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REPORT ON

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GROUNDWATER MONITORING REPORT
ENVIRONMENTAL MONITORING PROGRAM
OCTOBER 2003 TO MARCH 2008
FINDLAY CREEK VILLAGE
OTTAWA, ONTARIO

MINISTRY OF THE ENVIRONMENT
JUL 1 4 2008
KINGSTON - - ONTARIO
REGIONAL OFFICE

Submitted to:

Leitrim Monitoring Technical Advisory Committee
c/o City of Ottawa
110 Laurier Avenue West, 4th floor
Ottawa, Ontario
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50 BEST EMPLOYERS IN CANADA 2006

CANADA'S 50 BEST MANAGED COMPANIES

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1.0 INTRODUCTION

The Findlay Creek development is located on a parcel of land between Highway 31 (Bank Street) and Albion Road, and extends approximately 2 kilometres south from Leitrim Road in Ottawa, Ontario (Figure 1). The site slopes gently towards the east, with major features including the Leitrim Wetland to the west and southwest of the existing and future development area and Findlay Creek to the south, flowing in an easterly direction. Surrounding land uses are predominantly rural in nature, and include both residential and commercial buildings. The first and second Stages of the Findlay Creek development are under construction in the northeast and central portions of the site. The general land uses and features of the site are shown on Figure 2.

The southwest quadrant of the development area is occupied by a natural wetland. The Environmental Management Plan (EMP) (Cumming Cockburn Ltd. and Golder Associates Ltd., 2003) and updated EMP (IBI Group and Golder Associates Ltd., 2005) for this project defined monitoring programs during the construction phase and for a period post-construction to ensure that the development does not significantly affect the groundwater levels and associated natural biological ecosystem in the area that has been designated as the core wetland.

Golder Associates Ltd. (Golder Associates) has carried out several previous subsurface geotechnical and hydrogeologic investigations on this site. A geotechnical investigation was carried out in 1994 for the pre-design of the stormwater management facility. The results of that investigation along with guidelines on the pre-design were provided in a report titled "Hydrogeological and Geotechnical Considerations, Pre-Design of Stormwater Management Works, Leitrim Development Area, Gloucester, Ontario," dated August 1994 (report number 931-2360).

Golder Associates carried out further investigation as part of a groundwater and surface water monitoring program. The results of that investigation, as well as the results of the monitoring, were provided in a combined Golder Associates and Cumming-Cockburn report titled "Baseline Monitoring Program, Groundwater and Surface Water Regimes, Leitrim Development Area, City of Gloucester, Ontario," dated May 1999 (report number 971-2925/3029-MU-01).

In addition to these investigations, a number of earlier investigations have been carried out across this site. More recent investigations have also been carried out for final design of portions of the development area, both for site servicing and structure foundations.

2.0 SITE DESCRIPTION

2.1 Site Geology

Geological conditions in the area of the site are known from the results of site-specific subsurface investigation, as well as published information and the MOE water well records. In the western and central portions of the Findlay Creek Village land there is a significant thickness of fine-grained overburden (silt, sandy silt) overlying glacial till. In the southwest portion of the site (within the core wetland) there is a layer of peat/organic soil overlying the fine-grained soils. The silty and glacial till soils are relatively low to moderate permeability soils. The thickness of overburden decreases towards the east as the elevation of both the surfaces of the glacial till and underlying dolomitic bedrock rise to shallower depth. The upper bedrock is typically highly fractured. In the southeast part of the site adjacent to Bank Street, the bedrock is within about 2-4 metres of ground surface. The northern and eastern portions of the site are also underlain by surficial sandy/silty soils over glacial till.

Bedrock underlying the Leitrim residential development area has been shown through investigation to consist of dolomite of the Oxford Formation.

2.2 Groundwater Flow

Groundwater is transmitted under natural conditions or under the influence of pumping wells, primarily through permeable layers of surficial deposits and through networks of fractures in bedrock (bedding planes, and joints).

In the overburden, groundwater flows onto the Leitrim Village lands from a sand and gravel ridge to the southwest, and from the topographically higher lands to the north towards Findlay Creek in the southeast. Groundwater flow across the Leitrim lands is generally eastward in the overburden. Regional groundwater flow in the bedrock is known from previous studies to also be eastward. The interpolated groundwater level contours and flow direction in the overburden from August 24, 1998 are illustrated in Figure 3; this is reproduced from the Baseline Monitoring Program, with the approximate limit of the core wetland and wetland berm added for reference purposes.

2.3 Site Construction

Construction of trunk servicing and residential site servicing has taken place at the Findlay Creek development over several periods. The construction of deeper sections of trunk servicing and residential site servicing has involved the excavation of a trench through overburden, with some excavation into the upper portion of the underlying bedrock. The sewer excavations have extended below the groundwater table, with certain areas of the excavation extending into the upper few metres of bedrock. Due to the highly permeable and fractured nature of the upper bedrock, temporary groundwater control by pumping along the alignment has been required to complete the construction. The periods of groundwater control in bedrock and the allowable pumping rates as per associated Permit To Take Water are summarized in the following table.

Trench Section	**Period of Groundwater Control**	**Permit No.**	**Maximum Allowable Pumping Rate**
Findlay Creek Drive (Bank Street to Long Point Circle)	January 2003 – May 2003	03-P-4001	6,456,240 L/day
Findlay Creek Drive (Long Point Circle to Kelly Farm Drive)	January 2004 – April 2004	04-P-4004	10,476,984 L/day
Kelly Farm Drive (Findlay Creek Drive to north end)	January 2005 – May 2005	5246-66JMCD	13,747,380 L/day
Findlay Creek Drive west of Kelly Farm Drive and Deep trunk storm sewer to SWMP	September 2005 – November 2006	3860-6G9PVQ	51,580,800 L/day

The approximate extent of the four trench sections described in the above table are shown in Figure 2. Available pumping rates for the trunk storm sewer construction on both the east and the west sides of Bank Street from September 7, 2005 to August 8, 2006 are shown on Figure 14 and were typically on the order of 1,000,000 L/day with peaks for several days up to 10,000,000 L/day and 18,000,000 L/day in July 2006. Note that the peak pumping rates during this period are only about one-third of the allowable pumping rate. This is fairly typical of actual construction pumping requirements compared to the maximum allowable pumping rate and total duration of pumping. A conservatively high maximum pumping rate is requested to try to ensure that the trench can be initially pumped hard enough to get the water levels down quickly; a lower pumping rate is then needed to maintain the lowered water level to complete the construction.

A berm was built around the northern and eastern sides of the wetland area in the first part of 2004 to separate the wetland regime from the development drainage and to enable baseline surface water flow data to be collected for the design of the Findlay Creek Extension and habitat compensation measures.

Groundwater pumped from the excavations was discharged in one of three manners: to a settling pond, then to Findlay Creek (prior to October 2006); to the storm sewer system and Stormwater Management Pond (SMWP) (following its completion in October 2006); or to a settling pond, then into the wetland fringe (in early 2006) to encourage recharge in the wetland fringe as required. As the construction of the trunk storm sewer proceeded westwards in late 2005 and 2006, the depth to bedrock increased, thereby decreasing the depth of the sewer installation and amount of groundwater pumping required from the trenches. Although the depths of the trenches varied, most of the water entering the trenches came from the upper 1 to 2 metre fractured bedrock zone. Groundwater control requirements in trenches completed in the overburden were much smaller and not at a rate requiring a Permit To Take Water.

In addition to the above groundwater control by pumping, the construction of the portion of the Findlay Creek Extension, a 1 to 1.5 metre deep ditch, along the northwest boundary of the designated wetland area in September to October 2007 encountered surface water flowing northwards out of the wetland towards Findlay Creek. The surface water reaching the work area was intercepted and pumped to sedimentation ponds and then returned to Findlay Creek.

2.4 Background Information and Historical Groundwater Levels

Historical reports (Golder 1990, Golder 1999) contain manual groundwater levels measured at various monitors from 1990 to 1998, which are presented in Table 1. Baseline groundwater levels were measured at monitors BH97-2a and BH97-2b during February/April to November of 1998 and at monitors BH90-2 and BH90-3 during 1998. Monitors BH90-2 and BH97-2 are located along the northern and eastern edge of the wetland, respectively, and monitor BH90-3 is located approximately 500 m south of BH90-2 deep within the wetland (Figure 3). The groundwater elevations from 1998 (Table 1) are presented in Figure 4.

Groundwater monitors at BH90-2 and BH-90-3 consist of overburden wells, while in BH97-2 there is an overburden monitor and bedrock monitor installed. An overburden well is a shallower well constructed in the soil, while a bedrock well is a deeper well constructed within the bedrock. Fractures within the bedrock aquifer may or may not be well connected, since it depends on how well the fracture zones are connected. The screened interval, or portion of the well into which groundwater enters, in a bedrock well will be deeper than the screened interval in an overburden well. Overburden and bedrock wells may exist at the same location either as multilayer wells in the same borehole or in separate but nearby boreholes. These types of monitoring well installations are illustrated on the Record of Boreholes in Appendix A.

The water level in a monitoring well represents the hydraulic head at the centre of the screened interval. Two wells at the same location or at nearby locations which are screened at different depths may have different water levels (i.e., the hydraulic head at the centre of the screened interval is different). Groundwater flow is 3-dimentional and occurs in the direction of decreasing hydraulic head. If a bedrock and an overburden well at the same location or at a nearby location have different water levels, the groundwater flow direction at that location also has a vertical component. If the water level (hydraulic head) in the bedrock well is higher than the water level in the overburden well, the groundwater at that location is moving vertically upwards (or discharging), as well as horizontally. If the bedrock water level is lower than the overburden water level, the groundwater at that location is moving downwards (recharging), as well as horizontally.

The 1998 monitoring indicates that the groundwater levels were fairly consistent and typically near surface at all three monitors within the wetland. The groundwater level varies typically less than 0.3 m at BH90-2 and BH90-3 and up to 1 m at BH97-2. The higher variability at BH97-2 may be a result of this monitor being close to a ditch where the water level could be quite variable, depending on both precipitation and beaver dam activity. The difference between the groundwater level in the overburden and bedrock at BH97-2 was consistent over the monitoring period in 1998, which is likely indicative of a hydraulic connection between the overburden and bedrock. At BH97-2, the groundwater level in bedrock was consistently 0.1 to 0.2 m above the groundwater level in the overburden, indicating an upward vertical hydraulic gradient. Artesian conditions (groundwater level above ground surface) were observed at this location from late February to mid-May 1998.

3.0 GROUNDWATER MONITORING RATIONALE

As discussed in Section 2.3, temporary groundwater control has been required to complete portions of the construction of trunk sewer and site servicing installations. Temporary groundwater control was also required for the construction of the SWMP. Future trunk sewer and site servicing installations on some parts of the site will also necessitate groundwater control to allow the installation of site servicing. As well, as a part of fish habitat compensation at the site, a section of Findlay Creek will be realigned by construction of a new water course (the Findlay Creek Extension) to pass just along the north edge of the core wetland. As described in the updated EMP, the predicted potential effects from construction and operation of the above works included:

- Groundwater movement to the Findlay Creek Extension resulting in a lowering of groundwater elevations along the northern fringe area of the core wetland;
- A potential lowering of surface water levels in the wetland; and,
- Potential biological impacts to the core wetland in terms of its structure and ability to maintain current wetland habitat and function. Specifically, the most sensitive features identified in the core of the wetland are considered to be a fen, located in the eastern part of the wetland (Figure 2).

Potential biological impacts to the core wetland and fen were not expected to manifest during relatively brief construction periods. The potential migration of groundwater to the proposed Findlay Creek Extension is the most immediate potential effect that in turn could potentially result in the other effects listed above. The potential mechanisms by which site construction could affect groundwater levels are identified below.

The SWMP is located in the area northeast of the intersection of Blais Road and Bank Street, more than 800 metres from the Leitrim Wetland. The construction of the pond was anticipated to require temporary groundwater control from the upper bedrock zone for temporary pressure relief for the duration of construction. Because of the separation distance, it was not expected that this temporary groundwater control would affect groundwater levels below the core wetland area.

Temporary groundwater control by pumping from the overburden was anticipated to be required to construct the Findlay Creek Extension. In the silty soils, however, the amount and duration of pumping required was expected to be small. As noted previously, interception and pumping of surface water was required during September to October 2007 to construct the north central portion of the Extension. It was predicted that the post-construction operation of the Extension would have little effect on groundwater levels in the overburden (drawdown cone extending less than 20 metres from the creek alignment), and because of the shallow nature of the Extension relative to the overburden thickness and type, no effect on groundwater in the bedrock.

Future site servicing installations will require temporary groundwater control that may cause temporary groundwater level lowering in the bedrock beneath the wetland. Due to the short duration of construction periods, biological impacts to the core wetland are not anticipated.

In order to prevent the predicted potential effects listed above, a groundwater monitoring program, a trigger mechanism and a contingency plan were developed and submitted as a part of the original EMP and updated EMP. By means of regular review of the groundwater monitoring program results, implementation of the contingency plan was considered to prevent impacts to the core wetland.

The groundwater monitoring program included the installation of groundwater monitors at key locations within the core wetland area and adjacent to the Findlay Creek Extension. Overburden monitors were installed near the Findlay Creek Extension, while both overburden and bedrock monitors were installed in the east end portion of the wetland. Pressure transducers and dataloggers were installed to provide a continuous record of water levels in the monitoring wells. Monitoring results were reviewed on an approximate monthly basis to assess potential water level lowering in the bedrock, serving as an indicator for the potential for underdrainage of the overburden soils.

Fens are sensitive to water level changes as these types of wetlands are groundwater-dependent and rely on relatively stable conditions. There is no set "limit" to the amount of water level change that fen vegetation can withstand. Despite the uncertainty involved with predicting or preventing community change, one way to minimize the possibility of negative effects is to monitor wetland water levels and implement mitigation measures if levels fall below established trigger levels. The trigger mechanism included the development of groundwater trigger levels from seasonally low levels recorded during baseline groundwater level monitoring ("baseline" monitoring hereafter refers to monitoring in 1998), pre-berm groundwater level monitoring ("pre-berm" monitoring hereafter refers to monitoring in September to December 2003) and monitoring from May to December 2004, which corresponds to a period with no groundwater control. If a groundwater trigger was reached, precipitation conditions were compared with historical measurements to determine whether the trigger was due to low precipitation conditions or was a result of the works. If the measured overburden groundwater levels were due to the works, then the contingency measures would be put into effect.

The objective of the contingency measures was to maintain overburden groundwater levels in the core wetland. The measures to be put in place if the trigger mechanism was activated included:

- addition of surface water and shallow groundwater to the wetland fringe area in order to encourage replenishment of overburden groundwater levels;
- use of the wetland outlet control structure, once constructed, to regulate the discharge of surface water from the wetland; and,

- construction of a low-permeability liner along the Findlay Creek Extension to reduce the discharge of groundwater to the creek.

Due to delays in the issuance of regulatory approvals, the wetland outlet control structure has not yet been constructed as of April 2008.

4.0 METHODS

4.1 Monitoring Well and Pressure Transducer Installation

Groundwater monitors BH03-1, BH03-2, BH03-3, BH03-4, BH03-5, BH03-6, BH03-7A, BH03-7B, BH03-8A, BH03-8B, BH03-9A, BH03-9B, BH03-10A and BH03-10B were constructed between August 26 and October 17, 2003 at the locations shown on Figure 2 in order to conduct groundwater level monitoring adjacent to the ecologically sensitive areas. The location and design of these groundwater monitor installations was as proposed in the March 2003 EMP.

The drilling program included both portable and track mounting drilling equipment. Portable drilling equipment operated by OGS Inc. was used to drill in and around the core wetland. Care was taken to minimize disturbance to the wetland during well installation. A CME 55 track mounted drilling rig operated by Marathon Drilling Ltd. was used to install some of the monitoring wells outside of the core wetland.

Standard penetration tests were carried out in all the boreholes at 0.76 metre intervals, and soil samples were recovered using split spoon type samplers. In addition to the overburden monitoring wells, bedrock monitors were installed in boreholes BH03-07 through BH03-10. HQ-sized diamond drilling equipment was used to advance the coreholes. All monitoring wells were completed with 0.03 metre (1.25 inch) diameter monitoring well casing and well screen. Details of the well completions and the subsurface conditions encountered in the boreholes are provided in Appendix A, along with the logs from the previous boreholes installed at the site. All monitoring wells were completed with locking steel protective casings. Prior to commencing drilling, the proposed borehole locations were surveyed by Stantec Consulting Ltd.

The field work was supervised throughout by Golder Associates engineering staff who located the boreholes, directed drilling operations, and logged the boreholes and samples. All soil and rock samples were subsequently reviewed by a professional geoscientist.

Three monitoring well pairs were installed in the overburden to monitor groundwater elevations near the Findlay Creek Extension. Two monitoring well pairs were installed to monitor groundwater elevations in the overburden and bedrock near the residential area, along with existing monitors BH97-2A and BH97-2B. Two monitoring well pairs were installed to monitor groundwater elevations in the overburden and bedrock in the wetland fen area. The areas monitored by each monitoring well are summarized in the following table.

Monitor	Unit Monitored	Area Monitored
BH03-1	Overburden monitor at limit of development	Findlay Creek Extension
BH03-2	Overburden monitor 20 m south of BH03-01	
BH03-3	Overburden monitor at limit of development	
BH03-4	Overburden monitor 20 m south of BH03-03	
BH03-5	Overburden monitor at limit of development	
BH03-6	Overburden monitor 20 m south of BH03-05	
BH97-2A BH97-2B	Bedrock monitor ~ 30 m west of the east limit of the core wetland Overburden monitor at same location	Residential Subdivision Area
BH03-8A BH03-8B	Bedrock monitor north of BH97-2 Overburden monitor at same location	
BH03-10A BH03-10B	Bedrock monitor located just east of core wetland Overburden monitor at same location	
BH03-7A BH03-7B	Bedrock monitor near northeast edge of wetland fen Overburden monitor at same location	Wetland Fen
BH03-9A BH03-9B	Bedrock near southeast edge of wetland fen Overburden monitor at same location	

In order to continue to monitor groundwater elevations during the winter months, several wells that were prone to freezing were equipped with insulated boxes. The goal was to prevent freezing in wells with groundwater levels very near to or above ground surface. The boxes, which are approximately 1.2 m high by 0.8 m wide by 0.8 m long, were filled with insulation and installed at boreholes BH03-7, BH03-8 and BH03-9.

The groundwater level monitoring program included both manual and automated groundwater measurements with pressure transducers/data loggers in the monitoring wells. The pressure transducers used (Model 3001 LT M5 manufactured by Solinst Inc.) were accurate to within 0.005 metres, and had a pressure range of up to 4 metres of water column. The transducers were set such that the water level in each well was recorded every hour. During transducer installations, manual measurement of groundwater levels was performed to confirm that the transducers were providing accurate measurements. Subsequent manual checks with a water level meter were continued on a monthly basis to ensure that automated readings were representative of site conditions.

In order to compensate for changes in atmospheric barometric pressure, a pressure transducer/barologger was installed near monitoring well BH97-2. The pressure readings from the barologger were used to calculate the barometric efficiency of each well (see Section 5.2) and to calculate compensated groundwater elevations from the raw datalogger data. Due to flooding in the eastern wetland fringe, the barologger was submerged from October 19, 2005 to November 23, 2005, and the data collected by the barologger was unusable. Note that the data collected during this period at BH97-2 was usable since groundwater levels can be above the ground surface provided the top of the well casing is not submerged. None of the wells were known to have been submerged during the monitoring period, indicating that groundwater data collected is reliable; however, compensated groundwater elevations are not available from October 19, 2005 to November 23, 2005. The barologger was subsequently moved to a location along the wetland berm, nearest to BH03-7.

4.2 Groundwater Elevation Monitoring

Groundwater level monitoring started upon the completion of each monitoring well. The following table summarizes the monitoring wells included in the groundwater level monitoring program and identifies the period during which data was collected.

Monitoring Well	Monitoring Period
BH03-01	October 1, 2003 - present
BH03-02	October 2, 2003 - present
BH03-03	October 2, 2003 - present
BH03-04	October 2, 2003 - present
BH03-05	October 2, 2003 - present
BH03-06	October 2, 2003 - present
BH03-07a	October 7, 2003 - present
BH03-07b	October 12, 2003 - present
BH03-08a	October 12, 2003 - present
BH03-08b	October 12, 2003 - present
BH03-09a	October 17, 2003 - present[1]
BH03-09b	October 17, 2003 - present
BH03-10a	October 7, 2003 - present[2]
BH03-10b	September 30, 2003 - present[2]
BH97-2A	February 3, 1998 - November 6, 1998 October 22, 2003 - present
BH97-2B	April 7, 1998 - November 6, 1998 October 22, 2003 - present

Notes: [1] Datalogger sent for repairs on Feb. 9, 2007 and reinstalled on May 1, 2007

[2] Wells and dataloggers were damaged on or around Nov. 9, 2005; new dataloggers were installed in the repaired wells on Dec. 28, 2005

Data was downloaded from the dataloggers and reviewed on an approximately monthly frequency, with a higher download frequency (i.e. every two weeks) during periods of temporary groundwater control during sewer construction at the site. Due to high water conditions in the wetland eastern fringe from 2005 to 2007, data downloading was not conducted during the early winter and late spring due to safety hazards associated with partially-frozen water.

5.0 RESULTS

5.1 Baseline and Pre-Berm Elevations

Baseline water levels were measured and compared with pre-berm water levels at BH97-2, as shown in Figure 4. The 2003 groundwater levels are close to the 1998 groundwater levels and generally within 0.5 m of the 1998 groundwater levels.

Monitors BH03-1 through BH03-10 were installed from August to October 2003; therefore, no water level data exists for these monitors prior to or during the period of groundwater control from January to May 2003. It is noted, however, that groundwater levels have been shown to recover quickly from groundwater pumping and that long-term effects of groundwater control on water levels have not been observed. Therefore, pre-berm water levels from these monitors are considered to be representative of baseline water levels.

5.2 Groundwater Trigger Elevations

Groundwater trigger elevations were developed based on baseline data, pre-berm monitoring data and data collected from May to December 2004, which corresponds to a period with no groundwater control. The trigger water level elevations, as proposed in the updated 2005 EMP, are 0.1 m less than the seasonal minimum levels measured during the above-mentioned three periods to account for seasonal variations. Note that the pre-berm data were acquired during periods of heavy precipitation (approximately 20 to 60mm above normal monthly precipitation) based on the Ottawa Airport station data (Appendix B). Since water levels (both groundwater and surface water) fluctuate with the seasons, seasonal values were used at monitors that showed seasonal variation in water levels (i.e., BH03-5, BH03-6 and BH03-8B). For example, spring water levels should be between x (the lowest level historically measured) and y (the highest level historically measured). If, after construction commenced, levels fell below x during the spring, then mitigation measures would be triggered. The water level measurements were interpreted along with local precipitation data, such that unusually dry years did not trigger unnecessary actions. The trigger elevations and maximum groundwater elevations measured during baseline and pre-berm conditions, are given in the table below:

Monitor	Ground Surface Elevation (m)	Season	Trigger Water Level Elevation (m)	Maximum Groundwater Elevation (m) (Baseline and Pre-Berm Conditions)
BH97-2A	92.84	All	91.3	93.0
BH97-2B	92.85	All	91.2	92.6
BH03-1	94.87	All	94.5	94.8
BH03-2	94.88	All	94.5	95.0
BH03-3	94.07	All	93.2	93.9
BH03-4	94.08	All	93.5	94.0
BH03-5	93.44	Spring/summer (Apr-Sept) Fall/winter (Oct-Mar)	91.9 92.5	93.4
BH03-6	93.43	Spring/summer (Apr-Sept) Fall/winter (Oct-Mar)	91.9 92.5	93.0
BH03-7A	93.47	All	93.4	94.1
BH03-7B	93.40	All	92.6	93.4
BH03-8A	93.02	All	91.0	92.4
BH03-8B	93.01	Spring/summer (Apr-Sept) Fall/winter (Oct-Mar)	91.1 91.8	92.9
BH03-9A	93.75	All	92.4	93.4
BH03-9B	93.78	All	93.0	93.6
BH03-10A	92.47	All	90.9	92.7
BH03-10B	92.47	All	90.7	92.5

The maximum values from the above table could be used to establish upper trigger elevations. However, the upper trigger elevations could be above the maximum values considering the intensity and duration of precipitation events and beaver activity.

