January 5, 2018
MTE File No: C36123-200

Ministry of the Environment and Climate Change
Attention: Permit to Take Water, Director
Environmental Assessment and Approvals Branch
135 St. Clair Avenue West, 1st Floor
Toronto, ON M4V 1P5

Dear Director:

Re: Ferma Aggregates Inc. – Carden Quarry Zone of Influence Assessment
Category 3 PTTW Application
Lot 6-10, Concession 9, Carden Township, City of Kawartha Lakes, ON

MTE Consultants Inc. (MTE) has been retained by Ferma Aggregates Inc. to conduct a hydrogeological study in support of an application for a Category 3 Permit to Take Water (PTTW) for dewatering at the Ferma Carden Quarry a Class A, Category 2, quarry below water located on Lot 6-10, Concession 9 Township of Carden, Kawartha Lakes, ON (hereby referred to as the "Site") see **Figure 1**. This technical memo will assess potential dewatering impacts and recommend trigger values in relation to the dewatering of Phase 1.

The objectives of this technical memorandum are to:

- Establish baseline groundwater conditions;
- Calibrate an analytical model to current groundwater conditions;
- Use the calibrated analytical model to predict future drawdown as it relates to the extraction of Phase 1;
- Develop and recommend revised trigger values, for ongoing monitoring purposes; and
- Establish an appropriate pumping rate for the new Category 3 10 year PTTW application.

The Site currently has a Permit to Take Water (PTTW) No. 3358-AKYGHJ for the purposes of dewatering which expires on April 30, 2018; prior to this the Ferma Carden Quarry had a PTTW No. 8538-9YTK5V which expired on December 31, 2016. 2016 dewatering volumes related to PTTW No. 8538-9YTK5V were successfully submitted to the Water Taking Reporting System on February 10, 2017. 2017 discharge volumes as reported by the client can be seen in **Attachment 1**.

1.0 SCOPE OF WORK

The scope of work for this hydrogeology study included:

- A review of the Technical Guidance Document for Hydrogeology Studies in Support of Category 3 Applications for Permits to Take Water (MOECC, 2008);
- A review of the *Ontario Water Resources Act (R.S.O., 1990 C. O.40)*;
- A review of the Permit to Take Water (PTTW) Manual and the Guide to Permit to Take Water Application Form (MOECC, 2007);
- A review of the Water Management Policies and *Provincial Water Quality Objectives* (the "Blue Book") (Ministry of Envionment and Energy, 1994);
- A review of the *Clean Water Act (2006);*
- A review of published geological and water resources maps;
- A review of Ontario Base Maps (OBM maps);
- An examination of water well records on file with the Ontario Ministry of the Environment and Climate Change (MOECC);
- A review of the Hydrotechnical Report (Ferma – Carden Quarry) for Ferma Crushed Stone Inc. (Oliver, Magione, McCalla & Associates Ltd., 1994);
- A review of the Hydrotechnical Report (Ferma – Carden Quarry) for Ferma Crushed Stone Inc. (Oliver, Mangione, McCalla & Associates Ltd., 1995);
- A review of the Environmental Impact Assessment Report for Ferma Crushed Stone Inc. (Niblett Environmental Associates Inc., 2002);
- A review of the Hydrotechnical Report Update for Ferma Aggregates Inc. (Trow Consulting Engineers Ltd., 2002);
- A review of Ferma Carden Quarry Monitoring Data. (exp., 2011);
- A review of Cumulative Impacts Assessment for Groundwater Takings in the Carden Plain Area. (Golder Associates, 2016);
- Site specific field work that included:
    - Field reconnaissance completed by MTE between 2012 and 2017;
    - Inspection of two private water wells and establishment as permanent monitoring wells with data loggers by MTE in 2017;
    - Continuous measurement of groundwater levels using dedicated pressure transducers (data loggers) installed in monitoring wells and private wells by MTE; and
    - A geodetic survey of monitoring wells and private wells.
- Determination of groundwater flow patterns beneath the Site;
- Assessment of potential impacts to:
    - Groundwater aquifers; and
    - Private well water supplies.

Background information pertaining to Site characteristics such as physiography, surface drainage, geology, hydrogeology as well as monitoring well installation details and previous studies has been outlined in the following previous reports:

- Hydrotechnical Report (Ferma – Carden Quarry) for Ferma Crushed Stone Inc. (Oliver, Magione, McCalla & Associates Ltd., 1994);
- Hydrotechnical Report (Ferma – Carden Quarry) for Ferma Crushed Stone Inc. (Oliver, Mangione, McCalla & Associates Ltd., 1995);
- Environmental Impact Assessment Report for Ferma Crushed Stone Inc. (Niblett Environmental Associates Inc., 2002);
- Hydrotechnical Report Update for Ferma Aggregates Inc. (Trow Consulting Engineers Ltd., 2002); and
- Ferma Carden Quarry Monitoring Data. (exp., 2011).

2.0 FIELD DATA

On-Site monitoring wells were drilled and installed between 1993 and 2006 (**Figure 2**). Monitoring Wells BH1 to BH5, W9, W21 & W22 were installed in 1993, OH1, OH2 & OWA were installed in 2002, WC, WD, WE & BH2 which replaced the previous BH2 were installed in 2004 and WA, WB, WF, WG, WH & WI were installed in 2006. Currently there are 20 monitoring well locations on Site, of these 10 are installed as nested wells. Nested wells have been named to indicate the depth with A wells (WAA, WBA, WCA etc.) being the shallowest; B wells (WAB, WBB, WCB etc.) being installed at an intermediate depth and C wells (WAC,WBC, WCC etc.) being installed at the deepest depth. “A” wells generally correspond to wells screened within the Bobcageon Formation; “B” wells correspond to wells screened in the Lower Bobcageon Formation or Gull River Formation and “C” wells correspond to wells screened in the Shadow Lake Formation.

Dedicated pressure transducers (data logger) have been installed in 14 of the 47 monitoring well locations on-Site to monitor groundwater levels on an hourly basis. In addition data loggers were installed in the quarry sump and two off-Site domestic wells (W3 & W2 **Figure 2**) in August 2016 and October 2017 respectively. Groundwater elevation data from all monitoring locations from 2012 to 2017 can be found in **Table 1** as well as **Hydrographs 1-24.** The hydrographs also indicate the bottom elevation of each well.

3.0 CONCEPTUAL MODEL

The formation to be extracted during Phase 1 is composed of dolomitic limestones with interbedded shales (Bobcageon Formation) (Oliver, Mangione, McCalla & Associates Ltd., 1995) and will remain approximately 10 to 15 m above the sensitive green marker

beds of the Gull River Formation (Golder Associates, 2016). As such, an analytical zone-of-influence calculation will describe the potential impacts to groundwater resources from quarry operations within the Lower Bobcageon Formation to a depth 255 meters above mean sea level (mAMSL) which represents the final floor elevation of Phase 1. The conceptual model developed by MTE to describe how groundwater will enter the quarry at the conclusion of Phase 1 is outlined below:

- At the conclusion of quarrying activities, the final shape of the proposed quarry can be approximated by a rectangle oriented in a north-south direction;
- The bedrock excavation is modeled to perform as a circular well with an effective area equivalent to Phase 1 and that groundwater entering the well will occur through a gravity driven seepage process;
- The proposed final floor elevation of Phase 1 will be at approximately 255 mAMSL;
- Groundwater monitoring indicates the quarry has a static water level of approximately 266.7 mAMSL; and
- The entire quarry face will be dewatered via gravity, resulting in a maximum drawdown at the quarry face of approximately 11.7 m.

Prior to estimating a zone of influence for future quarry operations it was important to understand and model the current conditions to ensure that future predictions can be done so with accuracy. As such, two scenarios were considered, the first aims to model the groundwater inflow rate and zone of influence of the current extent of the quarry (i.e. calibration to current conditions) and the second aims to predict the groundwater inflow rate and zone of influence after Phase 1 has been fully extracted using the methods developed/calibrated in Scenario 1.

4.0 SCENARIO 1- CURRENT CONDITIONS

The current extraction area of the quarry covers an area of approximately 1.7 ha (**Figure 2**), with the majority of the excavated area at a depth of approximately 261 mAMSL. In addition there is a small trench in the south-east corner covering an area of approximately 3.3 x 10^{-2} ha to a depth of approximately 258 mAMSL. For the purposes of this analytical model, and consistent with the industry's approach to the application of analytical solutions of this type MTE assumes that the bedrock groundwater system at the Site acts as an ideal confined aquifer with the following characteristics (Fetter, 2001):

- The aquifer is bounded on the bottom by a confining layer;
- All geological formations are horizontal and have an infinite extent;
- The potentiometric surface of the aquifer is horizontal prior to the start of dewatering;

- All changes in the positions of the potentiometric surface are due to the effect of dewatering;
- The aquifer is homogeneous and isotropic;
- All flow is radial to the quarry;
- Groundwater flow is horizontal;
- Darcy's Law is valid;
- Groundwater has a constant density and viscosity;
- The quarry (well) is 'screened' over the entire thickness of the aquifer; and
- The quarry (well) has an infinitesimal diameter and is 100% efficient.

During the winter of 2016 & 2017 the excavated area of the quarry was allowed to fill up (equilibrate) to static conditions. As such, an increased dewatering rate hereby referred to as the "spring freshet rate" in the spring/summer of 2016 and 2017 was required in order to drain the quarry and facilitate working (dry) conditions on the quarry floor (261 mAMSL) in as short a time frame as possible. In 2016 the spring freshet rate was approximately 29 L/s whereas in 2017 the rate was approximately 60 L/s. Following initial quarry dewatering, dewatering at a reduced rate was implemented for the remainder of the year to maintain working conditions within the quarry, this rate will be hereby referred to as the "maintenance rate". Due to the large amount of water in storage in the quarry prior to dewatering, aquifer characteristics were not able to be determined until the quarry was effectively dewatered. After initial dewatering, effectively removing all water from storage, the pumping rate was reduced to the maintenance rate and pseudo steady state conditions were reached in which the amount of water pumped from the quarry was a function of the amount of groundwater entering under steady state conditions in conjunction with water from precipitation and/or runoff. Under these conditions, steady state drawdown effects in the confined aquifer can be described using the Thiem equation (1906) (**Equation 1**) (Fetter, 2001).

$$T = \frac{Q}{2\pi(h_2 - h_1)} \ln\left(\frac{r_2}{r_1}\right) \qquad \textit{Equation 1}$$

Where:
- T = aquifer transmissivity (m^2/day)
- Q = constant dewatering rate (m^3/day)
- h_1 = groundwater elevation at a distance "r_1" from the quarry (well) (mAMSL)
- h_2 = groundwater elevation at a distance "r_2" from the quarry (well) (mAMSL)

In addition to the assumptions presented above, the Thiem equation has the following assumptions (Fetter, 2004):

- The Aquifer is pumped at a constant discharge rate;
- There is no source of recharge to the aquifer (ie. infiltrating precipitation is not accounted for);

- The hydraulic gradient between the pumping well and monitoring wells is at steady state;
- The water removed from storage is discharged instantaneously with decline of head;
- The quarry drains at a constant rate; and
- Storage in the well can be neglected.

Equation 1 Parameters

Drainage/Pumping Rate (Q)

The drainage/pumping rate for groundwater inflow into the quarry is based on the pumping rate required to maintain a constant water level within the quarry sump during the maintenance pumping period. Through the analysis of pumping and precipitation data it was noted that between October 4th and October 10th 2016 the water level within the quarry sump remained relatively stable (± 0.02 m) during a time of little precipitation (**Hydrograph 22**) while a relatively constant pumping rate 355-375 L/min (**Table 2**) was maintained. As such, 355-375 L/min or 511-540 m^3/day (520 m^3/day on average) is interpreted to be the amount of groundwater entering into the quarry.

Groundwater Elevation (h)

20 of the 47 monitoring wells were selected to be representative of water levels within the lower Bobcageon Formation based on a screen mid-point depth between approximately 251 and 265 mAMSL and previously collected water level data. The analysis of 2016 and 2017 water level data indicate that WAB (**Hydrograph 13**) and WBB (**Hydrograph 14**) responded directly to pumping within the quarry sump (**Hydrograph 22**) and have been chosen as the monitoring wells that best reflect the effects of pumping from within the quarry sump. WCA (**Hydrograph 15**) also appears to show a direct correlation to pumping of the quarry sump but unfortunately a data logger was not installed in WCA until after pumping had begun in 2017 and as such has not been used in this analysis. Although some of the other wells may show some influence from what appears to be pumping, it is difficult to discern what is directly related to pumping and what is related to climate.

Groundwater elevations were taken from the WAB & WBB wells on October 7, 2016, corresponding to the same date in which the groundwater inflow rate is based on. As such the groundwater elevations for the WAB well and the WBB well were 262.86 (h_2) and 262.10 (h_1) mAMSL respectively.

Radial Distance from the Pumping Well (r)

In Equation 1, the radial distance from the pumping well (r) is used to assess pumping related drawdown at varying distances from the center of the quarry (well). MTE assumes that the area of the Site extracted acts as a large diameter well with an effective area equal to the area of the extracted area. The effective radius is given as:

$$r_s = \sqrt{A/\pi}$$

Where: r_s = Effective Radius
A = Area Extracted

The current excavation area is approximately 1.7 ha:

$$r_s = \sqrt{A/\pi}$$
$$= \sqrt{17{,}451\ m^2/\pi}$$
$$\approx 75\ m$$

Any drawdown calculated at a distance r within 75 m of the center of the quarry (well) is not meaningful as it would effectively be inside the "well". The distance from the well center to WA and WB is approximately 548 m (r_2) and 308 m (r_1) respectively.

Transmissivity

Based on an average pumping rate of 520 m^3/day the transmissivity was calculated to be 62.5 m^2/day, as shown below:

$$T = \frac{Q}{2\pi(h_2 - h_1)} \ln\left(\frac{r_2}{r_1}\right)$$
$$T = \frac{520}{2\pi(262.86 - 262.10)} \ln\left(\frac{548}{308}\right)$$
$$T = 62.5\ m^2/day$$

Groundwater Inflow (Q)

The amount of water currently entering into the existing excavated portion of the quarry can be estimated using the Darcy equation (**Equation 2).**

$$Q = KiA \qquad \textbf{\textit{Equation 2}}$$

Where:
Q = Volumetric Flow Rate (Groundwater Inflow Rate) (m^3/day)
K = Hydraulic Conductivity (m/day)
i = Hydraulic gradient
A = Area of the saturated quarry face (m^2)

Equation 2 Parameters

Area (A)

The current quarry can be conceptualized as a rectangular prism with a smaller rectangular prism located in the south eastern corner which represents the trench. To simplify the analytical modelling the quarry is conceptualized as a singular rectangular prism in which the volume of the trench has been uniformly applied over the volume of the entire quarry, causing the floor of the quarry to be conceptualized at 261.67 mAMSL, or 0.05 m lower than its actual elevation of 261.72 mMASL.

The aquifer thickness is presumed to be the difference between the static water level within the quarry sump prior to pumping (266.67 mAMSL) and the conceptualized quarry floor elevation of 261.67 mAMSL, this results in an aquifer thickness of five meters.

For Equation 2 it is assumed that the area contributing to the groundwater inflow into the quarry is equal to the area of the quarry face saturated under static conditions. Under static conditions it was found that the water level within the quarry prior to pumping was 266.67 mAMSL. The perimeter of the currently excavated area is approximately 569 m. The conceptualized depth of the quarry floor is 261.67 mAMSL. Assuming that water enters into the quarry from all sides the area is equal to the perimeter (569 m) of the quarry multiplied by the saturated thickness (5.0 m) or approximately 2845 m^2.

Gradient (i)

Groundwater flow gradients for each side of the quarry face were calculated based on the October 2016 groundwater flow map (**Figure 3**) and have been summarized in the table below. Additional groundwater flow maps for the months in which monitoring occurred in 2017 can be found in **Attachment 2**.

Face	Gradient
North	0.007
East	0.009
South	0.020
West	0.004

As there are no down gradient wells located within close proximity to the current quarry excavation the gradient on the west face was estimated to be approximately half that of the lowest gradient on the Site (North Face).

Hydraulic Conductivity (K)

Transmissivity is a product of the aquifer thickness (b) and the hydraulic conductivity (K) (T=Kb). Therefore the Hydraulic conductivity of the rock can be calculated by dividing the transmissivity (62.5 m^2/day) by the aquifer thickness (5 m) or 12.5 m/day (1.5 x 10^{-4} m/s).

Using a hydraulic conductivity of 12.5 m/day; a Q or the rate at which groundwater will flow into the quarry was estimated to be 401 m^3/day. This is almost 80% of the observed maintenance rate of 520 m^3/day as described above.

Zone of Influence

The Thiem equation was rearranged so that the distance at which a particular groundwater elevation occurred could be calculated.

$$T = \frac{Q}{2\pi(h_2 - h_1)} \ln\left(\frac{r_2}{r_1}\right)$$

$$r_2 = r_1 e^{\frac{2\pi T(h_2 - h_1)}{Q}}$$

A review of **Hydrographs 22, 14 & 13** indicate that water levels in the quarry sump, WBB and WAB were stable in mid-December 2016 prior to the pump being shut off. As such the water levels from these wells on December 16, 2016 were used in the Thiem equation.

Prediction Analysis - Scenario 1

It was found that the predictions made by the Thiem equation best described the empirical data when the groundwater inflow rate (Q) was 540 m^3/day and the transmissivity was 62.1 m^2/day. This represents the upper end of the observed groundwater inflow rate and less than a 0.5 m^2/day reduction in the transmissivity from that calculated. A summary of the Thiem equation results are presented in **Table 3** and presented on **Figure 4**. The predicted radial distance to the groundwater elevations observed in WAB and WBB were found to be within 22 m laterally for both wells. MTE considers this to be an acceptable result considering the limitations inherent with the analytical approach. As such, this approach will be subsequently used to predict the impacts from the full extraction of Phase 1.

A drawdown map based on the results of the Thiem equation is presented on **Figure 5,** for comparison purposes the drawdown observed in September 2017 was also plotted

as this month was observed to have the lowest water levels[1]. **Attachment 3** contains drawdown maps for all months in which pumping occurred in 2017.

Based on a review of **Figure 5** excluding the area directly to the south of the current extraction limit, the interpreted drawdown based on the Thiem equation coincides well in most places with that observed.

Differences between the results calculated using the Thiem equation and that observed are related to the assumptions inherent with the Thiem-equation specifically that the potentiometric surface is horizontal (when in reality it is sloped). As such, it is our opinion that using the method outlined above is a technically sound approach, on which additional drawdown predictions can be reliably and conservatively based.

5.0 SCENARIO 2- FULL EXTRACTION PHASE 1

Prior to using the Thiem equation to estimate groundwater drawdown as a result of dewatering Phase 1, the groundwater inflow (Q) must be calculated.

Groundwater Inflow (Q)

The amount was water entering the quarry following the full extraction of Phase 1 can be estimated using the Darcy equation (**Equation 2).**

$$Q = KiA \qquad \textbf{Equation 2}$$

Where: Q = Volumetric Flow Rate (Groundwater Inflow Rate) (m^3/day)
K = Hydraulic Conductivity (m/day)
i = Hydraulic gradient
A = Area of the saturated quarry face (m^2)

Equation 2 Parameters

Aquifer Thickness (b)

For the purposes of the analytical model the static groundwater elevation of 266.67 mAMSL observed in SG1 prior to pumping in 2017 will be applied as the static groundwater elevation for Phase 1.

[1] Drawdown maps were created by subtracting the groundwater water elevations measured or calculated from pre dewatering groundwater elevations (June 2017)

The proposed final floor depth of Phase 1 is 255 mAMSL, increasing the aquifer thickness from five metres (266.67 – 261.67 mAMSL) to 11.67 m (266.67 – 255 mAMSL).

Area (A)

The perimeter of Phase 1 of the quarry is approximately 3356 m. Phase 1 has a final floor elevation of 255 mAMSL. Assuming that water enters into the quarry from all sides the area is equal to the perimeter (3356 m) of the quarry multiplied by the saturated thickness (11.67 m) equaling an area of 39,165 m^2.

Gradient (i)

Since future groundwater gradients are not known at this time the groundwater gradients calculated in Scenario 1 will be applied to Scenario 2.

Based on the above the groundwater inflow rate (Q) for Phase 1 is estimated to be 4052 m^3/day or 56 L/s.

Zone of Influence

As stated in Scenario 1 transmissivity is a function of the hydraulic conductivity and the aquifer thickness (T =K x b) as the aquifer thickness has increased the transmissivity will also increase. As the aquifer thickness increased from 5 to 11.67 m, the transmissivity increased from 62.1 m^2/day to 144.9 m^2/day.

A summary of the Thiem equation results are presented in **Table 3** and presented on **Figure 6**. In addition a drawdown map (**Figure 7**) based on the results of the Thiem equation was created.

Prediction Analysis - Scenario 2

Based on the drawdown map created for Phase 1 (**Figure 7**) the greatest amount of drawdown will occur east of the Site in the up gradient direction of groundwater flow. The closest domestic wells to the east of the Site are located along Victoria road > 1.3 km from the quarry face and are located cross gradient from the direction of groundwater flow. As such, they are unlikely to be effected by dewatering activities from Phase 1.

There are three domestic wells located along Shrike road west of the Site, two of which are currently monitored (W3 & W2). Drawdown at W3 is predicted to be one to two meters whereas drawdown at W2 is predicted to be up to six meters. The predicted drawdown for the resident (W1) located directly west across Shrike Rd. from BH1 for

which an MOECC well record could not be found is estimated to be between eight and nine meters of drawdown.

6.0 DISCUSSION

Trigger Values

Trigger values are established in order to mitigate adverse effects to those domestic wells located within close proximity to the quarry. Trigger values were established in the past for wells BH1A and WF on the approved Operational Site Plan for the quarry, it should be noted that there is currently no trigger value for BH3A which is the closest monitoring well to W3. In order to mitigate potential impacts to W3, MTE recommends establishing a trigger value for BH3A.

Since the trigger value for WF was created prior to its construction MTE assumes that the trigger value outlined on the Site Operational Plan applies to WFA, which is the shallowest of the monitoring wells at this location and should be in the same aquifer as W2. Based on groundwater elevation data collected from the BH1A and WFA monitors, the trigger values outlined on the Site Operational Plan need to be updated to better reflect natural conditions. The current trigger value outlined on the Site Operational Plan for BH1A is 270 mAMSL yet groundwater elevation data collected indicates that the natural static water level in BH1A annually fluctuates between approximately 268 and 269 mAMSL. The current trigger value outlined on the Site Operational Plan for WF (which was developed prior to the installation of WF) is 265 mAMSL yet groundwater elevation data collected indicates that the static water level in WFA annually fluctuates between approximately 264 and 265 mAMSL.

Trigger values are intended to work as a early warning system to indicate that nearby domestic wells may be affected by drawdown in the near future. In order to develop effective trigger values the static groundwater elevation of the trigger well (i.e BH1A, WFA & BH3A) and those domestic wells (W1, W2 & W3) that may be affected must be known. In addition the amount of water column or available drawdown in each domestic well is also important in developing an effective trigger value. Unfortunately at this time access to W1 was not obtainable.

Hydrograph 25 indicates that the static water level in W2 is approximately 269-271 mAMSL and has 11.5-13.5 m of water column available; furthermore **Hydrograph 25** indicates that W2 and WFA have a similar trend in groundwater elevations, although the elevations themselves differ vertically by approximately 5 m. Since the groundwater elevations in WFA and W2 do not closely match each other WFA will not work as an effective trigger well to W2, instead a trigger value will have to be applied to W2 itself. The trigger value for W2 was developed by reviewing the results of Scenario 2 which indicated a potential drawdown at this location of approximately 6 m

and by taking into consideration the amount of available drawdown (11.5 m). Taking this information into account a trigger value of 263 mAMSL for W2 is recommended by MTE.

Hydrograph 26 indicates that the static water level in W3 is approximately 262-266 mAMSL and has 7-9 m of water column available; furthermore **Hydrograph 26** indicates that the groundwater elevation in W3 closely mimics that of BH3A. As the groundwater elevations in BH3A and W3 match each other BH3A can be used as an effective trigger well for W3. The trigger value for W3 was developed by reviewing the results of Scenario 2 which indicated a potential drawdown at this location of approximately 2 m and by taking into consideration the amount of available drawdown (7 m). Taking this information into account a trigger value of 259 mAMSL in BH3A is recommended by MTE.

As access to W1 was not obtainable and a MOECC record was not found at this time MTE cannot recommend a new trigger value.

Should quarry activities result in irreversible adverse effects to nearby domestic wells, the contingency measures as outlined on the Site Operational Plan shall be implemented.

Pumping Rate

Ferma Aggregates currently has a Certificate of Approval (COA) No. 9123-5WAQUT to discharge of up to 63 L/s. As such Ferma Aggregates will be applying for a pumping rate of 60 L/s in the enclosed PTTW application. A pumping rate of 60 L/s is required by Ferma to quickly dewater and maintain working conditions within the quarry.

In 2016 the spring freshet rate was approximately 29 L/s whereas in 2017 the spring freshet rate was approximately 60 L/s. Looking at the hydrographs, particularly those which clearly demonstrate an impact from pumping (WAB & WBB, **Hydrograph 13** & **Hydrograph 14**), supports that increasing the spring freshet rate from 29 L/s to 60 L/s did not cause any adverse impacts and simply resulted in the system reaching a pseudo steady-state faster.

7.0 SUMMARY

Based on the work conducted previously and the information presented in this letter, MTE Consultants Inc. offers the following summary:

- The formation to be extracted during Phase 1 is composed of dolomitic limestones with interbedded shales (Bobcageon Formation).
- The final floor elevation of Phase 1 is 255 mAMSL; as such the quarry will be approximately 11.7 m below the water table.
- Based on empirical data collected in 2016 and 2017 the transmissivity and hydraulic conductivity of the Lower Bobcageon Formation was estimated to be 62 m^2/day and 12.5 m/day respectively.
- The Thiem equation was effectively used to model drawdown related to pumping for the current conditions (Scenario 1).
- Using the same methods outlined in Scenario 1 the zone of influence for Phase 1 (Scenario 2) was estimated.
- The predicted drawdown following the extraction of Phase 1 at W3 and W2 was two and seven metres respectively. Drawdown at W1 was predicted to be up to nine metres.
- Based on groundwater elevation data collected by MTE from BH1A and WFA the previously established trigger values outlined on the Site Operational Plans are not applicable.
- Ferma Aggregates currently has a COA for the discharge of up to 63 L/s.
- Increasing the Spring Freshet Pumping Rate from 29 L/s in 2016 to 60 L/s in 2017 did not cause any adverse impacts to the system and resulted in pseudo steady state conditions being reached faster.

8.0 RECOMMENDATIONS

Based on the information presented in this letter, MTE Consultants Inc. offers the following recommendations:

- Revising the current trigger values such that:
  - WF be removed as a trigger well, as it does not reflect water levels within W2;
  - W2 be its own trigger well with a trigger value of 263 mAMSL;
  - Add BH3A as a trigger well for W3 with a trigger value of 259 mAMSL; and
  - Remove the trigger value of 270 mAMSL for BH1A as it is not representative of natural static conditions.
- Obtain access, if successful install a data logger and establish a trigger value for W1.
- Apply for a 10 year PTTW with a pumping rate of 60L/s which will facilitate and maintain working conditions within the quarry without causing an adverse impact to neighboring receptors.

9.0 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. 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.

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10.0 REFERENCES

1. exp. (2011). *Ferma Carden Quarry Monitoring Data.* Barrie.

2. Fetter, C. (2001). *Applied Hydrogeology.* Upper Saddle River: Prentice Hall.

3. Golder Associates. (2016). *Addendum - Cumulative Impacts Assessment for Groundwater Takings in the Carden Plain Area.* Ottawa.

