminant levels for MSW leachate. A Seattle facility that was supposed to accept only C/D waste has become a Superfund site requiring a $30 million cleanup (Apotheker, 1990).

Other studies have concentrated on the make-up of C/D waste and its potential contaminants. A study of nine C/D sites in New York was summarized by the New York State Department of Environmental Conservation (1991). Most of the landfills studied had received solid and industrial wastes that were not legitimate C/D wastes such as petroleum contaminated soils, domestic refuse, PCBs and pesticides in varying amounts. A study by the Massachusetts Department of Environmental Protection (Lambert and Domizio, 1992) included information from the hazardous and solid waste programs of

Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, Rhode Island, and Vermont. These regulators found hazardous materials contained within C/D waste. Table 1 lists some of the hazardous components of C/D waste and their sources. In addition, acrylic, arsenic, chromium, varnishes, and stains have been found.

Table 1.
Contaminants found in C/D waste

Contaminant	Sources
Asbestos	Shingles, Siding, Fireproof insulation, Roofing Flooring
Chromated copper arsenate (CCA)	Pressure-treated lumber
Creosote	Railroad ties, Telephone poles, Marine pilings
Formaldehyde	Plywood, Particleboard
Ignitable petroleum distillates	Wood from garages, barns or other out-buildings
Pentachlorphenol	Veneers, Laminated wood, Freshwater pilings, Telephone poles
Lead	Wood with lead-based paint
Mercury	Wood with mercury-based paint
Napthalene	Laminated wood
Paint (acrylic or water-based)	Cabinets, Interior or exterior trims
Phenol-Formaldehyde	Plywood, Particleboard
Urea	Plywood, Particleboard
Varnishes/Stain	Cabinets, Book shelves, Desk tops, Trim, etc.

Sources: Spencer, 1991; Lambert and Domizio, 1992.

In some cases contaminants may be released more readily through certain types of handling. For example, burning or chipping of painted or chemically treated wood can release heavy metals. Gypsum in drywall and sheetrock contains sulfate which can contaminate groundwater, and since it can decompose anaerobically it can produce a foul odor. Spencer (1989) states that some residents in Catskill, NY, suffered the odor of hydrogen sulfide (H_2S) for almost a year after an illegal C/D landfill became anaerobic. Spencer also states that another community in NY was inundated for a week with smoke and fumes, resulting in the evacuation of homes, after an illegal C/D dump caught fire. At least one C/D landfill in Wisconsin has had problems with fires throughout its life.

• *Illegal Dumping*
In addition to the problem of potential contamination, states are wrestling with the problem of illegal dumping. In the northeastern states, illegal dumping has been a particular problem and some states have enacted legislation allowing stiffer penalties for violators. This illegal dumping often occurs in a fragile environment such as wetlands or in remote locations where it can take place unseen (Lambert and Domizio, 1992). Closure of landfills, the inability of solid waste incinerators to incinerate C/D material and the cost of legal disposal options have been suggested as reasons for the increase in illegal dumping (Spencer, 1989).

• *Recycling*
One option for the C/D waste stream is to recycle suitable material. Some states are developing extensive recycling facilities for C/D debris. One facility in Florida is able to recycle about 50 percent of the C/D wastes it accepts (Woods, 1992).

The amount of C/D waste generated in an area can be a problem for the efficiency of recycling markets. In the Northeast, huge volumes of C/D waste have caused a glut in the market (Woods, 1992). Wisconsin, with a much lower population density, is less likely to be able to support any type of large-scale recycling facility. Instead, regulations allowing small C/D landfills were created to allow for some disposal of C/D debris under less stringent standards than those for MSW landfills. These less stringent standards were based on the assumption that C/D waste was much less of an environmental threat than MSW. However, the fast development in recycling is making it a more favorable option. The literature (Lambert and Domizio, 1992; Spencer, 1991; Kalin, 1991) has stated that a large fraction of processed C/D materials has potential reuse opportunities.

Groundwater Investigation at Two Large Wisconsin C/D Waste Landfills

In order to supplement existing information, groundwater monitoring wells were installed at two relatively large C/D landfills that had been operating for at least ten years. Groundwater samples were taken quarterly for a period of two years at both sites. The samples were analyzed and tested for a variety of selected parameters that would best indicate possible contamination.

Janesville C/D Waste Landfill

The City of Janesville construction and demolition landfill, is located within the city limits of Janesville, Rock County, just east of the Rock River (Figure 1). This landfill began to accept C/D waste in 1981 and was in operation until its closure in 1992. The estimated size of this site is 6.4 acres and contains more than 500,000 cubic yards of waste. The site was open to residents of Janesville and Rock County. Concrete, broken pavement, untreated/unpainted wood and brush were identified as acceptable materials. An attendant inspected all loads coming into the landfill. After the site was closed a two foot cap, consisting of compacted clay, was placed on the site.

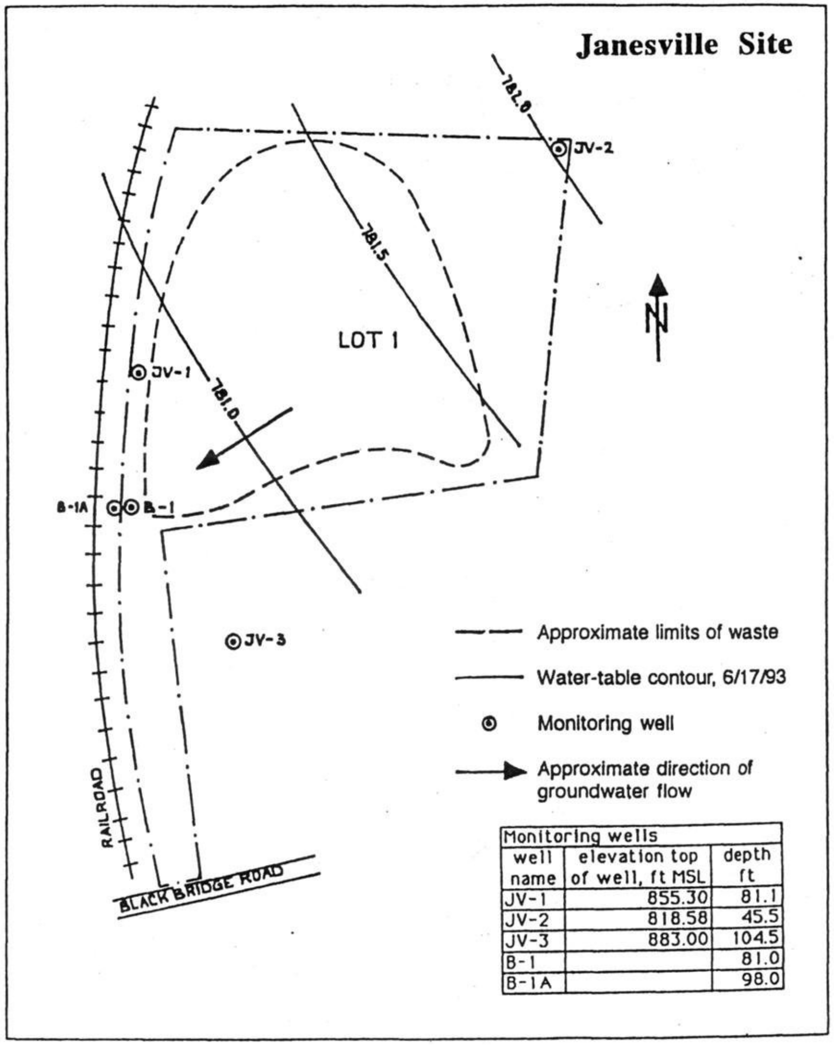
Terra C/D Waste Landfill

The Terra construction and demolition landfill is located in Dane County (Figure 1). The site was licensed in 1971 for C/D waste only and one owner has operated the site since 1972. Since that time the site has only been filled with waste materials from the company's C/D projects. Its size is approximately 4 acres. The waste stream is known to consist of mainly reinforced and unreinforced concrete, wood, masonry, brick, asphalt pavement, glass, steel and metal pieces, and brush.