5.3 Groundwater Elevation Monitoring

Barometric pressure changes cause water level fluctuations in most aquifers. The load associated with an increase in atmospheric pressure will push down on the water column in an open well, resulting in a relatively large drop in water level. Subsequent pressurization of the aquifer will result in a very small rise in water level. The overall effect is that in a well open to the atmosphere, an increase in barometric pressure causes a near instantaneous drop in water level. These fluctuations are highest in confined aquifers and smallest (to nil) in wells open to shallow unconfined aquifers.

Barometric pressure changes, as measured by the on-site barologger, were subtracted from the pressure transducer measurements in order to provide water level data that was unbiased by short-term changes in barometric pressure. In order to correct the water level data for changes in atmospheric pressure, the barometric efficiency of the aquifer was determined. The barometric efficiency is defined as the ratio of change in water level in a well to the corresponding change in atmospheric pressure. The transducer measurements in the wells were compared to the manually measured water level measurements, and an appropriate barometric efficiency was selected to correct the transducer measurements so that they were equal, on average, to the manually measured water levels. As summarized in the following table, the barometric efficiency of the bedrock wells ranged from 30% (BH03-7A) to 135% (BH03-10A).

Monitoring Well	**Barometric Efficiency**
BH03-01	1.0
BH03-02	0.72
BH03-03	0.72
BH03-04	0.80
BH03-05	0.76
BH03-06	0.80
BH03-07a	0.30
BH03-07b	1.0
BH03-08a	1.0
BH03-08b	0.85
BH03-09a	0.84
BH03-09b	0.72
BH03-10a	1.35[1]; 0.83[2]
BH03-10b	0.85[1]; 1.0[2]
BH97-2a	1.0
BH97-2b	1.2

Notes: [1] prior to November 9, 2005
[2] after December 28, 2005

The downloaded groundwater level data was compiled in a database... The groundwater elevation data were compared with climate data collected at the Ottawa Airport by Environment Canada data as well as precipitation data collected from three locations in Ottawa (Manotick, Riverside South, and Hawthorne) by the City of Ottawa. The location of the weather stations is shown in Figure 5. Figure 6 shows the total monthly precipitation data from all four locations from October 2003 to March 2008. Typically, the data from the stations were similar and the difference in the total monthly precipitation at the four locations was less than 20 mm. The Ottawa Airport station is closest to the site and is the only data set with values during the winter months; therefore, only the Ottawa Airport data were used for evaluation with the groundwater elevation data. The climate data from Environment Canada is presented in Appendix B for reference. Groundwater elevation data for the monitoring wells is summarized in Figures 7 through 13.

The average water elevations for each monitor from baseline and pre-berm data, and post-berm data ("post-berm" data hereafter refers to data collected after the construction of the berm in the first part of 2004) are presented in the table below:

Monitor	**Average Water Elevation (m)**		**Water Elevation Difference (m)**
	Data Collected from 1998 and 2003 (Baseline and Pre-Berm Conditions)	**Data Collected from 2004 to 2008 (Post-Berm Conditions)**	
BH03-1	94.69	94.74	-0.05
BH03-2	94.91	94.86	0.06
BH03-3	93.77	93.77	0.00
BH03-4	93.87	93.97	-0.11
BH03-5	93.18	93.14	0.04
BH03-6	92.83	92.88	-0.04
BH03-7a	93.51	93.46	0.06
BH03-7b	93.21	93.01	0.20
BH03-8a	91.77	91.12	0.65
BH03-8b	92.60	92.90	-0.30
BH03-9a	93.10	92.81	0.28
BH03-9b	93.49	93.35	0.14
BH03-10a	91.87	91.11	0.76
BH03-10b	91.97	91.01	0.96
BH97-2a	92.68	92.05	0.63
BH97-2b	92.43	91.78	0.65

Horizontal lines corresponding to the average water elevations given in the above table are given on Figures 7 to 13 for reference. The average water elevation from pre-berm to post-berm increased at BH03-1, BH03-4, BH03-6, and BH03-8b and decreased at the remainder of the monitors, except for BH03-3, where average water elevations were the same. The largest difference (0.96 m) was observed at monitor BH03-10b, which is located outside of the wetland and adjacent to the Findlay Creek Extension. At monitors where temporary declines in the water level occurred during pumping periods, this could cause the calculated average post-berm water level to be lower, even if the actual water level after pumping, or post-berm, was similar to the pre-berm level. Although post-berm average water levels are lower then pre-berm levels at many of the monitors, the groundwater levels quickly recover after groundwater controls cease, indicating that there are likely no long-term effects of groundwater pumping.

5.3.1 Area of Findlay Creek Extension

As described in Section 4.1, groundwater monitors BH03-1, BH03-2, BH03-3, BH03-4, BH03-5 and BH03-6 were used to monitor groundwater levels along the northern fringe of the core wetland in the area of the Findlay Creek Extension. Figure 7 illustrates the groundwater levels measured at these monitors. At the time of preparation of this report, temporary groundwater control during construction of the Extension had been conducted starting in September 2007 to October 22, 2007, but the realigned section of Findlay Creek was not yet operational.

Monitoring wells BH03-1 and BH03-2 are located approximately 300 metres east of Albion Road, and are the monitors located the farthest from previous temporary groundwater control activities at the site. As can be seen on Figure 7, groundwater elevations measured at these monitors from 2003 to the present varied between approximately 94.5 masl and 95.1 masl, and were unaffected by groundwater control activities at the site.

Monitoring wells BH03-3 and BH03-4 are located approximately 380 metres east of BH03-1 and BH03-2. As can be seen on Figure 7, groundwater elevations measured at these monitors from 2003 to the present varied between approximately 93.4 masl and 94.3 masl, and were affected by groundwater control activities during site servicing in early 2004 and early 2005. The groundwater level drawdown over these periods was approximately 0.5 metres. Approximately 0.2 metres of decline was recorded in these monitors in July and August 2006 during groundwater control activities associated with construction of the deep trunk sewer. Drawdown was not induced in the fall of 2007 during surface water control activities associated with the Findlay Creek Extension. Precipitation had a significant effect on groundwater levels, as evidenced by low groundwater levels in January to March 2004, July 2004, January to March 2005, August 2005, August 2006, January to March 2007, May to June 2007 and September 2007 during periods of low rainfall. Groundwater levels quickly rose in response to periods of high rainfall during August to September 2004, April and September 2005, September 2006, April, July and October 2007.

Monitoring wells BH03-5 and BH03-6 are located approximately 300 metres east of BH03-3 and BH03-4. As can be seen on Figure 8, groundwater elevations measured at these monitors from 2003 to the present varied between approximately 90.6 masl and 93.8 masl, and were affected by groundwater control activities during site servicing in early 2004, and early April 2005. The groundwater level drawdown over these periods was approximately 2.0 metres to 2.5 metres. Approximately 1.5 metres of drawdown was induced in these monitors in July and August 2006 during groundwater control activities associated with construction of the deep trunk sewer. Drawdown was not induced in the fall of 2007 during surface water control activities associated with the Findlay Creek Extension. Precipitation had a similar effect on groundwater levels as in monitoring wells BH03-3 and BH03-4. A summary of the periods of groundwater level drawdown and the associated reason for the drawdown in given below for monitors BH03-1 to BH03-6.

Monitor	Period of Groundwater Level Drawdown	Reason for Drawdown
BH03-1 and BH03-2	None	N/A
BH03-3, BH03-4, BH03-5 and BH03-6	January to March 2004	Groundwater control and low precipitation in January to March 2004. Groundwater levels rose within two days after groundwater control activities stopped.
	July to August 2004	Low precipitation in July 2004. Water levels rose within several days of heavy rainfall in August and September 2004.
	January to March 2005	Groundwater control and low precipitation in January, February and March 2005. Groundwater levels rose within a week due to either heavy rainfall in April 2005 and/or groundwater control activities ceasing.
	August 2005	Low precipitation in August 2005.
	July to August 2006	Groundwater control and low precipitation in August 2006. Groundwater levels rose within a day after either heavy rain in September 2006 and/or groundwater control activities ceasing.
	January to March 2007	Low precipitation in January to March 2007.
	June to September 2007	Low precipitation in May, June and September 2007. Groundwater levels rose during heavy rainfall in July and October 2007.

As seen on Figures 7 and 8, overburden groundwater levels at BH03-3, BH03-4, BH03-5 and BH03-6 recovered within hours to several days to baseline levels once temporary groundwater control activities ceased and after heavy rainfall. Groundwater levels at BH03-3 through BH03-6 recovered within two days of the pumping rates being lowered from approximately 18,000,000 L/day to 1,000,000 L/day in August 2006, as shown in Figure 14. Seasonal effects on groundwater levels were noted, particularly during the summer months when precipitation and recharge are lower.

5.3.2 Residential Subdivision Area

As described in Section 4.1, groundwater monitors BH03-8, BH03-10 and BH97-2 were used to monitor groundwater levels in the residential subdivision area. Figures 10, 12 and 13 (respectively) illustrate the groundwater levels measured at these monitors.

Monitoring well BH03-8 is located in the eastern wetland fringe, approximately 75 metres west of the wetland berm. As can be seen on Figure 10, groundwater elevations measured at the overburden monitor 03-8b from 2003 to the present varied between approximately 91.0 masl and 94.0 masl, and were affected by groundwater control activities during site servicing in early 2004, and early 2005. The groundwater level drawdown over these periods ranged from approximately 0.5 metres to 1.8 metres. Groundwater elevations measured at the bedrock monitor 03-8a varied between approximately 89.2 masl and 92.8 masl, and were affected by groundwater control activities during site servicing in early 2004 and early 2005. The groundwater level drawdown over these periods ranged from approximately 0.8 metres to 3.3 metres. Approximately 0.5 metres and 2.5 metres of drawdown were induced in the overburden and bedrock monitors, respectively, in 2006 during groundwater control activities associated with construction of the deep trunk sewer. Drawdown was not induced in the fall of 2007 during construction activities associated with the Findlay Creek Extension. Precipitation had a significant effect on groundwater levels, as evidenced by low groundwater levels in January to March 2004, July 2004, January to March 2005, August 2005, March to April 2006, August 2006, January to March 2007, May to June 2007 and September 2007 during periods of low rainfall. Groundwater levels quickly rose in response to periods of high rainfall during August to September 2004, April and September 2005, May and September 2006, April, July and October 2007.

Monitoring well BH03-10 is located immediately east of the Findlay Creek Extension, approximately 15 metres east of the wetland berm. As can be seen on Figure 12, groundwater elevations measured at the overburden (03-10b) and bedrock (03-10a) monitors varied between approximately 89.3 masl and 92.7 masl, and were affected by groundwater control activities during site servicing in early 2004, early 2005, and October 2005 (BH03-10a only). The groundwater level drawdown over these periods was approximately 3.2 metres, and the overburden groundwater level was drawn down below the overburden pressure transducer (approximately 90.1 masl). As can be seen on Figure 12, approximately 2.1 metres of drawdown was induced in the monitors in 2006 during groundwater control activities associated with construction of the deep trunk sewer. The overburden groundwater level during both events was drawn down below the overburden pressure transducer (approximately 90.2 masl). Drawdown was not induced in the fall of 2007 during construction activities associated with the Findlay Creek Extension. Precipitation had a similar effect on groundwater levels as in monitoring well BH03-8.

Monitoring well BH97-2 is located approximately 60 metres west of the proposed Wetland Outlet Control Structure. As can be seen on Figure 13, groundwater elevations measured at the overburden (97-2b) and bedrock (97-2a) monitors from 2003 to the present varied between approximately 90.0 masl and 93.8 masl, and were affected by groundwater control activities during site servicing in early 2004 and early 2005. The groundwater level drawdown over these periods was approximately 2.5 metres. Approximately 2.5 metres of drawdown was induced in these monitors in 2006 during groundwater control activities associated with construction of the deep trunk sewer. Drawdown was not induced in the fall of 2007 during construction activities associated with the Findlay Creek Extension. Precipitation had a similar effect on groundwater levels as in monitoring wells BH03-8 and BH03-10. High groundwater levels were also noted in October and November of 2005, which correspond to periods of high precipitation. A summary of the periods of groundwater level drawdown and the associated reason for the drawdown in given below for monitors BH03-8, BH03-10 and BH97-2.

Monitor	Groundwater Level Drawdown	Reason for Drawdown
BH03-8a, BH03-8b, BH03-10a, BH03-10b, BH97-2a, and BH97-2b	January to March 2004	Groundwater control and low precipitation in January to March 2004. Groundwater levels rose within two days after groundwater control activities stopped.
	July to August 2004	Low precipitation in July 2004. Water levels rose within several days of heavy rainfall in August and September 2004.
	January to March 2005	Groundwater control and low precipitation in January, February and March 2005. Groundwater levels rose within several days due to either heavy rainfall in April 2005 and/or groundwater control activities ceasing.
	August and September 2005	Low precipitation in August 2005.
	October 2005 (BH03-10a only)	Groundwater control.
	February to April 2006 (except for BH03-8b)	Groundwater control and low precipitation in March and April 2006.
	August to September 2006	Groundwater control and low precipitation in August 2006. Groundwater levels rose over a few weeks after either heavy rain in September 2006 and/or groundwater control activities ceasing.
	January to March 2007	Low precipitation in January to March 2007.
	June to September 2007	Low precipitation in May, June and September 2007. Groundwater levels rose during heavy rainfall in July and October 2007.

As seen on Figures 10, 12 and 13, overburden and bedrock groundwater levels typically recovered within hours to several days to baseline levels once temporary groundwater control activities ceased and after heavy rainfall. Groundwater levels fluctuated by approximately 2 m (except for overburden monitor BH03-8b) during groundwater control activities from October 2005 to August 2006 (Figure 14) and recovered within hours to several days of the pumping rates being lowered. Seasonal effects on groundwater levels were noted, particularly during the summer months when precipitation and recharge are lower.

5.3.3 Wetland Fen Area

As described in Section 4.1, groundwater monitors BH03-7 and BH03-9 were used to monitor groundwater levels in the wetland fen area. Figures 9 and 11 illustrate the groundwater levels measured at these monitors.

Monitoring well BH03-7 is located approximately 150 metres west of BH97-2, near the wetland fen area. As can be seen on Figure 9, groundwater elevations measured at the overburden monitor from 2003 to the present varied between approximately 91.6 masl and 94.0 masl, and were affected by groundwater control activities during site servicing in early 2004 and early 2005. The groundwater level drawdown over these periods was approximately 1.7 metres and 0.5 metres, respectively. Groundwater elevations measured at the bedrock monitor varied between approximately 92.7 masl and 93.7 masl, and were affected by groundwater control activities during site servicing in early 2004 and early 2005. The groundwater level drawdown over these periods was approximately 0.6 metres. Approximately 0.7 metres of drawdown was induced in both monitors in 2006 during groundwater control activities associated with construction of the deep trunk sewer. Drawdown was not induced in the fall of 2007 during construction activities associated with the Findlay Creek Extension. Precipitation had a significant effect on groundwater levels, as evidenced by low groundwater levels in January to March 2004, July 2004, January to March 2005, August 2005, March to April 2006, August 2006, January to March 2007, May to June 2007 and September 2007 during periods of low rainfall. Groundwater levels quickly rose in response to periods of high rainfall during August to September 2004, April and September 2005, May and September 2006, April, July and October 2007.

Monitoring well BH03-9 is located approximately 250 metres south of the northern arm of the wetland berm and 280 metres west of the eastern arm of the wetland berm, near the wetland fen area. As can be seen on Figure 11, groundwater elevations measured at the overburden monitor (03-9b) from 2003 to the present varied between approximately 92.7 masl and 94.0 masl, and were affected by groundwater control activities during site servicing in early 2004 and early 2005. The groundwater level drawdown over these periods was approximately 0.8 metres and 1.0 metres, respectively. Groundwater elevations measured at the bedrock monitor (03-9a) varied between approximately 91.6 masl and 93.5 masl, and were affected by groundwater control activities during site servicing in early 2004 and early 2005. The groundwater level drawdown over these periods was approximately 1.8 metres. Approximately 1.4 metres of drawdown was induced in these monitors in 2006 during groundwater control activities associated with construction of the deep trunk sewer. Drawdown was not induced in the fall of 2007 during construction activities associated with the Findlay Creek Extension. Precipitation had a similar effect on groundwater levels as in monitoring well BH03-7. A summary of the periods of groundwater level drawdown and the associated reason for the drawdown in given below for monitors BH03-7 and BH03-9.

Monitor	Groundwater Level Drawdown	Reason for Drawdown
BH03-7a, BH03-7b, BH03-9a, and BH03-9b,	January to March 2004	Groundwater control and low precipitation in January to March 2004. Groundwater levels rose within several days after groundwater control activities stopped.
	July to August 2004	Low precipitation in July 2004. Water levels rose within several days of heavy rainfall in August and September 2004.
	January to March 2005	Groundwater control and low precipitation in January, February and March 2005. Groundwater levels rose within several days due to either heavy rainfall in April 2005 and/or groundwater control activities ceasing.
	August and September 2005	Low precipitation in August 2005.
	February to April 2006 (except for BH03-7a and BH03-7b)	Groundwater control and low precipitation in March 2006 and April.
	July to August 2006	Groundwater control and low precipitation in August 2006. Groundwater levels rose over a few weeks after either heavy rain in September 2006 and/or groundwater control activities ceasing.
	January to March 2007	Low precipitation in January and March 2007.
	June to September 2007	Low precipitation in May, June and September 2007. Groundwater levels rose during heavy rainfall in July and October 2007.

As seen on Figures 9 and 11, once temporary groundwater control activities ceased and after heavy rainfall, overburden groundwater levels typically recovered within hours to several days to baseline levels. Groundwater levels at BH03-7a and BH03-7b recovered within two days of the pumping rates being lowered from approximately 18,000,000 L/day to 1,000,000 L/day in August 2006 (Figure 14). Groundwater levels at BH03-10a and BH03-10b fluctuated by approximately 1 metre during groundwater control activities from October 2005 to August 2006 (Figure 14) and recovered within hours to several days of the pumping rates being lowered. Seasonal effects on groundwater levels were noted, particularly during the summer months when precipitation and recharge are lower.

5.4 Groundwater Trigger Evaluation

During monthly review of monitoring data, groundwater levels at each of the monitoring wells were evaluated to determine if the groundwater elevations had dropped below groundwater trigger elevations. A summary of periods when groundwater levels dropped below trigger elevations is shown in Table 2 along with the interpreted reason for groundwater levels dropping below the triggers (either groundwater control activities or seasonally low water levels due to low precipitation).

The spring and early fall of 2007 were unusually dry, with much less precipitation falling during this time as compared to previous years. Groundwater elevations were observed to drop at many of the monitors through the summer and fall of 2007; these water level changes are attributed to seasonally dry conditions and not groundwater control at the site. It is noted that in a number of the overburden monitors, i.e., 03-5, 03-6, 03-7b, 03-8b, 03-9b, 03-10b, the natural decline in the groundwater level during the fall of 2007 was similar to that interpreted to be associated with groundwater control during trunk sewer construction in 2006. Water levels were observed to recover rapidly following precipitation events in July and October of 2007.

During the groundwater trigger events in early 2006, water was pumped behind the wetland berm in an effort to encourage recharge to the overburden along the wetland fringe and prevent groundwater elevation drawdown further into the wetland core. In general, this method did not prove to be an effective method at recharging groundwater elevations. However, on Figures 7 to 13, it is noted that the water levels increased by 0.5 to 1.0 m on January 15 to 17, 2006. This period did not coincide with heavy precipitation (a total of 2.5 mm of precipitation fell from January 15 to 17, 2006 (Appendix B)). Therefore, this increase in groundwater levels may have been a result of the pumping behind the wetland berm.

5.5 Vertical Hydraulic Gradients

The direction of the vertical hydraulic gradients within the eastern fringe of the wetland is generally consistent at each well but varies across the wetland as summarized in the table below.

Monitor	Direction of Vertical Hydraulic Gradient
BH03-7a and BH03-7b	Upwards
BH03-8a and BH03-8b	Downwards
BH03-9 and BH03-9b	Downwards
BH03-10a and BH03-10b	Upwards
BH97-2a and BH097-2b	Upwards

Differences in vertical hydraulic gradients result from varying recharge and geological conditions. The bedrock may have a significant impact on the vertical gradient since intact bedrock may limit groundwater flow while more fractured bedrock may promote groundwater flow. The upward gradient wells (BH03-7, BH03-10 and BH97-2) are all located within proximity to a ditch; therefore, potential groundwater discharge may be occurring into the nearby ditch. Typically, the direction of the vertical hydraulic gradient will not have a significant impact on the response of groundwater to pumping-induced drawdown. The groundwater levels in both upward and downward gradient wells responded quickly (i.e., within hours to a few days) to the cessation of groundwater pumping.

At BH03-10, the vertical hydraulic gradient is downwards during early 2004, early 2005 and 2006, which correspond to periods of temporary groundwater control. This is likely caused by the groundwater level in the bedrock being lowered due to temporary groundwater control, resulting in a temporary reversal of the vertical gradient.

6.0 DISCUSSION AND CONCLUSIONS

Temporary groundwater control activities carried out since 2004 for deep sewer construction purposes in Findlay Creek Village have caused temporary groundwater level drawdown in overburden and bedrock groundwater monitors installed along the Findlay Creek Extension, in the residential subdivision area, and near the wetland fen area. Temporary groundwater control activities have typically involved minor groundwater extraction from the overburden and relatively high groundwater extraction from the upper bedrock zones beneath the site.

Groundwater levels were compared to the trigger groundwater elevations established in the EMP, and groundwater levels fell below the triggers on occasion at many of the monitors. As a result of the trigger occurrences that were likely caused by groundwater control activities, contingency measures were initiated in 2006, and pumped water was directed behind the wetland berm to encourage recharge to overburden materials.

As seen on Figures 7 through 13, once temporary groundwater control activities ceased, overburden groundwater levels recovered within hours to several days to baseline levels. Seasonal effects on groundwater levels can also be noted, particularly during the summer months when precipitation and recharge are lower. Climate data collected at the Ottawa Airport by Environment Canada is included in Appendix B for reference; precipitation is plotted on Figure 6 together with data provided by the City of Ottawa from three other locations.

Few trigger occurrences due to groundwater control activities were recorded at overburden monitors and these occurrences were typically short-term and during the winter months. As a result of the rapid recovery of overburden groundwater levels and the relatively short duration of trigger occurrences, negative impacts to vegetation in the core wetland are not expected to have occurred. Observations in 2006 and 2007 by Golder biologists conducting a photo monitoring program in the wetland areas, as described in the EMP and required by the Fisheries Authorization applicable to construction of the external storm system (September 2005 to November 2006), have not indicated adverse effects. Monitoring of vegetation within the wetland is ongoing as directed by the Wetlands Advisory Committee.

Future site servicing activities may necessitate groundwater control. Due to the distance between the core wetland and Stage 2 (Figure 2), the effects of the groundwater control activities on overburden groundwater levels near the core wetland are expected to be small. Due to the distance between the core wetland and the future southeastern stage (Figure 2), the effects of the groundwater control activities on overburden groundwater levels near the core wetland are also expected to be small. Due to the larger thickness of overburden in the western portion of the site, groundwater control activities in the future western stage (Figure 2) are expected to be less extensive than in previously constructed stages. As less groundwater is anticipated to need to be controlled during site servicing of the western future stage, the effects of the groundwater control activities on overburden groundwater levels near the core wetland are expected to be minimal. In all three cases (Stage 2, future southeastern stage, future western stage), negative impacts to vegetation in the core wetland are not anticipated due to groundwater control activities.

7.0 RECOMMENDATIONS

The dataloggers near the Findlay Creek Extension are currently downloaded monthly and manual measurements are recorded at those times to confirm the transducer readings. During construction of the Findlay Creek Extension, the dataloggers will be downloaded bi-weekly with coinciding manual measurements. After completion of the Findlay Creek Extension, downloading of the dataloggers and manual measurements will occur monthly for a period of 3 months. After 3 months, the program for continued monitoring in the immediate area of the Findlay Creek Extension will be re-evaluated.