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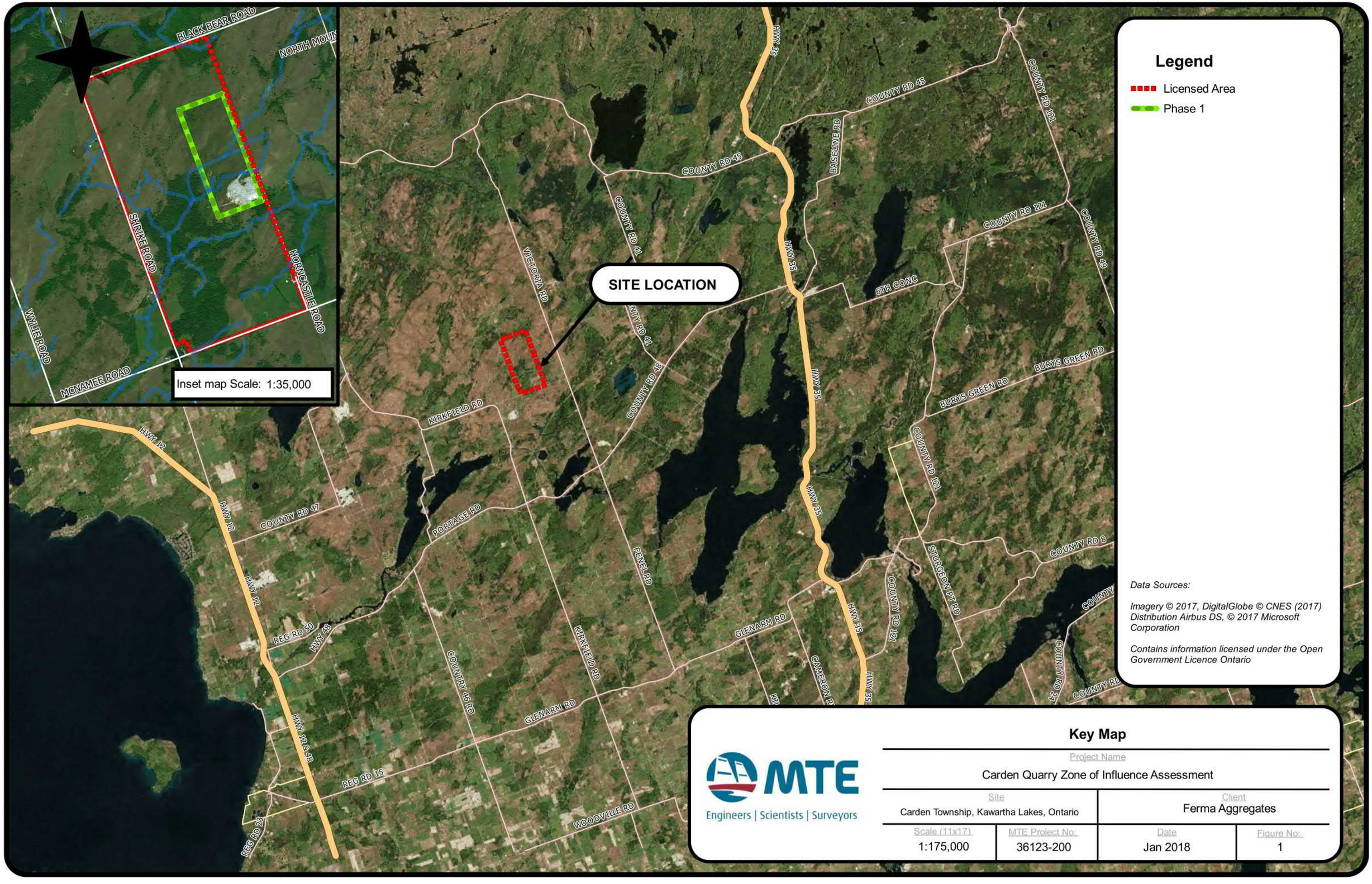
FIGURES



Project No: Q:/36123/200/Maps/36123-200 - Carden Quarry - QGIS.qgs

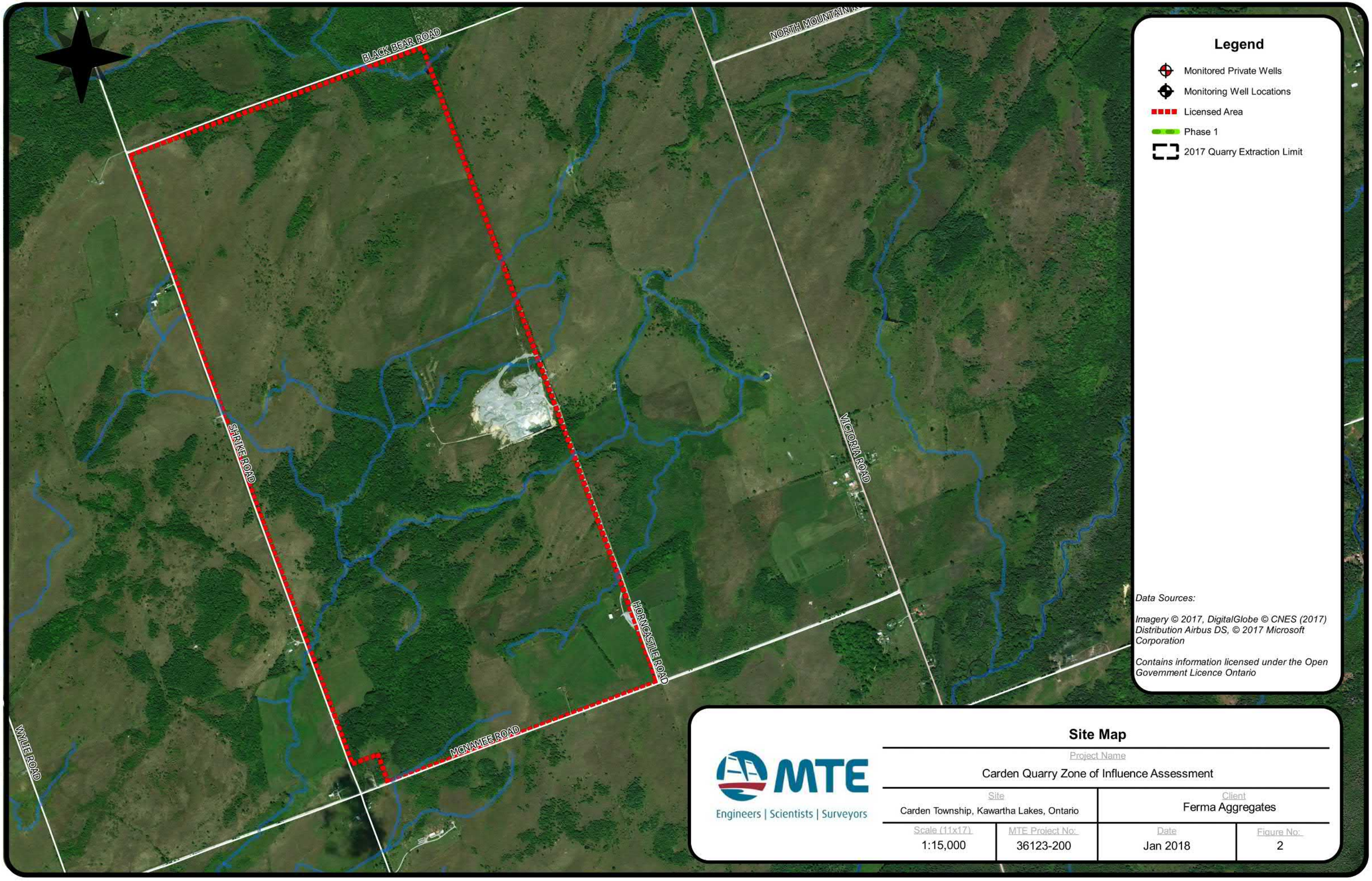
Key Map

January 03, 2018 - 08:53 - Plotted By: fcummings

Engineers | Scientists | Surveyors

Key Map

Project Name			
Carden Quarry Zone of Influence Assessment			
Site		Client	
Carden Township, Kawartha Lakes, Ontario		Ferma Aggregates	
Scale (11x17)	MTE Project No:	Date	Figure No:
1:175,000	36123-200	Jan 2018	1



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GW Flow

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MTE
Engineers | Scientists | Surveyors

Site Map

Project Name			
Carden Quarry Zone of Influence Assessment			
Site		Client	
Carden Township, Kawartha Lakes, Ontario		Ferma Aggregates	
Scale (11x17)	MTE Project No:	Date	Figure No:
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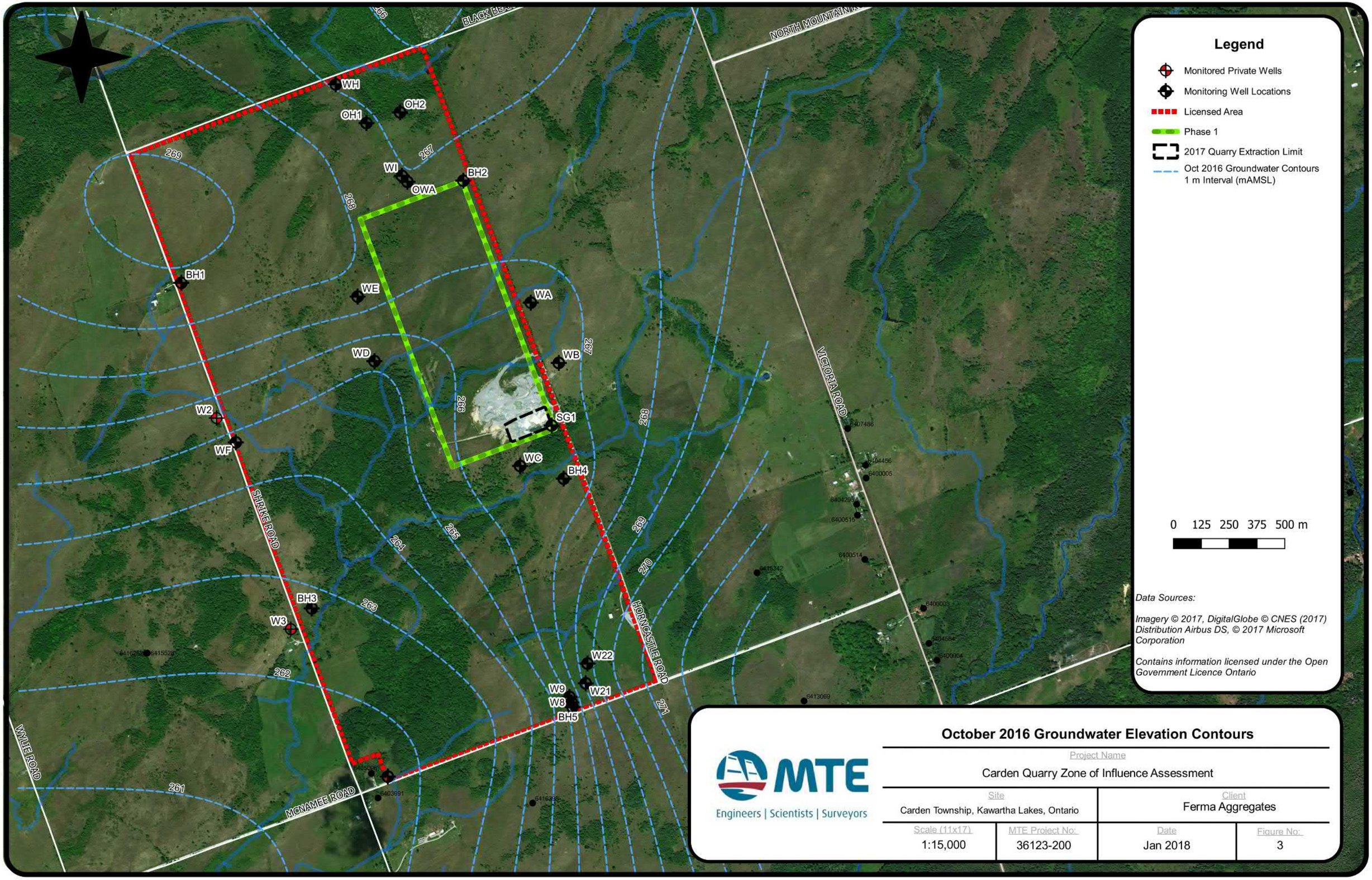

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GW Flow

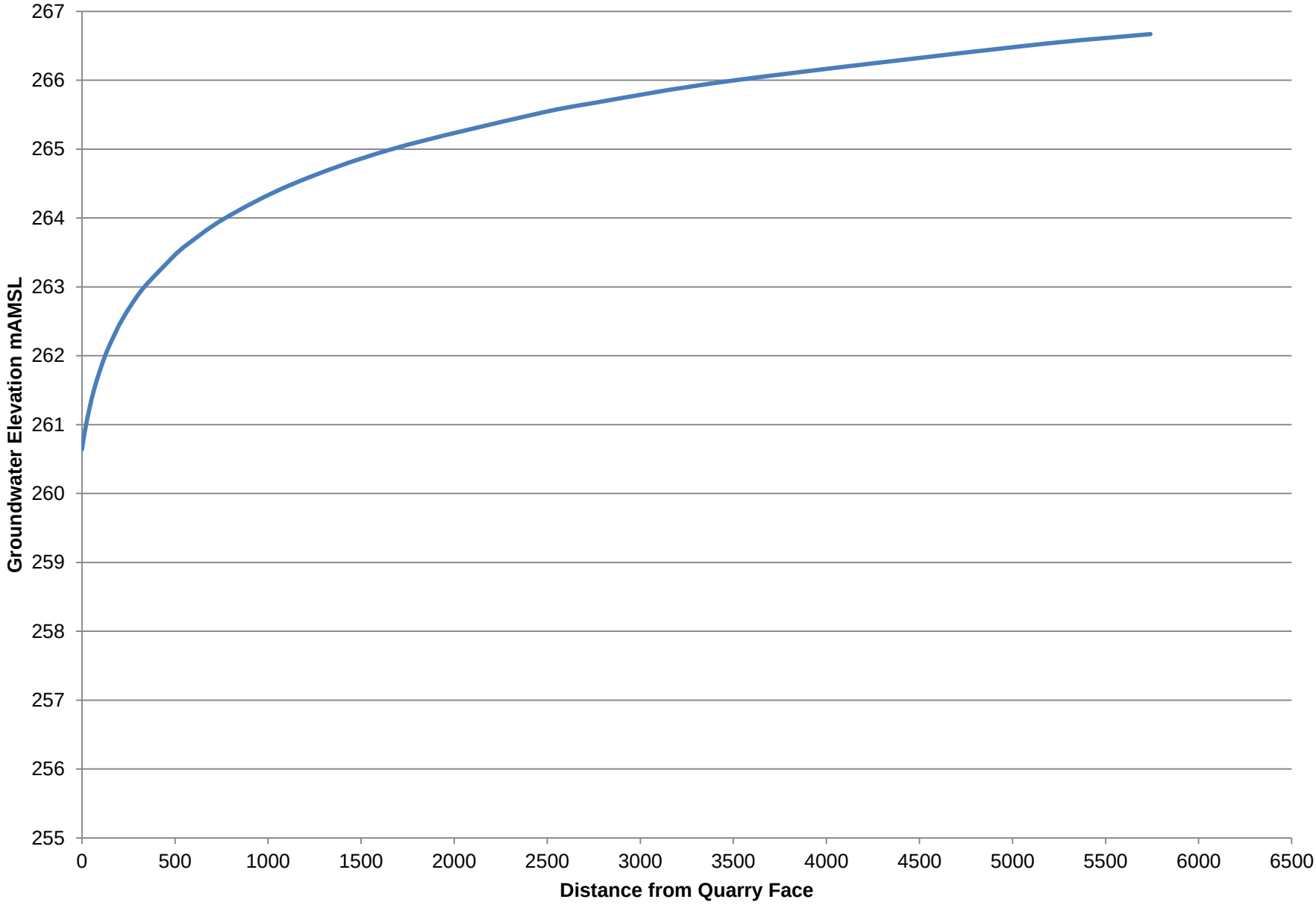
January 04, 2018 - 08:48 - Plotted By: fcummings

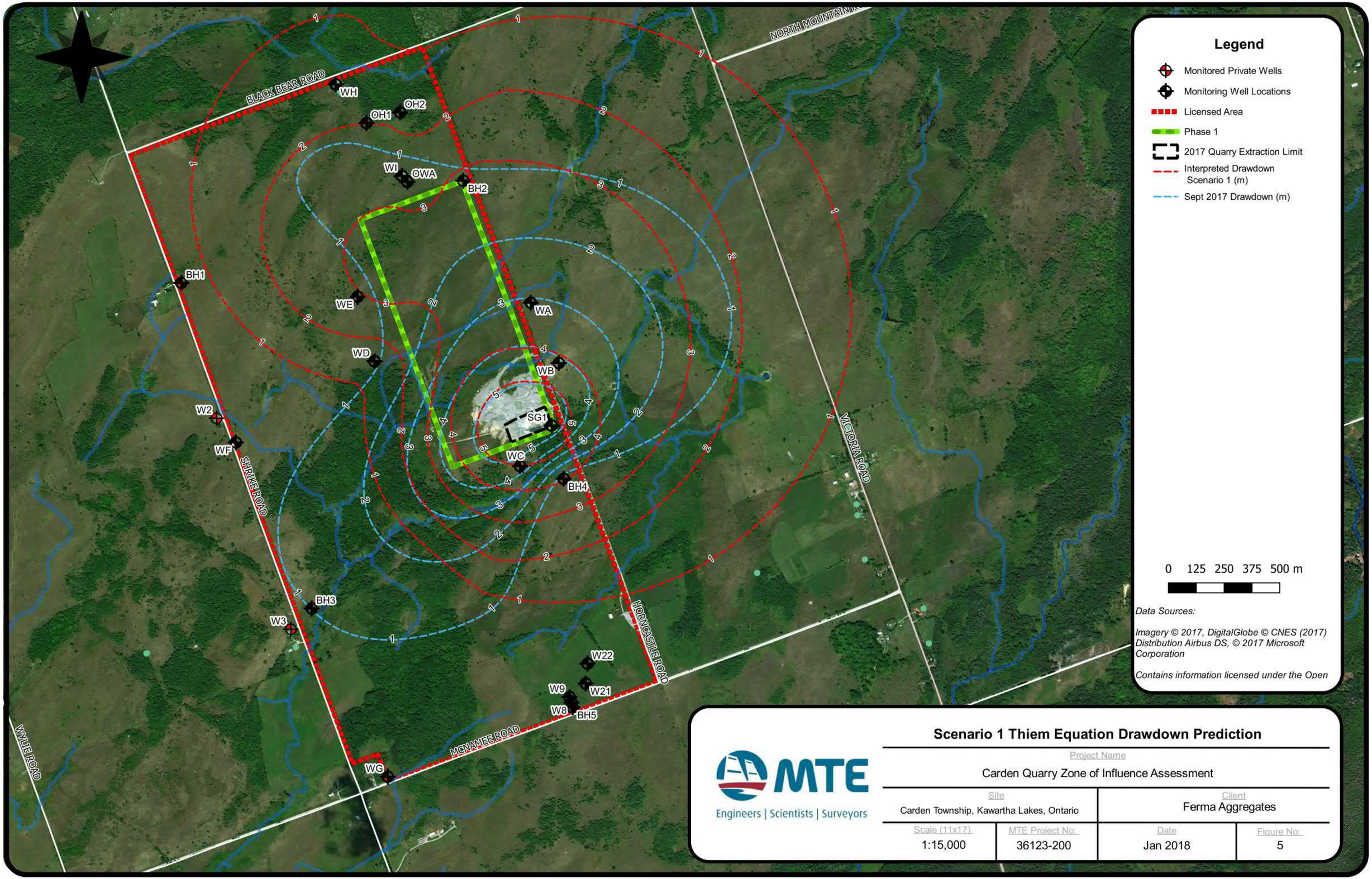
MTE
Engineers | Scientists | Surveyors

October 2016 Groundwater Elevation Contours

Project Name			
Carden Quarry Zone of Influence Assessment			
Site		Client	
Carden Township, Kawartha Lakes, Ontario		Ferma Aggregates	
Scale (11x17)	MTE Project No:	Date	Figure No:
1:15,000	36123-200	Jan 2018	3

Figure 4: Thiem Equation Results Scenario 1





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GW Flow

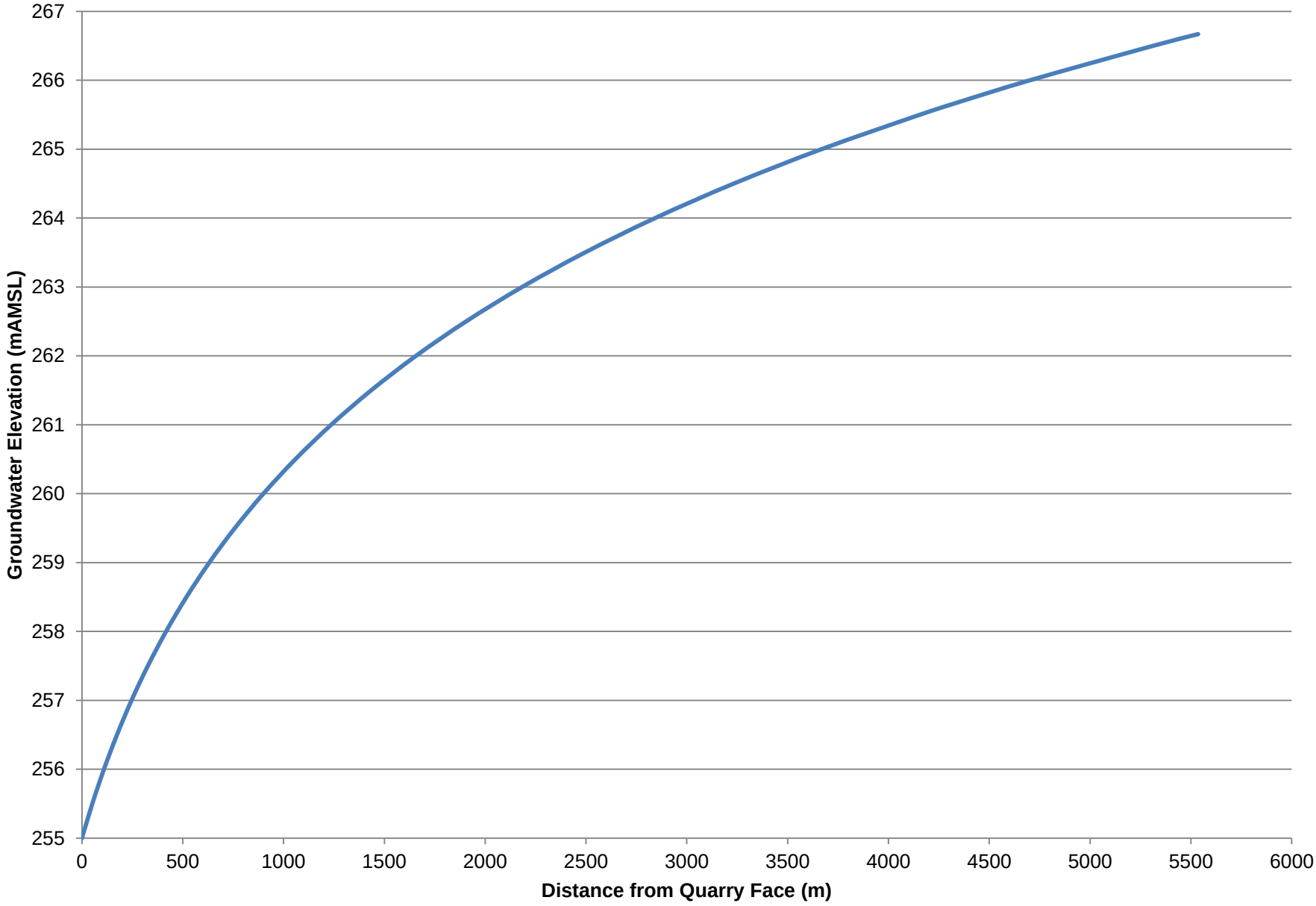
January 03, 2018 - 10:17 - Plotted By: fcummings

Scenario 1 Thiem Equation Drawdown Prediction

Engineers | Scientists | Surveyors

Project Name			
Carden Quarry Zone of Influence Assessment			
Site		Client	
Carden Township, Kawartha Lakes, Ontario		Ferma Aggregates	
Scale (11x17)	MTE Project No:	Date	Figure No:
1:15,000	36123-200	Jan 2018	5

Figure 6: Thiem Equation Results Scenario 2



Project No: Q:/36123/200/Maps/36123-200 - Carden Quarry - QGIS.qgs

GW Flow

January 03, 2018 - 11:54 - Plotted By: fcummings

Legend

- W1
- Monitored Private Wells
- Monitoring Well Locations
- Licensed Area
- Phase 1
- 2017 Quarry Extraction Limit
- Interpeted Drawdown Scenario 2 (m)
- MOECC Well Record Location

0 250 500 750 1000 m

Data Sources:

Imagery © 2017, DigitalGlobe © CNES (2017) Distribution Airbus DS, © 2017 Microsoft Corporation

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MTE
Engineers | Scientists | Surveyors

Scenario 2 Thiem Equation Drawdown Prediction

Project Name			
Carden Quarry Zone of Influence Assessment			
Site: Carden Township, Kawartha Lakes, Ontario		Client: Ferma Aggregates	
Scale (11x17): 1:30,000	MTE Project No: 36123-200	Date: Jan 2018	Figure No: 7

TABLES

Table 1: Groundwater Elevations (mAMSL) Manual Measurements - 2012 - 2017

	BH1A	BH1C	BH2A	BH2B	BH2C	BH3A	BH3C	BH4A	BH4C	OH1A	OH1B	OH2A	OH2B	OWA	W8	W9	WAA	WAB	WAC	WBA	WBB
T/case	274.33	274.33	272.24	272.24	272.24	265.55	265.55	268.36	268.36	269.29	269.29	267.91	267.91	273.02	269.98	270.21	271.59	271.59	271.59	272.81	272.81
T/PVC	274.43	274.45	272.22	272.22	272.23	265.41	265.36	268.49	268.43	269.25	269.13	267.93	267.92	No PVC Casing Installed			271.57	271.51	271.49	272.78	272.72
1-Jun-12	268.53	268.57	-	-	266.61	262.22	262.36	-	-	266.88	263.55	266.33	263.72	-	-	-	266.43	263.83	266.54	265.43	263.09
21-Jun-12	268.25	268.47	266.46	266.71	266.39	261.87	261.90	265.98	266.22	266.78	263.39	266.22	263.72	266.00	267.34	265.46	266.36	263.56	266.39	265.37	262.81
27-Jul-12	268.17	268.37	265.80	-	265.91	261.64	261.48	265.82	265.77	266.42	263.02	265.60	263.34	265.20	267.54	264.81	265.92	263.17	265.80	265.08	262.63
23-Aug-12	267.69	268.19	265.72	265.73	265.75	261.79	261.45	265.75	265.61	266.46	263.10	265.44	263.20	265.04	-	264.57	265.89	263.14	265.73	265.18	262.57
23-Nov-12	269.13	268.45	267.63	267.57	267.20	262.89	263.31	266.32	267.01	267.66	263.70	266.52	263.84	267.02	267.97	266.41	267.50	264.23	267.35	265.58	263.34
30-Oct-13	268.84	269.29	267.98	267.97	267.41	264.20	262.68	266.50	267.06	267.62	263.77	266.58	263.93	267.15	268.45	266.60	267.20	264.27	267.36	266.12	263.38
10-Sep-14	268.37	268.24	266.51	266.31	266.19	261.87	261.84	265.81	266.23	267.00	263.60	266.14	263.73	265.23	-	264.98	266.47	263.44	266.14	265.53	262.47
14-May-15	268.84	268.81	267.60	267.80	267.02	263.01	262.73	266.55	267.03	267.41	263.83	266.49	263.96	266.52	268.67	266.11	267.33	266.47	267.03	266.78	266.72
18-Jun-15	268.58	268.52	267.44	267.09	266.67	262.87	262.41	266.55	266.69	267.31	263.69	266.33	263.90	266.49	268.11	266.07	267.35	266.36	266.66	266.82	266.69
30-Jul-15	268.79	268.72	267.50	267.46	266.76	262.29	262.33	266.45	266.75	267.04	263.62	266.32	263.81	266.81	267.79	265.69	267.53	266.34	266.76	266.69	266.69
27-Aug-15	268.69	268.22	267.00	266.96	266.38	261.97	261.92	266.55	266.39	266.57	263.59	266.20	263.79	266.12	*	265.29	267.29	266.19	266.37	266.60	266.54
21-Sep-15	268.24	268.45	267.36	267.05	266.46	262.67	262.33	266.48	266.45	267.18	263.64	266.22	263.80	266.16	*	265.55	267.36	266.33	266.44	266.76	266.64
15-Oct-15	268.25	268.53	267.08	266.96	266.37	262.10	261.92	266.40	266.37	266.57	263.55	266.12	263.74	266.15	*	265.15	267.35	266.13	266.36	266.41	266.44
16-Dec-15	269.05	269.01	267.99	267.86	267.22	264.04	263.19	266.66	267.21	267.58	263.82	266.55	263.93	267.61	268.30	266.58	267.49	266.85	267.21	267.03	267.05
10-May-16	266.74	269.07	267.69	267.78	267.00	263.03	262.76	266.56	267.02	267.36	263.74	266.49	263.95	267.07	268.61	266.19	267.44	266.65	266.99	266.84	266.90
28-Jun-16	268.15	268.73	266.90	266.94	266.37	261.97	262.04	266.39	266.40	266.52	263.46	266.12	263.68	266.43	267.47	265.39	267.14	265.16	266.36	266.25	265.00
19-Jul-16	267.84	268.61	266.42	266.61	266.12	262.01	261.96	265.94	266.17	266.43	263.40	266.01	263.59	266.01	267.28	265.22	266.52	263.50	266.11	265.55	262.72
12-Aug-16	-	268.49	265.97	266.23	265.79	261.88	261.83	265.62	265.83	266.17	262.94	265.39	263.13	265.18	267.23	264.77	266.19	262.80	265.78	265.19	262.00
24-Aug-16	267.84	268.43	266.25	266.09	265.98	262.17	262.01	265.80	266.04	266.73	263.33	265.82	263.51	265.77	*	265.11	266.14	263.37	265.98	265.35	262.63
21-Sep-16	267.84	268.37	265.98	265.86	265.90	262.08	261.92	265.68	265.97	266.22	263.19	265.40	263.35	265.68	*	264.66	266.10	262.73	265.89	265.24	261.88
31-Oct-16	267.79	268.27	265.95	265.60	265.91	262.07	261.85	265.82	265.96	266.75	263.27	265.45	263.42	265.62	*	264.47	266.03	263.18	265.90	265.19	262.49
23-Nov-16	267.97	268.28	266.10	265.61	265.99	262.01	261.81	265.71	266.06	266.35	263.22	265.32	263.34	265.57	*	264.43	266.01	262.60	265.98	265.21	261.71
16-Dec-16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	*	-	-	-	-	-	-
21-Dec-16	268.71	268.54	267.27	267.13	266.57	262.89	262.39	265.97	266.61	267.42	263.51	-	-	-	*	265.47	266.63	263.81	266.56	265.71	262.94
20-Apr-17	269.28	269.25	268.15	268.22	267.62	263.83	263.46	266.68	267.65	267.43	263.79	266.56	264.04	267.52	269.24	266.66	267.46	266.55	267.62	266.98	266.64
26-May-17	269.00	269.21	267.74	268.02	267.21	263.25	262.88	266.62	267.24	267.39	263.78	266.49	264.02	266.19	268.80	266.33	267.62	266.68	267.20	266.89	266.90
21-Jun-17	268.83	269.13	267.60	267.63	266.94	262.79	262.56	266.57	266.98	267.25	263.74	266.47	263.99	267.07	268.37	266.11	267.56	266.62	266.92	266.83	266.84
28-Jul-17	269.04	269.09	267.71	267.73	267.06	263.00	262.68	266.39	267.12	267.13	263.62	266.49	263.90	266.95	268.36	266.12	267.57	265.10	267.05	266.36	264.58
3-Aug-17	268.80	269.07	267.32	267.35	266.85	262.51	262.31	266.20	266.90	266.87	263.54	266.44	263.82	266.65	268.17	265.94	267.30	264.18	266.83	265.94	263.36
21-Aug-17	268.95	268.44	266.75	266.76	266.45	262.00	261.93	265.95	266.50	266.74	263.54	266.34	263.79	266.37	267.78	265.58	266.76	263.61	266.44	265.73	262.69
18-Sep-17	268.12	268.79	266.44	266.43	266.20	261.78	261.77	265.90	266.26	266.47	263.42	266.09	263.68	265.78	*	265.22	266.51	263.53	266.19	265.60	262.70
26-Oct-17	268.53	268.62	267.34	267.37	266.45	262.16	262.07	266.04	266.50	267.29	263.53	266.22	263.76	266.88	*	265.59	266.76	263.76	266.43	265.79	262.87
23-Nov-17	269.18	269.14	268.02	267.91	267.31	264.31	263.90	266.34	267.35	267.47	263.74	266.58	263.99	267.95	268.26	266.66	267.07	264.60	267.29	266.26	263.68