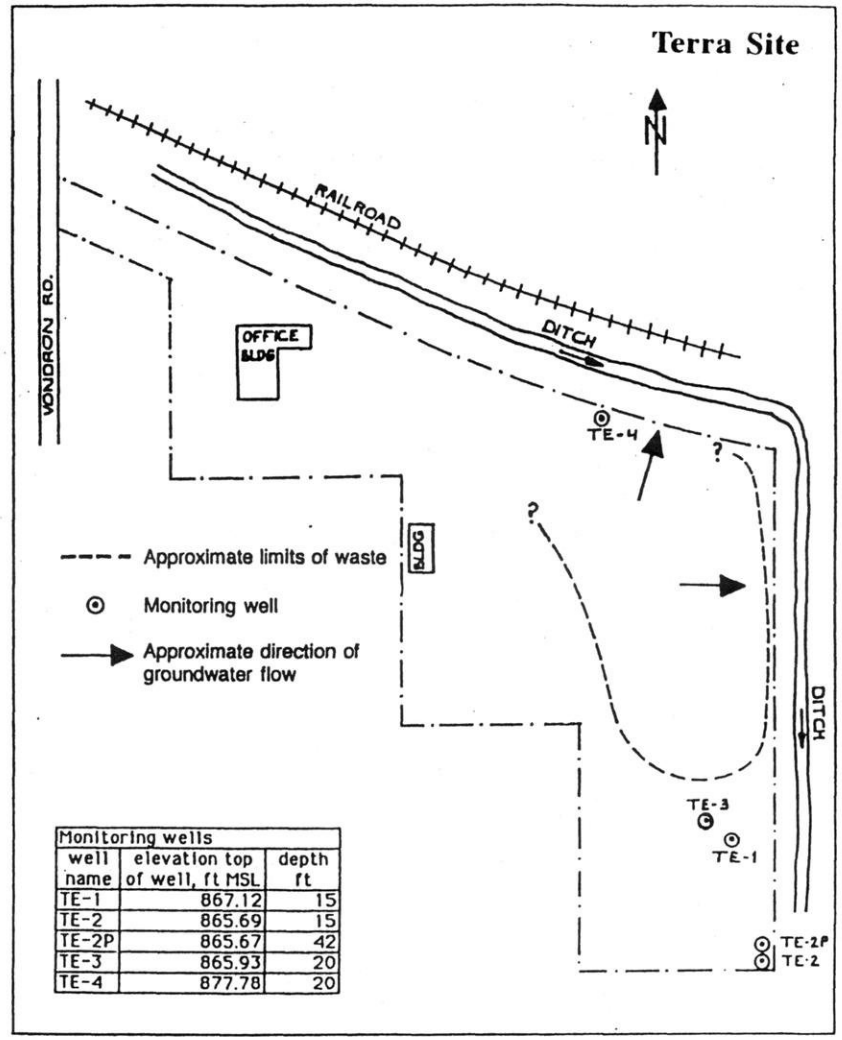
The landfill is in a drained marshy area bounded on two sides by drainage ditches. Surface water is routed around the fill on the southern end of the site. The land slopes slightly towards the southeast and just southwest of the site is a topographic high.

Monitoring Well Installation

Hollow stem augers were used to install five monitoring wells at each site, one upgradient and three downgradient water table wells, plus one piezometer (screened below the water table) nested with one of the downgradient wells. Split spoon samples were taken at 5 foot intervals. The wells were constructed in accordance with NR 141 Wisconsin Administrative Code, "Groundwater Monitoring Well Requirements". WDNR hydrogeologists supervised all work.



Monitoring wells		
well name	elevation top of well, ft MSL	depth ft
JV-1	855.30	81.1
JV-2	818.58	45.5
JV-3	883.00	104.5
B-1		81.0
B-1A		98.0



Monitoring wells		
well name	elevation top of well, ft MSL	depth ft
TE-1	867.12	15
TE-2	865.69	15
TE-2P	865.67	42
TE-3	865.93	20
TE-4	877.78	20

Figure 1.
Site maps for Janesville and Terra C/D landfills

Groundwater Sampling

From October 1991 to June 1993 eight sampling rounds were conducted at both sites. All samples were analyzed for inorganic and indicator parameters. Samples were analyzed for volatile organic compounds (VOCs) four times at Janesville and three times at Terra. All sampling was performed in accordance with the WDNR Groundwater Sampling Procedures Guidelines (Lindorff, et al., 1978). Field blank and duplicate sampling were done for all VOC sampling events and for some sampling rounds for inorganics.

Results

Janesville Site

Geology

The landfill is located in the drainage basin of the Rock River which flows south through the center of Rock County. The fill area lies in a large sand and gravel quarry which is still partly active. The unconsolidated deposits which underlay and surround the site are of Quaternary age and of glacial origin. The bedrock underlying these deposits is a sandstone which makes up the principal aquifer in this area and provides residents with potable water.

Groundwater Flow Characteristics

A water table map of the Janesville site indicates that the flow is generally from the northeast to the southwest with a strong westward component due to influence of the Rock River, which is about 1200 feet west of the site. Water table contour lines are shown in Figure 1. The depth to groundwater in the wells varies from 37 to 75 feet. The large fraction of sand and gravel in the area suggests that groundwater could be moving fairly rapidly.

Groundwater Sampling Results

All five wells at the Janesville site were sampled for volatile organic compounds (VOCs) on four occasions. None of the 49 VOCs listed on the WDNR Form 4800-5 (attached), were detected, except for two compounds in B-1 during the last sampling event. It was confirmed that this contamination was due to repair of the well.

Phenolics, a common constituent of tree and vegetative decay products, were detected once in one of the downgradient wells, slightly above laboratory reporting limits. Phenolic compounds were analyzed during first four sampling rounds. All of the raw data for this study is included as an appendix.

Arsenic (4 rounds), lead (4 rounds), and mercury (2 rounds) were not detected. Chromium, copper, and iron which were analyzed during all sampling rounds, were detected occasionally in trace quantities. Zinc was detected in quantities up to 200 mg/L, and quantities are higher in the down and sidegradient wells than the upgradient well. There seemed to be a downward trend over time in wells JV-1 and JV-3, but the concentration was fluctuating.

A number of parameters including sulfate, chloride, manganese, calcium, magnesium, and conductivity were elevated in wells JV-1 and B-1 both of which are downgradient from the fill area.

Sulfate exceeded Wisconsin enforcement standard (ES) of 250 mg/L in both JV-1 and B-1. Levels ranged from 700 to 1900 mg/L in JV-1, and from 510 to 1100 mg/L in well B-1 (Figure 2). Sulfate concentration is trending downward in well JV-1 and upward in B-1. Other wells have had very low and constant sulfate levels.

Chloride has increased at about the same rate in wells JV-1 and B-1 (Figure 2) through out the study period. Concentrations in JV-1 are above the ES, ranging from 340 to 430 mg/L. Chloride has climbed above the Wisconsin preventive action limit (PAL) in well B-1. The range in B-1 is from 83 to 180 mg/L. Again, other wells have had low but constant concentrations of chloride.