The dataloggers near the residential subdivision area and the wetland fen area are currently downloaded monthly and manual measurements are recorded at those times to confirm the transducer readings. The revised EMP specified that after completion of the SWMP and trunk sewer, downloading of the dataloggers and manual measurements was to occur monthly for a period of 12 months (i.e., until November 2007). The program for continued monitoring in the eastern wetland fringe and the wetland fen area should be re-evaluated based on the schedule for future site servicing installations and associated groundwater control activities; however, ongoing monthly monitoring and data review is considered appropriate at this time.

8.0 LIMITATIONS

This report was prepared by Golder Associates Ltd. (Golder Associates) for the use of the Leitrim Monitoring Technical Advisory Committee. Should additional parties require reliance on this report, written authorization from Golder Associates will be required. The report, which specifically includes all tables, figures and appendices is based on data and information collected during the site investigation conducted by Golder Associates and is based solely on the conditions of the property at the time of the field investigation, supplemented by historical information and data obtained by Golder Associates and others as described in this report.

Except where specifically stated to the contrary, the information contained in this report was compiled or provided to Golder Associates by others and has not been independently verified or otherwise examined by Golder Associates to determine its accuracy or completeness. Golder Associates has relied in good faith on this information and does not accept responsibility for any deficiency, misstatements, or inaccuracies contained in the information as a result of omissions, misinterpretation or fraudulent acts.

The services performed as described in this report were conducted in a manner consistent with that level of care and skill normally exercised by other members of the engineering and geoscience professions currently practicing under similar conditions, subject to the time limits and financial and physical constraints applicable to the services. Golder Associates accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

The findings and conclusions of this report are valid only as of the date of this report. If new information is discovered in future work, including excavations, borings, or other studies, Golder Associates should be requested to re-evaluate the findings of this report, and to provide amendments as required.

This report provides a professional opinion in light of the information available at the time of this report and therefore no warranty is either expressed, implied, or made as to the conclusions, advice or recommendations offered in this report.

The monitoring wells installed to carry out this work are the property of Findlay Creek Co-Tenancy, not Golder Associates.

9.0 CLOSURE

If there are any questions concerning this document, please do not hesitate to contact the undersigned.

Yours truly,

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TABLE 1
PRE-DEVELOPMENT GROUNDWATER ELEVATIONS FROM 1990 TO 1998

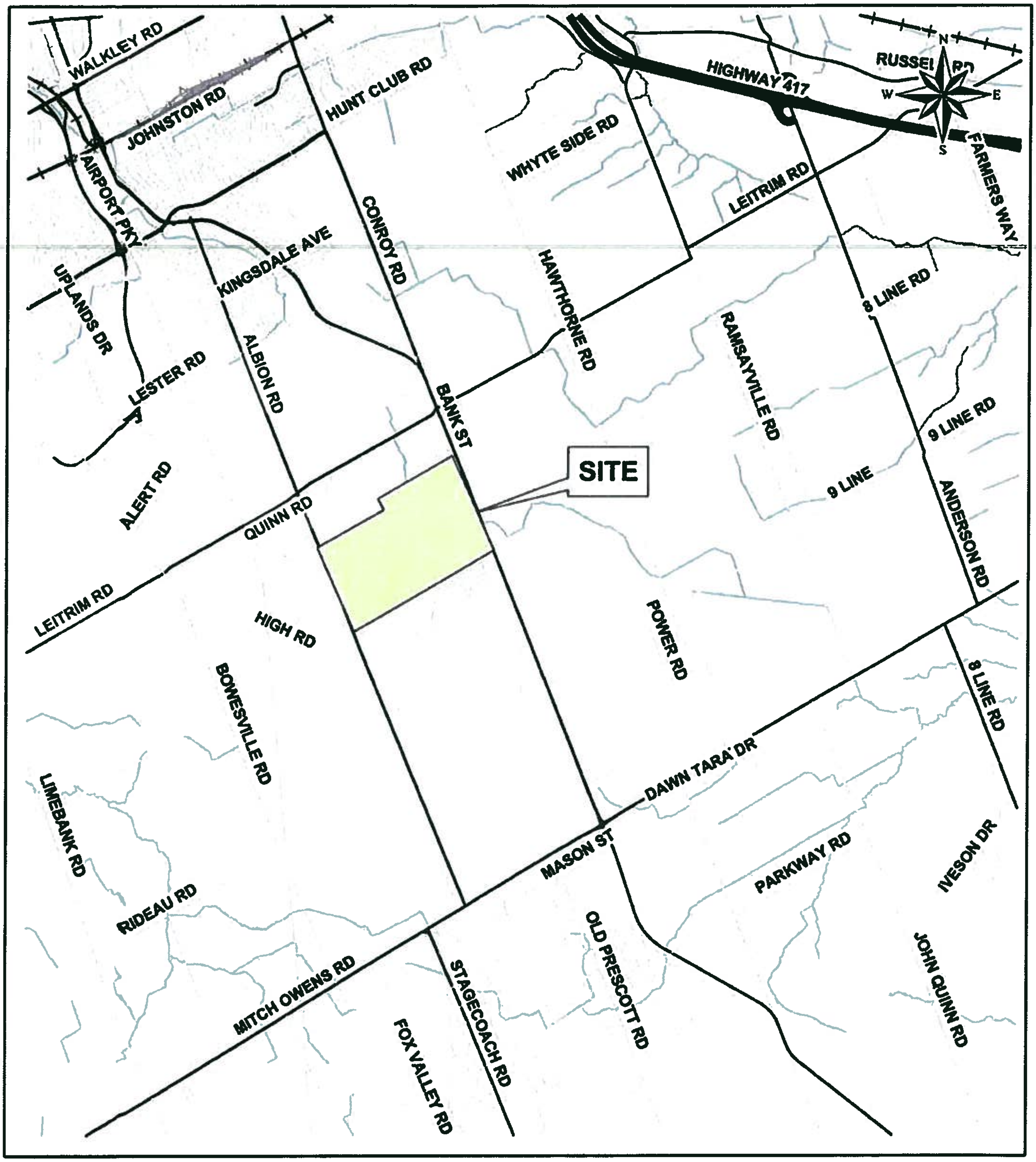
	Groundwater Elevations (m)																			
Well No.	**88-4**	**90-1**		**90-2**		**90-3**		**90-4**		**90-5**		**90-6**		**94-1**	**94-2**	**94-3**	**94-4**	**97-1**	**97-2**		**97-3**
Ground Surface	92.16	95.25	95.25	94.32	94.32	96.08	96.08	97.03	97.03	95.21	95.21	93.82	93.82	92.09	92.61	92.95	93.11	93.04	92.84	92.85	93.79
Date		A	B	A	B	A	B	A	B	A	B	A	B						A	B	
24-Jul-90		95.11	95.37	94.07	94.17	96.10	96.00	97.07	97.19												
13-Sep-90	90.92	95.19	95.07	93.92	94.13	94.97	95.21	96.48	97.02	94.81	94.73	93.77	93.84								
4-Mar-94														92.85	92.25						
6-Nov-95	91.80	95.30	95.20	94.32	94.32	95.92	95.93	96.98	97.00			93.82	93.82	91.83							
3-Feb-98						95.84	95.89												92.78	92.65	
7-Apr-98						95.93	96.04												92.95	92.82	
22-Apr-98	92.16	95.31	95.09	94.32	94.42	95.88	95.97	97.06	96.96	95.05	95.07	93.69	93.69	91.64	92.14	92.87	92.84	91.96	92.94	92.82	93.52
28-May-98	91.24	95.01	94.72	94.31	94.32	95.69	95.69	96.93	96.92	94.23	94.03	93.04	93.07		91.54	92.82	92.39	91.16	92.60	92.51	93.30
10-Jul-98						95.83	95.83	97.03	96.97						91.27				92.62	92.53	
14-Jul-98				94.30	94.32																
24-Aug-98	91.01			94.34	94.35	95.85	95.85	97.04	96.99	94.08	93.79	93.35	93.37	90.87	91.22	92.66	92.48	90.84	92.44	92.35	93.35
30-Sep-98				94.32	94.32	95.85	95.94	97.03	97.01									91.21	92.71	92.64	
5-Nov-98	91.35	95.25	95.03	94.32	94.32	95.84	95.84	97.03	96.98	94.86	94.81	93.61	93.66					91.34	92.77	92.70	93.45
6-Nov-98														91.29	91.67	92.89	92.73				

Notes: A, B - Deep and shallow monitoring wells, respectively
All monitoring wells in overburden, except 97-2a in bedrock.
For monitoring well locations, refer to Figure 3.

TABLE 2
GROUNDWATER TRIGGER EVALUATION

Monitor	Unit Monitored	Area Monitored	Trigger Water Level Elevation (m)	Periods with Water Levels Below Trigger Elevation	Minumum Water Level	Trigger Reason
BH03-1	Overburden	FCE*	94.5	None		-
BH03-2	Overburden	FCE*	94.5	None		-
BH03-3	Overburden	FCE*	93.2	None		-
BH03-4	Overburden	FCE*	93.5	None		-
BH03-5	Overburden	FCE*	91.9 (Apr-Sept) 92.5 (Oct-Mar)	January-March 2004	91.24	Groundwater control
				February-March 2005	90.96	Groundwater control
				August 24 - September 1, 2006	91.84	Seasonal low water levels
				March 2007	92.32	Seasonal low water levels
				July-August 2007	91.96	Seasonal low water levels
BH03-6	Overburden	FCE*	91.9 (Apr-Sept) 92.5 (Oct-Mar)	January-March 2004	90.94	Groundwater control
				February-March 2005	90.63	Groundwater control
				August 24 - September 2, 2006	91.61	Seasonal low water levels
				March, 2007	92.06	Seasonal low water levels
				July-August 2007	91.76	Seasonal low water levels
03-7A	Bedrock	Wetland Fen	93.4	December 2003	93.3	Seasonal low water levels
				January-March 2004	93.02	Groundwater control
				July-August 2004	93.27	Seasonal low water levels
				February-March 2005	93.1	Groundwater control
				August 2005	93.27	Seasonal low water levels
				March 2006	93.28	Groundwater control
				July-October 2006	93.11	Groundwater control
				July-October 2007	92.66	Seasonal low water levels
03-7B	Overburden	Wetland Fen	92.6	January-February 2004	91.61	Groundwater control
				July-October 2007	91.86	Seasonal low water levels
03-8A	Bedrock	Residential Subdivision Area	91.0	December 2003	90.9	Seasonal low water levels
				January-March 2004	89.2	Groundwater control
				January-March 2005	89.54	Groundwater control
				January-May 2006	89.58	Groundwater control
				July-October 2006	90.02	Groundwater control
				February-March 2007	90.79	Seasonal low water levels
				June-November 2007	90.2	Seasonal low water levels
03-8B	Overburden	Residential Subdivision Area	91.1 (Apr-Sept) 91.8 (Oct-Mar)	January-February 2004	90.96	Groundwater control
				July 8, 2007	91.03	Seasonal low water levels
				October 2007	91.17	Seasonal low water levels
03-9A	Bedrock	Wetland Fen	92.4	February-March 2004	91.59	Groundwater control
				February-March 2005	91.55	Groundwater control
				March 2006	92.1	Groundwater control
				July 19-31, 2006	92.35	Groundwater control
				August 14-September 19, 2006	91.89	Groundwater control
				August-October 2007	92.24	Seasonal low water levels
03-9B	Overburden	Wetland Fen	93.0	February-March 2004	92.67	Groundwater control
				February-March 2005	92.56	Groundwater control
				July 22-31, 2006	92.89	Groundwater control
				August 28-September 2, 2006	92.88	Groundwater control
				July-October 2007	92.68	Seasonal low water levels
03-10A	Bedrock	Residential Subdivision Area	90.9	January-March 2004	89.37	Groundwater control
				January-March 2005	89.35	Groundwater control
				October 6-19, 2005	89.82	Groundwater control
				February-April 2006	89.85	Groundwater control
				July-September 2006	89.87	Groundwater control
				February-March 2007	90.74	Seasonal low water levels
				June-November 2007	90.27	Seasonal low water levels
03-10B	Overburden	Residential Subdivision Area	90.7	January-March 2004	90.04	Groundwater control
				January-March 2005	89.94	Groundwater control
				August-September 2005	90.53	Groundwater control
				February-April 2006	90.17	Groundwater control
				June-October 2006	90.18	Groundwater control
				January-March 2007	90.36	Seasonal low water levels
				May-December 2007	90.17	Seasonal low water levels
97-2A	Bedrock	Residential Subdivision Area	91.3	January-March 2004	90.34	Groundwater control
				February-March 2005	90.72	Groundwater control
				February-March 2006	90.92	Groundwater control
				August-September 2006	90.94	Groundwater control
				August 22-October 11, 2007	91.16	Seasonal low water levels
97-2B	Overburden	Residential Subdivision Area	91.2	January-March 2004	89.92	Groundwater control
				February-March 2005	90.6	Groundwater control
				March 2006	90.89	Groundwater control
				August 18-September 13, 2006	90.98	Groundwater control
				July-October 2007	90.58	Seasonal low water levels

*FCE - Findlay Creek Extension



1,500 0 1,500

SCALE 1:75,000 METRES

REFERENCE

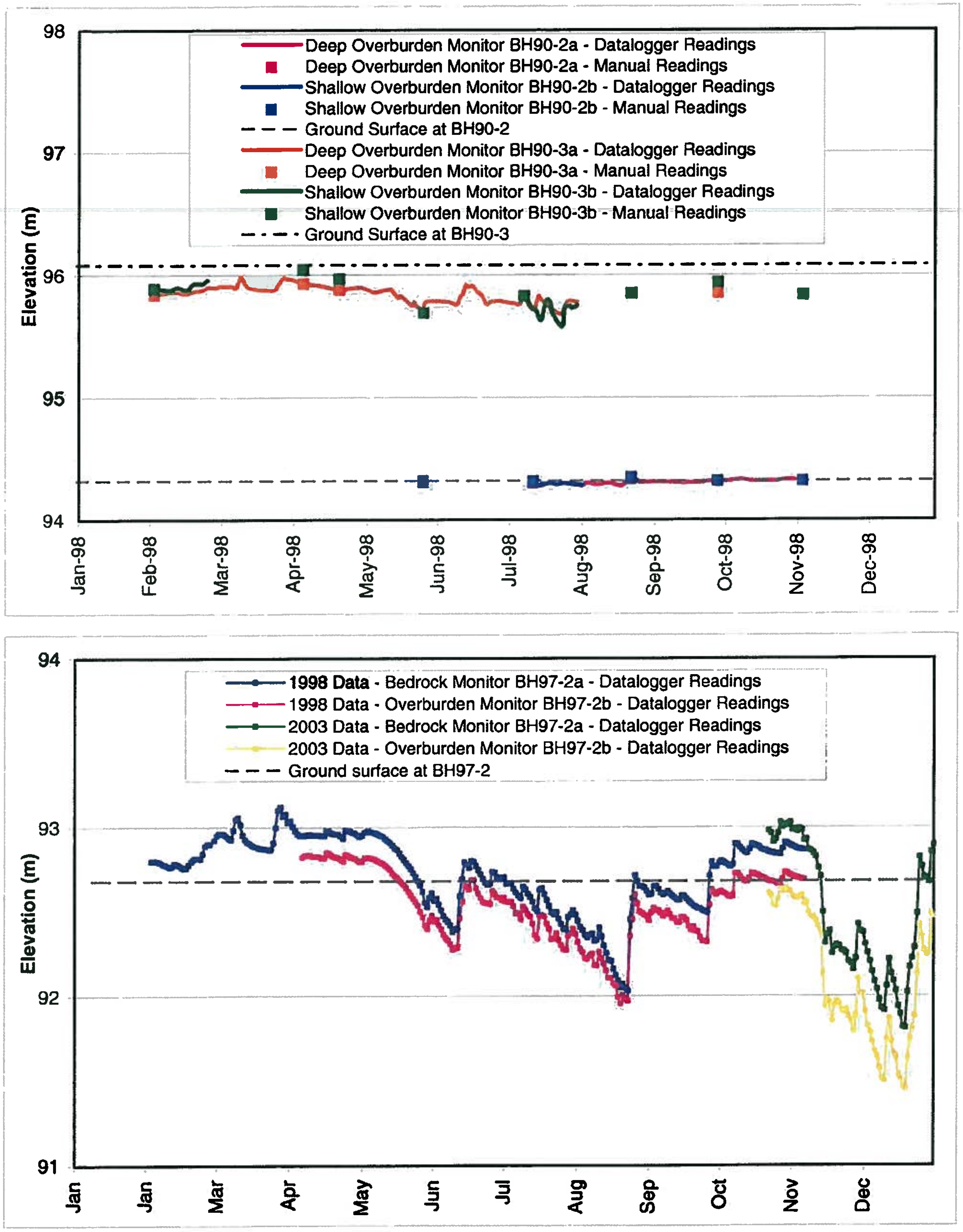
Digital base map data supplied by DMTI Spatial Inc. CANMAP, 2005

Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 18

Golder Associates
Ottawa, Ontario

DATE	DEC 03 2007	TITLE	KEY PLAN
DESIGN	BT		
GIS	BT		
PROJECT No. 03-1120-846	CHECK PAS	PROJECT	LEITRIM ENVIRONMENTAL PLAN GROUNDWATER MONITORING
SCALE AS SHOWN	REV. 0	REVIEW PAS	FIGURE: 1

N:\Active\2003\1120\ENVIRONMENTAL\03-1120-846 Leitrim EMP\GIS\GIS\mxd\03-1120-846-KeyPlan.mxd



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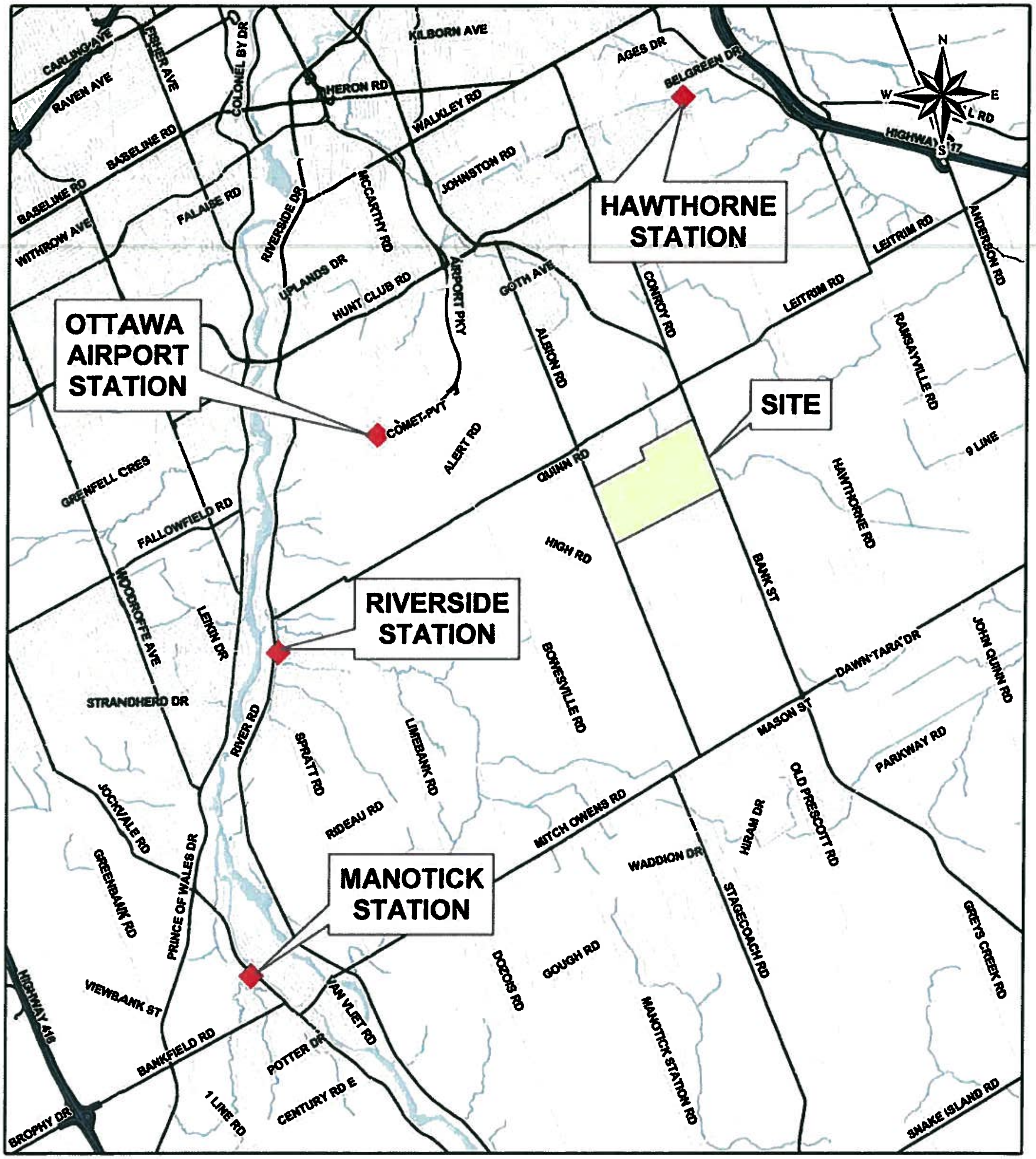
GROUNDWATER ELEVATIONS, BH90-2 AND BH90-3 (TOP) AND BH97-2 (BOTTOM) IN 1998 AND 2003

FIGURE 4



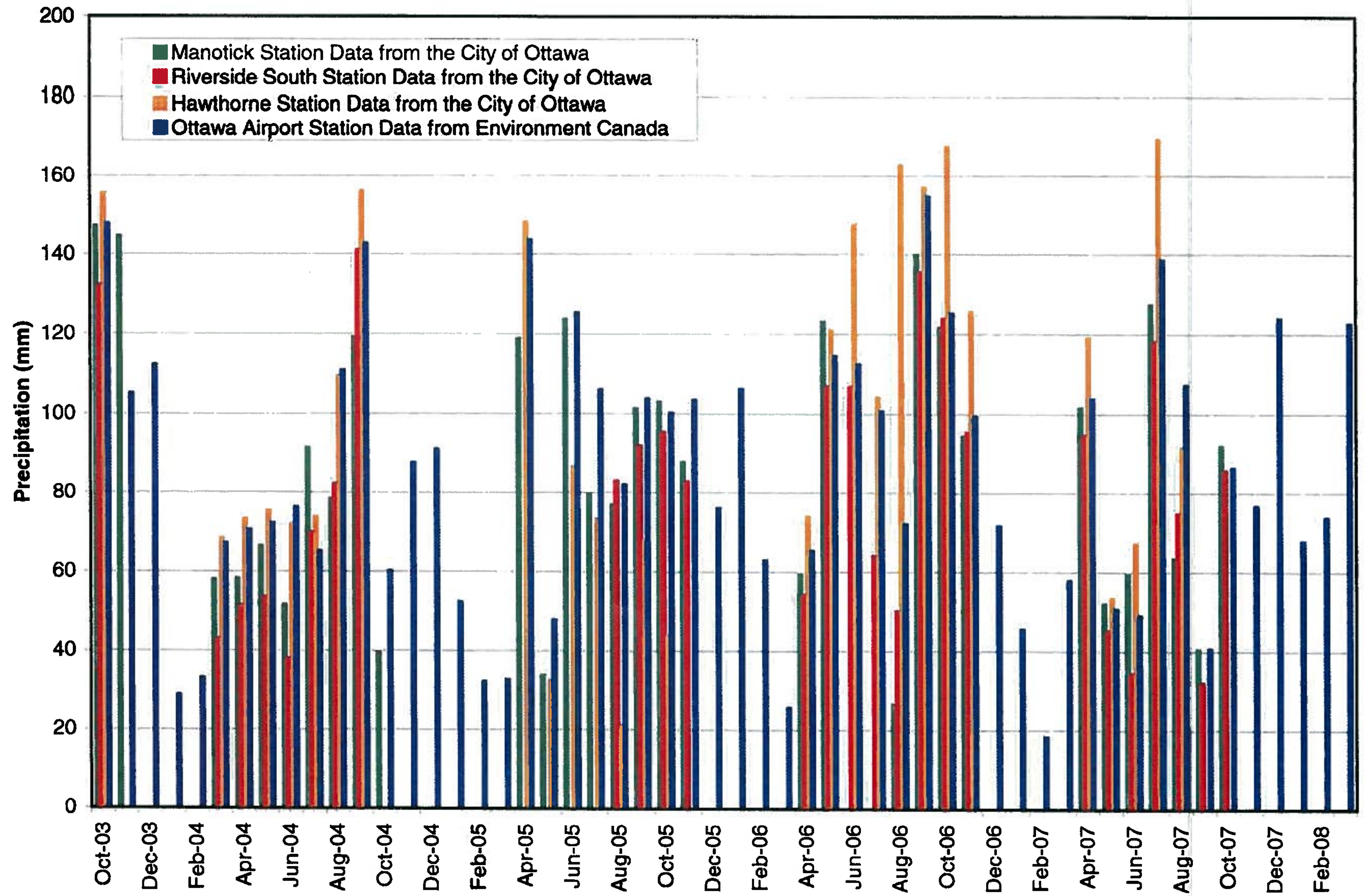
REFERENCE

Digital base map data supplied by DMTI Spatial Inc. CANMAP, 2005
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 18