Notes:

mAMSL = metres above mean sea level

T/case = top of steel casing

T/PVC = top of PVC Riser Pipe

- = not measured

** = Dry*

Table 1: Groundwater Elevations (mAMSL) Manual Measurements - 2012 - 2017

	WBC	WCA	WCB	WCC	WDA	WDB	WDC	WEA	WEB	WEC	WFA	WFB	WFC	WGA	WGB	WGC	WHA	WHB	WHC	WIA	WIB
T/case	272.81	271.47	271.47	271.47	268.04	268.04	268.04	270.19	270.19	270.19	271.56	271.56	271.56	264.20	264.20	264.20	268.96	268.96	268.96	273.92	273.92
T/PVC	272.69	271.44	271.44	271.44	268.02	268.00	268.00	270.15	270.14	270.13	271.55	271.55	271.53	264.15	264.17	264.16	269.04	269.06	269.07	273.85	273.88
1-Jun-12	266.59	264.91	266.49	266.48	264.44	265.68	266.53	267.21	266.55	266.56	264.40	261.03	259.35	261.34	262.23	260.29	266.47	264.36	266.77	265.63	263.49
21-Jun-12	266.37	264.65	266.40	266.26	264.31	265.40	266.31	266.98	266.32	266.31	264.36	260.70	259.03	261.29	262.13	260.08	266.40	264.14	266.51	265.38	263.46
27-Jul-12	265.90	264.23	266.26	265.78	263.76	264.77	265.81	266.56	265.84	265.83	263.96	260.24	258.58	260.84	261.97	259.74	266.17	264.06	266.03	264.78	263.10
23-Aug-12	265.69	264.31	266.17	265.64	263.71	263.57	265.69	266.45	265.72	265.72	263.91	260.12	258.51	260.87	261.83	259.62	265.84	264.60	265.86	264.31	263.06
23-Nov-12	266.88	265.08	265.81	267.17	265.35	265.86	267.13	267.96	267.16	267.17	265.13	261.55	260.05	261.85	261.64	261.01	266.16	263.95	267.40	266.28	263.65
30-Oct-13	267.29	265.01	265.15	267.31	265.92	265.86	267.34	268.30	267.38	267.38	265.26	261.40	259.76	261.96	261.87	261.09	266.30	264.20	267.59	266.29	263.70
10-Sep-14	266.08	262.32	264.74	266.06	264.33	265.05	266.13	267.18	266.15	266.17	264.27	258.57	260.29	261.21	261.92	259.95	266.34	264.70	266.38	264.73	263.53
14-May-15	267.14	266.66	265.20	266.92	265.16	265.76	266.96	267.69	266.98	266.99	264.72	261.43	259.55	261.76	262.16	260.62	266.45	264.52	267.20	265.42	263.76
18-Jun-15	266.55	266.72	265.30	266.62	264.89	265.45	266.97	267.37	266.19	266.29	264.74	260.60	258.75	261.84	262.11	260.59	266.41	264.49	266.85	265.23	263.70
30-Jul-15	266.76	267.41	265.47	266.70	264.72	265.36	266.70	267.48	266.72	266.73	264.51	260.77	258.81	261.34	262.03	260.31	266.42	264.48	266.95	265.41	263.62
27-Aug-15	266.36	266.65	265.54	266.35	264.50	265.26	266.65	267.30	266.61	266.39	264.16	260.30	258.30	261.33	261.94	260.03	266.37	264.44	266.56	265.00	263.59
21-Sep-15	266.37	266.70	265.63	266.42	265.02	265.02	266.40	267.25	266.41	266.42	264.59	260.33	258.41	261.60	261.86	260.31	266.32	264.43	266.63	265.05	263.62
15-Oct-15	266.51	266.54	265.67	266.34	264.31	264.89	266.31	266.98	266.33	266.34	264.18	260.28	258.30	261.32	261.78	260.02	266.29	264.41	266.57	264.94	263.54
16-Dec-15	267.12	266.94	265.83	267.12	265.67	265.72	267.16	268.03	267.18	267.19	265.03	261.35	259.47	262.00	261.81	260.78	266.37	264.38	267.42	265.86	263.83
10-May-16	267.05	266.87	266.17	266.90	265.18	265.62	266.93	267.70	266.95	266.95	264.75	261.53	259.61	261.69	262.33	260.80	266.56	264.75	267.18	265.40	263.76
28-Jun-16	266.37	264.91	266.23	266.25	264.30	264.83	266.31	266.78	266.32	266.33	264.18	260.35	258.32	261.29	262.27	260.09	266.42	264.61	266.56	264.77	263.47
19-Jul-16	266.11	262.48	266.14	266.00	264.15	264.57	266.07	266.58	266.08	266.08	264.10	260.12	258.10	261.32	262.17	260.01	266.32	264.54	266.31	264.16	263.39
12-Aug-16	265.78	261.84	265.88	265.69	263.77	264.27	265.73	266.47	265.74	265.75	264.01	259.90	257.95	260.86	262.04	259.76	266.08	264.46	265.99	263.20	262.95
24-Aug-16	265.80	262.40	265.76	265.88	264.08	264.40	265.93	266.70	265.94	265.95	264.14	260.00	258.20	261.36	261.97	260.04	266.00	264.46	266.19	263.86	263.32
21-Sep-16	265.86	261.47	265.48	265.80	263.83	264.30	265.85	266.56	265.85	265.87	263.92	259.93	257.95	261.03	261.82	259.75	265.73	264.42	266.10	263.67	263.19
31-Oct-16	265.76	262.41	265.13	265.80	264.13	264.26	265.85	266.68	265.86	265.87	263.94	259.88	257.94	261.08	261.62	259.67	265.35	264.38	266.11	263.64	263.26
23-Nov-16	265.94	261.36	264.93	265.88	264.10	264.35	265.93	266.74	265.94	265.96	263.82	260.01	258.03	261.17	261.54	259.58	265.40	264.36	266.20	263.63	263.19
16-Dec-16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
21-Dec-16	266.41	262.50	264.78	266.44	264.77	264.94	266.46	267.59	266.53	266.52	265.02	260.65	258.85	261.65	261.50	260.21	265.49	264.35	266.77	-	-
20-Apr-17	267.77	267.53	265.03	266.50	265.82	266.17	267.58	268.06	267.58	267.58	265.19	261.84	259.94	261.95	262.09	261.24	266.54	263.97	267.80	265.64	263.83
26-May-17	267.42	266.86	265.31	267.13	265.31	265.83	267.16	267.70	267.17	267.17	264.98	261.81	259.88	261.94	262.20	261.01	267.46	263.96	267.37	265.03	263.82
21-Jun-17	266.96	266.83	265.51	266.85	265.19	265.44	266.89	267.53	266.90	266.90	264.77	261.44	259.47	261.78	262.24	260.74	266.91	263.92	267.12	265.24	263.79
28-Jul-17	267.10	264.12	265.68	266.95	265.25	265.54	266.99	267.67	267.01	267.01	264.85	261.50	259.58	261.46	262.23	260.75	266.68	263.83	267.25	265.21	263.80
3-Aug-17	266.93	262.72	265.64	266.74	265.02	265.33	266.80	267.43	266.82	266.81	264.65	261.32	259.29	261.32	262.20	260.48	266.65	263.76	267.03	264.96	263.60
21-Aug-17	266.48	262.13	265.44	266.34	264.64	264.85	266.40	267.06	266.41	266.41	264.42	260.72	258.62	261.27	262.17	260.06	266.57	263.74	266.64	264.71	263.58
18-Sep-17	266.16	262.28	265.26	266.11	264.32	264.57	266.16	266.73	266.16	266.17	264.17	260.23	258.20	261.23	262.05	259.91	266.43	263.63	266.39	264.07	263.46
26-Oct-17	266.26	262.34	265.06	266.35	264.95	264.79	266.40	267.38	266.42	266.41	264.60	260.36	258.50	261.38	261.90	260.20	266.28	263.72	266.65	265.24	263.56
23-Nov-17	267.02	262.90	264.89	267.21	265.74	265.69	267.24	268.05	267.28	267.27	265.44	261.23	259.43	261.96	261.88	261.02	266.32	263.92	267.50	265.95	263.78

Notes:

mAMSL = metres above mean sea level

T/case = top of steel casing

T/PVC = top of PVC Riser Pipe

- = not measured

** = Dry*

Table 1: Groundwater Elevations (mAMSL) Manual Measurements - 2012 - 2017

	WIC	SG1	W2	W3
T/case	273.92			
T/PVC	273.87	268.97	271.35	265.46
1-Jun-12	266.58	-	-	-
21-Jun-12	266.38	-	-	-
27-Jul-12	265.83	-	-	-
23-Aug-12	265.76	-	-	-
23-Nov-12	267.20	-	-	-
30-Oct-13	267.41	-	-	-
10-Sep-14	266.20	-	-	-
14-May-15	267.06	-	-	-
18-Jun-15	266.69	-	-	-
30-Jul-15	266.79	-	-	-
27-Aug-15	266.39	-	-	-
21-Sep-15	266.48	-	-	-
15-Oct-15	266.39	-	-	-
16-Dec-15	267.24	-	-	-
10-May-16	267.01	-	-	-
28-Jun-16	266.38	-	-	-
19-Jul-16	266.15	260.96	-	-
12-Aug-16	265.81	260.54	-	-
24-Aug-16	266.00	261.25	-	-
21-Sep-16	265.92	260.04	-	-
31-Oct-16	265.92	261.41	-	-
23-Nov-16	266.01	259.33	-	-
16-Dec-16	-	260.59	-	-
21-Dec-16	-	261.51	-	-
20-Apr-17	267.65	266.40	-	-
26-May-17	267.24	266.85	-	-
21-Jun-17	266.98	266.81	-	-
28-Jul-17	267.08	263.44	-	-
3-Aug-17	266.87	261.66	-	-
21-Aug-17	266.48	260.97	-	-
18-Sep-17	266.23	261.27	-	-
26-Oct-17	266.48	261.29	269.77	262.25
23-Nov-17	267.34	261.88	270.48	265.19

Notes:

mAMSL = metres above mean sea level

T/case = top of steel casing

T/PVC = top of PVC Riser Pipe

- = not measured

** = Dry*

Table 2: 2016 Carden Quarry Pumping Records

Date	Time	Sump Pond A Surface Water Elevation (masl)	Flow Rate (L/Min)	Totalizer (L)	*Average (L/Day)	Comments
Ref. Elevation		267.57				
17-Jun-16	2:00 PM	267.02	-	-	*1,050,000*	Beginning of pumping with 15 hp pump
18-Jun-16	11:00 AM	266.81	1750	-	*2,520,000*	
19-Jun-16	2:00 PM	266.59	-	-	*2,520,000*	
20-Jun-16	4:00 PM	266.29	-	-	*2,520,000*	
21-Jun-16	2:00 PM	266.11	-	-	*2,520,000*	
22-Jun-16	3:00 PM	265.89	-	-	*2,520,000*	
23-Jun-16	1:00 PM	265.62	-	-	*2,520,000*	
24-Jun-16	-	-	-	-	*2,520,000*	
25-Jun-16	3:00 PM	265.22	-	-	*2,520,000*	
26-Jun-16	-	-	-	-	*2,520,000*	
27-Jun-16	3:00 PM	264.49	1750	-	*2,520,000*	
28-Jun-16	-	-	-	-	*2,520,000*	
29-Jun-16	12:00 AM	264.03	-	-	*2,520,000*	
30-Jun-16	-	-	-	-	*2,520,000*	
1-Jul-16	1:00 PM	263.73	-	-	*2,520,000*	
2-Jul-16	-		-	-	*2,520,000*	
3-Jul-16	1:30 PM	263.42	-	-	*2,520,000*	
4-Jul-16	6:00 PM	262.94	-	-	*2,520,000*	
5-Jul-16	6:00 PM	262.72	-	-	*2,520,000*	
6-Jul-16	-	-	-	-	*2,520,000*	
7-Jul-16	-	-	-	-	*2,520,000*	
8-Jul-16	8:00 AM	262.36	-	-	*2,520,000*	
9-Jul-16	1:00 PM	262.27	-	-	*2,520,000*	
10-Jul-16	-	-	-	-	*2,520,000*	
11-Jul-16	11:30 AM	262.02	-	-	*2,520,000*	
12-Jul-16	-	-	-	-	*2,520,000*	
13-Jul-16	12:00 PM	261.87	-	-	*2,520,000*	
14-Jul-16	-	-	-	-	*2,520,000*	
15-Jul-16	12:00 PM	261.72	-	-	*2,520,000*	
16-Jul-16	-	-	-	-	*2,520,000*	
17-Jul-16	8:00 AM	261.41	-	-	*2,520,000*	
18-Jul-16	10:00 AM	261.20	-	-	1,838,233	
18-Jul-16	3:00 PM	261.08	1752	59233300		Installed totalizer and flow gauge
19-Jul-16	8:20 AM	261.02	1709	-	1,838,233	
19-Jul-16	1:00 PM	260.96	-	-		
19-Jul-16	4:00 PM	260.93	1704	-		
20-Jul-16	12:40 PM	260.50	1653	-	1,838,233	
21-Jul-16	8:00 AM	260.74	1592	-	1,852,600	
21-Jul-16	9:15 AM	260.80	-	64029500		
21-Jul-16	4:15 PM	260.73	-	64748000		
22-Jul-16	12:30 PM	260.15	-	65882100	0	The pump stopped working and was left off
23-Jul-16	12:30 PM	260.45	-	-	0	Pump off
24-Jul-16	-	-	-	-	0	Pump off
25-Jul-16	3:00 PM	261.00	-	-	0	Pump off
26-Jul-16	12:00 PM	260.82	-	-	0	Pump off
27-Jul-16	10:30 AM	261.09	-	-	0	Pump off
27-Jul-16	6:00 PM	261.09	-	-	0	Pump off
28-Jul-16	7:20 PM	261.15	-	-	0	Pump off
29-Jul-16	4:00 PM	261.15	-	65882100	862,600	Pump off
29-Jul-16	4:25 PM	-	559	-		15 hp pump replaced with 3hp pump
30-Jul-16	4:30 PM	261.14	573	66744700	804,825	
31-Jul-16	-	-	-	-	804,825	
1-Aug-16	-	-	-	-	804,825	
2-Aug-16	4:10 PM	261.15	-	-	804,825	Pump shut down to switch discharge hose
2-Aug-16	4:40 PM	-	543.88			Pump started
3-Aug-16	3:30 PM	261.15	567.67	69964000	636,200	
4-Aug-16	10:30 AM	261.14	564.17	70600200	729,300	Pump shut down to add more discharge hose
5-Aug-16	-	-	-	-	729,300	
6-Aug-16	7:00 AM	260.67	559.64	72058800	892,150	
7-Aug-16	-	-	-	-	892,150	
8-Aug-16	1:00 PM	260.54	562.27	73843100	801,350	
9-Aug-16	-	-	-	-	801,350	
10-Aug-16	1:00 PM	260.25	546.5	75445800	686,500	
11-Aug-16	10:30 AM	260.25	533.37	76132300	676,700	
12-Aug-16	7:45 AM	260.68	506.44	76809000	753,400	
12-Aug-16	12:30 PM	260.59	-	-		
13-Aug-16	9:00 AM	260.68	485.45	77562400	747,850	
14-Aug-16	-	-	-	-	747,850	
15-Aug-16	2:30 PM	260.74	461.47	79058100	611,900	
16-Aug-16	-	-	-	-	611,900	
17-Aug-16	10:20 AM	260.91	474.95	80281900	854,300	Pump shut down to clean the in-line screen
17-Aug-16	10:35 AM		519.97			
18-Aug-16	1:15 PM	261.26	535.99	81136200	708,666	
19-Aug-16	-	-	-	-	708,666	
20-Aug-16	-	-	-	-	708,666	
21-Aug-16	8:15 AM	260.89	539.95	83262200	55,900	

Table 2: 2016 Carden Quarry Pumping Records

Date	Time	Sump Pond A Surface Water Elevation (masl)	Flow Rate (L/Min)	Totalizer (L)	*Average (L/Day)	Comments
Ref. Elevation		267.57				
22-Aug-16	3:00 PM	261.38	-	-	680,400	Electrical storm shut pump down
22-Aug-16	3:30 PM	-	455.97	83318100		
23-Aug-16	6:00 PM	261.17	411.11	83998500	422,100	
24-Aug-16	9:00 AM	261.17	411.97	84420600	688,000	Pump shut down to clean the in-line screen
24-Aug-16	11:00 AM	-	530.74	-		
25-Aug-16	8:30 AM	261.35	533.37	85108600	811,400	
26-Aug-16	10:00 AM	261.17	525.48	85920000	750,566	
27-Aug-16	-	-	-	-	750,566	
28-Aug-16	-	-	-	-	750,566	
29-Aug-16	9:30 AM	261.14	519.97	88171700	761,233	
30-Aug-16	-	-	-	-	761,233	
31-Aug-16	-	-	-	-	761,233	
1-Sep-16	12:00 PM	260.96	511.69	90455400	785,033	
2-Sep-16	-	-	-	-	785,033	
3-Sep-16	-	-	-	-	785,033	
4-Sep-16	4:00 PM	260.80	525.48	92810500	675,400	
5-Sep-16	-	-	-	-	675,400	
6-Sep-16	12:15 PM	260.70	498.57	94161300	572,400	
7-Sep-16	7:30 AM	260.64	482.82	94733700	843,000	
7-Sep-16	3:45 PM	260.47	-	-		
8-Sep-16	2:00 PM	260.50	461.34	95576700	693,525	
9-Sep-16	-	-	-	-	693,525	
10-Sep-16	-	-	-	-	693,525	
11-Sep-16	-	-	-	-	693,525	
12-Sep-16	5:00 PM	260.39	472.33	98350800	615,600	
13-Sep-16	-	-	-	-	615,600	
14-Sep-16	1:30 PM	260.38	432.39	99582000	328,446	
15-Sep-16	-	-	-	-	328,446	
16-Sep-16	-	-	-	-	328,446	
17-Sep-16	2:30 PM	260.25	429.77	-	328,446	Totalizer maxed out and started again
18-Sep-16	-	-	-	-	328,446	
19-Sep-16	2:00 PM	260.32	413.83	1224230	487,630	
20-Sep-16	10:00 AM	260.29	424.53	1711860	691,180	
21-Sep-16	1:00 PM	260.16	432.39	2403040	643,215	
22-Sep-16	-	-	-	-	643,215	
23-Sep-16	3:00 PM	260.15	419.29	3689470	521,660	
24-Sep-16	11:00 AM	260.09	424.53	4211130	594,273	
25-Sep-16	-	-	-	-	594,273	
26-Sep-16	-	-	-	-	594,273	
27-Sep-16	11:00 AM	260.10	419.29	5993950	556,780	
28-Sep-16	8:30 AM	-	413.83	6550730	663,540	
29-Sep-16	-	-	-	-	663,540	
30-Sep-16	5:45 PM	260.41	411.1	-	0	Shut down the pump for a couple days
1-Oct-16	-	-	-	-	0	Pump off
2-Oct-16	-	-	-	-	0	Pump off
3-Oct-16	-	-	-	-	0	Pump off
4-Oct-16	1:45 PM	261.23	-	-	663,540	Cleaned out in-line screen, pump started again
4-Oct-16	1:50 PM	-	472.33	-		
4-Oct-16	-	-	355.54	-		
5-Oct-16	5:00 PM	261.21	352.83	8541350	522,983	
6-Oct-16	-	-	-	-	522,983	
7-Oct-16	-	-	-	-	522,983	
8-Oct-16	5:15 PM	261.08	363.68	10110300	450,950	
9-Oct-16	-	-	-	-	450,950	
10-Oct-16	10:30 AM	261.18	374.24	11012200	823,550	
11-Oct-16	-	-	-	-	823,550	
12-Oct-16	5:00 PM	260.97	485.45	12659300	596,533	
13-Oct-16	-	-	-	-	596,533	
14-Oct-16	-	-	-	-	596,533	
15-Oct-16	8:30 AM	260.76	466.83	14448900	776,750	
16-Oct-16	-	-	-	-	776,750	
17-Oct-16	4:30 PM	-	461.34	16002400	0	Lightening hit pump shuting it off
18-Oct-16	-	-	-	-	0	Pump off
19-Oct-16	-	261.29	-	-	0	Pump off
20-Oct-16	-	-	-	-	0	Pump off
21-Oct-16	-	-	-	-	0	Pump off
22-Oct-16	11:00 AM	261.50	432.39	16002400	695,100	Pump restarted
23-Oct-16	9:00 AM	261.63	427.36		695,100	
24-Oct-16	4:38 PM	261.57	421.91	17392600	9,500	Pump broke down
25-Oct-16	-	-	-	-	0	Pump off
26-Oct-16	11:10 AM	261.75	392.56	17402100	712,600	Pump started
27-Oct-16	4:20 PM	261.47	395.17	18114700	569,300	
28-Oct-16	-	-	-	-	569,300	
29-Oct-16	10:30 AM	261.67	455.97	19253300	747,500	Cleaned screen
30-Oct-16	2:00 PM	261.63	453.35	20000800	717,800	

Table 2: 2016 Carden Quarry Pumping Records

Date	Time	Sump Pond A Surface Water Elevation (masl)	Flow Rate (L/Min)	Totalizer (L)	*Average (L/Day)	Comments
Ref. Elevation		267.57				
31-Oct-16	4:30 PM	-	445.49	20718600	645,750	
1-Nov-16	-	-	-	-	645,750	
2-Nov-16	4:30 PM	261.60	440.25	22010100	647,700	
3-Nov-16	-	-	-	-	647,700	
4-Nov-16	-	-	-	-	647,700	
5-Nov-16	4:30 PM	-	437.63	23953200	587,150	
6-Nov-16	-	-	-	-	587,150	
7-Nov-16	1:30 PM	261.47	437.63	25127500	605,800	
8-Nov-16	1:00 PM	261.44	421.91	25733300	530,200	
9-Nov-16	10:30 AM	261.40	405.64	26263500	616,100	
10-Nov-16	-	-	-	-	616,100	
11-Nov-16	-	-	-	-	616,100	Pump restarted
12-Nov-16	-	-	-	-	616,100	
13-Nov-16	1:00 PM	261.29	506.44	28727900	813,000	Pump screen cleaned and restarted
14-Nov-16	3:00 PM	261.29	-	-	801,600	Pump shut down to replace main discharge hose
14-Nov-16	3:30 PM	-	576	29540900		
15-Nov-16	2:45 PM	261.18	576	30342500	867,800	
16-Nov-16	3:50 PM	261.05	578.78	31210300	843,300	
17-Nov-16	4:13 PM	260.94	578.78	32053600	838,400	
18-Nov-16	4:25 PM	260.77	573.23	32892000	792,900	
19-Nov-16	2:39 PM	-	-	-	792,900	
20-Nov-16	4:00 PM	260.44	541.25	34477800	747,150	
21-Nov-16	-	-	-	-	747,150	
22-Nov-16	1:37 PM	260.04	-	-	692,400	
22-Nov-16	4:30 PM	260.01	501.19	35972100		
23-Nov-16	1:00 PM	259.58	300.16	-	346,200	
23-Nov-16	4:30 PM	259.71	305.55	36664500		
24-Nov-16	6:00 AM	-	-	-	568,500	
24-Nov-16	4:30 PM	-	472.33	37233000		
24-Nov-16	5:00 PM	-	395	-		
25-Nov-16	1:00 PM	259.83	-	-	487,000	
25-Nov-16	4:00 PM	259.86	387.32	37771600		
26-Nov-16	12:42 PM	259.86	397.79	38258600	690,800	
27-Nov-16	1:38 PM	259.95	455.97	38949400	618,300	
28-Nov-16	12:00 PM	259.77	450.73	39567700	732,200	
29-Nov-16	3:13 PM	259.83	448.11	40299900	701,100	
30-Nov-16	3:37 PM	259.61	474.52	41001000	698,200	
1-Dec-16	4:19 PM	260.22	477.58	41699200	609,850	
2-Dec-16	-	-	-	-	609,850	
3-Dec-16	9:30 AM	260.53	501.19	42918900	838,600	
4-Dec-16	2:19 PM	260.53	501.19	43757500	759,900	
5-Dec-16	-	-	-	-	759,900	
6-Dec-16	-	-	-	-	759,900	
7-Dec-16	4:32 PM	260.59	509.06	46037200	711,150	
8-Dec-16	-	-	-	-	711,150	
9-Dec-16	2:20 PM	260.71	519.19	47459500	723,800	Pump screen cleaned
10-Dec-16	-	-	-	-	723,800	
11-Dec-16	-	-	-	-	723,800	
12-Dec-16	-	-	-	-	723,800	
13-Dec-16	-	-	-	-	723,800	
14-Dec-16	-	-	-	-	723,800	
15-Dec-16	-	-	-	-	723,800	
16-Dec-16	10:30 AM	260.68	-	52526100	*327,090*	Shut pump shut off for winter

Notes:

masl: metres above sea level

The flow rates on June 18 and June 27, 2016 were estimated to be 1750 L/min

The flow rate on December 16, 2016 was estimated to be 519.19 L/min

*Average (L/Day): Is calculated based on two consecutive totlizer readings and then divided by the number of days between readings.

Italics: The *Average (L/Day) was calculated based on the estimated flow rate (L/min)

Table 3: Thiem Equation Scenario 1

Q (m3/day)	540
K (m/day)	12.42
B(m)	5
h_1(mAMSL)	260.64
r_1(m)	74.53
T =	62.1

Assessment Well	h_2 (m)	r_2 (m)	Actual (m)	Difference (m)
	260.64	0.00		
	261	22.14		
	261.5	64.21		
	262	124.59		
WBb	262.4	191.32	213	21.68
	262.5	211.24		
	262.7	255.67		
	263	335.60		
WAb	263.47	501.45	479	-22.45
	263.5	514.07		
	263.6	558.18		
	264	770.21		
	264.5	1,137.82		
	265	1,665.40		
	265.5	2,422.56		
	265.67	2,748.93		
	266	3,509.22		
	266.5	5,068.77		
	266.67	5,740.99		

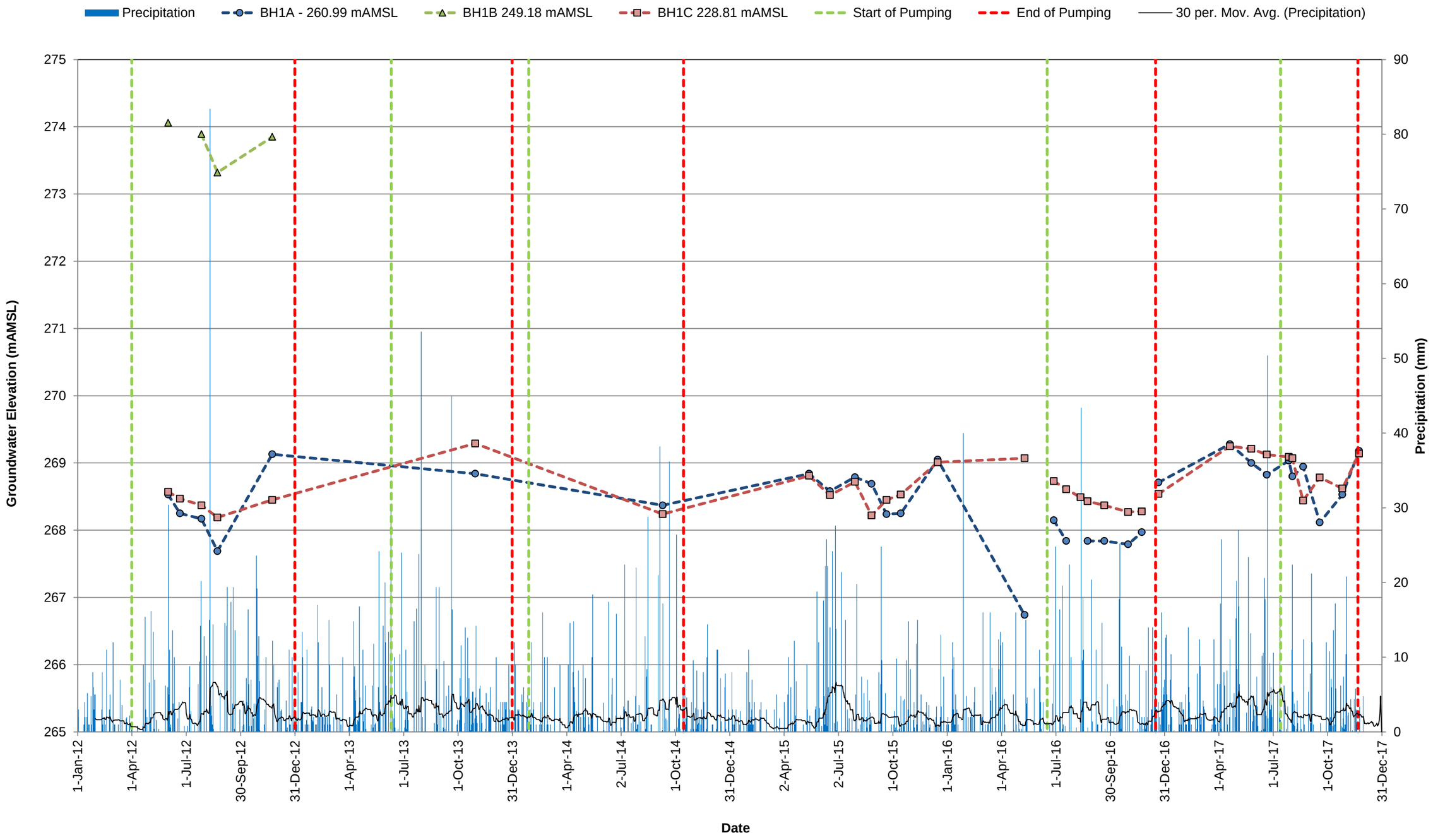
Table 4: Thiem Equation Scenario 2

Q (m3/day)	4052.8
K (m/day)	12.42
B(m)	11.67
h_1(mAMSL)	255
r_1(m)	433.60
T =	144.94

