Klohn Crippen Berger

# Yukon Government

## Faro Mine Complex

## *2016 Annual Geotechnical Review*

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March 27, 2017

Yukon Government
Faro Mine Remediation Project
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**Carrie Gillis**
**A/Project Manager - Faro Mine Remediation Project**

Dear Ms. Gillis:

**Faro Mine Complex**
**2016 Annual Geotechnical Review**

We are pleased to submit the report on Faro Mine Complex - 2016 Annual Geotechnical Review. The review covers the geotechnical and hydrotechnical aspects of the water management and tailings storage facilities at the Faro Mine Complex. The review is based on site observations by Mr. David Willms and Ms. Kate Patterson on May 15 to May 16, 2016 (emergency site visit by D. Willms in response to Intermediate Dam sloughing), July 27 to July 1, 2016 (spring site visit by K. Patterson) and September 2 to September 7, 2016 (fall site visit by D. Willms) and ongoing review of monitoring data.

Yours truly,

**KLOHN CRIPPEN BERGER LTD.**

David Willms, P.Eng. (YT)
Project Manager

DW/KP/DH:dl/jcp

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# Yukon Government

## Faro Mine Complex

## *2016 Annual Geotechnical Review*

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# 1 INTRODUCTION

## 1.1 Project Background

The Faro Mine Complex is located about 200 km north-northeast of Whitehorse, Yukon, as shown on Figure 1.1. This site consists of two mines: The Faro Mine and the Vangorda Plateau Mine. Faro Mine was in operation from 1969 to 1992. Vangorda Plateau Mine was in production between 1986 and 1998. The Faro Mine Complex was managed by court-appointed interim receiver Deloitte & Touche from 1998 to 2008. Since 2009 the site has been managed by the Yukon Government (YG). Ongoing care, maintenance and environmental protection activities are conducted by the care and maintenance contractor. These activities are focussed on a seasonal pumping and water treatment program for the Faro and Vangorda open pits, and inspection and maintenance of the water management and tailings storage structures. The role of care and maintenance contractor was filled by Denison Environmental Services (DES) from 2009 to 2011, by Tlicho Engineering and Environmental Services (TEES) from 2012 to 2016 and then Parsons since April 2016.

The Operations, Maintenance and Surveillance (OMS) Manual for the Secondary, Intermediate, Cross Valley, and Little Creek dams is currently being updated and will be issued in 2017. The Emergency Response Plan (ERP) for the four dams and the Rose Creek and Faro Creek diversion channels and the Vangorda Creek Diversion Flume is also being updated and will be issued in 2017.

