PROPOSED FREYMOND QUARRY

Final

Level 1 and Level 2 Hydrogeological Investigation Report

Project Location:
Lot 51 and 52
Concession W.H.R.
Township of Faraday, County of Hastings

Prepared for:
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1.0 INTRODUCTION

MTE Consultants Inc. (MTE) has been retained by Freymond Lumber Ltd. (Freymond) to prepare a Level 1 and Level 2 hydrogeological investigation report (Level 1/2 Report) for a proposed Category 2, Class A Quarry Below Water. The proposed Freymond quarry is located south of the Town of Bancroft, on Lot 51 and 52, Concession W.H.R. in the Township of Faraday, County of Hastings (hereby referred to as the "Site"). The Site location is illustrated in Figure 1. For the purposes of this investigation, the study area is defined as the area one kilometer from the Site boundary. The study area is illustrated on Figure 2.

Previously, MTE completed two other Level 1/2 Reports (dated June 3, 2013 and March 27, 2015) for a proposed quarry on this Site. The results of these reports were made available at a Public Open House hosted by Freymond on June 25, 2015 regarding an application for an Official Plan and Zoning By-law amendment.

The purpose of the Public Open House was to dialogue with the public and receive comments on the application so that they could be included in the scope of work for this investigation. This current report supersedes the results and interpretation presented in the previous two reports as this investigation includes:

- Additional field data;
- Considers a revised mining plan;
- A larger study area;
- A smaller extraction area;
- A new phasing plan to minimize site disturbance; and
- A new rehabilitation plan to promote ecological diversity.

1.1 Purpose and Objectives

The purpose of this report is to assess the geological, hydrogeological, and hydrological conditions at the Site and to identify any potential adverse effects on water resources, water uses, and the natural environment that the purposed quarry may have on these systems.

Additionally, this Level 1/2 Report provides technical data to support applications for:

1) Permits to Take Water (PTTW) as part of the proposed quarry; and
2) Environmental Compliance Approvals (ECA) for periodic discharge of water to watercourses.

The objectives of this Level 1/2 Report are to:

- Establish baseline groundwater and surface water conditions;
- Establish a baseline water budget for the proposed license area;

- Provide input for the operation of a quarry and rehabilitation, including water management, use, storage, and drainage;
- Identify potential effects of a quarry and end use operations on the quantity, quality, and function of groundwater and surface water resources; and
- Provide a monitoring program framework that will include an assessment process that will enable transparency and allow for on-going assessment of compliance with the Site Plan commitments.

1.2 Scope of Work

The scope of work for this Level 1/2 Report included:

- A review of the *Aggregate Resources Act (R.S.O., 1990)* and the *Aggregate Resources Provincial Standards (1997)* for the preparation of a Level 1 and 2 Hydrogeological Assessment;
- A review of the Provincial Policy Statement (2014);
- A review of the *Clean Water Act (2006);*
- A review of the County of Hastings Official Plan;
- A review of the Township of Faraday Official Plan;
- A review of published geological and water resources maps;
- A review of Ontario Base Maps (OBM maps);
- A review of the Approved Assessment Report for the Trent Source Protection Area;
- A review of the Regional Groundwater Study for the Quinte Conservation Authority by Dillon Consulting Ltd. completed dated October 20, 2014.
- A review of the Trent Source Protection Plan;
- A review of the Madawaska River Water Management Plan;
- A review of the 2014 Annual Water Report for the Town of Bancroft;
- A review of comments received at the June 25, 2015 Public Open House, comments received by the County on July 1, 2015 from Steve Gaebel, a letter received by the County on July 14, 2015 from Tara McMurtry, Adrianne Schutt and Daisy McCabe-Lokos and an email received by the County on September 16, 2015 from Sheila and Mike Schneider;
- An examination of water well records on file with the Ontario Ministry of the Environment (MOECC);
- Site specific field work that included:
  - Field reconnaissance completed during 26 Site visits from May 2009 to October 2016;
  - Construction of 13 bedrock groundwater monitoring wells;
  - 7 well performance tests performed on on-Site monitoring wells;
  - A pumping test to determine the well yield of MW7;
  - 26 Site visits to manually measure groundwater levels;
  - Continuous measurement of groundwater levels using pressure transducers (data loggers) installed in monitoring wells to develop a continuous water level data set spanning seven years; and

    - A geodetic survey and inspection of 15 private water wells within the study area.
- Establishment of the water table elevation beneath the Site;
- Determination of groundwater flow patterns beneath the Site;
- Assessment of potential impacts to:
    - Groundwater aquifers;
    - Private well water supplies;
    - Groundwater recharge/discharge zones; and
    - Natural environmental features including springs, streams, rivers and lakes within the Study Area.

2.0 SITE DESCRIPTION

The study area, including the Site boundary, adjacent licensed pits, geological cross-section locations, and the locations of private water supply wells are illustrated on Figure 2. As previously mentioned, the study area is defined as the area one kilometer from the Site boundary. The proposed ARA Site Plans are submitted under a separate cover but indicate the licensed area for the proposed quarry encompasses an area of 33.3 hectares (ha) with an extraction area of 27.5 ha.

2.1 Adjacent Land Uses

Land uses in the study area are primarily rural, agricultural, industrial/commercial (logging and lumber yards), and green space.

Adjacent to the north boundary of the Site is a gravel pit (Photo 1 - Appendix A) with a Class B license owned and operated by Freymond (ARA License No. 624804). The annual tonnage limit for this license is 20,000 tonnes. There is also a cemetery, adjacent to the northeast boundary. Lands further north are occupied by forests, residential dwellings along Gaebel Road and Mill Street, and an unnamed stream (hereby referred to as the North Stream) approximately 300 m from the Site, which drains into the York River. The Town of Bancroft is located approximately one kilometer north of the Site, which has a population of 3,880 (Statistics Canada, 2012).

A lumber mill operated by Freymond Lumber Ltd. is located east and southeast of the Site (Photo 2 – Appendix A). Another lumber yard not owned by Freymond Lumber Ltd. is located east of Mill Street. There are residential dwellings along Mill Street to the southeast and northeast. Further to the northeast is the York River. There is another gravel pit with a Class B License found approximately 850 m east of the Site, which is owned by Jan Woodlands (2001) Inc. This gravel pit has an annual tonnage limit of 20,000 tonnes.

Land south and west of the Site is covered primarily by forest. There is an unnamed stream (hereby referred to as the South Stream) located approximately 75 m from the Site, which drains into the York River. There are residential dwellings along Bay Lake Road and around Spurr Lake. Spurr Lake is approximately 0.85 km south of the Site. There is also one residential dwelling west of the Site at the end of Gaebel Road.

2.2 Topography

Figure 3 shows the topography of the Site and study area. Much of the study area is characterized by rugged hills with narrow incised valley bottoms. Site topography consists of undulating bedrock knobs in the western portion of the Site. Topography peaks at 392 metres above mean sea level (mAMSL) at the northwestern corner of the Site before dipping to a valley at 380 mAMSL, which roughly bisects the central portion of the Site. Site topography rises steeply again to the east from this central valley to approximately 389 mAMSL before topography falls sharply to 335 mAMSL at the eastern Site boundary.

2.3 Surface Water Features and Drainage

The Site and study area are located within the York River sub-watershed which is part of the Madawaska watershed (Figure 4).

OBM mapping shows that there are no surface water bodies or water courses on the Site.

There are two unnamed streams north (North Stream) and south (South Stream) of the Site that drain the surrounding area. Both streams flow eastwards where they join the York River, which is the closest major surface water course to the Site as seen on Figure 2. A stretch of the York River falls within the study area to the northeast.

The closest lake is Spurr Lake which lies approximately 850 m south of the Site at an elevation of approximately 356 mAMSL. Spurr Lake and other lakes in the surrounding area were formed by glacial scouring of the uneven bedrock surface from past glaciations. Seven additional lakes outside of the study area; L'Amable Lake, Tammarack Lake, West Mullet Lake, Bay Lake, Jeffery Lake, Marble Lake and Banner Lake, which are approximately between 1.5 and 2.5 km away from the Site were also formed by the same glacial scouring geologic process as Spurr Lake (OGS, 1989). Water entering these lakes will be primarily from surface water runoff from surrounding lands with a minor component coming from groundwater.

Field reconnaissance identified three small ponds on the Site (see Photos 4 through 8 – Appendix A). The first pond was found in the west central portion of the Site near MW3 and the other two are located near the southwest boundary at MW4. These ponds are located at the base of small closed topographic depressions where surface water pools. The water levels in these ponds decrease throughout the year achieving their maximum extent in the spring and decrease in size over the summer months. During field reconnaissance, MTE staff observed no groundwater seeps or springs on-Site.

2.4 Conceptual Model

Figure 5 shows a 3D conceptual model of the study area looking north, south, east and west. This model shows how precipitation drains across the Site as runoff and enters the North and South streams. Groundwater recharge occurs where precipitation and snowmelt infiltrate into the ground to feed aquifers, watercourses and wetlands. Significant recharge areas are typically associated with coarse-grained soils (i.e. sands and gravels) covering upland areas on the landscape. A significant groundwater recharge area (SGRA) represents an important area for groundwater to recharge the water table (Approved Trent Assessment Report, 2014).

While the Site is considered an upland area, it is not considered a SGRA because Quaternary and Precambrian geological mapping (described in Section 3.0) show that most of the Site is mapped as Precambrian bedrock at surface (Figures 7 & 8). The exposed bedrock allows little recharge due to its low permeability and porosity (MOE, 2003). Most of the recharge is directed overland to become soil seepage into nearby surface water features including the North and South Streams instead of infiltrating vertically down to the water table on-Site (Figure 5).

Only a small portion of the Site (approximately 8% in the southeast corner) is characterized as sand and gravel deposits at surface. Sand and gravel is also found adjacent to the northeast corner of the Site in the existing gravel pit (ARA License No. 624804). As such, a higher percentage of recharge water is expected to occur in these areas. Infiltrating water will eventually encounter the water table; which flows eastwards towards the York River, roughly mimicking the bedrock topography.

2.5 Well Head Protection Areas (WHPA)

Upon review of provincial source water protection areas MTE has found that the Town of Bancroft lies outside any of the currently assessed source water protection areas. The closest source water protection area to the Town of Bancroft is the Cardiff WHPA (Figure 6) which is located in the Trent Conservation Coalition Source Protection Region. The Trent Conservation Coalition Source Protection Region defines a WHPA as:

> *The surface and underground area surrounding a water well or well field that supplies a municipal residential system. "Wellhead protection areas are delineated based on the length of time it takes for water to move from the ground surface, underground to the well."*

The Cardiff WHPA is located approximately 14 km west of the Site in the Crowe Valley Watershed. Based on source area protection mapping, the Site lies beyond the limit of any nearby WHPA's.

The Town of Bancroft has a large municipal residential water treatment facility. The source of water to the Town of Bancroft water treatment facility is Clark Lake. Clark Lake has an approximate area of 40 ha, depth of 28 m and is located 2.5 km east from the Town of Bancroft and 3 km northeast of the Site.

3.0 GEOLOGY AND HYDROGEOLOGY

3.1 Quaternary Geology

Soils within the Madawaska Watershed are described as being in the Laurentian sub-region of the Canadian Shield and tend to be shallow (Ontario Power Generation & Ministry of Natural Resources, 2009). Due to the localized glacial history of the Bancroft area, the bedrock topography as well as the Quaternary geology can vary considerably on a local scale. Map sheets in publication (Barnett, 1985) regarding Quaternary geology of the Bancroft Area (Figure 7) describe the Site and surrounding area as containing:

1. Bedrock: exposed or with very thin drift cover.
2. Till: silty to sandy; stony.
3. Glaciofluvial outwash and deltaic deposits: gravelly sand, sand, gravel.
4. Bog and swamp deposits: muck, peat, marl.
5. Modern alluvium: unsubdivided-sand, silt, gravel, clay, muck.

Specifically, the Site is mapped by the Ontario Geological Survey as predominately bedrock at the surface with glaciofluvial outwash and deltaic deposits along its southeastern edge. Boreholes that have been equipped with a PVC well screen and riser pipes have been installed at varying depths in the bedrock beneath the Site to allow for the mapping of groundwater levels and flow in these different units where appropriate.

3.2 Precambrian Geology

Map sheets in publication (Lumbers and Vertolli, 1998) regarding the Precambrian geology of the Bancroft Area (Figure 8) describe the Site and surrounding area as containing:

1. Rusty weathering, graphitic, pyrite and pyrrhotite-bearing schist.
2. Amphibole-rich metasedimentary rocks. Medium to high metamorphic grade calcareous mudstone and sandstone with a metamorphic fabric and mainly diopside-amphibole-plagioclase gneiss locally containing phases rich in potassium feldspar, quartz, biotite, scapolite, epidote, carbonate, titanite, pyrite and iron-titanium minerals; intercalated thin units of siliceous marble are common.
3. Dolomitic Marble; medium-to coarse-grained, white to greenish, dolomitic marble containing up to 20% siliceous impurities; local intercalations of tremolite-rich dolomitic marble. Medium- to coarse-grained, cherty, dolomitic marble containing numerous discontinuous layers of coarsely recrystallized chert, possibly in part derived from silicified stromatolites and algal mats.

3.3 Geological Cross-Sections

Hydrogeological data was obtained from well records on file with the Ontario Ministry of the Environment and Climate Change (MOECC) and from boreholes constructed on-Site. This information, along with the topographical surface obtained from OBMs was used to construct geological cross-section A-A' and B-B' through the study area (Figure 9 & 10).

From the available MOECC well records, a total of 67 private wells were identified within the study area (Figure 2). Based on MOECC well records, Precambrian bedrock and Quaternary geology mapping, the geology is predominantly Precambrian bedrock consisting of metasedimentary rock with minor amounts of calcitic marble (Lumbers and Vertolli, 1998) with small surficial deposits of glacial outwash (sand & gravel).

3.4 Fault Mapping

Faults in the study area have been mapped by the Ontario Geological Survey (1998). The Precambrian map (Map 3385, Lumbers and Vertolli, 1998) shows a series of regional fault lines located approximately 250 m or more north of the Site (Figure 11). These fault lines generally trend southwest-northeast. The Ministry of Northern Development and Mines (1991) has also shown these same faults (Map 2545) and has divided them into two major classes:

1. Faults traceable in surface exposures; and
2. Faults cutting Precambrian basement rocks but not extending to the surface.

The faults are regional features and commonly relate to minor/major geological structures. There are no faults mapped on the Site. There are two Class 1 faults within the study area (343 m and 866 m north of the Site) and two more (1,750 m and 2650 m) outside the study area. There is one fault, known as the Severn Arch, approximately 20 km away from the Site that is considered Class 2 (OGS, 1991).

4.0 FIELD PROGRAM

Even though the mining plan was modified in 2015, MTE has reviewed the suitability of the borehole locations and depths and find them still applicable to the updated plan.

4.1 Borehole Construction and Monitoring Well Installation

On April 27, 2009 and May 4, 2009 through May 6, 2009 Freymond Lumber arranged for the construction of six nested monitoring wells (i.e. monitoring wells drilled at different depths at the same location). Boreholes were placed in accordance to the mining plan in order to gain information on the underlying geology and hydrogeology of the Site. MTE staff was on-Site to monitor and record drilling and monitoring well activities and installations. Boreholes were drilled using a track-mounted air percussion drill rig. At each borehole location, two monitoring wells (MW) were installed at a relatively common shallow (s) and deep (d) elevation in the bedrock to allow for comparison of groundwater levels and determination of hydrogeological characteristics. Monitoring well locations are illustrated on Figure 2.

In addition to the drilling of six monitoring well nests (MW1-MW6) a 40.5 m, 0.10 m diameter open borehole (MW7) was drilled on May 6, 2016, with the use of a NQ wet rotary drill rig. This borehole was cored and logged on-Site by an MTE representative to assess bedrock properties and fractures.

Borehole logs and monitoring well installation details are provided in Appendix B. Following installation, each monitoring well with the exception of MW7 was developed using the Waterra™ system to purge any drill fluids and/or drill cuttings from the monitoring well. MW7 was developed using a 2.9" Grundfos Redi-Flo3 submersible pump.

Deep monitoring wells (MWd) were constructed so that the bottom elevation of the monitor would correspond to the proposed final quarry floor at that location. Shallow monitoring wells (MWs) were constructed so that the bottom elevation of the monitor would correspond to an elevation that approximated the mid-depth point of the proposed quarry. MW7 was constructed as an open borehole to an approximate depth corresponding to the final quarry floor.

4.2 Groundwater Levels

Following their installation, MW1s, MW1d, MW2s, MW2d, MW5s, MW5d, MW6s, and MW6d were each instrumented with a dedicated pressure transducer (data logger) programmed to collect a water level every eight hours. Manually measured groundwater levels were also collected on a seasonal basis to supplement and aid in the accuracy and reliability of the data logger data.

Manually measured groundwater levels and elevations are presented in Table 1 and Table 2. Groundwater elevations generated from the data logger data are illustrated on Hydrograph 1.

By July 2009, four months after their installation, very little to no groundwater had entered the well screens at MW1d and MW5d even though they were installed at similar depths as the other monitors. Given the lack of water at these locations which was due to the limited number of fractures encountered during their drilling and installation, MTE determined that these monitors could not be used for groundwater mapping or for in-situ hydraulic conductivity testing. As such, the data loggers were removed and installed in MW4s and MW4d in August 2009. In addition, two data loggers were installed in MW3s and MW3d during the December 2009 groundwater monitoring event.

Even though MW1d and MW5d no longer have data loggers installed in them, they have been checked manually during each Site visit since 2009 to see if water was entering the well screen slowly over time. Seven months after installation (November 30, 2009) water appeared to be entering MW1d but MW5d has remained dry.

Since well development and data logger installation, groundwater levels in MW3s, MW3d, MW5s, MW6s, and MW6d have achieved equilibrium with the bedrock flow system and their water level trends are interpreted by MTE to be representative of natural seasonal groundwater fluctuations (static conditions) due to changing climatic conditions. A small decrease in the water level at MW3d was observed in September 2016 and is not related to natural seasonal fluctuations but instead related to the pumping test to determine the well yield of MW7 discussed further below (Section 4.6).

Groundwater levels at MW1s took approximately 11 months before reaching static conditions due to localized hydrogeologic conditions after well development. Since August 2009, groundwater levels at MW1d have recovered very slowly but do not appear to have reached static (or equilibrium) conditions.

Groundwater levels at MW2s took approximately one month to reach static conditions, while groundwater levels at MW2d took approximately five months.

Groundwater levels at MW4s and MW4d may still be recovering from well development following installation on May 5, 2009. Since installation, groundwater levels have risen 27 meters at MW4s and 36 meters at MW4d as the wells equilibrate to the water pressure in the fracture that is being monitored. At MW4, the pressure in the fractures has risen to a level above the ground surface. This relatively common occurrence is called a flowing artesian condition (Photo 15, Appendix A). In an effort to measure static conditions (i.e. when the pressure has been relieved or reached equilibrium with the atmosphere), a manometer[1] was added to these wells on April 24, 2015 (photo 16 – Appendix A). Throughout 2015, groundwater levels continued to rise and eventually flowed out the tops of each monometer tube. The monometer was extended on April 28, 2016. Water Levels appear to have stabilized but only seven months of data has been collected, thus another year of water levels will be required to confirm its static condition.

A dedicated pressure transducer was also installed in MW7 on September 22, 2016 and was programmed to collect a water level every eight hours. Initial water level measurements taken since the instillation of MW7 indicate that water levels have stabilized and represent natural conditions.

Monitoring wells with stabilized static water levels (MW1s, MW2s, MW2d, MW3s, MW3d, MW5s, MW6s, and MW6d) show groundwater naturally fluctuates seasonally between ~1-3 metres vertically across the Site. Since 2009, groundwater levels in shallow monitoring wells MW2s, MW3s, and MW6s show a general increasing trend relative to deeper monitoring wells as seen in Hydrograph 1. Water level measured at the MW4 location, while having not reached their static level, are consistent with the groundwater flow patterns and elevations predicted for this area of the Site.

[1] A manometer is an instrument that uses a column of liquid to measure pressure, although the term is currently often used to mean any pressure measuring instrument.

4.3 Water Table Elevation

The groundwater elevation in the shallow bedrock, as defined by measured water levels (Table 2) obtained from wells with stabilized groundwater levels, ranges from 356.24 mAMSL (MW5s) to 375.95 mAMSL (MW3s). The groundwater elevation in the deeper bedrock, as defined by measured water levels obtained from monitoring wells with stabilized groundwater levels, ranges from 352.37mAMSL (MW2d) to 373.88 mAMSL (MW3d).

The proposed finished quarry floor ranges from 340 mAMSL to 333 mAMSL, 337 mAMSL on average. Using the water levels measured from the monitors installed in the shallow bedrock, the base of the proposed quarry will be about 40 m below the water table at the deepest point.

4.4 Groundwater Flow

Regional Groundwater Flow

The direction of regional groundwater flow in the study area generally mimics topography as do surface water drainage patterns. Dillon Consulting Ltd. completed a Regional Groundwater Study for the Quinte Conservation Authority dated October 20, 2014. The direction of regional groundwater flow was reported by Dillon to flow to the northeast across the study area. Local-scale groundwater flow directions can deviate from regional groundwater flow directions because of the effects of local topography.

Local Groundwater Flow

Local groundwater flow mapping was conducted using groundwater data (i.e. measured water levels in monitoring wells) collected over time. MTE selected the October 27, 2014 groundwater elevation data as being representative of static (or pre-extraction) conditions for the groundwater flow system across the Site. Groundwater contours and flow patterns for the shallow and deep bedrock are illustrated in Figure 12 and Figure 13.

While the manually collected groundwater elevation for MW1d is presented in Figure 13, this groundwater elevation is not reflective of static conditions as the well is still recovering and is therefore used here to provide guidance only in determining groundwater flow direction patterns in the deep bedrock groundwater system. In addition, the following monitoring wells were not used in creating the groundwater flow maps:

- MW4s and MW4d – groundwater elevations may not be representative of static conditions due to non-equilibrated artesian conditions; and
- MW5d – well was dry during monitoring event.

On October 27, 2014, groundwater in the shallow bedrock flowed in a northeasterly direction. A horizontal hydraulic gradient of 0.04 m/m was calculated for the shallow bedrock groundwater flow system on this day.

On October 27, 2014, groundwater in the deeper bedrock flowed in a predominately northeastern direction across the Site towards the York River, which was consistent with Dillon's 2004 findings. A horizontal hydraulic gradient of 0.08 m/m was calculated for the deeper bedrock groundwater system on this day.

4.5 Groundwater Vertical Hydraulic Gradients

Vertical hydraulic gradients were calculated for the on-Site monitoring wells with the exception of MW4 and MW7 (Table 3). Moderate to strong downward vertical hydraulic gradients were calculated indicating that bedrock groundwater was migrating vertically downward from the shallow bedrock to the deeper bedrock at the time of data collection.

Vertical gradients could not be calculated for MW4 because water levels may not have reached their static condition. An additional year of water level measurements will be required to confirm static conditions. Even though a vertical gradient was not calculated, this well is showing a positive vertical gradient due to the artesian conditions observed at this well.

Regardless of whether water levels have reached their static conditions at MW4, the observed water level elevations, and subsequent predicted static elevations are consistent with the groundwater flow patterns in this vicinity of the Site and as such, their results will not change MTE's interpretation of the direction of groundwater flow beneath the Site.

Vertical gradients could not be calculated for MW7 as this well is not a nested well.

4.6 Well Performance Testing

The purpose of well performance testing is to estimate the hydraulic conductivity of the geological formation that a screen is constructed in. There are a variety of methods used to estimate hydraulic conductivity, these include:

- Grain Size Analysis;
- Pumping Tests;
- Packer Tests; and
- Recovery or Slug Tests (Single Well Hydraulic Response Tests).

In determining hydraulic conductivity, first the appropriate method must be chosen. Since the monitoring wells are screened within Precambrian bedrock, grain size analysis is not an appropriate method, as groundwater flow occurs through secondary porosity features, including fractures and joints.

The very slow recovery rates observed after monitoring well drilling, construction and well development is indicative of slow groundwater flow conditions at the Site. As such, a constant rate pumping test of an extended duration was also not considered viable because the majority of the wells on-Site become dry after a short period of pumping. This is because there is not enough water in the bedrock fractures to sustain a constant pumping rate for an extended period of time. Therefore single well hydraulic response tests were chosen as the most appropriate, method to estimate a value for bulk hydraulic conductivity at the Site.

Recovery tests and slug tests were performed to define the hydraulic conductivity of the bedrock groundwater system around each monitoring well. Recovery tests were conducted on MW1s, MW2s, MW2d, MW4s, MW4d, MW6s on May 7, 2009. Monitoring wells were pumped dry using Waterra™ tubing and foot valves. Once dry, the tubing and foot valve were removed and the recovery was recorded using dedicated pressure transducers (data loggers). The data loggers recorded the recovery rates in the wells every minute until May 8, 2009.

On September 22, 2016 a slug test was performed on MW7. This test involved the introduction of a “slug” (a predetermined solid length of PVC with a known displacement) which causes a near instantaneous rise in the water level within the well. The water level rise was followed by a gradual decrease back to the static conditions (the water level within the well prior to slug introduction), as a result of the natural flow of groundwater back into the well.

Once the water level returned to static conditions, the slug was removed quickly resulting in a near instantaneous drop in the water level within the well followed by a rise in the water level back to the static conditions. The recovery, or return to the static water level was recorded using dedicated pressure transducers (data loggers). The slug test was repeated three times to ensure accurate results.

Water level data from single well response testing of MW1s, MW2s, MW2d, MW4s, MW4d, MW6s and MW7 were used to analyze bedrock hydraulic properties.

4.6.1 Pumping Test

On September 22, 2016, a pumping test to determine well yield was conducted on MW7 as this well is completed as an open borehole (not screened at a specific interval) allowing water to flow into the well from anywhere along the profile of the well. As such, MW7 can be used to mimic the conditions along the quarry face once fully excavated. The pumping test was conducted using a 3” submersible pump placed at the bottom of the well. The well was pumped for 2 hours with a sustained yield of 52 L/min, similar to that of a domestic water well. Water level data for the duration of the test was collected through the use of a dedicated pressure transducer within the well and is presented in Hydrograph 2.

Water levels were collected prior to the well test to establish background conditions. Upon initiating the test, the water level in the well decreased 27 m from 372 masl to 345 masl within 19 minutes. Following the initial rapid water level decrease, the drawdown rate lessened to an additional meter over the remainder of the test (101 minutes). This lower drawdown trend of water levels at 345 masl suggests that MW7 encounters a water bearing fracture at this depth, which correlates to a fracture noted in the borehole log.

There was a slight disruption between 85 and 93 minutes into the test as a result of a power failure. During this time, water levels increased but quickly fell again once power was restored. After 120 minutes of testing, the pump was shut off and it took approximately six minutes for the water level to rise approximately 23 m and then an additional eight hours to achieve 90% recovery (an additional three meters) before stabilizing around 369.4 masl.

4.6.2 Hydraulic Conductivity

The results of the well performance tests were used to calculate the hydraulic conductivity of the bedrock surrounding each well using the Hvorslev method in AquiferTest© software. AquiferTest© data sheets have been presented in Appendix C. Calculated hydraulic conductivities have been summarized in Table 4 and range from 3.4×10^{-6} m/sec to 5.6×10^{-11} m/sec. A geometric mean of 7.9×10^{-10} m/sec was calculated from the hydraulic conductivities derived from the Hvorslev analysis. These values are consistent with published values for Precambrian metasedimentary rocks (Freeze and Cherry, 1979).

As noted above, these very low hydraulic conductivity values are corroborated by the slow water level recovery trends established for some of the monitoring wells since their installation in 2009. In some cases, static water levels have not yet been achieved, some seven years after well installation.

4.7 Private Wells

MOECC Well Records

A review of the 2014 Annual Water Report for the Town of Bancroft written by the Ontario Clean Water Agency dated January 29, 2015 showed that the Town obtains its water supply from Clark Lake. Clark Lake lies approximately 2.5 km northeast of the Town. Many residents outside of the Town centre that do not have access to the municipal water supply obtain their water from domestic wells.

Information related to domestic water wells is available on water well records on file with the MOECC. A review of these records identified 67 wells within the Study Area (Figure 2). Information pertaining to the construction of these wells is summarized in Table 5.

Based on MOECC well records, 53 wells obtain water from the Precambrian bedrock at a depth of 52.5 m on average, while 10 wells obtain water from the sand and gravel overburden (glaciofluvial outwash deposits) at a depth of 19 m, on average.

Private wells were plotted on geological cross-sections A-A' and B-B' in relation to the proposed depth of the quarry floor (Figure 9 and 10). These cross-sections showed that the majority of wells in the study area are completed at depths below the quarry floor or in a different geological formation (i.e. sand and gravel overburden or calcitic marble) than the rock proposed to be quarried.

Private Well Inventory

MTE completed a private well inventory to field verify the information provided by the well records. On April 20, 2010, a questionnaire (well inventory form) was delivered by hand to each residence within one kilometer of the Site. The door to door survey was conducted along Bay Lake Road, Gaebel Road, Jeffery Lake Road, and Highway 62.

Where possible, local residents were interviewed in person and a private well inventory form was completed at the time. In addition to providing details regarding their well, residents were queried about any past water quality or quantity problems. When no resident was available, a well inventory form and covering letter was left with the request that the inventory be completed to the best of the resident's knowledge and returned to MTE in the provided self-addressed stamped envelope.

In 2010 a total of 20 well inventories were delivered with seven being returned to MTE. A total of six drilled wells and one dug well were reported. Of the seven private wells, four agreed to be part of the Private Well Monitoring Program (PW3, PW5, PW8 & PW9).

Private Well Monitoring Program

To measure background water levels from private wells in the Study Area, MTE invited residents to participate in a Private Well Monitoring Program. An MTE Licensed Well Technician visited each resident on a seasonal basis (three times per year) to measure a static water level from their water supply well using a sterilized electronic water level tape.

Seven years of water levels have been measured from PW3, PW5 & PW9 and five years from PW8. Groundwater levels and elevations are presented in Table 1 and Table 2 and can be seen in Hydrographs 3-6.

To augment the manually measured water levels at PW8, a dedicated pressure transducer (data logger) was installed so that a continuous data set of water levels could be obtained. The data logger was programmed to record a static water level every eight hours.

