Petroleum Release Remedial Investigation Report

Lake & Hiawatha Site (Former Clark Station)

Prepared for
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1.0 Introduction

This report presents the results of a petroleum release remedial investigation (RI) at the Lake and Hiawatha site, which is owned by the Minnesota Department of Transportation (Mn/DOT). The site is located at the northeast corner of the intersection of East Lake Street and Hiawatha Avenue South in Minneapolis, Minnesota. The site was the former location of a Clark Oil gasoline station and has been assigned leak # 8324 by the Minnesota Pollution Control Agency (MPCA). The RI was conducted during the fall of 1995 in accordance with Work Order Number 1 under Agreement Number 73661 between Mn/DOT and Barr Engineering Company (Barr).

This work is being performed to define the nature and extent of petroleum hydrocarbon impacts that were identified at the Lake and Hiawatha site during an investigation of the adjacent Miller & Holmes (M & H) Station #27 site (MPCA leak # 0360).

The Lake and Hiawatha site is being investigated prior to road construction which is scheduled to begin in the spring of 1996. The work will reconstruct Trunk Highway (TH) 55, which follows Hiawatha Avenue through south Minneapolis. The work will include the construction of bridge footings, an on-ramp, and a retaining wall across a portion of the site.

1.1 Report Organization

The remedial investigation report is organized as follows:

- Section 1–Introduction
- Section 2–Remedial Investigation Activities
- Section 3–Remedial Investigation Results
- Section 4–Discussion
- Section 5–Recommendations

Section 1 is a description of the report organization, the site history, and previous investigations in the immediate area. Section 2 is a description of the investigation tasks and the methods and procedures followed during the investigation. Section 3 is a presentation of the results of the investigation, including the geology, hydrogeology, and laboratory analytical results. Section 4 is a

discussion of the results, including soil and groundwater quality. Section 5 is a presentation of recommendations.

1.2 Site Description

The site is located in an industrial/commercial area of the City of Minneapolis, Hennepin County, Minnesota. The site is located in Section 36, Township 29 North, Range 24 West, of the St. Paul West, Minnesota, 7.5 Minute United States Geological Survey Quadrangle (Figure 1). The site is bounded to the south by East Lake Street, to the west by Hiawatha Avenue South, and to the north and east by CP Rail Systems property. The address of the site is 2308 East Lake Street. The site comprises Lots 12 through 17, Block 1, Harvester Addition to the City of Minneapolis.

1.3 Site History and Setting

The majority of the site property was owned by the Wiedemann Company. The businesses that have been located on the Wiedemann property include a retail gasoline station, a bulk petroleum storage facility, and a dry cleaner drop-off/pick-up store. A small portion of the site was owned by the Oklahoma Oil Company. The only known operation on this part of the property was a restaurant. Figure 2 shows the locations of structures that have been located on the site.

The gasoline station was originally constructed in 1927 and was leased to Clark Oil and Refining (Clark) from the Wiedemann Company in the 1950s. The Wiedemann Company owned the property, underground storage tanks, signs and miscellaneous equipment during the operation of the facility by Clark. The station office and service bay were located in the northwestern portion of the site and the fuel dispenser islands were located in the southwestern portion of the site (Figure 2). A property appraisal performed in 1968 by LaSalle, Ruppert, and Lowe indicates that only premium gasoline was sold at the station. Three gasoline underground storage tanks (USTs) were located in basins near the south end of the office and east of the dispenser islands (Figure 2). The southern basin contained two of the tanks. The tank volumes were 1,000, 3,000, and 6,000 gallons.

During the early 1960s the station service bay was closed and subleased by Clark Oil and Refining to Shapiro Brothers, a dry cleaning establishment (Figure 2). The Clark station and the dry cleaner operated concurrently until the early 1970s. The property appraisal performed by LaSalle,

Ruppert, and Lowe indicates that Shapiro Brothers used the facility as a drop-off and pick-up station only, and that no cleaning was actually done on site.

The bulk storage facility was comprised of fourteen above ground storage tanks and a shed which housed valves and pumps (Figure 2). The tanks were operated by Tankar Gas, which was owned by the Wiedemann Company. The tanks appear on aerial photographs from 1937, 1940, and 1953, and on Sanborn maps from 1950, 1952, and 1963. The Sanborn maps indicate that oil was stored in the tanks and that a concrete containment wall surrounded the tanks. The date of removal of the tanks is unknown; however, the tanks do not appear on Sanborn maps from 1968, or on an aerial photograph from 1970. The valve shed associated with the tanks was present on the 1970 photograph. The former existence or location of distribution lines is uncertain.

A restaurant, The Pizza Shack, was located in the southeastern portion of the site (Figure 2), on property owned by the Oklahoma Oil Company. The restaurant building was built in 1928. An appraisal of the property performed in 1968 by Janski and Gibson indicates that the building had not been used for anything other than a restaurant.

The site was purchased by Mn/DOT from the Wiedemann Company and the Oklahoma Oil Company in the early 1970s. The USTs were removed following the purchase. From the late 1970s into the 1980s, the site and much of the property north of the site were leased by Mn/DOT to Bituminous Roadways, Incorporated. The property was used to stockpile recyclable road materials until the lease was terminated in 1987.

The site has been vacant since the late 1980s and no structures are currently present on the site. Much of the site is covered with a layer of asphalt. In addition, a remnant of the foundation that was the front (southwest) wall of the former dry cleaner/service bay is present. The northern two-thirds of the site of the has very little relief, with a ground surface elevation that slopes from 842 feet above mean sea level (feet MSL) along Hiawatha Avenue to 841 feet MSL along the CP Rail railroad tracks. A small mound occupies the southern third of the site. The top of the mound is at an elevation of approximately 845 feet MSL. The only trees present are located along Hiawatha Avenue and the CP Rail tracks.

1.4 Previous Investigations at Adjacent Properties.

No previous investigations of the former Clark Station have been completed. However, a petroleum release RI/corrective action is currently in progress at the former M & H gasoline station #27 site (M & H site), located immediately west of the Lake and Hiawatha site (Figure 2) (LBG, 1988 and 1991; Geraghty & Miller, 1992 and 1996). In addition to investigating the M & H property, this work included the placement of soil borings and a monitoring well at the Lake and Hiawatha site. The borings and wells placed during the M & H site investigations are shown on Figure 3. Mn/DOT currently owns the M & H site property, although M & H was the previous property owner and sole operator of the former USTs at this site.

During these investigations contaminated soil and free product were detected at both sites. M & H performed product recovery at well MW1 (Figure 3) from January 1990 until May 1991. In 1995 free product was detected in well MW2 (Figure 3) following the completion of a supplemental investigation. M & H is seeking closure for the site (Geraghty and Miller, 1996).

Product was detected in well MW4 at the Lake and Hiawatha site (Figure 3) in August 1991. Mn/DOT has performed ongoing product recovery at well MW4 since April 1995, through the use of a "wick stick" passive product collector. Approximately 2 gallons of product have been recovered. The results of the M & H investigations, as related to the Lake and Hiawatha site, are reviewed and discussed in Sections 3 and 4 of this report.

A number of soil borings and piezometers have been placed along Hiawatha Avenue by Braun Intertec (Braun, 1994). The borings and piezometers were placed as part of the preconstruction investigation of the TH 55 corridor. The locations of the borings and piezometers placed in the vicinity of the Lake and Hiawatha site are shown on Figure 3. The results of the corridor investigation, as related to the Lake and Hiawatha site, are reviewed and discussed in Sections 3 and 4 of this report.

1.5 Remedial Investigation Focus

The UST basins at the Lake and Hiawatha site were the primary focus of this investigation. The bulk storage facility was also investigated. Although records indicated that no cleaning was done at the dry cleaner, it was also investigated for evidence of any possible chlorinated hydrocarbon

release. The goals of the investigation were to define soil contamination in the unsaturated zone, define groundwater contamination at the water table, and delineate the extent of free product.

2.0 Remedial Investigation Activities

The RI began in October 1995 and field activities were concluded in December 1995. This section describes the activities associated with the soil and groundwater investigations. The soil investigation tasks included the advancement of soil borings, the collection of soil samples, and the laboratory analysis of soil samples. The groundwater investigation tasks included monitoring well installation, hydraulic conductivity testing, water level monitoring, and groundwater sample collection and analysis.

2.1 Soil Investigation

The objectives of the soil investigation were to delineate the site geology and define the extent of contaminated soil above the water table. This was accomplished through the placement of soil borings from which soil samples were collected, examined, and classified. The results of the soil investigation are presented in Section 3.

2.1.1 Soil Boring Advancement

Nine soil borings were advanced to the water table at the site. Soil borings in which monitoring wells were to be installed were given the designator MW. Soil borings without wells were given the designator SB. The locations of well borings MW101 through MW103 and soil borings SB104 through SB109 are shown on Figure 3. The locations of the borings were chosen based on the locations of former site structures, and the results of previous investigations at the M & H site. Borings MW101 and MW103 were placed upgradient and downgradient of the site, respectively. Boring MW102 was placed to investigate possible impacts from sources west of the UST basins, including the Lake and Hiawatha site fuel dispensers and the M & H site. Borings SB104, SB105, SB107, and SB108 were placed to investigate specific locations where product releases could have occurred. Boring SB106 was placed to delineate contamination observed at MW-4. Boring SB109 was placed to investigate the dry cleaner. A summary of the borings, including total depth and location rationale, is presented in Table 1.

The well borings were advanced using a 4.25-inch inside diameter (ID) hollow-stem auger. Soil borings were advanced using a 3.25-inch ID hollow-stem auger. The augers were advanced using a

truck-mounted drilling rig. All borings not completed as monitoring wells were abandoned by backfilling the borehole with tremied neat cement grout. Boring logs are presented in Appendix A. The drilling subcontractor's report, which also includes soil boring logs, is presented in Appendix B.

The ground surface elevation of each boring was surveyed and tied to a mean sea level datum. The locations of the borings, streets, and railroad tracks were also surveyed and tied to a common coordinate system. The ground surface elevations for each boring appear in Table 1 and on the boring logs in Appendix A.

2.1.2 Soil Sample Collection

Soil samples were collected continuously from the borings using a 2-inch-diameter split-barrel sampler in accordance with ASTM D1586, Standard Method for Penetration Test and Split-Barrel Sampling of Soil. The sampler was equipped with one brass liner held at the bottom of the sampler. Upon sample recovery, the brass liner was removed, covered with aluminum foil and plastic end caps, and placed in an ice-filled cooler for possible submittal to the laboratory. New laboratory-cleaned jars were also filled for possible submittal to the laboratory and placed in the ice-filled cooler. A portion of the remaining sample was placed in a new quart jar and screened for organic vapors using the jar headspace method. The samples were classified in accordance with ASTM D2488, Standard Practice for Description and Identification of Soils (Visual-Manual Method). In addition, all samples were examined for any unusual discoloration, oil sheen, and odor.

2.1.3 Laboratory Analysis

Soil samples were chosen for laboratory analysis on the basis of organic vapor screening results and the elevation of the water table. At all of the borings, the sample from just above the water table had the highest organic vapor concentration; therefore, one analytical sample was submitted from each of the borings from this interval. An additional analytical sample was collected from boring SB104 to characterize shallow contamination near the former southern UST basin (Figure 3). An additional sample was also collected from soil boring SB105, because the water table was believed to be deeper than the depth interval with the highest organic vapor concentration. After the analytical samples had been packaged and shipped to the laboratory, the water level in the borehole later stabilized to the elevation of that sample. Analytical samples

were not collected from the well borings. A summary of the samples submitted for laboratory analysis is shown in Table 2.