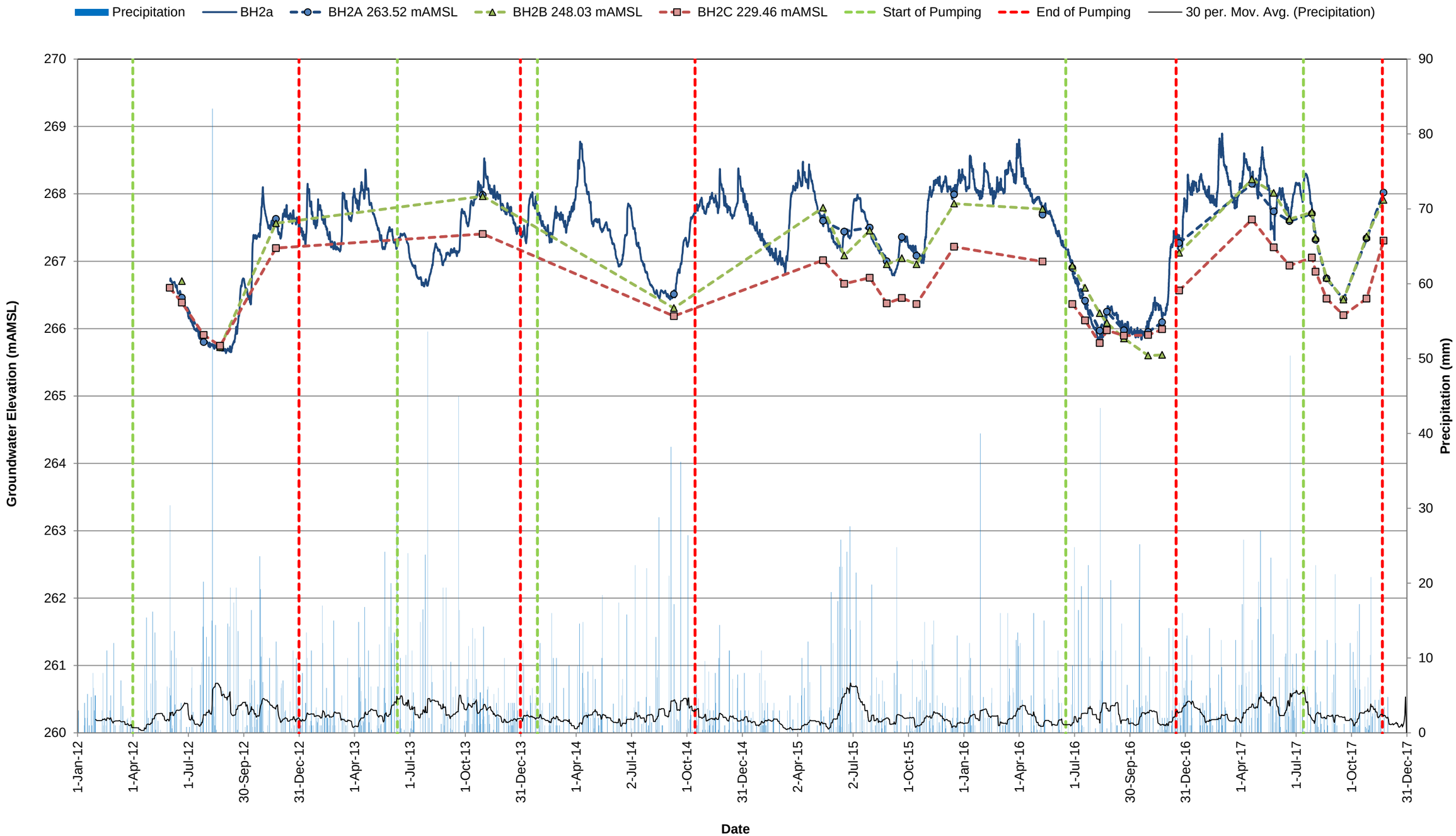
h_2 (m)	r_2 (m)
255	0.00
255.5	51.56
256	109.25
256.5	173.80
257	246.02
257.5	326.83
258	417.25
258.5	518.43
259	631.63
259.5	758.29
260	900.02
260.5	1,058.59
261	1,236.03
261.5	1,434.56
262	1,656.70
262.5	1,905.25
263	2,183.36
263.5	2,494.53
264	2,842.71
264.5	3,232.29
265	3,668.19
265.5	4,155.93
265.67	4,334.64
266	4,701.66
266.5	5,312.28
266.67	5,536.02

HYDROGRAPHS

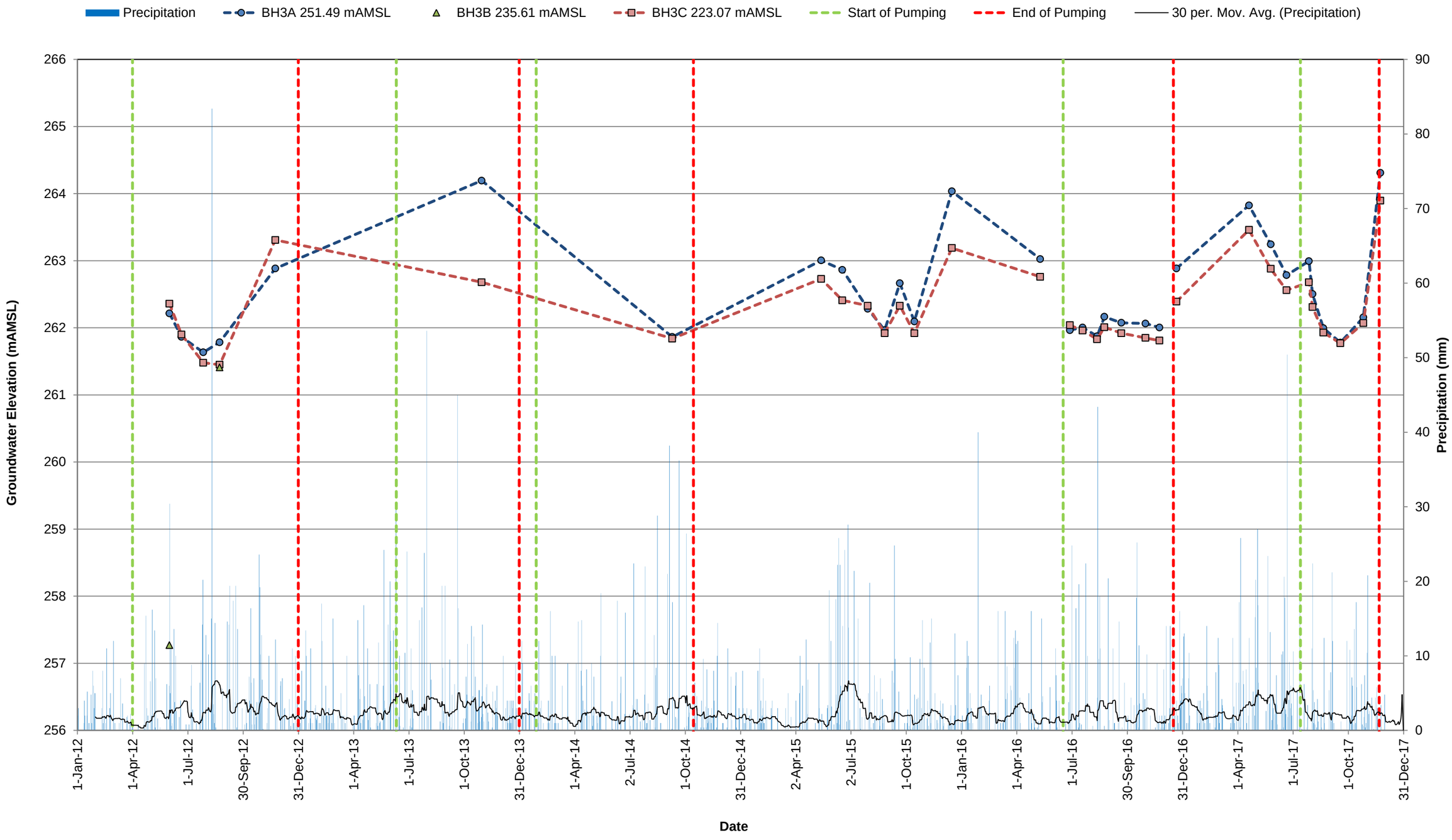
Hydrograph 1: Groundwater Elevations (mAMSL) - BH1 - Carden Quarry - 2012 - 2017



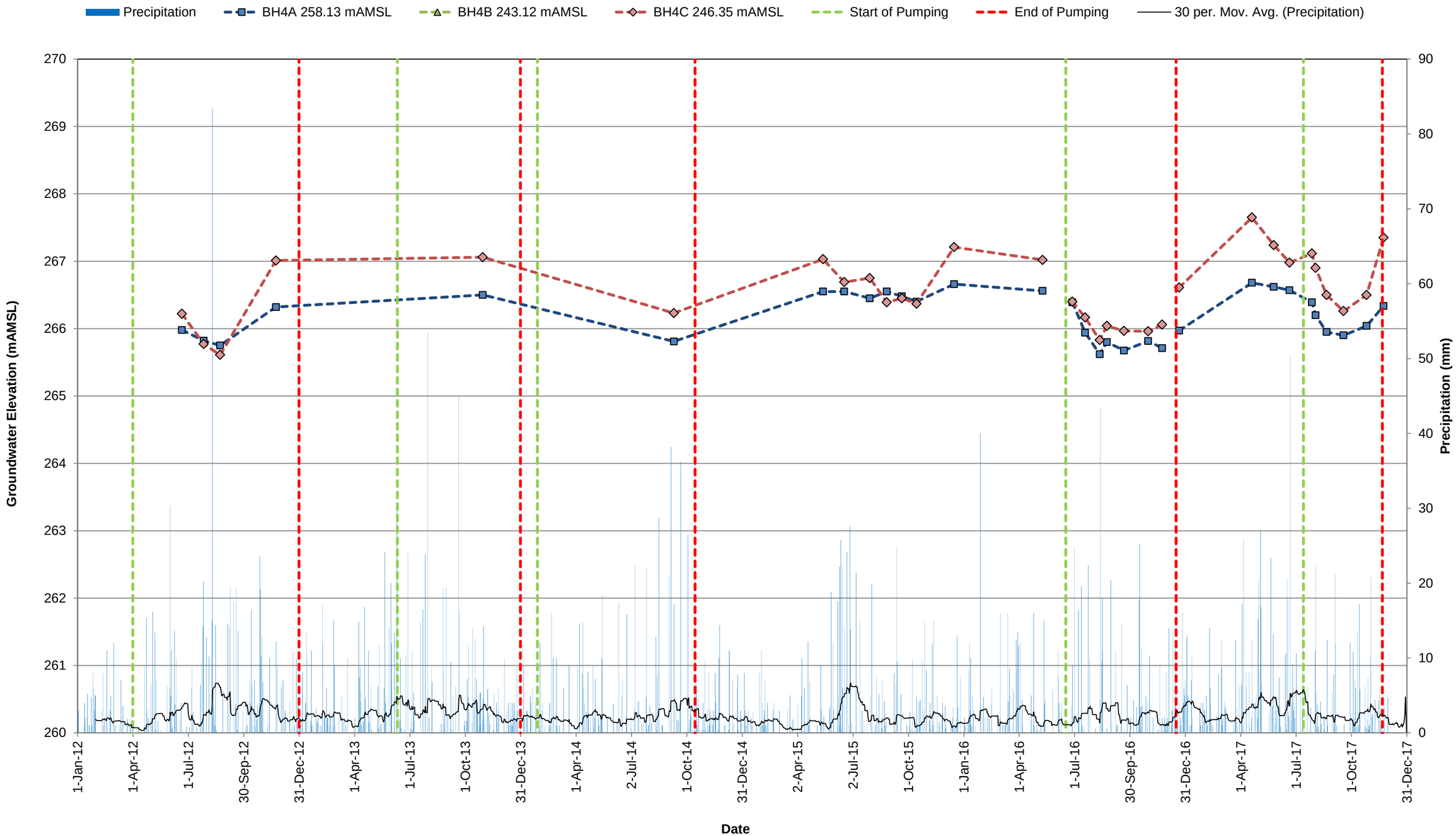
Hydrograph 2: Groundwater Elevations (mAMSL) - BH2 - Carden Quarry - 2012 - 2017



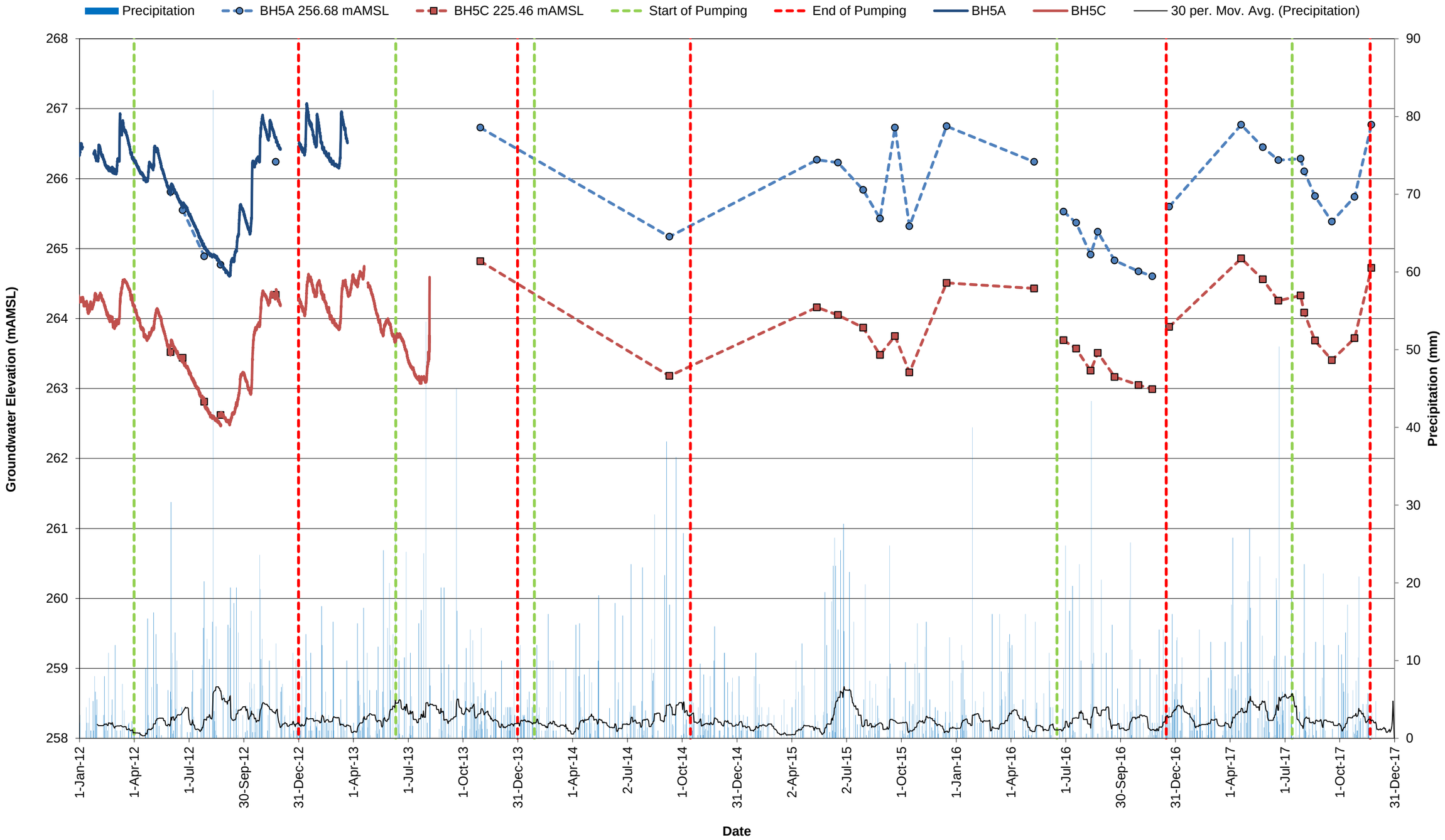
Hydrograph 3: Groundwater Elevations (mAMSL) - BH3 - Carden Quarry - 2012 -2017



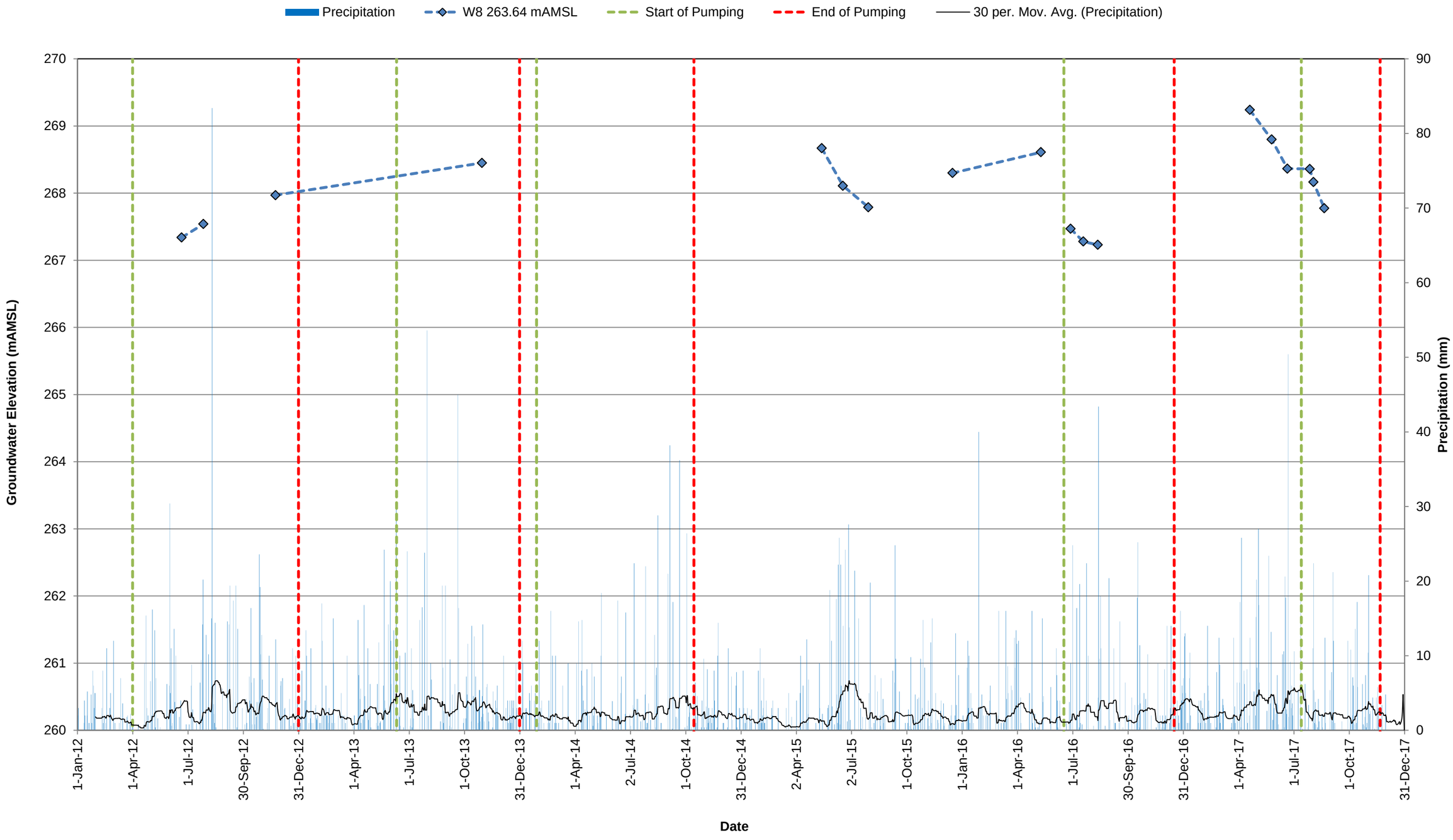
Hydrograph 4: Groundwater Elevations (mAMSL) - BH4 - Carden Quarry - 2012- 2017



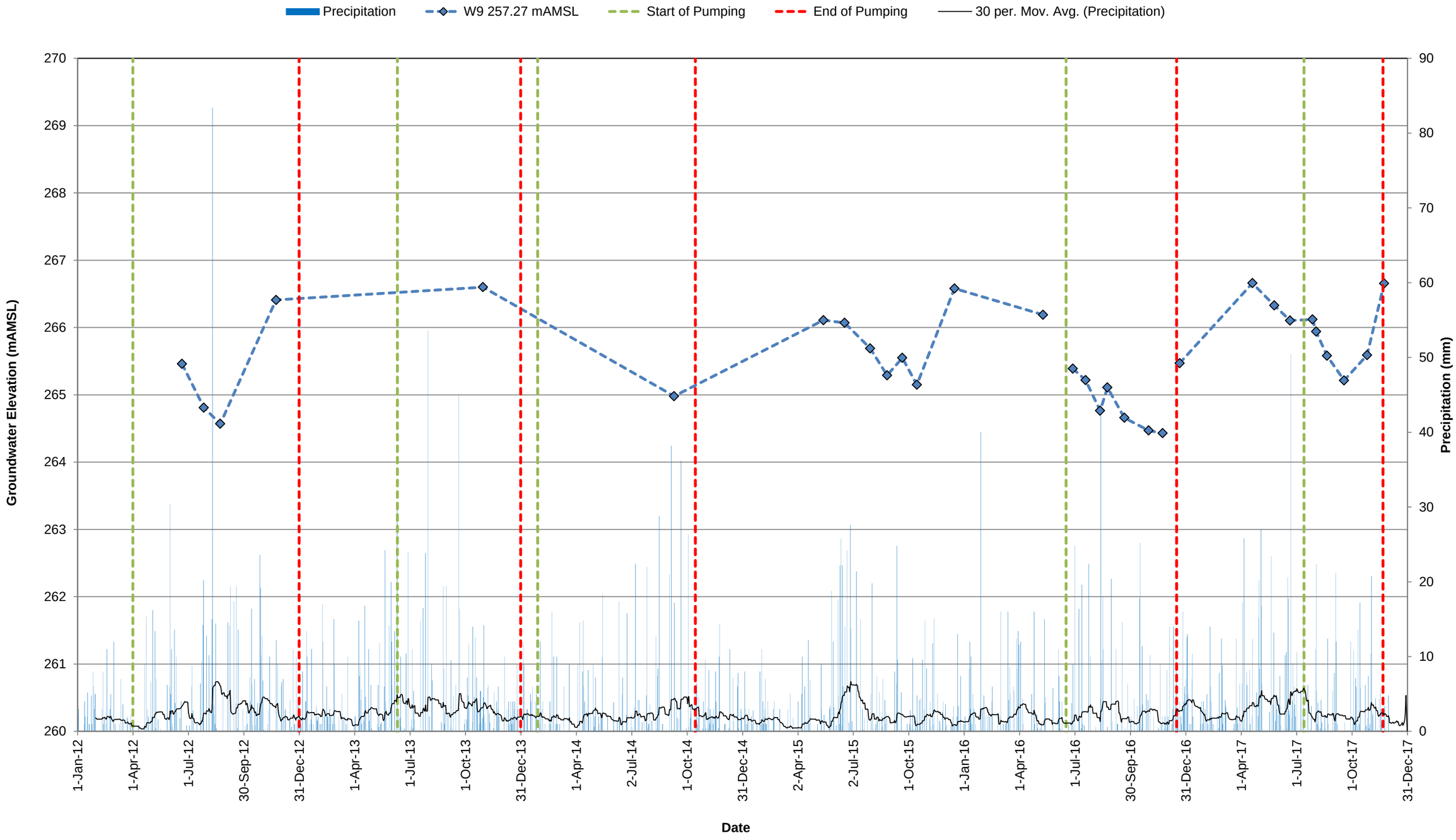
Hydrograph 5: Groundwater Elevations (mAMSL) - BH5 - Carden Quarry - 2012 - 2017



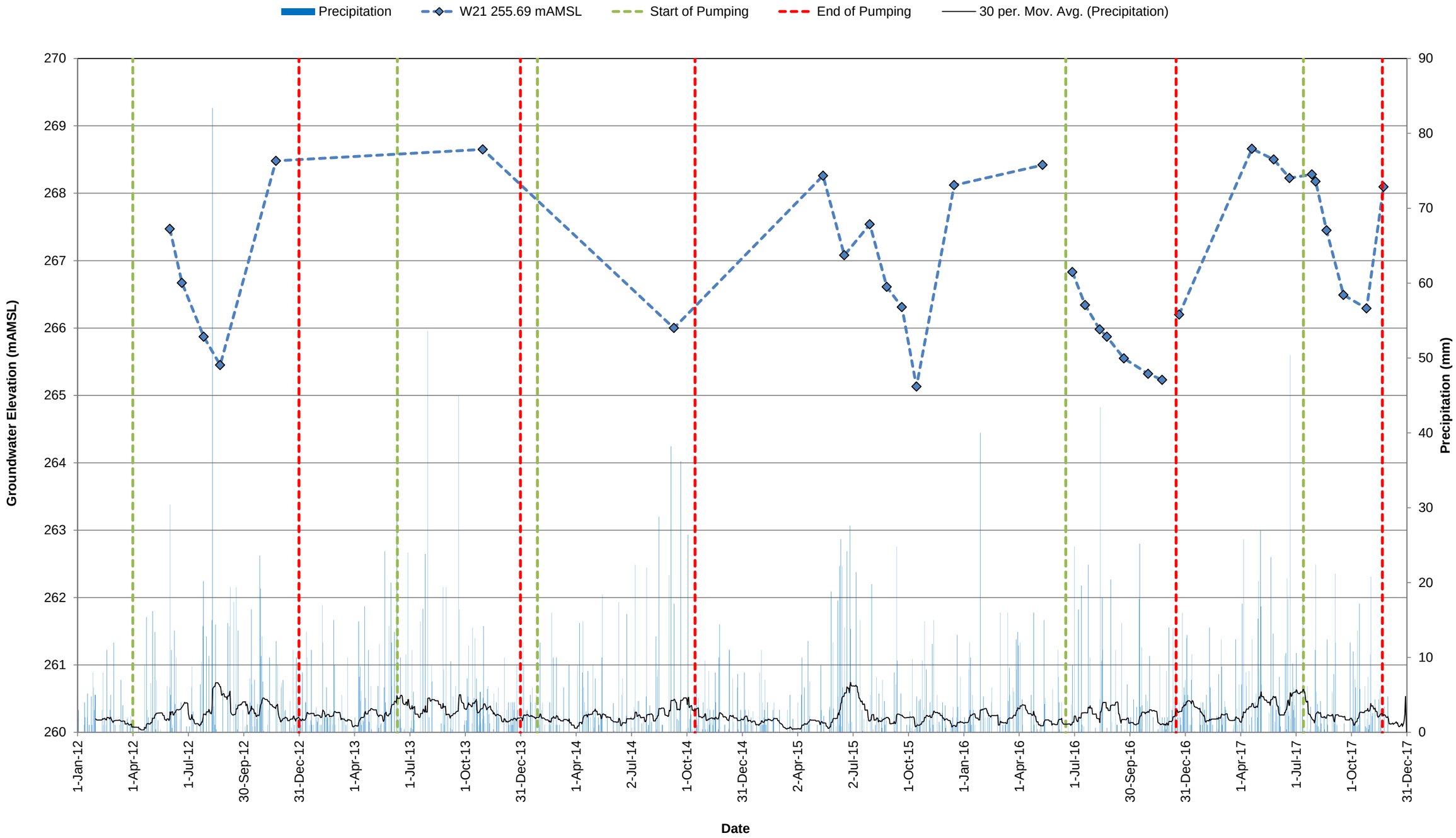
Hydrograph 6: Groundwater Elevations (mAMSL) -W8- Carden Quarry - 2012 - 2017



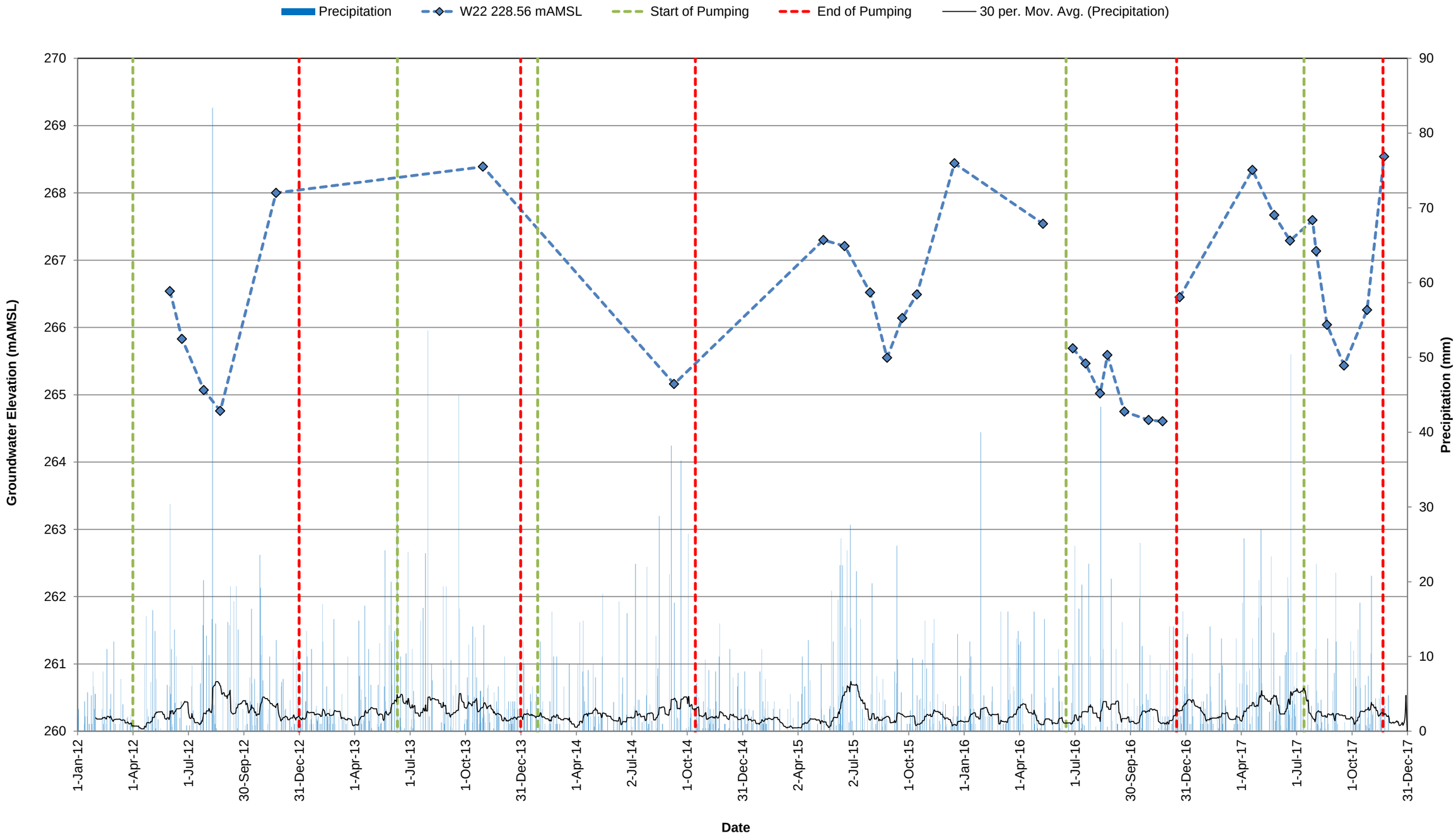
Hydrograph 7: Groundwater Elevations (mAMSL) - W9 - Carden Quarry - 2012 - 2017