The manganese levels were above the ES (50 ug/L) in JV-1 for the first five sampling events, but below thereafter. The range in JV-1 was from <40 to 710 ug/L. Well B-1 had two results above the ES, but concentrations were relatively low in other sampling events. The manganese concentration was below 40 mg/L during the entire study period in all other wells (Figure 2).

The pH was not significantly different at any of the wells at Janesville, generally a little above pH 7. Most samples were slightly basic. The water is very hard because of the elevated calcium and magnesium ion concentrations, especially in JV-1 where it reaches 2500 mg/L.

Discussion of Janesville Results

Surprisingly, iron, which is a very common component of C/D waste, and can be quite soluble in an aqueous system, was not detected in elevated levels at any of the Janesville wells. The pH of the groundwater was generally above 7, therefore, not very favorable for dissolving iron or other metals. The groundwater generally possessed a high alkalinity and, therefore had a high buffering capacity against acidity.

The high sulfate levels in JV-1 and B-1 might be impacts from the landfill's waste. Sulfate is a common constituent of C/D waste, in gypsum wallboard for example, and can be quite soluble, and when gypsum is dissolved it becomes ions of calcium and sulfate. Sulfate in leachate can be reduced to sulfide which has a high tendency to precipitate many metals (Hem, 1992). If the sulfate decomposes under anaerobic conditions it can produce a hydrogen sulfide gas. Sulfate levels were clearly decreasing during the entire study period in JV-1 while constantly increasing in B-1. Hydrogen sulfide odor was apparent in B-1 in the last sampling event.

Manganese was elevated in JV-1 during the first half of the study, but steadily decreased thereafter. Manganese may be present in soil, but not in soluble forms. However, wood wastes and paints can contain this element which is an essential factor for plants and animals (Hem, 1992).

Hardness in well JV-1 and B-1 is elevated above background and suggests that they are being impacted by the landfill.

Terra Site

Geology

The subsurface geology of the site has been defined as undifferentiated glacial deposits mainly consisting of ground moraine. This material typically contains poorly sorted deposits of clay, silt, sand, gravel, and boulders. This composition was confirmed by

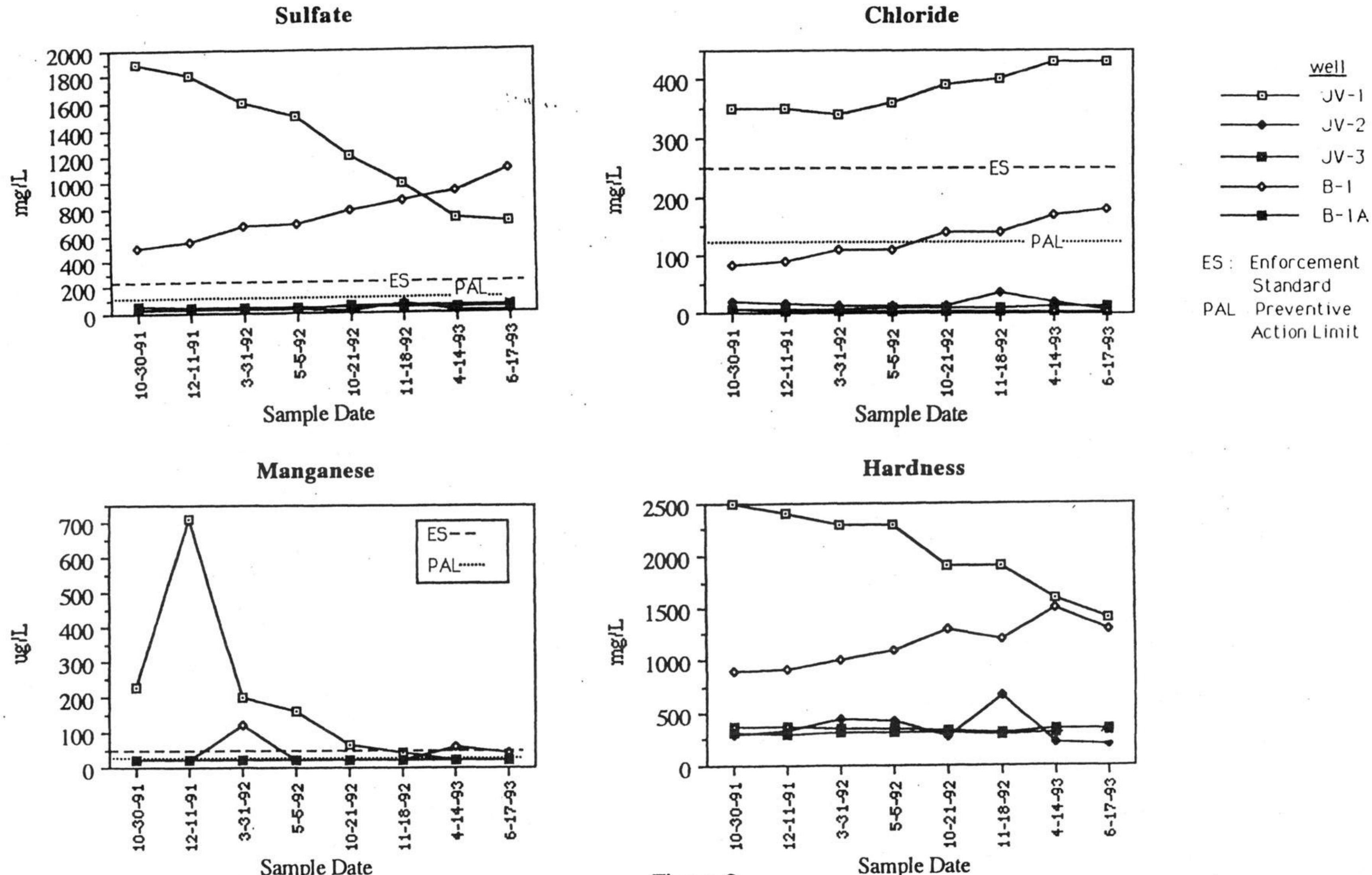


Figure 2.
Sulfate, chloride, manganese, and hardness in groundwater at Janesville Site

borings on the site during the installation of the monitoring wells. The unconsolidated material below the surface included layers of sand, silt and clay with some sand seams and sand and gravel lenses. Underlying the 100 foot thick deposits is a sandstone which acts as a principal aquifer for Dane County residents.

Groundwater Flow Characteristics

Well placement was determined partly by the regional groundwater flow direction and topography, but primarily by site configuration. Waste extends to the ditch in the north and east direction and heavy equipment traffic prohibits well placement to the west. As a consequence groundwater flow direction is difficult to determine from water table elevations measured in the wells. Groundwater flow appears to be affected by the adjacent drainage ditch and likely flows in an east and north direction towards the ditch. This interpretation is based partly on sampling results. Measured depth to groundwater at the site is from 2.5 to 10 feet.

Groundwater Sampling Results

Samples were collected from the five wells at the Terra site on three different occasions, and analyzed for VOCs. None of the 49 VOCs listed on WDNR Form 4800-5 were detected.

Arsenic, mercury, and phenolics were analyzed two to four times, but no detectable quantities were reported. Lead was detected only once at the site in well TE-4, at the laboratory reporting limit (3 ug/L).

Chromium and copper were detected occasionally at very low levels in most wells. Copper was most frequently detected in TE-4 at a maximum value of 10 ug/L; however, chromium was never detected in this well.