The soil samples were submitted to Quality Analytical Laboratories, Incorporated (QAL) of Redding, California. Samples submitted to QAL were analyzed for volatile organic compounds (VOCs), gasoline range organic (GRO) compounds, diesel range organic (DRO) compounds, and lead. Analytical method 465D VOC protocol was followed for these analyses. The full list of parameters is shown in the laboratory reports in Appendix C.

2.1.4 Vapor Risk Assessment

No basements or underground utilities are present on the site. A discussion of vapor risk assessment for off-site utility lines is included in Section 5.

2.2 Groundwater Investigation

The objectives of the groundwater investigation were to evaluate groundwater flow conditions beneath the site and to characterize the quality of groundwater in the uppermost water-bearing unit at the site. This was accomplished through the installation of monitoring wells for water level monitoring, groundwater sample collection, and hydraulic conductivity testing.

2.2.1 Monitoring Well Installation

As discussed above in Section 2.1.1, monitoring wells were installed in three of the borings. The wells were installed so that they were screened across the water table at the site. The wells are designated MW101 through MW103 and their locations are shown on Figure 3. The figure also shows the locations of wells installed during previous investigations. Following advancement of each well boring, a well was assembled and installed to the bottom of the boring. The wells were 2-inch diameter and constructed of stainless steel screens attached to black steel riser pipes. A filter sand pack was installed around the screen and riser of each well from the bottom of the boring to at least 2 feet above the top of the screen. A bentonite seal at least 1 foot thick was placed above the filter pack in each well. Tremied cement grout was placed above the filter pack up to the ground surface in each well. A locking protective steel casing was installed over the riser, and three protective posts were installed around each well. Monitoring well construction logs are in Appendix D. A summary of monitoring well construction details is presented in

Table 3. The drilling subcontractor's report, which includes additional monitoring well construction logs, is in Appendix B.

The riser pipe and ground surface elevations of each well were surveyed and tied to mean sea level. These elevations appear on the well logs in Appendix D and in Table 3. The riser pipe and ground surface elevations of M & H wells MW-1 through MW-4 were also surveyed and tied to mean sea level. The location of each well was surveyed and tied to a common coordinate system.

2.2.2 Hydraulic Conductivity Testing

In situ hydraulic conductivity tests were completed in two of the three monitoring wells. The two wells were MW101 and MW103. Well MW102 was not evaluated since free product was present in the well. The wells were tested using the slug test method, and the results were evaluated using the Bouwer and Rice Method. The hydraulic conductivity methods and calculations are presented in Appendix E.

2.2.3 Groundwater Sample Collection and Laboratory Analysis

Two rounds of groundwater samples were collected from monitoring wells MW101 and MW103. The samples were collected on November 2, and December 4, 1995. Water levels in the three monitoring wells, along with M & H site monitoring wells MW1 through MW4, were measured during the sampling events. Well MW102 was not sampled due to the presence of free product. During the December event, the wick stick in well MW4 was moved to well MW102.

Groundwater samples were field analyzed for temperature, conductivity, and pH. New laboratory-cleaned vials were filled and placed in ice-filled coolers. The samples were submitted to QAL of Redding, California to be analyzed for VOCs, GRO compounds, DRO compounds, and lead. Analytical method 465D VOC protocol was followed for these analyses. The full list of parameters is shown in the laboratory reports in Appendix C. Field sampling reports for both events are presented in Appendix F.

2.2.4 Well Search

A well search was completed as part of the investigation at the M & H site (LBG, 1991). Since the M & H site is located 60 feet from the Lake and Hiawatha site, the M & H well search information can be used for the Lake and Hiawatha site.

3.0 Remedial Investigation Results

Data gathered during the soil and groundwater investigations described in Section 2 were correlated with information from the M & H and corridor investigations to conceptualize site hydrogeologic conditions. These results are presented in this section. The results are also presented on MPCA Leaking Underground Storage Tank (LUST) Cleanup Program Fact Sheets #6 (Remedial Investigation Report Worksheet) and #24 (Hydrogeologic Setting and Groundwater Contamination Worksheet) in Appendices G and H, respectively.

3.1 Soil Investigation Results

The soil investigation results indicate that the site geology is dominated by alternating layers of till and alluvium. Organic vapor, VOC, GRO, and DRO concentrations were greatest in the shallowest till layer in the southwestern and central portions of the site. These locations were near the locations of former storage tanks and fuel dispensers.

3.1.1 Geology

The units encountered at the site, in descending order, were mixed fill, fill/remnant soil, terrace alluvium, till, alluvium, and till. Cross sections have been constructed to show the stratigraphic relationships of the units. The cross section locations are shown on Figure 4 and the cross sections are shown on Figures 5 and 6.

The entire site is covered with a layer of fill. As was noted in Section 1.3, much of the site is covered with asphalt. The fill is composed of a silty sand matrix with varying amounts of gravel, clay, pieces of concrete, asphalt, wood, brick, glass, coal fines, and other debris. The fill is typically black to dark brown in color. The thickness of the fill on the site ranges from 2.0 to 5.4 feet, except at boring SB104, where it is 11.3 feet thick. In the vicinity of the M & H site, the fill ranges in thickness from 2.0 to 5.5 feet, except at MW2, where it is 10.0 feet thick (Figures 5 and 6).

Over most of the site, the first unit encountered beneath the fill was a lean clay. It is typically firm and varies in color from gray to dark brown and black. Most samples of the clay were

massive, although a few were fractured. The clay was encountered at all borings located in the eastern two-thirds of the site and was not encountered at boring locations along the western edge of the site near Hiawatha Avenue (i.e., MW102, TB-1, TB-2, TB-3, ST-247, and ST-248; Figure 3). This clay unit was not encountered at the M & H site. The maximum observed thickness of the clay is 3.5 feet at SB106 near the CP Rail tracks (Figure 5). The upper surface of the unit slopes downward to the west. The clay may be another fill layer or a remnant soil horizon.

The next unit encountered was composed of poorly graded sand and poorly graded sand with silt. The unit is interpreted to be alluvium, possibly a terrace deposit. The alluvium is brown, stratified, fine- to medium-grained sand with 0 to 10 percent silt, and contains minor amounts of coarse sand and fine gravel. The alluvium was encountered in all borings placed at both sites. Its thickness typically ranges from 2.5 to 9.0 feet, except at MW3 west of the M & H site, where it is 16.0 feet thick (Figure 5).

Dense silty sand and silty clayey sand were encountered beneath the alluvium. This unit is classified as a till. It ranges in thickness from 3.0 to 15.5 feet (Figure 5 and 6) and is composed of fine- to medium-grained sand with 20 to 30 percent silt, 5 to 15 percent clay, and minor amounts of coarse sand and fine gravel. The till is hard, dense, massive to faintly stratified, and is brown to reddish-brown. A few thin lenses of sand up to approximately 0.5 feet thick were observed within the till. The till was encountered in all borings placed at both sites.

The upper surface of the till shows variable elevations, with a maximum relief of approximately 5.5 feet. The elevation of the upper till surface is highest at the northern end of the site and south of the site across Lake Street. An oblong depression with an approximate east-west axis is present in the upper surface of the till in the southern portion of the site (Figure 7). The till surface elevation is lowest at boring TB-3 and well MW4. The till surface is above the water table except in the depression near TB-3 and MW4.

At the locations of SB106, TB-3, MW2, and MW4, poorly graded sand and poorly graded sand with silt were encountered beneath the till. This unit is classified as alluvium. The alluvium contains fine- to coarse-grained sand with 5 to 10 percent silt, varying amounts of gravel, and has a reddish-brown color. The thickness of the unit ranges from 0.5 to 7.0 feet (Figure 5). As shown on Figure 5, the unit is probably present at SB104, although the boring was not advanced deep enough to penetrate it. At TB-3, MW2, and probably SB104, more till is present beneath this alluvium (Figure 5).

Beneath the alluvium at MW4 and beneath the till at MW101, MW1, and MW3, a unit of lean clay to sandy lean clay was encountered. The clay is classified as till. The unit is possibly beneath the alluvium at SB106 and beneath the till at SB104, MW2, and TB-3 (Figure 5), and may be continuous beneath the site. The clay is gray to black, dense, and contains a trace to 30 percent sand. Only MW3 fully penetrated the unit.

No borings were advanced to bedrock during the M & H investigations, the TH 55 corridor investigation, or the Lake and Hiawatha RI. It is believed that bedrock occurs at a depth of approximately 50 feet below the ground surface at an elevation of approximately 790 feet MSL (Bloomgren, Cleland, and Olsen, 1989). Olsen and Bloomgren (1989) indicate that a small outlier of Decorah Shale is present in the vicinity of the Lake and Hiawatha site. The bedrock unit below the Decorah Shale is the Platteville Limestone.

3.1.2 Field Screening Results

As discussed in Section 2.1.2, soil samples were examined for discoloration, oil sheen, and odor, and screened for organic vapors using the jar headspace method. The results indicate that soil contamination is present in the fill and alluvium in the vicinity of the southern UST basin and at much lower concentrations in the bulk storage facility (Figure 2). Contamination is present in the upper portion of the till over much of the site.

Soil samples of the fill exhibited organic vapor concentrations less than 10 parts per million (ppm), no discoloration, no sheen, and no odor, except for those collected from borings SB104, SB107, and SB109 (Figure 3). Samples from the lower two feet of fill at borings SB107 and SB109 had organic vapor concentrations between 15 and 25 ppm, a weak petroleum hydrocarbon odor, no oil sheen, and no discoloration. Samples from the lower seven feet of fill at SB104 exhibited organic vapor concentrations between 430 and 656 ppm, a weak to moderate petroleum hydrocarbon odor, no oil sheen, and black discoloration.

Samples of the clay located beneath the fill exhibited organic vapor concentrations less than 2.5 ppm, no odors, no oil sheens, and no discolorations, except at boring SB104. Samples collected from this boring had organic vapor concentrations between 430 and 1,000 ppm, a light oil sheen, a moderate petroleum hydrocarbon odor, and black discoloration.

Samples of the alluvium collected from all of the borings except SB104 and SB107 exhibited organic vapor concentration of 7.5 ppm or less, no odor, no oil sheen, and no discoloration.

Samples collected from SB104 exhibited organic vapor concentrations between 600 and 1,000 ppm, a strong petroleum hydrocarbon odor, heavy oil sheen, and gray discoloration. Samples collected from the lower four feet of alluvium at boring SB107 had organic vapor concentrations between 25 and 270 ppm, a weak to moderate petroleum hydrocarbon odor, no to very light oil sheen, and grayish-brown discoloration.

Soil samples collected from the till at borings MW101, MW103, SB109, and the upper 2 feet of the till at SB108, exhibited organic vapor concentrations less than 5 ppm, no odor, no oil sheen, and no discoloration, except one sample from SB109 which had an organic vapor concentration of 11.6 ppm. Samples collected from the till in borings MW102, SB104, SB105, SB106, SB107, and from the lower 4 feet of till in SB108 had organic vapor concentrations between 200 and 675 ppm and dark gray to black discoloration generally in thin (0.5 inches) horizontal laminations. Soil in the laminations exhibited a light to heavy oil sheen and a moderate to strong petroleum hydrocarbon odor. Soil between these zones of discoloration had a light to no oil sheen and a weak to moderate petroleum hydrocarbon odor.