Following the Public Open House on June 25, 2015 hosted by Freymond, eight other residents expressed interest in participating in the Private Well Monitoring Program. In January 2016, MTE inspected each of these wells and a total of five drilled wells and three dug wells were added to the Private Well Monitoring Program. These wells include PW7, PW11 through PW15. Groundwater levels and elevations are presented in Table 1 and Table 2 and can be seen in Hydrographs 7-12.

Completed private well inventories are provided in Appendix D and summarized in Table 6. Figure 2 shows the locations of the private wells currently part of the monitoring program.

5.0 QUARRY OPERATIONS

Extraction of the Site is proposed in four phases and will occur sequentially to minimize the disturbed area. Phase 1 is proposed in the northeastern portion of the site and is to be extracted to an elevation range of 333 mAMSL to 336 mAMSL. Phase 2 proceeds west to the northwestern portion of the site and is to be extracted to an elevation range of 337 mAMSL to 338 mAMSL. Phase 3 proceeds south to the southwestern portion of the site and is to be extracted to an elevation range of 337 mAMSL to 340 mAMSL. Phase 4 proceeds east to the southeastern portion of the site and is to be extracted to an elevation range of 333 mAMSL to 336 mAMSL. Extraction within each phase will take place in 1-2 benches. Aggregate processing will commence within Phase 1 and will be later relocated to Phase 2 for the remainder of the proposed quarry. There will be no processing in Phase 3 and Phase 4.

The ARA Site Plans for the proposed quarry indicate that progressive rehabilitation will be incorporated into the mining plan. Progressive rehabilitation will ensure that the amount of land disturbed at one time is minimized. Figures 14 through 18 show how progressive rehabilitation will be incorporated in the mining plan.

5.1 Proposed Quarry Floor Elevation

The proposed final quarry floor elevation will slope from 340 to 333 masl running west to east across the Site, 337 masl on average. As previously mentioned in Section 4.3, the proposed quarry will be about 40 m below the water table at the deepest point.

5.2 Proposed Water Diversion, Storage, and Drainage Facilities

Since the proposed quarry is for a below-water-table extraction, groundwater and precipitation accumulating in the quarry are to be diverted to maintain dry operating conditions. Drainage and diversions of groundwater and precipitation will be via a gravity driven process. There will be no pumping to dewater the quarry, and as such a Permit To Take Water will not be required.

Figures 15 through 18 show how the proposed quarry will be extracted in phases. Given this phased approach, the disturbed area requiring water management will be minimized. The approaches that will be used to manage water on-Site will include:

1) Quarry floor grading;
2) A drainage collection swale;
3) Depressed storage areas; and
4) A stormwater management (SWM) facility, which will provide water quality treatment and peak flow attenuation before stormwater re-enters the natural environment.

A drainage collection swale will be constructed through the disturbed area of each phase to collect groundwater and precipitation running off the extraction area. The quarry floor will be graded to direct water running across the active area to the drainage swale. The drainage swale will traverse through the active area and direct water into a SWM facility to be constructed at the southeastern end of the Site (Figure 19). In addition to the drainage swale, depressed storage areas outlined on figures 15-18 will be constructed and will allow for the storage of water during times of increased surface water discharge (spring melt). Following spring melt, water within the depressed storage areas will slowly evaporate and these areas are expected to dry up come late summer.

Stormwater will be treated by the SWM facility, as described in Section 5.3, and discharged via gravity to the South Stream and eventually to the York River. The stormwater management facility will function to maintain water quality during the operation of the proposed quarry, and provide erosion control and flood hazard mitigation for the South Stream.

Upon rehabilitation, the proposed quarry floor will be graded such that precipitation and groundwater will flow to the stormwater management facility. This facility will remain post-extraction and continue to function to provide water quality treatment, erosion control, and flood hazard mitigation to the South Stream.

5.3 Stormwater Management Facility

The stormwater management facility will maintain water quality by providing a permanent pool volume, a long settling length through the use of internal berms, and a 24 hour extended detention time for most storms. The facility will also provide erosion control and flood hazard mitigation through the use of an outlet designed to limit post-extraction peak flows to the South Stream to pre-extraction levels. A detailed design is provided in Appendix E and on drawing Figure 19.

Fine-grained materials suspended in the water will be allowed to settle out along the flow path and any chemicals (e.g. trace amounts of residual ammonia from blasting) that may be introduced to runoff water during blasting will have time to dissipate.

Regular water samples will be collected from the SWM facility to ensure that discharge water meets the Provincial Water Quality Objectives (PWQO). A proposed monitoring program for SWM facility discharge has been presented in Section 7.5.

The SWM facility will require a MOECC Environmental Compliance Approval (ECA) prior to construction. This approval will require a Stormwater Management Report including a Water Management Plan demonstrating how the natural environment will be protected during extraction.

6.0 IMPACT ASSESSMENT

The following section identifies potential changes that the proposed quarry operations may have on surrounding private water uses, natural features, and on quarry operations. An assessment of each potential impact has been provided. Section 7.0 is dedicated to trigger mechanisms and mitigative measures for each potential adverse effect identified below.

6.1 Macro Drainage Analysis

MTE completed a macro-drainage analysis to assess the hydrologic impact of the proposed quarry on the North and South Streams. Progression of the proposed quarry as it relates to the catchment areas of the North and South Streams can be seen in Figures 14-18. Details of the macro-drainage analysis can be found in the technical memorandum presented in Appendix F.

In summary, following quarry operations the catchment area for the North Stream will decrease by 6.84 ha (1.7%) of the total catchment area with a decrease in annual volume of approximately 1.7%. The catchment area for the South Stream will increase by 6.84 ha (6.3%) of the total catchment area with an increase in annual volume of approximately 7.8% due to the increased runoff area directed to the South Stream.

Due to the incorporation of progressive rehabilitation into the mining plan, predicted changes to stream flows to both the North and South Stream are less than 8% and therefore are likely to be indistinguishable from natural season fluctuations. The increase in flow to the South Stream will be mitigated by the SWM facility. Both streams will continue to flow into the York River, with essentially the same combined contribution pre and post extraction.

6.2 Groundwater Drawdown and Zone of Influence

The effects of daily quarry extraction from below the water table were determined by completing a drawdown calculation using the Theis method. A drawdown calculation is used to estimate drawdown at certain distances away from the extraction area. This calculation allows for the estimation of a theoretical zone of influence. The details of the drawdown calculation are presented in the technical memorandum found in Appendix G.

In summary, theoretical drawdown using the Theis method was calculated for distances of 1, 100 and 500 metres from the quarry face, after each phase and 20 years following the end of quarry extraction (Phase 4). Drawdown following Phases 1, 2, 3, and 20 years after the completion of phase 4 is estimated to be limited to within 500 m and have a maximum drawdown 1 meter away from the quarry of approximately 12 m (Phase 1), 20 m (Phase 2), 27 m (Phase 3), and 35 m (20 years following Phase 4). Figures 20 through 23 present the zone of influence following the extraction of phases 1 through 3 and 20 years following the completion of phase 4. The predicted drawdown 20 years following the completion of Phase 4 is estimated to be approximately 35 m, 15 m and 0.4 m at respective distances of 1, 100 and 500 m away from the quarry edge.

MTE considers measurable drawdown to be 1 m as water levels fluctuate 1-3 m annually (Section 4.2). As such at a radial distance of 500 m from the quarry face, the drawdown was calculated to be 0.4 m, which will be indiscernible from seasonal water table fluctuations (Hydrograph 1). It is also noted that the drawdown of the water table resulting from quarrying is limited to where ground elevations are higher than the final quarry floor, which will be 337 masl, on average.

6.3 Aquifers

An aquifer is defined as a geologic deposit capable of storing and transmitting quantities of water capable for human consumption. Aquifers vary in thickness, areal extent, and geological make-up. Some aquifers are small and may only be able to supply water to one or a few households, while others are large and range in size from a few hectares to hundreds of square kilometers.

The predominant '*aquifer'* in the study area is identified as metasedimentary Precambrian bedrock. Groundwater flows through secondary porosity features, including fractures and joints in the bedrock. According to water well records on file with the MOECC the bedrock provides water to private water wells but at low yields (about 37 L/min on average – see Table 5). Groundwater flow moving towards these private wells occurs through localized vertical and horizontal fractures within the bedrock and not through the major regional faults reported in Section 3.4.

In general, the top 10 to 30 m of the bedrock is more fractured (Dillon, 2004) due to weathering by glaciations. Bedrock tends to become more competent, or dense with depth where the connectivity of the fractures is reduced. Many wells in the study area are deeper than 30 meters (47 m on average) because they encountered few shallow water bearing fractures and subsequently require a deep open borehole serving also as a reservoir capable of storing water to meet individual water needs.

The bedrock aquifer in this area is not capable of supplying, large quantities of groundwater, as evidenced not only by the results of the on-Site testing undertaken and reported herein, but also by the fact that the Town of Bancroft utilizes a Clark Lake as its potable water supply source.

Wells beyond 500 m of the Site

Those wells which are located outside of 500 m will not be affected by quarrying activities as drawdown was predicted to be negligible at this distance 20 years following the completion of Phase 4 (Appendix G). Although all monitoring private wells (PW's) with the exception of PW2 and PW13 are located outside of the 500 m zone of influence (Figure 23), continued water level measurement is recommended to ensure these wells are within historical (pre-quarry) levels (Hydrographs 3-12).

Wells within 500 m of the Site

Wells within 500m of the Site can be assessed by determining where the water bearing fractures were encountered. Cross-sections A-A' and B-B' (Figure 9 & 10) show where water bearing fractures (denoted as "*water found*") were encountered by domestic wells. The majority of the wells encountered water bearing fractures at depths below the proposed quarry floor. Several wells that were part of MTE's private well survey did not have a corresponding well record. For these wells, MTE surmised that the depth of water found was similar to the total depth of the well. As noted above, the driller would have drilled deep enough to encounter a water bearing fracture(s) capable of supplying the needs of a domestic well (i.e. 37 L/min, on average).

At depths below the proposed quarry floor, there is limited risk to water supplies regardless of distance as water bearing fractures are deeper than the quarry floor. For example, PW3 and PW13 are located within close proximity to the quarry (Figure 23) but measured groundwater elevations (Hydrograph 3) indicate that groundwater levels in these wells are below that of the proposed quarry floor and therefore will not be affected by quarry activities.

Water Bearing Zones above the Proposed Quarry Floor

PW4 is located 250 m southeast of the Site and side gradient with respect to groundwater flow. This well is shallow and only 4.57 m deep. Through the well inspection, MTE determined that this well obtains its water from a local sand and gravel aquifer and not from the underlying bedrock. Since this well obtains water from a different formation replenished from a recharge source side-gradient to the proposed quarry, their water supply will not be affected by quarrying activities.

Well 2912953 is located approximately 300 m southwest of the Site on a topographic high, upgradient with respect to groundwater flow. The maximum drawdown 20 years after the extraction of phase 4 is completed at this well is predicted to be about 9 m (Figure 23). This well has approximately 41.75 m of water column pre-quarry (Table 5) which may be lowered to 32.75 m post-quarry. This 22% reduction of available drawdown and remaining water column is interpreted by MTE to be sufficient to meet their domestic water needs. Further, since this well is located on a topographic high

(Figure 2), it is interpreted to be part of a separate local groundwater regime from the Site. The upgradient location along with the large available water column should protect this well from any adverse effect as a result of quarrying activities.

With the proposed quarry floor being above the bottom of the majority of wells within the study area combined with minimal predicted changes to post quarry infiltration, the proposed quarry will pose minimal risk to the bedrock aquifer and its ability to supply groundwater to private wells in the study area. A well complaint procedure and monitoring program is recommended to ensure private wells are protected (Section 7.1 & 7.5).

6.4 Bedrock Groundwater Flow

Flow through the bedrock groundwater system occurs through secondary porosity features, including joints and fractures, as opposed to primary porosity features (i.e. open spaces between individual grains of sand or gravel) found in unconsolidated overburden sediments. The ease at which water is transmitted through these fractures under a hydraulic gradient is dependent on the permeability or hydraulic conductivity of the bedrock. The hydraulic conductivity testing showed that the hydraulic conductivity of the bedrock is very low (geometric mean of 7.9×10^{-10} m/sec). This value means that the bedrock under the Site does not transmit groundwater readily. For example, a rock with a hydraulic conductivity of 7.9×10^{-10} m/s transmits just 25 litres of water per year for every square metre of rock under a unit hydraulic gradient, which is a very low flow rate. For a geologic unit 20 m thick, a hydraulic conductivity of 1.9×10^{-10} m/s translates into a transmissivity of just 1.4×10^{-3} m^2/d.

Another way to assess the permeability or hydraulic conductivity of the bedrock is to observe groundwater levels over time. Hydrograph 1 shows groundwater elevations measured from on-Site monitoring wells over a period of seven years. The shallow monitors were drilled 21 meters deep, on average, while the deep monitors were drilled 36 meters, on average, into the Precambrian Bedrock.

Many of the monitoring wells required an extended period of time (five months to a year on average) to reach static conditions or equilibrium. Monitoring well MW1s required almost a year to achieve static conditions, while MW1d has still not reached static conditions even after seven years. Monitoring well MW2s took approximately one month while MW2d took approximately five months to reach static conditions. In fact, MW5d is dry despite being drilled down to the same depths as the other wells seven years ago (in 2009). Observations from on-Site wells indicate that any fractures or joints that transmit groundwater through the Precambrian bedrock are discontinuous and/or not connected. All this information indicates that there is very little groundwater transmitted through the bedrock under the Site. As such, when extraction occurs on-Site, the flow of groundwater from the rock into the quarry will be very slow.

The pumping test conducted on MW7 indicated that there was a water bearing zone or fracture at or around 345 masl. When tested, this bedrock zone had a relatively higher hydraulic conductivity than the bedrock at other monitoring wells (10^{-6} m/s vs 10^{-10} m/s).

During the pumping test a decrease in water level was also noted in MW3d which is located 180 m away from MW7, likely because it is screened across the same water bearing zone or fracture. MW3d is the only well that showed a response to the testing conducted on MW7. This lack of response at other monitoring wells highlights the discontinuous and random nature of the fractures within the bedrock.

The movement of groundwater vertically was measured using monitors installed in the shallow and deep bedrock. The calculations resulted in either positive or negative gradients and are presented in Table 3. All but one monitor showed that the groundwater vertical gradient is negative across the Site, meaning that groundwater is flowing primarily downward from shallow to deep bedrock due to gravity. At one location (MW4) a positive gradient, upward flow, was observed due to artesian conditions. Both MW4s and MW4d required about 1.5 years before the flow reached the top of the PVC pipe and another three months in 2015 to reach the top of the monometer. In fact, the water level in both of these wells may still be recovering. Despite there being one variation in vertical hydraulic gradient (MW4) where upward gradients were observed, it is apparent that the rate of flow into the quarry will be very slow, particularly in the vertical direction, when extraction occurs.

6.5 Spills

As with any aggregate extraction operation, there exists the possibility of an accidental release of petroleum hydrocarbons from equipment operating on the Site. The release of petroleum hydrocarbons at the Site has the potential to enter groundwater and/or surface water courses and impact water quality. A spills plan to address the accidental release of petroleum hydrocarbons is a requirement under the ARA Operational Standards, which apply to all aggregate licenses.

6.6 Blasting

The proposed operation has the potential to introduce residual ammonia into the groundwater and surface water courses via runoff following blasting. Furthermore, there is the potential that blasting could also increase total suspended solids (TSS) in surface water bodies and courses. To avoid this, water collected in the quarry will be treated using a SWM facility before leaving the Site.

6.7 Streams, Rivers, Lakes and Ponds

Streams

The Site makes up 2% of the catchment area for the North Stream and 24% of the catchment area for the South Stream. The Macro-Drainage Analysis (Section 7.1) showed that the flows to the North Stream will decrease annually by approximately

1.7% (~1 L/sec) post extraction, while the flows to the South Stream will increase by approximately 7.8% (~1.4 L/sec). Since these changes are small, the hydrologic regimes of both streams will not be negatively impacted, especially since both streams drain into the York River in relatively close proximity with a near neutral combined flow rate pre and post quarry extraction. Any increase in flow to the South Stream will be mitigated by the SWM facility. The outlet to the SWM facility has been designed to discharge water at a rate that will mimic pre-quarry conditions. As such, there is no potential for the small increase in flows to cause erosion impacts downstream.

In addition to mitigating increased flows to the South Stream, the SWM facility will also function to ensure no negative impacts to water quality leaving the Site. The SWM facility will treat quarry water prior to discharge to the South Creek, and will require MOECC approval so that any potential water quality impacts will be mitigated.

On-Site depressed storage areas will create habitat for local amphibian species native to the Site as outlined in the Natural Environment Level 1 and 2 Technical Report by Robin Craig.

There will be no discharges of quarry water to the North Stream. As such, there is no potential for the proposed quarry to affect the water quality or quantity of the North Stream.

Rivers

A stretch of the York River falls within the study area, to the northeast of the Site (Figure 2). Since the North and South Streams drain into the York River, potential changes to water quantity and quality of runoff entering the York River were addressed above.

The York River also potentially receives inputs via groundwater recharge along its base and banks, which were identified in Section 2.4. Since there are no significant groundwater recharge zones on-Site, the proposed quarry will not negatively impact the quantity of groundwater that may enter this stretch of the York River. There is a groundwater recharge zone adjacent to the Site in the existing gravel pit (ARA License No. 624804) but this area is not part of the application and will not be affected by the proposed quarry. Groundwater will continue to infiltrate as it has, post-extraction.

Lakes

The closest lake is Spurr Lake, which lies approximately 850 m south of the Site at an elevation of approximately 356 mAMSL. There are also seven additional lakes outside of the study area; L'Amable Lake, Tammarack Lake, West Mullet Lake, Bay Lake, Jeffery Lake, Marble Lake and Banner Lake, which are approximately between 1.5 and 2.5 km away. At this distance, these lakes are outside of the zone of influence for the proposed quarry. The extent of the zone of influence as it relates to Sprurr Lake is shown on Figure 23.

In addition, geological cross-section B-B (Figure 10) shows a topographical divide separating the Site and Spurr Lake that prevents runoff from the Site from interacting with runoff entering Spurr Lake. As such, the Site is outside the surface water catchment area of Spurr Lake.

Ponds

Field reconnaissance identified three small ponds (i.e. a temporary pool of water) on the Site (see Photos 4 through Photo 8 – Appendix A). The first pond was found in the west central portion of the Site near MW3 and the second and third near the southwest boundary at MW4. These ponds occur at the base of small closed topographic depressions where surface water pools.

These ponds will be removed during Phases 2 and 3 of the proposed quarry operation. Given their small size and the fact that they are situated on bedrock with very low permeability, they are not deemed significant groundwater recharge features. Further, the Natural Environment Report (Robin Craig, 2016) indicated that these ponds are not deemed significant wildlife habitat.

6.8 Groundwater Springs

During field reconnaissance, MTE staff observed no groundwater seeps or springs on-Site.

As a result of the low hydraulic conductivity of the metasedimentary rock the proposed quarry will primarily have to manage water ponding on-Site as a result of precipitation. Precipitation and any captured groundwater will be directed to the SWM facility prior to treatment and being discharged to the South Stream.

6.9 Wellhead Protection Areas (WHPAs)

Upon investigation MTE notes that there are no source water protection areas mapped in proximity to the Site. The closest WHPA is in the Town of Cardiff approximately 14 km west of the Site. As a result of measureable drawdown being confined to 500 m of the Site and because this WHPA is far removed from the Site, there is no potential for quarry operations to impact this WHPA.

6.10 Groundwater Recharge and Vulnerability

As previously mentioned, there are no significant groundwater recharge zones on-Site, There is a groundwater recharge zone adjacent to the Site in the existing gravel pit (ARA License No. 624804). Groundwater will continue to infiltrate as it has, post-extraction. Since this area is already operating as a gravel pit, the proposed quarry will not change the vulnerability of this recharge area because aggregate extractions are not deemed a "*significant threat*" to source water (Trent Source Protection Plan, 2015).

7.0 MITIGATIVE MEASURES

A limited number of potential adverse effects have been identified in Section 6. The following describes details for mitigative measures to those potential adverse effects.

7.1 Well Interference Complaints Procedure

All existing water wells are protected under the Ontario Water Resources Act, with the intent that groundwater is a resource to be shared by everyone. Should a well experience an interference[2] then the person (or organization) responsible for the interference is responsible for returning the groundwater supply to its former condition or providing an alternative suitable water supply. The following describes a proposed contingency plan that can be executed if a groundwater interference is observed during activities at the Freymond Quarry. Based on the proposed operation and the nature of private wells in the study area, there is a very low risk of any private well interference occurring as a result of the proposed quarrying operations.

Response Procedures:

1) Private well owners experiencing disruption or quality problems shall immediately notify Freymond. Upon receipt of any water supply disruption compliant, Freymond shall notify the MOECC.
2) Should the owner of an existing private water supply experience well interference; and the quarry cannot be immediately excluded as the cause, Freymond shall supply each affected well with a temporary water supply within 24 hours of notification, and thereafter until such time as the cause of the disturbance can be determined and the situation addressed. Freymond shall investigate the cause of the interference compliant through the servicing of an independent qualified professional and shall report to the MOECC, and the affected party.
3) If, after consultation with the affected party and Freymond, the MOECC determines that below water table extraction at the quarry has caused an adverse effect at the well in question, Freymond shall, at their expense, either restore or replace the affected water supply to ensure that historic water supply and/or water quality are restored.
4) If the MOECC have determined that the quarry has not caused the adverse effect to the well in question, then Freymond shall document the results of the investigation and submit a copy the affected party and the MOECC for future reference.

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[2] A "*well interference*" is an unacceptable reduction in groundwater quantity and/or degradation in water quality.

7.2 Bedrock Groundwater and Quarry Operations

As previously mentioned, analytical modeling predicted a zone-of-influence with a maximum radial distance of 500 m from the quarry face. Throughout the life of the quarry, the zone-of-influence will be monitored using on-Site monitoring wells and the Private Well Monitoring Program. The results of these monitoring programs will ensure that groundwater resources are protected while the quarry proceeds. Based on the proposed operation and the nature of bedrock under the Site, there is a very low risk to groundwater resources.

7.3 Spills Plan

As per Condition 3.5 of the Aggregate Resources Act Provincial Standards, a spills plan will be prepared.

7.4 Groundwater and Surface Water Discharge

During extraction, precipitation and groundwater collected in the quarry will be intercepted by a drainage collection swale and re-directed to a SWM facility where fines and other potential contaminants introduced during blasting and quarrying will be allowed to settle or be removed. The collected water will then be discharged in a controlled manner into the South Stream at the southeastern corner of the Site.

Flows to the South Stream are expected to increase by approximately 1.4 L/s due to an increase in runoff from the Site. This flow increase is not anticipated to cause an adverse effect on either the South Stream or the York River into which the South Stream drains.

7.5 Monitoring Program

The following describes the proposed monitoring program that can be used on-Site to ensure surface water and groundwater resources are protected while the quarry proceeds.

Groundwater Monitoring:

1. On-Site monitoring wells shall be monitored on a monthly basis for the months the quarry is in operation for at least two years after operations commence.
2. The results of the groundwater monitoring shall be presented in an annual report. This report shall be submitted to the MNRF and MOECC by March 31 of each calendar year. The report shall present and interpret the results of the groundwater monitoring as it relates to the development of the quarry and shall be prepared by a Qualified Person (i.e. an independent hydrogeologist).
3. After two years of operations and annual reporting, the groundwater monitoring program may be reviewed and revised if necessary.

4. Changes to the groundwater monitoring program will require written sign-off from the MOECC and the MNRF after their review of the annual reports.

Private Well Monitoring:

1. Private wells of residents participating in the Private Well Monitoring Program, shall be monitored monthly during the months of quarry operation, so long as the private well remains readily and safely accessible, and that the owner of any private well currently in the monitoring program continues to grant permission to monitor their well; and
2. The results of the private well monitoring shall be included in the annual groundwater reports.

SWM Monitoring:

1. An ECA will be required from the MOECC prior to the constriction of the SWM facility;
2. The ECA is required to regulate and ensure proper construction and performance of the facility; and
3. Monitoring of the SWM facility will be conducted in accordance to the ECA requirements set out by the MOECC.

8.0 REQUIRED PERMITS

As previously mentioned in Section 1.1, this Level 1/2 Report can be used to provide technical support of applications for:

1) Environmental Compliance Approvals (ECA) for periodic discharge of water to watercourses.

The SWM facility will provide water quality treatment and peak flow attenuation before stormwater re-enters the natural environment. The SWM facility will require a MOECC ECA prior to construction. This approval will require a Stormwater Management Report including a Water Management Plan demonstrating how the natural environment will be protected during extraction.

Given the current mining plan, which incorporates dewatering the Site via gravity drainage without active pumping, a PTTW will not be required to maintain dry working conditions in the proposed quarry. All water management will be accomplished through a gravity driven process where water collected as runoff and groundwater will be diverted using the techniques described in Section 5.2 and then to a SWM facility.

9.0 CONCLUSIONS

Based on the hydrogeological investigation, MTE Consultants Inc. offers the following conclusions:

- The Site is predominately a Precambrian bedrock knoll that peaks in elevation at 392 mAMSL in the west portion of the Site and falls sharply to 335 mAMSL at the eastern Site boundary.
- There are no surface water bodies or water courses on Site.
- There are no springs on the Site.
- There are three ponds on the Site that are not deemed significant habitat nor groundwater recharge features.
- There are no significant groundwater recharge zones on the Site.
- There are no Wellhead Protection Areas (WHPA) on the Site or in the Study area.
- There are no faults mapped on the Site.
- Water levels measured from the monitoring wells showed that groundwater naturally fluctuates vertically seasonally between ~1-3 metres.
- Groundwater flow in the shallow and deep bedrock groundwater systems generally mimic each other and flows northeast towards the York River. A horizontal hydraulic gradient of 0.04 m/m was calculated for the shallow bedrock and a horizontal hydraulic gradient of 0.08 m/m was calculated for the deeper bedrock.
- With an average quarry floor elevation of 337 mAMSL, the proposed quarry will be about 30 m below the water table.
- Groundwater moves primarily downward from the shallow bedrock to the deep bedrock across the Site. At MW4, low pressure artesian conditions were observed where the vertical hydraulic gradient is upward.
- Well tests showed that the bedrock has a low permeability and porosity.
- Hydraulic conductivity testing showed that the permeability of the bedrock is very low (7.9×10^{-10} m/s on average). This value means that the bedrock under the Site does not transmit groundwater readily.
- The groundwater flow rate through the bedrock was estimated to be 25 litres of water per year for every square metre of rock under a unit hydraulic gradient which is a very low flow rate.
- In 2010 a total of 20 well inventories were delivered with seven being returned to MTE. A total of six drilled wells and one dug well were reported. Of the seven private wells, four agreed to be part of the Private Well Monitoring Program (PW3, PW5, PW8 & PW9).
- Cross-sections A-A and B-B indicated that the majority of wells in the study area are completed at depths below the quarry floor or in a different geological formation (i.e. sand and gravel overburden or calcitic marble) than the rock proposed to be quarried.

- Following the Public Open House on June 25, 2015 hosted by Freymond, eight other residents expressed interest in participating in the Private Well Monitoring Program. In January 2016, MTE inspected each of these wells and a total of five drilled wells and three dug well were added to the Private Well Monitoring Program. These wells include PW7 and PW11 through PW15.
- The measureable zone-of-influence (1 m of drawdown) that will be created at 20 years following the conclusion of extraction is predicted to extend approximately 500 metres from the upgradient quarry face.
- With the proposed quarry floor located above the depth of the majority of domestic wells within the study area combined with minimal predicted changes to post quarry infiltration, the proposed quarry will pose minimal risk to the bedrock aquifer and its ability to supply groundwater to private wells in the study area.
- Provided the recommendations outlined in Section 10.0 are designed, implemented, and maintained, MTE does not anticipate any adverse effects to groundwater/surface water resources during operation of the proposed Freymond Quarry.

10.0 RECOMMENDATIONS

In order to address any adverse effects to groundwater/surface water resources during operation of the proposed Freymond Quarry, MTE recommends the following mitigation measures be implemented:

- A well interference response plan as per Section 7.1;
- A spills Plan as per Section 7.3;
- A monitoring Program as per Section 7.5; and
- Design a SWM facility and obtain an MOECC ECA prior to discharging water from the quarry as per Section 8.0.

11.0 LIMITATIONS

Services performed by **MTE Consultants Inc.** (MTE) were conducted in a manner consistent with the level of care and skill ordinarily exercised by members of the Environmental Engineering & Consulting profession. No other warranty or representation expressed or implied as to the accuracy of the information, conclusions or recommendations is included or intended in this report.

This report was completed for the sole use of MTE and the client. It was completed in accordance with the Scope of Work referred to in Section 1.1. As such, this report may not deal with all issues potentially applicable to the Site and may omit issues, which are or may be of interest to the reader. MTE makes no representation that the present report has dealt with any and all of the important features, including any or all important environmental features, except as provided in the Scope of Work. All findings and conclusions presented in this report are based on Site conditions as they existed during the time period of the investigation. This report is not intended to be exhaustive in scope or to imply a risk-free facility.

Any use which a third party makes of this report, or any reliance on, or decisions to be made based upon it, are the responsibility of such third parties. MTE accepts no responsibility for liabilities incurred by or damages, if any, suffered by any third party as a result of decisions made or actions taken, based upon this report. Others with interest in the Site should undertake their own investigations and studies to determine how or if the condition affects them or their plans.

It should be recognized that the passage of time may affect the views, conclusions and recommendations (if any) provided in this report because environmental conditions of a property can change. Should additional or new information become available, MTE recommends that it be brought to our attention in order that we may re-assess the contents of this report.

Respectfully Submitted,

MTE CONSULTANTS INC.