Zinc was commonly detected in all wells, with the highest range of 19 to 132 ug/L in well TE-1. This is far below the Preventive Action Limit (PAL) of 2500 ug/L and the Enforcement Standard (ES) of 5000 ug/L. Concentrations of zinc appear to be dropping in all wells.

Sulfate was elevated in two wells, TE-4 and TE-2, with much higher concentrations in TE-4 (Figure 3). In TE-4 the concentrations fluctuated between 490 and 600 mg/L until the two last sampling events when it dropped just below the ES, which is 250 mg/L. The concentrations in TE-2 fluctuated around the ES until the last sampling event when it jumped up to 420 mg/L. In the other three wells the concentrations were low and very constant at around 40 or 50 mg/L.

Chloride was elevated in only one well, TE-4 (Figure 3). Concentrations in this well ranged from 170 to 380 mg/L. In the other wells the concentrations were low and constant.

Manganese was commonly detected far above the ES (50 ug/L) in all wells, except TE-3, with a maximum value of 1400 ug/L in well TE-4. The trend was downward in TE-4, TE-1, and TE-2P, but the concentration in TE-2 is very constant except for the first value which is suspiciously low compared to later values. The trends are illustrated in Figure 3.

pH was not significantly different for the wells, always above 7 and ranging as high as 8.2.

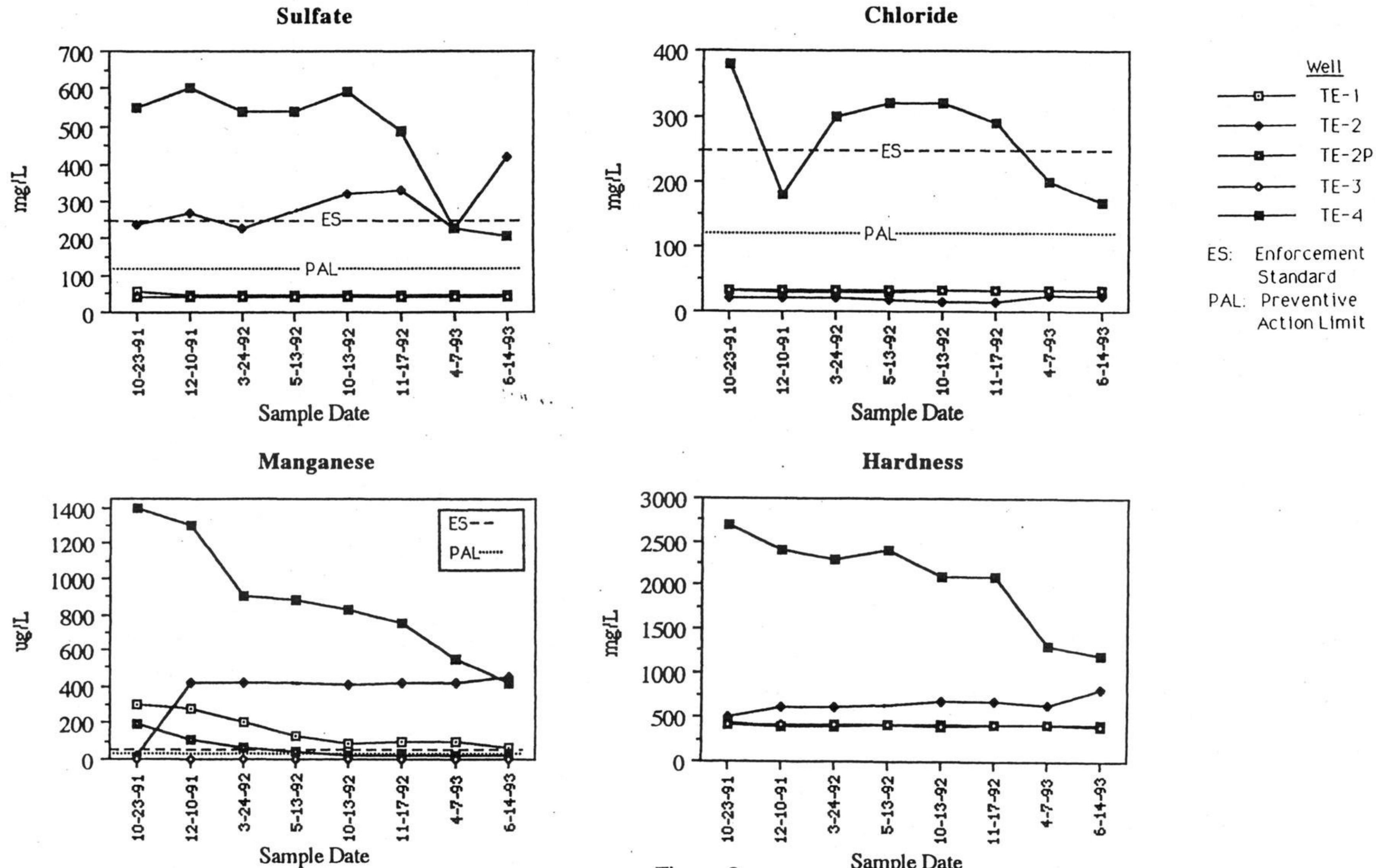


Figure 3.
Sulfate, chloride, manganese, and hardness in groundwater at Terra Site

Discussion of Terra Results

Groundwater in Dane County has naturally high concentrations of calcium and magnesium, with an average hardness of 326 mg/L as $CaCO_3$. Bicarbonate is also naturally elevated in the groundwater with typical concentrations slightly above 300 mg/L (Cline, 1965).

Monitoring well TE-4, which was unintentionally located within or on the boundary of the fill, is significantly impacted. This well has elevated levels of sulfate, chloride, and manganese. Hardness is also very high, from 1200 to 2700 mg/L though the trend is clearly downward through the study. The same can be said for total dissolved solids which has ranged from 1420 to 3340 mg/L, field conductivity which ranged from 1280 to 3250 umhos/cm, and alkalinity which ranged from 810 to 1840 mg/L.

Other wells, which according to water level measurements and chemical analyzes are sidegradient of the landfill, were not apparently contaminated, except TE-2 which had sulfate levels around the ES (250 mg/L), and manganese levels well above the ES (50 ug/L). This is not readily explained, since other wells closer to the landfill are uncontaminated.

General Discussion

The results indicate certain elevated parameters at both landfills, including sulfate, chloride, and manganese. It is, therefore, of interest to attempt to identify the source for these contaminants. As stated earlier, concrete, asphalt and timber make up a major portion of C/D waste. The question is then, to what extent do these materials contribute to groundwater contamination.

Concrete is a mixture of approximately (by volume) 70% aggregate, 20% cement, and 10% water. The aggregate generally consist of natural rock ranging in size from fine sand to large pebbles or can consist of crushed, recycled concrete. The cement is commonly Portland cement which consists mainly of the following, approximate (by weight): 65% lime (CaO), 22% silica (SiO_2), 5% alumina (Al_2O_3), 5% iron (Fe_2O_3), 2.5% sulfur trioxide (SO_3), and, 1% magnesia (MgO). The sulfur trioxide comes mostly from gypsum ($CaSO_4 \cdot 2H_2O$) which is added in the manufacturing process. Sometimes other chemicals are added to concrete to change its physical properties. For example, calcium chloride ($CaCl_2$) is commonly added to accelerate the rate of hardening, however its use has lately been discouraged because of its potential to corrode reinforcement bars (Illston, et al., 1979).