The only other units encountered in the Lake and Hiawatha RI borings were the alluvium observed at the bottom of SB106 and the lean clay till at the bottom of MW101. The alluvium at SB106 had an organic vapor concentration of 310 ppm, a moderate to heavy oil sheen, a moderate petroleum hydrocarbon odor, and black discoloration. The lean clay till at MW101 exhibited a organic vapor concentration of 0.4 ppm, no odor, no oil sheen, and no discoloration.

3.1.3 Analytical Results

As discussed in Section 2.1.3, soil samples were chosen for laboratory analysis on the basis of headspace screening and the location of the water table. A summary of the samples submitted for analysis is shown in Table 2. The soil analytical results are presented in Table 5. The concentrations of VOCs, GRO compounds, and DRO compounds were highest in samples collected near the water table in the vicinity of the southern UST basin and the bulk storage facility.

VOCs were reported in all of the submitted soil samples except SB10808. Several different VOCs were detected in the samples, including: ethyl benzene; xylenes; naphthalene; acetone; butylbenzenes; propylbenzene; 1,3,5-trimethylbenzene; 1,2,4-trimethylbenzene; cumene; and p-cymene. The highest VOC concentrations were detected in samples SB10407 and SB10707. These samples were collected from near the water table in borings SB104 and SB107, which were placed in the vicinity of the southern UST basin and the bulk storage facility, respectively

(Figure 3). No chlorinated compounds were detected in any of the samples (Table 5), including the sample collected from boring SB109, which was placed in the vicinity of the former dry cleaner (Figure 3).

GRO compounds were reported in all of the submitted samples at total concentrations that ranged from 1.1 to 1,200 mg/kg. DRO compounds were reported in all of the submitted samples, except SB10404 and SB10908, at concentrations that ranged from 5.5 to 830 mg/kg. The highest concentrations of GRO and DRO compounds were detected in the samples collected from just above the water table in borings SB104, placed near the southern UST basin and in the till depression, and SB107, placed in the vicinity of the former bulk storage facility (Table 5 and Figure 3).

Lead was detected in all of the submitted samples at concentrations that ranged from 2.76 to 187 mg/kg. The highest concentrations were detected in samples collected from boring SB104 (Table 5) in the southern UST basin (Figure 3).

3.2 Groundwater Investigation Results

Groundwater was encountered between elevations of 826 and 829 feet during this investigation. The uppermost continuously saturated unit at the site is the till unit. The general groundwater flow direction within the till appears to be to the northwest, although the unit's low hydraulic conductivity, seasonal water table fluctuations, and sewer line influences appear to cause inconsistent horizontal flow directions. VOCs, GRO compounds, and DRO compounds have not been detected in samples collected from wells MW101 and MW103. Free product is present in well MW102.

3.2.1 Groundwater Occurrence

The top of the saturated zone was encountered between elevations of 826 and 829 feet MSL. This was within the dense silty sand till deposit at most boring locations (Figures 5 and 6). The till samples were moist to wet; however, sand lenses within the till were usually saturated. At each boring location, water filled the augers and stabilized to an elevation between 826 and 829 feet MSL. This was a few feet below the upper till surface at all of the locations except SB104, which is located in the till depression. The lower 0.7 feet of alluvium was saturated at SB104. Alluvium beneath the till was saturated and low permeability units beneath the till were moist. The

monitoring wells were installed so that approximately 60 percent to 70 percent of each screen was located in the saturated zone. No zones of perched groundwater were encountered.

The elevations of the groundwater in the wells measured during the two sampling events are summarized in Table 4. The elevations range from 828.4 and 826.1 feet MSL. This indicates that the water table is located beneath the upper till surface except in the area of the depression. Product was encountered in wells MW102 (1.71 to 2.32 feet) and MW4 (0.01 feet). A corrected water table elevation for these wells was calculated by multiplying the free product thickness by a correction factor of 0.76, and then adding this value to the elevation of the free product/water interface. The 0.76 specific gravity correction factor, which is slightly higher than the specific gravity of gasoline, has been used for the M & H site (Geraghty and Miller, 1996) and was also used for the Lake and Hiawatha site. This factor was chosen since products with higher specific gravities may have sold at the gasoline station prior to Clark's sale of only gasoline in the 1960s. The corrected elevations are shown in Table 4. The corrected elevations appear to indicate that a water table "mound" is present near MW102.

Prior data show that groundwater elevations have fluctuated in the past. Annual fluctuation at the sites has been greater than 3 feet, and some wells have experienced a total fluctuation greater than 5 feet since installation (Geraghty and Miller, 1996).

3.2.2 Groundwater Flow

Groundwater flow in the unsaturated zone is downward vertical seepage to the upper surface of the till unit. The till surface likely directs flow laterally along its sloping surface (Figure 7) until the saturated zone is encountered.

Hydraulic conductivities in the till are calculated to be 1.0×10^{-5} feet/minute (1.4×10^{-2} feet/day) at MW101 and 3.3×10^{-4} feet/minute (4.8×10^{-1} feet/day) at MW103 (Appendix E). During sampling, the wells were able to sustain pumping rates of approximately 0.25 gallons per minute (Appendix F). Using these hydraulic conductivities, a gradient of 0.01 feet/feet from Figure 8, and an estimated porosity of 0.3 (representative value for silty sand), an average linear groundwater flow velocity (horizontal) was calculated to be between 0.2 and 6.0 feet/year.

The groundwater elevations measured during the two sampling events are shown on Figures 8 and 9. These patterns indicate a general flow direction toward the northwest. During the December event, it appeared that groundwater flow was north from MW101 towards the site

(Figure 9). Data from the M & H site (Geraghty and Miller, 1996) indicate that groundwater flow has been generally to the north-northwest. Flow direction reversal (towards the south) was noted by Geraghty and Miller (1996) from December 1991 through January 1992. Groundwater elevations were relatively higher during the reported flow direction reversals.

These data indicate that the direction of groundwater flow in the vicinity of the Lake and Hiawatha site may be inconsistent. Apparent horizontal flow directions can be uncertain and may be stagnant, due to inconsistent elevation changes at individual monitoring wells. Inconsistent flow directions are commonly observed in low permeability water table aquifers because they are typically dominated by vertical seepage and/or evapotranspiration flux. As a result, at times there may be very little actual horizontal flow of groundwater at the site.

In addition, the groundwater elevations (and therefore flow directions) may be influenced by storm and sanitary sewers located beneath Lake Street and Hiawatha Avenue. The sewer below Hiawatha is at an elevation of approximately 832 feet MSL (Geraghty and Miller, 1996), and flow is to the north (Figures 8 and 9). Because these elevations are above the observed water table, this sewer probably does not influence groundwater elevations (unless the pipe is leaking). The sewer beneath Lake Street is at an elevation of approximately 829 feet MSL (Geraghty and Miller, 1996) and flows to the east (Figures 8 and 9). This sewer elevation is within the range of elevations at which the water table occurs, especially near Lake Street between wells MW4 and MW101. It appears that the water table intersects the Lake Street sewer line near the eastern portion of the site (Figures 8 and 9). Influences from the sewer lines are the most probable cause of the apparent groundwater flow divide across the Lake and Hiawatha site.

3.2.3 Groundwater Analytical Results

VOCs, GRO compounds, and DRO compounds were not detected in the groundwater samples collected from wells MW101 and MW103 during either sampling event (Table 6). It should be noted that no chlorinated hydrocarbons were detected during the VOC analyses (Table 6). Lead was detected in samples collected from well MW101 during both events at concentrations that ranged from 0.0010 to 0.0013 mg/L. Lead was not detected in the samples collected from well MW103 (Table 6).

3.2.4 Well Search Results

The well search performed by LBG (1991) identified twenty-one wells within a one-mile radius of the M & H and the Lake and Hiawatha sites. All of the wells are cased through the unconsolidated fill and glacial sediments and the Decorah Shale. All of the wells, except one located 0.77 miles west of the site, are also cased through the Platteville Limestone and the Glenwood Formation. One well was completed from the St. Peter Sandstone down into the Prairie du Chien Group and one well was completed from the St. Peter Sandstone down into the Galesville Sandstone. Six wells were completed in only the St. Peter Sandstone. The remainder of the wells were completed in the Prairie du Chien Group or deeper formations (LBG, 1991).

The well closest to the Lake and Hiawatha site is located approximately 500 feet northeast of the site and is completed from the Prairie du Chien Group down into the St. Lawrence Formation. The next closest well is located approximately 1,000 feet northeast of the site and is completed in the St. Peter Sandstone. No wells are located within the one-mile radius in what is believed to be the general downgradient direction (northwest) of the site. The well completed from the St. Peter Sandstone down into the Galesville Sandstone is located approximately 1,700 feet north of the site. One well completed in the Hinkley Formation is located approximately 2,200 feet north-northwest of the site (LBG, 1991).

4.0 Discussion

The results of the investigations indicate that the extent of contaminated soil in the unsaturated zone is very limited. The identified impacts at the site are present mostly in the saturated zone due to a limited pool of light, nonaqueous-phase liquid (LNAPL), or free product, at the water table.

4.1 Soil Quality

The following discussion of soil quality is divided into two sections, the unsaturated zone and the saturated zone, since much of the observed contamination in soil in the saturated zone results from chemical migration in groundwater rather than from a release of product at a directly overlying location.

4.1.1 Unsaturated Zone

At all boring locations at the Lake and Hiawatha site, except SB104 and SB107, the soils in the unsaturated zone showed no evidence of contamination. Although one sample of the fill from boring SB109 had a slightly elevated organic vapor concentration, there were no other indications of possible contamination at this location. This would indicate that these two boring locations are near possible sources of contamination. As Figure 3 shows, these borings are located in the southern UST basin and the bulk storage facility.

4.1.2 Saturated Zone

The soil at the water table exhibited evidence of contamination at all borings except MW101, MW103, and ST-247 (Figure 3). The gray to black laminations observed in the till are evidence of a smear zone, or an interval of thin bands of residual contamination left by a fluctuating water table. The average thickness of this smear zone is approximately 3 feet. GRO and DRO analytical data for samples collected from this interval are shown on Figure 10. The concentrations were greatest in samples collected from borings SB104, SB107, and ST-248. The results from borings SB104 and SB107 support the hypothesis that these borings were placed close to contaminant

source areas. The data from boring ST-248 corresponds with the fact that product has collected in well MW102, which was placed near the location of ST-248.

The contamination in the soil in the saturated zone is due to the migration of contaminants in groundwater. Dissolved constituents have migrated to the locations of borings SB108 and SB105 (Figure 10). Borings SB106 and SB109 were apparently placed on the edge of the contaminant plume. Borings MW101, MW103, and ST-247 were placed beyond the contaminant plume.

4.2 Free Product Extent

Free product was detected in wells MW102 and MW4 during both sampling events (Table 4). Due to the low permeability of the till unit, it was difficult to determine during soil boring advancement whether free product was present. Free product has also been detected in wells MW1 and MW2 at the M & H site (Geraghty and Miller, 1996). Product was detected in well MW1 from August 7, 1989, until May 9, 1991, and was recovered from the well from January 1990 into May 1991. Product was detected in well MW2 from March 21 until May 3, 1995. Although product was not detected in this well from May 1991 until March 1995, or after May 1995, it should be noted that the groundwater elevations during both of these time periods were above the top elevation of the well screen, which would prevent product from entering the well. Therefore, product may actually have been present at the location of MW2 for longer periods of time. Figure 11 shows the estimated extent of free product that has been detected at both of the sites, prior to product recovery.