Fraser Cummings, M.Sc, G.I.T
Environmental Scientist

Jay Flanagan, B.E.S, B.Ed.,
Project Manager

Peter A. Gray, P.Geo., QP_{ESA}
VP, Senior Hydrogeologist

FTC:clt

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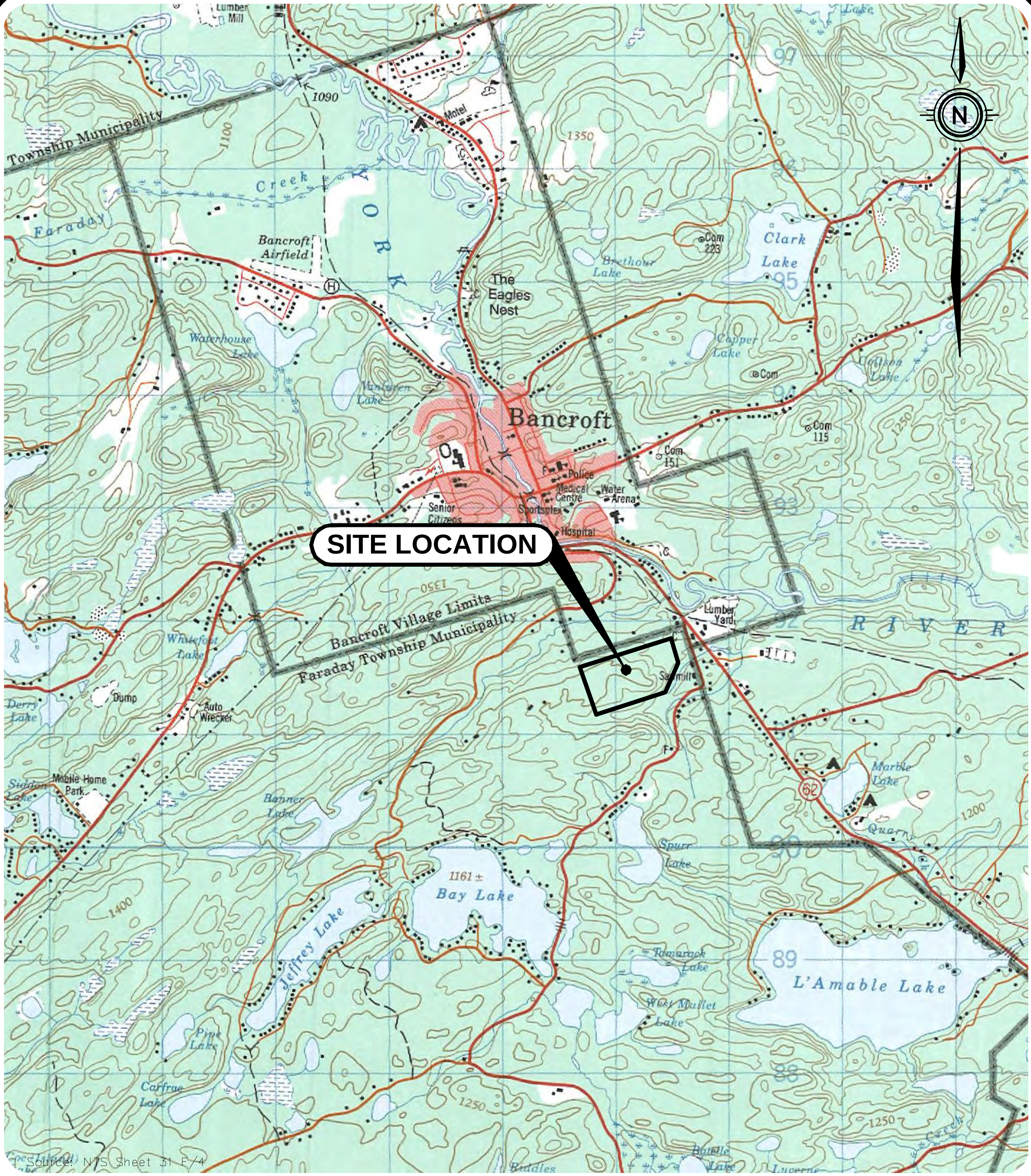
FIGURES



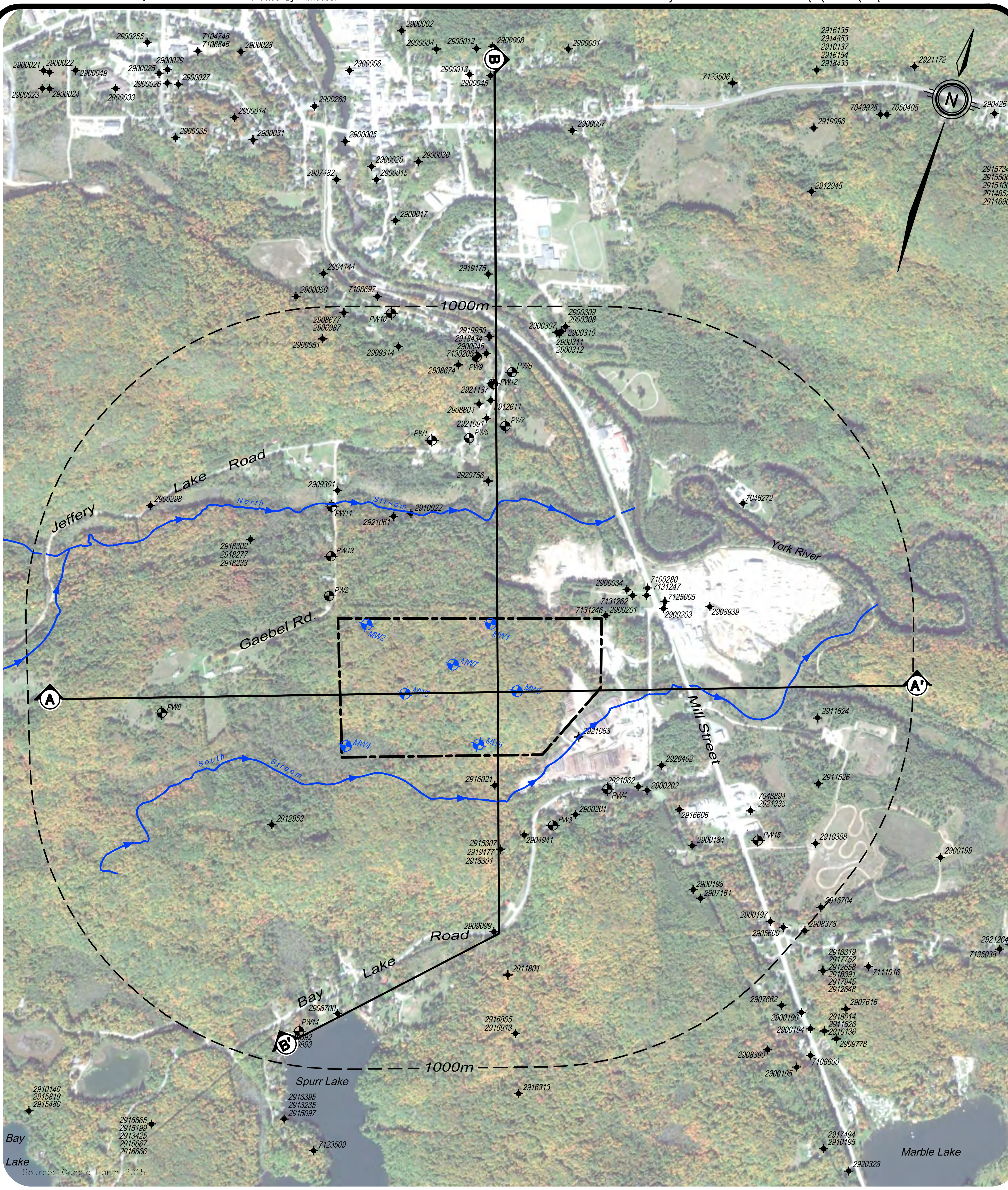
SITE MAP

Engineers | Scientists | Surveyors

Project Name			
Freymond Proposed Quarry			
Site		**Client**	
Bancroft, Ontario		Freymond Lumber Limited	
Scale.	**MTE Project No.**	**Date**	**Figure No.**
1:50,000	33886-100	December 2016	1

February 12, 2016 – 8:44 a.m. – Plotted By: kmadsen EV1.1 Project: 33886-100 CAD: P:\P\33886\EV\33886-100-EV1.DWG

November 11, 2016 — 9:48 a.m. — Plotted By: kmadsen EV7.2 Project: 33886-100 CAD: P:\P\33886\EV\33886-100-EV7.DWG



LEGEND

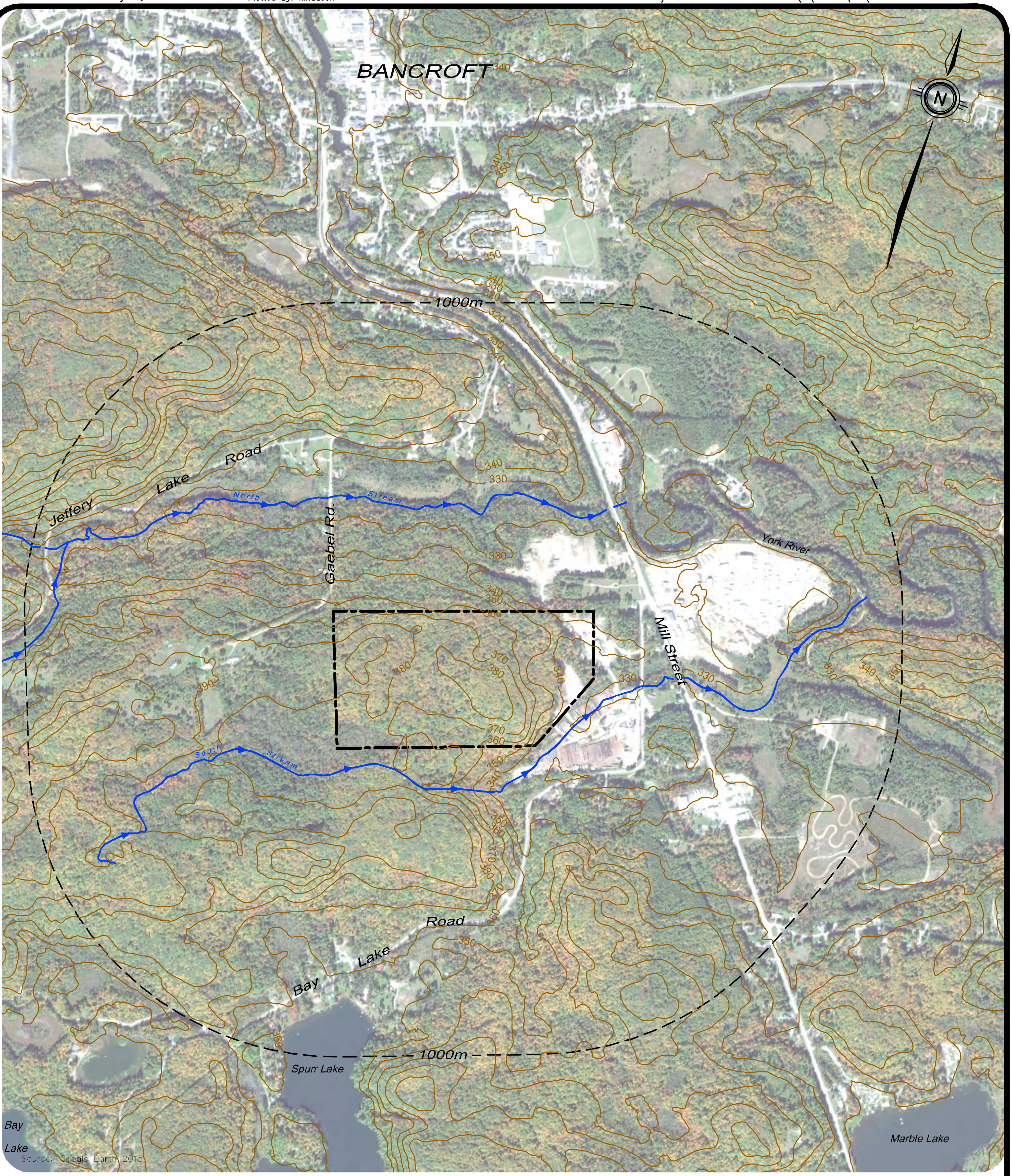
- Monitoring Well
- MOECC Well Location
- Private Well Monitoring Location
- Section Location

0 125 250 375 500 625m
1:12500

STUDY AREA MAP

MTE Engineers | Scientists | Surveyors

Project Name			
Freymond Proposed Quarry			
Site: Bancroft, Ontario		Client: Freymond Lumber Limited	
Scale (11x17): 1:12,500	MTE Project No.: 33886-100	Date: December 2016	Figure No.: 2



LEGEND

OBM Contours

0 125 250 375 500 625m
1:12500

TOPOGRAPHY

MTE Engineers | Scientists | Surveyors

Project Name			
Freymond Proposed Quarry			
Site: Bancroft, Ontario		Client: Freymond Lumber Limited	
Scale (11x17): 1:12,500	MTE Project No.: 33886-100	Date: December 2016	Figure No.: 3

Project: 33886-100 CAD: P:\P\33886\EV\33886-100-EV21.DWG

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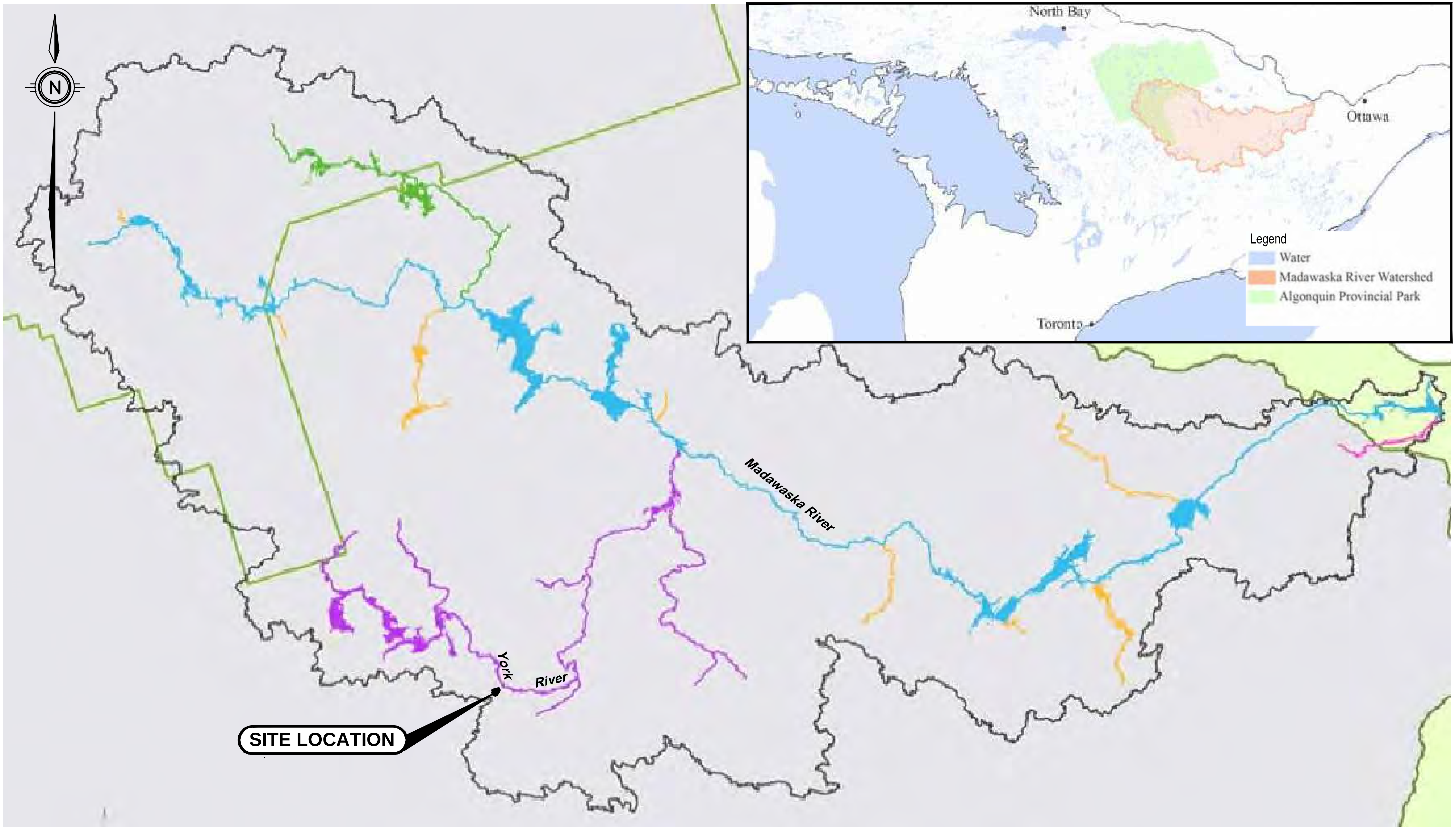

EcoZone
Canadian Sheild
Ottawa Valley Plains

MTE
Engineers | Scientists | Surveyors

MADAWASKA WATERSHED

Project Name: Freymond Proposed Quarry			
Site: Bancroft, Ontario		Client: Freymond Lumber Limited	
Scale: 1:500,000	MTE Project No.: 33886-100	Date: December 2016	Figure No.: 4

Project: 33886-100 CAD: P:\P\33886\EV\33886-100-EV20.DWG

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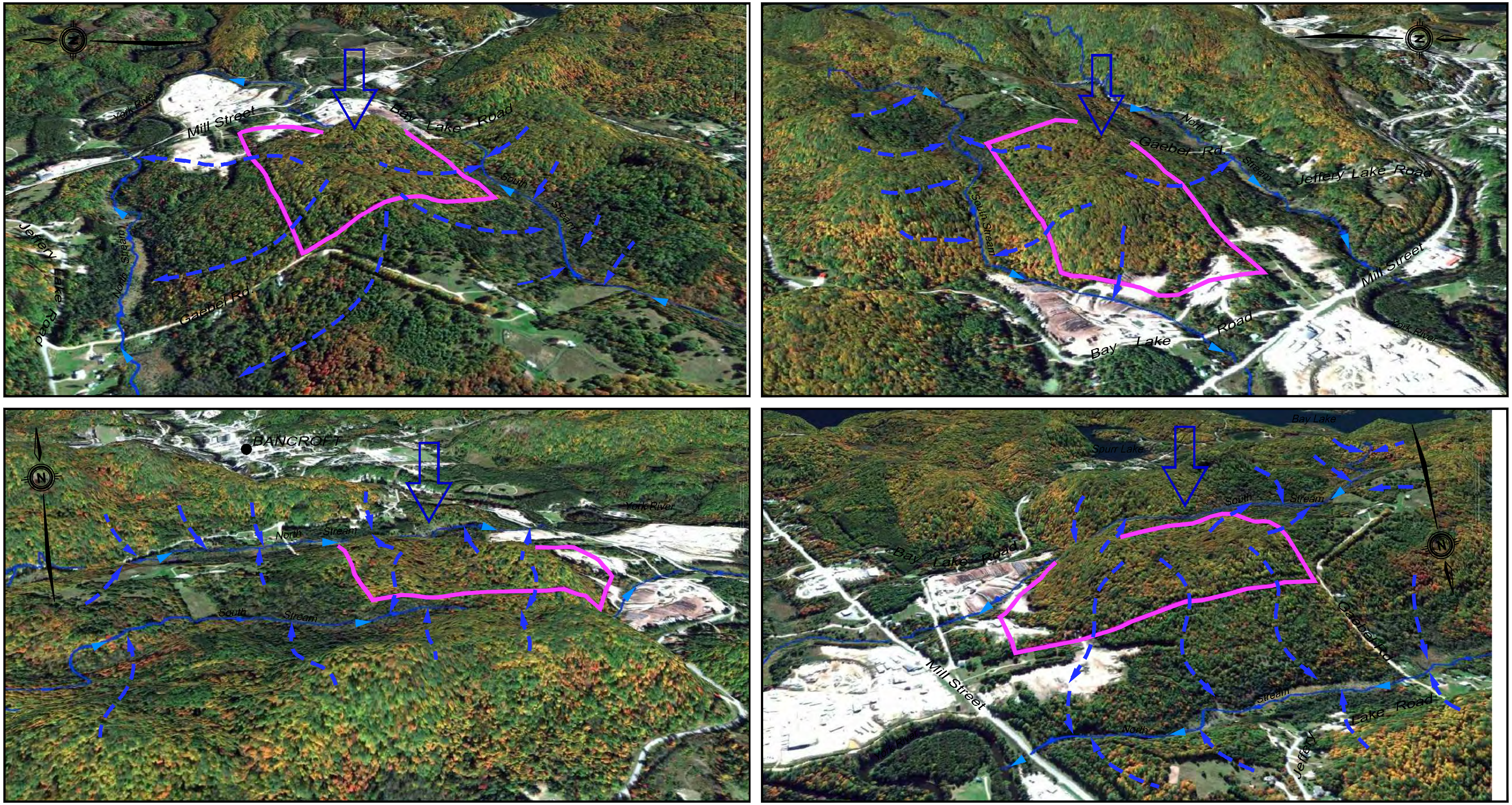


LEGEND

Pricipitation

Runoff

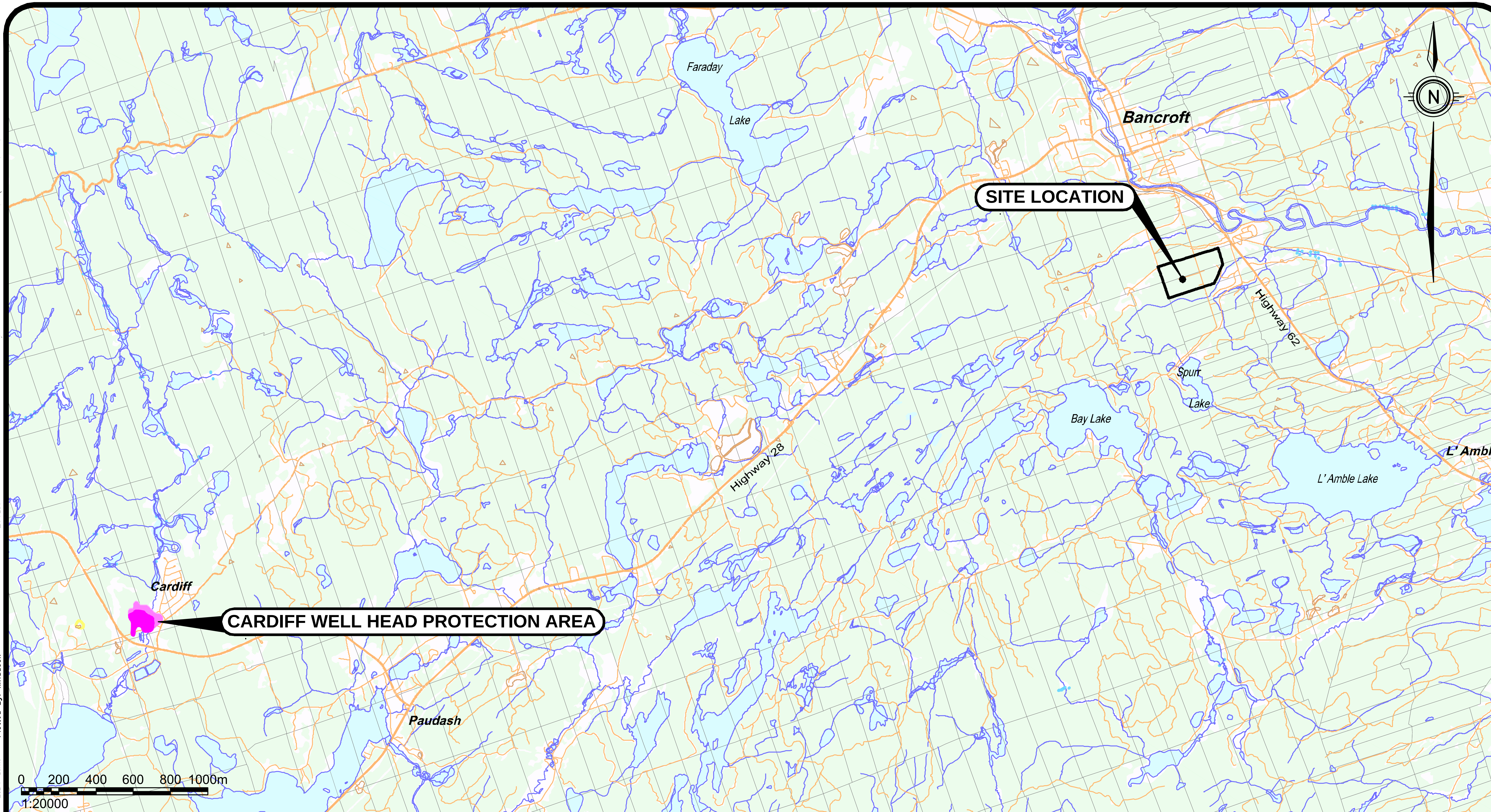
Source: Google Earth 2013.

CONCEPTUAL MODEL

MTE Engineers | Scientists | Surveyors

Project Name	
Freymond Proposed Quarry	
Site	Client
Bancroft, Ontario	Freymond Lumber Limited

Scale	MTE Project No.	Date	Figure No.
NTS	33886-100	December 2016	5



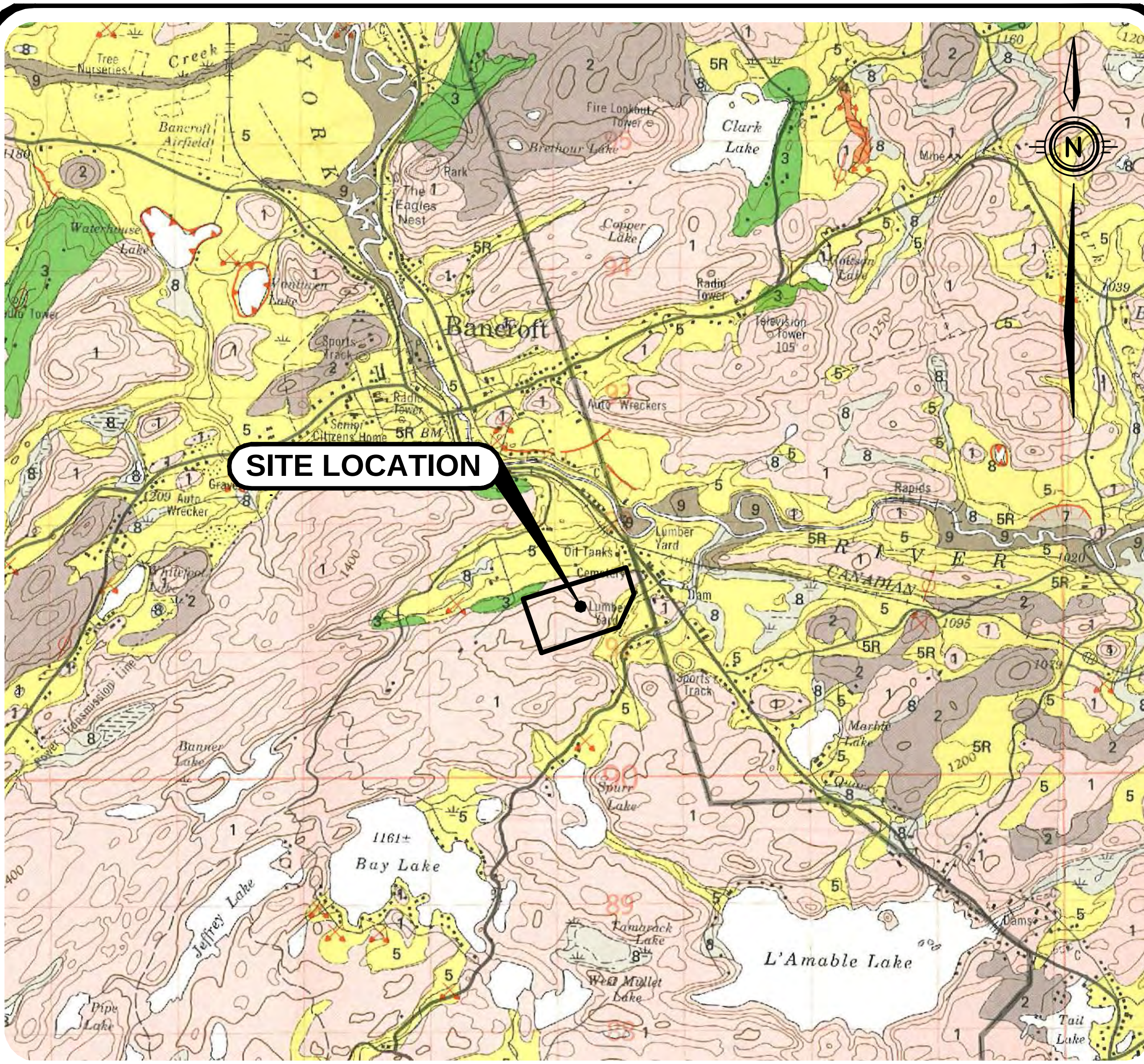
EV18.1

February 12, 2016 — 8:54 a.m. — Plotted By: kmadsen

MTE
Engineers | Scientists | Surveyors

WELLHEAD PROTECTION AREAS

Project Name			
Freymond Proposed Quarry			
Site		Client	
Bancroft, Ontario		Freymond Lumber Limited	
Scale (11x17)	MTE Project No.	Date	Figure No.
1:20,000	33886-100	December 2016	6



LEGEND

- **1** Pre-Cambrian Bedrock
- **2** Drift - Bedrock Complex
- **3** Till: Silty to sandy; Stony
- **4** Glaciofluvial ice contact Deposits
- **5** Glaciofluvial outwash and deltaic deposits
- **8** Bog and swamp deposits
- **9** Modern Alluvium

For symbol definitions refer to OGS Map 2500 or 1: 50 000 National Topographic System. For subgroup descriptions, refer to OGS Map 2500