2,000 0 2,000
SCALE 1:100,000 METRES

Golder Associates
Ottawa, Ontario

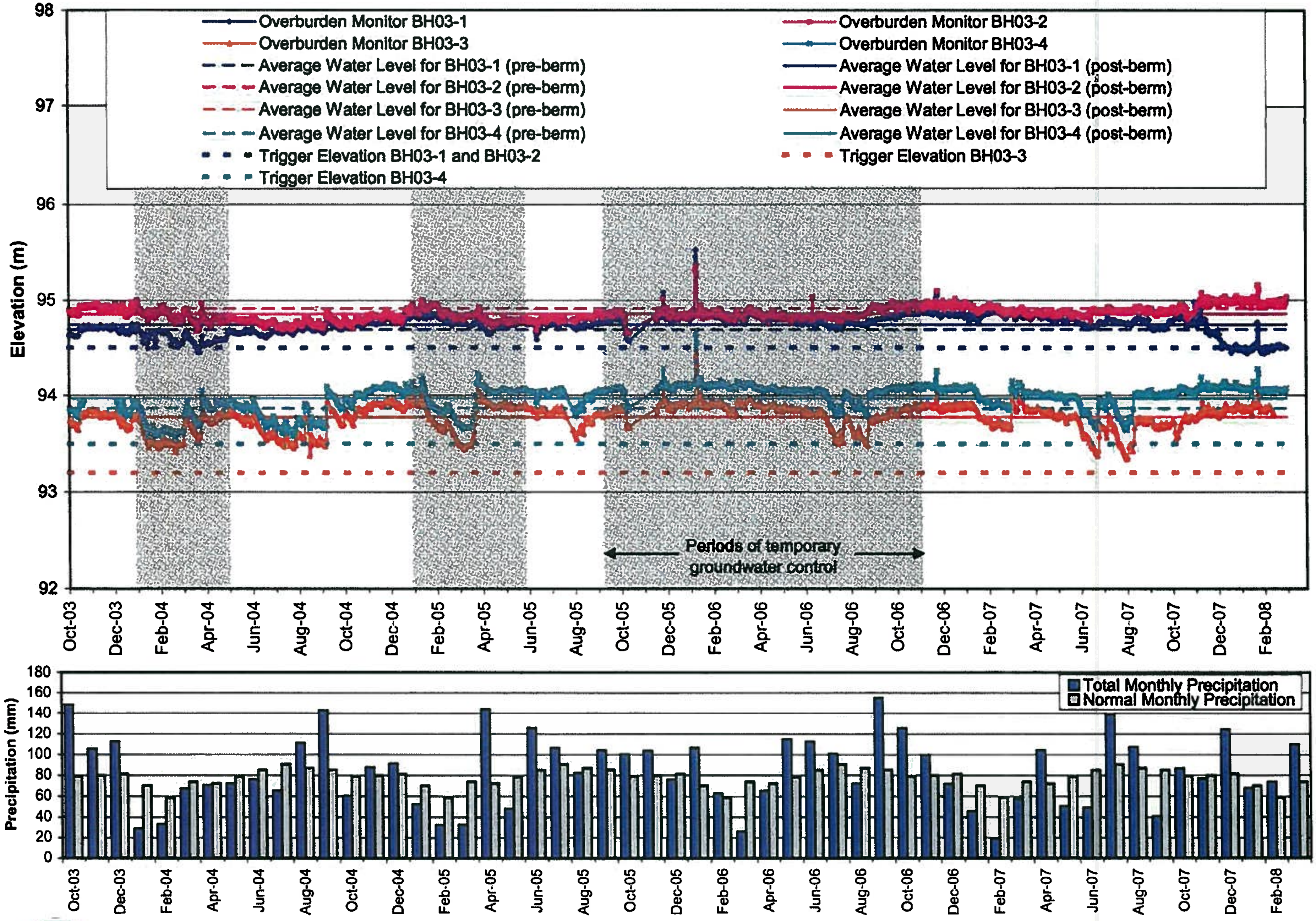
DATE	01 Apr. '08	TITLE	PRECIPITATION STATIONS LOCATIONS	
DESIGN	JEM			
GIS	JEM			
PROJECT No. 03-1120-846-1040		CHECK	PAS	PROJECT LEITRIM EMP
SCALE AS SHOWN	REV. 0	REVIEW	PAS	FIGURE: 5



TOTAL MONTHLY PRECIPITATION DATA

FIGURE 6

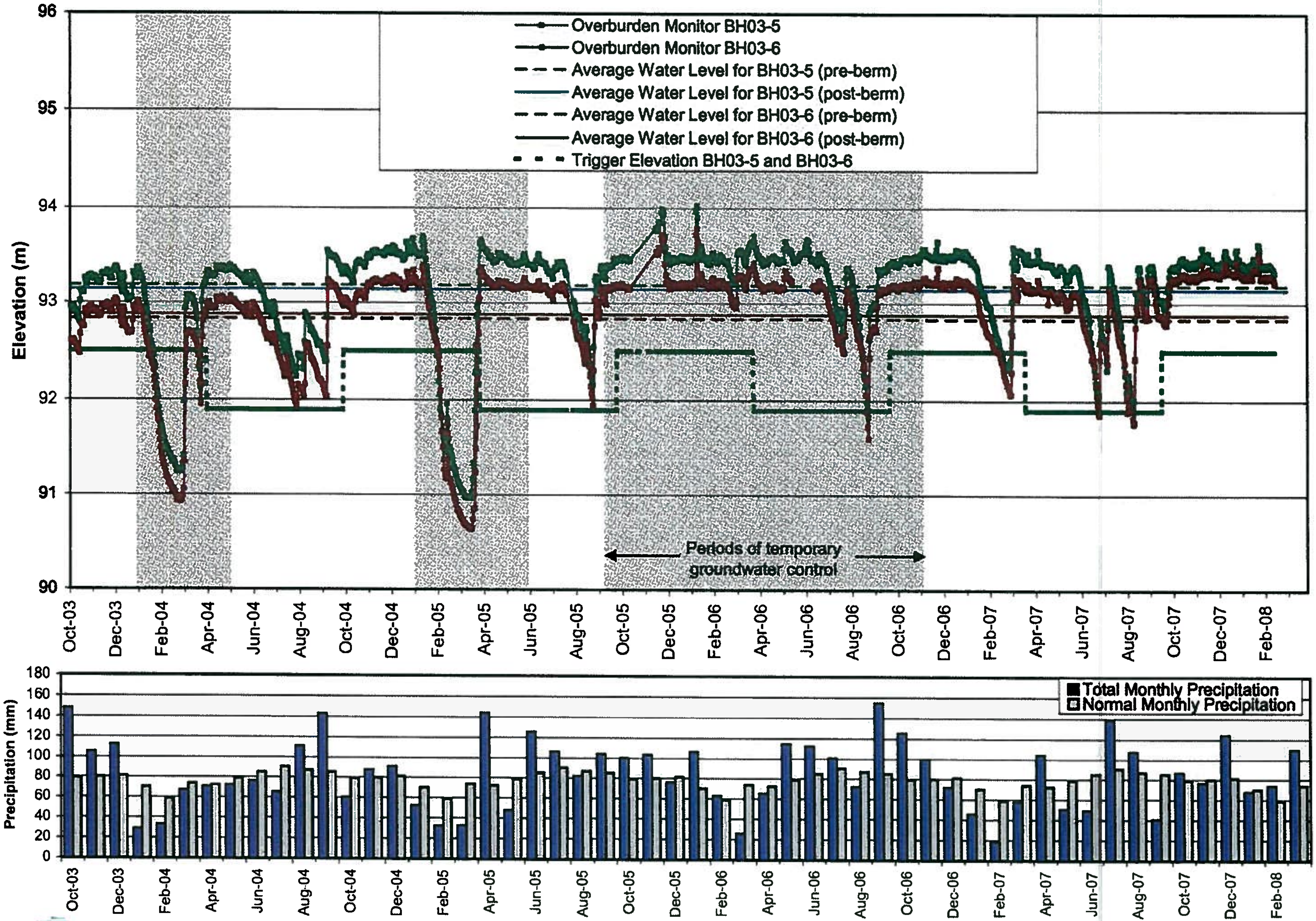
N:\Active\2003\1120\ENVIRONMENTAL\03-1120-846 Leitrim EMP\Monitoring Data\Precipitation\Precipitation data - City & EC



GROUNDWATER ELEVATIONS MW 03-1 to MW 03-4 (TOP)
AND MONTHLY PRECIPITATION (BOTTOM)

FIGURE 7

N:\Active\2003\1120\ENVIRONMENTAL\03-1120-846 Leitrim EMP\Monitoring Reports\Leitrim graphs _ April 2008.xls



GROUNDWATER ELEVATIONS MW 03-5 AND MW 03-6 (TOP)
AND MONTHLY PRECIPITATION (BOTTOM)

FIGURE 8

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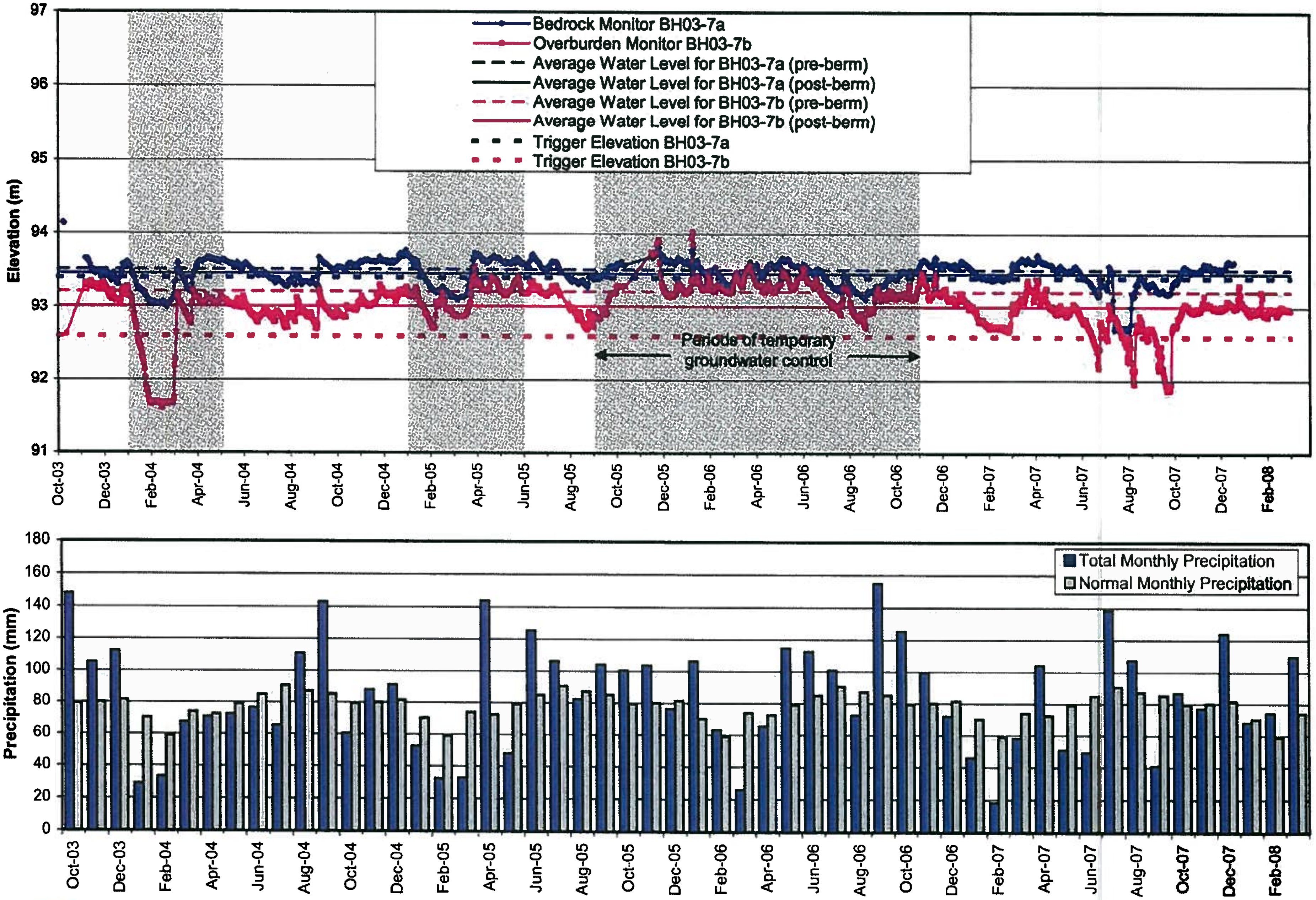
N:\Active\2003\1120\ENVIRONMENTAL\03-1120-846 Leitrim EMP\Monitoring Reports\Leitrim graphs _ April 2008.xls



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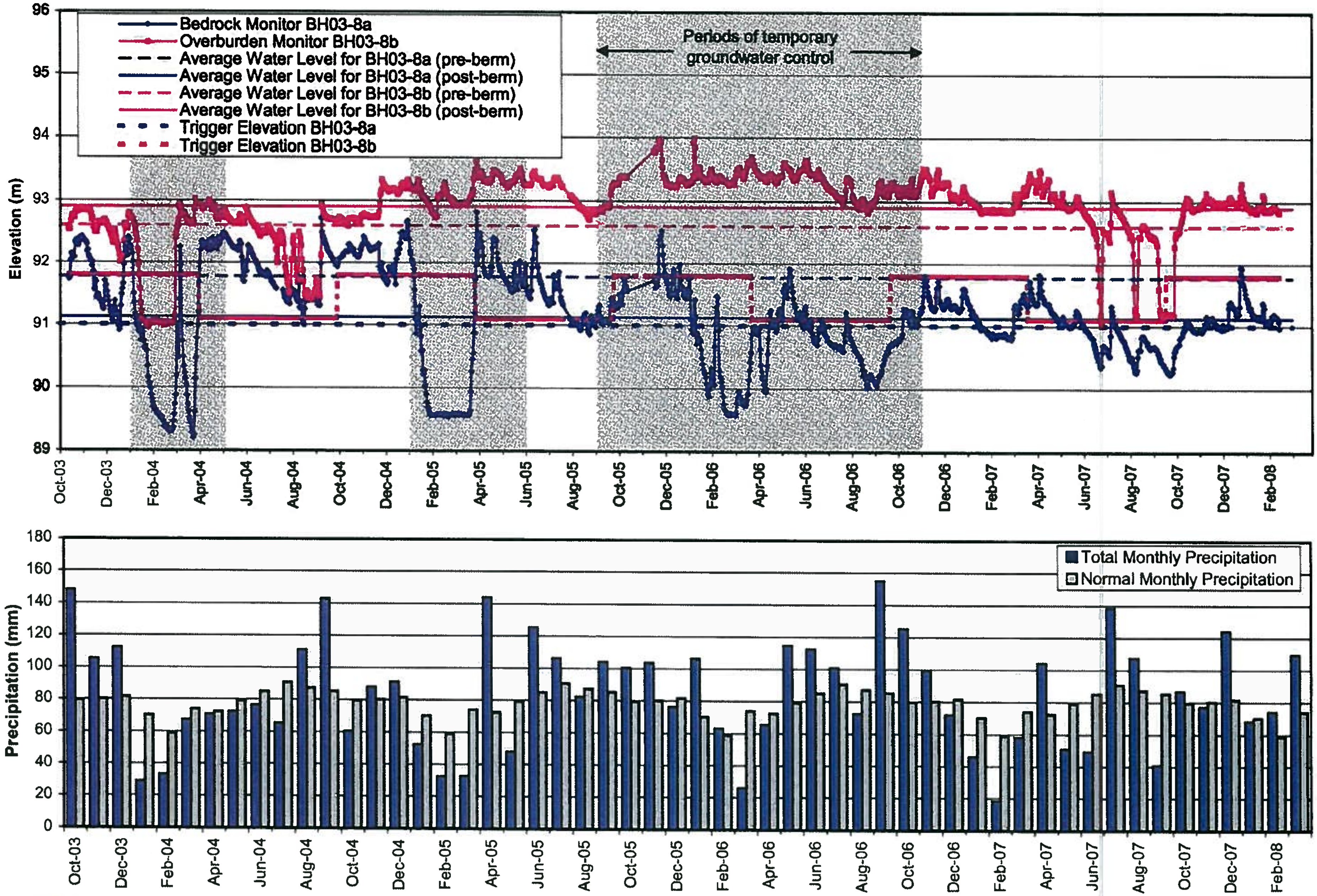
GROUNDWATER ELEVATIONS MW 03-7a AND MW 03-7b (TOP)
AND MONTHLY PRECIPITATION (BOTTOM)

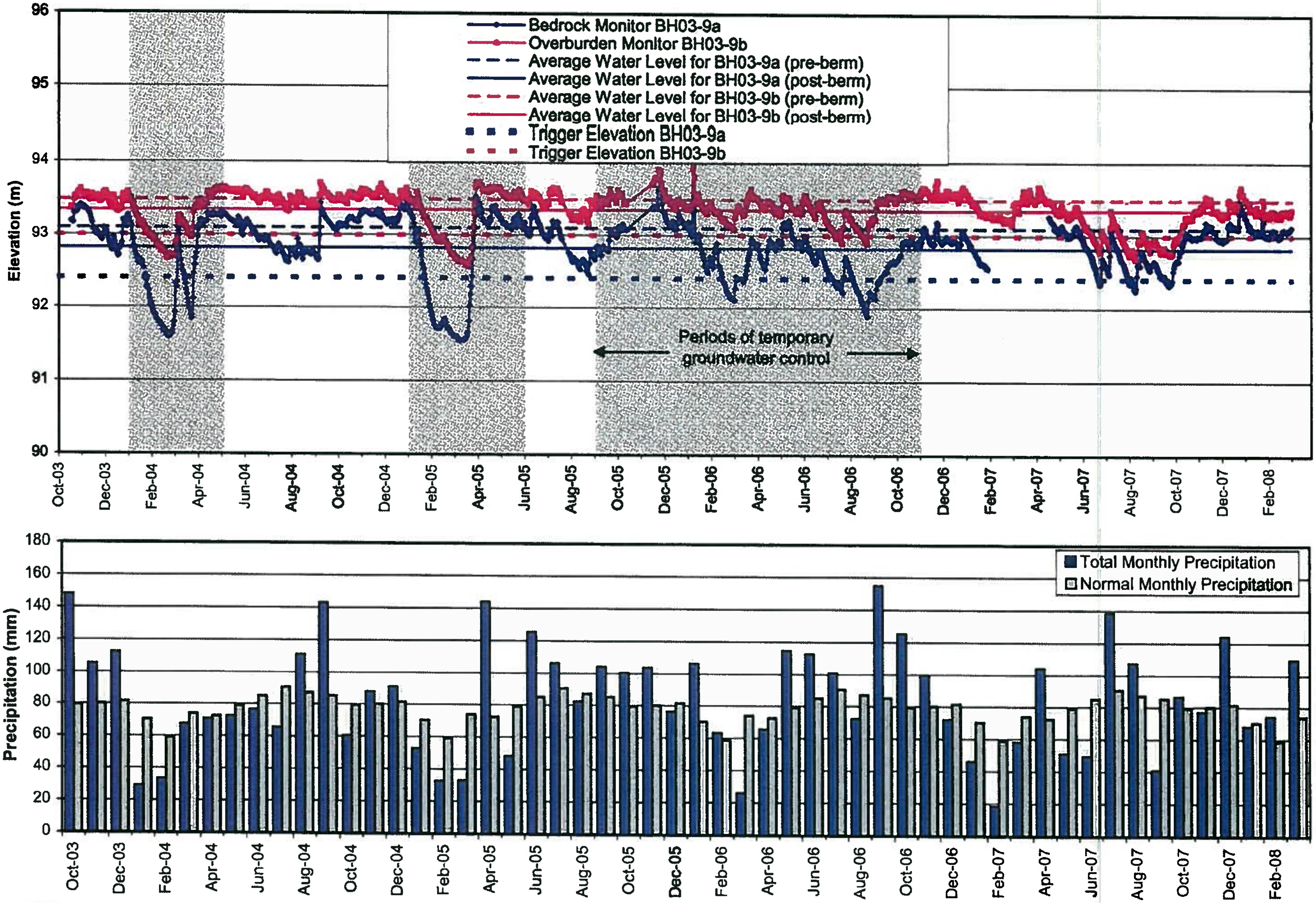
FIGURE 9



GROUNDWATER ELEVATIONS MW 03-8a AND MW 03-8b (TOP)
AND MONTHLY PRECIPITATION (BOTTOM)

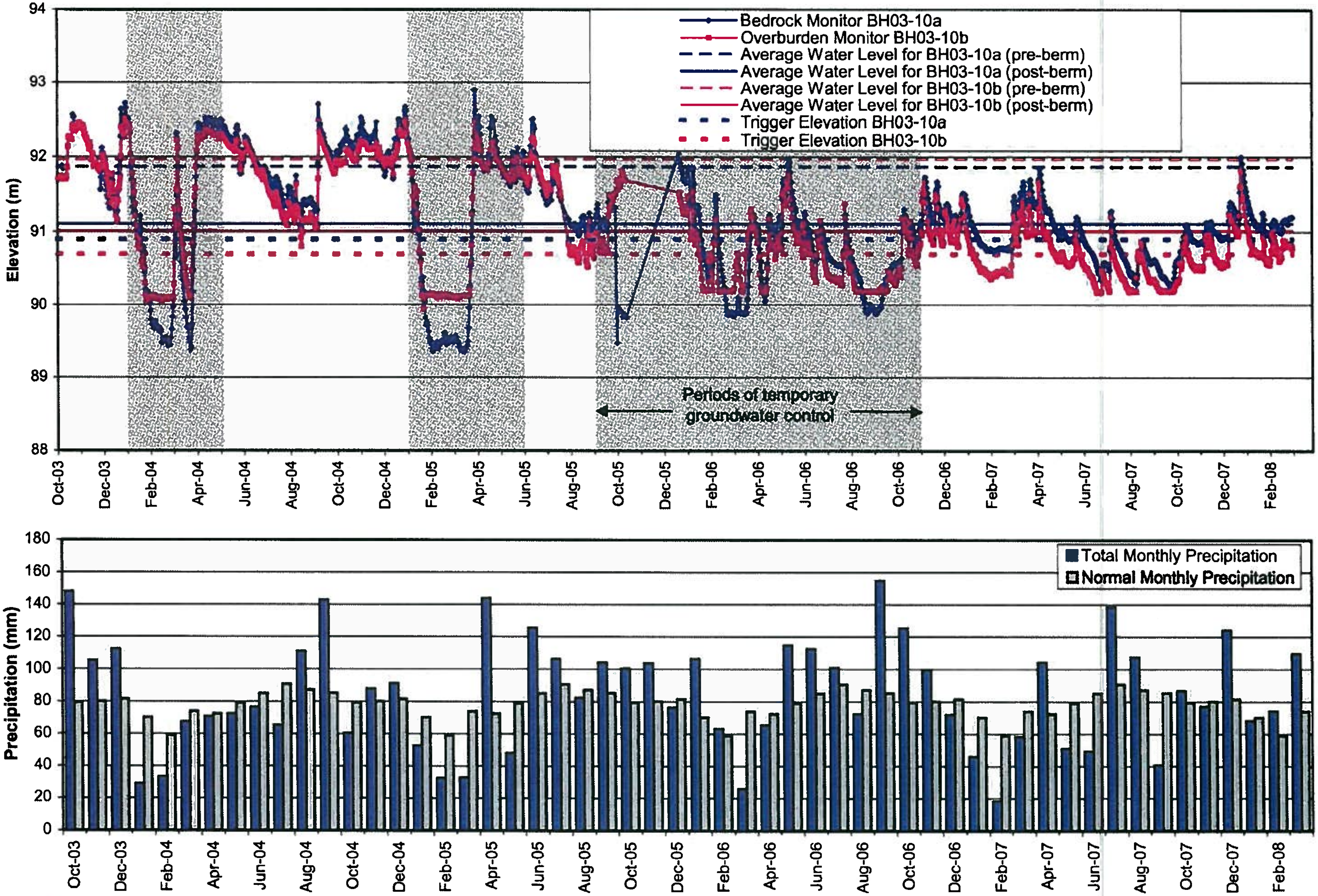
FIGURE 10

N:\Active\2003\1120\ENVIRONMENTAL\03-1120-846 Leitrim EMP\Monitoring Reports\Leitrim graphs _ April 2008.xls