The source of the product appears to have been leaking USTs at the sites. In addition to the Lake and Hiawatha site USTs, it is also possible that product released at the M & H site has migrated to the Lake and Hiawatha site. Product released from the M & H site would migrate downward through the fill and alluvium until encountering the upper surface of the till. As shown on Figures 5 and 7, the upper surface of the till near the former M & H UST basins is above the water table and slopes downward to the east, toward the Lake and Hiawatha site. Any product not infiltrating the till would likely flow along the till surface toward the depressions beneath the Lake and Hiawatha site.

4.3 Groundwater Quality

No VOCs, GRO, or DRO compounds have been detected in samples collected from wells MW101 or MW103. These results indicate that there has been no migration of petroleum constituents as a dissolved plume along groundwater flow directions, or through diffusion of contaminants, to the locations of these two wells. The lead concentrations detected in the samples from well MW101 are below regulatory levels of concern. The lack of chlorinated compounds in the samples indicates that groundwater has not been impacted by dry cleaning activities at the site.

The extent of the contaminant plume on the site is best illustrated by the extent of contaminated soils at the water table, as described above in Section 4.1 and shown on Figure 10. As presented in Section 3.2.2, groundwater flow is apparently to the northwest, but is variable. The flow may become stagnant at times or may be influenced by the storm sewer located beneath Lake Street. Groundwater quality northwest of the site has been characterized by M & H well MW-6. Petroleum-related compounds were detected in samples collected from this well (Geraghty & Miller, 1996) and the results are shown on Figure 11. This impact may be due to a contaminated groundwater plume migrating from the M & H site, the Lake and Hiawatha site, or both sites. No petroleum-related compounds were detected in a groundwater sample collected from a Geoprobe boring placed approximately 200 feet north-northwest of MW-6 (Geraghty and Miller, 1996).

The vertical migration of contaminants to deeper aquifers through the unconsolidated deposits is not viewed as a risk due to the presence of the low permeability till units beneath the site, and the LNAPL-related chemicals (petroleum products) at the source areas.

The risk of this plume impacting a resource aquifer is low. Since the hydraulic conductivity of till is low and the unit is not a viable source of water in the area, it is not a resource aquifer (MPCA, 1995). The well search (LBG, 1991) indicates that all wells within one mile of the site are cased through unconsolidated sediments and the Decorah Shale. None of the wells appear to be located generally downgradient of the site. Therefore, the low hydraulic conductivity of the till, the depth of the casings of the identified wells, and the locations of the identified wells indicate that the potential impact to these wells from a dissolved plume at the Lake and Hiawatha site is extremely low.

5.0 Recommendations

As stated in Section 1, the future planned use for the site is for highway structures to be built during the TH 55 reconstruction. There will be no opportunity for the public to come into contact with the soil at the site following construction, since the site will be covered with an on-ramp, a retaining wall, and bridge footings. In addition, most of the site soils are already covered with a layer of asphalt. Further, the extent of contaminated soil above the water table is limited to the areas near borings SB104 and SB107. Therefore, it is recommended that the soils be left in place. It is possible that contaminated soil may be encountered during utility installation and road construction. This soil should be addressed as needed during these activities.

Although groundwater at the site has been impacted by petroleum products, the extent of the impacts appears to be limited. Petroleum constituents detected northwest of the site at well MW6 may be due to a contaminant plume migrating from the M & H site, the Lake and Hiawatha site, or from both sites. The impacted groundwater is not part of a resource aquifer. The corridor in which the site is located is industrialized, with several known sites of contamination. A groundwater monitoring program could be implemented using the existing well network; no additional well installations would be necessary. The goal of any monitoring program should be to provide site data to evaluate natural attenuation mechanisms. If attenuation can be documented at the site, no further monitoring should be necessary given the intended use of the property.

Free product is present at the site, and possible free-product receptors include utilities and trenches. The water table and free product are located at a depth of approximately 14 feet below grade. The storm sewer beneath Lake Street is at a depth of approximately 16.5 feet. The storm sewer beneath Hiawatha Avenue is located at a depth of approximately 9 feet. The deepest excavations to be completed during the road construction will be to depths of approximately 10 feet (for bridge footings). Although the potential risk of exposure to free product and contaminated groundwater in the trenches and the sewer beneath Hiawatha Avenue will be low, it is necessary to assess the risk of vapors entering these features. It is possible that contaminated groundwater or free product could enter the sewer trench beneath Lake Street. Therefore, it is recommended that a vapor risk assessment be completed on the Lake Street sewer line east of the Lake Street/Hiawatha Avenue intersection.

It is recommended that free product should be recovered from the site. Two methods of recovery are suggested. The first method would be the continuation of passive product recovery at existing monitoring wells where free product has been detected. The second method would be to excavate a trench to the water table and recover the product that collects in the trench with a vacuum truck or through other temporary construction means. This could be effectively completed during highway construction. Free-product recovery would serve to remove the source of groundwater contamination and reduce the risk of vapors or product entering utilities. Once free product is recovered, the concentrations of residual contaminants in the groundwater would be eventually lowered by natural attenuation.

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Table 1

Soil Boring Summary

Soil Boring	Ground Surface Elevation (feet MSL)	Total Depth (feet)	Bottom Elevation (feet MSL)	Rationale
MW(SB)101	841.7	22.0	819.7	Upgradient well/boring
MW(SB)102	842.6	20.0	822.6	Investigate possible impact from fuel dispensers and migration from M&H site
MW(SB)103	841.5	20.0	821.5	Downgradient well/boring
SB104	843.8	18.0	825.8	Investigate underground storage tank basin
SB105	841.9	24.0	817.9	Investigate underground storage tank basin
SB106	841.2	18.0	823.2	Delineate contamination east of MW-4
SB107	841.9	22.0	819.9	Investigate bulk storage area
SB108	841.8	18.0	823.8	Delineate contamination north of SB107
SB109	842.8	20.0	822.8	Investigate dry cleaner area

Table 2

Analytical Soil Sample Summary

Soil Boring	Soil Sample	Depth (feet)	Elevation (feet MSL)
SB104	04	6–8	837.8–835.8
	07	12–14	831.8–829.9
SB105	07	12–14	829.9–827.9
	11	20–22	821.9–819.9
SB106	07	12–14	829.2–827.2
SB107	07	12–14	829.9–827.9
SB108	08	14–16	827.8–825.8
SB109	08	14–16	828.8–826.8

Table 3

Monitoring Well Construction Summary

Well	Total Depth (feet BGS)	Elevation (feet MSL)			Well Diameter (inches)	Screen Slot Size (inches)	Screen Material	Riser Material
		Top of Riser	Ground Surface	Screen Interval				
MW101	19.9	844.17	841.7	821.8–831.8	2	0.01	Stainless steel	Black steel
MW102	19.9	844.58	842.6	822.7–832.7	2	0.01	Stainless steel	Black steel
MW103	19.5	843.46	841.5	822.0–832.0	2	0.01	Stainless steel	Black steel

BGS below ground surface

Table 4

Groundwater Elevation Summary

Well	Top of Riser Elevation (feet MSL)	11/2/95					12/4/95				
		Product		Water		Estimated (Corrected) Water Elevation (feet MSL)	Product		Water		Estimated (Corrected) Water Elevation (feet MSL)
		Depth (feet)	Elevation (feet MSL)	Depth (feet)	Elevation (feet MSL)		Depth (feet)	Elevation (feet MSL)	Depth (feet)	Elevation (feet MSL)	
MW101	844.17	NP	—	15.85	828.32	—	NP	—	16.15	828.02	—
MW102	844.58	14.75	829.83	16.46	828.12	829.42	14.50	830.08	16.82	827.76	829.52
MW103	843.36	NP	—	15.16	828.20	—	NP	—	15.76	827.60	—
MW1	845.76	NP	—	19.65	826.11	—	NP	—	19.27	826.49	—
MW2	845.55	NP	—	18.22	827.33	—	NP	—	18.32	827.23	—
MW3	848.98	NP	—	22.40	826.58	—	NP	—	21.93	827.05	—
MW4	846.61	19.03	827.58	19.04	827.57	827.58	19.15	827.46	19.16	827.45	827.46

NP not present

TABLE 5

SOIL QUALITY DATA
LAKE AND HIAWATHA RI

(concentrations in ug/kg)

	SB10404	SB10407	SB10507	SB10511	SB10607	SB10707	SB10808	SB10908
	10/18/95	10/19/95	10/18/95	10/18/95	10/19/95	10/18/95	10/24/95	10/24/95
Depth (feet)	6-8	12-14	12-14	20-22	12-14	12-14	14-16	14-16
Acetone	15	<14000	<650	19	12	<6600	<5.4	6.9
Allyl Chloride	<5.4	<14000	<650	<5.4	<11	<6600	<5.4	<5.4
Benzene	<1.1	<2800	<130	<1.1	<2.2	<1300	<1.1	<1.1
Bromobenzene	<1.1	<2800	<130	<1.1	<2.2	<1300	<1.1	<1.1
Bromochloromethane	<1.1	<2800	<130	<1.1	<2.2	<1300	<1.1	<1.1
Bromodichloromethane	<1.1	<2800	<130	<1.1	<2.2	<1300	<1.1	<1.1
Bromoform	<2.2	<2800	<130	<1.1	<2.2	<1300	<1.1	<1.1
Bromomethane	<1.1	<2800	<130	<2.2	<4.4	<1300	<2.2	<2.2
Butylbenzene	1.1	39000	270	<1.1	6.0	4900	<1.1	<1.1
Sec-butylbenzene	<1.1	8200	<130	<1.1	2.7	<1300	<1.1	<1.1
Tert-Butylbenzene	<1.1	<2800	<130	<1.1	<2.2	2200	<1.1	<1.1
Carbon Tetrachloride	<1.1	<2800	<130	<1.1	<2.2	<1300	<1.1	<1.1
Chlorobenzene	<1.1	<2800	<130	<1.1	<2.2	<1300	<1.1	<1.1
Chloroethane	<2.2	<2800	<130	<2.2	<4.4	<1300	<2.2	<2.2
Chloroform	<1.1	<2800	<130	<1.1	<2.2	<1300	<1.1	<1.1
Chloromethane	<1.1	<2800	<130	<1.1	<2.2	<1300	<1.1	<1.1
o-Chlorotoluene	<1.1	<2800	<130	<1.1	<2.2	<1300	<1.1	<1.1
p-Chlorotoluene	<1.1	<2800	<130	<1.1	<2.2	<1300	<1.1	<1.1
1,2-Dibromo-3-chloropropane	<1.1	<2800	<130	<1.1	<2.2	<1300	<1.1	<1.1
Chlorodibromomethane	<1.1	<2800	<130	<1.1	<2.2	<1300	<1.1	<1.1
Dichlorofluoromethane	<1.1	<2800	<130	<1.1	<2.2	<1300	<1.1	<1.1
1,2-Dibromoethane	<1.1	<2800	<130	<1.1	<2.2	<1300	<1.1	<1.1
Dibromomethane (Methylene Bromide)	<1.1	<2800	<130	<1.1	<2.2	<1300	<1.1	<1.1
1,2-Dichlorobenzene	<1.1	<2800	<130	<1.1	<2.2	<1300	<1.1	<1.1
1,3-Dichlorobenzene	<1.1	<2800	<130	<1.1	<2.2	<1300	<1.1	<1.1
1,4-Dichlorobenzene	<1.1	<2800	<130	<1.1	<2.2	<1300	<1.1	<1.1
Dichlorodifluoromethane	<1.1	<2800	<130	<1.1	<2.2	<1300	<1.1	<1.1
1,1-Dichloroethane	<1.1	<2800	<130	<1.1	<2.2	<1300	<1.1	<1.1
1,2-Dichloroethane	<1.1	<2800	<130	<1.1	<2.2	<1300	<1.1	<1.1
1,1-Dichloroethylene	<1.1	<2800	<130	<1.1	<2.2	<1300	<1.1	<1.1
1,2-Dichloroethylene, cis	<1.1	<2800	<130	<1.1	<2.2	<1300	<1.1	<1.1
1,2-Dichloroethylene, trans	<1.1	<2800	<130	<1.1	<2.2	<1300	<1.1	<1.1
1,2-Dichloropropane	<1.1	<2800	<130	<1.1	<2.2	<1300	<1.1	<1.1
1,3-Dichloropropane	<1.1	<2800	<130	<1.1	<2.2	<1300	<1.1	<1.1
2,2-Dichloropropane	<1.1	<2800	<130	<1.1	<2.2	<1300	<1.1	<1.1
1,1-Dichloro-1-propene	<1.1	<2800	<130	<1.1	<2.2	<1300	<1.1	<1.1
Cis-1,3-Dichloro-1-propene	<1.1	<2800	<130	<1.1	<2.2	<1300	<1.1	<1.1
Trans-1,3-Dichloro-1-propene	<1.1	<2800	<130	<1.1	<2.2	<1300	<1.1	<1.1
Ethyl Benzene	<1.1	7000	<130	<1.1	<2.2	2200	<1.1	<1.1
Ethyl Ether	<1.1	<2800	<130	<1.1	<2.2	<1300	<1.1	<1.1
Hexachlorobutadiene	<1.1	<2800	<130	<1.1	<2.2	<1300	<1.1	<1.1
Cumene	<1.1	<2800	<130	<1.1	<2.2	5600	<1.1	<1.1
p-Cymene (Isopropyltoluene)	<1.1	<2800	<130	<1.1	3.3	<1300	<1.1	<1.1
Methyl Ethyl Ketone	<5.4	<14000	<650	<5.4	<11	<6600	<5.4	<5.4
Methyl Isobutyl Ketone	<5.4	<14000	<650	<5.4	<11	<6600	<5.4	<5.4
tert-Butyl Methyl Ether	<1.1	<2800	<130	<1.1	<2.2	<1300	<1.1	<1.1
Methylene Chloride	<5.4	<14000	<650	<5.4	<11	<6600	<5.4	<5.4
Naphthalene	<1.1	9200	280	4.1	<2.2	3900	<1.1	<1.1
Propylbenzene	1.4	<2800	<130	<1.1	2.2	2300	<1.1	<1.1
Styrene	<1.1	<2800	<130	<1.1	<2.2	<1300	<1.1	<1.1