QUATERNARY GEOLOGY

MTE Engineers | Scientists | Surveyors

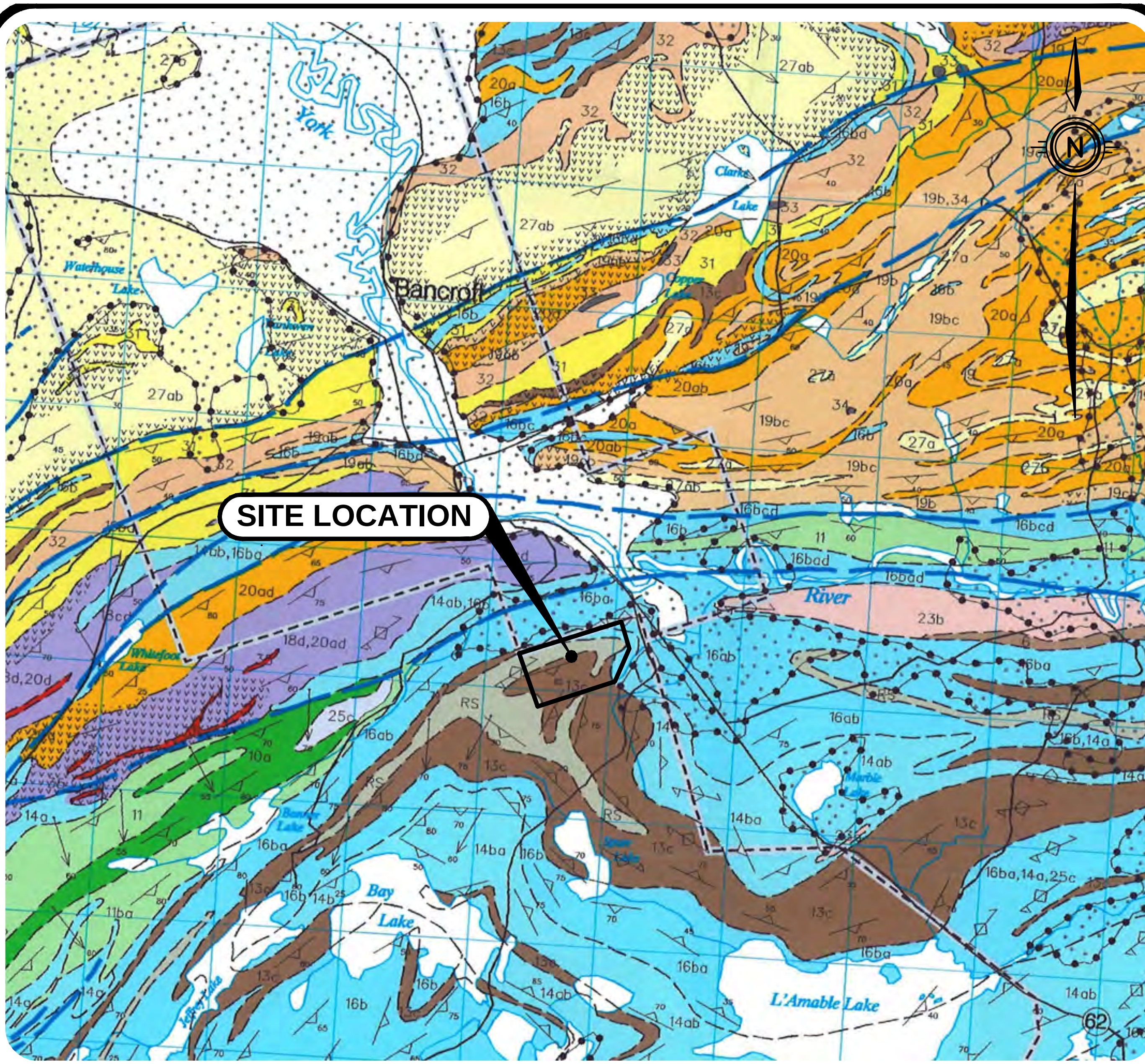
Project Name			
Freymond Proposed Quarry			
Site: Bancroft, Ontario		Client: Freymond Lumber Limited	
Scale: 1:50,000	MTE Project No.: 33886-100	Date: December 2016	Figure No.: 7

February 12, 2016 – 8:58 a.m. – Plotted By: kmadsen EV1.2 Project: 33886-100 CAD: P:\P\33886\EV\33886-100-EV1.DWG

Project: 33886-100 CAD: P:\P\33886\EV\33886-100-EV1.DWG

EV1.3

December 1, 2016 — 3:54 p.m. — Plotted By: kmadsen



LEGEND

10	Mafic Metavolcanic Rocks
11	Felsic Metavolcanic Rocks
13	Amphibole rich Metasedimentary Rocks
14	Dolomitic Marble
16	Calcitic Marble Medium to High Metamorphic Grade
18	Mafic Alkalic Rocks
19	Nepheline Syenite
20	Alkalic Syenite
23	Trondhjemite and Granodiorite
27	Felsic Intrusive Rocks
31	Fenite
32	Fenite
35	Late Pegmatite
RS	Rusty-weathering, graphitic pyrite and pyrrhotite -bearing schist
— —	Fault

For symbol definitions refer to OGS Map 3385 or 1: 50 000 National Topographic System. For subgroup descriptions, refer to OGS Map P. 3385

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Engineers | Scientists | Surveyors

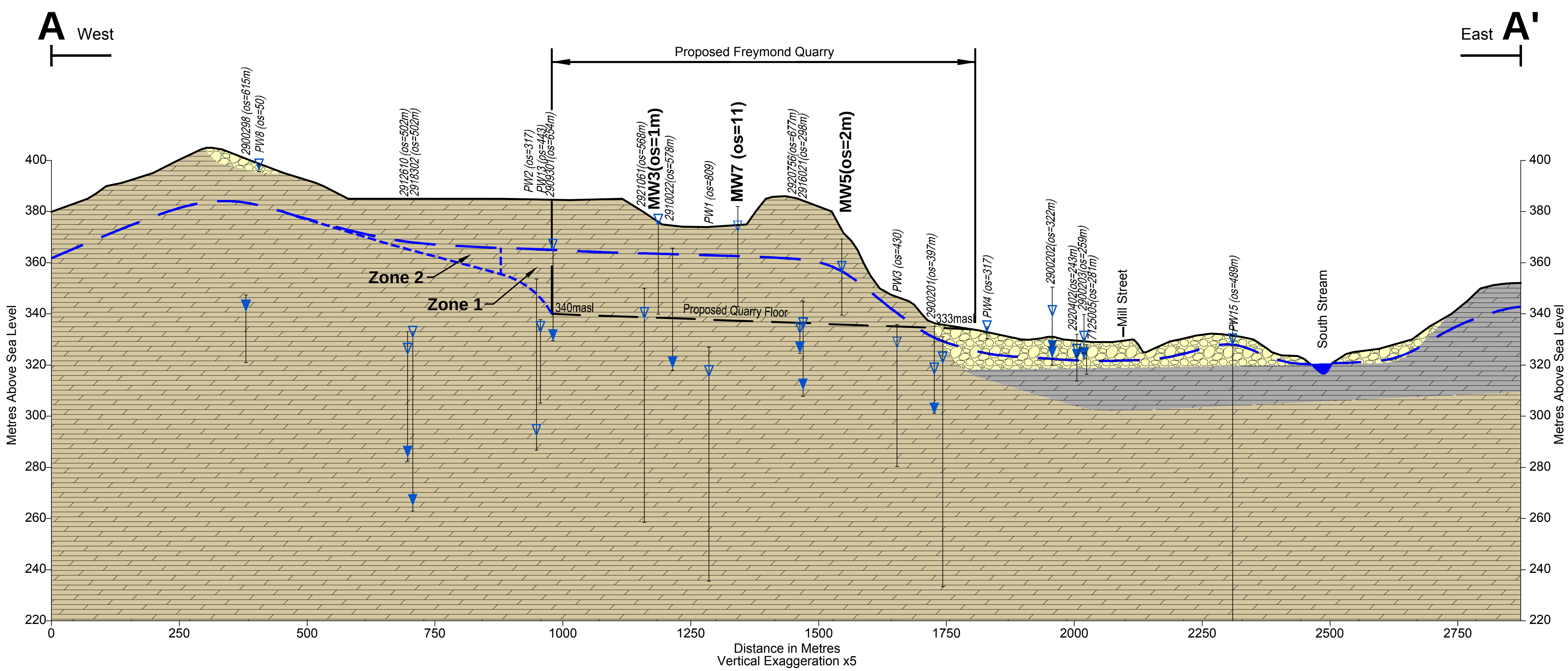
PRECAMBRIAN GEOLOGY

Project Name			
Freymond Proposed Quarry			
Site		**Client**	
Bancroft, Ontario		Freymond Lumber Limited	
Scale	**MTE Project No.**	**Date**	**Figure No.**
1:50,000	33886-100	December 2016	8

Project: 33886-100 CAD: P:\P\33886\EV\33886-100-EV7.DWG

EV7.3

November 11, 2016 — 9:50 a.m. — Plotted By: kmodsen



LEGEND

Glaciofluvial Outwash - Sand and Gravel

Calcitic Marble

Metasedimentary Rock

Interpreted Water Table Surface

Static Water Level

Water Found

2920756 (os=27m) MOECC Well Identification No. and offset (m)

Private Well

Zone 1 - 100m 7-12m Predicted Drawdown

Zone 2 - 500m 1-7m Predicted Drawdown

MTE Engineers | Scientists | Surveyors

GEOLOGICAL CROSS-SECTION A-A'

Project Name			
Freymond Proposed Quarry			
Site: Bancroft, Ontario		Client: Freymond Lumber Limited	
Scale (11x17)	MTE Project No.	Date	Figure No.
1:10,000	33886-100	December 2016	9

Project: 33886-100 CAD: P:\P\33886\EV\33886-100-EV7.DWG
EV7.4
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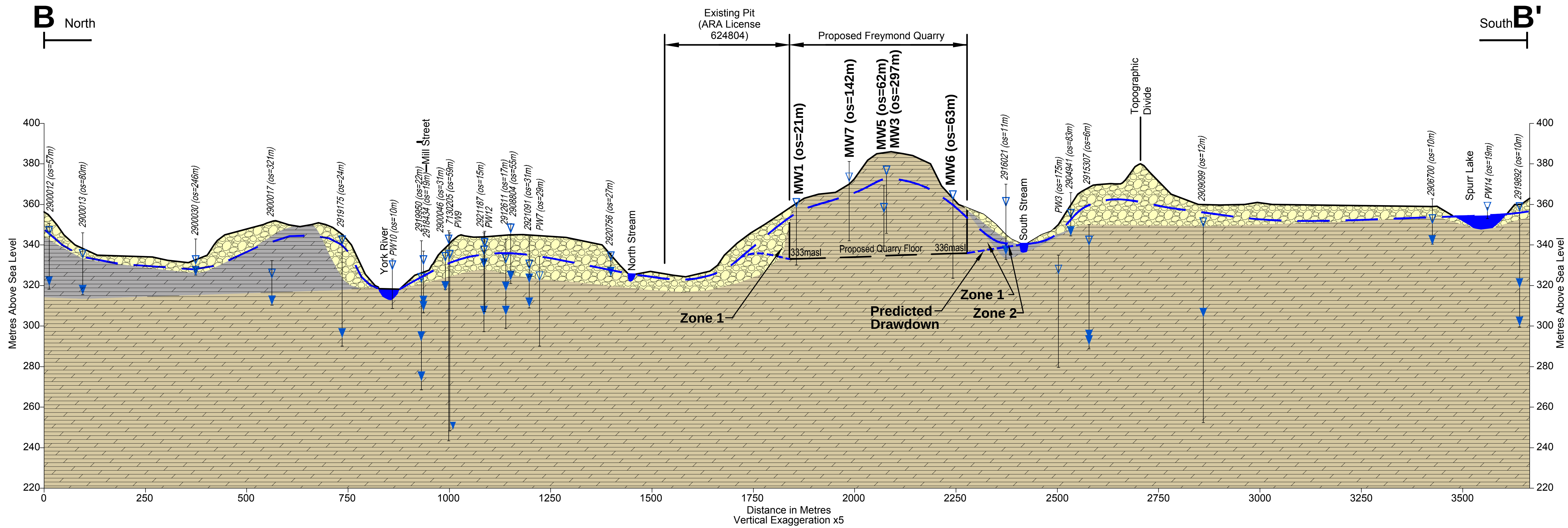


LEGEND

Glaciofluvial Outwash - Sand and Gravel	Interpreted Water Table Surface
Calcitic Marble	Static Water Level
Metasedimentary Rock	Water Found

2920756 (os=27m) — MOECC Well Identification No. and offset (m)

Private Well

Zone 1 - 100m 7-12m Predicted Drawdown

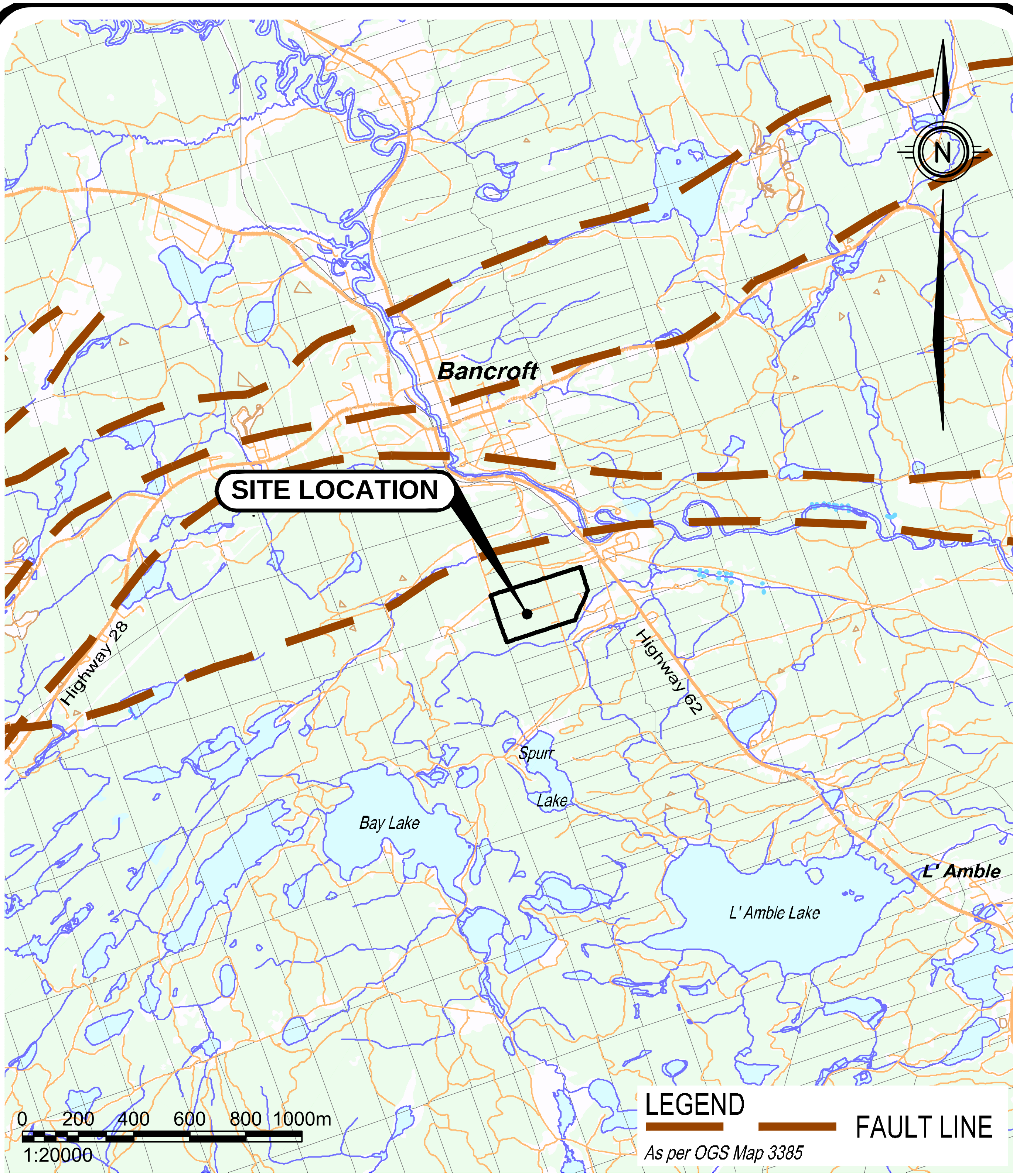
Zone 2 - 500m 1-7m Predicted Drawdown

MTE
Engineers | Scientists | Surveyors

GEOLOGICAL CROSS-SECTION B-B'

Project Name	
Freymond Proposed Quarry	
Site	Client
Bancroft, Ontario	Freymond Lumber Limited

Scale (11x17)	MTE Project No.	Date	Figure No.
1:10,000	33886-100	December 2016	10



FAULT LINES

MTE
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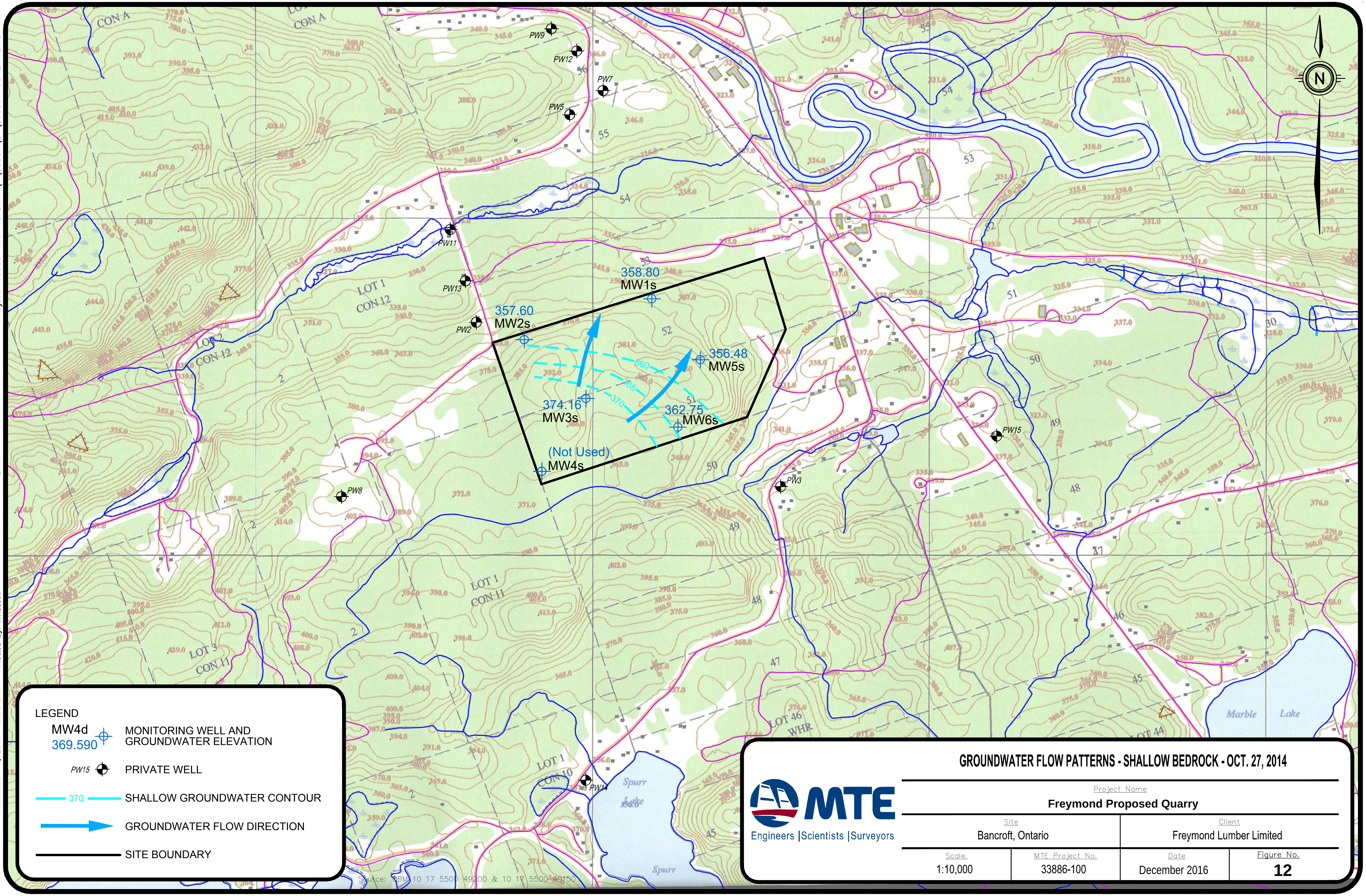
Project Name			
Freymond Proposed Quarry			
Site		Client	
Bancroft, Ontario		Freymond Lumber Limited	
Scale (8.5x11)	MTE Project No.	Date	Figure No.
1:20,000	33886-100	December 2016	11

Project: 33886-100 CAD: P:\P\33886\EV\33886-100-EV4.DWG

EV4.1

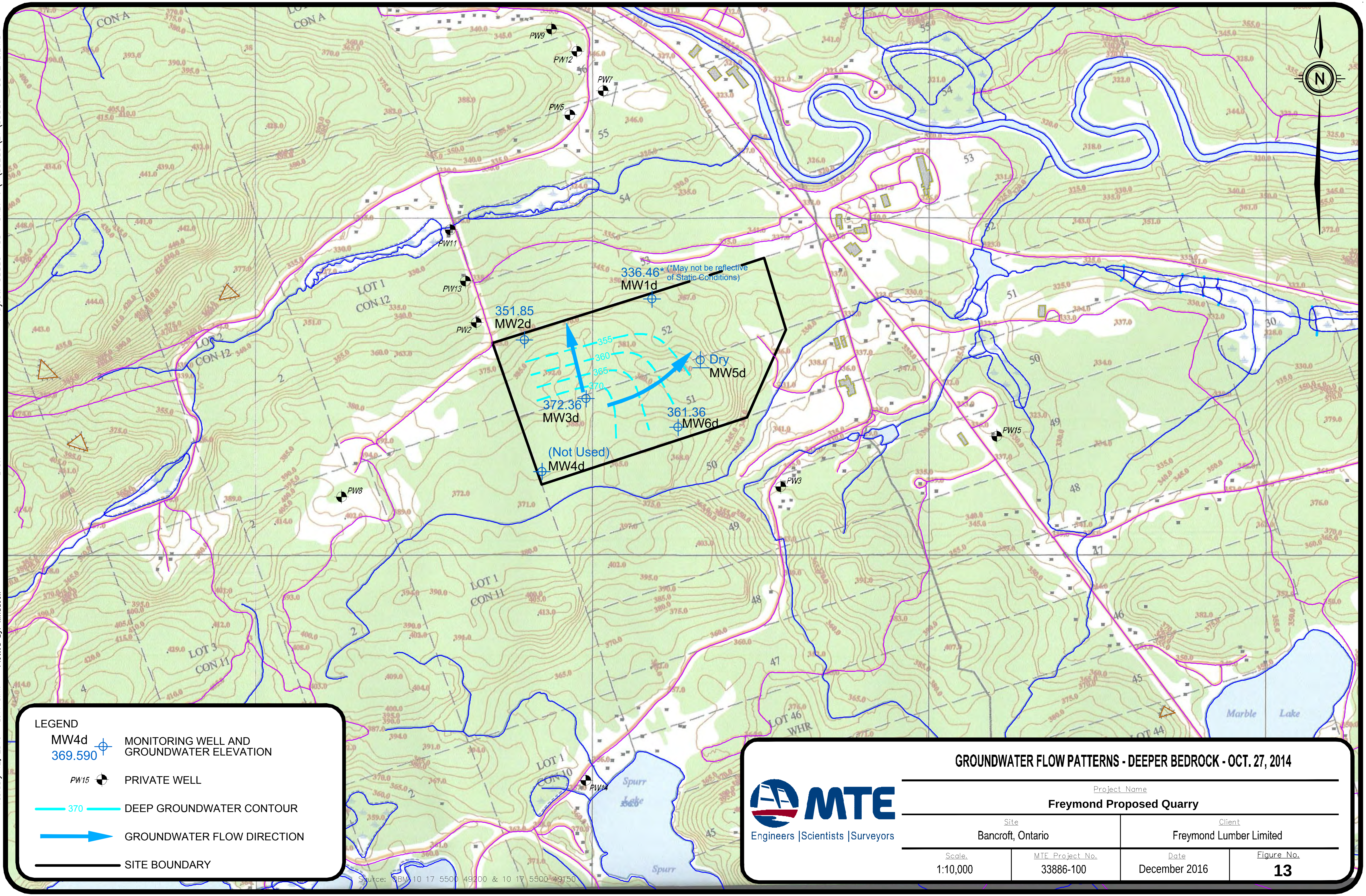
November 11, 2016 – 9:53 a.m. – Plotted By: kmadsen



GROUNDWATER FLOW PATTERNS - SHALLOW BEDROCK - OCT. 27, 2014

MTE
Engineers | Scientists | Surveyors

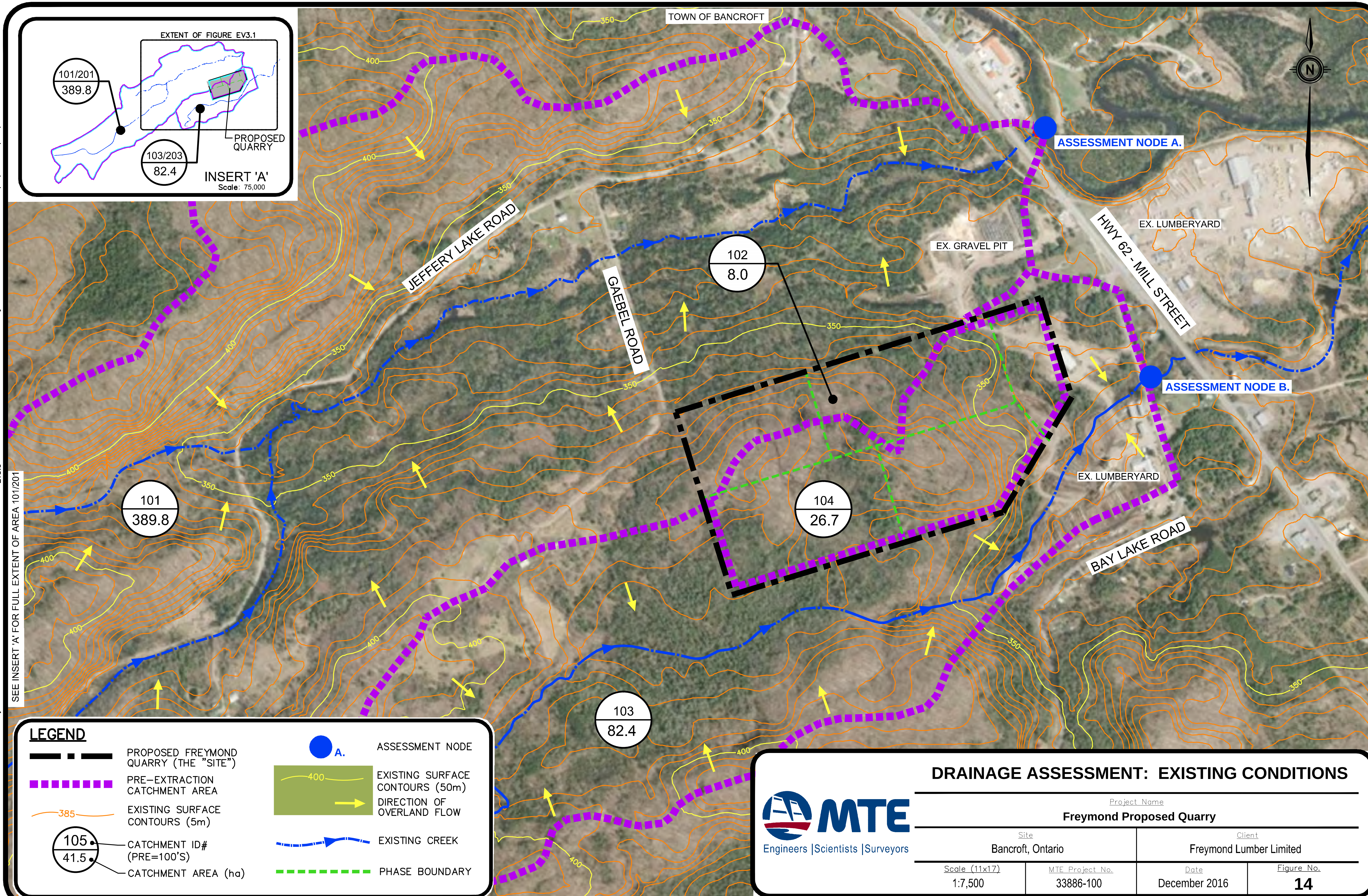
Project Name: Freymond Proposed Quarry			
Site: Bancroft, Ontario		Client: Freymond Lumber Limited	
Scale: 1:10,000	MTE Project No.: 33886-100	Date: December 2016	Figure No.: 12



Project: 33886-100 CAD: P:\P\33886\EV\33886-100-EV5.DWG

EV5.1

February 12, 2016 – 9:41 a.m. – Plotted By: kmadsen



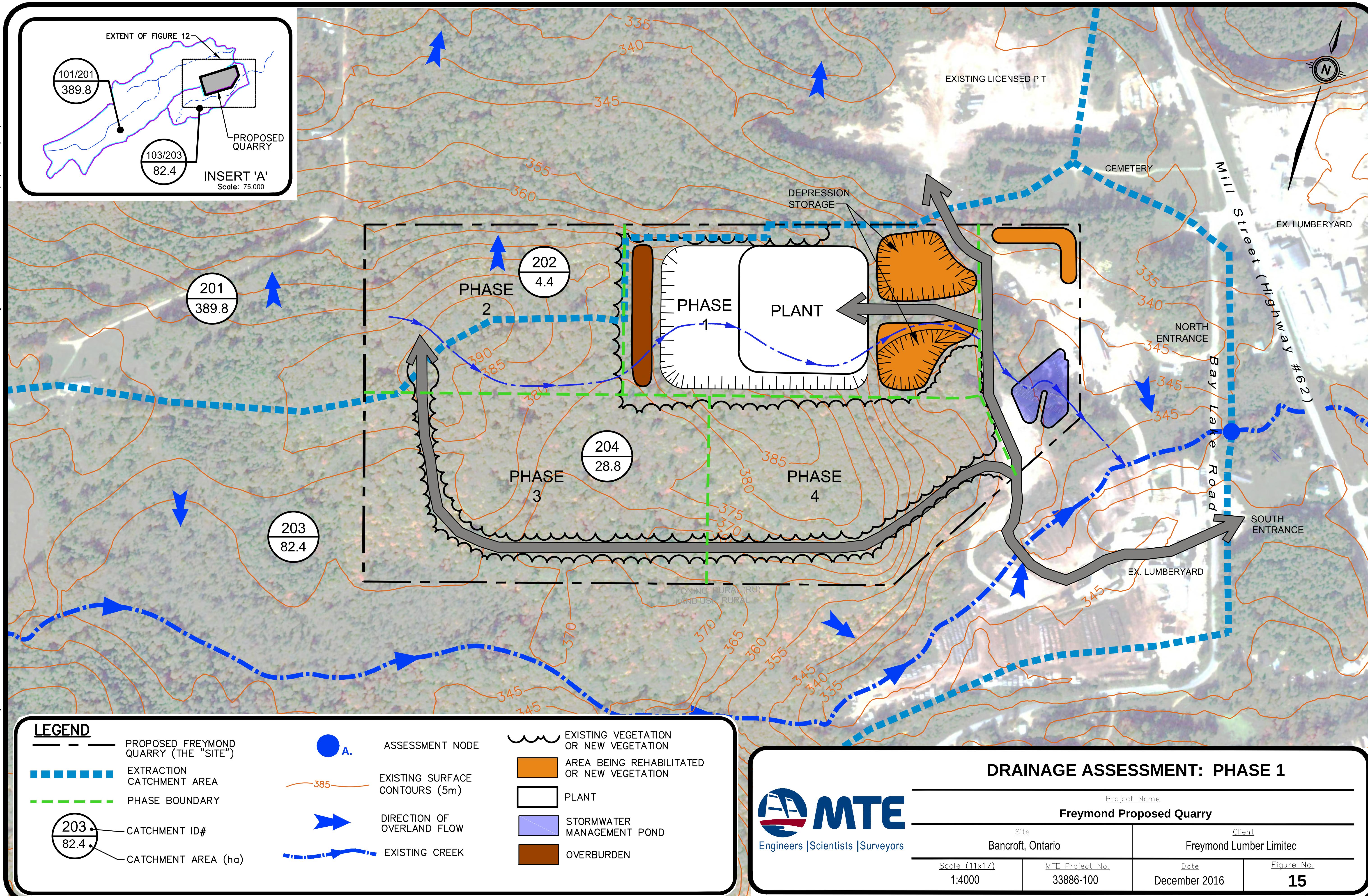
DRAINAGE ASSESSMENT: EXISTING CONDITIONS

MTE Engineers | Scientists | Surveyors

Project Name	
Freymond Proposed Quarry	
Site: Bancroft, Ontario	Client: Freymond Lumber Limited