When concrete is crushed in a demolition process, some very fine grain materials are generated. This fine concrete powder is not as inert as an intact concrete block. Percolating surface water seeps between the grains and the chemical imbalance stimulates dissolution of the solid. Concrete is highly alkaline and has pH levels commonly around 12.5. The concrete in the C/D waste consists of both relatively inert blocks and fine soluble material which may significantly contribute to certain groundwater contamination.

Some of the concrete disposed of at C/D landfills may come from road pavements, sidewalks or road bridges. In northern latitudes the concrete is commonly exposed to intense salting, which can adsorb to surfaces. In the landfill, the salt can then dissolve and contribute to chloride and sodium contamination in groundwater.

Wood is often a large fraction of C/D waste. Its chemical composition is commonly as follows: cellulose (40-50 % by weight), hemicelluloses (20-25 %), lignin (25-30 %), and extractives (0-10 %). The cellulose and the hemicelluloses are carbohydrates while the lignin is a complex aromatic compound composed of phenyl groups. The extractives, which are complex organic compounds, are often a small fraction depending on the type of wood and can consist of waxes, fats, sugars, or resin from which turpentine is distilled (Illston, et al., 1979).

Wood can decompose relatively rapidly under certain conditions, especially where water is present. In a C/D landfill wood can contribute to organic acids formation and high oxygen demand (BOD). Furthermore, a decomposed wood can give off the elements that trees take up as nutrients, including manganese which was mentioned earlier. The decomposition process also gives off heat, and at the Janesville site the mean temperature in the downgradient well JV-1 was 17.5 centigrade while it was 12.7 in the upgradient well. Some chemicals used to protect wood against fungi and insecticides, may have contained arsenic, pentachlorphenol, and creosote (mix of phenol compounds).

Many other materials, may end up as part of the C/D waste stream. Such as, various insulation materials, shingles, pipes, glue/foam/paint/solvent/lubricant/cleaner containers, and MSW from construction workers. These materials may contribute to various contaminants in the leachate.

Evaluation of Small C/D Landfills

Wisconsin has currently about twenty approved small C/D landfills, each with a waste limit of 50,000 cubic yards. Our evaluation of the data for ten relatively young sites did not reveal any significant groundwater impacts. Eight of these ten landfills have three groundwater monitoring wells, one has two wells, and one has four wells. The amount of available data from these landfills varies (1-5 years). About half of the sites have tested for VOCs, but no detects were found. A few wells were found to have slightly elevated inorganic parameters.

Conclusion

The monitoring results from the two large construction and demolition landfills studied indicate some adverse groundwater quality impacts resulting from C/D waste disposal. The Janesville site had two wells with significantly higher chemical concentrations than background levels. The same can be said for one of the wells at the Terra site. At both of these sites sulfate, chloride, and manganese commonly exceeded groundwater standards. A number of other parameters were elevated including hardness, alkalinity, total dissolved solids, and conductivity.

Groundwater was not found to be contaminated by VOCs or with any heavy metal compound analyzed. This seems to indicate that the two landfills studied historically received only C/D waste.

Recommendations

- *Encourage recycling of C/D waste*
- *Train and educate operators and facility personnel*
- *Minimize infiltration of precipitation and surface water on/after the operation lifetime*

• *Continue monitoring and data evaluation at existing C/D landfills. Of special interest is to see if the groundwater quality will improve at the Janesville site after the cap was placed on the landfill*

• *Encourage further studies on this issue*

• *Use the results of this study and monitoring results from small demolition landfills approved since 1988 to determine what modifications are needed, if any, to current code requirements for small C/D landfills*

• *Limit the size of small C/D landfills to minimize the possibility of groundwater contamination unless they are lined and collect leachate*

References

Apotheker, S. 1990. Construction and demolition debris-the invisible waste stream. Resources Recycling, December, p.67.

Cline, D. R. 1965. Geology and Ground-Water resources of Dane County, Wisconsin Geological Survey Water Supply Paper 1779-U. United States Government Printing Office, Washington, pp 1-64.

Connelly, J.P., Pugh, L., & Mitchell, G. 1991. Demolition Landfills-How Much Regulation is Needed? Proceedings of The 1991 National Solid Waste Forum on Integrated Municipal Waste Management, July 15-17, pp. 257-267.

Franklin Associates, Ldt. 1992. Wisconsin Waste Generation and Composition Study, Waste Management Study. September.

Hem, J.D. 1992. Study and Interpretation of the Chemical Characteristics of Natural Water. U.S. Geological Survey Water Supply Paper 2254.

Illston, J.M., Dinwoodie, J.M., & Smith, A.A. 1979. Concrete Timber and Metals. Spottiswoode Ballantine Ltd., Great Britain, London.

Kalin, Z. 1991. Canada Targets C&D Debris. BioCycle, January, pp. 35-36.

Lambert, G., and Domizio, L. 1992. Construction and Demolition Waste Disposal: Management Problems and Alternative Solutions. Prepared for Northeast Waste Management Officials' Association.

Lindorff, D.E., Feld, J., and Connelly, J.P. 1987. Groundwater Sampling Procedures and Guidelines. Wisconsin Department of Natural Resources Publication WR-153-87, pp. 1-91.

New York State Department of Environmental Conservation. 1991. Executive Summary from the preliminary site assessments at nine construction and demolition landfills in New York . Conducted by Dunn Geoscience Engineering Company.

Norstrom, J., Williams, C.E., and Pabor, P.A. 1991. Properties of Leachate from Construction/Demolition Waste Landfills. Presented at the 14th Annual Waste Conference September 25-26, 1991. Department of Engineering Professional Development, University of Wisconsin-Madison.

O'Leary, P., and Walsh, P. 1992. Disposal of Hazardous and Special Wastes. Waste Age. February, pp. 81-88.

Spencer, R. 1989. Recycling Opportunities for Demolition Debris. BioCycle, November, pp. 42-44.

Spencer, R. 1991. Taking Control of C&D Debris. BioCycle, July, pp. 65-68.

Woods, R. 1992. C&D Debris: A Crisis is Building. Waste Age, January, pp. 26-36.

Appendixes are on 7 following pages
(monitoring data and WDNR Form 4800-5)