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TABLE 5 (cont.)

SOIL QUALITY DATA
LAKE AND HIAWATHA RI

(concentrations in ug/kg, unless noted otherwise)

	SB10404	SB10407	SB10507	SB10511	SB10607	SB10707	SB10808	SB10908
	10/18/95	10/19/95	10/18/95	10/18/95	10/19/95	10/18/95	10/24/95	10/24/95
Depth (feet)	6-8	12-14	12-14	20-22	12-14	12-14	14-16	14-16
1,1,1,2-Tetrachloroethane	<1.1	<2800	<130	<1.1	<2.2	<1300	<1.1	<1.1
1,1,2,2-Tetrachloroethane	<1.1	<2800	<130	<1.1	<2.2	<1300	<1.1	<1.1
Tetrachloroethylene	<1.1	<2800	<130	<1.1	<2.2	<1300	<1.1	<1.1
Tetrahydrofuran	<5.4	<14000	<650	<5.4	<11	<6600	<5.4	<5.4
Toluene	<1.1	<2800	<130	<1.1	<2.2	<1300	<1.1	<1.1
1,2,3-Trichlorobenzene	<1.1	<2800	<130	<1.1	<2.2	<1300	<1.1	<1.1
1,2,4-Trichlorobenzene	<1.1	<2800	<130	<1.1	<2.2	<1300	<1.1	<1.1
1,1,1-Trichloroethane	<1.1	<2800	<130	<1.1	<2.2	<1300	<1.1	<1.1
1,1,2-Trichloroethane	<1.1	<2800	<130	<1.1	<2.2	<1300	<1.1	<1.1
Trichloroethylene	<1.1	<2800	<130	<1.1	<2.2	<1300	<1.1	<1.1
Trichlorofluoromethane	<1.1	<2800	<130	<1.1	<2.2	<1300	<1.1	<1.1
1,2,3-Trichloropropane	<1.1	<2800	<130	<1.1	<2.2	<1300	<1.1	<1.1
Trichlorotrifluoroethane	<1.1	<2800	<130	<1.1	<2.2	<1300	<1.1	<1.1
1,2,4-Trimethylbenzene	2.1	78000	410	<1.1	<2.2	10000	<1.1	<1.1
1,3,5-Trimethylbenzene	<1.1	17000	<130	<1.1	<2.2	<1300	<1.1	<1.1
Vinyl Chloride	<1.1	<2800	<130	<1.1	<2.2	<1300	<1.1	<1.1
m & p Xylene	<2.1	21000	<260	<2.2	<4.3	<2700	<2.2	<2.1
o-Xylene	<1.1	6400	<130	<1.1	<2.2	<1300	<1.1	<1.1
Gasoline Range Organics, mg/kg	33	1200	260	0.76	21	600	130	1.1
Diesel Range Organics, mg/kg	<85	830	180	5.5	6.1	370	160	<4.2
Lead, mg/kg	185	187	3.21	2.89	3.13	3.33	2.76	23.2

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TABLE 6

GROUNDWATER QUALITY DATA
LAKE AND HIAWATHA RI

(concentrations in ug/L)

	MW101		MW103		
	11/02/95	12/04/95	11/02/95	12/04/95 Sample	12/04/95 Duplicate
Acetone	<5.0	<5.0	<5.0	<5.0	<5.0
Allyl Chloride	<5.0	<5.0	<5.0	<5.0	<5.0
Benzene	<1.0	<1.0	<1.0	<1.0	<1.0
Bromobenzene	<1.0	<1.0	<1.0	<1.0	<1.0
Bromochloromethane	<1.0	<1.0	<1.0	<1.0	<1.0
Bromodichloromethane	<1.0	<1.0	<1.0	<1.0	<1.0
Bromoform	<1.0	<1.0	<1.0	<1.0	<1.0
Bromomethane	<1.0	<1.0	<1.0	<1.0	<1.0
Butylbenzene	<1.0	<1.0	<1.0	<1.0	<1.0
Sec-butylbenzene	<1.0	<1.0	<1.0	<1.0	<1.0
Tert-Butylbenzene	<1.0	<1.0	<1.0	<1.0	<1.0
Carbon Tetrachloride	<1.0	<1.0	<1.0	<1.0	<1.0
Chlorobenzene	<1.0	<1.0	<1.0	<1.0	<1.0
Chloroethane	<1.0	<1.0	<1.0	<1.0	<1.0
Chloroform	<1.0	<1.0	<1.0	<1.0	<1.0
Chloromethane	<1.0	<1.0	<1.0	<1.0	<1.0
o-Chlorotoluene	<1.0	<1.0	<1.0	<1.0	<1.0
p-Chlorotoluene	<1.0	<1.0	<1.0	<1.0	<1.0
1,2-Dibromo-3-chloropropane	<1.0	<1.0	<1.0	<1.0	<1.0
Chlorodibromomethane	<1.0	<1.0	<1.0	<1.0	<1.0
Dichlorofluoromethane	<1.0	<1.0	<1.0	<1.0	<1.0
1,2-Dibromoethane	<1.0	<1.0	<1.0	<1.0	<1.0
Dibromomethane (Methylene Bromide)	<1.0	<1.0	<1.0	<1.0	<1.0
1,2-Dichlorobenzene	<1.0	<1.0	<1.0	<1.0	<1.0
1,3-Dichlorobenzene	<1.0	<1.0	<1.0	<1.0	<1.0
1,4-Dichlorobenzene	<1.0	<1.0	<1.0	<1.0	<1.0
Dichlorodifluoromethane	<1.0	<1.0	<1.0	<1.0	<1.0
1,1-Dichloroethane	<1.0	<1.0	<1.0	<1.0	<1.0
1,2-Dichloroethane	<1.0	<1.0	<1.0	<1.0	<1.0
1,1-Dichloroethylene	<1.0	<1.0	<1.0	<1.0	<1.0
1,2-Dichloroethylene, cis	<1.0	<1.0	<1.0	<1.0	<1.0
1,2-Dichloroethylene, trans	<1.0	<1.0	<1.0	<1.0	<1.0
1,2-Dichloropropane	<1.0	<1.0	<1.0	<1.0	<1.0
1,3-Dichloropropane	<1.0	<1.0	<1.0	<1.0	<1.0
2,2-Dichloropropane	<1.0	<1.0	<1.0	<1.0	<1.0
1,1-Dichloro-1-propene	<1.0	<1.0	<1.0	<1.0	<1.0
Cis-1,3-Dichloro-1-propene	<1.0	<1.0	<1.0	<1.0	<1.0
Trans-1,3-Dichloro-1-propene	<1.0	<1.0	<1.0	<1.0	<1.0
Ethyl Benzene	<1.0	<1.0	<1.0	<1.0	<1.0
Ethyl Ether	<1.0	<1.0	<1.0	<1.0	<1.0
Hexachlorobutadiene	<1.0	<1.0	<1.0	<1.0	<1.0
Cumene	<1.0	<1.0	<1.0	<1.0	<1.0
p-Cymene (Isopropyltoluene)	<1.0	<1.0	<1.0	<1.0	<1.0
Methyl Ethyl Ketone	<5.0	<5.0	<5.0	<5.0	<5.0
Methyl Isobutyl Ketone	<5.0	<5.0	<5.0	<5.0	<5.0
tert-Butyl Methyl Ether	<1.0	<1.0	<1.0	<1.0	<1.0
Methylene Chloride	<5.0	<5.0	<5.0	<5.0	<5.0
Naphthalene	<1.0	<1.0	<1.0	<1.0	<1.0
Propylbenzene	<1.0	<1.0	<1.0	<1.0	<1.0
Styrene	<1.0	<1.0	<1.0	<1.0	<1.0

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TABLE 6 (cont.)