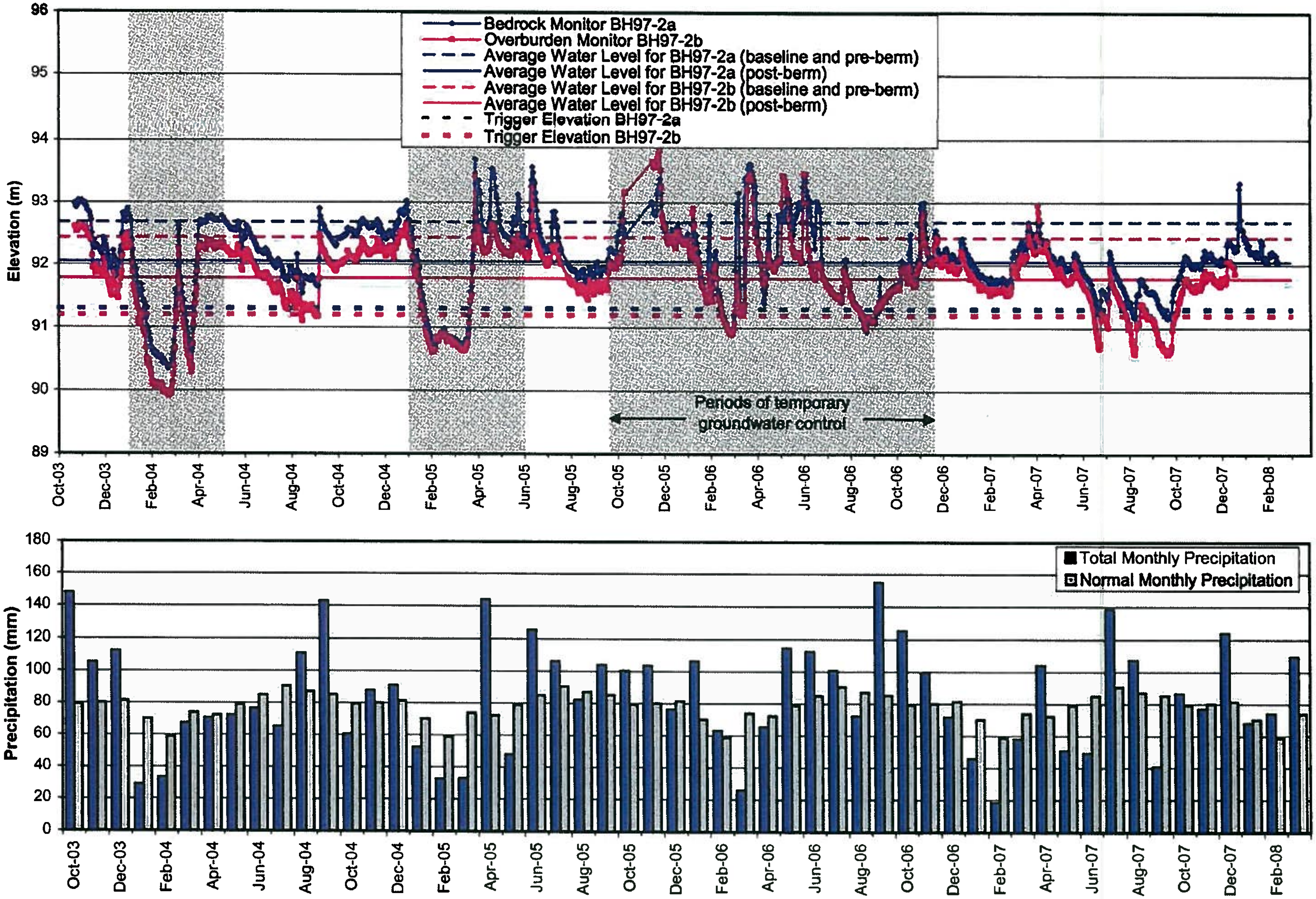
**GROUNDWATER ELEVATIONS MW 03-9a AND MW 03-9b (TOP)
AND MONTHLY PRECIPITATION (BOTTOM)**

FIGURE 11



GROUNDWATER ELEVATIONS MW 03-10a AND MW 03-10b (TOP)
AND MONTHLY PRECIPITATION (BOTTOM)

FIGURE 12



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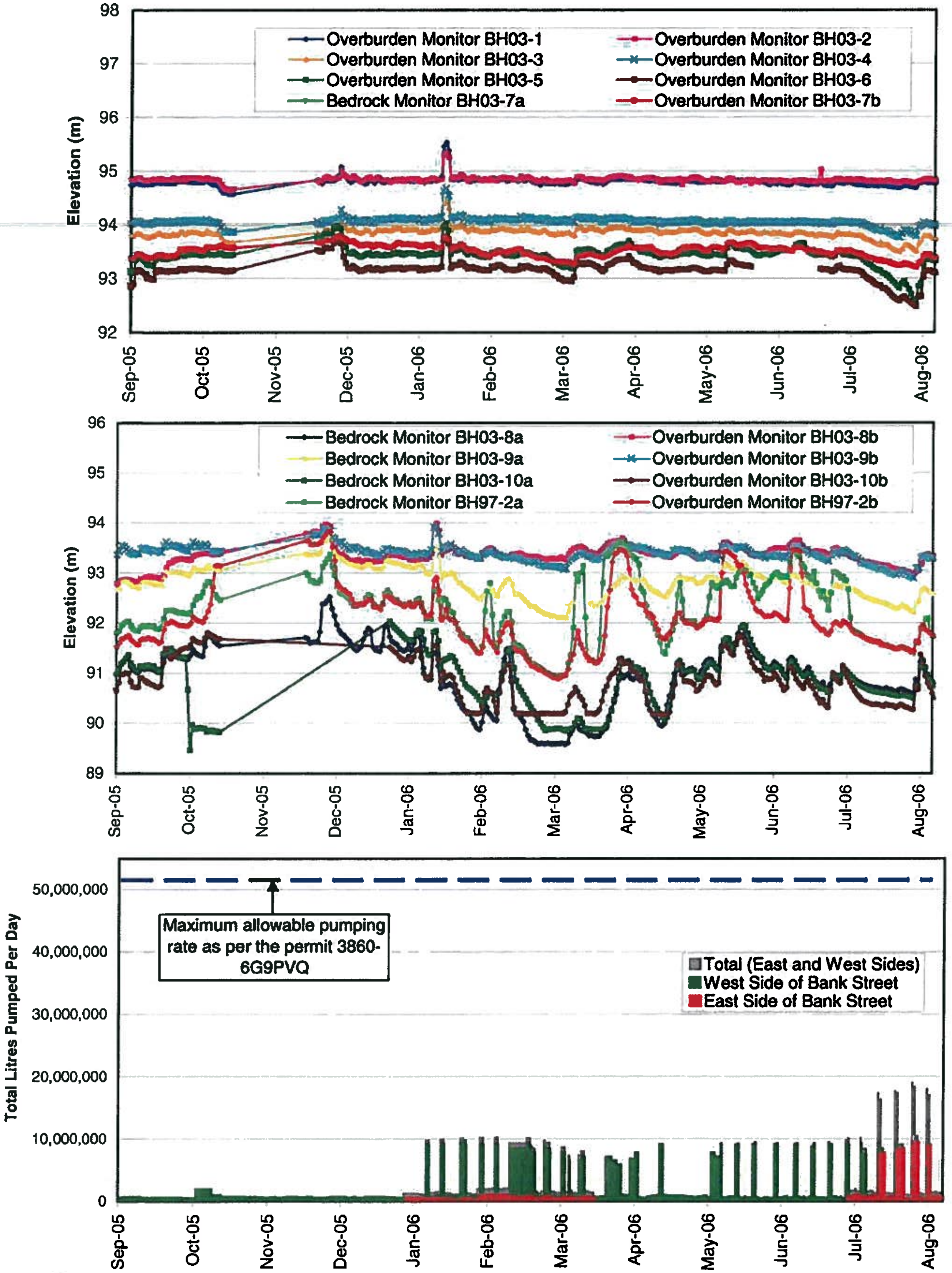
GROUNDWATER ELEVATIONS MW 97-2a AND MW 97-2b (TOP)
AND MONTHLY PRECIPITATION (BOTTOM)

FIGURE 13



Golder Associates

GROUNDWATER ELEVATIONS AND PUMPING RECORDS
FOR SEPTEMBER 2005 TO AUGUST 2006

FIGURE 14

APPENDIX A

RECORD OF BOREHOLE SHEETS

LIST OF ABBREVIATIONS

The abbreviations commonly employed on Records of Boreholes, on figures and in the text of the report are as follows:

I. SAMPLE TYPE

AS	Auger sample
BS	Block sample
CS	Chunk sample
DO	Drive open
DS	Denison type sample
FS	Foil sample
RC	Rock core
SC	Soil core
ST	Slotted tube
TO	Thin-walled, open
TP	Thin-walled, piston
WS	Wash sample

II. PENETRATION RESISTANCE

Standard Penetration Resistance (SPT), N:

The number of blows by a 63.5 kg. (140 lb.) hammer dropped 760 mm (30 in.) required to drive a 50 mm (2 in.) drive open Sampler for a distance of 300 mm (12 in.)

DD- Diamond Drilling

Dynamic Penetration Resistance; N_d:

The number of blows by a 63.5 kg (140 lb.) hammer dropped 760 mm (30 in.) to drive Uncased a 50 mm (2 in.) diameter, 60^0 cone attached to "A" size drill rods for a distance of 300 mm (12 in.).

PH:	Sampler advanced by hydraulic pressure
PM:	Sampler advanced by manual pressure
WH:	Sampler advanced by static weight of hammer
WR:	Sampler advanced by weight of sampler and rod

Peizo-Cone Penetration Test (CPT):

An electronic cone penetrometer with a 60^0 conical tip and a projected end area of 10 cm^2 pushed through ground at a penetration rate of 2 cm/s. Measurements of tip resistance (Q_t), porewater pressure (PWP) and friction along a sleeve are recorded Electronically at 25 mm penetration intervals.

III. SOIL DESCRIPTION

(a) Cohesionless Soils

Density Index (Relative Density)	N Blows/300 mm Or Blows/ft.
Very loose	0 to 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very dense	over 50

(b) Cohesive Soils

Consistency	C_u, S_u Kpa	Psf
Very soft	0 to 12	0 to 250
Soft	12 to 25	250 to 500
Firm	25 to 50	500 to 1,000
Stiff	50 to 100	1,000 to 2,000
Very stiff	100 to 200	2,000 to 4,000
Hard	Over 200	Over 4,000

IV. SOIL TESTS

w	water content
w_p	plastic limited
w_l	liquid limit
C	consolidaiton (oedometer) test
CHEM	chemical analysis (refer to text)
CID	consolidated isotropically drained triaxial test[1]
CIU	consolidated isotropically undrained triaxial test with porewater pressure measurement[1]
D_R	relative density (specific gravity, G_s)
DS	direct shear test
M	sieve analysis for particle size
MH	combined sieve and hydrometer (H) analysis
MPC	modified Proctor compaction test
SPC	standard Proctor compaction test
OC	organic content test
SO_4	concentration of water-soluble sulphates
UC	unconfined compression test
UU	unconsolidated undrained triaxial test
V	field vane test (LV-laboratory vane test)
γ	unit weight

Note:

1. Tests which are anisotropically consolidated prior shear are shown as CAD, CAU.

LIST OF SYMBOLS

Unless otherwise stated, the symbols employed in the report are as follows:

I. GENERAL

π	= 3.1416
ln x, natural logarithm of x	
$\log_{10}$ x or log x, logarithm of x to base 10	
g	Acceleration due to gravity
t	time
F	factor of safety
V	volume
W	weight

II. STRESS AND STRAIN

γ	shear strain
Δ	change in, e.g. in stress: $\Delta\sigma'$
ε	linear strain
ε_v	volumetric strain
η	coefficient of viscosity
ν	Poisson's ratio
σ	total stress
σ'	effective stress ($\sigma' = \sigma''-u$)
σ'_{vo}	initial effective overburden stress
$\sigma_1\sigma_2\sigma_3$	principal stresses (major, intermediate, minor)
σ_{oct}	mean stress or octahedral stress $= (\sigma_1+\sigma_2+\sigma_3)/3$
τ	shear stress
u	porewater pressure
E	modulus of deformation
G	shear modulus of deformation
K	bulk modulus of compressibility

III. SOIL PROPERTIES

(a) Index Properties

$\rho(\gamma)$	bulk density (bulk unit weight*)
$\rho_d(\gamma_d)$	dry density (dry unit weight)
$\rho_w(\gamma_w)$	density (unit weight) of water
$\rho_s(\gamma_s)$	density (unit weight) of solid particles
γ'	unit weight of submerged soil ($\gamma'=\gamma-\gamma_w$)
D_R	relative density (specific gravity) of solid particles ($D_R= p_s/p_w$) formerly (G_s)
e	void ratio
n	porosity
S	degree of saturation

* Density symbol is p. Unit weight symbol is γ where γ=pg(i.e. mass density x acceleration due to gravity)

(a) Index Properties (cont'd.)

w	water content
w_l	liquid limit
w_p	plastic limit
I_p	plasticity Index=(w_l-w_p)
w_s	shrinkage limit
I_L	liquidity index=$(w-w_p)/I_p$
I_c	consistency index=$(w_l-w)/I_p$
e_{max}	void ratio in loosest state
e_{min}	void ratio in densest state
I_D	density index-$(e_{max}-e)/(e_{max}-e_{min})$ (formerly relative density)

(b) Hydraulic Properties

h	hydraulic head or potential
q	rate of flow
v	velocity of flow
i	hydraulic gradient
k	hydraulic conductivity (coefficient of permeability)
j	seepage force per unit volume

(c) Consolidation (one-dimensional)

C_c	compression index (normally consolidated range)
C_r	recompression index (overconsolidated range)
C_s	swelling index
C_a	coefficient of secondary consolidation
m_v	coefficient of volume change
c_v	coefficient of consolidation
T_v	time factor (vertical direction)
U	degree of consolidation
σ'_p	pre-consolidation pressure
OCR	Overconsolidation ratio=σ'_p/σ'_{vo}

(d) Shear Strength

$\tau_p\tau_r$	peak and residual shear strength
ϕ'	effective angle of internal friction
δ	angle of interface friction
μ	coefficient of friction=tan δ
c'	effective cohesion
c_u, s_u	undrained shear strength (ϕ=0 analysis)
p	mean total stress $(\sigma_1+\sigma_3)/2$
p'	mean effective stress $(\sigma'_1+\sigma'_3)/2$
q	$(\sigma_1-\sigma_3)/2$ or $(\sigma'_1-\sigma_3)/2$
q_u	compressive strength $(\sigma_1-\sigma_3)$
S_t	sensitivity

Notes: 1. τ=c'σ' tan |'

2. Shear strength=(Compressive strength)/2

PROJECT 881-2426

881-2426

RECORD OF BOREHOLE 88-4

SHEET 1 of 1

LOCATION: See Figure 2
BORING DATE: Dec 1, 1988
DATUM: Geodetic

SAMPLER HAMMER: 63.5kg, DROP 760mm
PENETRATION TEST HAMMER: 63.5kg, DROP 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	ELEV. / DEPTH (M)	SAMPLES: NUMBER	TYPE	BLOWS/0.3M	CORE RECOVERY (%)	R.Q.D. (%)	S.C.R. (%)	PIEZOMETER OR STANDPIPE INSTALLATION
0		Ground Surface	92.16							
	POWER AUGER 200mm DIAM. (H.S.)	TOPSOIL	0.00							Bentonite Seal
		Compact brown sandy silt, some clay and gravel, numerous cobbles and boulders from 1.65 ~ 3.02 metre depth (GLACIAL TILL)	0.24							Backfill
1				1	50 DO	21				
2	ROTARY DRILL BXL core			2	BX RC	--	78			
3		Faintly weathered grey DOLOMITE BEDROCK, some fractured zones	89.14 3.02	3	BX RC	--	100	77	93	
4				4	BX RC	--	93	35	58	
		End of Hole	87.41 4.75							

W.L. in Standpipe at Elev. 90.98 Dec. 19, 1988

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m

SHEAR STRENGTH Cu, kPa — nat.V.- + Q.- ● rem.V.- ⊕ U.- ○

HYDRAULIC CONDUCTIVITY, k, CM/SEC

WATER CONTENT, PERCENT — Wp — W — Wl — 20 40 60 80

ADDITIONAL LAB. TESTING

15 ⊕ 6 PERCENT AXIAL STRAIN AT FAILURE (0, 10)

DEPTH SCALE
1 : 60

Golder Associates

LOGGED J.COBISA
CHECKED

PROJECT: 901-2831
LOCATION: See Figure 2
SAMPLER HAMMER, 63.5kg; DROP, 760mm

RECORD OF BOREHOLE 90-1A

BORING DATE: July 10, 1990

SHEET 1 OF 1
DATUM: GEODETIC
PENETRATION TEST HAMMER, 63.5kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m / SHEAR STRENGTH Cu, kPa nat.V - + Q - ● rem.V - ⊕ U - ○ 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s 10^{-6} 10^{-5} 10^{-4} 10^{-3} / WATER CONTENT, PERCENT Wp W Wl 20 40 60 80	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
0	Hand Auger 75mm Solid Stem	Ground Surface		95.25 0.00							Bentonite Seal Native Backfill
1		FOR SUBSURFACE STRATIGRAPHY, SEE RECORD OF BOREHOLE 90-1B									
2		End of Hole		92.81 2.44							
3											W.L. in Well Screen at Elev.95.11 July 24, 1990
4											
5											
6											
7											
8											
9											
10											

15 ◆ 5 PERCENT AXIAL STRAIN AT FAILURE
0
10

DEPTH SCALE
1 to 50

Golder Associates

LOGGED: S.Leighton
CHECKED: DB

PROJECT: 901-2831
LOCATION: See Figure 2
SAMPLER HAMMER, 63.5kg; DROP, 760mm

RECORD OF BOREHOLE 90-1B

BORING DATE: July 10, 1990

SHEET 1 OF 1
DATUM: GEODETIC

PENETRATION TEST HAMMER, 63.5kg; DROP, 760mm

BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m
Hand Auger 75mm Solid Stem	Ground Surface	95.25 0.00			
	TOPSOIL				
	Loose grey brown SANDY SILT to SILTY SAND	94.88 0.37	1	50 DO	4
	Brown SILTY FINE SAND	94.03 1.22			
	Loose grey SANDY SILT, occasional silty fine sand layers, some clay	93.81 1.44	2	50 DO	6
			3	50 DO	6
			4	50 DO	6
			5	50 DO	6
	Loose grey silty sand, some clay and gravel (GLACIAL TILL)	88.88 6.37	6	50 DO	8
	End of Hole	6.55			

DEPTH SCALE METRES: 0 1 2 3 4 5 6 7 8 9 10

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m

SHEAR STRENGTH Cu, kPa — nat.V - + Q - ● rem.V - ⊕ U - ○ — 20 40 60 80

HYDRAULIC CONDUCTIVITY, k, cm/s — 10^{-6} 10^{-5} 10^{-4} 10^{-3}

WATER CONTENT, PERCENT — Wp ├──○ W──┤ Wl — 20 40 60 80

ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION

Native Backfill

Bentonite Seal

Native Backfill

W.L in Well Screen 8 at Elev.95.37 July 24, 1990

15 ◆ 5 PERCENT AXIAL STRAIN AT FAILURE (0, 10)

DEPTH SCALE
1 to 50

Golder Associates

LOGGED: S.Leighton
CHECKED: DB

PROJECT: 301-2831

RECORD OF BOREHOLE 90-2A

SHEET 1 OF 1

LOCATION: See Figure 2

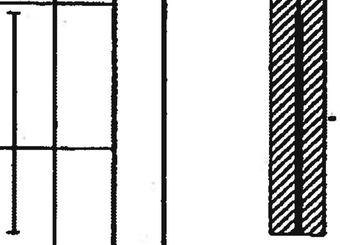
BORING DATE: July 12, 1990

DATUM: GEODETIC

SAMPLER HAMMER, 63.5kg; DROP, 760mm

PENETRATION TEST HAMMER, 63.5kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m SHEAR STRENGTH Cu, kPa (nat.V - + Q - ● rem.V - ⊕ U - ○) 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s 10^{-6} 10^{-5} 10^{-4} 10^{-3} WATER CONTENT, PERCENT Wp ─○W─ Wl 20 40 60 80	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
	Hand Auger 75mm Solid Stem	Ground Surface		94.32							
0				0.00							Bentonite Seal Native Backfill
1		FOR SUBSURFACE STRATIGRAPHY, SEE RECORD OF BOREHOLE 90-2B									
2											
				91.49 2.83							
3		End of Hole									W.L. in Well Screen B at Elev.94.07 July 24, 1990
4											
5											
6											
7											
8											
9											
10											



15 ─◆─ 5 PERCENT AXIAL STRAIN AT FAILURE (0 above, 10 below)