PARAMETER	JV-1 downgradient								JV-2 upgradient							
	10/30/91	12/11/91	3/31/92	5/5/92	10/21/92	11/18/92	4/14/93	6/17/93	10/30/91	12/11/91	3/31/92	5/5/92	10/21/92	11/18/92	4/14/93	6/17/93
Temp.-Field (Deg-C)	18	16	18	18	18	14	15	23	10	16	12.7			11.2	7.1	20
pH-Lab (su)	7.9	7.7	7.8	7.1	7.55	7.37	7.26	7.54	8.0	7.6	8.2	7.4	7.94	7.42	7.86	7.84
Lead-Diss. (ug/L)	<3	<3	<3	<3					<3	<3	<3	<3				
Chromium-Diss. (ug/L)	<3	<3	<3	<3	<3	<3	1	<1	<3	<3	<3	<3	<3	<3	<1	<1
Copper-Diss. (ug/L)	5	<3	6	<20	7	<20	<20	2.6	<3	<3	<3	<20	4	<20	<20	3.7
Chloride-Diss. (mg/L)	350	350	340	360	390	400	430	430	19	16	13	12	14	37	20	6
Mangan.-Diss(ug/L)	230	710	200	160	69	46	<40	<40	<40	<40	<40	<40	<40	<40	<40	<40
COD-Diss. (mg/L)	63	52	40	53		80	79	26	<5	<5	<5	6		33	36	71
Calcium-Diss. (mg/L)	490	490	470	460	380	380	310	280	55	68	99	99	55	140	50	50
Magnes.-Diss.(mg/L)	300	280	280	270	230	220	190	170	36	38	48	46	33	71	22	21
Sulfate-Diss. (mg/L)	1900	1800	1600	1500	1200	990	730	700	24	23	27	24	21	79	18	13
Arsenic-Diss. (ug/L)	<10	<10	<10	<10					<10	<10	<10	<10				
Barium-Diss. (ug/L)	220	180	140	290	180	91	77	99	300	210	460	64	160	170	52	63
Iron-Diss. (mg/L)	<0.05	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05	<0.05	0.07	<0.05	<0.05	<0.05	<0.05	<0.05
Sodium-Diss. (mg/L)				180			94					4.8			8.5	
Zinc-Diss. (ug/L)				200	170	30	53	43				<10	66	96	13	<10
Mercury-Diss. (ug/L)	<0.03	<0.03							<0.03	<0.03						
Hardness-Diss. (mg/L)	2500	2400	2300	2300	1900	1900	1600	1400	290	330	450	430	270	660	220	210
Phenolics-Diss. (ug/L)	<5	<5	<5	<5					<5	<5	<5	<5				
Alkalinity-Diss. (mg/L)	347	462	470	469	458	455	432	422	247	278	383	387	232	556	176	191
TDS (mg/L)	3770	3780	3534	3360	2660	2710	2120	2140	338	342	464	440	<10	746	258	232
Cond.field(UMHOS/cm)	2650	3420	3500	3400		2800	2460	2800	400	600	670			960	245	330
Cond.lab(@25 deg C)			3960	3830	3480	3440	3000	2920			767	767	516	1190	426	391
Depth to Groundw. (ft.)	76.8	75.3	76.4	76.2		76.3		74.43	39.1	39.2	39.7	39.27		39.24		36.56

empty cell indicates data not available

Table 2.
Groundwater monitoring data from Janesville Site

	JV-3 sidegradient								B-1 downgradient							
PARAMETER	10/30/91	12/11/91	3/31/92	5/5/92	10/21/92	11/18/92	4/15/93	6/17/93	10/30/91	12/11/91	3/31/92	5/5/92	10/21/92	11/18/92	4/14/93	6/17/93
Temp.-Field (Deg-C)	10	11	13	13.5		9.5	8	20	12	15	15	17		11	12.5	20
pH-Lab (su)	8.2	7.5	7.8	7.9	7.97	7.41	7.5	7.55	7.9	7.8	8.0	7.4	7.58	7.35	7.39	7.28
Lead-Diss. (ug/L)		<3	<3	<3					<3	<3	<3	<3				
Chromium-Diss. (ug/L)		<3	<3	<3	<3	<3	2	<1	4	4	<3	<3	<3	<3	12	<1
Copper-Diss. (ug/L)		3	4	<20	5	<20	<20	2.3	4	4	3	<20	<3	<20	<20	1.7
Chloride-Diss. (mg/L)	5	4	4	3	4	3	3	3	83	91	110	110	140	140	170	180
Mangan.-Diss.(ug/L)		<40	<40	<40	<40	<40	<40	<40	<40	<40	120	<40	<40	<40	63	47
COD-Diss. (mg/L)	110	25				22	<5	7	10	11	<5	16		25	68	17
Calcium-Diss. (mg/L)		88	84	87	86	80	89	85	190	190	220	240	290	270	330	290
Magnes.-Diss.(mg/L)		36	35	35	30	30	34	32	100	100	110	130	140	140	170	150
Sulfate-Diss. (mg/L)	63	50	50	48	46	45	43	43	510	541	660	680	780	860	940	1100
Arsenic-Diss. (ug/L)		<10	<10	<10					<10	<10	<10	<10				
Barium-Diss. (ug/L)		370	490	380	210	200	100	130	190	120	200	170	94	140	74	120
Iron-Diss. (mg/L)		<0.05	<0.05	<0.05	<0.05	<0.05	0.07	<0.05	0.05	<0.05	0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Sodium-Diss. (mg/L)				6.9			3.8					8.4			23	
Zinc-Diss. (ug/L)				150	96	77	17	22				130	27	82	73	55
Mercury-Diss. (ug/L)									<0.03	<0.03						
Hardness-Diss. (mg/L)		370	350	360	340	320	360	350	880	910	1000	1100	1300	1200	1500	1300
Phenolics-Diss. (ug/L)									<5	<5	5.03	<5				
Alkalinity-Diss. (mg/L)	533	318	311	308	308	307	318	311	202	236	241	239	253	261	268	297
TDS (mg/L)	630	394	392	388	70	376	384	378	1140	1210	1450	1460	1530	1820	2010	2140
Cond.field(UMHOS/cm)	600	510	465	451		425	650	625	1120	1250	1500	1570		1625	1875	2450
Cond.lab(@25 deg C)			641	630	621	629	642	628			1760	1800	2030	2170	2400	2480
Depth to Groundw.(ft)	107.3	102.4	103.5	103.67				102.3	73.3	73.3	73.3	73.05		73.25		

empty cell indicates data not available

Table 2 (continued).
Groundwater monitoring data from Janesville Site

	B-1A downgradient							
PARAMETER	10/30/91	12/11/91	3/31/92	5/5/92	10/21/92	11/18/92	4/14/93	6/17/93
Temp.-Field (Deg-C)	13	16	16	16.5		14	14.5	well
pH-Lab (su)	8.2	8.1	8.3	7.8	7.72	7.84	7.79	out
Lead-Diss. (ug/L)	<3	<3	<3	<3				of
Chromium-Diss. (ug/L)	<3	<3	<3	<3	<3	<3	1.6	order
Copper-Diss. (ug/L)	6	<3	<3	<20	<3	<20	<20	
Chloride-Diss. (mg/L)	8	6	8	9	9	10	12	
Mangan.-Diss(ug/L)	<40	<40	<40	<40	<40	<40	<40	
COD-Diss. (mg/L)	35	<5	17	33		10	5	
Calcium-Diss. (mg/L)	78	73	76	77	80	74	77	
Magnes.-Diss.(mg/L)	29	29	30	30	29	28	32	
Sulfate-Diss. (mg/L)	37	42	34	31	62	58	70	
Arsenic-Diss. (ug/L)	<10	<10	<10	<10				
Barium-Diss. (ug/L)	360	360	200	180	120	160	190	
Iron-Diss. (mg/L)	0.18	0.10	<0.05	<0.05	<0.05	<0.05	<0.05	
Sodium-Diss. (mg/L)				2.8				
Zinc-Diss. (ug/L)				54	22	65	120	
Mercury-Diss. (ug/L)	<0.03	<0.03						
Hardness-Diss. (mg/L)	320	300	310	310	320	300	320	
Phenolics-Diss. (ug/L)	<5	<5	<5					
Alkalinity-Diss. (mg/L)	246	240	253	253	240	237	227	
TDS (mg/L)	338	324	338	334	110	370	364	
Cond.-field(UMHOS/cm)	410	490	460	460		450	465	
Cond.lab(@25 deg C)			544	552	582	578	590	
Depth to Groundw.(ft)	74.0	73.7	73.9	73.97		73.95		