GROUNDWATER QUALITY DATA
LAKE AND HIAWATHA RI

(concentrations in ug/L, unless noted otherwise)

	MW101		MW103		
	11/02/95	12/04/95	11/02/95	12/04/95 Sample	12/04/95 Duplicate
1,1,1,2-Tetrachloroethane	<1.0	<1.0	<1.0	<1.0	<1.0
1,1,2,2-Tetrachloroethane	<1.0	<1.0	<1.0	<1.0	<1.0
Tetrachloroethylene	<1.0	<1.0	<1.0	<1.0	<1.0
Tetrahydrofuran	<5.0	<5.0	<5.0	<5.0	<5.0
Toluene	<1.0	<1.0	<1.0	<1.0	<1.0
1,2,3-Trichlorobenzene	<1.0	<1.0	<1.0	<1.0	<1.0
1,2,4-Trichlorobenzene	<1.0	<1.0	<1.0	<1.0	<1.0
1,1,1-Trichloroethane	<1.0	<1.0	<1.0	<1.0	<1.0
1,1,2-Trichloroethane	<1.0	<1.0	<1.0	<1.0	<1.0
Trichloroethylene	<1.0	<1.0	<1.0	<1.0	<1.0
Trichlorofluoromethane	<1.0	<1.0	<1.0	<1.0	<1.0
1,2,3-Trichloropropane	<1.0	<1.0	<1.0	<1.0	<1.0
Trichlorotrifluoroethane	<1.0	<1.0	<1.0	<1.0	<1.0
1,2,4-Trimethylbenzene	<1.0	<1.0	<1.0	<1.0	<1.0
1,3,5-Trimethylbenzene	<1.0	<1.0	<1.0	<1.0	<1.0
Vinyl Chloride	<1.0	<1.0	<1.0	<1.0	<1.0
m & p Xylene	<2.0	<2.0	<2.0	<2.0	<2.0
o-Xylene	<1.0	<1.0	<1.0	<1.0	<1.0
Gasoline Range Organics, mg/L	<0.050	<0.050	<0.050	<0.050	<0.050
Diesel Range Organics, mg/L	<0.10	<0.10	<0.10	<0.10	<0.10
Lead, mg/L	0.0013	0.0010	<0.0006	<0.0006	<0.0006

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Source: Minneapolis South and St. Paul West, Minnesota Quadrangles, 7.5 Minute Series, 1993.

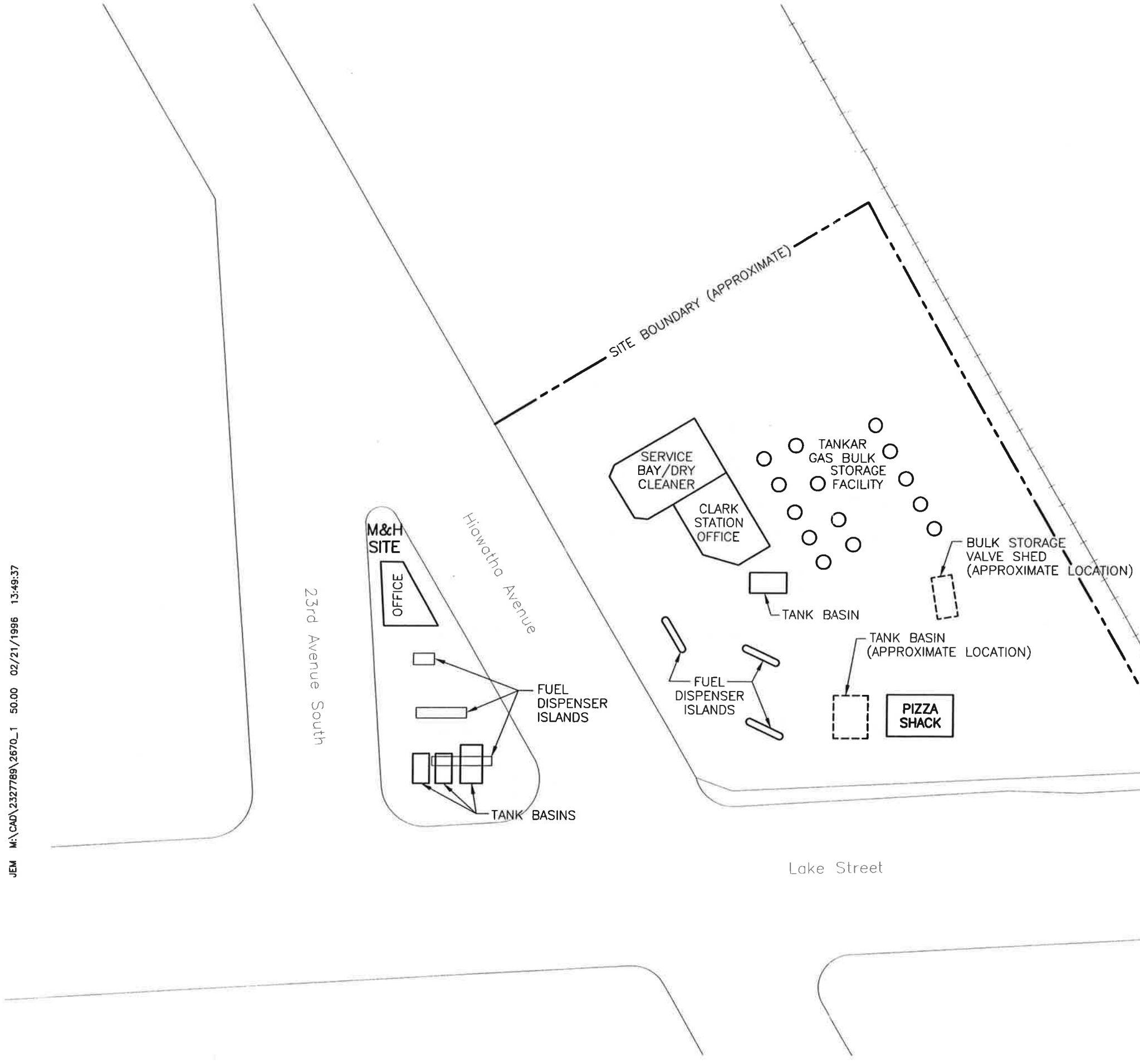
N

0 2000 4000

Scale in Feet

QUADRANGLE LOCATION

Figure 1
PROPERTY LOCATION MAP



0 50 100
SCALE IN FEET

Currently, no structures are present on the sites.

JEM M:\CAD\2327789\2670_1 50.00 02/21/1996 13:49:37

Figure 2

HISTORIC SITE FEATURES
Lake & Hiawatha RI
Minneapolis, Minnesota

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Figure 7

STRUCTURE CONTOUR MAP OF
UPPER TILL SURFACE
Lake & Hiawatha RI
Minneapolis, Minnesota

Appendix A

Soil Boring Logs

BORING LOG

PROJECT: Lake and Hiawatha (Clark Station) RI
DATE STARTED: 10/23/95
DATE COMPLETED: 10/23/95
FIELD INSPECTOR: G. Remple (BEC)
CREW CHIEF: C. Bonde (AET)

BORING NUMBER: MW101
GROUND SURFACE ELEVATION: 841.7 Ft. MSL
TOTAL DEPTH OF HOLE (FT): 22.0
DEPTH TO GROUNDWATER (FT): 14.0
DRILLING METHOD: 4-1/4" ID HSA

Depth (Feet)	Sample Type/No.	Analytical Sample Number	Sample Recovery (Ft.)	P.I.D. Headspace (ppm)	Oil Sheen	Moisture Content	Lithologic Unit	ASTM Soil Classification	DESCRIPTION OF MATERIALS AND REMARKS
0–5	SB01	NA	1.6	1.9	n	Moist	Fill	SM	SILTY SAND WITH GRAVEL – black, brown, and gray fine to medium sand with approximately 20% silt, 15% gravel, 0–5% clay, contains fragments of concrete and asphalt, no odor, no sheen (FILL).
	SB02		1.2	0.2					
5–10	SB03		1.3	0.4			Fill/Soil	CL	LEAN CLAY WITH SAND – black (10YR2/1) to grayish brown (10YR5/2), firm, massive, approximately 15% fine sand, no odor, no sheen.
	SB04		1.4	0.2			Alluvium	SP-SM	POORLY GRADED SAND/POORLY GRADED SAND WITH SILT – brown (10YR4-5/3), stratified, approximately 70 to 75% fine-grained sand, 15% medium-grained sand, 5% coarse-grained sand, 0–5% gravel, 5–10% silt, no odor, no sheen (ALLUVIUM). sand becomes coarse with 40% gravel, 9.7'–10.0'.
	SB05		1.4	0.4					
10–15	SB06		1.9	0.2			Till	SM	SILTY SAND – reddish-brown (5YR4/3), dense, hard, faint stratification, fine- to medium-grained sand with 5% coarse sand, 0–5% fine gravel, 25–30% silt, 5–10% clay, no odor, no sheen (TILL).
	SB07		2.0	0.2					
15–20	SB08		2.0	0.2				SM/SC	SILTY CLAYEY SAND/CLAYEY SILTY SAND – brown (7.5YR4/2), dense, very hard, massive, fine- to medium-grained sand with 5% coarse sand, 0–5% fine gravel, 20–15% silt, 15–20% clay, no odor, no sheen (TILL)
	SB09		2.0	ND					
20–25	SB10		2.0	ND					
	SB11		1.9	0.4				CL	LEAN CLAY – dark gray (10YR4/1), firm, massive, approximately 5% fine sand, no odor, no sheen (TILL).
25–30									*End of sampling at 22.0'. Monitoring Well MW101 installed in borehole*

COMMENTS: Borehole advanced and well installed by American Engineering Testing (AET) of St. Paul, Minnesota. Boring advanced using 4.25" ID hollow stem augers. Split barrel (SB) samples collected in accordance with ASTM D1586. Soil samples classified in accordance with ASTM D2488.

BORING LOG

PROJECT: Lake and Hiawatha (Clark Station) RI
DATE STARTED: 10/20/95
DATE COMPLETED: 10/20/95
FIELD INSPECTOR: G. Remple (BEC)
CREW CHIEF: B. Roman (AET)

BORING NUMBER: MW102
GROUND SURFACE ELEVATION: 842.6 Ft. MSL
TOTAL DEPTH OF HOLE (FT): 20.0
DEPTH TO GROUNDWATER (FT): 13.1
DRILLING METHOD: 4-1/4" ID HSA

Depth (Feet)	Sample Type/No.	Analytical Sample Number	Sample Recovery (Ft.)	P.I.D. Headspace (ppm)	Oil Sheen	Moisture Content	Lithologic Unit	ASTM Soil Classification	DESCRIPTION OF MATERIALS AND REMARKS
0	SB01	NA	1.4	7.5	n	Moist	Fill	SM	SILTY SAND WITH GRAVEL - black, brown, and gray fine to medium sand with approximately 20% silt, 15% gravel, 0-5% clay, contains fragments of concrete and asphalt, no odor, no sheen (FILL).
	SB02		1.6	6.2					
5	SB03		1.7	2.1		Sl Moist	Alluvium		SILTY SAND/POORLY GRADED SAND WITH SILT - light olive brown (2.5YR5/3), approximately 80 - 90% fine-grained sand, 10 - 20% silt, no odor, no sheen (ALLUVIUM).
	SB04		1.3	ND				SP-SM	POORLY GRADED SAND/POORLY GRADED SAND WITH SILT - brown (10YR5/3), stratified, approximately 60 - 75% fine-grained sand, 15 - 25% medium-grained sand, 5 - 10% coarse-grained sand, 0-5% gravel, 5-10% silt, no odor, no sheen (ALLUVIUM).
	SB05		1.8	1.0					
10	SB06		1.0	0.5		Moist			
	SB07		1.4	660	l-m				SILTY SAND - brown (7.5YR4/2 - 5/3), dense, hard, fine- to medium-grained sand with 5% coarse sand, 0-5% fine gravel, 25-30% silt, 5-10% clay. From 12.3' to 14.0', unit exhibits thin laminations of black discoloration, moderate to strong petroleum hydrocarbon odor, light to moderate sheen. No discoloration, weak to moderate petroleum hydrocarbon odor, no to light sheen from 14.0' to 17.6' (TILL).
15	SB18		2.0	327			Till	SM	
	SB09		1.6	282	n-l	V Moist			
	SB10		1.7	250	h	Sat		SP	Poorly graded sand lens from 17.6' to 18.2'. Dark grayish-brown (10YR4/2), stratified, strong petroleum hydrocarbon odor, heavy sheen.
20					n	V Moist		SM	Till exhibits weak to moderate petroleum hydrocarbon odor, no sheen from 18.2' to 20.0'.
									End of sampling at 20.0'. Monitoring Well MW102 installed in borehole
25									
30									

COMMENTS: Borehole advanced and well installed by American Engineering Testing (AET) of St. Paul, Minnesota. Boring advanced using 4.25" ID hollow stem augers. Split barrel (SB) samples collected in accordance with ASTM D1586. Soil samples classified in accordance with ASTM D2488.