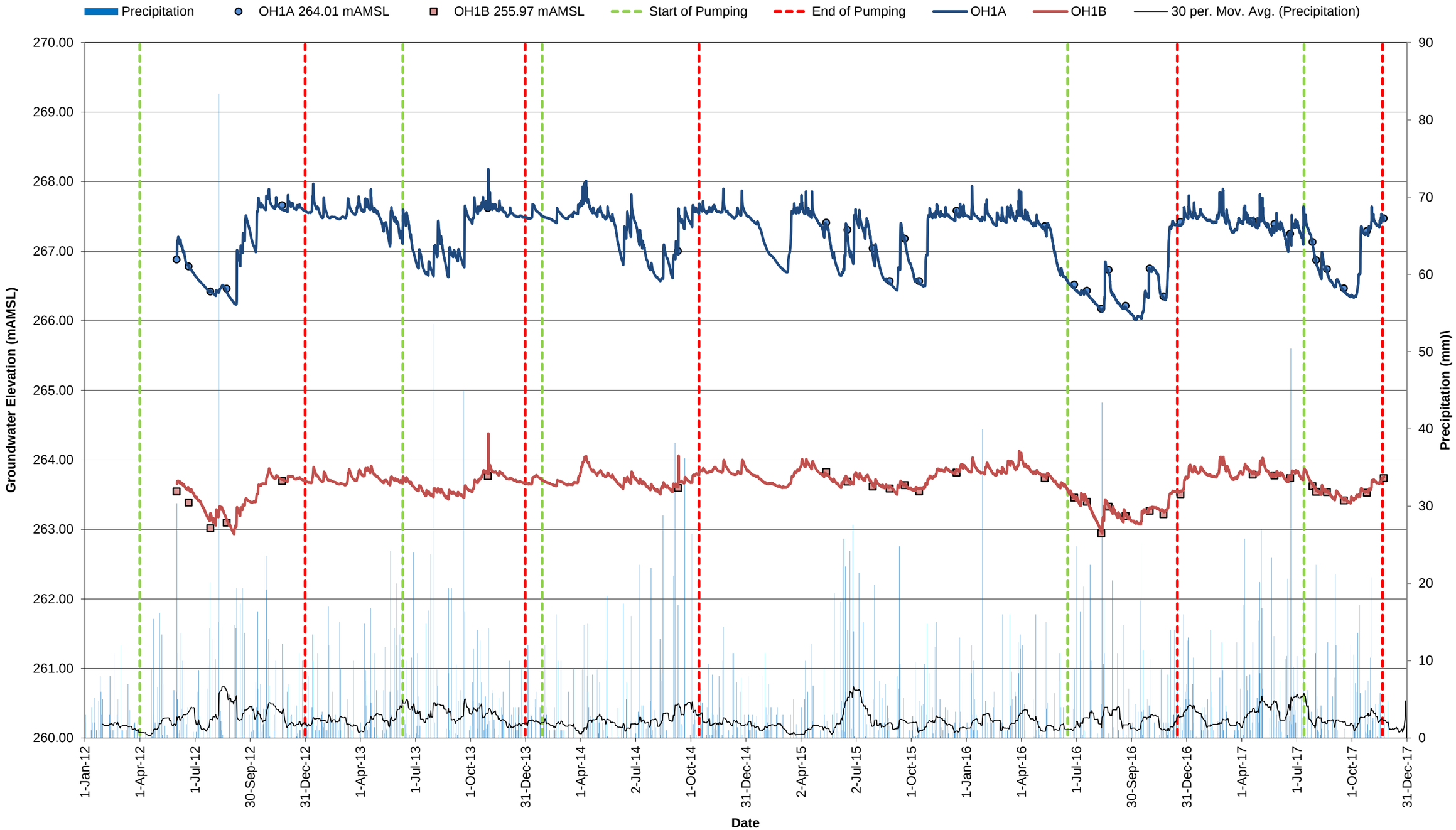
Hydrograph 8: Groundwater Elevations (mAMSL) -W21 - Carden Quarry - 2012 - 2017



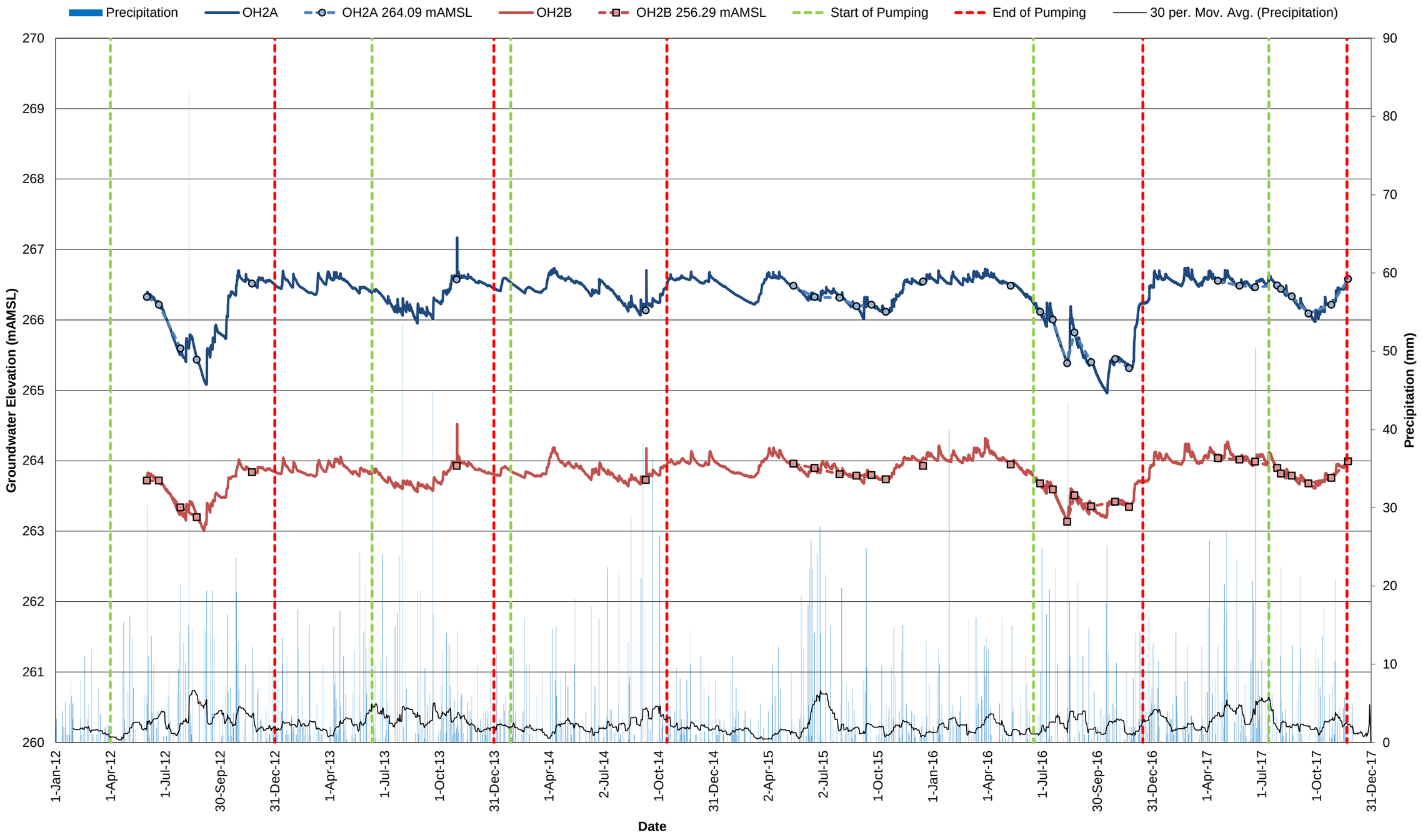
Hydrograph 9: Groundwater Elevations (mAMSL) -W22 - Carden Quarry - 2012 -2017



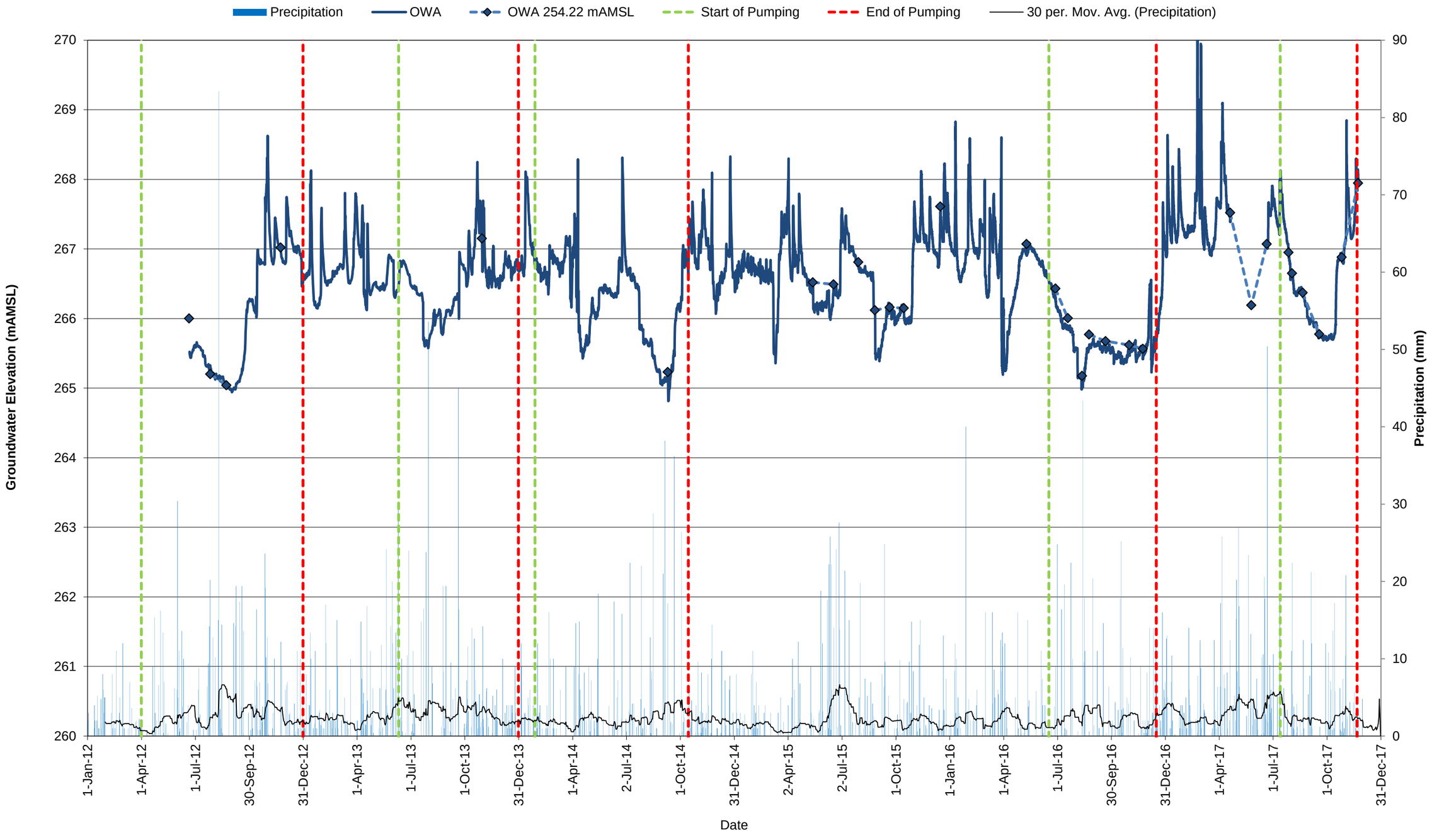
Hydrograph 10: Groundwater Elevations (mAMSL) - OH1 - Carden Quarry - 2012- 2017



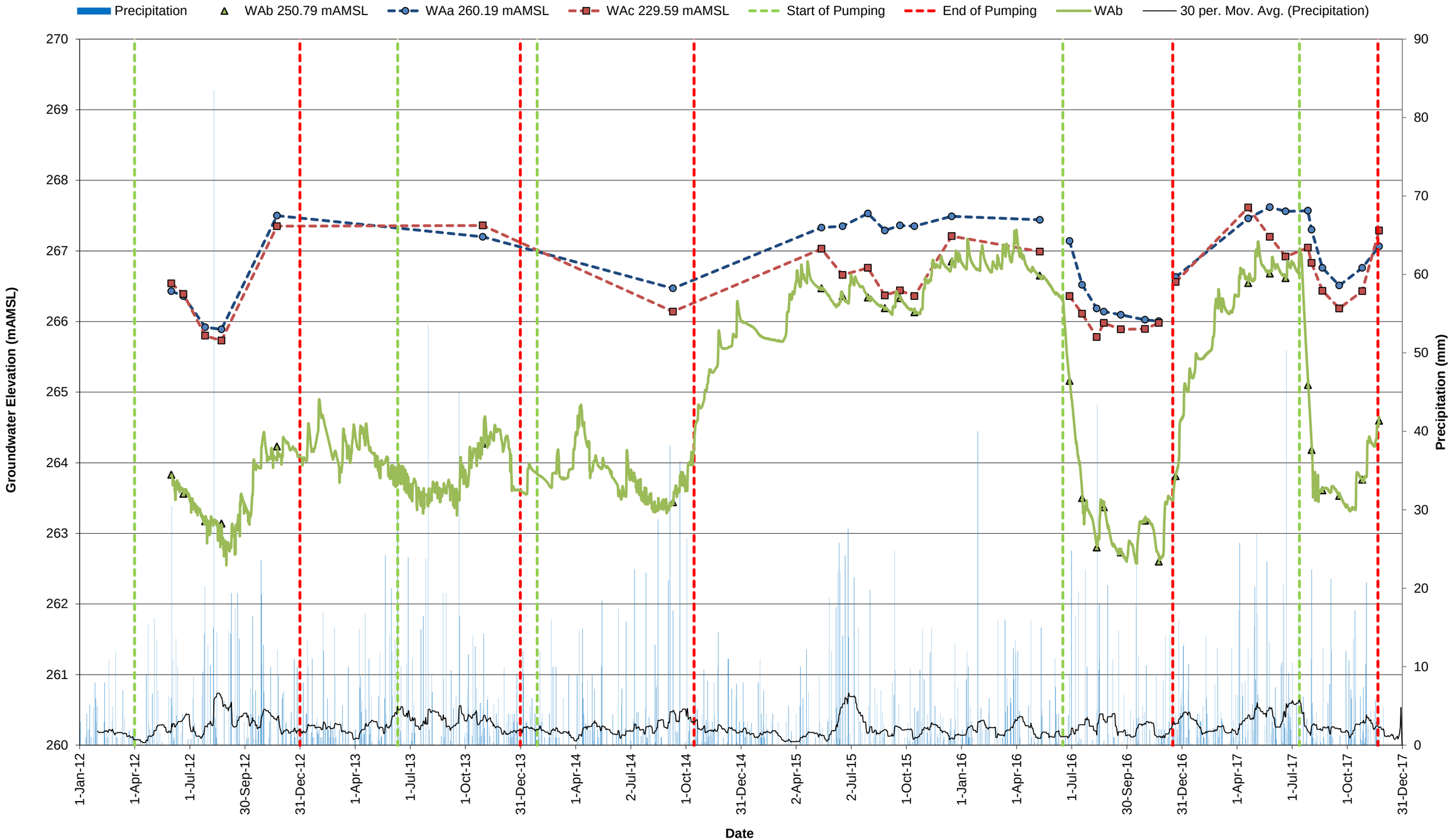
Hydrograph 11: Groundwater Elevations (mAMSL) - OH2 - Carden Quarry - 2012- 2017



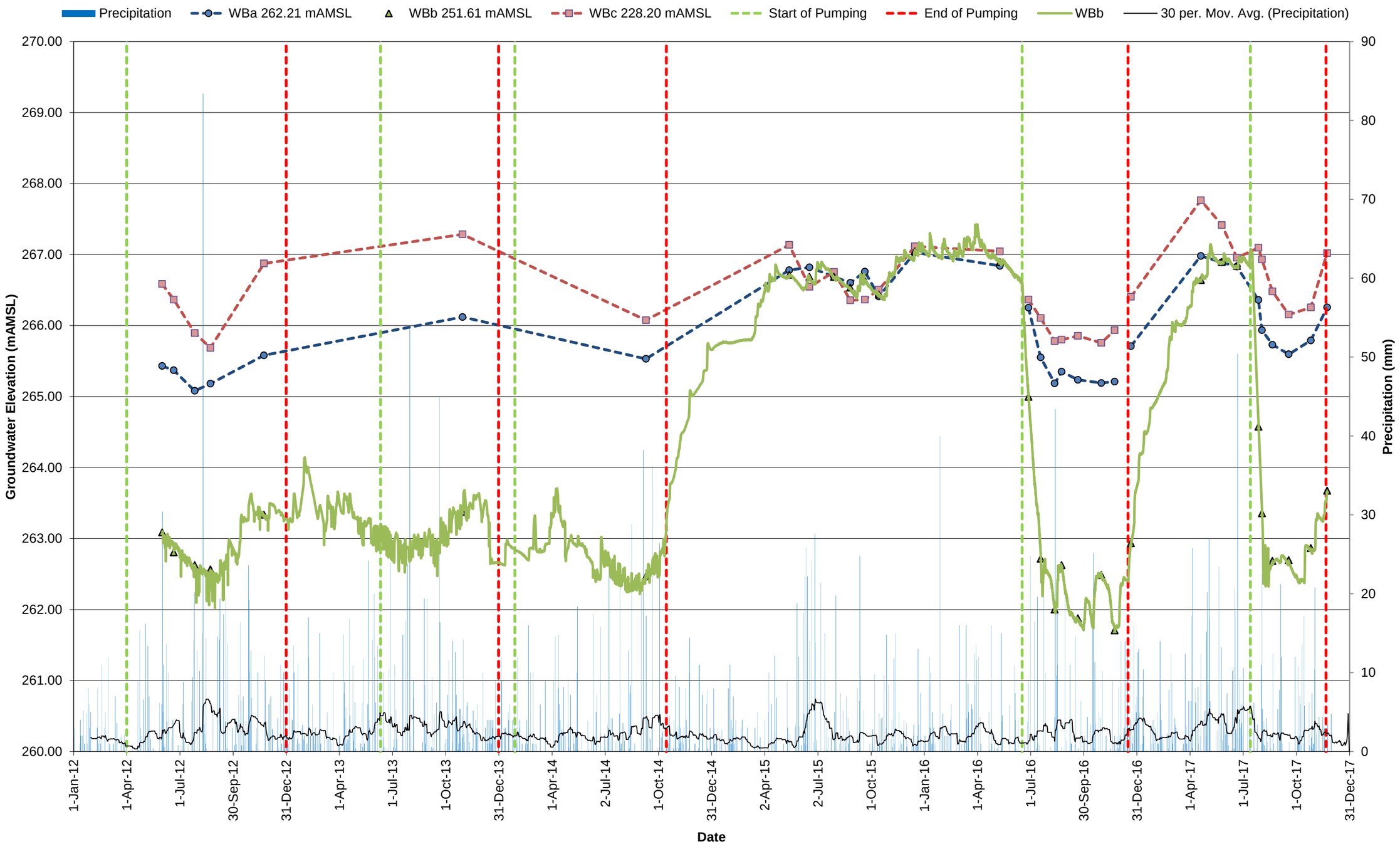
Hydrograph 12: Groundwater Elevations (mAMSL) - OWA - Carden Quarry - 2012- 2017



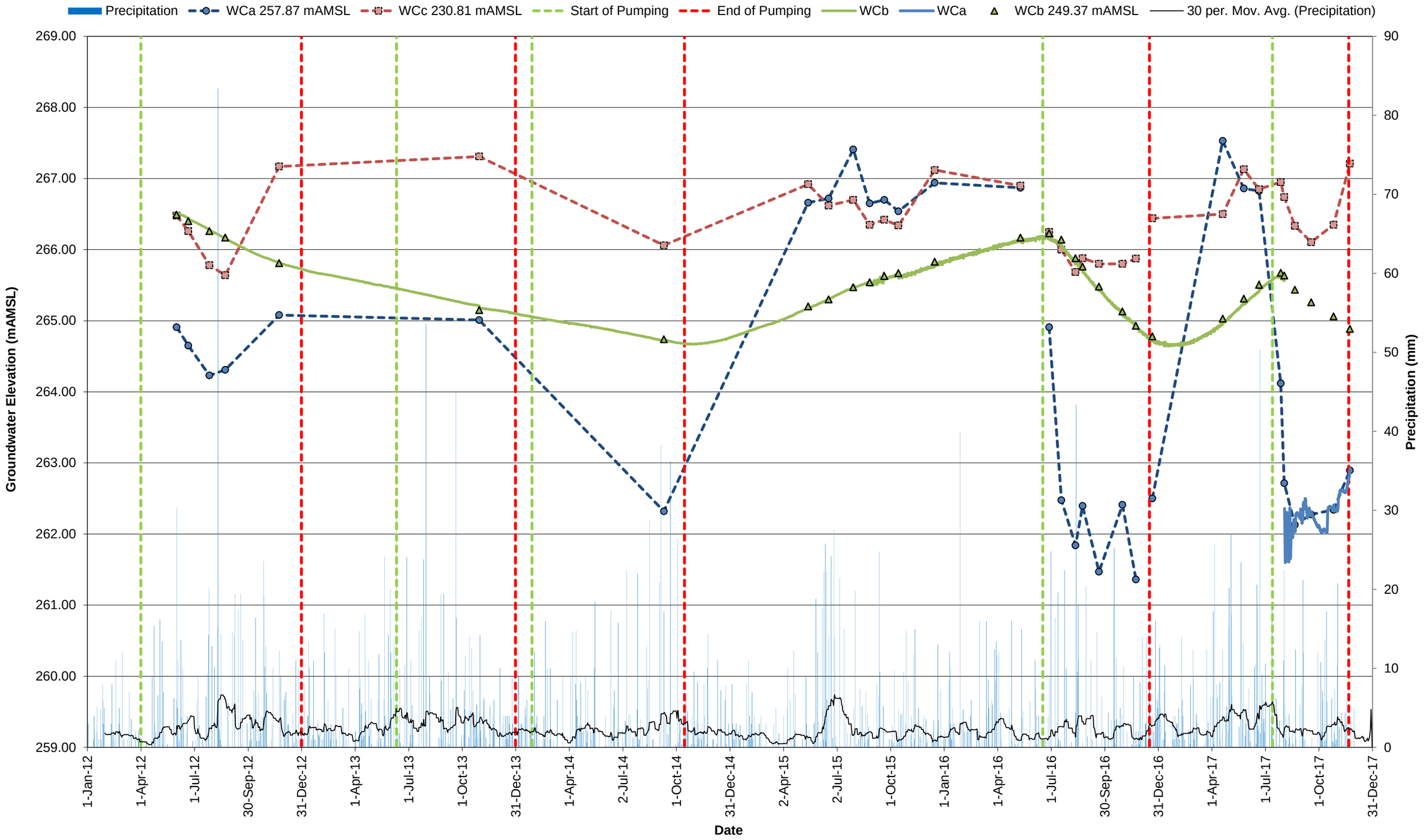
Hydrograph 13: Groundwater Elevations (mAMSL) - WA - Carden Quarry - 2012- 2017



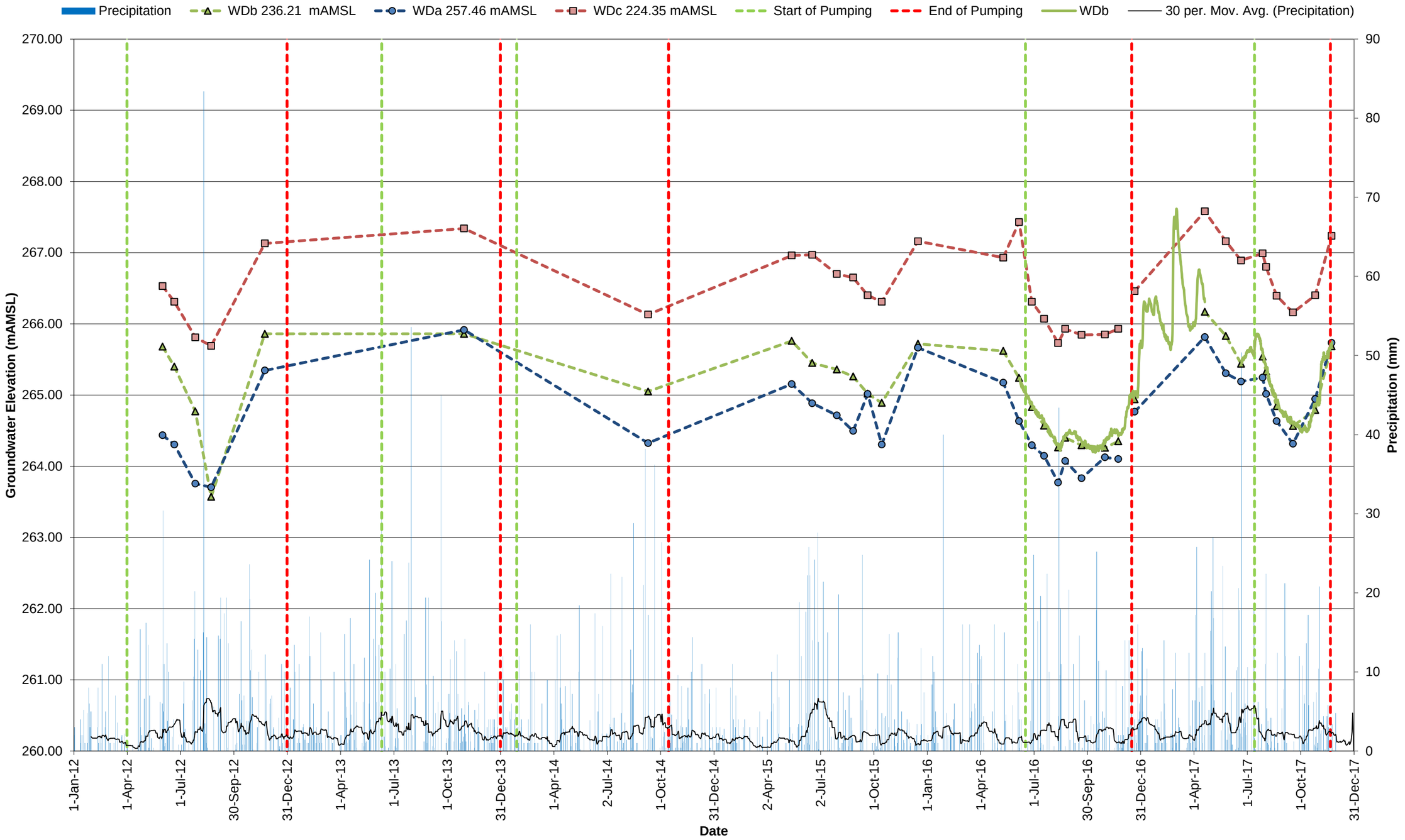
Hydrograph 14: Groundwater Elevations (mAMSL) - WB - Carden Quarry - 2012- 2017



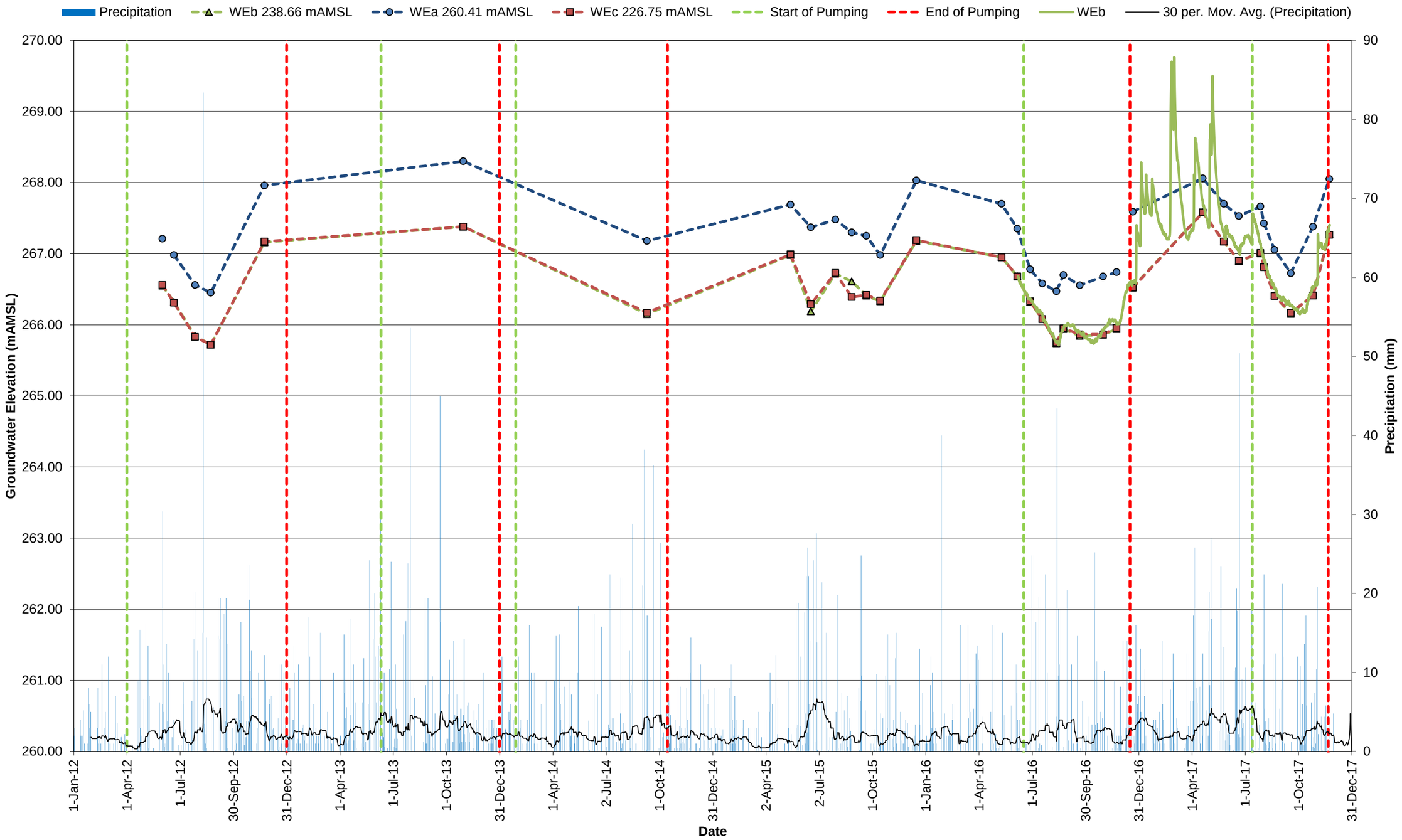
Hydrograph 15: Groundwater Elevations (mAMSL) - WC - Carden Quarry - 2012 - 2017