DEPTH SCALE

1 to 50

Golder Associates

LOGGED: S.Leighton

CHECKED: DB

PROJECT: 901-2831

LOCATION: See Figure 2

SAMPLER HAMMER, 63.5kg; DROP, 760mm

RECORD OF BOREHOLE 90-2B

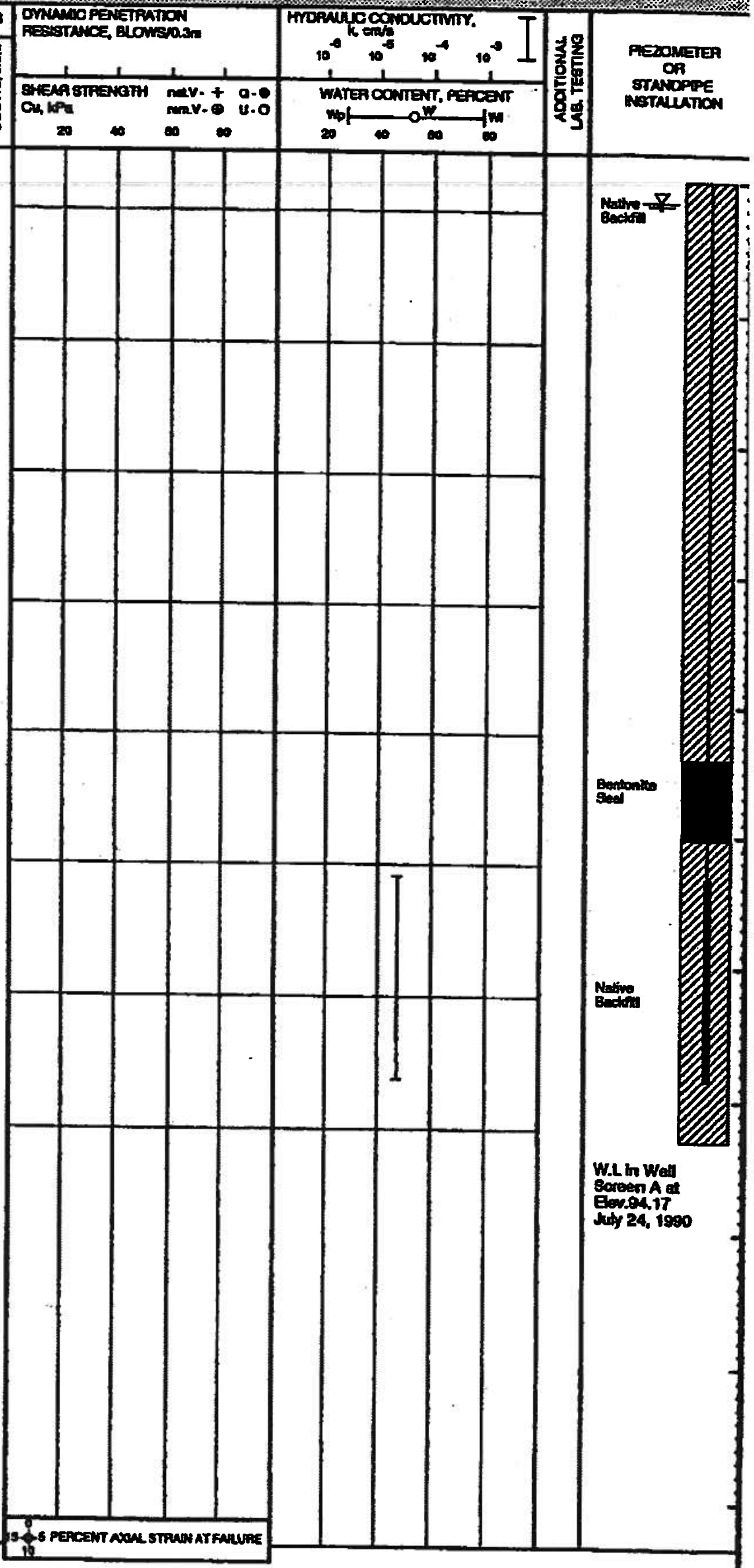
BORING DATE: July 12, 1990

SHEET 1 OF 1

DATUM: GEODETIC

PENETRATION TEST HAMMER, 63.5kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m
0	Hand Auger 76mm Solid Stem	Ground Surface		94.32			
		PEAT		0.00			
1		Loose to compact grey SANDY SILT to SILTY SAND, trace gravel, occasional fine to medium sand layers		93.01 1.31			
2					1	50 DO	4
3					2	50 DO	
5					3	50 DO	6
6					4	50 DO	9
7		Compact grey silty sand, some clay and gravel (GLACIAL TILL)		87.46 6.86	5	50 DO	15
		End of Hole		87.00 7.32			
8							
9							
10							



DEPTH SCALE
1 to 50

Golder Associates

LOGGED: S.Leighton
CHECKED: DB

PROJECT: 971-2925

LOCATION: 0.75m Ease of Existing BH 90-2 Deep

SAMPLER HAMMER, 63.6kg; DROP, 760mm

RECORD OF BOREHOLE 90-2 SHALLOW NEW

BORING DATE: July 13, 1998

SHEET 1 OF 1

DATUM:

PENETRATION TEST HAMMER, 63.6kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m / SHEAR STRENGTH Cu, kPa nat.V - + Q - ● rem.V - ⊕ U - ○ 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s / WATER CONTENT, PERCENT Wp ⊢—○W—⊣ Wl 20 40 60 80	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
0		GROUND SURFACE		94.32 0.00							
	Hand Auger 90 mm Diam.	PEAT.									Native Backfill
1											Bentonite Seal
		Organic, CLAYEY SILT.		93.12 1.20							
		Grey layered, SILTY fine SAND, SANDY SILT and CLAYEY SILT.		93.02 1.30							Silica Sand
2											25mm PVC #10 slot Screen
		END OF BOREHOLE		92.12 2.20							
3											
4											
5											

DATA INPUT: 9728-925.BHS WM

DEPTH SCALE

1 to 25

Golder Associates

LOGGED: PAH

CHECKED:

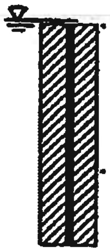
PROJECT: 901-2831
LOCATION: See Figure 2
SAMPLER HAMMER, 63.5kg; DROP, 760mm

RECORD OF BOREHOLE 90-3A

BORING DATE: July 18, 1990

SHEET 1 OF 1
DATUM: GEODETIC
PENETRATION TEST HAMMER, 63.5kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m SHEAR STRENGTH Cu, kPa nat.V - + Q - ● rem.V - ⊕ U - ○ 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s 10^{-6} 10^{-5} 10^{-4} 10^{-3} WATER CONTENT, PERCENT Wp ├──○W──┤ Wl 20 40 60 80	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		Ground Surface		96.08							
0	Hand Auger 76mm Solid Stem	FOR SUBSURFACE STRATIGRAPHY, SEE RECORD OF BOREHOLE 90-3B		0.00							Native Backfill
1											
		End of Hole		94.56 1.52							W.L in Well Screen B at Elev.96.10 July 24, 1990
2											
3											
4											
5											
6											
7											
8											
9											
10											



15 ◆ 5 PERCENT AXIAL STRAIN AT FAILURE
10

DEPTH SCALE
1 to 50

Golder Associates

LOGGED: S.Leighton
CHECKED: JB

PROJECT: 901-2831
LOCATION: See Figure 2
SAMPLER HAMMER, 63.5kg; DROP, 760mm

RECORD OF BOREHOLE 90-3B

BORING DATE: July 18, 1990

SHEET 1 OF 1
DATUM: GEODETIC
PENETRATION TEST HAMMER, 63.5kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
0		Ground Surface	96.08 0.00					
1	Hand Auger 75mm Solid Stem	PEAT, occasional cobble or boulder						Native Backfill
2		Loose to compact grey fine to coarse SAND, some gravel	94.56 1.52	1	50 DO	9		Bentonite Seal
3				2	50 DO	10	M	Native Backfill
4		Compact grey coarse SAND and GRAVEL, some fine to medium sand, trace cobbles	92.12 3.96	3	50 DO	24	M	
5		End of Hole	91.05 5.03					W.L in Well Screen A at Elev.96.00 July 24, 1990
6								
7								
8								
9								
10								

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m

SHEAR STRENGTH Cu, kPa — nat.V - + Q - ● rem.V - ⊕ U - ○ — 20 40 60 80

HYDRAULIC CONDUCTIVITY, k, cm/s — 10^{-6} 10^{-5} 10^{-4} 10^{-3}

WATER CONTENT, PERCENT — Wp ├──O W──┤ Wl — 20 40 60 80

15 ◆ 5 PERCENT AXIAL STRAIN AT FAILURE (0 above, 10 below)

DEPTH SCALE
1 to 50

Golder Associates

LOGGED: S.Leighton
CHECKED: DB

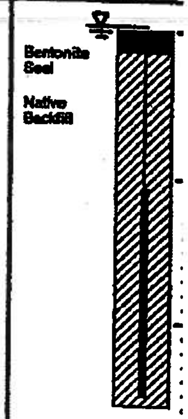
PROJECT: 901-2831
LOCATION: See Figure 2
SAMPLER HAMMER, 63.5kg; DROP, 760mm

RECORD OF BOREHOLE 90-4A

BORING DATE: July 13&16,1990

SHEET 1 OF 1
DATUM: GEODETIC
PENETRATION TEST HAMMER, 63.5kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m 20 40 60 80; SHEAR STRENGTH Cu, kPa nat.V - + Q - ● rem.V - ⊕ U - ○	HYDRAULIC CONDUCTIVITY, k, cm/s 10^{-6} 10^{-5} 10^{-4} 10^{-3}; WATER CONTENT, PERCENT Wp ⊢—○W—⊣ Wl 20 40 60 80	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
0		Ground Surface		97.03 0.00							Bentonite Seal Native Backfill
1	Hand Auger 75mm Solid Stem	FOR SUBSURFACE STRATIGRAPHY, SEE RECORD OF BOREHOLE 90-4B									
2											
		End of Hole		94.44 2.59							
3											W.L in Well Screen at Elev.97.07 July 24, 1990
4											
5											
6											
7											
8											
9											
10											



15 ◈ 5 PERCENT AXIAL STRAIN AT FAILURE

DEPTH SCALE
1 to 50

Golder Associates

LOGGED: S.Leighton
CHECKED: DB

PROJECT: 301-2831
LOCATION: See Figure 2
SAMPLER HAMMER, 63.5kg; DROP, 760mm

RECORD OF BOREHOLE 90-4B

BORING DATE: July 13&16,1990

SHEET 1 OF 1
DATUM: GEODETIC
PENETRATION TEST HAMMER, 63.5kg; DROP, 760mm

BORING METHOD: Hand Auger 76mm Solid Stem

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m

SHEAR STRENGTH Cu, kPa: nat.V - + Q - ● rem.V - ⊕ U - O; 20 40 60 80

HYDRAULIC CONDUCTIVITY, k, cm/s

WATER CONTENT, PERCENT Wp├──O W──┤Wl; 20 40 60 80

DEPTH SCALE METRES	SOIL PROFILE DESCRIPTION	ELEV. / DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
0	Ground Surface	97.03 0.00					
	PEAT						Native Backfill
1	Very loose grey fine to medium SAND, some silt	95.96 1.07					
2			1	50 DO	3		
3	Loose grey medium to coarse SAND	94.51 2.52	2	50 DO	6		
4							
5			3	50 DO	7		
	Loose grey fine to medium SAND, some silt layers	92.05 4.98					Bentonite Seal
6			4	50 DO	6	MH	Native Backfill
7			5	50 DO	2		
	End of Hole	89.41 7.62					
8							W.L in Well Screen A at Elev.97.19 July 24, 1990
9							
10							

15 ◆ 5 PERCENT AXIAL STRAIN AT FAILURE (0 above, 10 below)

DEPTH SCALE
1 to 50

Golder Associates

LOGGED: S.Leighton
CHECKED: DB

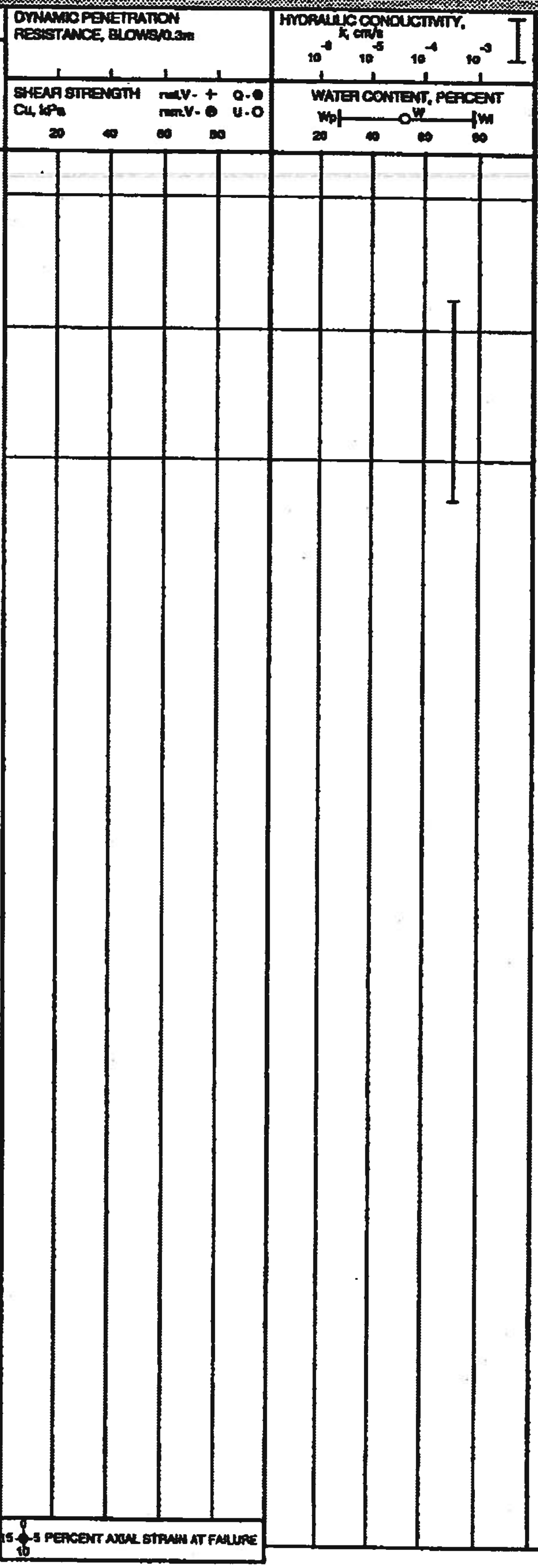
PROJECT: 901-2851
LOCATION: See Figure 2
SAMPLER HAMMER, 63.5kg; DROP, 760mm

RECORD OF BOREHOLE 90-5A

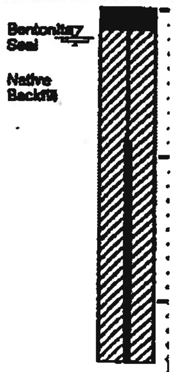
BORING DATE: July 10,1990

SHEET 1 OF 1
DATUM: GEODETIC
PENETRATION TEST HAMMER, 63.5kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	ADDITIONAL LAB. TESTING
0	Hand Auger 75mm Solid Stem	Ground Surface		95.21 0.00				
1		FOR SUBSURFACE STRATIGRAPHY, SEE RECORD OF BOREHOLE 90-5B						
2				92.77 2.44				
		End of Hole						
3								
4								
5								
6								
7								
8								
9								
10								



PIEZOMETER OR STANDPIPE INSTALLATION



W.L in Well Screen B at Elev.95.01 July 24, 1990

DEPTH SCALE
1 to 50

Golder Associates

LOGGED: S.Leighton
CHECKED: DB

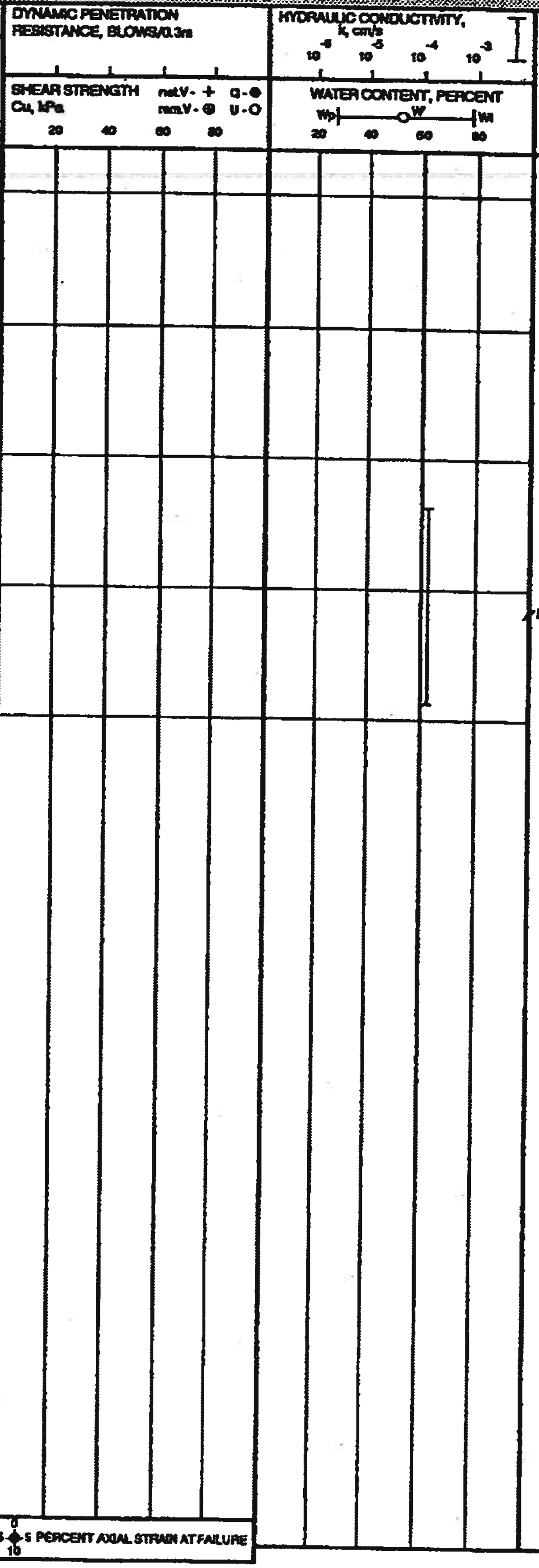
PROJECT: 901-2831
LOCATION: See Figure 2
SAMPLER HAMMER, 63.5kg; DROP, 760mm

RECORD OF BOREHOLE 90-5B

BORING DATE: July 10, 1990

SHEET 1 OF 1
DATUM: GEODETIC
PENETRATION TEST HAMMER, 63.5kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	ADDITIONAL LAB. TESTING
0	Hand Auger 76mm Solid Stem	Ground Surface	95.21				
		TOPSOIL	95.03 0.18				
1		Compact brown to grey SILT and SANDY SILT					
2				1	50 DO	19	
			92.77 2.44				
3		Loose grey SANDY SILT and SILTY SAND with silty fine sand seam		2	50 DO	9	MH
4		Dense silty sand to sandy silt, some gravel, occasional cobbles (GLACIAL TILL)	91.25 3.96	3	50 DO	41	
		End of Hole	91.03 4.18				



PIEZOMETER OR STANDPIPE INSTALLATION

W.L in Well Screen B at Elev. 95.01 July 24, 1990

DEPTH SCALE
1 to 50

Golder Associates

LOGGED: S.Leighton
CHECKED: DB

PROJECT: 901-2831

LOCATION: See Figure 2

SAMPLER HAMMER, 63.5kg; DROP, 760mm

RECORD OF BOREHOLE 90-6A

BORING DATE: July 13, 1990

SHEET 1 OF 1

DATUM: GEODETIC

PENETRATION TEST HAMMER, 63.5kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m / SHEAR STRENGTH Cu, kPa (nat.V - + Q - ● rem.V - ⊕ U - ○) 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s 10^{-6} 10^{-5} 10^{-4} 10^{-3} / WATER CONTENT, PERCENT Wp —○W— Wl 20 40 60 80	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
0	Hand Auger 76mm Solid Stem	Ground Surface		93.82 0.00							Bentonite Seal
1		FOR SUBSURFACE STRATIGRAPHY, SEE RECORD OF BOREHOLE 90-6B									Native Backfill
2		End of Hole		92.09 1.73							W.L in Well Screen B at Elev.93.87 July 24, 1990
3											
4											
5											
6											
7											
8											
9											
10											

15 ⊕ 5 PERCENT AXIAL STRAIN AT FAILURE (0, 10)

DEPTH SCALE

1 to 50

Golder Associates

LOGGED: S.Leighton

CHECKED: DB

PROJECT: 901-2631

LOCATION: See Figure 2

SAMPLER HAMMER, 63.5kg; DROP, 760mm

RECORD OF BOREHOLE 90-6B

BORING DATE: July 13,1990

SHEET 1 OF 1

DATUM: GEODETIC

PENETRATION TEST HAMMER, 63.5kg; DROP, 760mm

BORING METHOD: Hand Auger
75mm Solid Stem

DEPTH SCALE METRES	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m
	Ground Surface	93.82			
0	PEAT	0.00			
	Loose grey SILTY fine SAND with clayey silt layers	93.62 0.20			
2			1	50 DO	4
3			2	50 DO	5
	Very loose fine to coarse SILTY SAND, trace gravel	90.16 3.66			
5			3	50 DO	2
	GLACIAL TILL	88.55	4	50 DO	17
	End of Hole	5.33			

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m

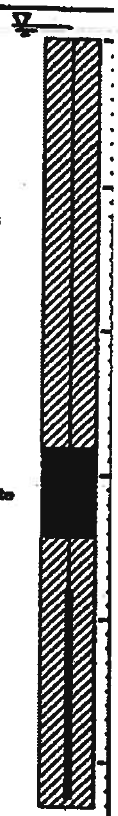
SHEAR STRENGTH Cu, kPa — nat.V - + Q - ● rem.V - ⊕ U - ○ — 20 40 60 80

HYDRAULIC CONDUCTIVITY, k, cm/s — 10^{-6} 10^{-5} 10^{-4} 10^{-3}

WATER CONTENT, PERCENT — Wp ├──○W──┤ Wl — 20 40 60 80

ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION



Native Backfill

Bentonite Seal

Native Backfill

W.L in Well Screen A at Elev.93.89 July 24, 1990

15 ⊕ 5 PERCENT AXIAL STRAIN AT FAILURE

DEPTH SCALE

1 to 50

Golder Associates

LOGGED: S.Leighton

CHECKED: DB.

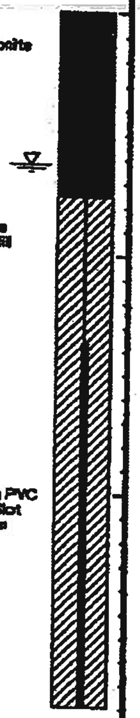
PROJECT: 931-2360
LOCATION: See Plan
SAMPLER HAMMER, 63.5kg; DROP, 760mm

RECORD OF BOREHOLE 94-1

BORING DATE: Feb. 4, 1994

SHEET 1 OF 1
DATUM: Geodetic
PENETRATION TEST HAMMER, 63.5kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE			SAMPLES			DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m SHEAR STRENGTH Cu, kPa nat.V - + Q - ● rem.V - ⊕ U - ○	HYDRAULIC CONDUCTIVITY, k, cm/s WATER CONTENT, PERCENT Wp ├──○W──┤ Wl 20 40 60 80	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m				
0		Ground Surface		92.09 0.00							
	Power Auger 200mm Diam (Hollow Stem)	Dark brown silty TOPSOIL									Bentonite Seal
		Loose brown SANDY SILT, some silty sand layers		91.79 0.30							
1		Compact brown to grey sandy silt, some clay, gravel, cobbles and boulders (GLACIAL TILL)		91.18 0.91	1	50 DO	6				Native Backfill
2					2	50 DO	20				50mm PVC #10 Slot Screen
					3	50 DO	15				
3		End of Hole Refusal to Auger		89.17 2.92							W.L in Screen at Elev.91.47m Mar. 4, 1994
4											
5											
6											



DATA INPUT: Disk 18, S.Leighton

DEPTH SCALE
1 to 30

Golder Associates

LOGGED: R.A.M
CHECKED:

PROJECT: 931-2360

LOCATION: See Plan

SAMPLER HAMMER, 63.5kg; DROP, 760mm

RECORD OF BOREHOLE 94-2

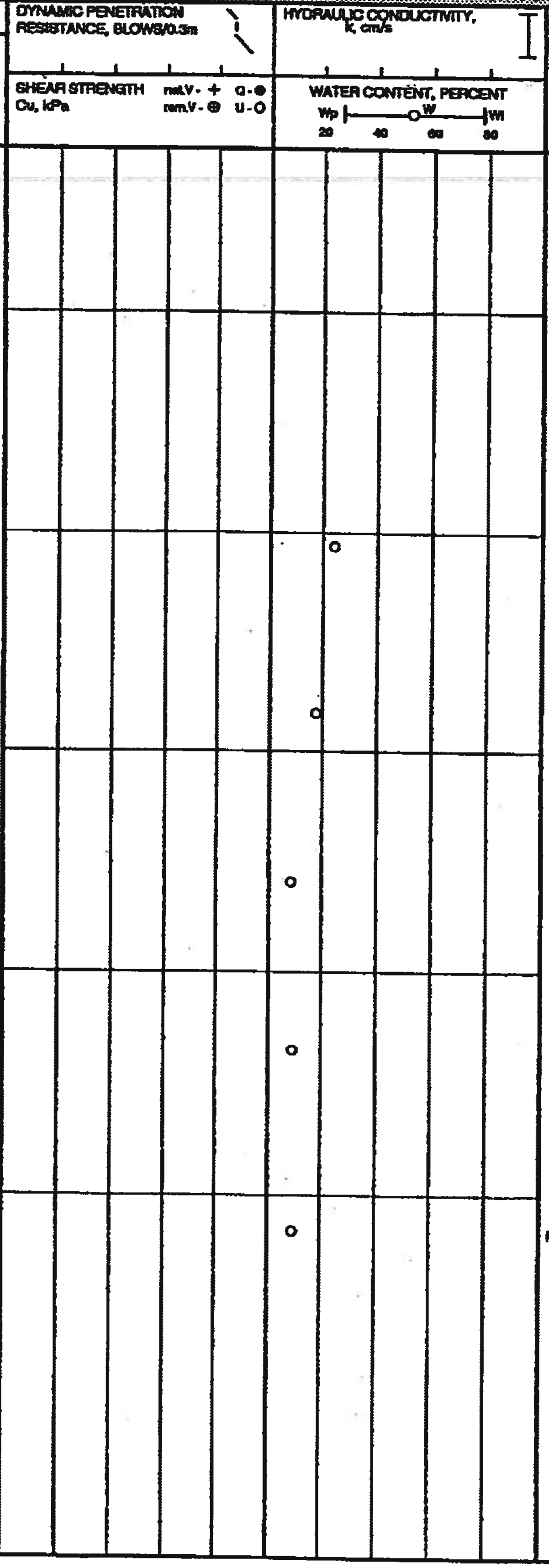
BORING DATE: Feb. 7, 1994

SHEET 1 OF 1

DATUM: Geodetic

PENETRATION TEST HAMMER, 63.5kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	ADDITIONAL LAB. TESTING
0	Power Auger 200mm Diam (Hollow Stem)	Top of Ice		92.61				
		ICE		0.00				
		Dark brown silty TOPSOIL		92.46 0.15				
1		Loose brown to grey SILTY SAND, some fine to coarse sand and sandy silt		92.15 0.46	1	50 DO	1	
2					2	50 DO	4	
		Loose to compact grey sandy silt, trace clay, some gravel and cobbles, some pockets of fine to medium sand (GLACIAL TILL)		90.32 2.29	3	50 DO	28	
3					4	50 DO	10	
4					5	50 DO	6	
					6	50 DO	> 100	MH
5		End of Hole Refusal to Sampler		87.64 4.97				
6								