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BORING LOG

PROJECT: Lake and Hiawatha (Clark Station) RI
DATE STARTED: 10/19/95
DATE COMPLETED: 10/20/95
FIELD INSPECTOR: G. Remple (BEC)
CREW CHIEF: C. Bonde/B. Roman (AET)

BORING NUMBER: MW103
GROUND SURFACE ELEVATION: 842.6 Ft. MSL
TOTAL DEPTH OF HOLE (FT): 20.0
DEPTH TO GROUNDWATER (FT): 13.1
DRILLING METHOD: 4-1/4" ID HSA

Depth (Feet)	Sample Type/No.	Analytical Sample Number	Sample Recovery (Ft.)	P.I.D. Headspace (ppm)	Oil Sheen	Moisture Content	Lithologic Unit	ASTM Soil Classification	DESCRIPTION OF MATERIALS AND REMARKS	Depth (Feet)
0	SB01	NA	1.7	0.5	n	Moist	Fill	SM	SILTY SAND WITH GRAVEL - black, brown, and gray fine to medium sand with approximately 20% silt, 15% gravel, 0-5% clay, contains coal fines, fragments of concrete, no odor, no sheen (FILL).	0
5	SB02		1.8	1.7						5
	SB03		1.7	0.1				CL	LEAN CLAY - grayish-brown (2.5Y5/2) soft to firm, a few fractures filled with brown (7.5YR4/4) silt, approximately 5% fine sand, no odor, no sheen.	
	SB04		1.4	ND		V Moist	Alluvium	SP-SM	POORLY GRADED SAND/POORLY GRADED SAND WITH SILT - brown (10YR5/3) to dark grayish-brown (10YR4/2), stratified, approximately 60 - 75% fine-grained sand, 15 - 25% medium-grained sand, 5 - 10% coarse-grained sand, 0-5% gravel, 5-10% silt, no odor, no sheen (ALLUVIUM).	
10	SB05		1.4	ND						10
	SB06		1.3	1.1				SP	POORLY GRADED SAND WITH GRAVEL - brown (10YR4/2-3), stratified, approximately 10% fine-grained sand, 45% medium-grained sand, 20% coarse-grained sand, 20% gravel, 5% silt, no odor, no sheen (ALLUVIUM).	
	SB07		1.1	1.7		Moist	Till	SM	SILTY SAND - brown (7.5YR4/2), dense, hard, fine- to medium-grained sand with 5% coarse sand, 0-5% fine gravel, 25-30% silt, 5-10% clay, no odor, no sheen (TILL).	
15	SB08		1.2	1.9						15
	SB09		1.5	1.6		V Moist/ wet			Till contains a few thin (<0.1') lenses of saturated fine-grained sand from 16.0' to 20.0'.	
	SB10		1.6	0.5						
20									*End of sampling at 20.0'. Monitoring Well MW103 installed in borehole*	20
25										25
30										30

COMMENTS: Borehole advanced and well installed by American Engineering Testing (AET) of St. Paul, Minnesota. Boring advanced using 4.25" ID hollow stem augers. Split barrel (SB) samples collected in accordance with ASTM D1586. Soil samples classified in accordance with ASTM D2488.

BORING LOG

PROJECT: Lake and Hiawatha (Clark Station) RI
DATE STARTED: 10/19/95
DATE COMPLETED: 10/19/95
FIELD INSPECTOR: G. Remple (BEC)
CREW CHIEF: C. Bonde (AET)

BORING NUMBER: SB104
GROUND SURFACE ELEVATION: 843.8 Ft. MSL
TOTAL DEPTH OF HOLE (FT): 18.0
DEPTH TO GROUNDWATER (FT): 14.0
DRILLING METHOD: 3-1/4" ID HSA

Depth (Feet)	Sample Type/No.	Analytical Sample Number	Sample Recovery (Ft.)	P.I.D. Headspace (ppm)	Oil Sheen	Moisture Content	Lithologic Unit	ASTM Soil Classification	DESCRIPTION OF MATERIALS AND REMARKS
0	SB01		1.9	5.3		Moist	Fill	SM	SILTY SAND WITH CLAY AND GRAVEL – black and brown fine to medium sand with approximately 20% silt, 15% gravel, 5–10% clay, contains cinders, fragments of concrete, asphalt, and wood, no odor, no sheen (FILL).
	SB02		0.4	16					
									Concrete slab
5	SB03		1.2	68	n				SILTY/CLAYEY SAND WITH AND GRAVEL – black and brown fine to medium sand with approximately 20% silt, 20% clay, 15% gravel, contains cinders, fragments of concrete, asphalt, and wood, weak petroleum hydrocarbon odor, no sheen (FILL).
	SB04	SB10404	1.2	275		Moist		SM	
	SB05		0.2	NSR					
10	SB06		1.7	430					
	SB07	SB10407	1.3	>1000	l		Fill/Soil	CL	LEAN CLAY – dark gray (5Y4/1), firm, massive approximately 10% fine sand, weak to moderate petroleum hydrocarbon odor, no to light sheen.
					m	V Moist	Alluvium	SP-SM	POORLY GRADED SAND/POORLY GRADED SAND WITH SILT – gray (2.5Y5/1), stratified, approximately 60% fine-grained sand, 25% medium-grained sand, 5% coarse-grained sand, 0–5% gravel, 5–10% silt, moderate petroleum hydrocarbon odor, light to moderate sheen (ALLUVIUM).
15	SB08		1.1	609	ll	Sat			
	SB09		1.6	325	l	V Moist	Till	SM	POORLY GRADED SAND WITH GRAVEL – black (2.5Y2/1), stratified, approximately 45% fine-grained sand, 15% medium-grained sand, 20% coarse-grained sand, 20% gravel, strong petroleum hydrocarbon odor, heavy sheen (ALLUVIUM).
20									SILTY SAND – brown (7.5YR4/2), dense, hard, faint stratification, fine- to medium-grained sand with 5–10% coarse sand, 0–5% fine gravel, 25–30% silt, 5–10% clay. Weak to moderate petroleum hydrocarbon odor, light oil sheen. (TILL)
									Poorly graded sand lens from 16.5' to 16.6'. Black, strong petroleum hydrocarbon odor, saturated with product.
25									*End of sampling at 18.0'. Borehole backfilled with tremied neat cement grout*
30									

COMMENTS: Borehole advanced by American Engineering Testing (AET) of St. Paul, Minnesota. Boring advanced using 3.25" ID hollow stem augers. Split barrel (SB) samples collected in accordance with ASTM D1586. Soil samples classified in accordance with ASTM D2488.

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BORING LOG

PROJECT: Lake and Hiawatha (Clark Station) RI
DATE STARTED: 10/18/95
DATE COMPLETED: 10/18/95
FIELD INSPECTOR: G. Remple (BEC)
CREW CHIEF: C. Bonde (AET)

BORING NUMBER: SB105
GROUND SURFACE ELEVATION: 841.9 Ft. MSL
TOTAL DEPTH OF HOLE (FT): 24.0
DEPTH TO GROUNDWATER (FT): 14.0
DRILLING METHOD: 3-1/4" ID HSA

Depth (Feet)	Sample Type/No.	Analytical Sample Number	Sample Recovery (Ft.)	P.I.D. Headspace (ppm)	Oil Sheen	Moisture Content	Lithologic Unit	ASTM Soil Classification	DESCRIPTION OF MATERIALS AND REMARKS
0	SB01		1.4	1.7	n	Moist	Fill	SM	SILTY SAND WITH CLAY AND GRAVEL - black and brown fine to medium sand with approximately 20% silt, 15% gravel, 5-10% clay, contains cinders, fragments of concrete, asphalt, and wood, no odor, no sheen (FILL).
	SB02		0.7	1.1		V Moist			
5	SB03		1.2	0.8		Moist	Fill/Soil	CL	LEAN CLAY - black (2.5YR2.5/1) to gray (2.5Y2/1) firm, massive, approximately 10% fine sand, no odor, no sheen.
	SB04		1.0	2.2		V Moist	Alluvium	SP-SM	POORLY GRADED SAND/POORLY GRADED SAND WITH SILT - brown (10YR4/3) to dark grayish brown (10YR4/2), stratified, approximately 50 to 70% fine-grained sand, 25-30% medium-grained sand, 5-20% coarse-grained sand, 0-5% gravel, 5-10% silt, no odor, no sheen (ALLUVIUM).
10	SB05		1.1	2.6					
	SB06		1.1	4.6					
	SB07	SB10507	1.7	560	l-m	Moist	Till	SM	SILTY SAND - reddish-brown (5YR4/2), dense, hard, faint stratification, fine- to medium-grained sand with 5-10% coarse sand, 0-5% fine gravel, 25-30% silt, 5-10% clay. No odor, no sheen from 11.1' to 12.5'. Moderate petroleum hydrocarbon odor, no to light sheen from 12.5' to 21.8'. Laminations of black discoloration with light to moderate oil sheen from 12.5' to 15.5'. (TILL)
15	SB08		1.4	460					
	SB09		1.6	530	l				
	SB10		1.5	615					
20	SB11	SB10511	1.6	410		Sat		SP-SM	Poorly graded sand with silt lens from 21.8' to 22.2'. Black, weak petroleum hydrocarbon odor, very light oil sheen.
	SB12		1.2	335	n	Moist		SM	Till exhibits a weak petroleum hydrocarbon odor and no sheen from 22.2' to 24.0'.
25									*End of sampling at 24.0'. Borehole backfilled with tremied neat cement grout*
30									

COMMENTS: Borehole advanced by American Engineering Testing (AET) of St. Paul, Minnesota. Boring advanced using 3.25" ID hollow stem augers. Split barrel (SB) samples collected in accordance with ASTM D1586. Soil samples classified in accordance with ASTM D2488.