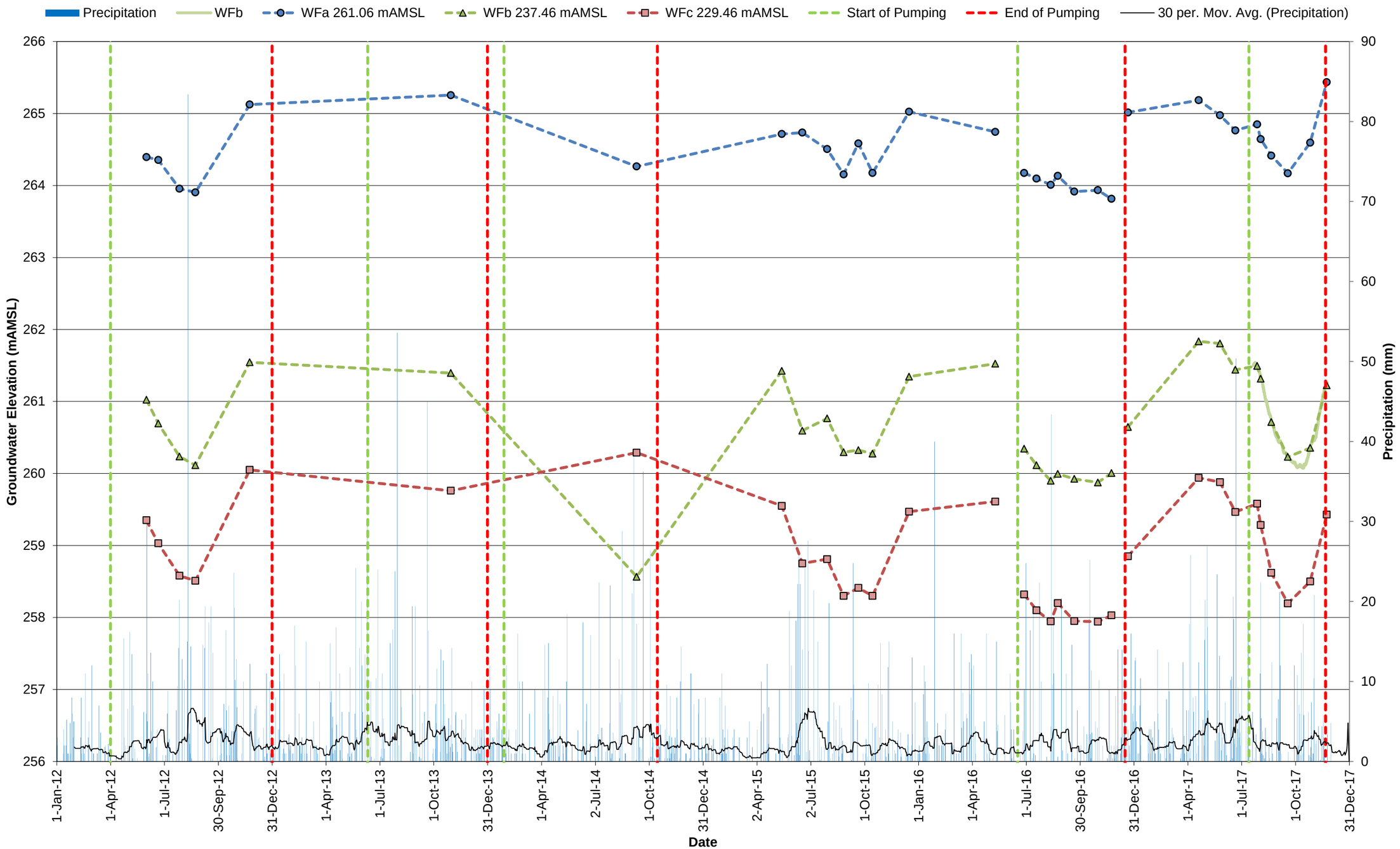
Hydrograph 16: Groundwater Elevations (mAMSL) - WD - Carden Quarry - 2012 - 2017



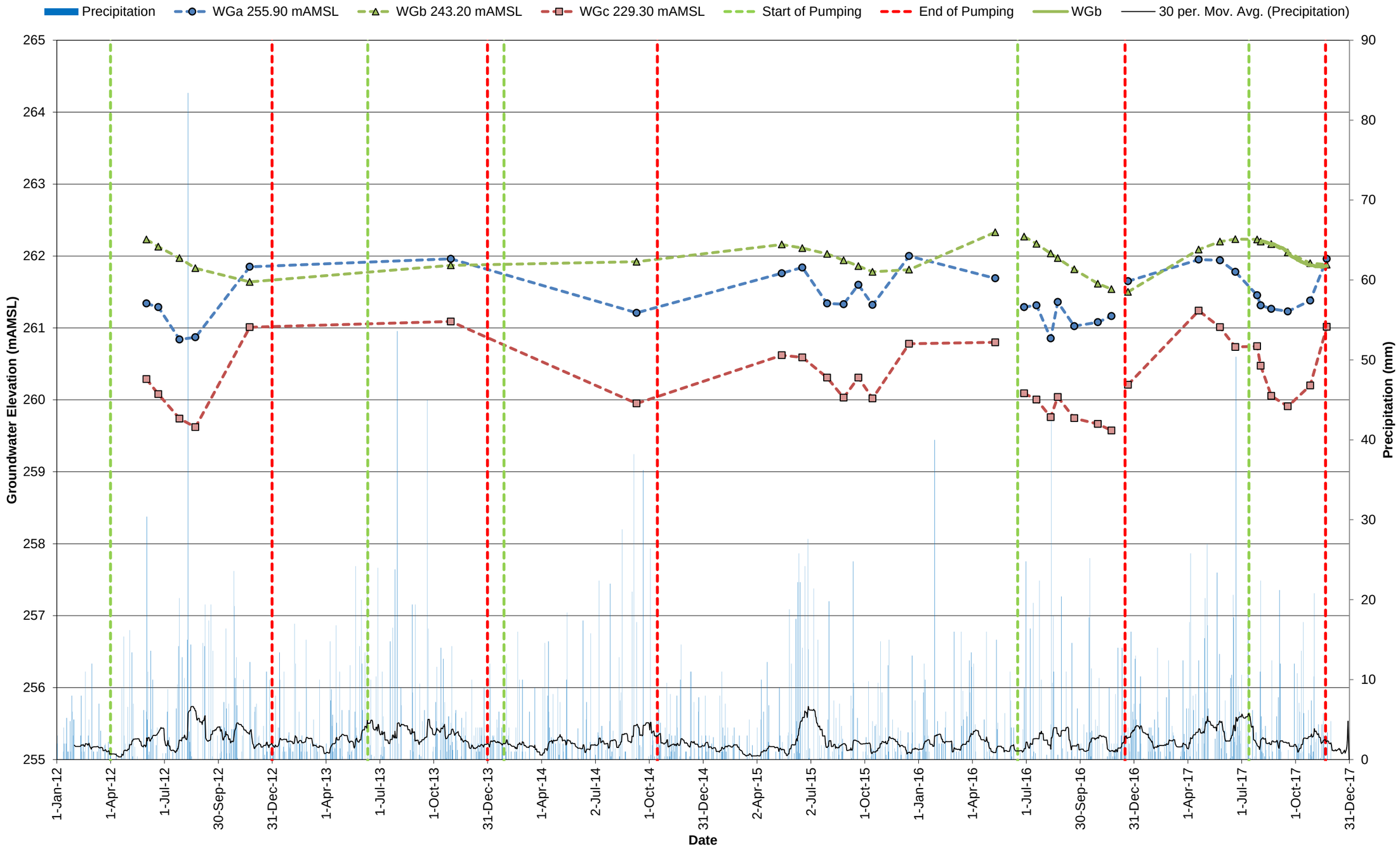
Hydrograph 17: Groundwater Elevations (mAMSL) - WE - Carden Quarry - 2012 - 2017



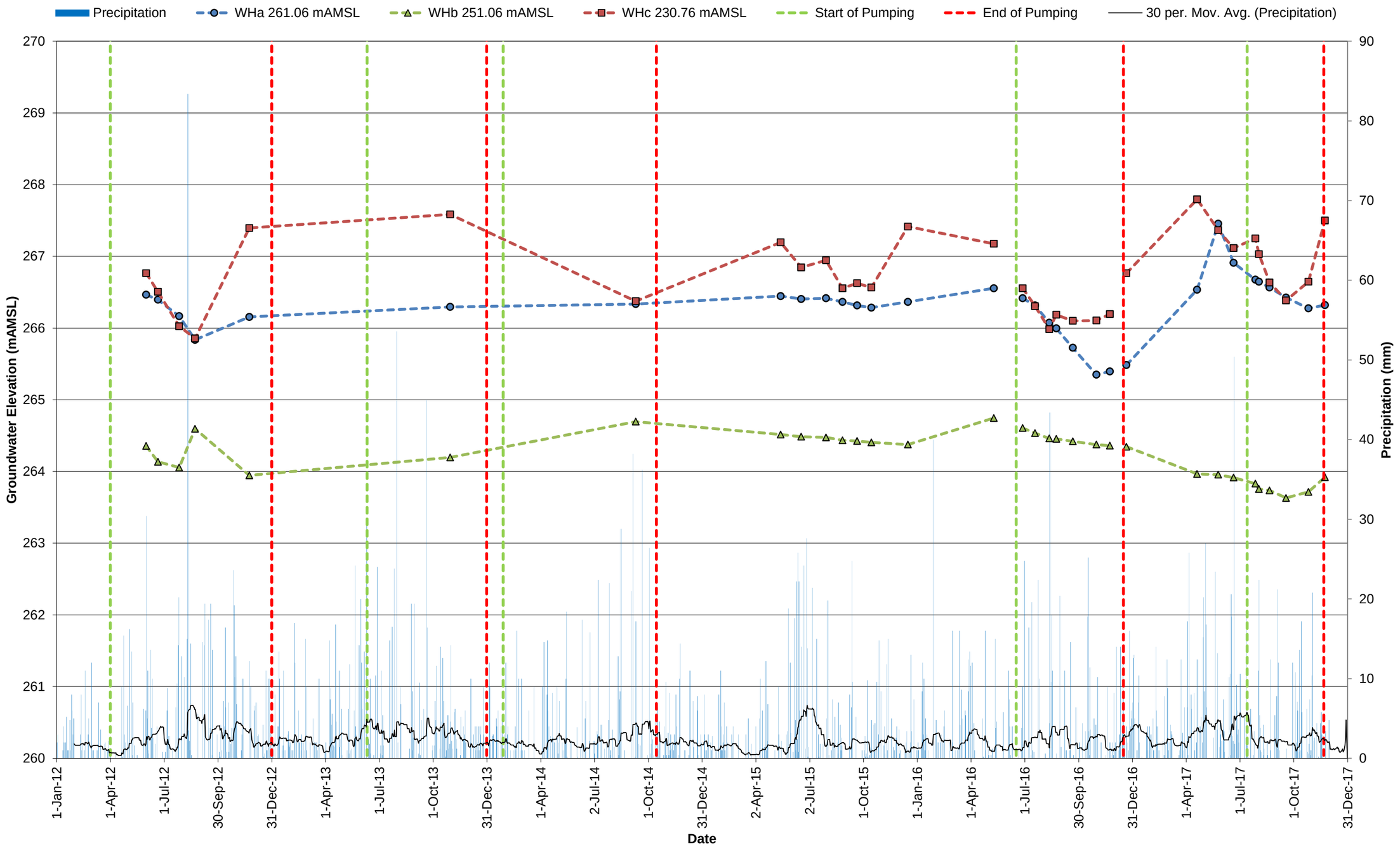
Hydrograph 18: Groundwater Elevations (mAMSL) - WF - Carden Quarry - 2012 - 2017



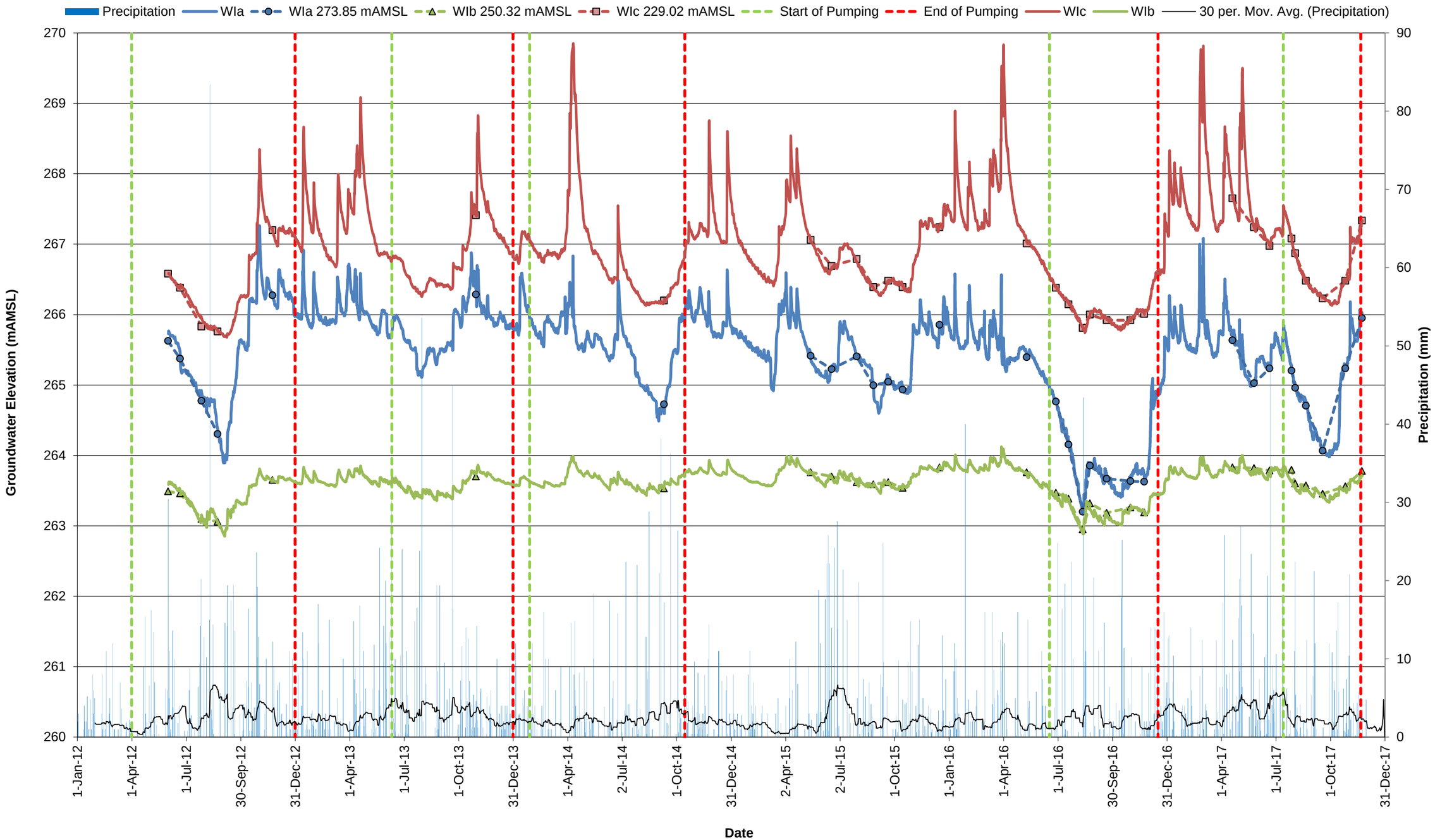
Hydrograph 19: Groundwater Elevations (mAMSL) - WG - Carden Quarry - 2012 - 2017



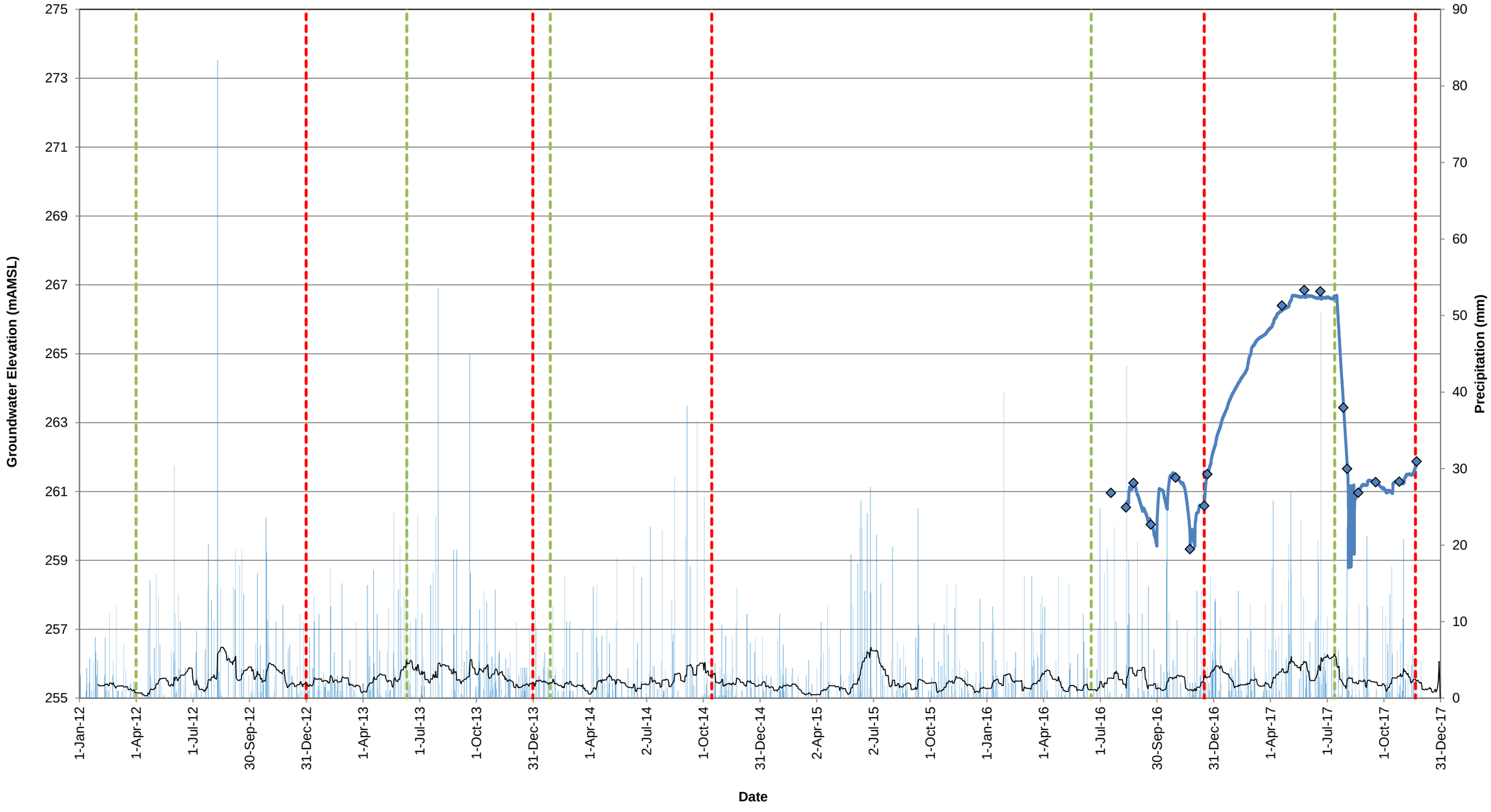
Hydrograph 20: Groundwater Elevations (mAMSL) - WH - Carden Quarry - 2012 - 2017



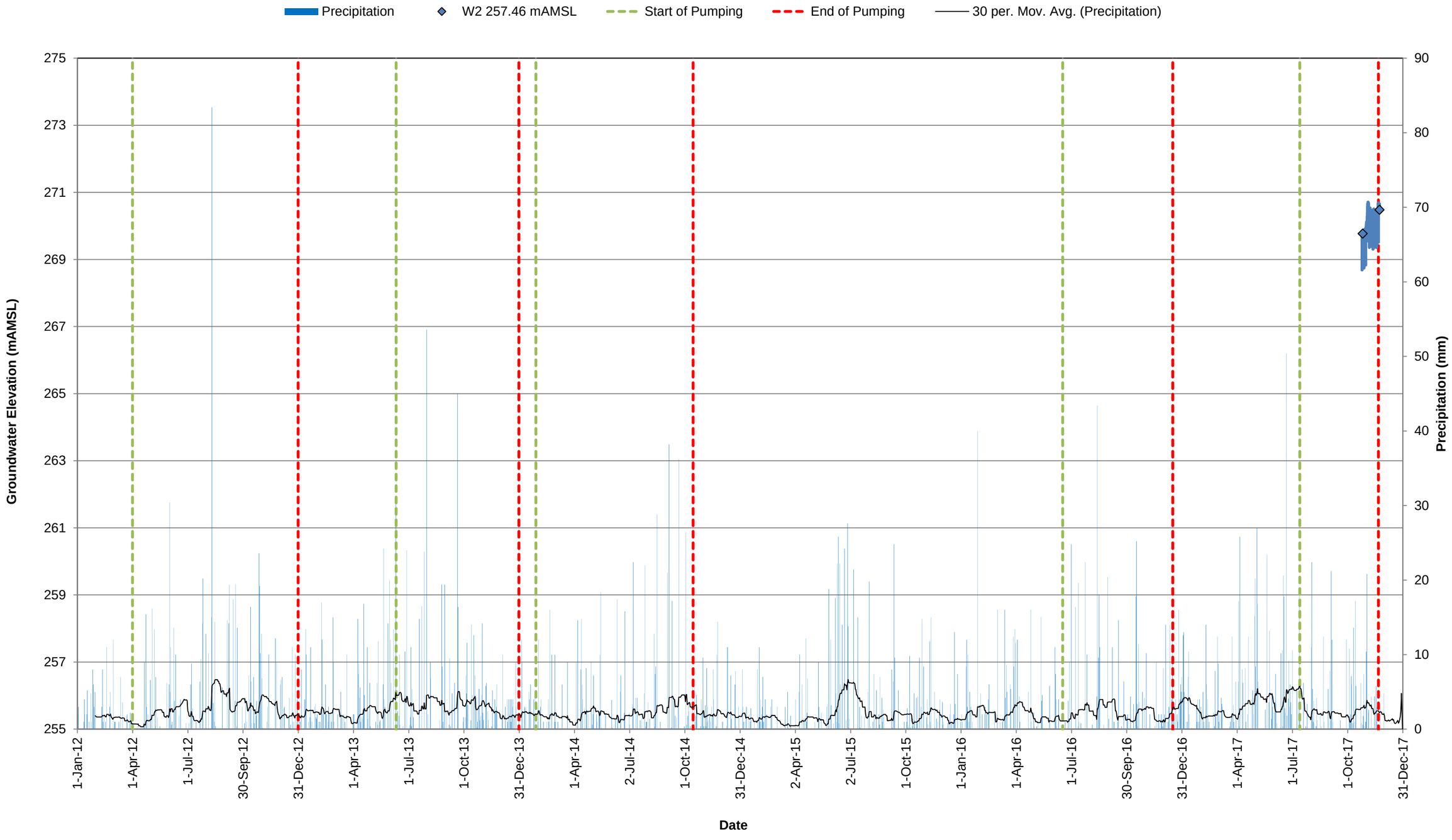
Hydrograph 21: Groundwater Elevations (mAMSL) - WI - Carden Quarry - 2012 - 2017



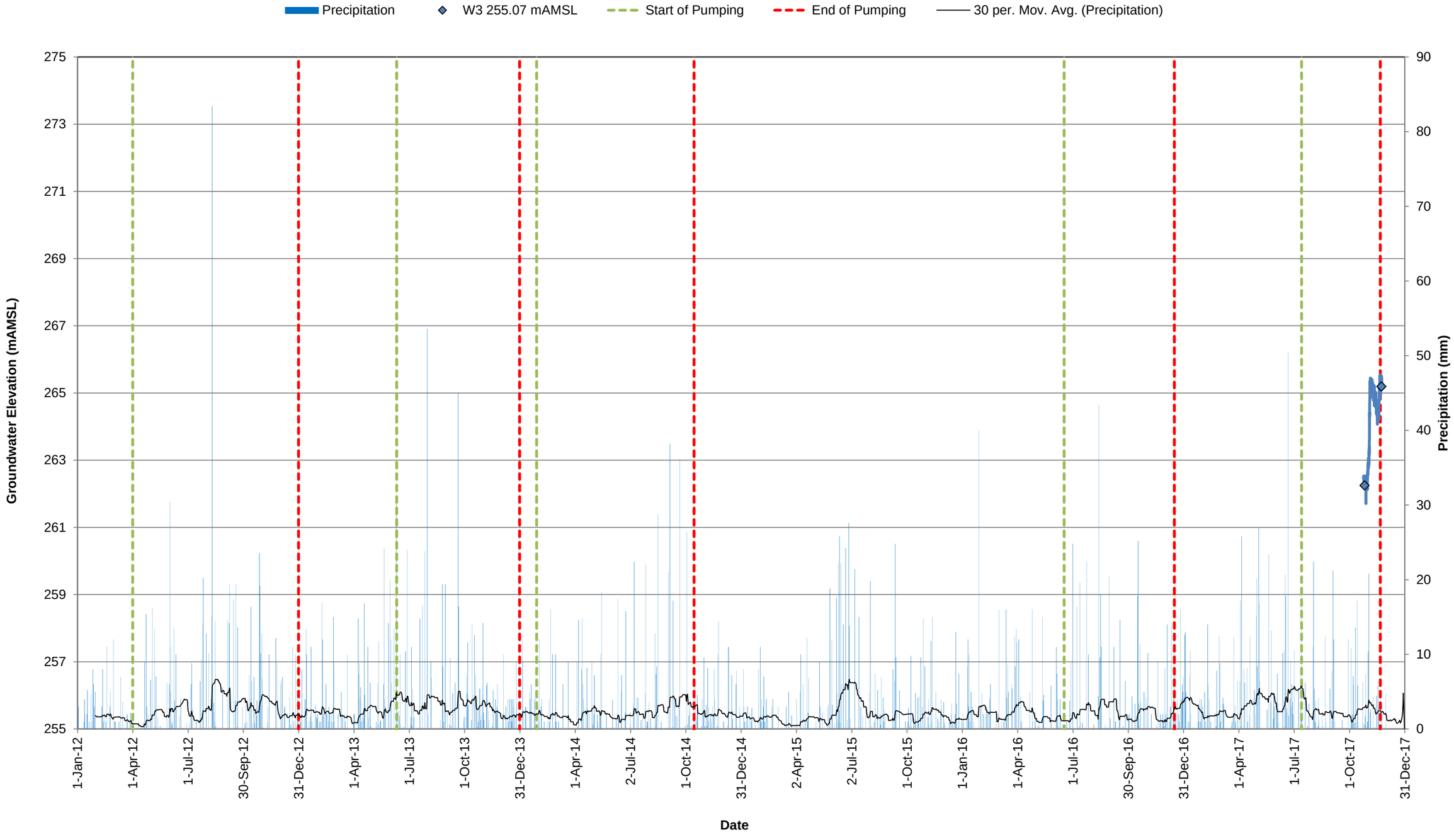
Hydrograph 22: Surface Water Elevations (mAMSL) - SG1 - Carden Quarry - 2012- 2017



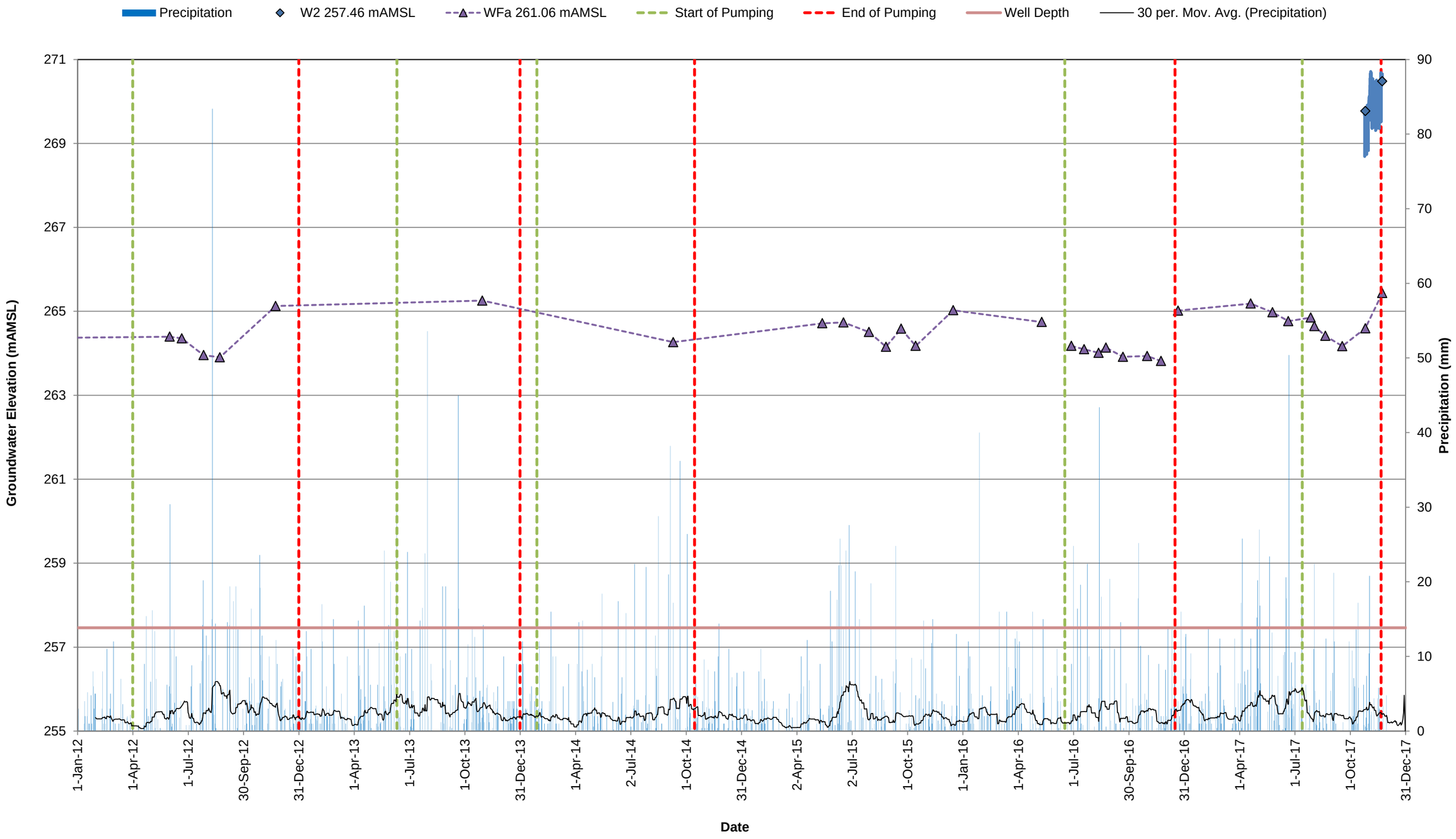
Hydrograph 23: Groundwater Elevations (mAMSL) - W2- Carden Quarry - 2012- 2017