Scale (11x17)	MTE Project No.	Date	Figure No.
1:7,500	33886-100	December 2016	14

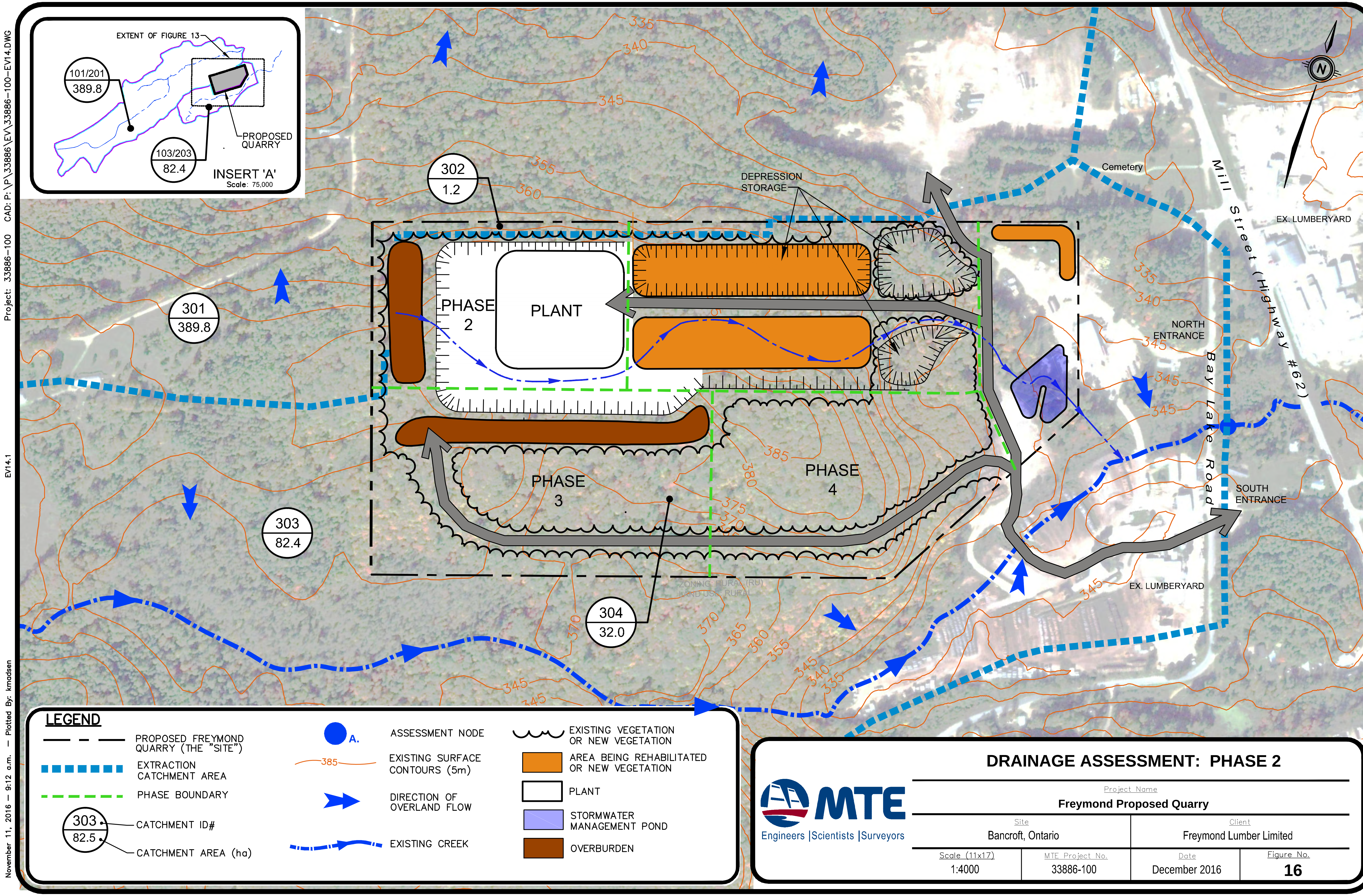
Project: 33886-100 CAD: P:\P\33886\EV\33886-100-EV3.DWG
EV3.3
November 11, 2016 — 10:00 a.m. — Plotted By: kmadsen



Project: 33886-100 CAD: P:\P\33886\EV\33886-100-EV13.DWG

EV13.1

November 11, 2016 — 9:06 a.m. — Plotted By: kmadsen

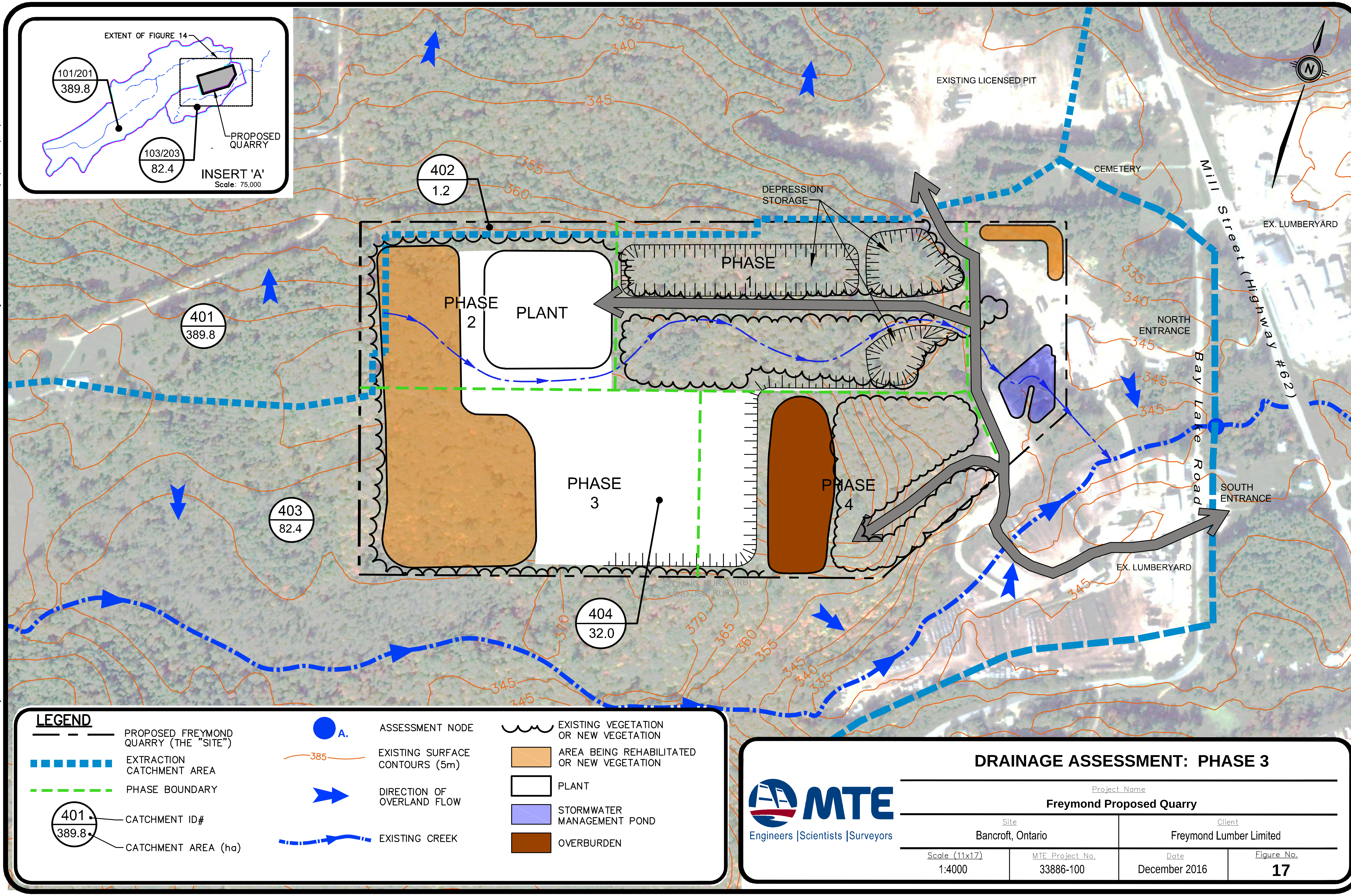


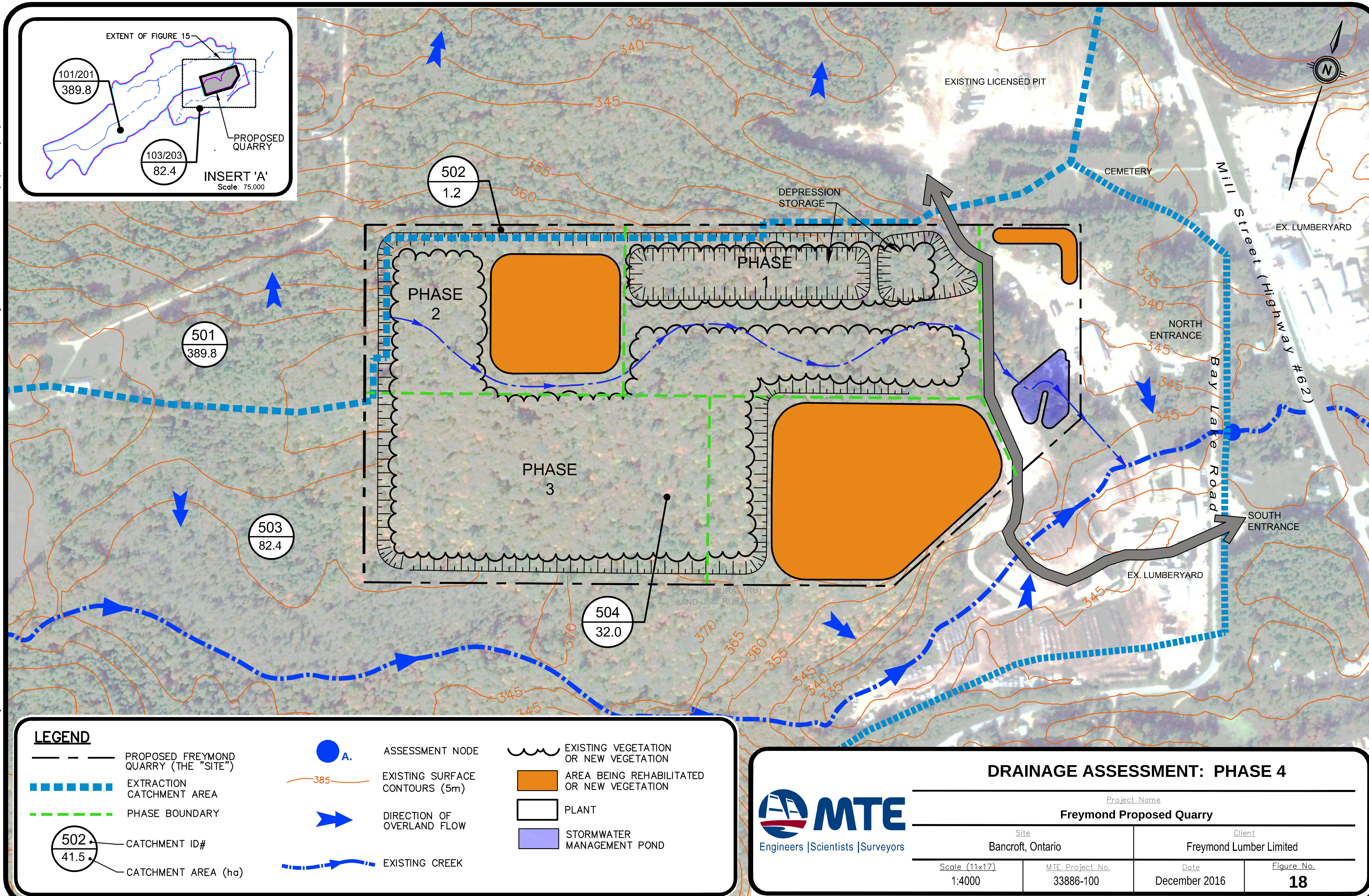
November 11, 2016 – 9:12 a.m. – Plotted By: kmadsen
EV14.1
Project: 33886-100 CAD: P:\P\33886\EV\33886-100-EV14.DWG
EXTENT OF FIGURE 13
101/201
389.8
103/203
82.4
PROPOSED QUARRY
INSERT 'A'
Scale: 75,000
302
1.2
301
389.8
303
82.4
304
32.0
PHASE 2
PLANT
PHASE 3
PHASE 4
DEPRESSION STORAGE
Cemetery
Mill Street (Highway #62)
Bay Lake Road
EX. LUMBERYARD
NORTH ENTRANCE
SOUTH ENTRANCE
EX. LUMBERYARD
335
340
345
355
360
365
370
375
380
385
LEGEND
PROPOSED FREYMOND QUARRY (THE "SITE")
EXTRACTION CATCHMENT AREA
PHASE BOUNDARY
303
82.5
CATCHMENT ID#
CATCHMENT AREA (ha)
A.
ASSESSMENT NODE
385
EXISTING SURFACE CONTOURS (5m)
DIRECTION OF OVERLAND FLOW
EXISTING CREEK
EXISTING VEGETATION OR NEW VEGETATION
AREA BEING REHABILITATED OR NEW VEGETATION
PLANT
STORMWATER MANAGEMENT POND
OVERBURDEN
DRAINAGE ASSESSMENT: PHASE 2
MTE
Engineers | Scientists | Surveyors
Project Name
Freymond Proposed Quarry
Site
Bancroft, Ontario
Client
Freymond Lumber Limited
Scale (11x17)
1:4000
MTE Project No.
33886-100
Date
December 2016
Figure No.
16

Project: 33886-100 CAD: P:\P\33886\EV\33886-100-EV15.DWG

EV15.1

November 11, 2016 — 9:17 a.m. — Plotted By: kmadsen





DRAINAGE ASSESSMENT: PHASE 4

MTE Engineers | Scientists | Surveyors

Project Name			
Freymond Proposed Quarry			
Site: Bancroft, Ontario		Client: Freymond Lumber Limited	
Scale (11x17)	MTE Project No.	Date	Figure No.
1:4000	33886-100	December 2016	18

Project: 33886-100 CAD: P:\P\33886\EV\33886-100-EV16.DWG

EV16.1

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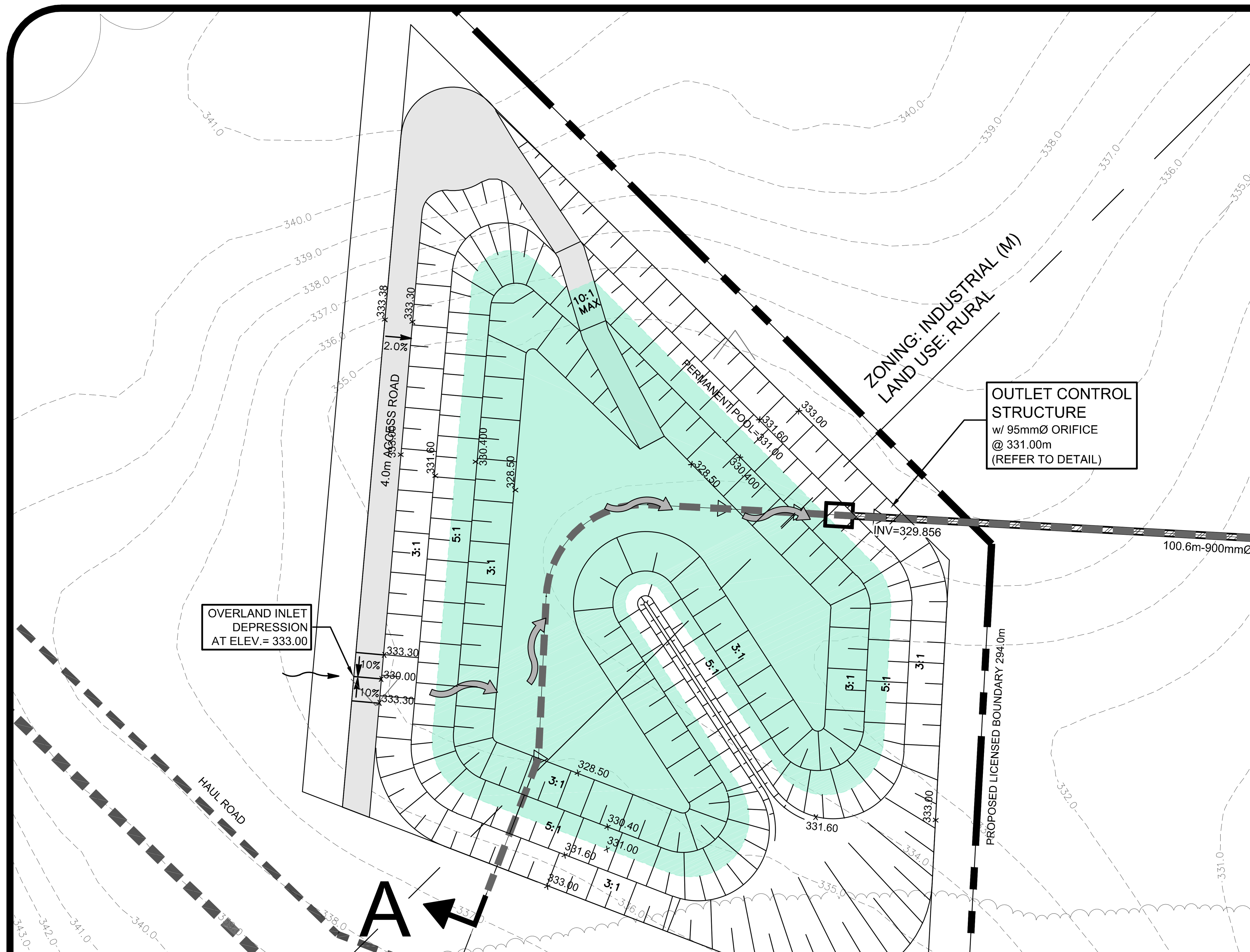
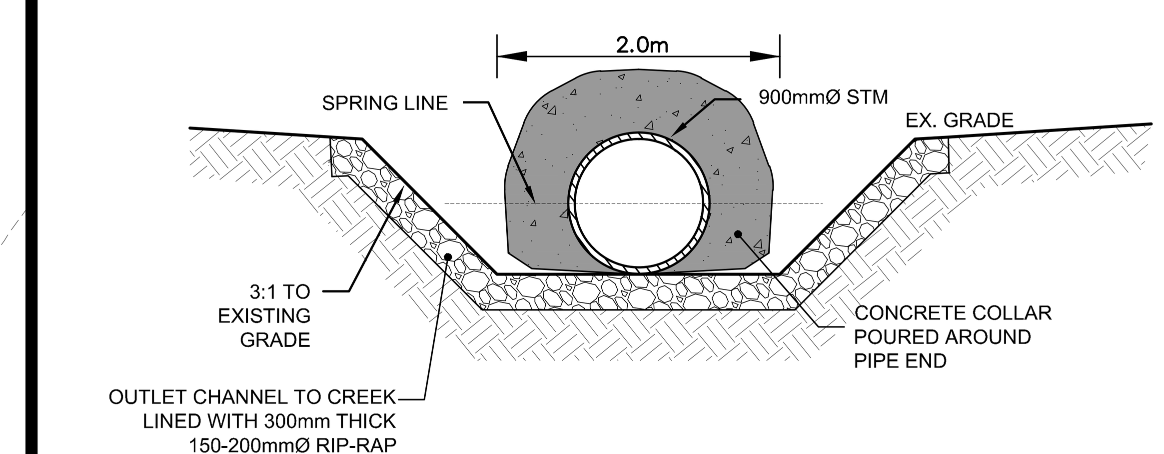
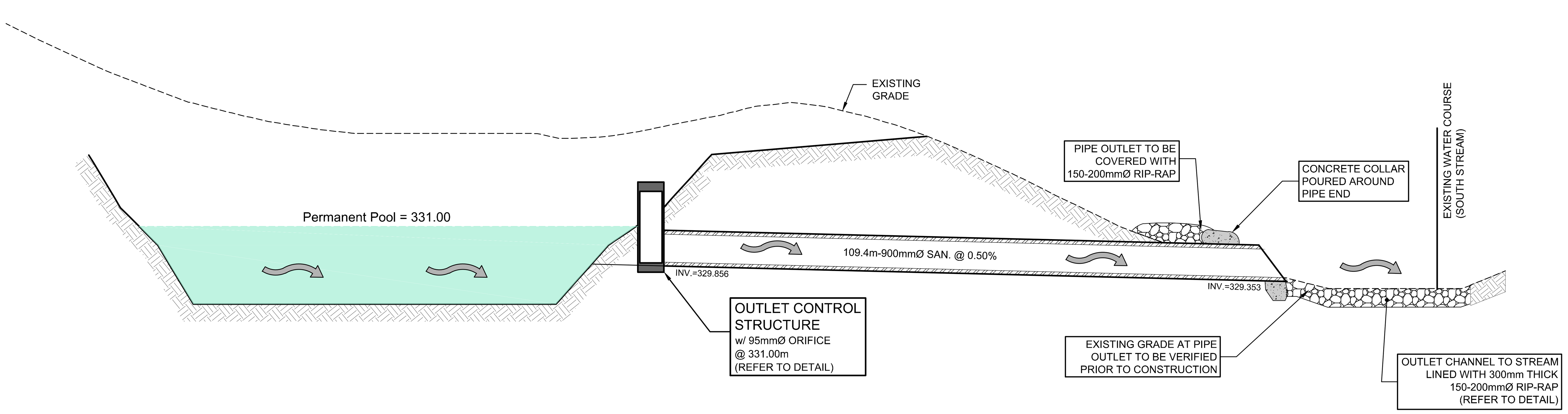
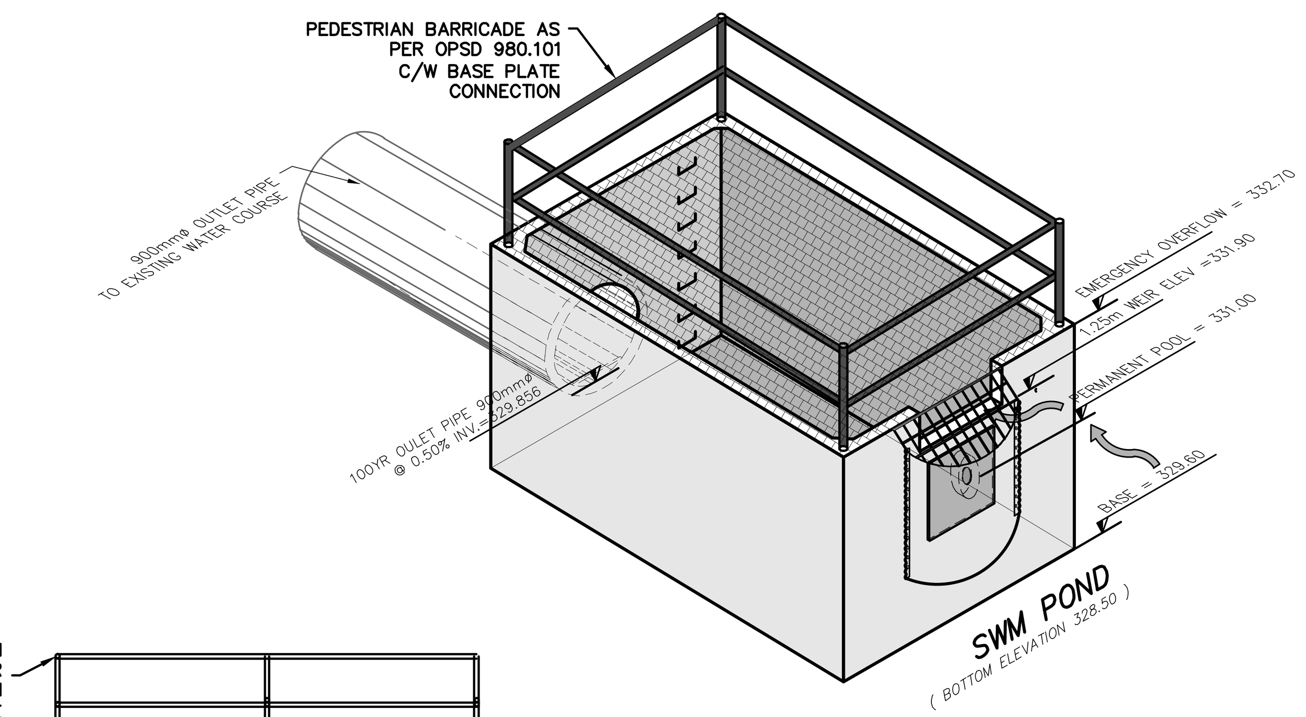


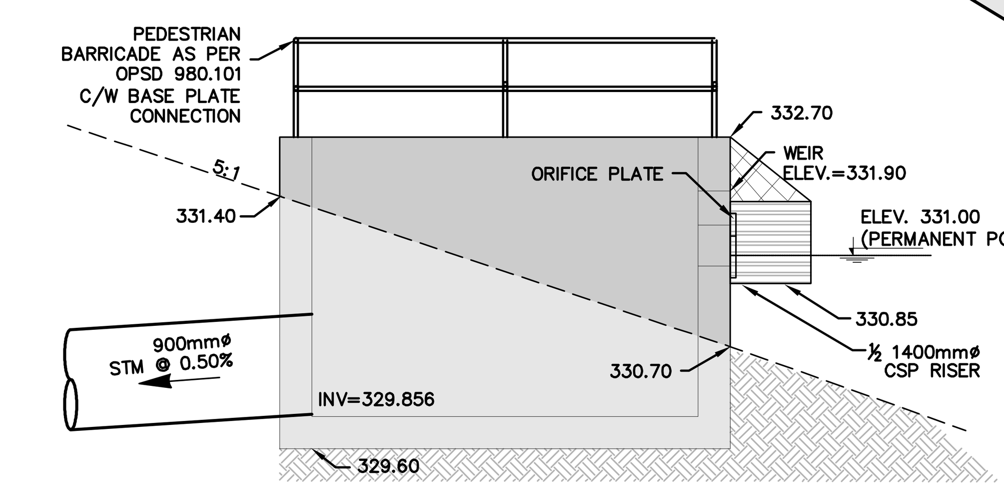


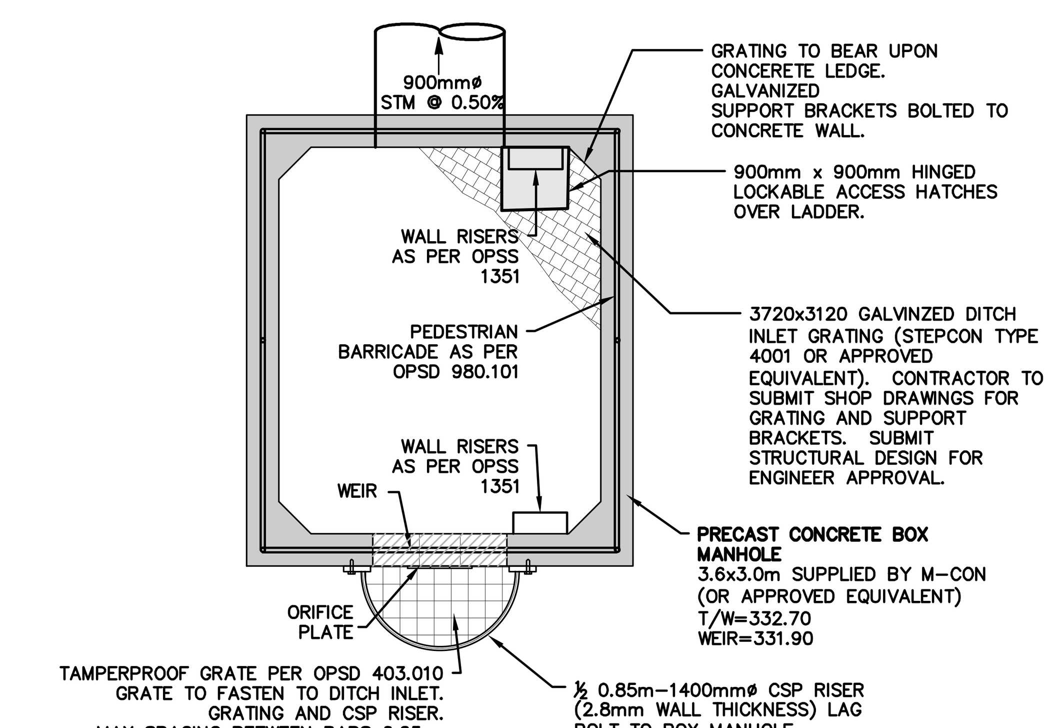
OUTLET CHANNEL
N.T.S.