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BORING LOG

PROJECT: Lake and Hiawatha (Clark Station) RI
DATE STARTED: 10/19/95
DATE COMPLETED: 10/19/95
FIELD INSPECTOR: G. Remple (BEC)
CREW CHIEF: C. Bonde (AET)

BORING NUMBER: SB106
GROUND SURFACE ELEVATION: 841.2 Ft. MSL
TOTAL DEPTH OF HOLE (FT): 18.0
DEPTH TO GROUNDWATER (FT): 14.1
DRILLING METHOD: 3-1/4" ID HSA

Depth (Feet)	Sample Type/No.	Analytical Sample Number	Sample Recovery (Ft.)	P.I.D. Headspace (ppm)	Oil Sheen	Moisture Content	Lithologic Unit	ASTM Soil Classification	DESCRIPTION OF MATERIALS AND REMARKS
0	SB01		1.4	5.5	n	Moist	Fill	SM	SILTY SAND WITH CLAY AND GRAVEL - black and brown fine to medium sand with approximately 20% silt, 15% gravel, 5-10% clay, contains cinders, coal fines, fragments of concrete, no odor, no sheen (FILL).
	SB02		1.2	2.1			Fill/Soil	CL	LEAN CLAY - black (10YR2/1) to grayish brown (10YR5/2) firm, massive, approximately 10% fine-grained sand, no odor, no sheen, contains plant fibers. clay becomes fractured at 4.5', fractures filled with brown (7.5YR4/4) silt
5	SB03		0.9	0.9					
	SB04		1.3	1.3			Alluvium	SP-SM	POORLY GRADED SAND/POORLY GRADED SAND WITH SILT - brown (10YR4/3), stratified, approximately 55% fine-grained sand, 20% medium-grained sand, 10% coarse-grained sand, 5% gravel, 10% silt, no odor, no sheen (ALLUVIUM).
	SB05		1.3	3.6					
10	SB06		1.4	235	l		Till	SM	SILTY SAND - brown (10YR4/3), grayish-brown (10YR5/2) dense, hard, faint stratification, fine- to medium-grained sand with 5-10% coarse sand, 0-5% fine gravel, 25-30% silt, 5-10% clay. Weak petroleum hydrocarbon odor, no sheen from 10.6' to 12.0'. Moderate petroleum hydrocarbon odor, no to light sheen from 12.0' to 16.0'. (TILL)
	SB07	SB10607	1.7	675	l-m				
15	SB08		1.3	550	l				
	SB09		1.8	310	l	Sat	Alluvium	SP-SM	POORLY GRADED SAND WITH SILT - black, stratified, approximately 75% fine-grained sand, 10% medium-grained sand, 5% coarse-grained sand, 10% silt, moderate petroleum hydrocarbon odor, heavy sheen in upper 0.1', then light to moderate sheen to 18.0'.
20									*End of sampling at 18.0'. Borehole backfilled with tremied neat cement grout*
25									
30									

COMMENTS: Borehole advanced by American Engineering Testing (AET) of St. Paul, Minnesota. Boring advanced using 3.25" ID hollow stem augers. Split barrel (SB) samples collected in accordance with ASTM D1586. Soil samples classified in accordance with ASTM D2488.

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BORING LOG

PROJECT: Lake and Hiawatha (Clark Station) RI
DATE STARTED: 10/18/95
DATE COMPLETED: 10/18/95
FIELD INSPECTOR: G. Remple (BEC)
CREW CHIEF: C. Bonde (AET)

BORING NUMBER: SB107
GROUND SURFACE ELEVATION: 841.9 Ft. MSL
TOTAL DEPTH OF HOLE (FT): 22.0
DEPTH TO GROUNDWATER (FT): 13.1
DRILLING METHOD: 3-1/4" ID HSA

Depth (Feet)	Sample Type/No.	Analytical Sample Number	Sample Recovery (Ft.)	P.I.D. Headspace (ppm)	Oil Sheen	Moisture Content	Lithologic Unit	ASTM Soil Classification	DESCRIPTION OF MATERIALS AND REMARKS
0	SB01		1.2	8.1	n	Moist	Fill	SM	Asphalt pavement SILTY SAND WITH CLAY AND GRAVEL – black, brown, and gray fine to medium sand with approximately 20% silt, 15% gravel, 5–10% clay, contains fragments of concrete, asphalt, and wood, no odor and no sheen from 0' to 2', weak petroleum hydrocarbon odor and no sheen from 2' to 4' (FILL).
	SB02		1.3	22					
5	SB03		1.2	1.5		V Moist	Fill/Soil	CL	LEAN CLAY – black (10YR2/1) to gray (10YR5/1) hard, massive, approximately 5% fine sand, no odor, no sheen.
	SB04		1.2	5.5		Moist	Alluvium	SP-SM	POORLY GRADED SAND/POORLY GRADED SAND WITH SILT – brown (10YR4-5/3) to grayish-brown (10YR5/2), stratified, approximately 50 to 70% fine-grained sand, 25–30% medium-grained sand, 5–20% coarse-grained sand, 0–5% gravel, 5–10% silt, no odor and no sheen from 6' to 8', weak to moderate petroleum hydrocarbon odor and no sheen from 8'to 11.8' (ALLUVIUM).
10	SB05		1.2	28					
	SB06		1.1	267		V Moist			
	SB07	SB10707	0.9	675	l-m	Moist	Till	SM	SILTY SAND – reddish-brown (5YR4/2) to brown (7.5YR4-5/2-3), dense, hard, faint stratification, fine- to medium-grained sand with 5–10% coarse sand, 0–5% fine gravel, 25–30% silt, 5–10% clay. Strong petroleum hydrocarbon odor and light sheen from 11.8' to 15.9. Weak to moderate petroleum hydrocarbon odor, no to light sheen from 16.4' to 22.0'. Laminations of black discoloration with light to moderate oil sheen from 11.8' to 16.4'. (TILL)
15	SB08		1.9	500					
	SB09		1.3	360	h	Sat		SP-SM	Poorly graded sand with silt lens from 15.9' to 16.4'. Brown (7.5YR4/2), strong petroleum hydrocarbon odor, heavy oil sheen.
	SB10		1.2	610	n-l	Moist		SM	
20	SB11		1.6	648					
									End of sampling at 22.0'. Borehole backfilled with tremied neat cement grout
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COMMENTS: Borehole advanced by American Engineering Testing (AET) of St. Paul, Minnesota. Boring advanced using 3.25" ID hollow stem augers. Split barrel (SB) samples collected in accordance with ASTM D1586. Soil samples classified in accordance with ASTM D2488.

BORING LOG

PROJECT: Lake and Hiawatha (Clark Station) RI
DATE STARTED: 10/24/95
DATE COMPLETED: 10/24/95
FIELD INSPECTOR: G. Remple (BEC)
CREW CHIEF: C. Bonde (AET)

BORING NUMBER: SB108
GROUND SURFACE ELEVATION: 841.8 Ft. MSL
TOTAL DEPTH OF HOLE (FT): 18.0
DEPTH TO GROUNDWATER (FT): 15.0
DRILLING METHOD: 3-1/4" ID HSA

Depth (Feet)	Sample Type/No.	Analytical Sample Number	Sample Recovery (Ft.)	P.I.D. Headspace (ppm)	Oil Sheen	Moisture Content	Lithologic Unit	ASTM Soil Classification	DESCRIPTION OF MATERIALS AND REMARKS
0	SB01		1.7	ND	n	Moist	Fill	SM	SILTY SAND WITH CLAY AND GRAVEL - black, brown, and gray fine to medium sand with approximately 20% silt, 15% gravel, 5-10% clay, contains fragments of concrete and asphalt, no odor, no sheen (FILL).
	SB02		1.5	ND					
5	SB03		1.7	ND			Fill/Soil	CL	LEAN CLAY - black (10YR2/1) to brown (10YR4/2) hard, massive, approximately 5% fine sand, no odor, no sheen.
	SB04		1.8	ND			Alluvium	SP-SM	POORLY GRADED SAND/POORLY GRADED SAND WITH SILT - brown (10YR4/3) to dark grayish-brown (10YR4/2), stratified, approximately 65 to 70% fine-grained sand, 20% medium-grained sand, 5-10% coarse-grained sand, 0-5% gravel, 5-10% silt, no odor, no sheen (ALLUVIUM).
10	SB05		1.3	0.1					
	SB06		1.4	0.3		V Moist			
	SB07		1.2	1.0					
	SB08	SB10308	2.0	395	n-1	Moist	Till	SM	SILTY SAND - dark reddish-gray (5YR4/2), dense, hard, faint stratification, fine- to medium-grained sand with 5-10% coarse sand, 0-5% fine gravel, 25-30% silt, 5-10% clay, no odor, no sheen from 11.8' to 13.5'. From 13.5' to 16.0', unit exhibits thin laminations of black discoloration, moderate petroleum hydrocarbon odor, light sheen. No discoloration, weak to moderate petroleum hydrocarbon odor, no to light sheen from 16.0' to 18.0' (TILL). Till contains a few thin (<0.1') lenses of saturated fine-grained sand from 16.0' to 20.0'.
15	SB09		2.0	480					
20									*End of sampling at 18.0'. Borehole backfilled with tremied neat cement grout*
25									
30									

COMMENTS: Borehole advanced by American Engineering Testing (AET) of St. Paul, Minnesota. Boring advanced using 3.25" ID hollow stem augers. Split barrel (SB) samples collected in accordance with ASTM D1586. Soil samples classified in accordance with ASTM D2488.

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BORING LOG

PROJECT: Lake and Hiawatha (Clark Station) RI
DATE STARTED: 10/24/95
DATE COMPLETED: 10/24/95
FIELD INSPECTOR: G. Remple (BEC)
CREW CHIEF: C. Bonde (AET)

BORING NUMBER: SB109
GROUND SURFACE ELEVATION: 842.1 Ft. MSL
TOTAL DEPTH OF HOLE (FT): 20.0
DEPTH TO GROUNDWATER (FT):
DRILLING METHOD: 3-1/4" ID HSA

Depth (Feet)	Sample Type/No.	Analytical Sample Number	Sample Recovery (Ft.)	P.I.D. Headspace (ppm)	Oil Sheen	Moisture Content	Lithologic Unit	ASTM Soil Classification	DESCRIPTION OF MATERIALS AND REMARKS	Depth (Feet)
0	SB01		1.2	3.4	n	Moist	Fill	SM	SILTY SAND WITH CLAY AND GRAVEL - black and brown, fine to medium sand with approximately 20% silt, 15% gravel, 5-10% clay, contains fragments of concrete and asphalt, no odor, no sheen (FILL).	0
	SB02		1.9	24						
5	SB03		1.4	ND			Fill/Soil	CL	LEAN CLAY - black (10YR2/1) to dark gray (10YR4/1) to dark grayish-brown (10YR4/2), hard, massive, approximately 5% fine sand, no odor, no sheen.	5
	SB04		1.3	5.7			Alluvium	SP-SM	POORLY GRADED SAND/POORLY GRADED SAND WITH SILT - dark grayish-brown (10YR4/2) to light olive brown (2.5Y5/3), stratified, approximately 65 to 70% fine-grained sand, 15% medium-grained sand, 5-10% coarse-grained sand, 0-5% gravel, 5-10% silt, no odor, no sheen (ALLUVIUM).	
	SB05		1.5	3.2						
10	SB06		1.5	7.5				SP	POORLY GRADED SAND WITH GRAVEL - dark grayish-brown (10YR4/2), stratified, approximately 10% fine-grained sand, 45% medium-grained sand, 25% coarse-grained sand, 15% gravel, 5% silt, no odor, no sheen (ALLUVIUM).	10
	SB07		1.8	3.4		V Moist	Till	SM	SILTY SAND - brown (7.5YR4/2) to reddish-brown (5YR4/2), dense, hard, faint stratification, fine- to medium-grained sand with 5-10% coarse sand, 0-5% fine gravel, 25-30% silt, 5-10% clay, no odor, no sheen (TILL).	
15	SB08	SB10908	1.5	14.9						15
	SB09		2.0	2.7		Moist				
	SB10		2.0	11.6						
20									*End of sampling at 20.0'. Borehole backfilled with tremied neat cement grout*	20
25										25
30										30

COMMENTS: Borehole advanced by American Engineering Testing (AET) of St. Paul, Minnesota. Boring advanced using 3.25" ID hollow stem augers. Split barrel (SB) samples collected in accordance with ASTM D1586. Soil samples classified in accordance with ASTM D2488.

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