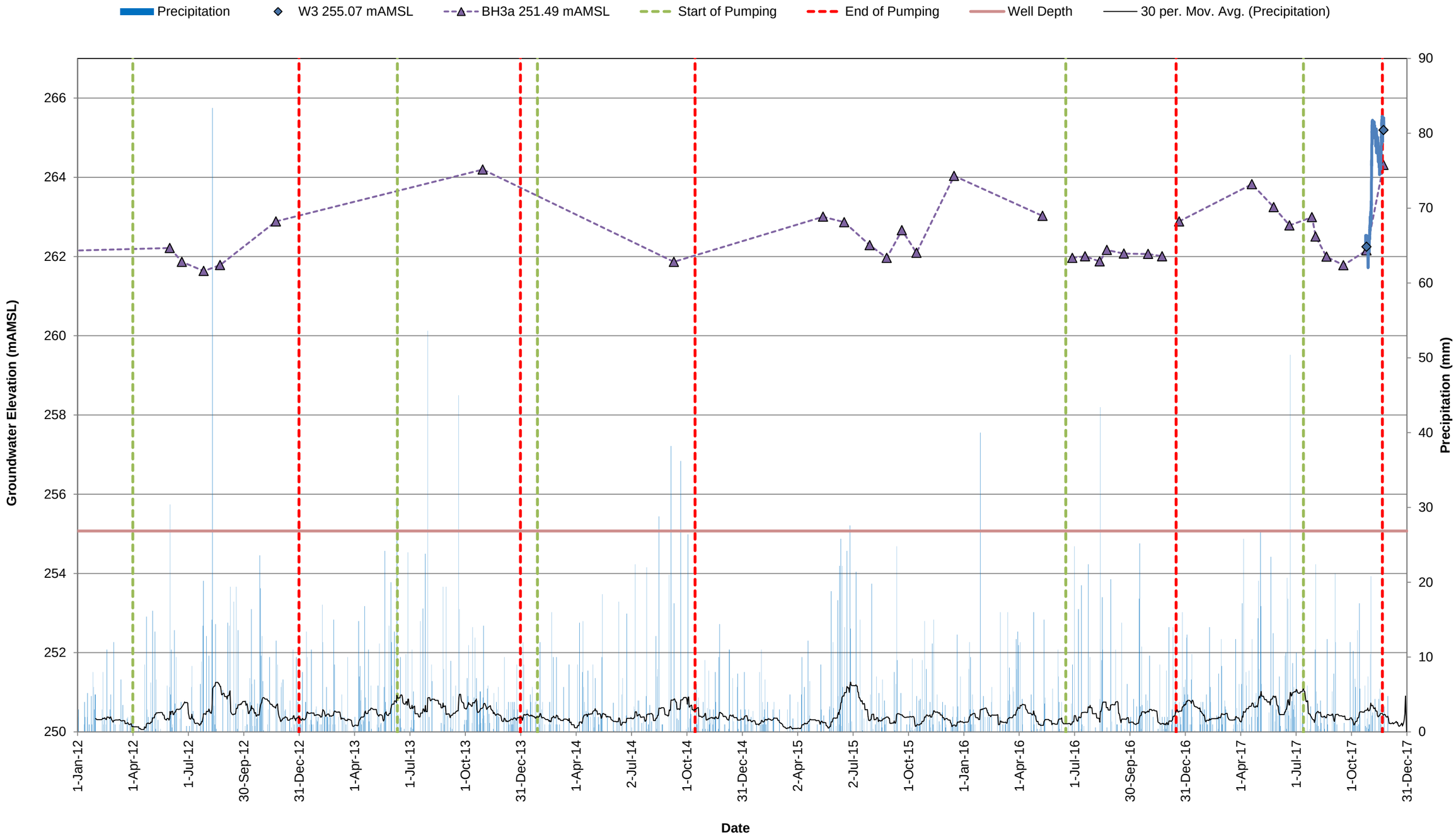
Hydrograph 24: Groundwater Elevations (mAMSL) - W3 - Carden Quarry - 2012- 2017



Hydrograph 25: Groundwater Elevations (mAMSL) - WFa & W2 - Carden Quarry - 2012- 2017



Hydrograph 26: Groundwater Elevations (mAMSL) - BH3A & W3- Carden Quarry - 2012- 2017



ATTACHMENT 1

2017 DISCHARGE RECORDS

INDUSTRIAL SEWAGE WORKS
Number 9123-5WAQUT

Date	Time	Discharge Volume (litres per second)	Staff Gauge	Cumulative Discharge (litres)
17/7/17	10:55am	60	26.9'	245,760
18/7/17	10:15am	60	25.9'	5,521,399
19/7/17	3:20pm	60	24.7'	12,105,026
21/7/17	10:20am	60	22.8'	21,804,756
24/7/17	8:45am	60	20.0'	37,519,299
25/7/17	5:10pm	60	18.8'	44,684,204
26/7/17	4:30pm	60	17.9'	49,761,393
28/7/17	9:45am	60	16.4'	58,818,970
29/7/17	10:00am	60	15.4'	64,268,622
02/8/17	7:20am	60	11.9'	84,858,762
03/8/17	4:30pm	60	10.5'	91,917,597
04/8/17	11:00am	60	9.5'	95,894,919
Meter changed over				
05/8/17	3:00pm	60	3.0'	1,340,980
Shut discharge down for awhile				
07/8/17	4:00pm		8.0'	
Start to discharge again				
	5:00pm	60		
Shut discharge down again				1,582,835
08/8/17	4:40pm		8.8'	
Start to discharge again				
09/8/17	8:00am	60		
Shut discharge down again			3.0'	4,999,254
	2:15pm		6.6'	
10/8/17	4:00pm		8.0'	
11/8/17				
Start to discharge again				
	1:25pm	60		
Shut discharge down again				
	7:40pm			6,375,973
13/8/17	4:30pm			
Start to discharge again		60		
	7:00pm			
Shut discharge down again			2.2'	6,942,308
Discharge on & off.				
14/8/17	7:15am		2.2'	10,221,266

PERMIT TO TAKE WATER # 3358-AKYGHJ

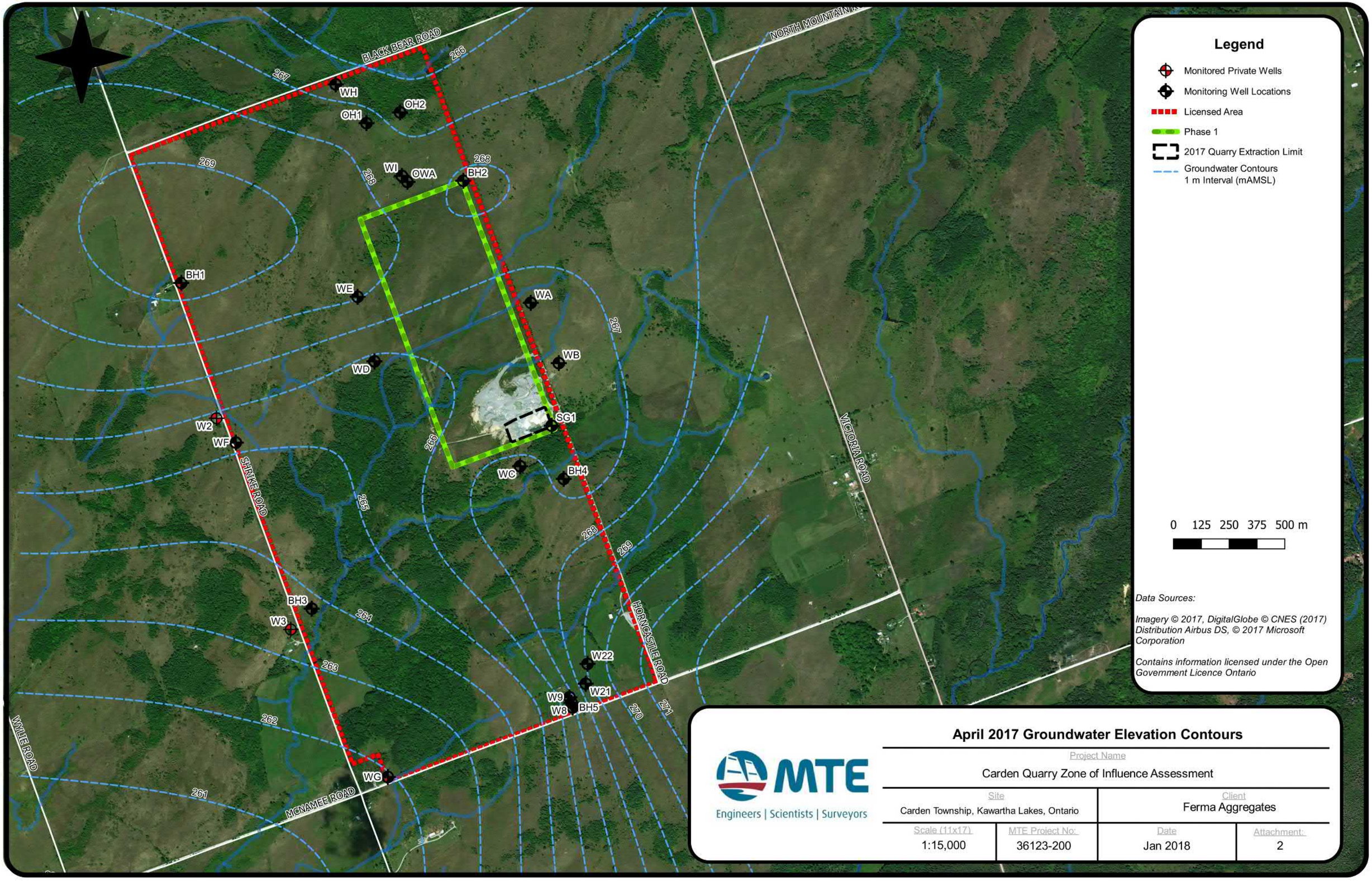
Date	Time	Litres/Min	Staff Gauge	Meter Reading
15/8/17	10:50am	564.90	7.6'	525,360 x 100
20/8/17	9:50am	557.01	8.0'	565,087
21/8/17	5:15pm	541.25	8.0'	575,385
24/8/17	9:00am	528.11	8.5'	595,687
Lots of rain this week.				
26/8/17	2:37pm	535.99	8.7'	612,506
28/8/17	2:34pm	519.84	8.9'	627,415
Shut down to clean in line screen				
	3:00pm	564.90		
04/9/17	9:00am	533.37	8.9'	681,692
05/9/17	3:00pm	528.11	9.0'	691,559
06/9/17	1:45pm	535.99	9.0'	698,443
More rains.				
Shut down to clean screen and shortened up the discharge hose.				
	2:05pm	591.93	9.5'	
08/9/17	9:20am	594.73	9.5'	713,853
Lots of rain.				
11/9/17	10:00am	543.88	9.4'	738,674
	6:00pm shut down to clean screen, then restarted.			
		584.04		
12/9/17	3:15pm	578.78	9.35'	748,596
15/9/17	10:45am	557.01	9.30'	771,606
Lost some time due to hydro outage.				
17/9/17	10:40am	581.41	9.50'	782,925
18/9/17	8:50am	576.00	?	790,629
20/9/17	10:00am	543.88	?	806,981
22/9/17	2:00pm	533.37	9.1'	823,737
25/9/17	5:15pm	525.48	8.9'	847,655
27/9/17	7:20am	took discharge water temperature 16.1 degrees Celsius.		
28/9/17	5:30pm	506.00 shut down to clean screen.		
	5:45pm	584.04	8.7'	870,413
29/9/17				
Very heavy rains.				
30/9/17	9:45am	573.25	8.8'	884,405
05/10/17	2:30pm	576.00	8.2'	927,592
06/10/17				
Heavy Rains.				
Storm shut down hydro for awhile.				

PERMIT TO TAKE WATER # 3358-AKYGHJ

07/10/17	3:30pm	599.82	8.4'	942,557
14/10/17	7:30am			
Meter has changed over to a 10x multiplier.				
	6:00pm	586.67	8.5'	
Heavy rains over the past few days.				
18/10/17	1:30pm	509.06	8.7'	303,315 x 10
20/10/17				
Shut down to clean screen.				
	1:30pm	599.82	8.8'	448,075
24/10/17	4:30pm	591.67	?	802,592
26/10/17	3:40pm			
Made some changes to interceptor ditch to reduce seepage back into the quarry.				
Shut down to clean screen.				
	3:45pm	599.82	8.9'	944,262
Meter changed over to a 100x multiplier.				
27/10/17	10:40am	584.04	8.8'	101,099 x 100
29/10/17				
It appears that the seepage has reduced.				
30/10/17				
MOE inspection today.				
30/10/17	10:30am	533.37	?	124,989
Staff gauge broke.				
02/11/17				
Cleaned screen.				
02/11/17	3:10pm	564.90	?	147,143
05/11/17				
Heavy rains				
	10:00am	474.95	9.2	167,818
Shut down to clean screen.				
06/11/17	2:30pm	564.90	9.3'	174,819
09/11/17				
Covered the meter with an insulated blanket to prevent freezing.				
10/11/17				
Very cold -18 degrees Celsius, wind and snow.				
18/11/17				
Heavy rains.				
19/11/17				
Snow over night.				
21/11/17	1:00pm	284.50	?	269,068
MTE took the last water sample from the discharge for 2017.				

ATTACHMENT 2

2017 GROUNDWATER ELEVATION MAPS



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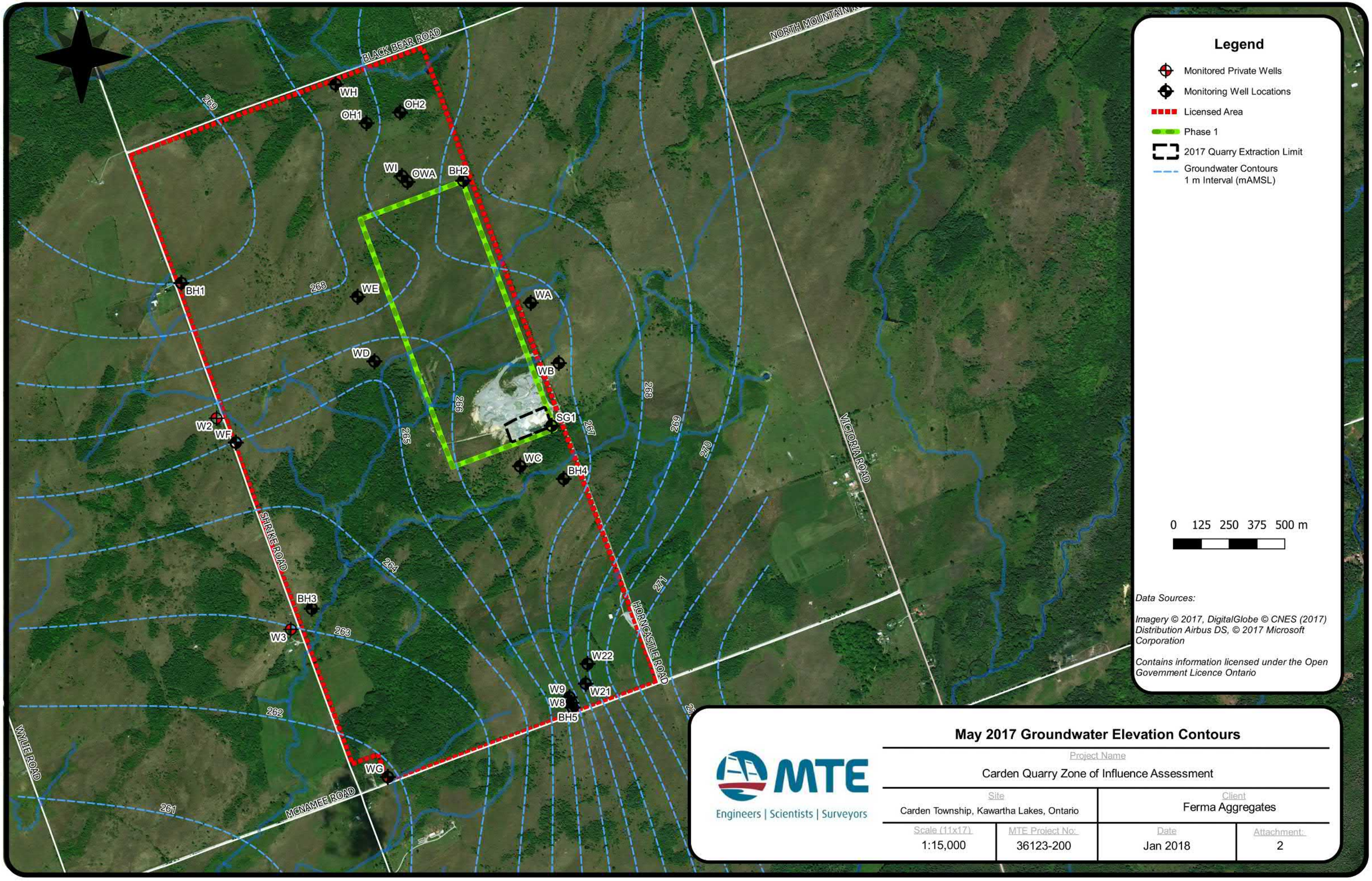
GW Flow

January 04, 2018 - 16:28 - Plotted By: fcummings

MTE
Engineers | Scientists | Surveyors

April 2017 Groundwater Elevation Contours

Project Name			
Carden Quarry Zone of Influence Assessment			
Site		Client	
Carden Township, Kawartha Lakes, Ontario		Ferma Aggregates	
Scale (11x17)	MTE Project No:	Date	Attachment:
1:15,000	36123-200	Jan 2018	2



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GW Flow

January 05, 2018 - 09:19 - Plotted By: fcummings

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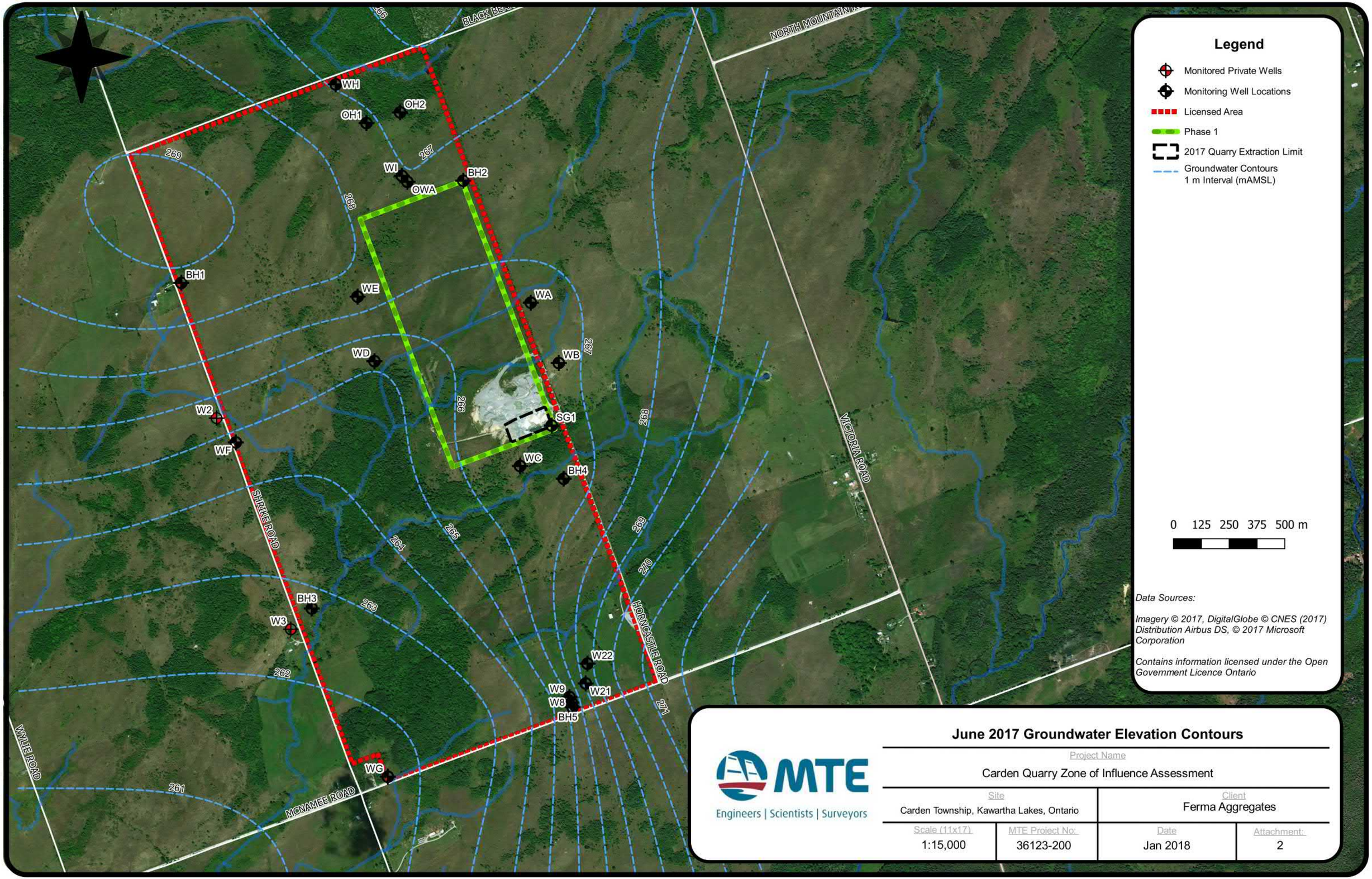
May 2017 Groundwater Elevation Contours

Project Name			
Carden Quarry Zone of Influence Assessment			
Site: Carden Township, Kawartha Lakes, Ontario		Client: Ferma Aggregates	
Scale (11x17): 1:15,000	MTE Project No: 36123-200	Date: Jan 2018	Attachment: 2



Project No: Q:\36123\200\Maps\36123-200 - Carden Quarry - QGIS.qgs

GW Flow

January 04, 2018 - 16:40 - Plotted By: fcummings

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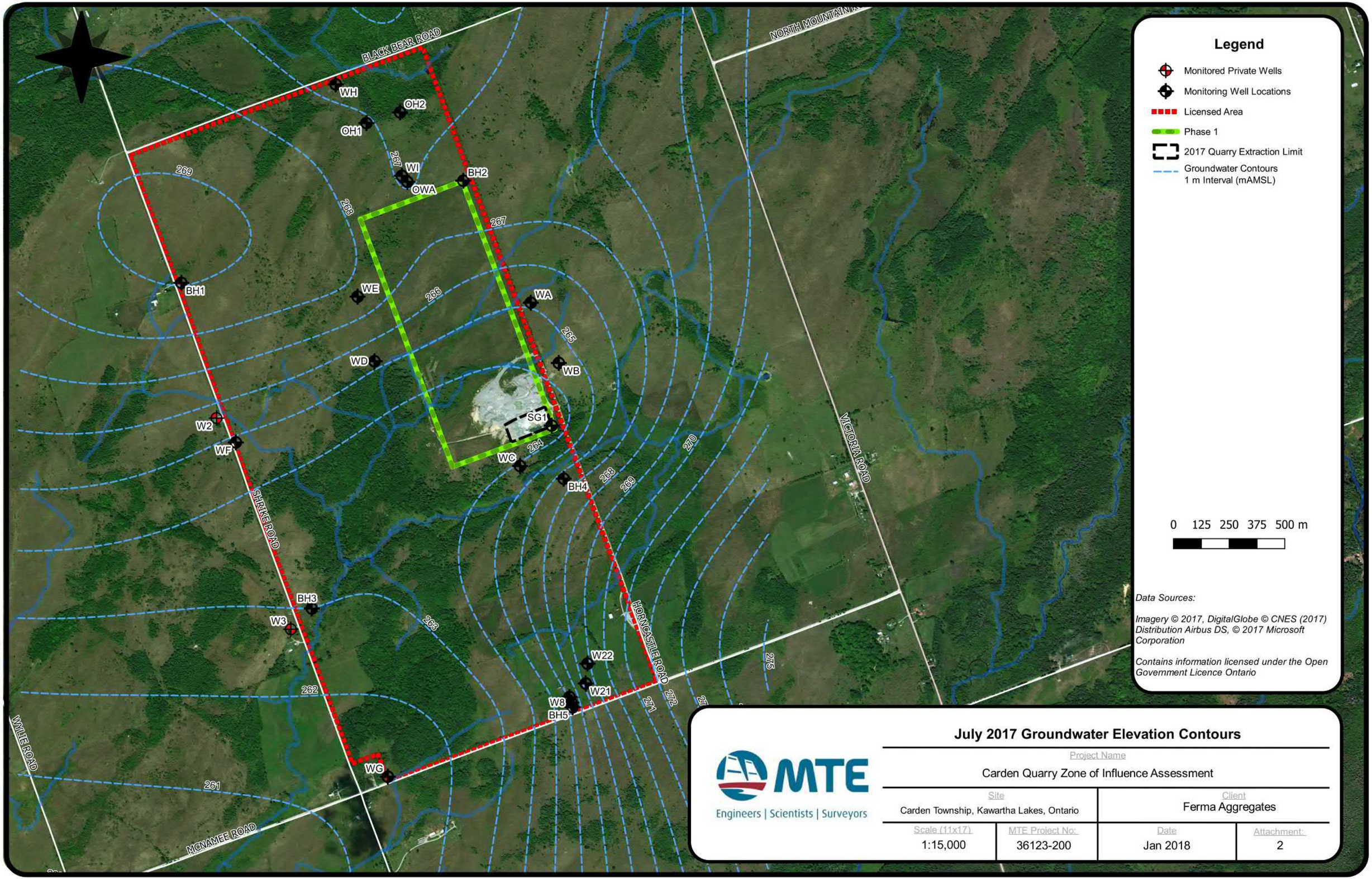
June 2017 Groundwater Elevation Contours

Project Name			
Carden Quarry Zone of Influence Assessment			
Site		Client	
Carden Township, Kawartha Lakes, Ontario		Ferma Aggregates	
Scale (11x17)	MTE Project No:	Date	Attachment:
1:15,000	36123-200	Jan 2018	2



Legend

- Monitored Private Wells
- Monitoring Well Locations
- Licensed Area
- Phase 1
- 2017 Quarry Extraction Limit
- Groundwater Contours 1 m Interval (mAMSL)

0 125 250 375 500 m

Data Sources:

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July 2017 Groundwater Elevation Contours

Project Name			
Carden Quarry Zone of Influence Assessment			
Site: Carden Township, Kawartha Lakes, Ontario		Client: Ferma Aggregates	
Scale (11x17): 1:15,000	MTE Project No: 36123-200	Date: Jan 2018	Attachment: 2

Project No: Q:/36123/200/Maps/36123-200 - Carden Quarry - QGIS.qgs

GW Flow

January 05, 2018 - 08:52 - Plotted By: fcummings

Project No: Q:/36123/200/Maps/36123-200 - Carden Quarry - QGIS.qgs

GW Flow

January 05, 2018 - 08:56 - Plotted By: fcummings

BLACK BEAR ROAD

NORTH MOUNTAIN ROAD

VICTORIA ROAD

SHRIKE ROAD

HORNCASTLE ROAD

WYLIE ROAD

MCNAMEE ROAD

WH
OH1
OH2
WI
OWA
BH2
BH1
WE
WA
WB
WD
W2
WF
SG1
WC
BH4
BH3
W3
W22
W9
W21
W8
BH5
WG

268
269
266
267
265
264
263
261
262
270
271
272
274
276

Legend

- Monitored Private Wells
- Monitoring Well Locations
- Licensed Area
- Phase 1
- 2017 Quarry Extraction Limit
- Groundwater Contours 1 m Interval (mAMSL)

0 125 250 375 500 m

Data Sources:

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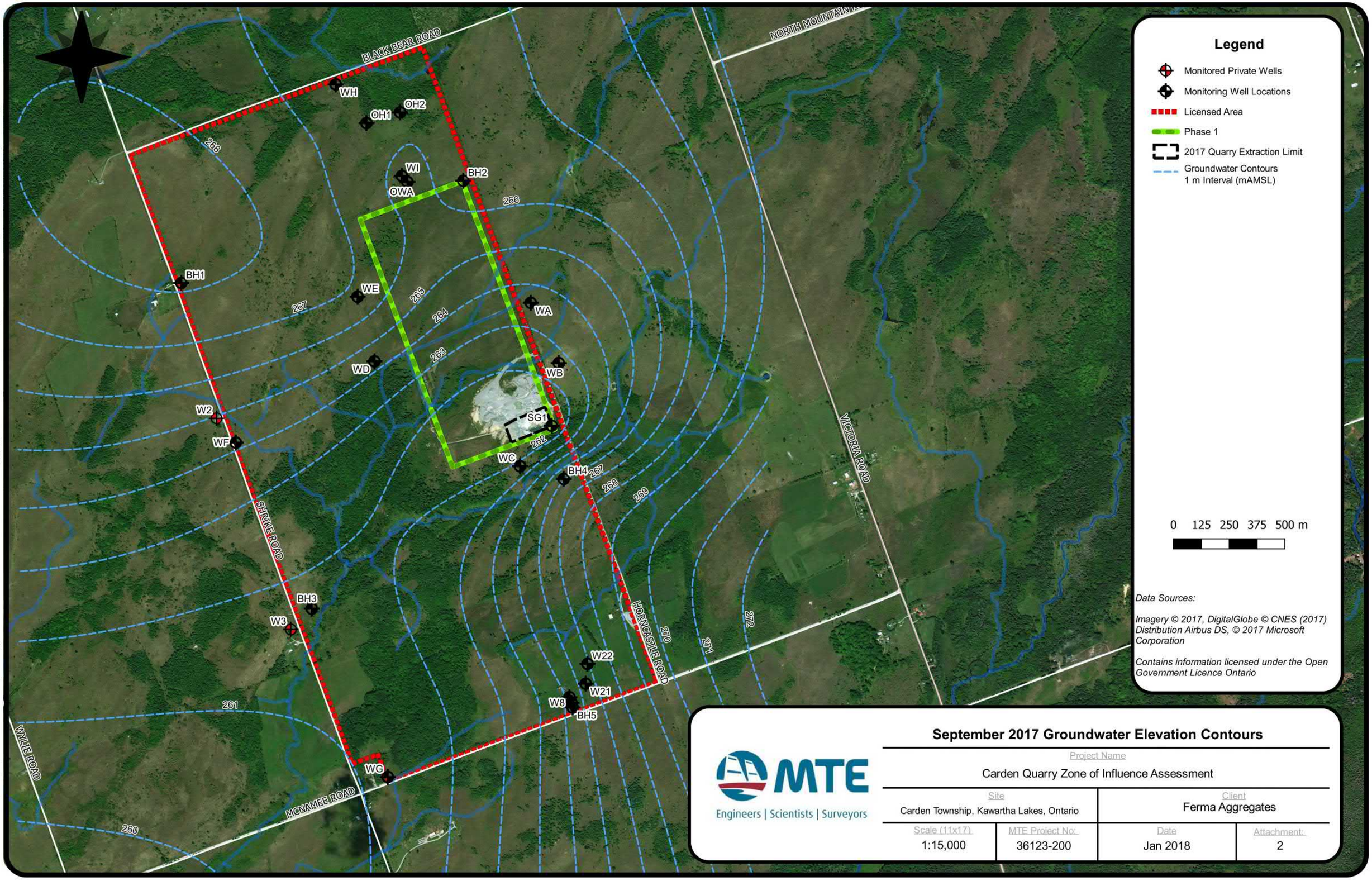
August 2017 Groundwater Elevation Contours

Project Name			
Carden Quarry Zone of Influence Assessment			
Site: Carden Township, Kawartha Lakes, Ontario		Client: Ferma Aggregates	
Scale (11x17): 1:15,000	MTE Project No: 36123-200	Date: Jan 2018	Attachment: 2



Project No: Q:/36123/200/Maps/36123-200 - Carden Quarry - QGIS.qgs

GW Flow

January 05, 2018 - 09:00 - Plotted By: fcummings

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September 2017 Groundwater Elevation Contours