empty cell indicates data not available

Table 2 (continued).
Groundwater monitoring data from Janesville Site

	TE-1 sidegradient								TE-2 sidegradient							
PARAMETER	10/23/91	12/10/91	3/24/92	5/13/92	10/13/92	11/17/92	4/7/93	6/14/93	10/23/91	12/10/91	3/24/92	5/13/92	10/13/92	11/17/92	4/7/93	6/14/93
Temp.-Field (Deg-C)	15	11	7.8	10.5	11.2	9.75	10.2	20	15.5	90	9.1	no	12.5	9	9.9	18
pH-Lab (su)	7.5	8.2	7.70	8.09	7.82	7.8	7.78	7.8	7.5	7.7	7.60	sample	7.73	7.74	7.71	7.63
Lead-Diss. (ug/L)	<3	<3	<3	<3					<3	<3	<3					
Chromium-Diss. (ug/L)	<3	<3	<3	<3	<3	<3	1.2	<1	<3	<3	<3		<3	<3	<1	<1
Copper-Diss. (ug/L)	<3	<3	<20	<3	<20	<20	<20	5	<3	5	<20		<20	<20	<20	1.7
Chloride-Diss. (mg/L)	33	33	34	33	33	33	33	33	22	21	21		16	16	25	23
Mangan.-Diss(ug/L)	300	260	200	130	86	95	97	63	<40	420	420		410	420	420	95
COD-Diss. (mg/L)	97	<5	19	25		<5	8	17	52	6	29			26	27	53
Calcium-Diss. (mg/L)	93	88	91	90	87	91	91	82	79	130	130		150	150	140	170
Magnes.-Diss(mg/L)	48	46	49	50	46	47	48	47	74	71	70		77	77	72	95
Sulfate-Diss. (mg/L)	55	49	49	46	47	48	46	48	240	270	230		320	330	230	420
Sodium-Diss.(mg/L)					10		8.8						9.7		7.6	
Zinc-Diss.(ug/L)					120	132	120	19					67	70	37	20
Arsenic-Diss. (ug/L)	<10	<10	<10	<10					<10	<10	<10					
Barium-Diss. (ug/L)	270	360	240	250	360	300	240	81	290	220	170		130	130	86	54
Iron-Diss. (mg/L)	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.07		<0.05	0.08	0.05	<0.05
Mercury-Diss. (ug/L)	<0.03	<0.03							<0.03	<0.03						
Hardness-Diss. (mg/L)	430	400	430	430	410	420	420	400	500	610	620		680	690	640	820
Phenolics-Diss. (ug/L)	<5	<5	<5	<5					<5	<5	<5					
Alkalinity-Diss. (mg/L)	339	335	339	337	337	335	332	328	362	377	376		393	390	397	396
TDS (mg/L)	488	454	476	452	458	456	462	462	852	794	724		878	894	778	1030
Cond.-field(UMHOS/cm)	650	600	590	580	595	590	575	460	900	890	750		910	920	775	760
Cond.-lab(@ 25 deg C)			779	765	772	776	784	768			1050		1200	1200	1120	1360
Depth to Groundw.(ft)	7.0	6.25	7.15	7.1	6.7	6.1	5.42	4.68	5.92	4.3	4.55		5.4	4.93	3.59	3.12

empty cell indicates data not available

Table 3.
Groundwater monitoring data from Terra Site

PARAMETER	TE-2P sidegradient 10/23/91	12/10/91	3/24/92	5/13/92	10/13/92	11/17/92	4/7/93	6/14/93	TE-3 sidegradient 10/23/91	12/10/91	3/24/92	5/13/92	10/13/92	11/17/92	4/7/93	6/14/93
Temp.-Field (Deg-C)	14	10		13	11	8.1	11.4	16.5	16	9.5	11.5	13	12	9.2	11.5	22
pH-Lab (su)	7.7	7.9	7.70	8.09	7.74	7.93	7.98	7.76	7.8	8.1	7.8	8.16	7.7	7.89	7.94	7.8
Lead-Diss. (ug/L)	<3	<3	<3	<3					<3	<3	<3	<3				
Chromium-Diss. (ug/L)	<3	<3	<3	<3	<3	<3	2.1	1.9	3	<3	<3	<3	<3	<3	1.8	2.1
Copper-Diss. (ug/L)	<3	4	<20	<3	<20	<20	<20	1.8	<3	<3	<2	<3	<20	<20	<20	3
Chloride-Diss. (mg/L)	32	31	31	31	32	32	32	33	32	32	32	32	32	33	33	33
Mangan.-Diss(ug/L)	190	110	60	44	<40	<40	<40	<40	<40	<40	<40	<40	<40	<40	<40	<40
COD-Diss. (mg/L)	<5	<5	<5	7		<5	<5	51	16	<5	<5	<5		27	<5	9
Calcium-Diss. (mg/L)	91	84	84	86	85	90	91	86	90	86	90	88	83	89	91	83
Magnes.-Diss(mg/L)	51	47	47	48	46	47	48	49	50	48	46	49	45	47	48	46
Sulfate-Diss. (mg/L)	42	42	42	40	43	42	41	42	40	40	40	40	41	41	40	40
Sodium-Diss.(mg/L)					9		7.9						9.5		8.5	
Zinc-Diss.(ug/L)					60	110	<10	<10					60	53	<10	14
Arsenic-Diss. (ug/L)	<10	<10	<10	<10					<10	<10	<10	<10				
Barium-Diss. (ug/L)	200	330	150	130	140	210	66	49	240	240	320	400	200	100	77	77
Iron-Diss. (mg/L)	0.1	<0.05	0.05	0.05	0.08	<0.05	<0.05	<0.05	0.15	0.07	0.08	<0.05	<0.05	<0.05	<0.05	<0.05
Mercury-Diss. (ug/L)	<0.03	<0.03							<0.03	<0.03						
Hardness-Diss. (mg/L)	440	400	400	410	400	420	420	410	430	410	410	420	390	420	430	400
Phenolics-Diss. (ug/L)	<5	<5	<5	<5					<5	<5	<5	<5				
Alkalinity-Diss. (mg/L)	342	338	340	340	339	338	335	335	339	334	337	340	338	337	337	337
TDS (mg/L)	456	456	464	452	462	458	460	476	478	444	464	446	466	464	472	472
Cond.-field(UMHOS/cm)	630	590	590	625	600	585	600	450	670	600	600	625	620	600	600	445
Cond.-lab(@ 25 deg C)			778	769	783	784	788	783			776	773	784	785	797	790
Depth to Groundw.(ft)	5.90	4.2	4.24	4.1	5.15	4.78	3.05	2.36	5.3	3.9	4.04	4.05	4.84	4.39	2.93	2.35

empty cell indicates data not available

Table 3 (continued).
Groundwater monitoring data from Terra Site

PARAMETER	TE-4 well is located adjacent to waste							
	10/23/91	12/10/91	3/24/92	5/13/92	10/13/92	11/17/92	4/7/93	6/14/93
Temp.-Field (Deg-C)	15	10		14	12.8	10.2	10	21
pH-Lab (su)	7.5	7.2	7.3	7.66	7.24	7.15	7.29	7.18
Lead-Diss. (ug/L)	3	<3	<3	<3				
Chromium-Diss. (ug/L)	<3	<3	<3	<3	<3	<3	<1	<1
Copper-Diss. (ug/L)	10	6	<20	5	<20	<20	<20	3.7
Chloride-Diss. (mg/L)	360	180	300	320	320	290	200	170
Mangan.-Diss(ug/L)	1400	1300	900	880	830	750	550	420
COD-Diss. (mg/L)	80	83	50	59		53	18	69
Calcium-Diss. (mg/L)	590	560	540	570	490	480	290	250
Magnes.-Diss(mg/L)	300	250	240	250	210	210	130	140
Sulfate-Diss. (mg/L)	550	600	540	540	590	490	230	210
Sodium-Diss.(mg/L)					130		51	
Zinc-Diss.(ug/L)					78	100	<10	11
Arsenic-Diss. (ug/L)	<10	<10	<10	<10				
Barium-Diss. (ug/L)	380	340	310	350	280	280	110	98
Iron-Diss. (mg/L)	0.95	3.7	4.2	5.5	6.4	4.5	<1.9	0.05
Mercury-Diss. (ug/L)	<0.03	<0.03						
Hardness-Diss. (mg/L)	2700	2400	2300	2400	2100	2100	1300	1200
Phenolics-Diss. (ug/L)	<5	<5	<5	<5				
Alkalinity-Diss. (mg/L)	1300	1840	1700	1780	1790	1590	915	810
TDS (mg/L)	3340	3180	2728	3040	3140	2770	1530	1420
Cond.-field(UMHOS/cm)	3250	3100	3010	3000	3180	2750	1725	1280
Cond.-lab(@ 25 deg C)			4040	4020		3790	2350	2100
Depth to Groundw.(ft)	13.1	11.5	11.6	11.6	12.43	12.07	10.9	10.23