W.L in Screen at Elev.91.86m Mar. 4, 1994

DATA INPUT: Disk 16, S.Leighton

DEPTH SCALE

1 to 30

Golder Associates

LOGGED: R.A.M

CHECKED: RM

PROJECT: 931-2360
LOCATION: See Plan
SAMPLER HAMMER, 63.5kg; DROP, 760mm

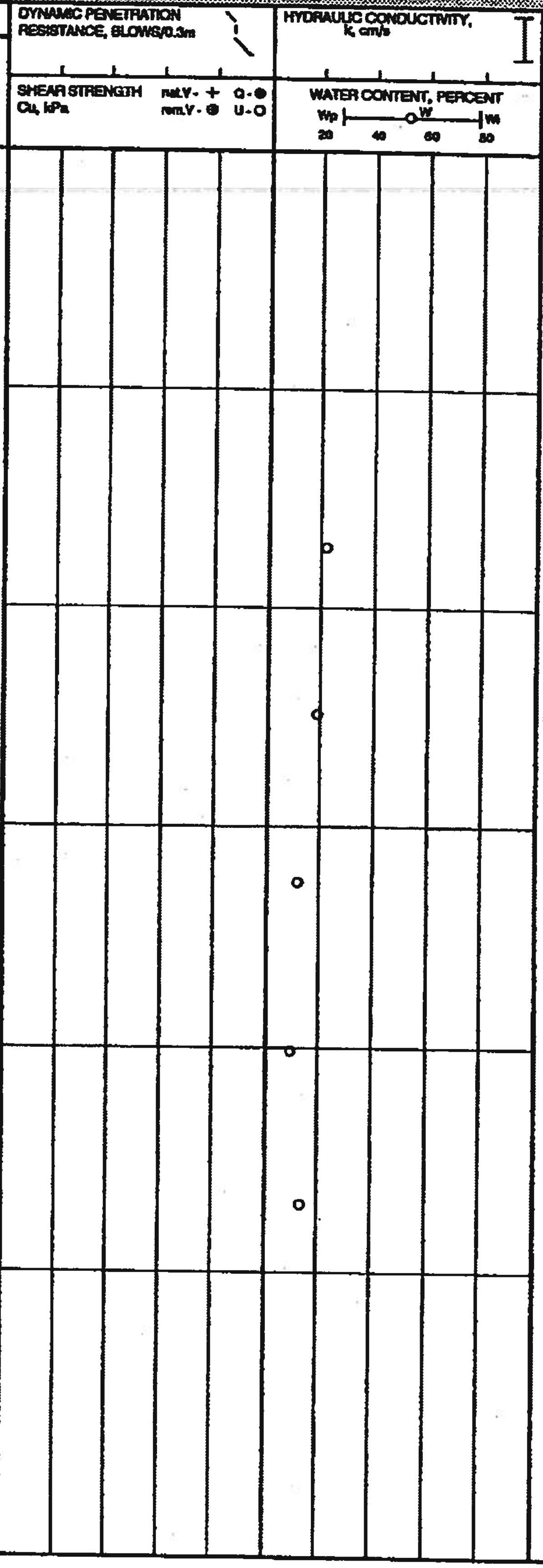
RECORD OF BOREHOLE 94-3

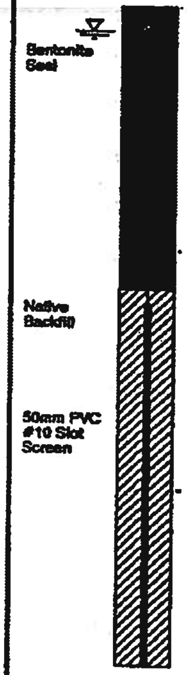
BORING DATE: Feb. 8, 1994

SHEET 1 OF 1
DATUM: Geodetic
PENETRATION TEST HAMMER, 63.5kg; DROP, 760mm

BORING METHOD: Power Auger, 200mm Diam (Hollow Stem)

DEPTH SCALE METRES	SOIL PROFILE: DESCRIPTION	ELEV. DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
0	Top of Ice	92.95 0.00					
	ICE	92.80 0.15					Bentonite Seal
	Dark brown silty TOPSOIL	92.41 0.54					
	Brown SANDY SILT	92.22 0.73					
1	Loose brown to grey SILTY SAND, some sandy silt		1	50 DO	7		Native Backfill
			2	50 DO	10		50mm PVC #10 Slot Screen
2			3	50 DO	8	MH	
3	Compact grey sandy silt, trace clay, some gravel and cobbles (GLACIAL TILL)	89.90 3.05	4	50 DO	23		
4			5	50 DO	28		
			6	50 DO	17		
5	End of Hole Refusal to Auger	88.07 4.88					W.L. in Screen at Elev.92.85m Mar. 4, 1994
6							





DATA INPUT: Disk 18, S.Leighton

DEPTH SCALE
1 to 30

Golder Associates

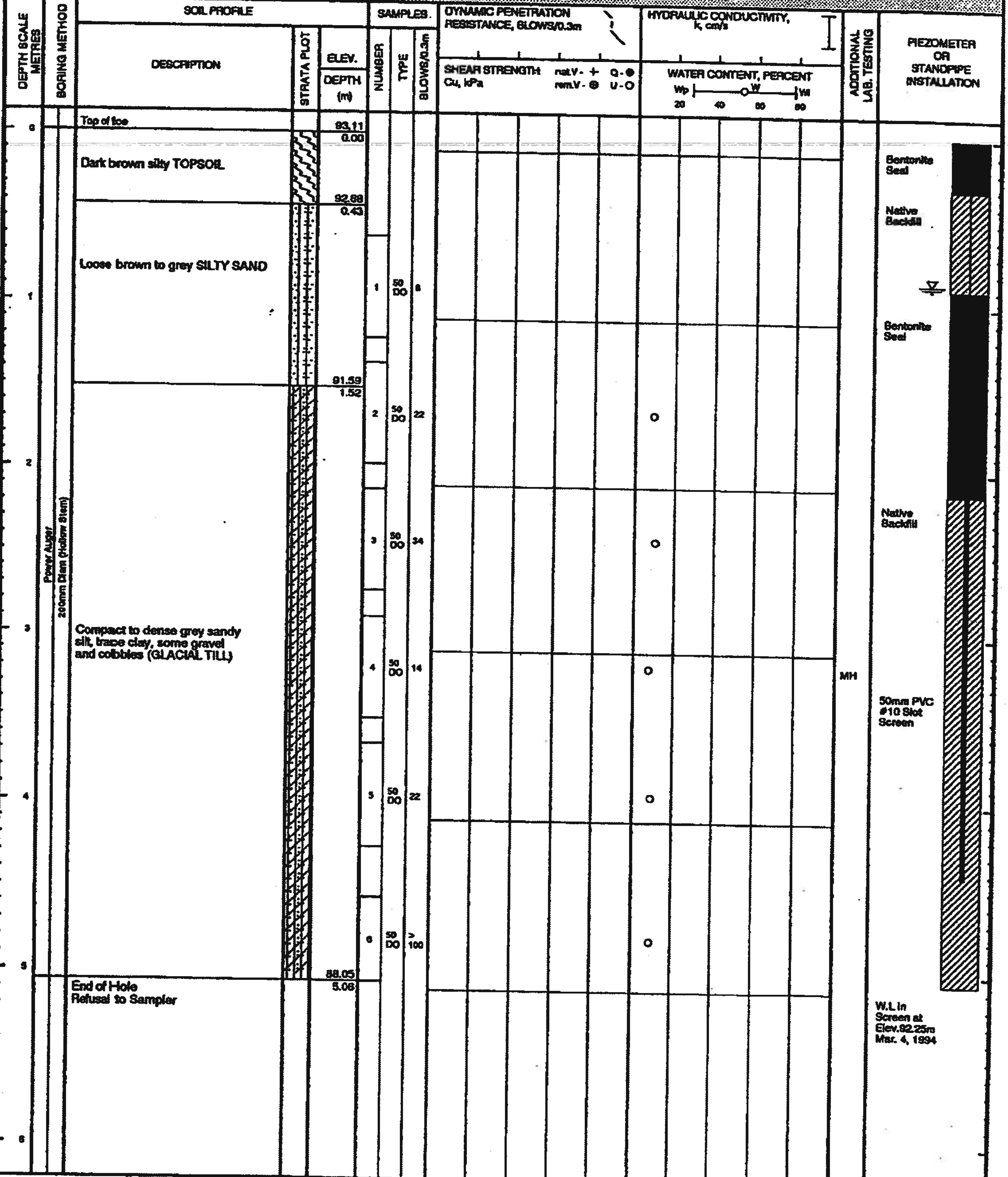
LOGGED: R.A.M
CHECKED: Ry

RECORD OF BOREHOLE 94-4

PROJECT: 931-2360
LOCATION: See Plan
SAMPLER HAMMER: 63.5kg; DROP, 760mm

BORING DATE: Feb. 7, 1994

SHEET 1 OF 1
DATUM: Geodetic
PENETRATION TEST HAMMER, 63.5kg; DROP, 760mm



DESCRIPTION	ELEV. DEPTH (m)
Top of Ice	93.11 0.00
Dark brown silty TOPSOIL	92.68 0.43
Loose brown to grey SILTY SAND	91.59 1.52
Compact to dense grey sandy silt, trace clay, some gravel and cobbles (GLACIAL TILL)	88.05 5.08
End of Hole Refusal to Sampler	

NUMBER	TYPE	BLOWS/0.3m	ADDITIONAL LAB. TESTING
1	50 DO	8	
2	50 DO	22	
3	50 DO	34	
4	50 DO	14	MH
5	50 DO	22	
6	50 DO	> 100	

Bentonite Seal
Native Backfill
Bentonite Seal
Native Backfill
50mm PVC #10 Slot Screen
W.L in Screen at Elev.92.25m Mar. 4, 1994

DATA INPUT: Disk 18, S.Leighton

DEPTH SCALE
1 to 30

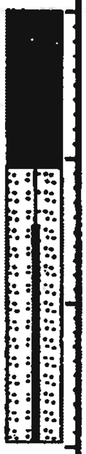
Golder Associates

LOGGED: R.A.M
CHECKED:

RECORD OF BOREHOLE 97-1

PROJECT: 971-2925
SHEET 1 OF 1
LOCATION: REFER TO PLAN
BORING DATE: NOV 25/97
DATUM:
SAMPLER HAMMER, 21.2kg; DROP, 760mm
PENETRATION TEST HAMMER, 21.2kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m / SHEAR STRENGTH Cu, kPa (nat.V - +, rem.V - ⊕, Q - ●, U - ○)	HYDRAULIC CONDUCTIVITY, k, cm/s / WATER CONTENT, PERCENT (Wp ├──○W──┤ Wl)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		93.04							
0	203mm CME 55 POWER AUGER 108mm I.D. HOLLOW STEM AUGERS	Dark brown silty TOPSOIL.		0.00							
		Brown SANDY SILT scattered trace of gravel.		92.54 0.50				NOTE: 'N' VALUES CORRECTED FOR 1/3 WT. HAMMER			BENTONITE SEAL
1		Loose to compact, brown to grey stratified SILTY fine SAND.		92.06 0.98	1	50 DO	11				
2					2	50 DO	6				SAND
		Compact, grey SILTY SAND, some gravel, trace clay. (Glacial Till)		90.76 2.28	3	50 DO	14				
3		END OF BOREHOLE Auger Refusal		90.06 2.98							
4											
5											
6											
7											
8											
9											
10											



DATA INPUT: PS APRIL 8/98

DEPTH SCALE
1 to 50

Golder Associates

LOGGED: PH
CHECKED: PAS

PROJECT: 971-2925
LOCATION: REFER TO PLAN
SAMPLER HAMMER, 21.2kg; DROP, 760mm

RECORD OF BOREHOLE 97-2

BORING DATE: DEC.15-19/97

SHEET 1 OF 1
DATUM:
PENETRATION TEST HAMMER, 21.2kg; DROP, 760mm

DEPTH SCALE METRES: 0 to 10
BORING METHOD: HW CASING (0 to 2 m); PORTABLE ELECTRIC DRILL

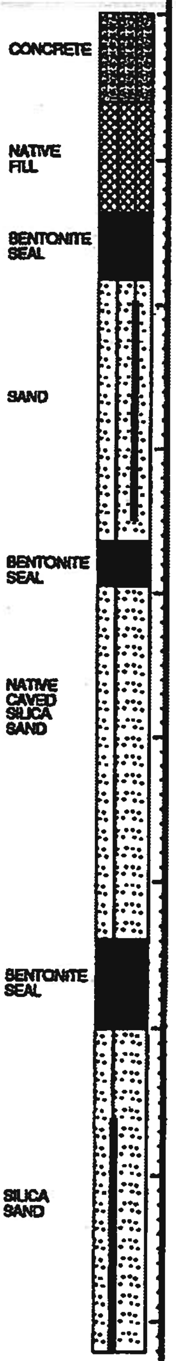
SOIL PROFILE DESCRIPTION	ELEV. / DEPTH (m)
GROUND SURFACE	93.64
PEAT	0.00
Grey SILTY fine SAND.	93.34 0.30
Compact, grey SANDY SILT, some gravel, cobbles, occ. boulder. (Glacial Till)	92.42 1.22
Sound, grey DOLOMITIC LIMESTONE (BEDROCK)	87.54 6.10
END OF BOREHOLE	84.42 9.22

SAMPLES NUMBER	TYPE	BLOWS/0.3m	
1	50 DO	7	
2	50 DO	13	
3	BW	DD	
4	50 DO	12	
5	50 DO	20	
6	BW	DD	
7	BW	DD	
8	BW	DD	
9	BW	DD	
10	AW	DD	
11	50 DO	40	
12	AW	DD	
13	AW	DD	
14	AW RC	DD	T.C.R. 100% S.C.R. 90% R.Q.D. 78%
15	AW RC	DD	T.C.R. 99.5% S.C.R. 99% R.Q.D. 75%

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m
SHEAR STRENGTH Cu, kPa — nat.V - + Q - ● rem.V - ⊕ U - ○
HYDRAULIC CONDUCTIVITY, k, cm/s
WATER CONTENT, PERCENT Wp ├──○W──┤ Wl
ADDITIONAL LAB. TESTING

NOTE:
'N' VALUES CORRECTED FOR 1/3 WT. HAMMER

PIEZOMETER OR STANDPIPE INSTALLATION



DATA INPUT: PS APRIL 6/98

DEPTH SCALE
1 to 50

Golder Associates

LOGGED: PH
CHECKED: PAS

PROJECT: 971-2925

RECORD OF BOREHOLE 97-3

SHEET 1 OF 1

LOCATION: REFER TO PLAN

BORING DATE: JAN.14-15/98

DATUM:

SAMPLER HAMMER, 21.2kg; DROP, 760mm

PENETRATION TEST HAMMER, 21.2kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m
		GROUND SURFACE		93.79			
0		PEAT		0.00			
1	HAND AUGER BW CASING	Loose to compact, grey sandy SILT.		92.88 0.91	1	50 DO	6
2					2	50 DO	14
3					3	50 DO	10
					4	50 DO	10
4					5	50 DO	9
		END OF BOREHOLE		89.52 4.27			
5							
6							
7							
8							
9							
10							

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m

SHEAR STRENGTH Cu, kPa nat.V - + Q - ● rem.V - ⊕ U - ○

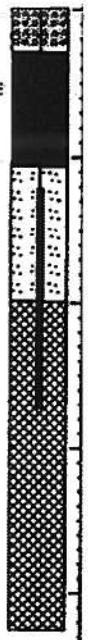
HYDRAULIC CONDUCTIVITY, k, cm/s

WATER CONTENT, PERCENT Wp ├──○W──┤ Wl

ADDITIONAL LAB. TESTING

NOTE:
'N' VALUES CORRECTED FOR 1/3 WT. HAMMER

PIEZOMETER OR STANDPIPE INSTALLATION



DATA INPUT: PS APRIL 6/98

DEPTH SCALE
1 to 50

Golder Associates

LOGGED: PH
CHECKED: PAS

PROJECT: 03-1120-846

RECORD OF BOREHOLE: 03-1

SHEET 1 OF 1

LOCATION: See Site Plan

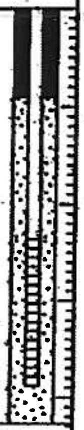
BORING DATE: September 24, 2003

DATUM:

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. / DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT Wp ⊢—○W—⊣ Wl (10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		Ground Surface	94.87							
0	Portable Drill Open Hole	Very loose black fibrous PEAT	0.00	1	50 DO	1				Bentonite Seal
		Loose grey SANDY SILT	94.03 0.84	2	50 DO	7				
				3	50 DO	6				Silica Sand Backfill
				4	50 DO	5				
				5	50 DO	4				32mm Diam. PVC #10 Slot Screen
				6	50 DO	7				
			90.60	7	50 DO	9				
		End of Borehole	4.27							



BOREHOLE 03-1120-846.GPJ HYDROGEO.GDT 6/10/05

DEPTH SCALE

1 : 75

Golder Associates

LOGGED: S.L.

CHECKED: ---------

PROJECT: 03-1120-846

RECORD OF BOREHOLE: 03-2

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: September 24, 2003

DATUM:

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m 20 40 60 80 / SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - O 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s 10^{-6} 10^{-5} 10^{-4} 10^{-3} / WATER CONTENT PERCENT Wp ⊢—O W—⊣ Wl 10 20 30 40	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		Ground Surface		94.88							
0	Portable Drill Open Hole	Very loose black fibrous PEAT		0.00	1	50 DO	PM				Bentonite Seal
				93.97	2	50 DO	4				
1		Loose to compact grey SANDY SILT		0.91							Silica Sand Backfill
					3	50 DO	9				
2					4	50 DO	10				32mm Diam PVC #10 Slot Screen
					5	50 DO	15				
3					6	50 DO	25				
				91.45							
		End of Borehole Sampler Refusal		3.43							
4											
5											
6											
7											
8											
9											
10											
11											
12											
13											
14											
15											

DEPTH SCALE

1 : 75

LOGGED: H.E.C.

CHECKED: ————

PROJECT: 03-1120-846

RECORD OF BOREHOLE: 03-3

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: September 22, 2003

DATUM:

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m: 20 40 60 80

SHEAR STRENGTH Cu, kPa: nat V. + Q - ● rem V. ⊕ U - ○ 20 40 60 80

HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-6} 10^{-5} 10^{-4} 10^{-3}

WATER CONTENT PERCENT: Wp ⊢—○W—⊣ Wl 10 20 30 40

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		Ground Surface						
0	Portable Drill Open Hole	Very loose black fibrous PEAT	0.00	1	50 DO	2		Bentonite Seal
				2	50 DO	10		Silica Sand
1		Compact grey SANDY SILT	0.97	3	50 DO	23		
		Compact to dense grey fine sand and gravel (GLACIAL TILL)	1.52	4	50 DO	22		Bentonite Seal
2				5	50 DO	42		
3				6	50 DO	17		32mm Diam. PVC #10 Slot Screen
				7	50 DO	27		
		End of Borehole	3.73					
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								

DEPTH SCALE

1 : 75

Golder Associates

LOGGED:

CHECKED:

PROJECT: 03-1120-846

RECORD OF BOREHOLE: 03-4

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: September 23, 2003

DATUM:

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m: 20 40 60 80

SHEAR STRENGTH Cu, kPa: nat V. + Q - ● rem V. ⊕ U - ○ 20 40 60 80

HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-6} 10^{-5} 10^{-4} 10^{-3}

WATER CONTENT PERCENT: Wp ⊢—○W—⊣ Wl 10 20 30 40

ADDITIONAL LAB. TESTING

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	PIEZOMETER OR STANOPIPE INSTALLATION
		Ground Surface					
0	Portable Drill Open Hole	Very loose black fibrous PEAT	0.00	1	50 DO	1	Bentonite Seal
1		Loose grey brown SANDY SILT, trace gravel	0.91	2	50 DO	7	
		Loose grey SANDY SILT	1.16				
		Loose to compact grey SILTY SAND, some gravel, trace clay (GLACIAL TILL)		3	50 DO	17	Silica Sand
2				4	50 DO	21	
				5	50 DO	6	32mm Diam. PVC #10 Slot Screen
3		Compact grey SILTY SAND, some gravel, trace clay, interbedded with fine to medium sand (GLACIAL TILL)	2.90	6	50 DO	15	
				7	50 DO	20	
4		End of Borehole Spoon Refusal	3.61				
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							

DEPTH SCALE
1 : 75

Golder Associates

LOGGED: S.I.
CHECKED: ———

PROJECT: 03-1120-846

RECORD OF BOREHOLE: 03-5

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: September 22, 2003

DATUM:

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m 20 40 60 80 / SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s 10⁻⁶ 10⁻⁵ 10⁻⁴ 10⁻³ / WATER CONTENT PERCENT Wp ⊢—○W—⊣ Wl 10 20 30 40	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		Ground Surface									
0	Portable Drill Open Hole	Very loose black fibrous PEAT		0.00	1	50 DO	2				Bentonite Seal
1		Compact grey SANDY SILT		0.60	2	50 DO	7				Silica Sand
					3	50 DO	10				
2					4	50 DO	11				32mm Diam. PVC #10 Slot Screen
3					5	50 DO	12				
					6	50 DO	23				
4		End of Borehole		3.66							
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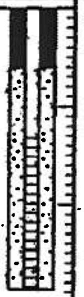
14											
15											



DEPTH SCALE

1 : 75

Golder Associates

LOGGED:

CHECKED:

PROJECT: 03-1120-846

RECORD OF BOREHOLE: 03-6

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: September 22, 2003

DATUM:

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m: 20 40 60 80

SHEAR STRENGTH Cu, kPa: nat V. + Q - ● rem V. ⊕ U - ○ 20 40 60 80

HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-6} 10^{-5} 10^{-4} 10^{-3}

WATER CONTENT PERCENT: Wp ⊢—○W—⊣ Wl 10 20 30 40

ADDITIONAL LAB. TESTING

BORING METHOD: Portable Drill, BW Casing

DEPTH SCALE METRES	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)
0	Ground Surface	
0	Very loose black fibrous PEAT	0.00
	Compact to dense grey SANDY SILT, trace gravel, fine sand at depth	0.76
	End of Borehole	3.66

SAMPLES NUMBER	TYPE	BLOWS/0.3m
1	50 DO	2
2	50 DO	7
3	50 DO	9
4	50 DO	26
5	50 DO	37
6	50 DO	40

PIEZOMETER OR STANDPIPE INSTALLATION

- Bentonite Seal
- Silica Sand
- Bentonite Seal
- 32mm Diam. PVC #10 Slot Screen

DEPTH SCALE 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

DEPTH SCALE
1 : 75

Golder Associates

LOGGED:

CHECKED:

PROJECT: 03-1120-846

RECORD OF BOREHOLE: 03-7A

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: September 30, 2003

DATUM:

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)
	Ground Surface	
Portable Drill BW Casing	Very loose black fibrous PEAT	0.00
	Loose to compact grey SANDY SILT	0.84
	Compact grey fine to medium sand, gravel, cobbles, some boulders (GLACIAL TILL)	2.29
Portable Drill NQ Core	Grey DOLOSTONE with black shale interbeds	7.92
	End of Borehole	12.98

NUMBER	TYPE	BLOWS/0.3m	T.C.R. (%)	S.C.R. (%)	R.Q.D. (%)
10	NQ RC	DD	100	91	67
11	NQ RC	DD	75	54	29
12	NQ RC	DD	[illegible]	[illegible]	[illegible]
13	NQ RC	DD	93	83	45
14	NQ RC	DD	100	65	40
15	NQ RC	DD	100	86	57
16	NQ RC	DD	100	95	87

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m: 20 40 60 80

SHEAR STRENGTH Cu, kPa: nat V. + Q - ● rem V. ⊕ U - ○ 20 40 60 80

HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-6} 10^{-5} 10^{-4} 10^{-3}

WATER CONTENT PERCENT: Wp ⊢—○W—⊣ Wl 10 20 30 40

ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION

DEPTH SCALE
1 : 75

Golder Associates

LOGGED: H.E.C.