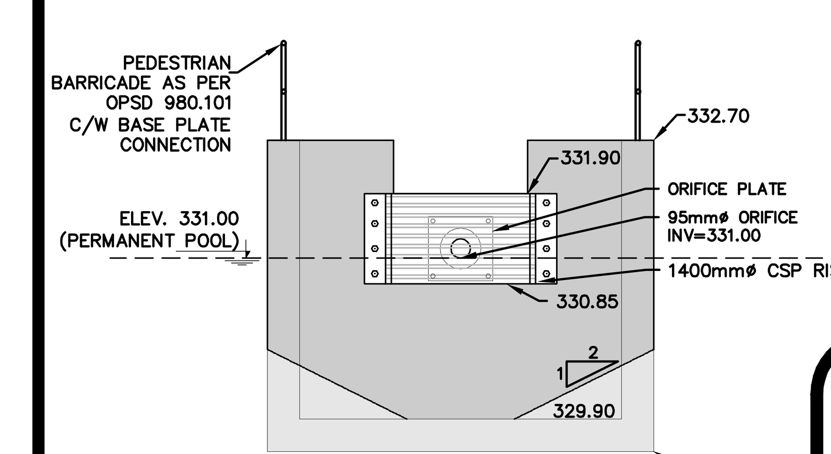
SECTION A-A
SCALE: 500H 100V











OUTLET CONTROL STRUCTURE
N.T.S.

FIGURE 19.0
Date: AUG.26/16
Scale: 1:500

FREYMOND QUARRY STORMWATER MANAGEMENT FACILITY

MTE
Engineers | Scientists | Surveyors

Project No.: 33886-100

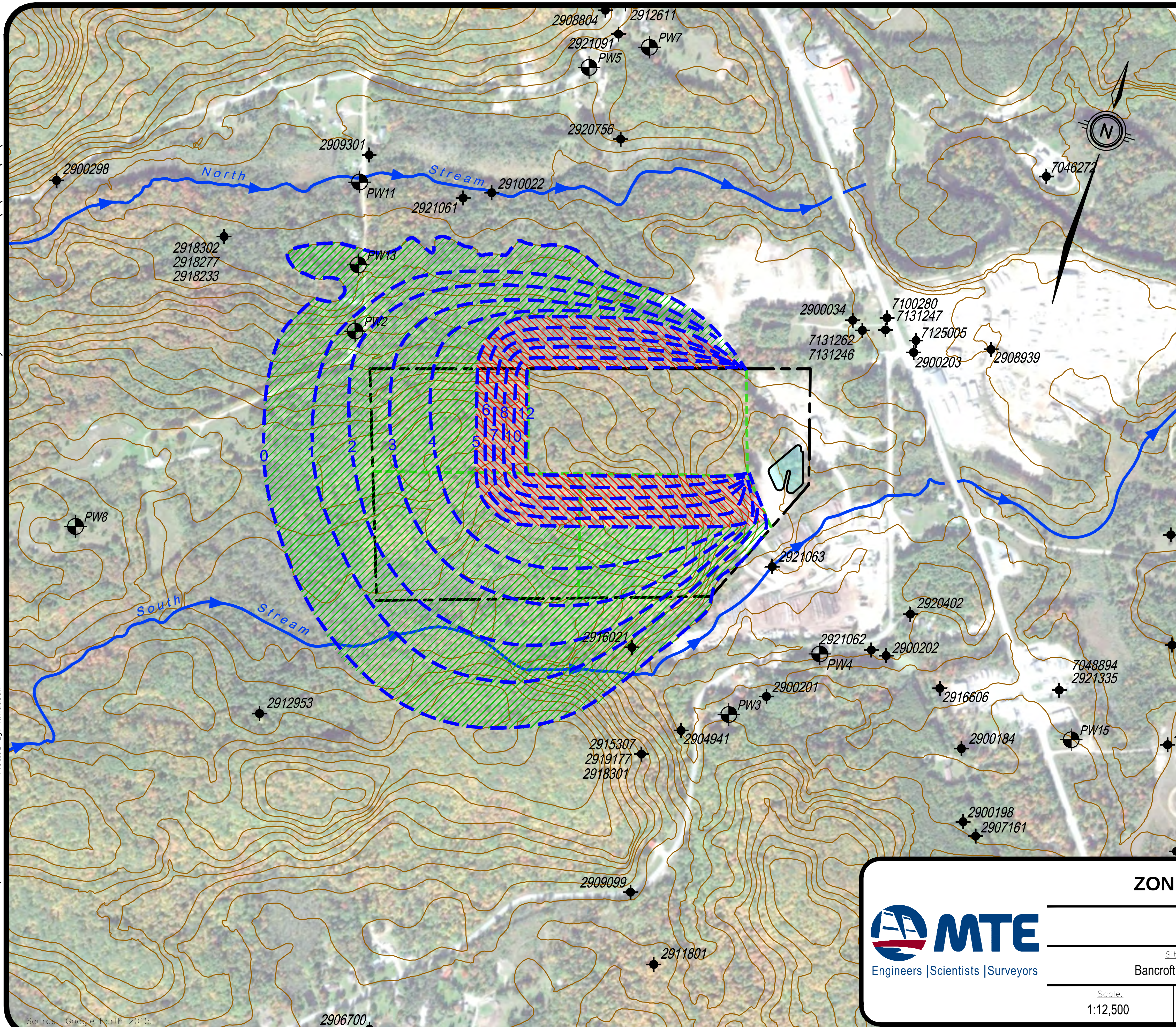
November 8, 2016 — 11:19 a.m. — Plotted By: ahewson

P:\P\33886\33886-100-MS2.dwg

Project: 33886-100 CAD: P:\P\33886\EV\33886-100-EV22.DWG

EV22.1

November 11, 2016 — 10:08 a.m. — Plotted By: kmodsen



LEGEND

SITE BOUNDARY

PHASE BOUNDARY

2908939 MOECC WELL LOCATION

PW15 PRIVATE WELL

STORMWATER MANAGEMENT POND

ZONE OF INFLUENCE - 100m
5 - 12m OF PREDICTED DRAWDOWN

500m 0.0 - 5m DRAWDOWN

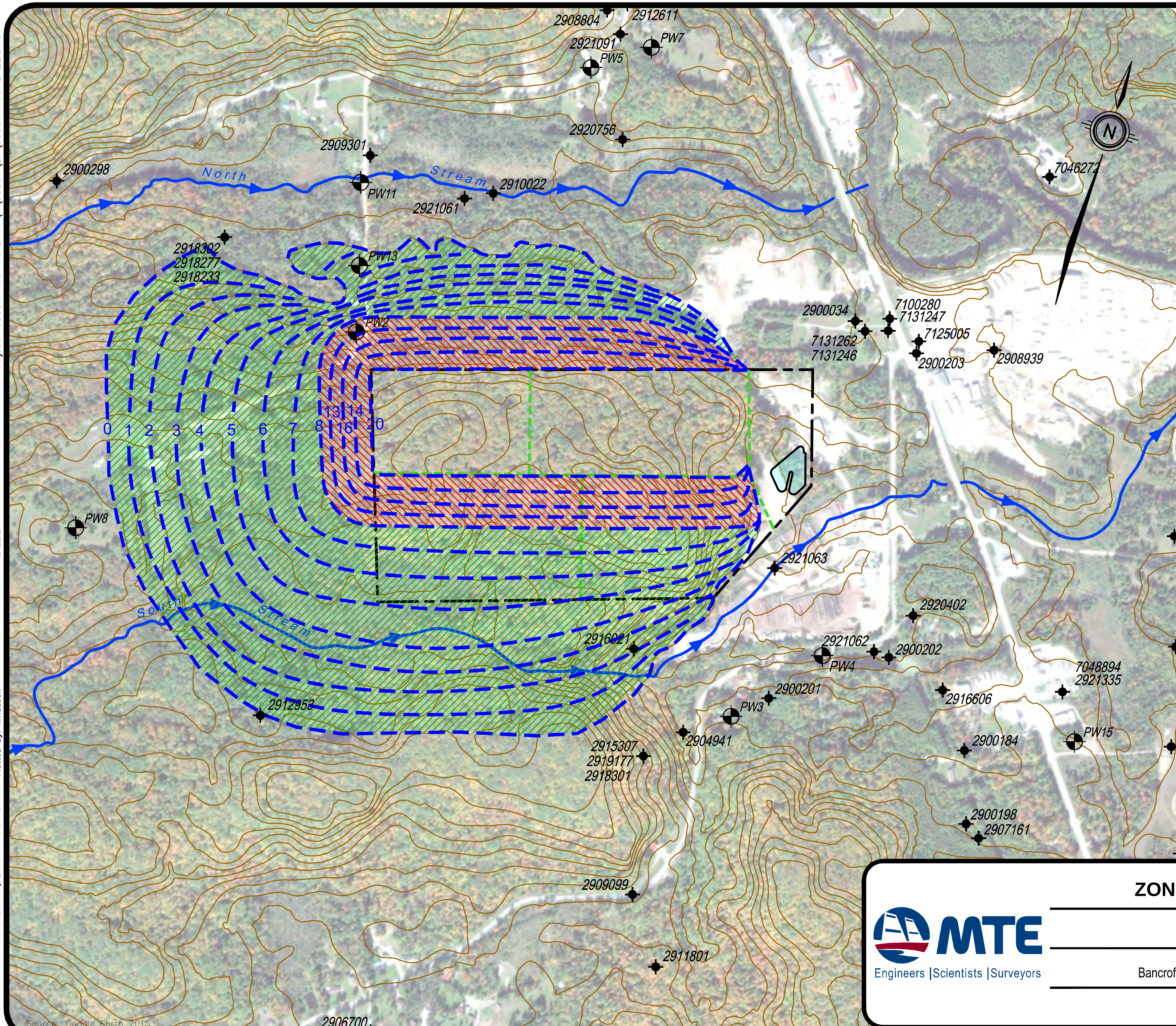
4 PREDICTED DRAWDOWN CONTOURS (m)

ZONE OF INFLUENCE - Post Phase 1

MTE
Engineers | Scientists | Surveyors

Project Name			
Freymond Proposed Quarry			
Site: Bancroft, Ontario		Client: Freymond Lumber Limited	
Scale: 1:12,500	MTE Project No.: 33886-100	Date: December 2016	Figure No.: 20

Project: 33886-100 CAD: P:\P\33886\EV\33886-100-EV22.DWG
EV22.2
November 11, 2016 — 10:07 a.m. — Plotted By: kmadsen



LEGEND

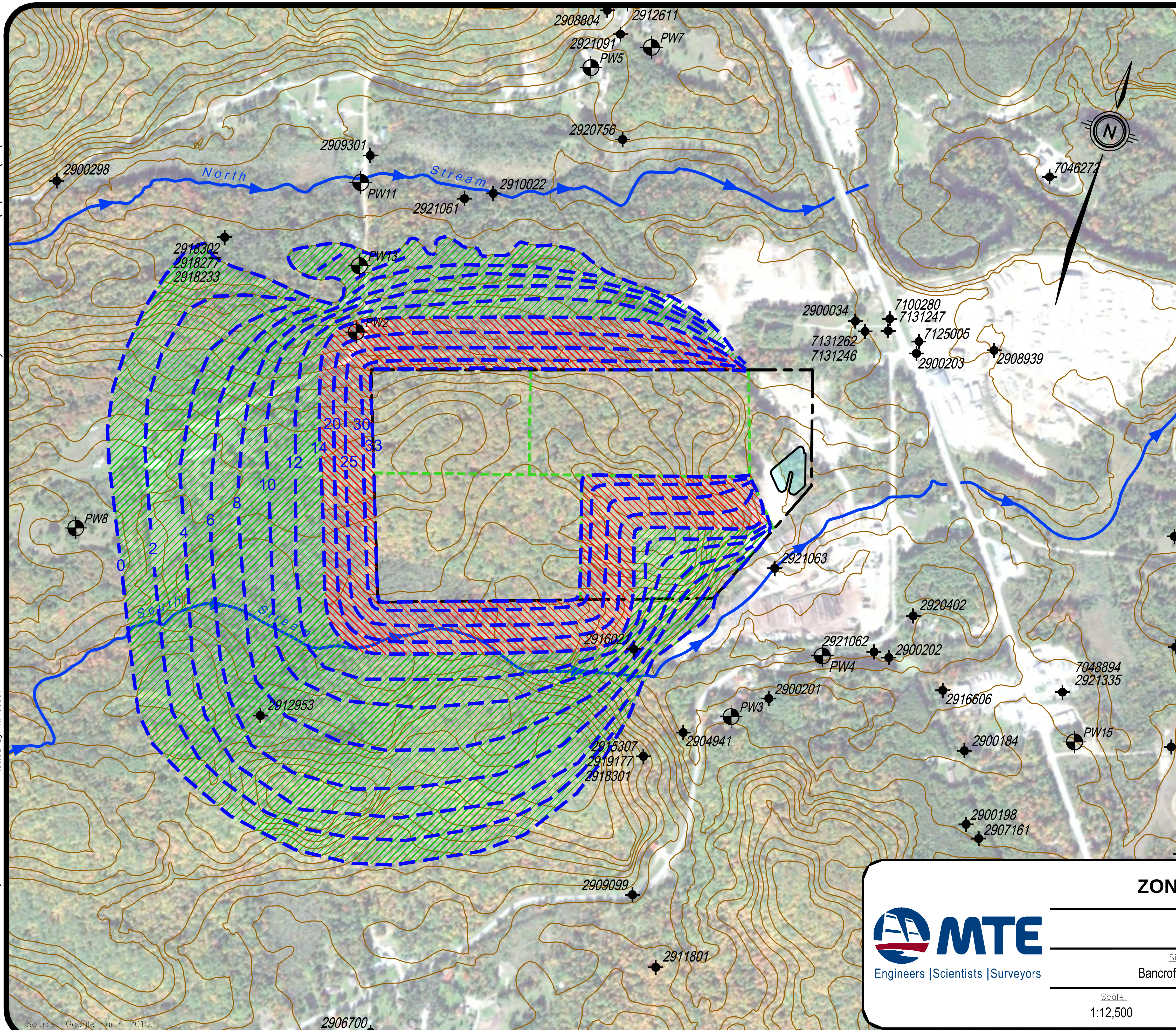
- SITE BOUNDARY
- PHASE BOUNDARY
- 2908939 MOECC WELL LOCATION
- PW15 PRIVATE WELL
- STORMWATER MANAGEMENT POND
- ZONE OF INFLUENCE - 100m 8 - 20m OF PREDICTED DRAWDOWN
- 500m 0.0 - 8m DRAWDOWN
- 4 PREDICTED DRAWDOWN CONTOURS (m)

MTE
Engineers | Scientists | Surveyors

ZONE OF INFLUENCE - Post Phase 2

Project Name	
Freymond Proposed Quarry	
Bancroft, Ontario	Client: Freymond Lumber Limited

MTE Project No.	Date	Figure No.
33886-100	December 2016	21



LEGEND

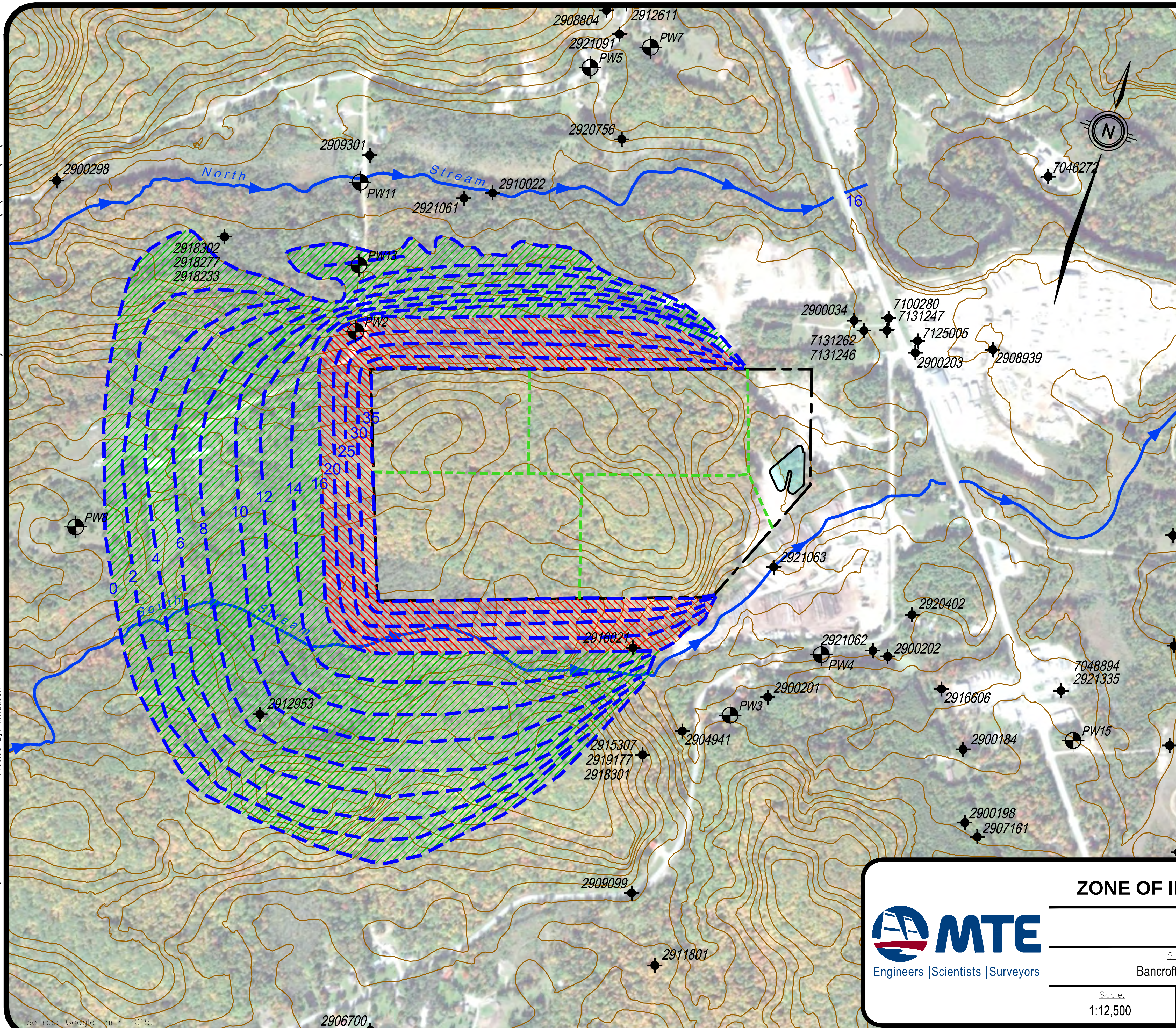
- SITE BOUNDARY
- PHASE BOUNDARY
- 2908939 MOECC WELL LOCATION
- PW15 PRIVATE WELL
- STORMWATER MANAGEMENT POND
- ZONE OF INFLUENCE - 100m 14 - 33m OF PREDICTED DRAWDOWN
- 500m 0.14 - 11m DRAWDOWN
- 4 PREDICTED DRAWDOWN CONTOURS (m)

ZONE OF INFLUENCE - Post Phase 3

MTE
Engineers | Scientists | Surveyors

Project Name			
Freymond Proposed Quarry			
Site: Bancroft, Ontario		Client: Freymond Lumber Limited	
Scale: 1:12,500	MTE Project No.: 33886-100	Date: December 2016	Figure No.: 22

Project: 33886-100 CAD: P:\P\33886\EV\33886-100-EV22.DWG
EV22.3
November 11, 2016 — 10:06 a.m. — Plotted By: kmodsen



LEGEND

SITE BOUNDARY

PHASE BOUNDARY

2908939 MOECC WELL LOCATION

PW15 PRIVATE WELL

STORMWATER MANAGEMENT POND

ZONE OF INFLUENCE - 100m
16 - 35m OF PREDICTED DRAWDOWN

500m 0 - 16m DRAWDOWN

4 PREDICTED DRAWDOWN CONTOURS (m)

ZONE OF INFLUENCE - 20 Years Post Extraction

MTE
Engineers | Scientists | Surveyors

Project Name	
Freymond Proposed Quarry	
Site	Client
Bancroft, Ontario	Freymond Lumber Limited

Scale	MTE Project No.	Date	Figure No.
1:12,500	33886-100	December 2016	23

Project: 33886-100 CAD: P:\P\33886\EV\33886-100-EV22.DWG
EV22.4
November 11, 2016 — 10:05 a.m. — Plotted By: kmodsen

TABLES

Table 1: Groundwater Levels (mBTOC)
Manual Measurements - 2009-2016

Date	MW1s	MW1d	MW2s	MW2d	MW3s	MW3d	MW4s	MW4d	MW5s	MW5d	MW6s	MW6d	MW7
21-May-09	12.83	31.24	14.70	29.83	2.00	3.29	26.35	35.18	12.93	*	3.35	3.60	-
1-Jul-09	9.88	31.20	13.06	21.66	2.80	3.40	18.61	25.93	13.05	*	3.66	3.84	-
24-Aug-09	6.27	*	13.32	17.70	3.74	4.10	10.41	15.57	13.18	*	3.75	3.78	-
22-Sep-09	5.09	*	13.53	17.25	3.87	4.45	7.41	12.69	*	*	3.94	3.86	-
30-Nov-09	3.11	30.83	12.85	17.04	2.13	3.63	2.84	5.96	13.30	30.22	3.40	3.42	-
19-Apr-10	1.81	30.53	11.00	16.63	1.32	2.77	0.12	1.65	13.38	30.21	3.33	3.31	-
27-May-10	1.73	30.44	11.04	16.52	1.31	2.97	0.91	1.28	13.39	30.22	3.40	3.41	-
21-Jun-10	1.73	30.38	11.40	16.51	1.70	3.40	0.86	1.08	13.40	30.24	3.53	3.40	-
6-Oct-10	1.75	30.18	12.68	17.28	2.05	4.28	0.14	0.39	13.48	*	3.15	3.20	-
29-Apr-11	1.40	29.73	9.70	16.26	**	2.35	0.66	**	13.47	*	2.72	2.99	-
15-Aug-11	1.68	*	11.11	16.22	2.95	4.11	0.21	0.05	13.50	*	3.55	3.80	-
30-Sep-11	2.16	29.36	11.65	16.77	3.65	4.84	0.04	0.10	13.56	*	3.81	4.00	-
4-May-12	1.50	28.90	9.35	17.19	1.37	2.82	0.20	0.12	13.55	*	2.52	3.41	-
20-Jul-12	1.72	*	10.34	17.10	3.23	4.00	0.05	0.10	13.55	*	3.07	3.90	-
29-Oct-12	1.41	28.52	11.01	17.61	3.90	5.13	0.01	0.22	13.61	*	3.13	3.72	-
31-May-13	1.44	27.60	8.27	17.46	0.58	2.83	0.52	0.09	13.61	*	2.23	3.18	-
26-Jul-13	1.58	27.33	9.74	17.23	1.61	3.55	0.76	0.09	13.62	*	2.38	3.42	-
11-Oct-13	1.74	27.01	10.70	17.33	2.72	4.57	0.80	0.08	13.66	*	2.86	3.56	-
28-May-14	1.38	25.92	8.35	16.52	**	2.35	0.07	0.12	13.58	*	1.32	2.80	-
17-Jul-14	1.49	26.10	9.42	16.41	1.28	2.79	0.02	0.12	13.58	*	1.91	3.23	-
27-Oct-14	1.67	25.24	10.48	16.74	2.37	3.87	0.76	0.12	13.61	*	1.94	3.02	-
24-Apr-15	1.50	24.40	8.02	16.52	0.23	2.55	0.76	0.11	13.60	*	0.91	2.55	-
9-Oct-15	1.77	23.67	10.34	17.23	2.84	4.14	0.00	0.00	13.67	*	2.40	3.49	-
28-Apr-16	1.33	22.77	7.83	16.90	0.15	1.70	***	***	13.62	*	1.01	2.67	-
17-Aug-16	1.71	22.29	9.34	16.43	2.65	3.92	-0.55	0.39	13.67	*	2.56	3.63	11.57
17-Oct-16	1.83	22.11	10.14	16.97	2.66	4.67	0.45	-0.53	13.69	*	2.54	3.64	11.61

*Notes: * = well was dry at time of measurement*
*** = well was flowing at time of measurement*
**** = well was frozen at time of measurement*
- = well was not measured
negative numbers indicate a water level higher than the base of the manometer

Table 1: Groundwater Levels (mBTOC)
Manual Measurements - 2009-2016

Date	PW3	PW5	PW7	PW8	PW9	PW11	PW12	PW13	PW14	PW15
21-May-09	-	-	-	-	-	-	-	-	-	-
1-Jul-09	-	-	-	-	-	-	-	-	-	-
24-Aug-09	-	-	-	-	-	-	-	-	-	-
22-Sep-09	-	-	-	-	-	-	-	-	-	-
30-Nov-09	-	-	-	-	-	-	-	-	-	-
19-Apr-10	-	-	-	-	-	-	-	-	-	-
27-May-10	-	-	-	-	-	-	-	-	-	-
21-Jun-10	8.98	7.64	-	-	-	-	-	-	-	-
6-Oct-10	8.94	9.32	-	-	15.07	-	-	-	-	-
29-Apr-11	8.524	5.298	-	-	6.47	-	-	-	-	-
15-Aug-11	10.21	7.94	-	-	11.65	-	-	-	-	-
30-Sep-11	10.18	10.98	-	-	14.3	-	-	-	-	-
4-May-12	8.82	7.44	-	1.15	8.27	-	-	-	-	-
20-Jul-12	10.52	11.13	-	-	14.04	-	-	-	-	-
29-Oct-12	-	10.04	-	1.89	18.14	-	-	-	-	-
31-May-13	-	6.2	-	1.52	9.06	-	-	-	-	-
26-Jul-13	-	7.22	-	1.79	11.095	-	-	-	-	-
11-Oct-13	9.41	8.72	-	2.04	17.76	-	-	-	-	-
28-May-14	8.57	5.64	-	1.32	6.57	-	-	-	-	-
17-Jul-14	8.62	5.91	-	1.53	6.83	-	-	-	-	-
27-Oct-14	9.34	9.13	-	1.8	14.33	-	-	-	-	-
24-Apr-15	8.96	6.53	-	1.26	9.01	-	-	-	-	-
9-Oct-15	-	-	-	-	-	-	-	-	-	-
28-Apr-16	9.16	5.17	14.55	1.29	7.31	0.52	4.51	1.87	1.57	7.75
17-Aug-16	9.39	8.17	18.37	1.98	9.2	0.45	10.22	3.98	1.76	10.22
17-Oct-16	9.58	9.56	18.68	1.71	14.28	0.75	11.58	5.17	1.89	8.89

*Notes: * = well was dry at time of measurement*
*** = well was flowing at time of measurement*
- = well was not measured

Table 2: Groundwater Elevations (mAMSL)
Manual Measurements - 2009-2016

Date	MW1s	MW1d	MW2s	MW2d	MW3s	MW3d	MW4s	MW4d	MW5s	MW5d	MW6s	MW6d	MW7
TOC Elevation	360.39	361.70	368.08	368.59	376.53	376.23	370.44	371.24	369.90	370.10	364.69	364.38	383.17
					376.97	375.79	371.25						
							371.06						
							371.68 †	372.42 †					
							371.1 †	371.98 †					
21-May-09	347.56	330.46	353.38	338.76	374.53	372.94	344.09	336.06	356.97	*	361.34	360.78	-
1-Jul-09	350.51	330.50	355.02	346.93	373.73	372.83	351.83	345.31	356.85	*	361.03	360.54	-
24-Aug-09	354.12	*	354.76	350.89	372.79	372.13	360.03	355.67	356.72	*	360.94	360.60	-
22-Sep-09	355.30	*	354.55	351.34	372.66	371.78	363.03	358.55	*	*	360.75	360.52	-
30-Nov-09	357.28	330.87	355.23	351.55	374.40	372.60	367.60	365.28	356.60	339.88	361.29	360.96	-
19-Apr-10	358.58	331.17	357.08	351.96	375.21	373.46	370.32	369.59	356.52	339.89	361.36	361.07	-
27-May-10	358.66	331.26	357.04	352.07	375.22	373.26	370.34	369.96	356.51	339.88	361.29	360.97	-
21-Jun-10	358.66	331.32	356.68	352.08	374.83	372.83	370.39	370.16	356.50	339.86	361.16	360.98	-
6-Oct-10	358.64	331.52	355.40	351.31	374.49	371.95	370.92	370.85	356.42	*	361.54	361.18	-
29-Apr-11	358.99	331.97	358.38	352.34	**	373.88	370.40	**	356.43	*	361.97	361.39	-
15-Aug-11	358.71	*	356.97	352.37	373.58	372.12	370.85	371.19	356.40	*	361.14	360.58	-
30-Sep-11	358.23	332.34	356.43	351.82	372.88	371.39	371.02	371.14	356.34	*	360.88	360.38	-
4-May-12	358.89	332.80	358.73	351.41	375.16	373.41	370.87	371.13	356.35	*	362.17	360.98	-
20-Jul-12	358.67	*	357.74	351.49	373.30	372.23	371.01	371.14	356.35	*	361.62	360.48	-
29-Oct-12	358.98	333.18	357.07	350.98	372.63	371.10	371.05	371.02	356.29	*	361.56	360.66	-
31-May-13	358.95	334.10	359.81	351.13	375.95	373.40	370.54	371.15	356.29	*	362.46	361.20	-
26-Jul-13	358.81	334.37	358.34	351.36	374.92	372.68	370.30	371.15	356.28	*	362.31	360.96	-
11-Oct-13	358.65	334.69	357.38	351.26	373.81	371.66	370.27	371.16	356.24	*	361.83	360.82	-
28-May-14	359.01	335.78	359.73	352.07	**	373.88	370.99	371.12	356.32	*	363.37	361.58	-
17-Jul-14	358.90	335.60	358.66	352.18	375.25	373.44	371.04	371.12	356.32	*	362.78	361.15	-
27-Oct-14	358.72	336.46	357.60	351.85	374.16	372.36	370.30	371.12	356.29	*	362.75	361.36	-
24-Apr-15	358.89	337.30	360.06	352.07	376.30	373.68	370.30	371.13	356.30	*	363.78	361.83	-
9-Oct-15	358.62	338.03	357.74	351.36	373.69	372.09	371.68	372.42	356.23	*	362.29	360.89	-
28-Apr-16	359.06	338.93	360.25	351.69	376.38	374.53	***	***	356.28	*	363.68	361.71	-
17-Aug-16	358.68	339.41	358.74	352.16	373.88	372.31	371.65	371.59	356.23	*	362.13	360.75	371.60
17-Oct-16	358.56	339.59	357.94	351.62	373.87	371.56	370.65	372.51	356.22	*	362.15	360.74	371.57