empty cell indicate data not available

Table 3 (continued).
Groundwater monitoring data from Terra Site

Public health and welfare groundwater qality standards	
ES	PAL
15	1.5
100	10
1300	130
250	125
50	25
250	125
5000	2500
50	5
2000	400
0.3	0.15
2	0.2

Same units as in Table 3

Table 4
Wisconsin Groundwater Standards

Department of Natural Resources

VOCS
Form 4800-5 Rev. 12-87

☐ if New Facility

Bill to: ☐ Solid Waste ☐ Hazardous Waste ☐ Wastewater ☐ Water Supply ☐ Spills ☐ Other ____

I.D. Number _ _ _ _ _ _ _ _ _ _   Point/ Well # _ _ _   Field No. ___ ____   County # _ _   Route Code _ _ _ _

I.D. Name ____________________   P.O. or City ____________________

Collection Date _ _ / _ _ / _ _ (M M / D D / Y Y)   Time: _ _ : _ _ (H H : M M)   Sample Location ____________________

Description ____________________

Send Report To: [box]

Account Number _ _ _ _ _ _ _

Collected By ____________________

Phone (_ _ _) _ _ _ - _ _ _ _

Check any appropriate:

☐ S Split ☐ E Enforcement ☐ B Field Blank ☐ S Surface Source ☐ T Treated

__ MW Monitoring Well
__ LY Lysimeter
__ LE Leachate
__ SE Sediment
__ SU Surface Water
__ PW Private Well
__ EF Effluent
__ IF Influent
__ SO Soil
__ OI Oil
__ SL Sludge
__ OT Other
__ OW Waste

Analysis Type:
__ Q GC/MS Screen and Quantification
S GC/MS Screen
__ O Parameter Specific
(NOTE: if followup enter previous sample no.) _ _ _ _ _ _ _

Water System Type (Water Supply Use ONLY)
__ M Community-Municipal
__ O Community-OTM
__ N Non-community
__ P Private
__ X Non-potable

Sample Type:
__ D (SDWA) Compliance Sample
__ C (SDWA) Check
__ __ / __ __ / __ __ (Initial Sample Date)
__ W Raw Water __ ✓ if New Well
__ I Miscellaneous Distribution

__ Free Chlorine Residual (Field) _ . _ _ mg/L

__ Free Chlorine Residual (Lab) _ . _ _ mg/L

Detection limits (ug/L) are indicated by [ ]	Detected	ug/L
__ Benzene [1.0]	__ 025	_ _ _ . _
__ Bromobenzene [4.0]	__ 046	_ _ _ . _
__ Bromodichloromethane [2.0]**	__ 051	_ _ _ . _
__ Bromoform [5.0]**	__ 053	_ _ _ . _
__ Bromomethane [1.0]	__ 055	_ _ _ . _
__ Carbon Disulfide [5.0]	__ 071	_ _ _ . _
__ Carbon Tetrachloride [2.0]	__ 073	_ _ _ . _
__ Chlorobenzene [2.0]	__ 083	_ _ _ . _
__ Chloroethane [2.0]	__ 087	_ _ _ . _
__ 2-Chloroethylvinyl ether [4.0]	__ 093	_ _ _ . _
__ Chloroform [1.0]**	__ 095	_ _ _ . _
__ 0-Chlorotoluene [1.0]	__ 108	_ _ _ . _
__ P-Chlorotoluene [1.0]	__ 110	_ _ _ . _
__ Dibromomethane [2.0]	__ 146	_ _ _ . _
__ Dibromochloromethane [2.0]**	__ 147	_ _ _ . _
__ 1,2-Dibromo-3-Chloropropane [7.0]	__ 148	_ _ _ . _
__ 1,2-Dichlorobenzene [2.0]	__ 153	_ _ _ . _
__ 1,3-Dichlorobenzene [2.0]	__ 155	_ _ _ . _
__ 1,4-Dichlorobenzene [2.0]	__ 157	_ _ _ . _
__ 1,1-Dichloroethane [1.0]	__ 165	_ _ _ . _
__ 1,2-Dichloroethane [1.0]	__ 167	_ _ _ . _
__ 1,2-Dichloroethylene, cis [1.0]	__ 168	_ _ _ . _
__ 1,1-Dichloroethylene [1.0]	__ 169	_ _ _ . _
__ 1,2-Dichloroethylene, trans [1.0]	__ 170	_ _ _ . _
__ 1,3-Dichloropropane [1.0]	__ 178	_ _ _ . _
__ 1,1-Dichloropropene [2.0]	__ 180	_ _ _ . _
__ 1,2-Dichloropropane [1.0]	__ 181	_ _ _ . _

	Detected	ug/L
__ 2,2-Dichloropropane [2.0]	__ 182	_ _ _ . _
__ 1,3-Dichloropropene, cis [2.5]	__ 183	_ _ _ . _
__ 1,3-Dichloropropene, trans [2.5]	__ 185	_ _ _ . _
__ Ethylbenzene [1.0]	__ 233	_ _ _ . _
__ Ethylene Dibromide [1.0]	__ 236	_ _ _ . _
__ Methylethylketone (MEK) [12]	__ 319	_ _ _ . _
__ Methylene Chloride [5.0]	__ 325	_ _ _ . _
__ Styrene [2.0]	__ 393	_ _ _ . _
__ 1,1,1,2-Tetrachloroethane [3.0]	__ 396	_ _ _ . _
__ 1,1,2,2-Tetrachloroethane [3.0]	__ 397	_ _ _ . _
__ Tetrachloroethylene [1.0]	__ 399	_ _ _ . _
__ Tetrahydrofuran (THF) [200]	__ 401	_ _ _ . _
__ Toluene [1.0]	__ 411	_ _ _ . _
__ 1,2,4-Trichlorobenzene [1.0]	__ 419	_ _ _ . _
__ 1,1,1-Trichloroethane [1.0]	__ 421	_ _ _ . _
__ 1,1,2-Trichloroethane [2.0]	__ 423	_ _ _ . _
__ Trichloroethylene [1.0]	__ 425	_ _ _ . _
__ Trichlorofluoromethane [1.0]	__ 427	_ _ _ . _
__ Trichlorotrifluoroethane [3.0]	__ 428	_ _ _ . _
__ 1,2,3-Trichloropropane [2.0]	__ 432	_ _ _ . _
__ Vinyl Chloride [1.0]	__ 434	_ _ _ . _
__ Xylenes [2.0]	__ 437	_ _ _ . _
** Total Trihalomethanes	__	_ _ _ . _

☐ NO Detects

Date Received And Sample No. ____________________

Date Reported ____________________

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