Project Name			
Carden Quarry Zone of Influence Assessment			
Site		Client	
Carden Township, Kawartha Lakes, Ontario		Ferma Aggregates	
Scale (11x17)	MTE Project No:	Date	Attachment:
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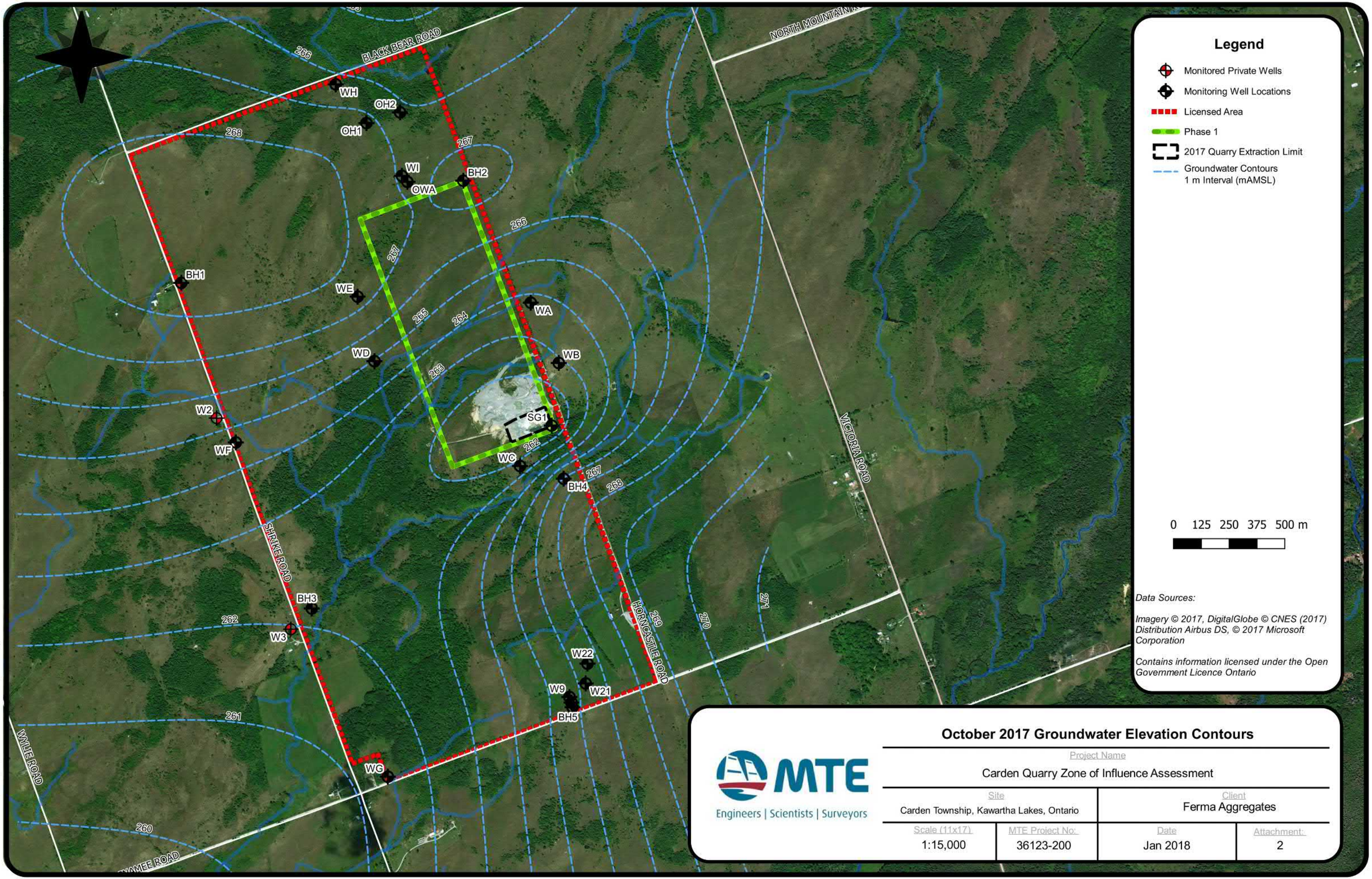

Legend

- Monitored Private Wells
- Monitoring Well Locations
- Licensed Area
- Phase 1
- 2017 Quarry Extraction Limit
- Groundwater Contours 1 m Interval (mAMSL)

0 125 250 375 500 m

Data Sources:

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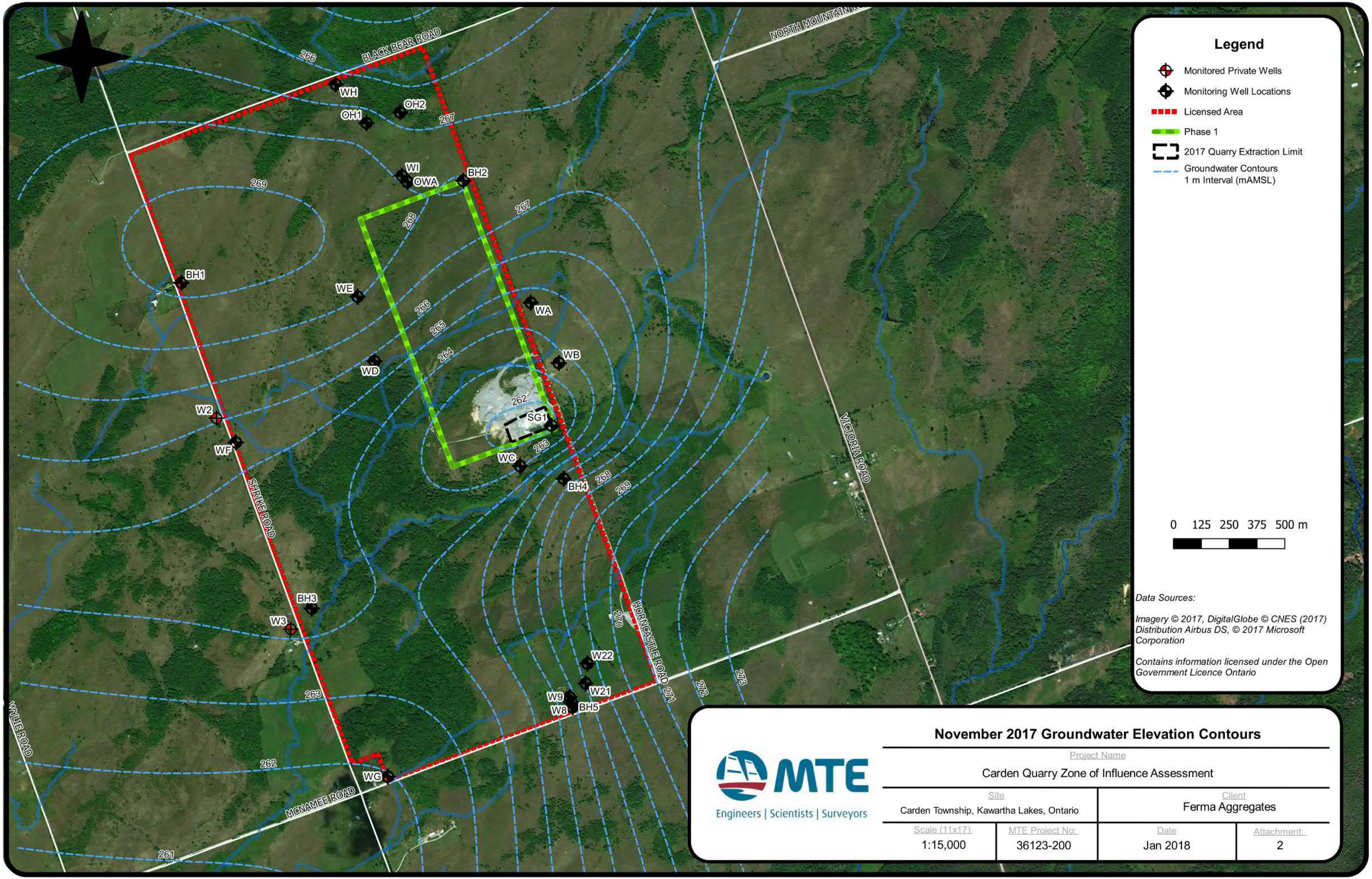
October 2017 Groundwater Elevation Contours

Project Name			
Carden Quarry Zone of Influence Assessment			
Site: Carden Township, Kawartha Lakes, Ontario		Client: Ferma Aggregates	
Scale (11x17): 1:15,000	MTE Project No: 36123-200	Date: Jan 2018	Attachment: 2

Project No: Q:/36123/200/Maps/36123-200 - Carden Quarry - QGIS.qgs

GW Flow

January 05, 2018 - 09:03 - Plotted By: fcummings



Legend

- Monitored Private Wells
- Monitoring Well Locations
- Licensed Area
- Phase 1
- 2017 Quarry Extraction Limit
- Groundwater Contours 1 m Interval (mAMSL)

0 125 250 375 500 m

Data Sources:

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MTE Engineers | Scientists | Surveyors

November 2017 Groundwater Elevation Contours

Project Name			
Carden Quarry Zone of Influence Assessment			
Site: Carden Township, Kawartha Lakes, Ontario		Client: Ferma Aggregates	
Scale (11x17): 1:15,000	MTE Project No: 36123-200	Date: Jan 2018	Attachment: 2

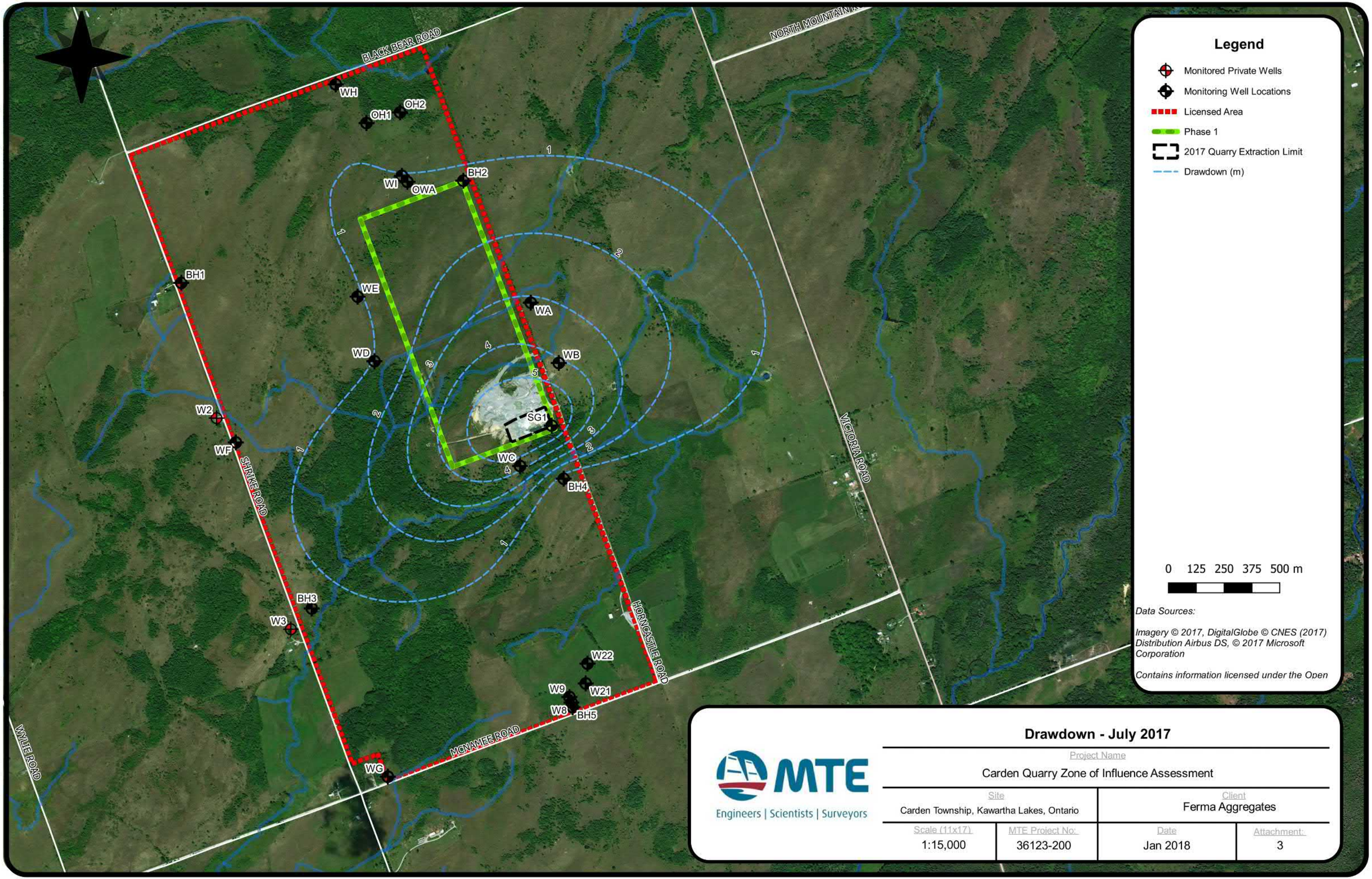
Project No: Q:/36123/200/Maps/36123-200 - Carden Quarry - QGIS.qgs

GW Flow

January 05, 2018 - 09:05 - Plotted By: fcummings

ATTACHMENT 3

2017 DRAWDOWN MAPS



Project No: Q:\36123\200\Maps\36123-200 - Carden Quarry - QGIS.qgs

GW Flow

January 04, 2018 - 15:56 - Plotted By: fcummings

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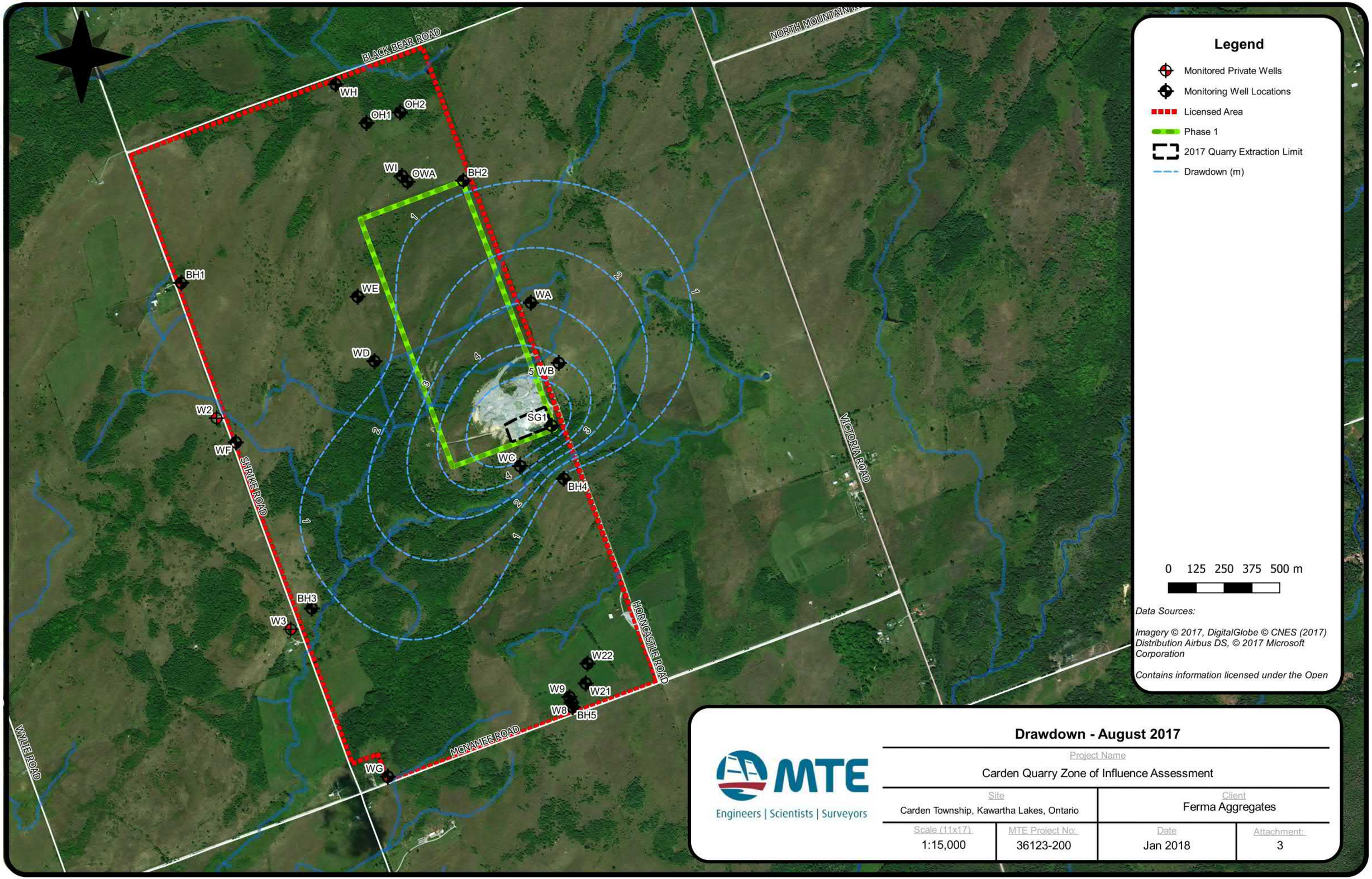
Drawdown - July 2017

Project Name			
Carden Quarry Zone of Influence Assessment			
Site: Carden Township, Kawartha Lakes, Ontario		Client: Ferma Aggregates	
Scale (11x17): 1:15,000	MTE Project No: 36123-200	Date: Jan 2018	Attachment: 3



Legend

- Monitored Private Wells
- Monitoring Well Locations
- Licensed Area
- Phase 1
- 2017 Quarry Extraction Limit
- Drawdown (m)

0 125 250 375 500 m

Data Sources:

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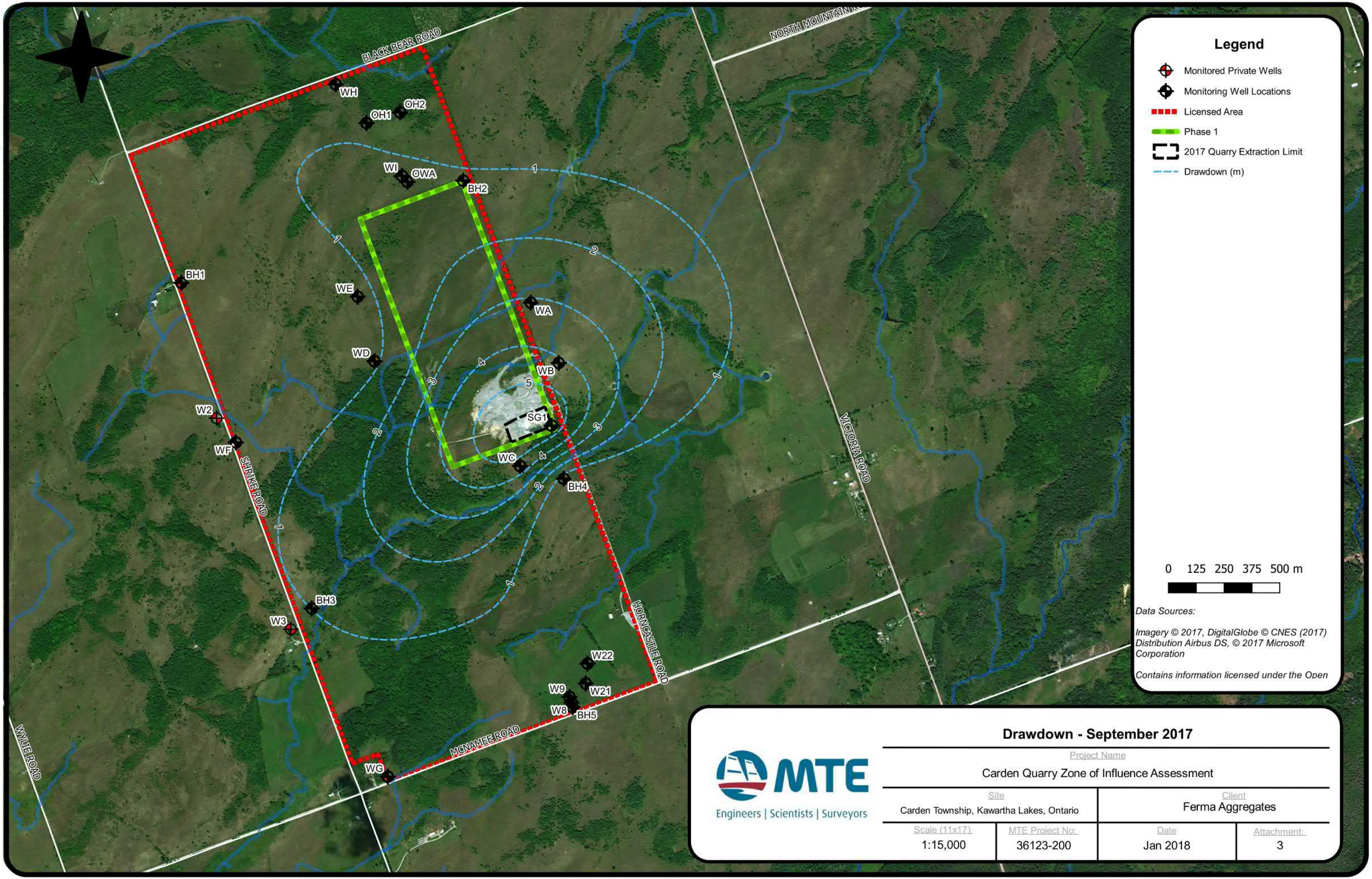
Drawdown - August 2017

Project Name			
Carden Quarry Zone of Influence Assessment			
Site		Client	
Carden Township, Kawartha Lakes, Ontario		Ferma Aggregates	
Scale (11x17)	MTE Project No:	Date	Attachment:
1:15,000	36123-200	Jan 2018	3

Project No: Q:/36123/200/Maps/36123-200 - Carden Quarry - QGIS.qgs
GW Flow
January 04, 2018 - 15:59 - Plotted By: fcummings



Project No: Q:\36123\200\Maps\36123-200 - Carden Quarry - QGIS.qgs

GW Flow

January 04, 2018 - 16:05 - Plotted By: fcummings

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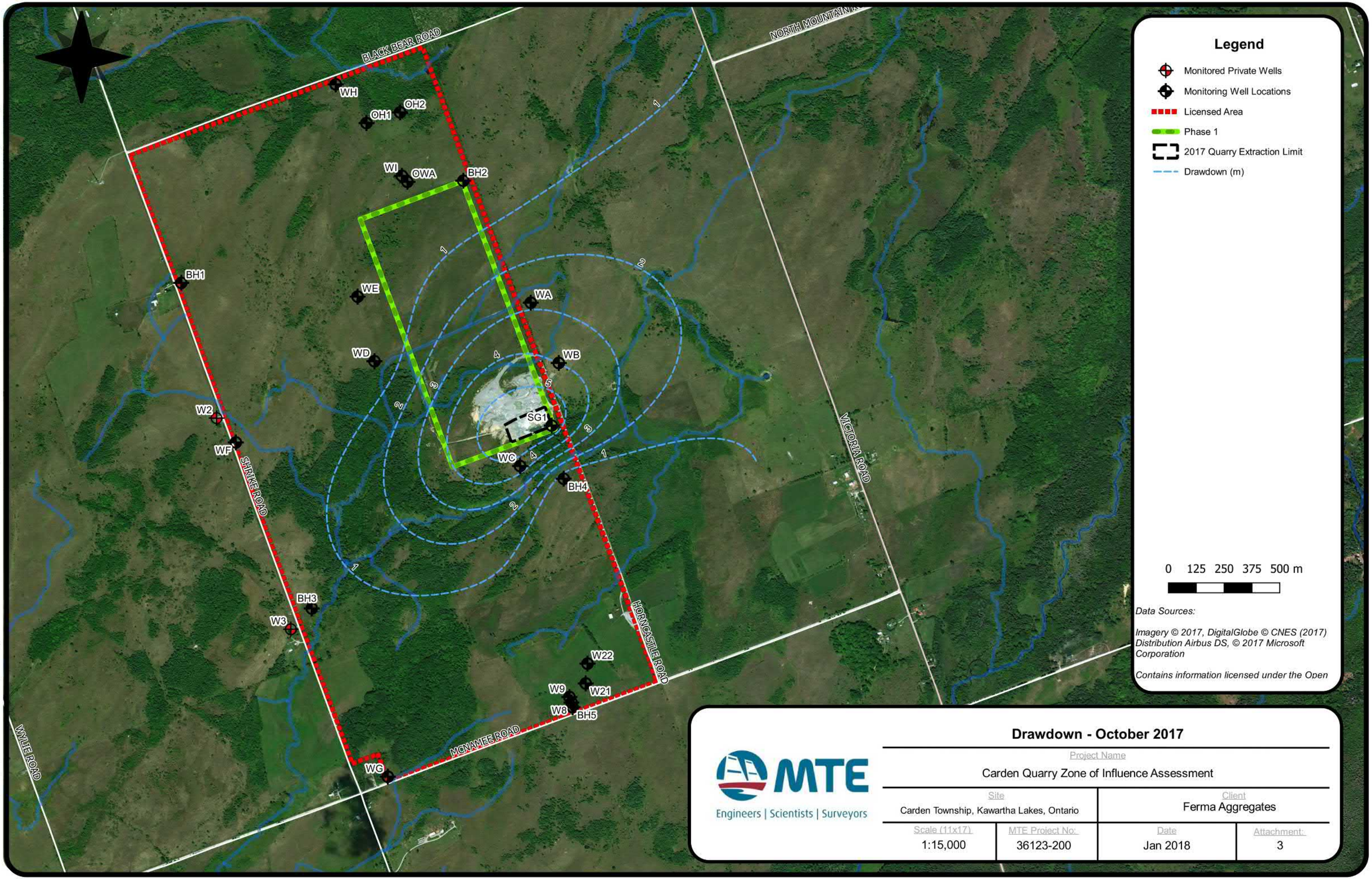
Drawdown - September 2017

Project Name			
Carden Quarry Zone of Influence Assessment			
Site		Client	
Carden Township, Kawartha Lakes, Ontario		Ferma Aggregates	
Scale (11x17)	MTE Project No:	Date	Attachment:
1:15,000	36123-200	Jan 2018	3



Project No: Q:/36123/200/Maps/36123-200 - Carden Quarry - QGIS.qgs

GW Flow

January 04, 2018 - 16:02 - Plotted By: fcummings

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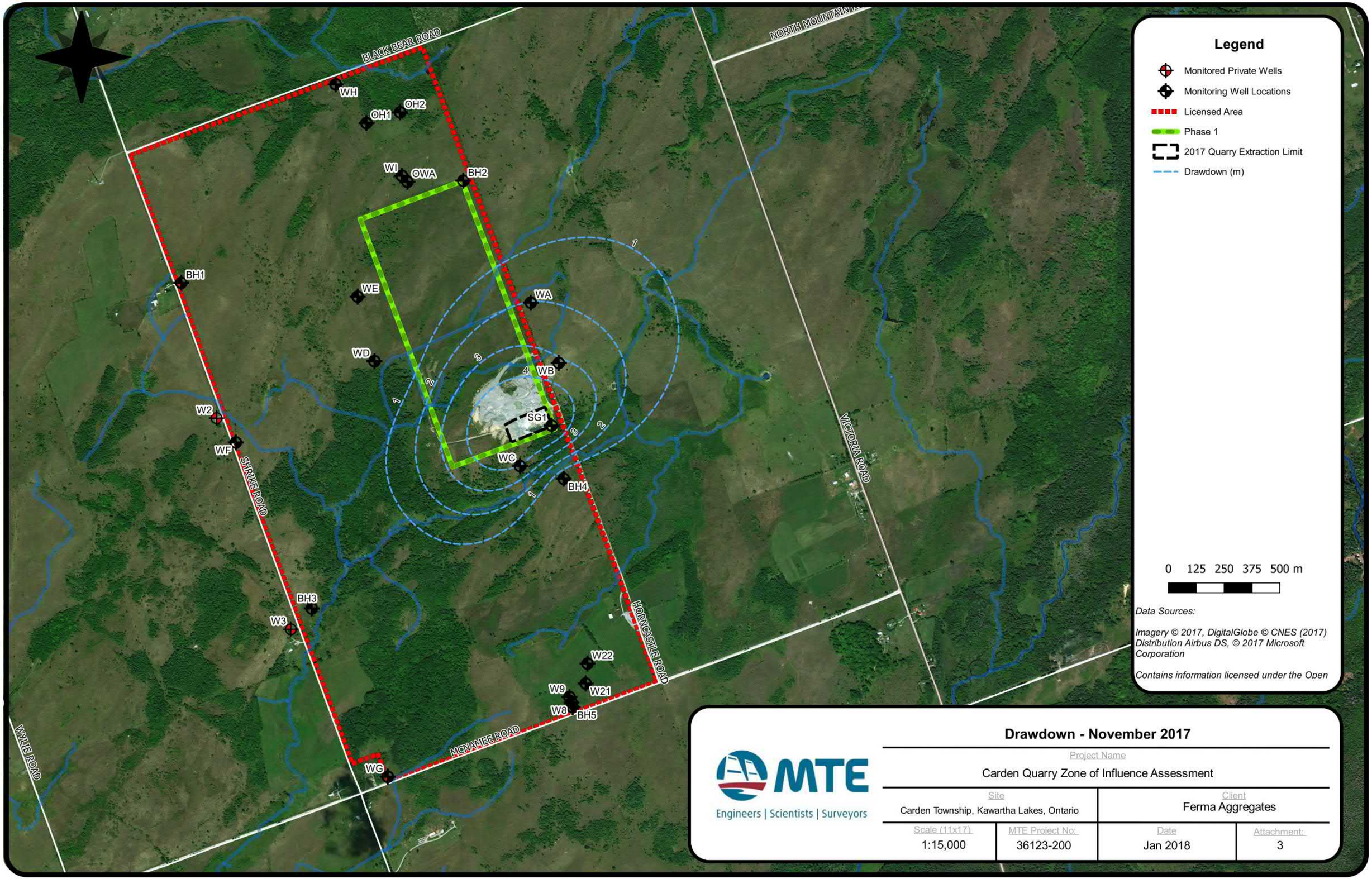
Drawdown - October 2017

Project Name			
Carden Quarry Zone of Influence Assessment			
Site		Client	
Carden Township, Kawartha Lakes, Ontario		Ferma Aggregates	
Scale (11x17)	MTE Project No:	Date	Attachment:
1:15,000	36123-200	Jan 2018	3



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GW Flow

January 04, 2018 - 16:03 - Plotted By: fcummings

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Drawdown - November 2017

Project Name			
Carden Quarry Zone of Influence Assessment			
Site		Client	
Carden Township, Kawartha Lakes, Ontario		Ferma Aggregates	
Scale (11x17)	MTE Project No:	Date	Attachment:
1:15,000	36123-200	Jan 2018	3