Notes: TOC = top of casing
mAMSL= metres above mean sea level
** = well was dry at time of measurement*
*** = well was flowing at time of measurement*
**** = well was frozen at time of measurement*
- = well was not measured
†= Base of Manometer

Table 2: Groundwater Elevations (mAMSL)
Manual Measurements - 2009-2016

Date	PW3	PW5	PW7	PW8	PW9	PW11	PW12	PW13	PW14	PW15
TOC Elevation	337.92	334.67	334.27	398.24	346.00	325.54	346.7	337.74	358.48	337.00
21-May-09	-	-	-	-	-	-	-	-	-	-
1-Jul-09	-	-	-	-	-	-	-	-	-	-
24-Aug-09	-	-	-	-	-	-	-	-	-	-
22-Sep-09	-	-	-	-	-	-	-	-	-	-
30-Nov-09	-	-	-	-	-	-	-	-	-	-
19-Apr-10	-	-	-	-	-	-	-	-	-	-
27-May-10	-	-	-	-	-	-	-	-	-	-
21-Jun-10	328.94	327.03	-	-	-	-	-	-	-	-
6-Oct-10	328.98	325.35	-	-	330.93	-	-	-	-	-
29-Apr-11	329.40	329.37	-	-	339.53	-	-	-	-	-
15-Aug-11	327.71	326.73	-	-	334.35	-	-	-	-	-
30-Sep-11	327.74	323.69	-	-	331.70	-	-	-	-	-
4-May-12	329.10	327.23	-	397.09	337.73	-	-	-	-	-
20-Jul-12	327.40	323.54	-	-	331.96	-	-	-	-	-
29-Oct-12	-	324.63	-	396.35	327.86	-	-	-	-	-
31-May-13	-	328.47	-	396.72	336.94	-	-	-	-	-
26-Jul-13	-	327.45	-	396.45	334.91	-	-	-	-	-
11-Oct-13	328.51	325.95	-	396.20	328.24	-	-	-	-	-
28-May-14	329.35	329.03	-	396.92	339.43	-	-	-	-	-
17-Jul-14	329.30	328.76	-	396.71	339.17	-	-	-	-	-
27-Oct-14	328.58	325.54	-	396.44	331.67	-	-	-	-	-
24-Apr-15	328.96	328.14	-	396.98	336.99	-	-	-	-	-
9-Oct-15	-	-	-	-	-	-	-	-	-	-
28-Apr-16	328.76	329.50	319.72	396.95	338.69	325.02	342.19	335.87	356.91	329.25
17-Aug-16	328.53	326.50	315.90	396.26	336.80	325.09	336.48	333.76	356.72	326.78
17-Oct-16	328.34	325.11	315.59	396.53	331.72	324.79	335.12	332.57	356.59	328.11

Notes: TOC/TOM = top of casing/top of manometer
mAMSL= metres above mean sea level
** = well was dry at time of measurement*
*** = well was flowing at time of measurement*
**** = well was frozen at time of measurement*
- = well was not measured

Table 3: Vertical Hydraulic Gradients

Date	MW1	MW2	MW3	MW4	MW5	MW6
21-May-09	-1.11	‡	-0.12		*	-0.03
1-Jul-09	-1.30	‡	-0.07		*	-0.03
24-Aug-09	*	-0.21	-0.05		*	-0.02
22-Sep-09	*	-0.17	-0.07		*	-0.01
30-Nov-09	-1.72	-0.20	-0.14		-1.08	-0.02
19-Apr-10	-1.78	-0.28	-0.14	-0.09	-1.07	-0.02
27-May-10	-1.78	-0.27	-0.15	-0.05	-1.07	-0.02
21-Jun-10	-1.78	-0.25	-0.16	-0.03	-1.07	-0.01
6-Oct-10	-1.76	-0.22	-0.20	-0.01	*	-0.02
29-Apr-11	-1.76	-0.33	**		*	-0.03
15-Aug-11	*	-0.25	-0.11	0.04	*	-0.03
30-Sep-11	-1.68	-0.25	-0.12	0.02	*	-0.03
4-May-12	-1.70	-0.39	-0.14	0.03	*	-0.06
20-Jul-12	*	-0.34	-0.08	0.02	*	-0.06
29-Oct-12	-1.68	-0.33	-0.12	0.00	*	-0.05
31-May-13	-1.62	-0.47	-0.20	0.08	*	-0.07
26-Jul-13	-1.59	-0.38	-0.18	0.11	*	-0.07
11-Oct-13	-1.56	-0.33	-0.17	0.12	*	-0.05
28-May-14	-1.51	-0.41	**	0.02	*	-0.09
17-Jul-14	-1.51	-0.35	-0.14	0.01	*	-0.09
27-Oct-14	-1.45	-0.31	-0.14	0.11	*	-0.07
24-Apr-15	-1.40	-0.43	-0.21	0.11	*	-0.10
9-Oct-15	-1.34	-0.34	-0.13	0.10	*	-0.07
28-Apr-16	-1.31	-0.46	-0.15		*	-0.10
17-Aug-16	-1.25	-0.35	-0.12	-0.01	*	-0.07
17-Oct-16	-1.23	-0.34	-0.18	0.24	*	-0.07

Notes: Negative values equal downward vertical hydraulic gradient
Positive values equal upward vertical hydraulic gradient
** = deep monitoring well was dry*
‡ = well still recovering at time of measurement
*** = well was flowing during monitoring event*
No vertical hydraulic gradients were calculated for MW4;
Collected water levels may not be repsentative of static conditions

Table 4: Hydraulic Conductivity (m/sec) Summary

Location	Hydraulic Conductivity (m/sec)
	Hvorslev
Shallow Bedrock Wells	
MW1s	6.97E-11
MW2s	2.41E-10
MW4s	5.61E-11
MW6s	1.07E-08
Geomean	3.17E-10
Deeper Bedrock Wells	
MW2d	6.36E-11
MW4d	6.34E-11
Geomean	6.35E-11
Deeper Bedrock Wells	
MW7 Falling	6.54E-06
MW7 Rising	3.35E-06
Geomean	4.68E-06
Geomean (All)	7.89E-10

Table 5: MOECC Well Information Summary

Well ID	X UTM Coordinate	Y UTM Coordinate	Elevation (m)	Depth (m)	WaterLevel (m)	WaterYield (lpm)	Water use	Water status	Screen depth (m)	Lithology
Bedrock Wells										
2918233	275360.26	4991789.96	N/A	30.48	2.13	N/A	Domestic	Water Supply	N/A	Dolostone
2921063	276553.02	4991498.99	N/A	97.6	10	40	Domestic	Water Supply	N/A	Dolostone
2900046	275903.38	4992583.01	338.33	20.42	6.1	9.09	Domestic	Water Supply	N/A	Granite
2900051	275389.43	4992471.97	365.76	30.48	8.53	31.82	Domestic	Water Supply	N/A	Granite
2900184	277003.37	4991274.00	335.28	42.67	12.19	N/A	Not Used	Abandoned-Quality	N/A	Granite
2900197	277314.42	4991116.97	335.28	14.33	3.66	31.82	Domestic	Water Supply	N/A	Granite
2900201	276616.41	4991257.97	335.28	34.14	18.59	4.55	Domestic	Water Supply	N/A	Granite
2900202	276812.42	4991401.03	350.52	30.48	11.28	N/A	Industrial	Water Supply	N/A	Granite
2900298	275021.36	4991797.03	347.47	26.52	6.1	13.64	Domestic	Water Supply	N/A	Granite
2904941	276479.41	4991146.98	365.76	21.34	12.19	68.19	Commercial	Water Supply	N/A	Granite
2905600	277359.43	4991111.95	335.28	12.8	2.44	45.46	Domestic	Water Supply	N/A	Granite
2906606	276929.37	4991372.02	347.47	120.4	39.62	N/A	Industrial	Water Supply	N/A	Granite
2906700	276079.43	4990422.05	362.71	22.25	11.89	31.82	Domestic	Water Supply	N/A	Granite
2906987	275429.39	4992572.00	347.47	29.26	9.14	18.18	Domestic	Water Supply	N/A	Granite
2907161	277079.44	4991121.96	341.38	52.43	6.1	4.55	Domestic	Water Supply	N/A	Granite
2908674	275829.41	4992521.99	350.52	44.81	5.49	4.55	Domestic	Water Supply	N/A	Granite
2908677	275429.39	4992572.00	350.52	29.26	5.49	13.64	Domestic	Water Supply	N/A	Granite
2908804	275929.41	4992422.04	350.52	29.57	4.27	9.09	Domestic	Water Supply	N/A	Granite
2909099	276479.36	4990821.99	350.52	98.15	1.22	4.55	Domestic	Water Supply	N/A	Granite
2909301	275579.37	4992022.04	365.76	36.27	0.61	13.64	Domestic	Water Supply	N/A	Granite
2909814	275628.40	4992520.95	350.52	28.04	N/A	90.92	Domestic	Water Supply	N/A	Granite
2910022	275825.49	4992023.06	350.52	47.85	N/A	31.82	Domestic	Water Supply	N/A	Granite
2911526	277330.11	4991584.01	N/A	36.58	5.49	13.64	Domestic	Water Supply	N/A	Granite
2911624	277264.83	4991785.05	N/A	32	4.88	22.73	Domestic	Water Supply	N/A	Granite
2912610	275360.26	4991789.96	N/A	50.6	8.53	18.18	Domestic	Water Supply	N/A	Marble
2912611	275962.39	4992445.01	N/A	44.2	11.58	22.73	Domestic	Water Supply	N/A	Granite
2912953	275697.77	4990936.98	N/A	47.24	5.49	45.46	Domestic	Water Supply	N/A	Granite
2915307	276423.08	4991079.00	N/A	61.26	9.75	45.46	Domestic	Water Supply	N/A	Granite
2915704	277456.03	4991209.01	N/A	91.74	10.67	13.64	Domestic	N/A	N/A	Granite
2918277	275360.26	4991789.96	N/A	49.38	4.88	45.46	Domestic	Water Supply	N/A	Granite
2918434	275898.62	4992638.01	N/A	30.48	6.4	31.82	Domestic	Water Supply	N/A	Granite
2921061	275776.00	4991996.99	N/A	91.5	11.6	18	Domestic	Water Supply	N/A	Granite
2921062	276781.97	4991402.98	N/A	61	12.7	18	Domestic	Water Supply	N/A	Granite
2921091	275967.02	4992386.01	N/A	35.1	15.5	22.75	Domestic	Water Supply	N/A	Granite
2921187	275947.98	4992497.02	N/A	48.8	10.6	20.5	Domestic	Water Supply	N/A	Granite
7046272	276832.01	4992370.00	N/A	340	10.3	10	Municipal	Water Supply	N/A	Granite Bedrock

Table 5: MOECC Well Information Summary

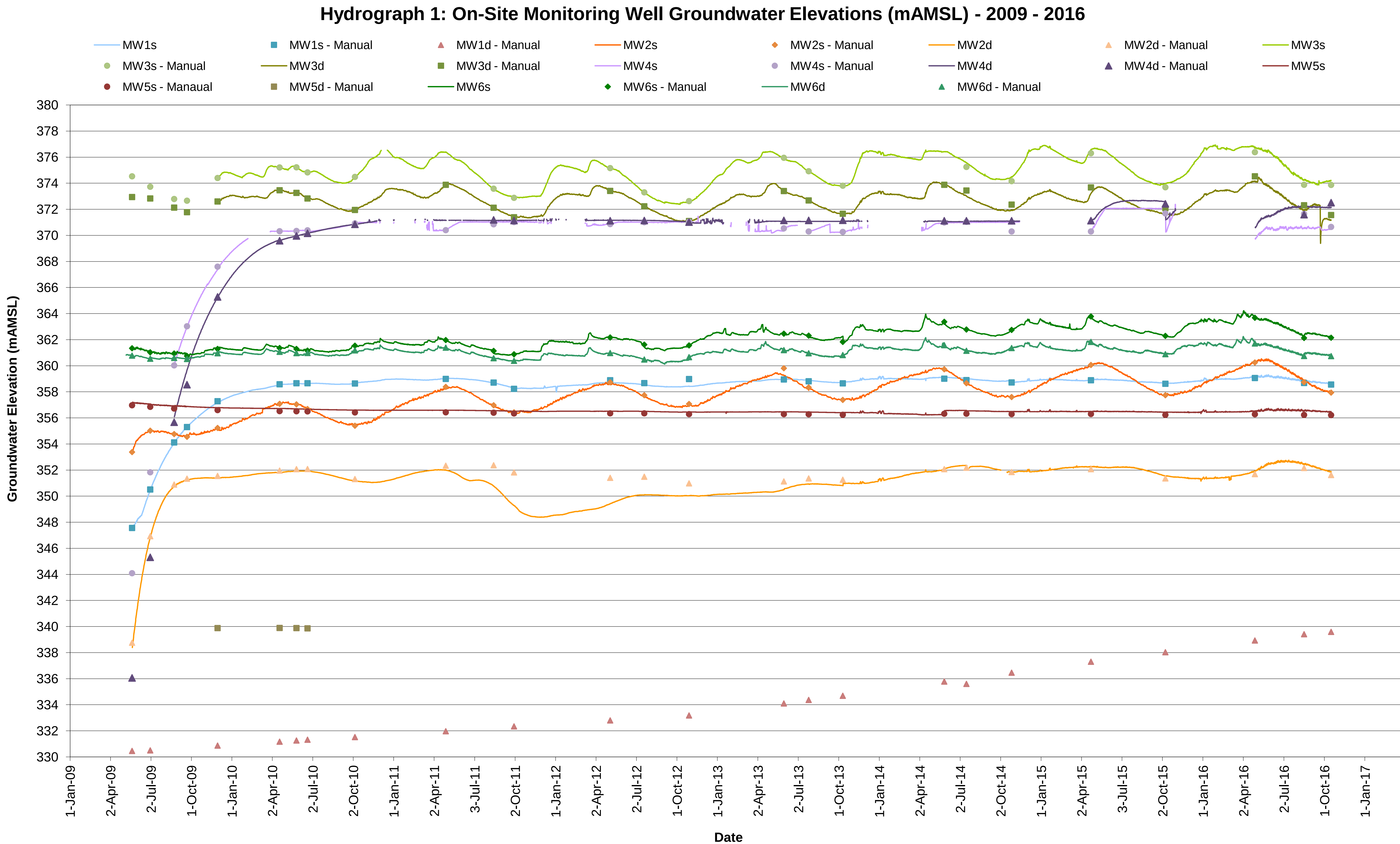
Well ID	X UTM Coordinate	Y UTM Coordinate	Elevation (m)	Depth (m)	WaterLevel (m)	WaterYield (lpm)	Water use	Water status	Screen depth (m)	Lithology
7130205	275880.04	4992567.03	N/A	103.63	6.13	45.46	Domestic	Water Supply	N/A	Granite Bedrock
2910388	277378.92	4991399.01	N/A	100.28	7.32	0	Commercial	Water Supply	N/A	Granite
2911801	276563.13	4990703.04	N/A	13.41	3.05	90.92	Domestic	Water Supply	N/A	Granite
2919177	276420.47	4991080.98	N/A	54.86	7.01	45.46	Domestic	Water Supply	N/A	Granite
2919892	275941.57	4990256.05	N/A	59.44	2.13	45.46	Domestic	Water Supply	N/A	Granite
2919950	275895.50	4992639.01	N/A	73.46	20.12	13.64	Domestic	Water Supply	N/A	Granite
2900198	277048.40	4991140.96	335.28	100.28	15.24	4.55	Domestic	Water Supply	N/A	Limestone
2900308	276120.39	4992740.99	335.28	15.24	N/A	N/A	N/A	Test Hole	N/A	Limestone
2900309	276120.39	4992740.99	335.28	15.24	N/A	N/A	N/A	Test Hole	N/A	Limestone
2900310	276113.42	4992721.99	335.28	19.2	4.57	N/A	Not Used	Test Hole	N/A	Limestone
2900311	276107.42	4992712.97	335.28	15.85	N/A	N/A	N/A	Test Hole	N/A	Limestone
2918301	276423.08	4991079.00	N/A	61.57	8.23	22.73	Domestic	Water Supply	N/A	Limestone
2918302	275360.26	4991789.96	N/A	70.1	3.35	45.46	Domestic	Water Supply	N/A	Limestone
2916021	276341.89	4991271.04	N/A	37.19	10.67	340.96	Domestic	Water Supply	N/A	Limestone Marble
2916913	276641.80	4990531.00	N/A	54.86	4.27	22.73	Domestic	Water Supply	N/A	Marble
2920402	276832.99	4991490.96	N/A	18.3	7.92	40	Domestic	Water Supply	N/A	Marble
2916805	276641.80	4990531.00	N/A	49.38	4.27	45.46	Domestic	Water Supply	N/A	Marble
	Average			52.49	8.54	35.08				
Overburden Wells										
2900034	276559.42	4991996.05	332.23	16.46	10.67	22.73	Commercial	Water Supply	N/A	Sand Gravel
2900203	276689.39	4991972.03	339.85	17.07	10.67	N/A	Industrial	Water Supply	N/A	Sand Gravel
7125005	276687.04	4991995.02	N/A	11.58	N/A	N/A	Test Hole	Test Hole	N/A	Sand Gravel
2920756	276031.03	4992195.01	N/A	11.5	3.5	23.4	Domestic	Water Supply	N/A	Sand Gravel
7131247	276624.97	4991996.98	N/A	10.06	N/A	N/A	Monitoring	Observation Wells	From 7.0104 to 10.06	Sand Gravel
2921335	277148.02	4991437.00	N/A	10.6	N/A	N/A	N/A	Observation Wells	From 7.6 to 10.60	Sand Silt
7100280	276620.97	4992020.03	N/A	11.43	N/A	N/A	Not Used	Observation Wells	From 8.23 to 11.43	Sand Silt
2908939	276829.44	4992021.95	320.04	42.67	10.36	113.65	Commercial	Water Supply	N/A	Gravel
2900312	276105.37	4992713.04	332.23	13.41	4.57	N/A	Public	Water Supply	From 9.7536 to 13.11	Gravel Gravel Sand
2900307	276099.41	4992716.03	320.04	45.42	N/A	N/A	N/A	Test Hole	N/A	Clay Gravel
	Average			19.02	7.95	53.26				
Unknown Water Source										
2919893	275941.57	4990256.05	N/A	N/A	N/A	N/A	Not Used	Abandoned-Supply	N/A	N/A
7048894	277148.97	4991436.96	N/A	N/A	N/A	N/A	N/A	Abandoned-Other	N/A	N/A
7131246	276583.01	4991982.99	N/A	N/A	N/A	N/A	N/A	Abandoned-Other	N/A	N/A
7131262	276583.01	4991982.99	N/A	N/A	N/A	N/A	N/A	Abandoned-Other	N/A	N/A

Table 6: Private Well Inventory Summary

ID	Type	Diameter (m)	Depth (m)	Water Source	In Use
PW1	Drilled	0.15*	91.44*	Bedrock*	Yes
PW2	Drilled	0.20*	67.05*	Bedrock*	Yes
PW3	Drilled	0.15*	55.47*	Bedrock*	Yes
PW4	Dug	0.90*	4.57*	Overburden*	Yes
PW5	Drilled	0.15*	Unknown	Unknown	Yes
PW6	Drilled	0.20*	Unknown	Overburden*	Yes
PW7	Drilled	0.15*	44.2*	Bedrock	Yes
PW8	Dug	0.90*	2.56	Overburden*	Yes
PW9	Drilled	0.20*	97.54*	Bedrock	Yes
PW10	Drilled	0.158	24.38*	Bedrock	Yes
PW11	Dug	0.9	2.45	Overbudren*	Yes
PW12	Drilled	0.15	39.62*	Bedrock*	Yes
PW13	Drilled	0.15	32.65	Bedrock	Yes
PW14	Dug	0.9	5.49*	Overbudren*	Yes
PW15	Drilled	0.15	121.92*	Bedrock*	Yes

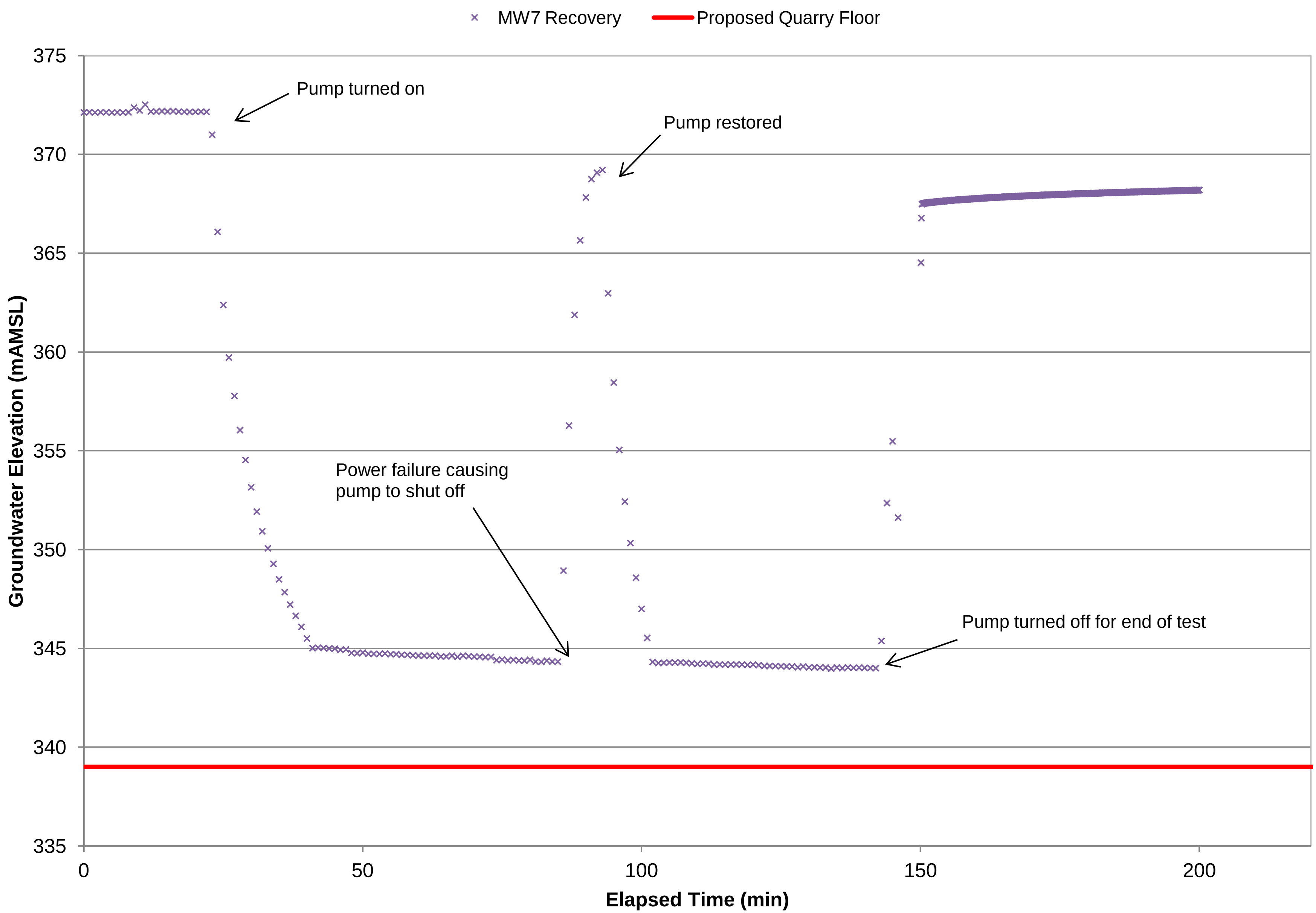
*Notes: * = reported by homeowner*

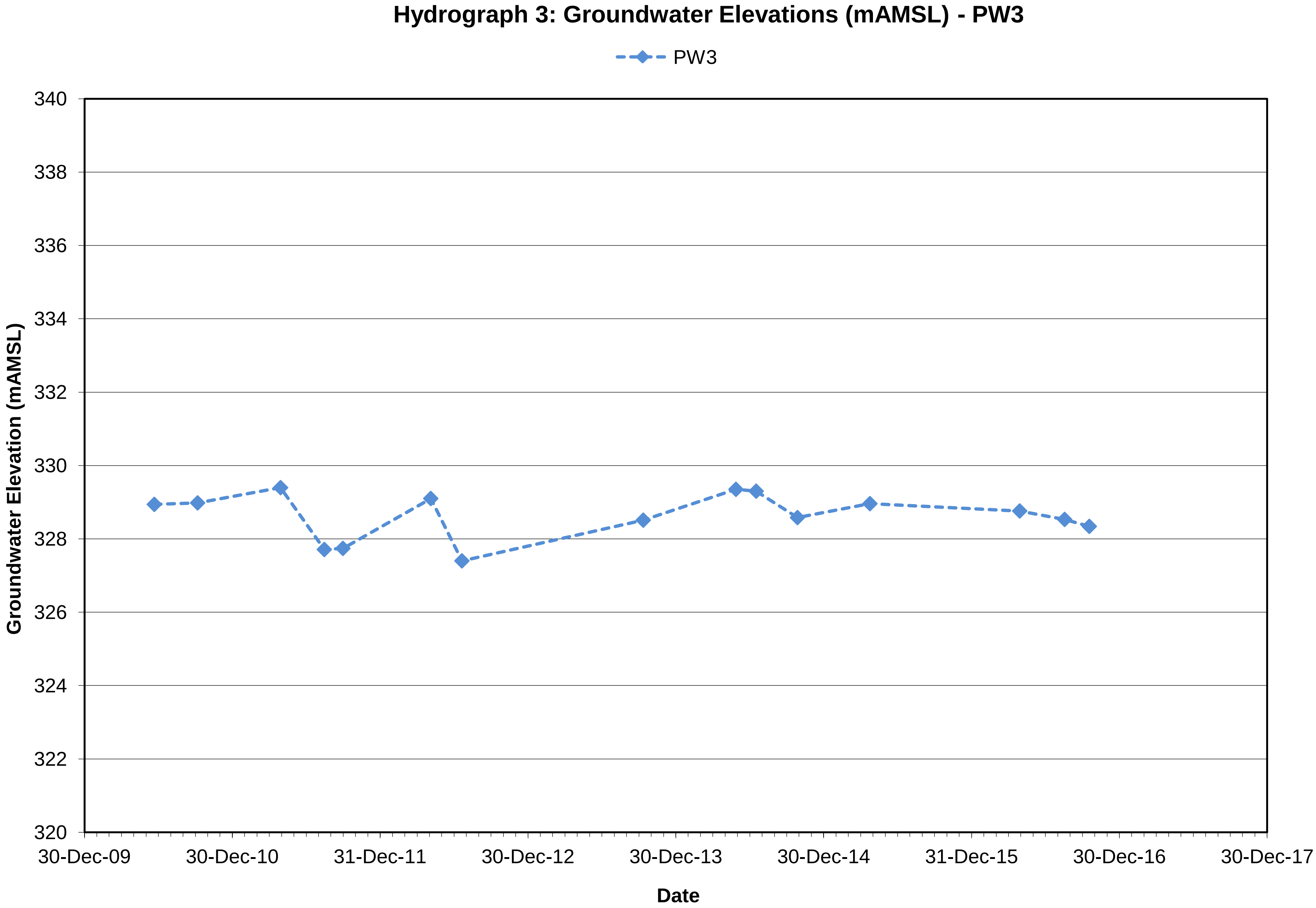
HYDROGRAPHS



Hydrograph 1: On-Site Monitoring Well Groundwater Elevations (mAMSL) - 2009 - 2016
MW1s
MW1s - Manual
MW1d - Manual
MW2s
MW2s - Manual
MW2d
MW2d - Manual
MW3s
MW3s - Manual
MW3d
MW3d - Manual
MW4s
MW4s - Manual
MW4d
MW4d - Manual
MW5s
MW5s - Manaual
MW5d - Manual
MW6s
MW6s - Manual
MW6d
MW6d - Manual
Groundwater Elevation (mAMSL)
380
378
376
374
372
370
368
366
364
362
360
358
356
354
352
350
348
346
344
342
340
338
336
334
332
330
1-Jan-09
2-Apr-09
2-Jul-09
1-Oct-09
1-Jan-10
2-Apr-10
2-Jul-10
2-Oct-10
1-Jan-11
2-Apr-11
3-Jul-11
2-Oct-11
1-Jan-12
2-Apr-12
2-Jul-12
1-Oct-12
1-Jan-13
2-Apr-13
2-Jul-13
1-Oct-13
1-Jan-14
2-Apr-14
2-Jul-14
2-Oct-14
1-Jan-15
2-Apr-15
3-Jul-15
2-Oct-15
1-Jan-16
2-Apr-16
2-Jul-16
1-Oct-16
1-Jan-17
2-Apr-17
Date