CHECKED: ——————

PROJECT: 03-1120-846

RECORD OF BOREHOLE: 03-7B

SHEET 1 **OF** 1

LOCATION: See Site Plan

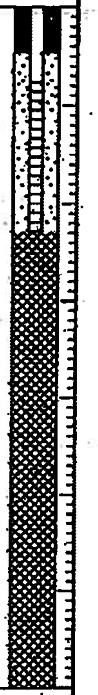
BORING DATE: September 30, 2003

DATUM:

SAMPLER HAMMER, 64kg; **DROP,** 760mm

PENETRATION TEST HAMMER, 64kg; **DROP,** 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT Wp ⊢—○W—⊣ Wl (10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		Ground Surface									
0	Portable Drill BW Casing	For stratigraphy see Record of Borehole 03-7A	▤	0.00	1	50 DO	WH				Bentonite Seal
											Silica Sand Backfill
1					2	50 DO	6				
					3	50 DO	9				32mm Diam PVC #10 Slot Screen
2					4	50 DO	11				
					5	50 DO	32				
3					6	50 DO	19				
4											
5					7	50 DO	19				Native Backfill
					8	50 DO	28				
6											
7					9	50 DO	28				
		End of Borehole Sampler Refusal		7.01							
8											
9											
10											
11											
12											
13											
14											
15											



DEPTH SCALE

1 : 75

Golder Associates

LOGGED: H.E.C.

CHECKED: ————

PROJECT: 03-1120-846

RECORD OF BOREHOLE: 03-8A

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: October 7, 2003

DATUM:

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m: 20 40 60 80

SHEAR STRENGTH Cu, kPa: nat V. + Q- ● rem V. ⊕ U- ○ : 20 40 60 80

HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-6} 10^{-5} 10^{-4} 10^{-3}

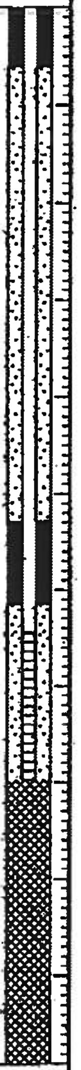
WATER CONTENT PERCENT: Wp ⊢—○W—⊣ Wl : 10 20 30 40

ADDITIONAL LAB. TESTING

BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. / DEPTH (m)
	Ground Surface	
Portable Drilling BW Casing	Very loose black fibrous PEAT	0.00
	Loose to compact grey SANDY SILT	0.84
	Compact grey fine to medium sand and gravel (GLACIAL TILL)	1.32
	Dark grey dolomite boulders, trace grey fine sand (GLACIAL TILL)	5.11
Portable Drilling NQ Core	Light grey to dark grey DOLOSTONE with black shale interbeds at depth	5.84
	End of Borehole	10.90

SAMPLES NUMBER	TYPE	BLOWS/0.3m	T.C.R. (%)	S.C.R. (%)	R.Q.D. (%)
1	NQ RC	DD	50	0	0
2	NQ RC	DD	94	70	66
3	NQ RC	DD	72	30	30
4	NQ RC	DD	64	36	36
5	NQ RC	DD	61	33	0
6	NQ RC	DD	67	0	0
7	NQ RC	DD	60	35	0
8	NQ RC	DD	100	93	79

PIEZOMETER OR STANDPIPE INSTALLATION



- Bentonite Seal
- Silica Sand Backfill
- Bentonite Seal
- Silica Sand Backfill
- 32mm Diam PVC #10 Slot Screen
- Native Backfill

DEPTH SCALE

1 : 75

Golder Associates

LOGGED: H.E.C.

CHECKED: ———

PROJECT: 03-1120-846

RECORD OF BOREHOLE: 03-8B

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: October 7, 2003

DATUM:

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m: 20 40 60 80

SHEAR STRENGTH Cu, kPa: nat V. + Q - ● rem V. ⊕ U - ○ 20 40 60 80

HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-6} 10^{-5} 10^{-4} 10^{-3}

WATER CONTENT PERCENT: Wp ⊢——○W——⊣ Wl 10 20 30 40

ADDITIONAL LAB. TESTING

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m	PIEZOMETER OR STANDPIPE INSTALLATION
		Ground Surface						
0	Portable Drill NW Casing	For stratigraphy see Record of Borehole 03-8A		0.00	1	50 DO	1	Bentonite Seal
1					2	50 DO	6	Silica Sand Backfill
					3	50 DO	28	32mm Diam PVC #10 Slot Screen
2					4	50 DO	30	
					5	50 DO	26	
3					6	50 DO	17	
4					7	50 DO	24	Native Backfill
	Portable Drill HW Casing				8	50 DO	17	
5					9	50 DO	32	
	Portable Drill NQ Core				10	NQ RC	DD	
					11	NQ RC	DD	
					12	NQ RC	DD	
6		End of Borehole		6.20				
7								
8								
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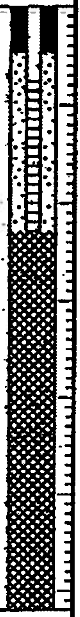
10								
11								
12								
13								
14								
15								



DEPTH SCALE
1 : 75

Golder Associates

LOGGED: H.E.C.
CHECKED: ————

PROJECT: 03-1120-846

RECORD OF BOREHOLE: 03-9A

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: October 17, 2003

DATUM:

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)
		Ground Surface	
0	Portable Drill NW Casing	Very loose fibrous black PEAT	0.00
		Very loose grey organic SILT	1.30
		Loose grey SANDY SILT	1.58
5		Compact grey fine to medium sand and gravel (GLACIAL TILL)	4.88
6	Portable Drill BW Casing	Dense grey fine sand and gravel, some cobbles and boulders (GLACIAL TILL)	6.30
8	Portable Drill NQ Core	Fractured dark grey to light grey subilithographic to medium crystaline, thinly to thickly bedded DOLOSTONE with interbeds of black, very fine grained, thickly laminated to thinly bedded shale Calcite filled vugs and fractures are common	7.87
13		End of Borehole	12.73

SAMPLES NUMBER	TYPE	BLOWS/0.3m	T.C.R. (%)	S.C.R. (%)	R.Q.D. (%)
1	NQ RC	DD	87.5	0	0
2	NQ RC	DD	100	0	0
3	NQ RC	DD	100	0	0
4	NQ RC	DD	100	0	0
5	NQ RC	DD	100	0	0
6	NQ RC	DD	100	43	29
7	NQ RC	DD	100	97	57
8	NQ RC	DD	100	77	53
9	NQ RC	DD	100	54.5	43

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m: 20 40 60 80

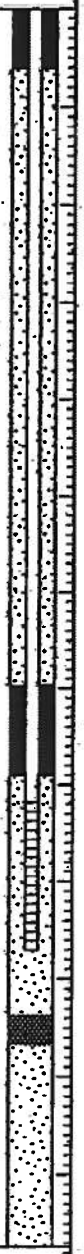
SHEAR STRENGTH Cu, kPa: nat V. + Q - ● rem V. ⊕ U - ○ 20 40 60 80

HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-6} 10^{-5} 10^{-4} 10^{-3}

WATER CONTENT PERCENT: Wp ⊢—○W—⊣ Wl 10 20 30 40

ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION



DEPTH SCALE
1 : 75

Golder Associates

LOGGED: H.E.C.
CHECKED: ———

PROJECT: 03-1120-846

RECORD OF BOREHOLE: 03-9B

SHEET 1 OF 1

LOCATION: See Site Plan

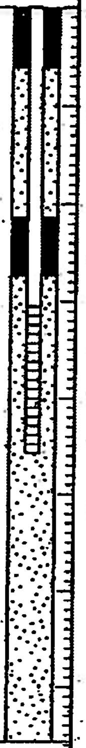
BORING DATE: October 17, 2003

DATUM:

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m 20 40 60 80 SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s 10⁻⁶ 10⁻⁵ 10⁻⁴ 10⁻³ WATER CONTENT PERCENT Wp ⊢—○W—⊣ Wl 10 20 30 40	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
0		Ground Surface									
	Portable Drill NW Casing	For stratigraphy see Record of Borehole 03-9A		0.00	1	50 DO	PM				Bentonite Seal
1					2	50 DO	2				
					3	50 DO	11				Silica Sand Backfill
2					4	50 DO	9				
					5	50 DO	8				Bentonite Seal
3					6	50 DO	6				Silica Sand Backfill
4					7	50 DO	6				32mm Diam PVC #10 Slot Screen
					8	50 DO	8				
5					9	50 DO	18				
6					10	50 DO	11				
	Portable Drill BW Casing				11	50 DO	29				Native Backfill
7					12	50 DO	41				
	Portable Drill NQ Core				13	NQ RC	DD				
		End of Borehole		7.57							
8											
9											
10											
11											
12											
13											
14											
15											



DEPTH SCALE

1 : 75

Golder Associates

LOGGED: H.E.C.

CHECKED: ——————

PROJECT: 03-1120-646

RECORD OF BOREHOLE: 03-10A

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: September 29, 2003

DATUM:

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. / DEPTH (m)
		Ground Surface	94.73
0	Portable Drill / NW Casing	Fibrous black PEAT	94.50 0.23
		Loose mottled grey brown SANDY SILT, occasional thinly bedded brown medium to coarse sand	93.43 1.30
1		Loose grey SANDY SILT	91.63 3.10
3		Compact grey SANDY SILT, trace gravel and clay (GLACIAL TILL)	90.46 4.27
4	Portable Drill / NQ Core	Fractured dark grey to light grey sublithographic to medium crystaline, thinly to thickly bedded DOLOSTONE with interbeds of fresh black, very fine grained, thickly laminated to thinly bedded shale, calcite filled vugs and fractures are common	85.43 9.30
		End of Borehole	

SAMPLES NUMBER	TYPE	BLOWS/0.3m	T.C.R. (%)	S.C.R. (%)	R.Q.D. (%)
1	NQ RC	DD	100	100	100
2	NQ RC	DD	0	100	62.5
3	NQ RC	DD	100	0	0
4	NQ RC	DD	100	12.5	12.5
5	NQ RC	DD	100	14.3	0
6	NQ RC	DD	100	0	0
7	NQ RC	DD	100	0	0
8	NQ RC	DD	98.8	87.5	48.8
9	NQ RC	DD	94.4	81.5	82
10	NQ RC	DD	100	81.3	56.3

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m: 20 40 60 80

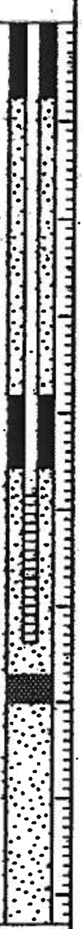
SHEAR STRENGTH Cu, kPa: nat V. + Q - ● rem V. ⊕ U - ○ 20 40 60 80

HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-6} 10^{-5} 10^{-4} 10^{-3}

WATER CONTENT PERCENT: Wp ⊢—○W—⊣ Wl 10 20 30 40

ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION



DEPTH SCALE

1 : 75

Golder Associates

LOGGED: H.E.C.

CHECKED: ———

PROJECT: 03-1120-846

RECORD OF BOREHOLE: 03-10B

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: September 25, 2003

DATUM:

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m 20 40 60 80 / SHEAR STRENGTH Cu, kPa nat V. + Q- ● rem V. ⊕ U- ○ 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s 10^{-6} 10^{-5} 10^{-4} 10^{-3} / WATER CONTENT PERCENT Wp ⊢—○W—⊣ Wl 10 20 30 40	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		Ground Surface		94.73							
0	Portable Drill / BW Casing	For stratigraphy see Record of Borehole 03-10A		0.00	1	50 DO	2				Bentonite Seal
											Silica Sand Backfill
1					2	50 DO	6				Bentonite Seal
					3	50 DO	6				Silica Sand Backfill
2					4	50 DO	9				32mm Diam PVC #10 Slot Screen
					5	50 DO	9				
3					6	50 DO	10				
4					7	50 DO	11				Bentonite Seal
	Portable Drill / NQ Core				8	NQ RC	DD	T.C.R. (%) 82.5 S.C.R. (%) 12.5 R.Q.D. (%) 0			Silica Sand Backfill
5					9	NQ RC	DD	T.C.R. (%) 100 S.C.R. (%) 60.9 R.Q.D. (%) 60.9			
				89.17							
		End of Borehole		5.56							
6											
7											
8											
9											
10											
11											
12											
13											
14											
15											

DEPTH SCALE

1 : 75

Golder Associates

LOGGED: H.E.C.

CHECKED: ———

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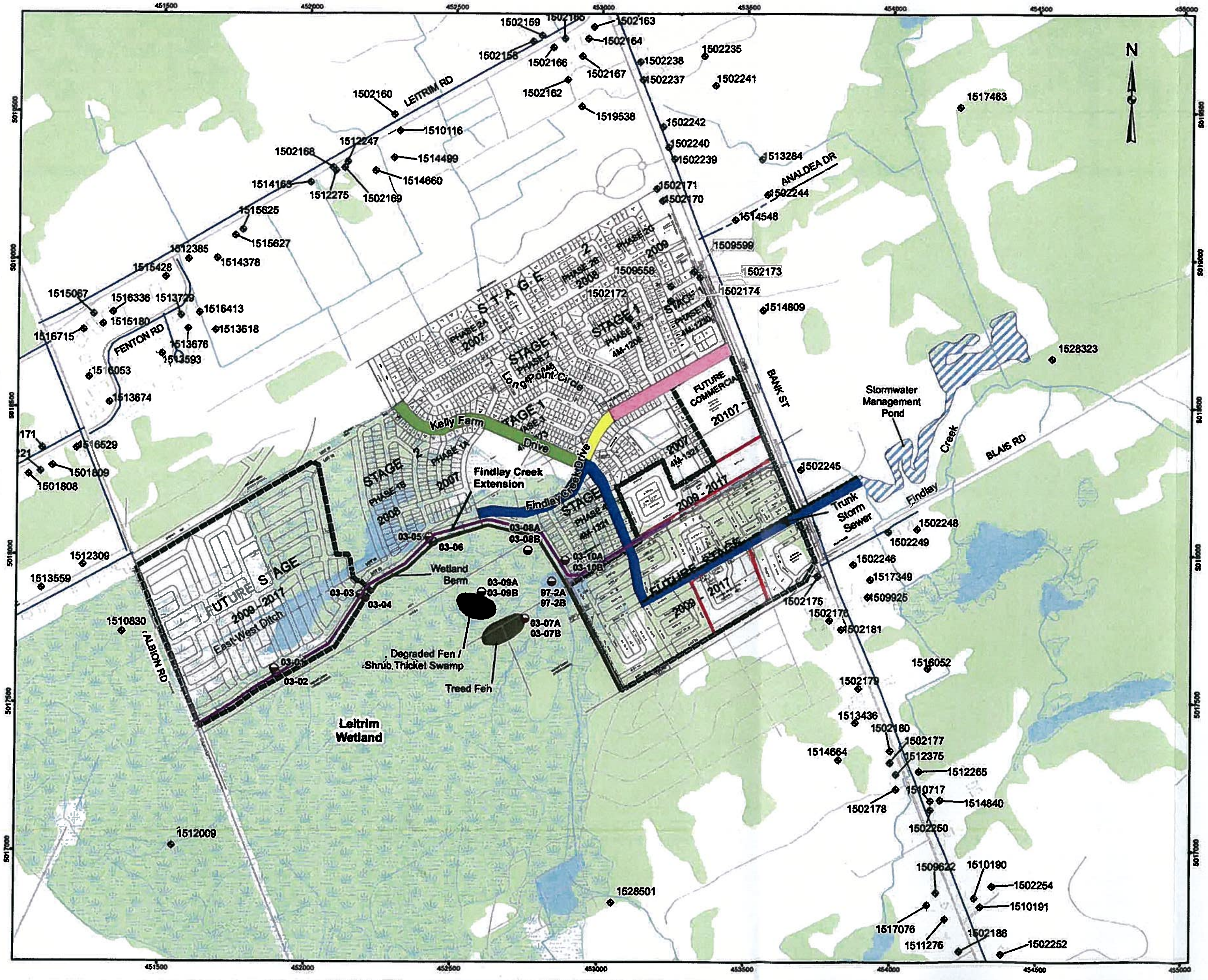


LEGEND

- ◐ Monitoring Well
- ◈ MOE-Listed Water Well
- Building
- Building Outline
- Railroad
- Roadway
- Proposed Lot Layout
- City of Ottawa Watermain Service
- Watercourse
- Findlay Creek Extension
- Trunk Storm Sewer
- ▨ Stormwater Management Pond
- ■ Fen
- Wetland
- Waterbody
- Wooded Area
- ⬚ Future Stage

Periods of Temporary Groundwater Control

- 🟪 Jan - May 2003
- 🟨 Jan - April 2004
- 🟩 Jan - May 2005
- 🟦 Sept '05 - Nov '06

REFERENCE

Digital OBM NRVIS data provided by Ontario Ministry of Natural Resources
Queen's Printer, used under licence, 2006
Base plan provided by Stantec Geomatics Ltd.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 18

160 80 0 160 320 480 640
Meters

PROJECT

LEITRIM ENVIRONMENTAL MANAGEMENT PLAN

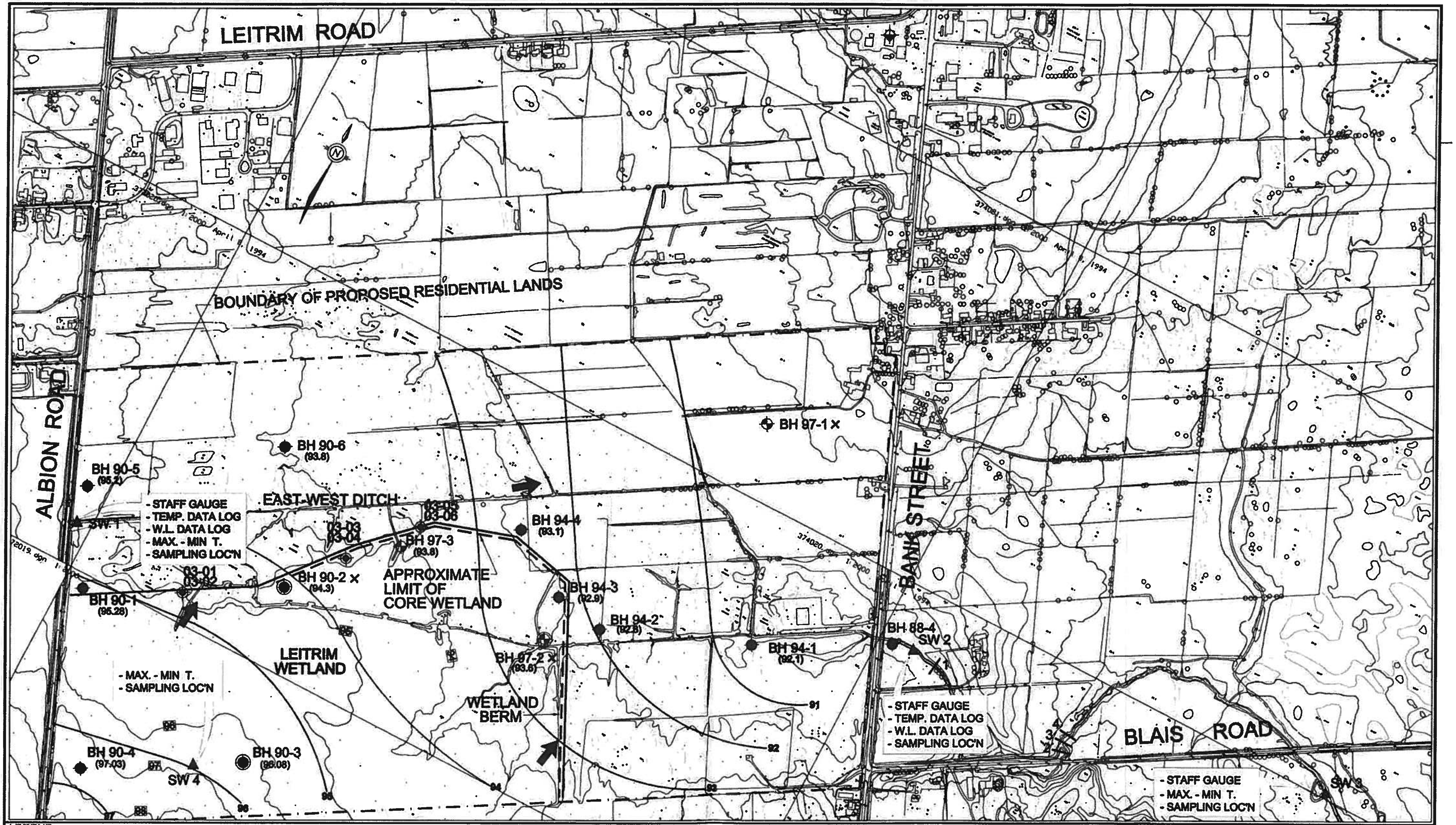
TITLE

SITE PLAN

Golder Associates
Ottawa, Ontario

PROJECT No. 03-1120-846-1040			1:15,000	REV 0
DESIGN	CAMC	03 Dec. 2007	FIGURE: 2	
GIS	BT/JEM	11 Feb. 2008		
CHECK	PAS	22 Apr. 2008		
REVIEW	PAS	22 Apr. 2008		

FILE: N:\Active\2003\1120\ENVIRONMENTAL\03-1120-846 Leitrim EMP\ACAD\Phase1040\031120846-1040-03(1).dwg



LEGEND

- EMP MONITORING WELL
- BOREHOLE PUT DOWN IN 1997 - MONITORING LOCATION
- ● BOREHOLE PUT DOWN BEFORE 1997 - MONITORING LOCATION
- ○ DATA LOGGER FOR GROUNDWATER LEVEL MEASUREMENT
- ▲ SURFACE WATER MONITORING LOCATION
- \1 EROSION MONITOR LOCATION
- × GROUNDWATER SAMPLING LOCATION
- PRECIPITATION GAUGE
- 95 GROUND SURFACE CONTOUR ELEVATION (m)
- 96 OVERBURDEN GROUNDWATER ELEVATION CONTOUR (m), August 24, 1998
- (97.77) GROUND SURFACE ELEVATION (m)
- GROUNDWATER FLOW DIRECTION

SCALE

(IN METERS)

100 0 50 100 200 300 400 500

1 :10000

SPECIAL NOTE
THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ACCOMPANYING REPORT

REFERENCE BASEMAP: CUMMING COCKBURN LIMITED
CONSULTING ENGINEERS AND PLANNERS

SCALE: AS SHOWN		
PROJECT No.03-1120-846-1040		
DES BY		
DR BY	J.E.M.	
CHK BY	P.A.S	APR. 2006

PROJECT: LEITRIM EMP

SHEET TITLE: INTERPOLATED GROUNDWATER
LEVEL CONTOURS AND FLOW DIRECTION
on August 24, 1998

Golder Associates

DRAWING
FIGURE 3