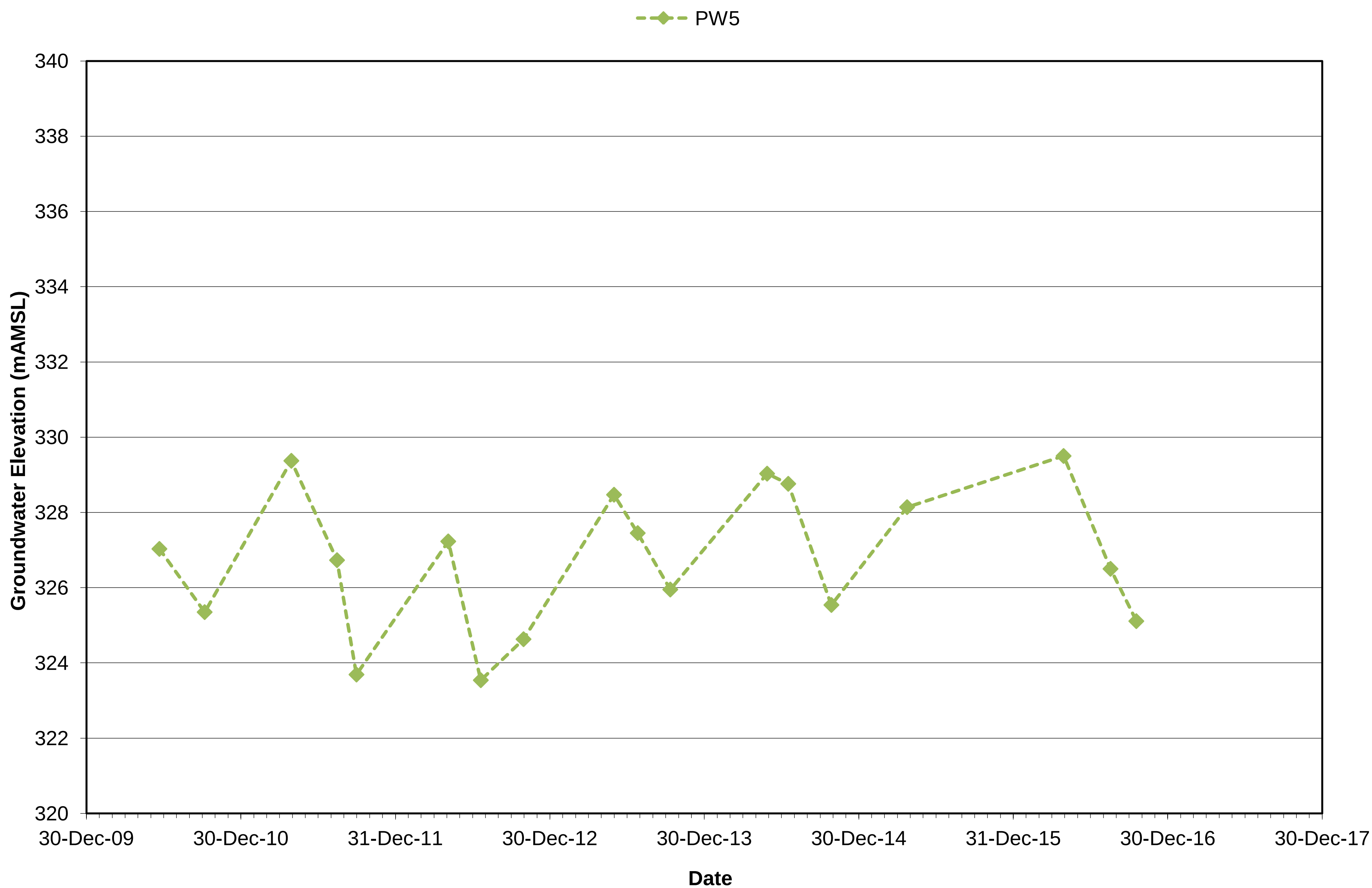
Hydrograph 2: Pumping Test of MW7



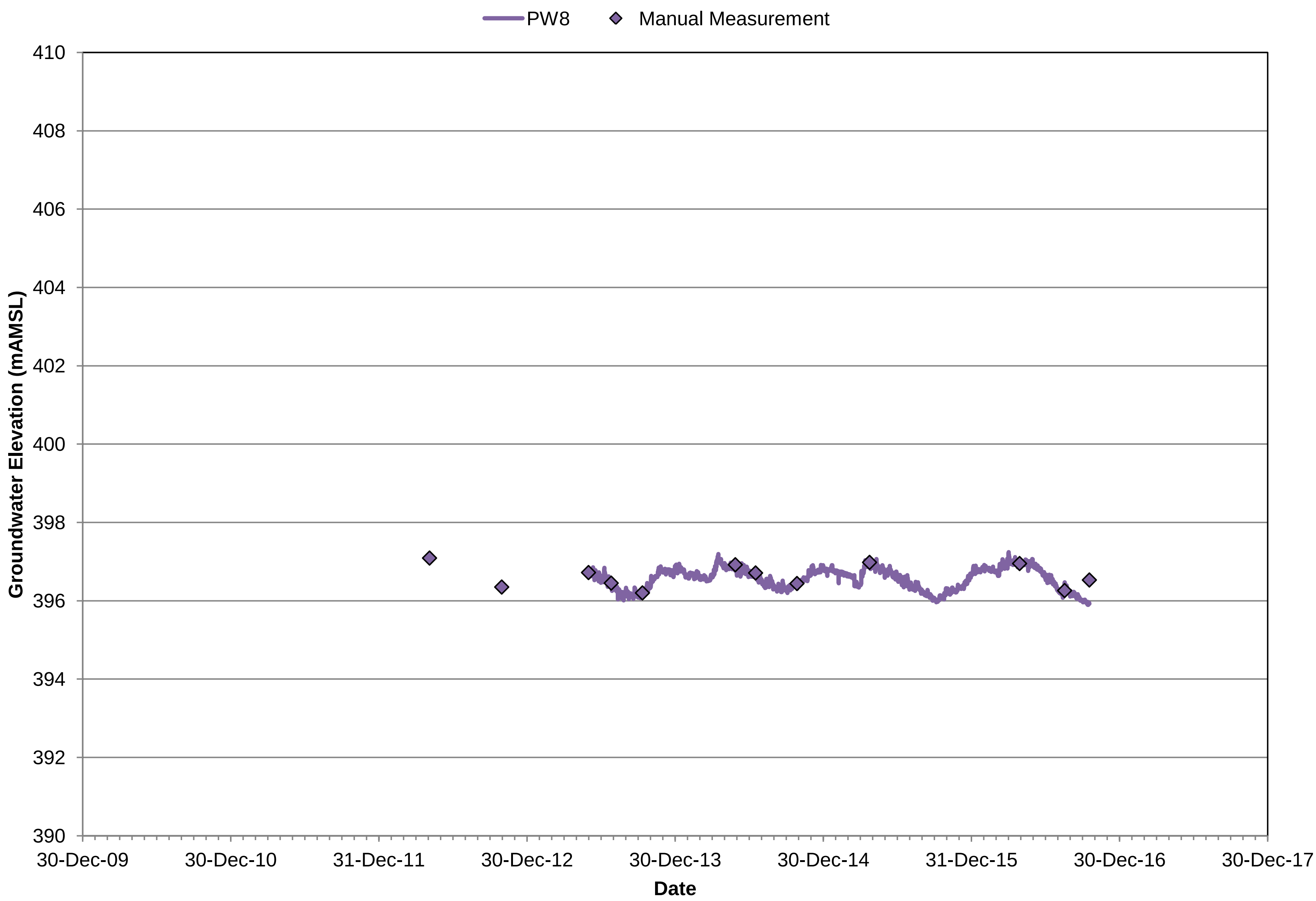


Hydrograph 3: Groundwater Elevations (mAMSL) - PW3
PW3
Groundwater Elevation (mAMSL)
340
338
336
334
332
330
328
326
324
322
320
30-Dec-09
30-Dec-10
31-Dec-11
30-Dec-12
30-Dec-13
30-Dec-14
31-Dec-15
30-Dec-16
30-Dec-17
Date

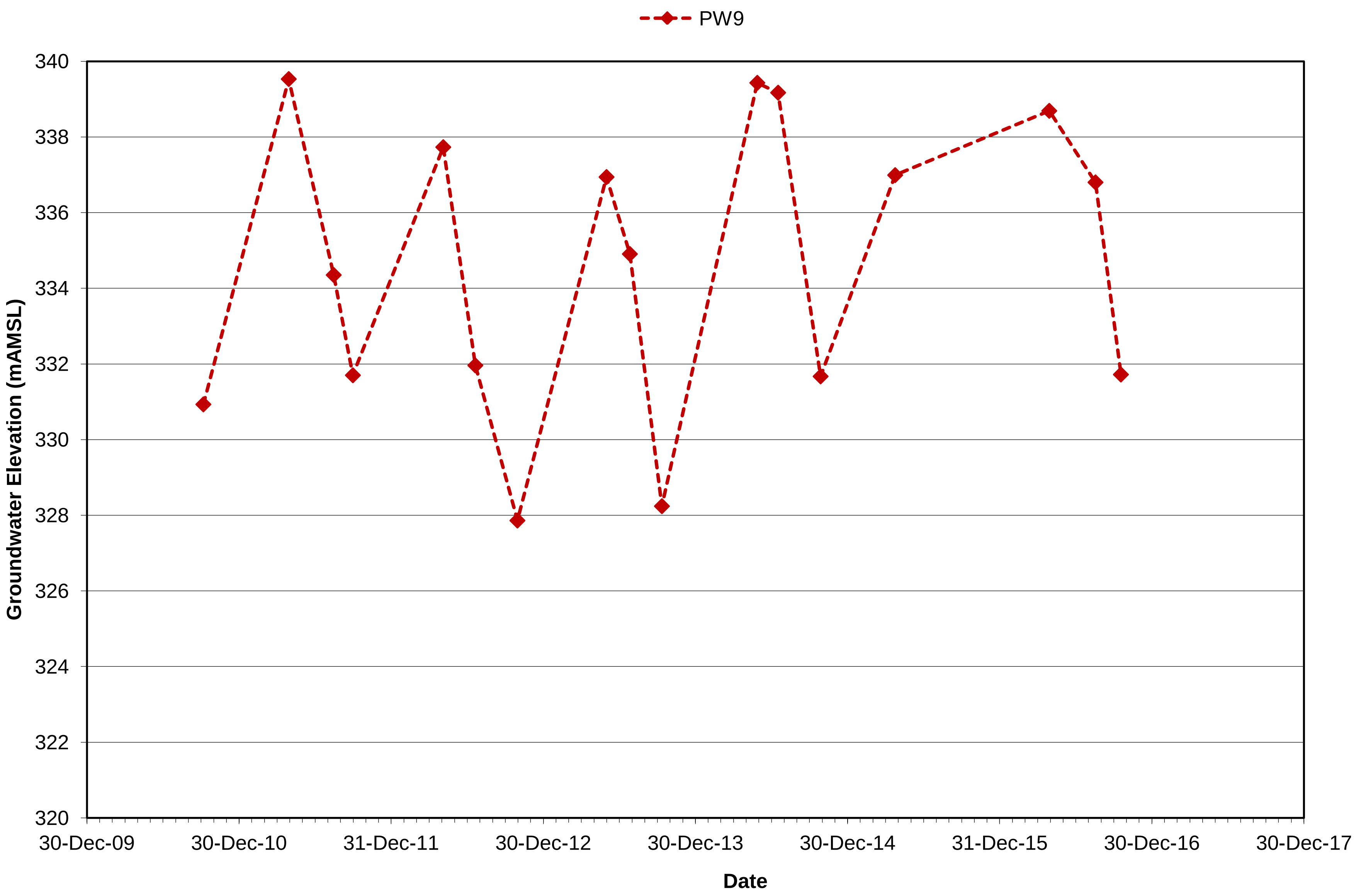
Hydrograph 4: Grounwater Elevations (mAMSL) - PW5



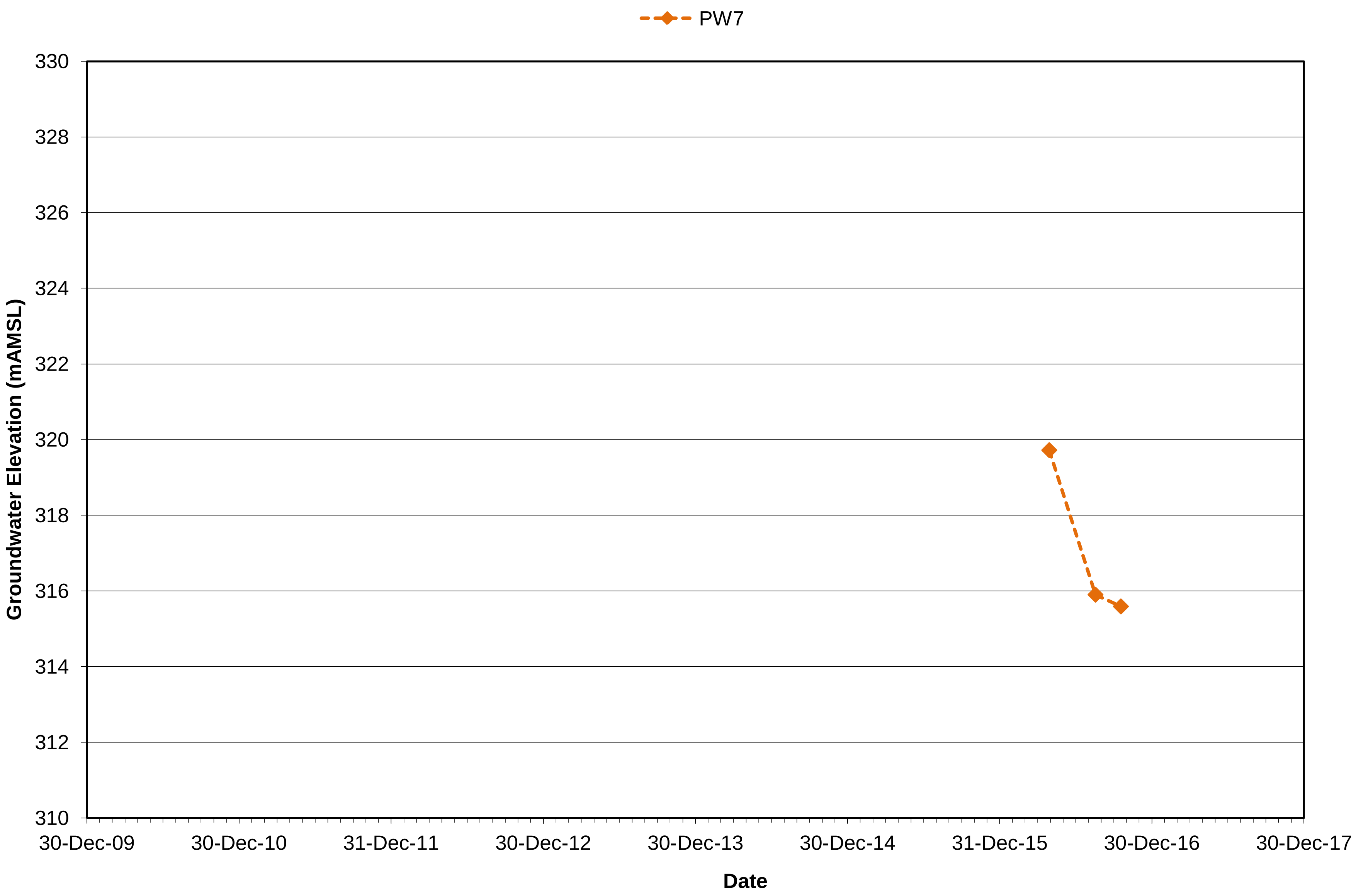
Hydrograph 5: Groundwater Elevations (mAMSL) - PW8



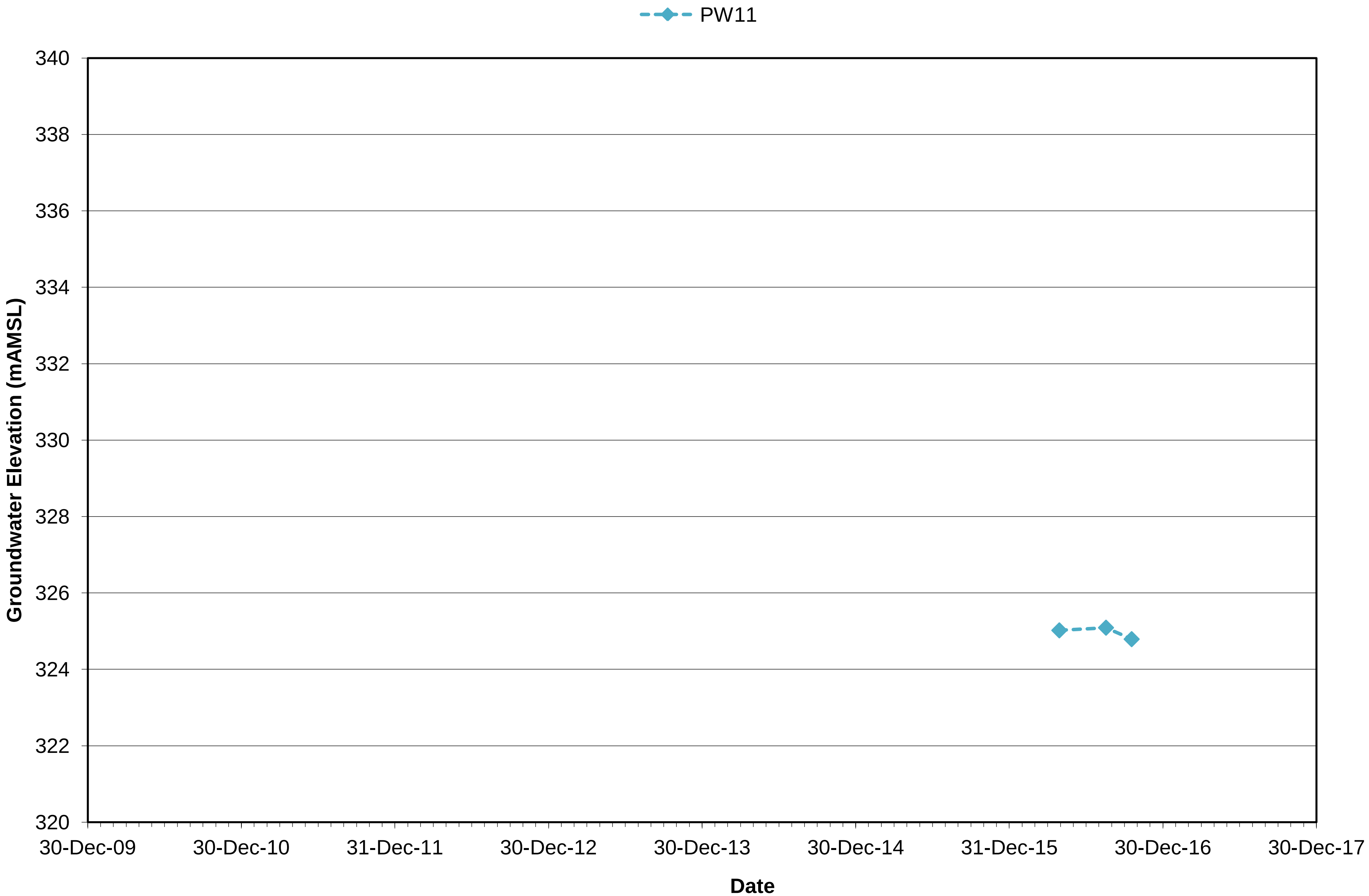
Hydrograph 6: Groundwater Elevations (mAMSL)- PW9



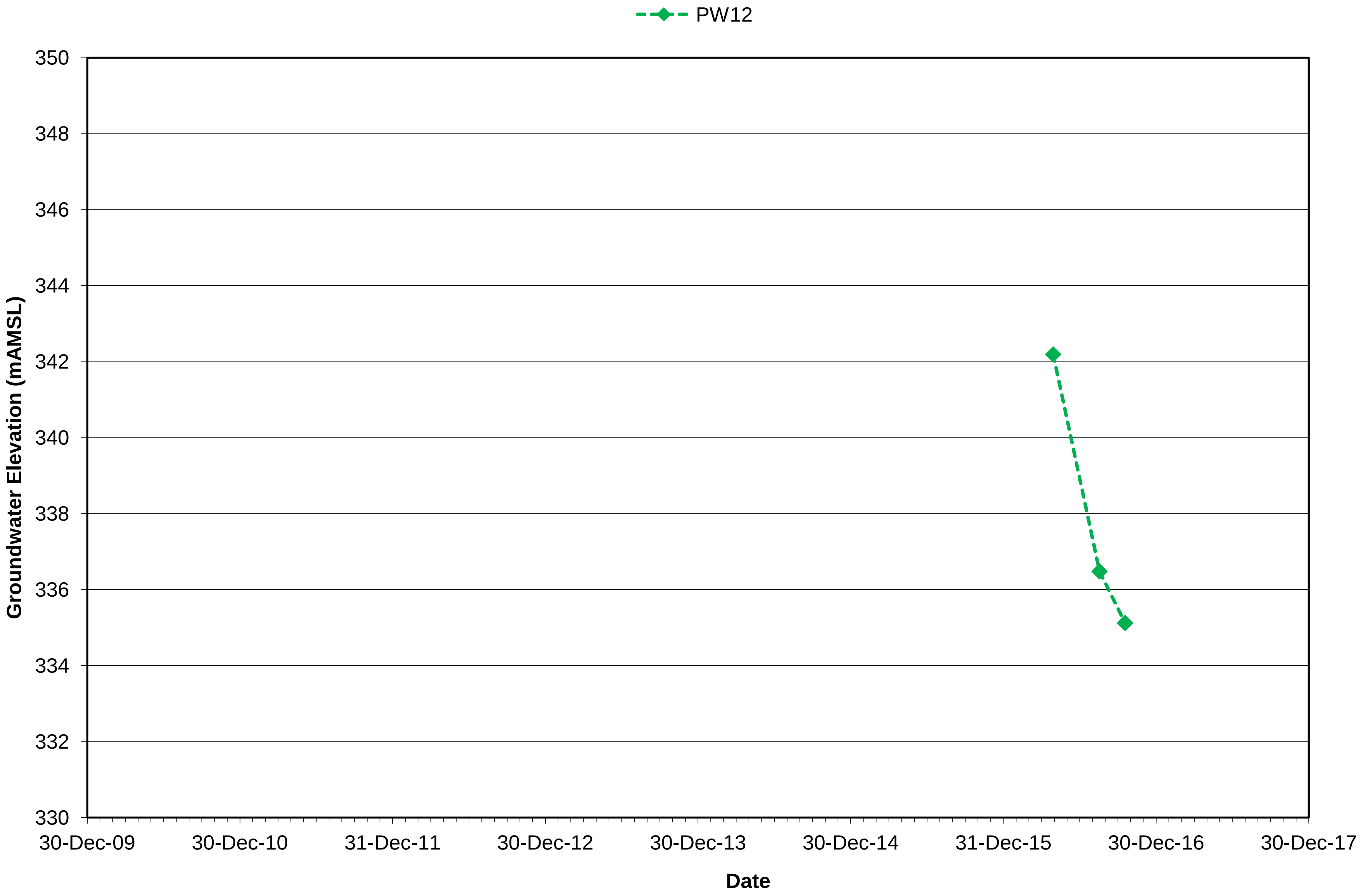
Hydrograph 7: Groundwater Elevations (mAMSL)- PW7



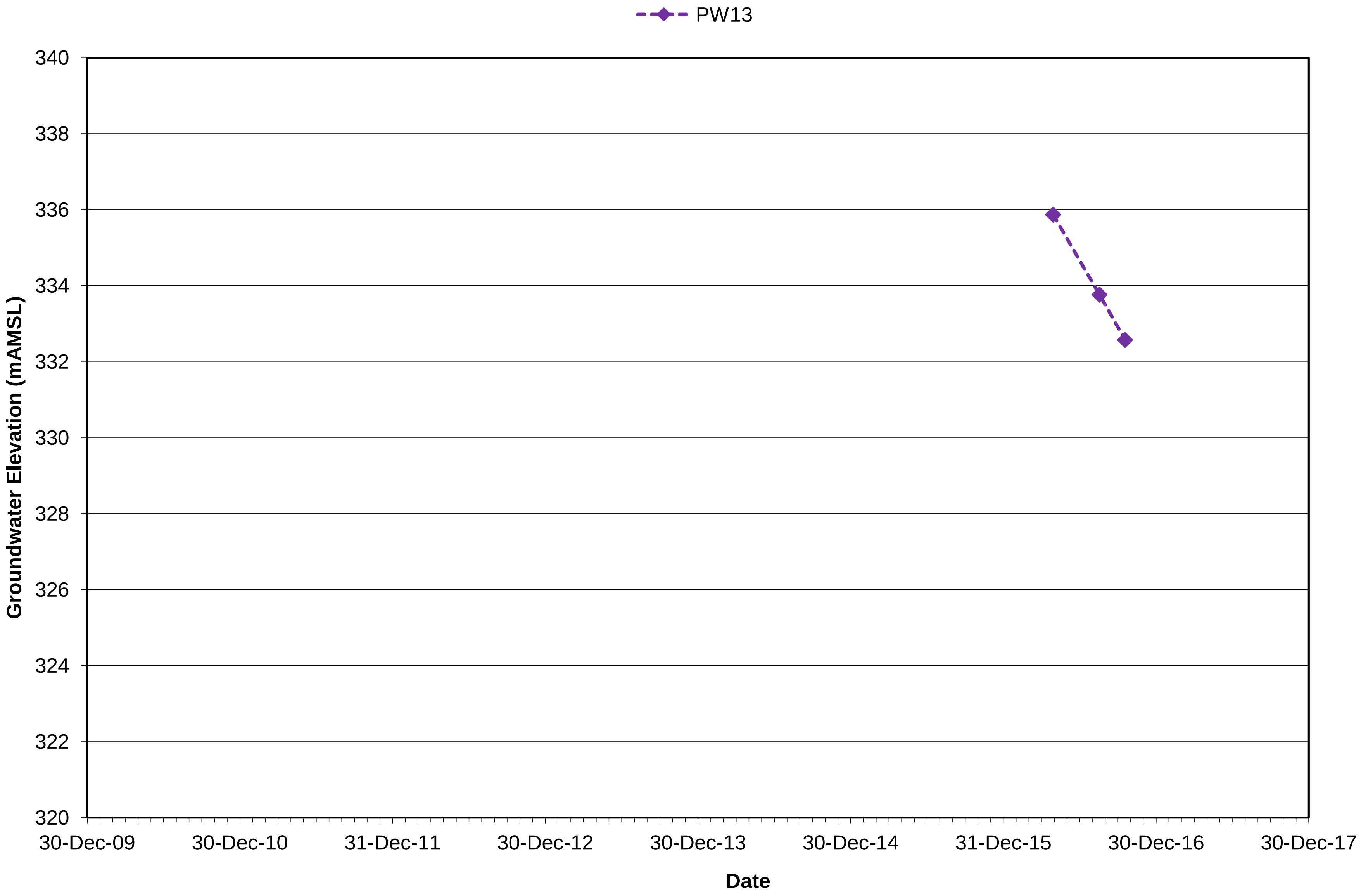
Hydrograph 8: Groundwater Elevations (mAMSL)- PW11



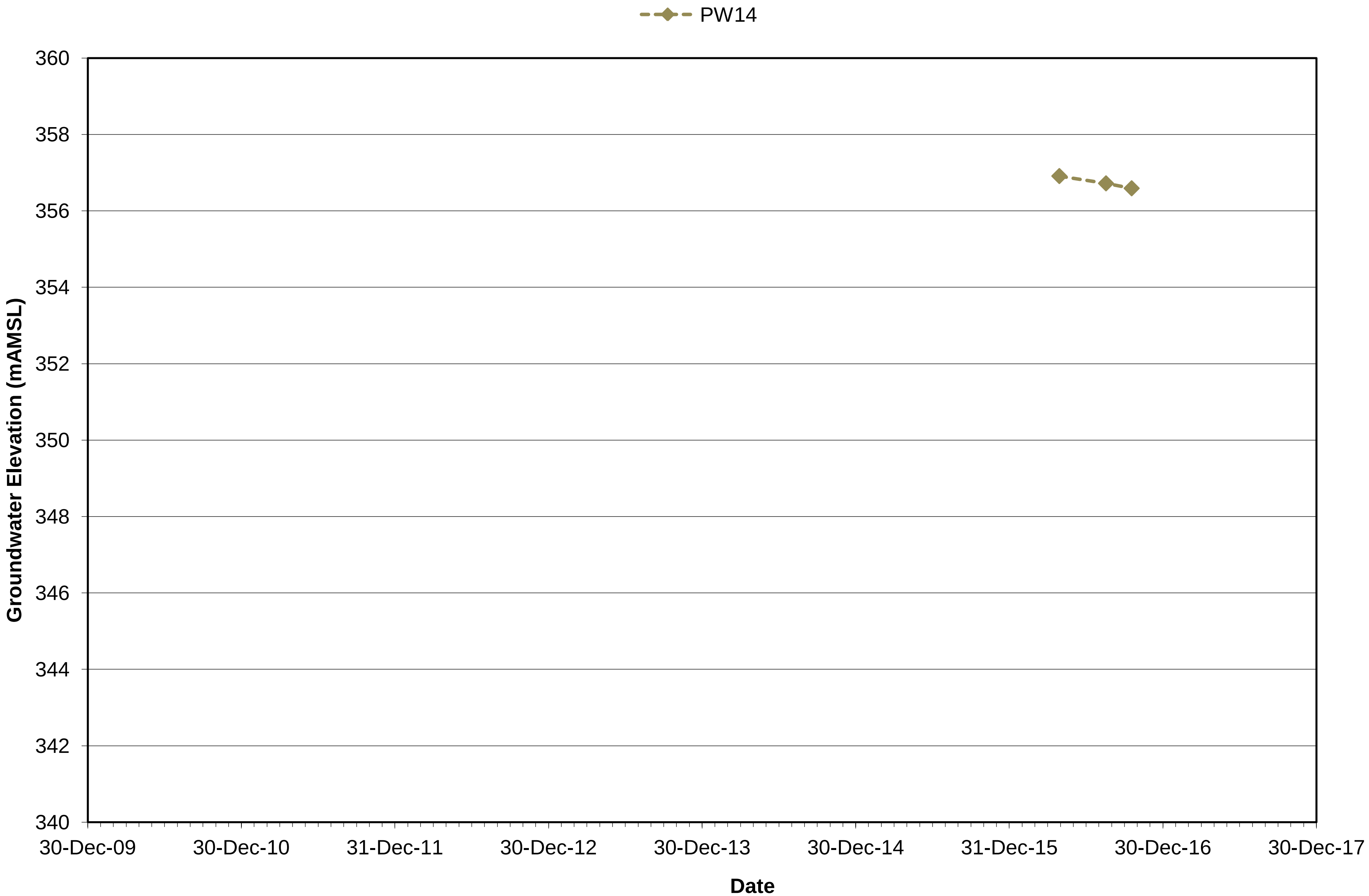
Hydrograph 9: Groundwater Elevations (mAMSL)- PW12



Hydrograph 10: Groundwater Elevations (mAMSL)- PW13



Hydrograph 11: Groundwater Elevations (mAMSL)- PW14



Hydrograph 12: Groundwater Elevations (mAMSL)- PW15