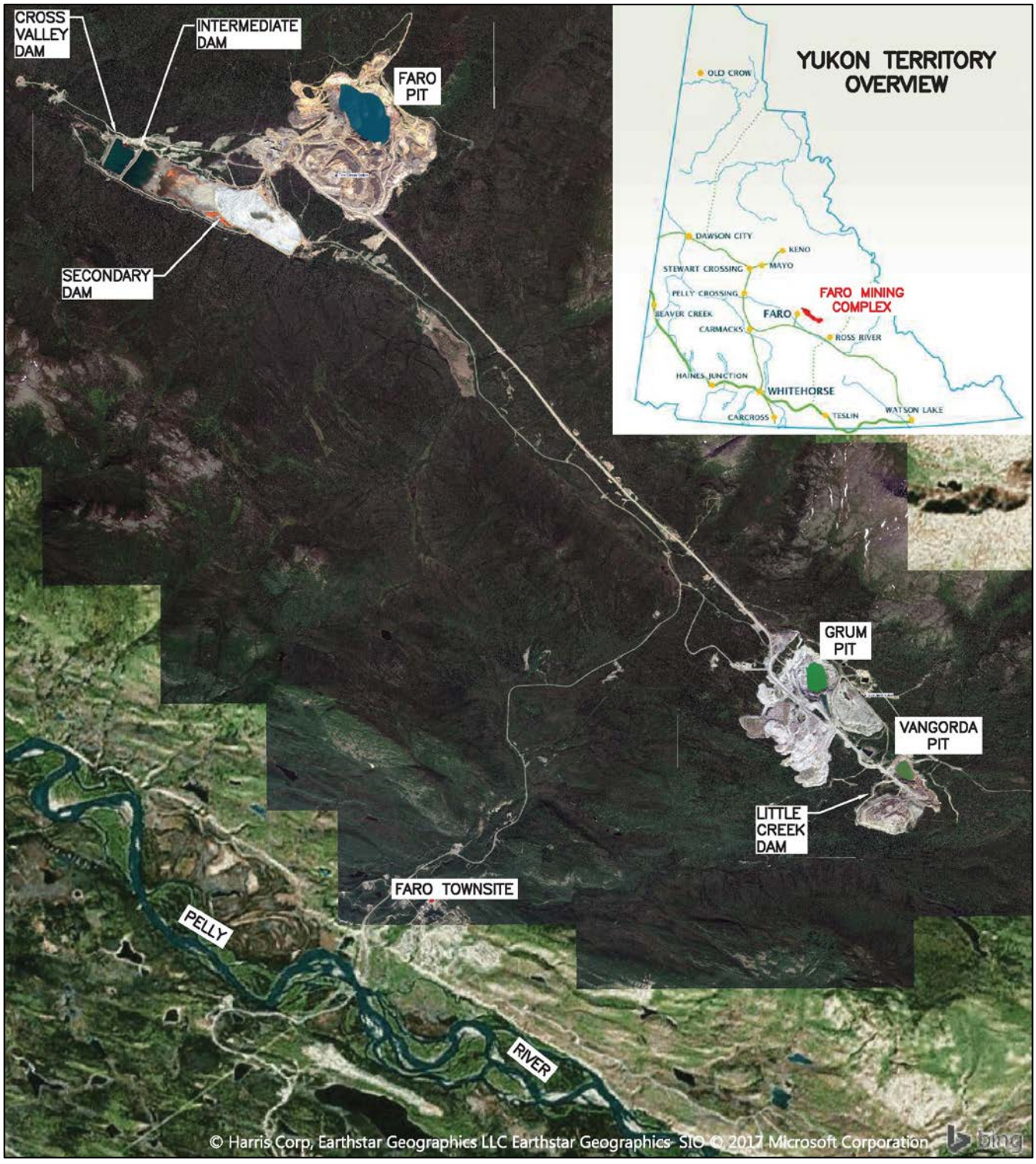
The Intermediate Dam and Cross Valley Dams are located in the Rose Creek Valley and were constructed between 1981 and 1991 to form the Down Valley tailings area (Golder 1980, 1981, 1982, 1983, 1990a, 1990b and 1992). The Little Creek Dam, constructed in 1991 with a spillway added in 1998, is located adjacent to Vangorda Creek to capture water discharging from the Vangorda Waste Rock Dump (SRK 1990 and 1998).

The annual geotechnical review reports for the mine contain a summary of the site observations, provide the instrumentation monitoring data, and note recommendations for operation and maintenance for the coming year. These reports have been prepared by Golder Associates Ltd. (Golder 1996 to 1999, 2010, 2011), BGC Engineering (BGC 2000 to 2009), and SRK Consulting Engineers (SRK 1996 to 2011). Geo-Engineering (MST 1999) conducted an independent review for government agencies. The annual reviews for 2011 to 2015 were completed by Klohn Crippen Berger (KCB 2012 to 2013, 2014d, 2015c and 2016a).

In September 2014 Worley Parsons conducted a dam safety review (DSR) for the Intermediate Dam, Cross Valley Dam and Little Creek Dam with a site visit on September 25 and 26, 2014 (Worley Parsons 2015). Worley Parsons concluded that all three dams should be classified as “high” consequence.

A list of design references for the dams and a summary of the designs are given in the OMS Manual.

**Figure 1.1 Site Location Plan**



## 1.2 Project Scope

The review is based on our site observations in 2016 and ongoing review of monitoring data collected by KCB and Parsons. This report documents the 2016 annual review of the geotechnical performance of the following waste and water management facilities at the Faro Mine Complex:

**Faro Site (see Figures 1 and 2):**

- Faro Pit and Faro Creek Diversion Channel;
- North Valley Wall Interceptor Ditch;
- Rose Creek Diversion Channel;
- North Fork Rock Drain;
- K8 Creek Rock Drain;
- Secondary Dam;
- Intermediate Dam; and
- Cross Valley Dam.

**Vangorda Plateau Site (see Figures 3 to 5):**

- Grum Pit;
- Vangorda Pit;
- Grum Overburden Dump;
- Vangorda Waste Rock Dump;
- Grum Interceptor Ditch;
- Vangorda Northeast Interceptor Ditch;
- Vangorda Creek Diversion Flume;
- Little Creek Dam;
- Sheep Pad Sediment Ponds;
- Grum Settling Pond;
- V-15 Seepage Ditch and Moose Pond; and
- Sludge Pond Embankment at Vangorda Water Treatment Plant.

Representative photos are provided in Appendix I.

Monitoring data are summarized in Appendix II.

KCB was on site from June 27 to July 1 reviewing the condition of geotechnical instruments associated with the tailings dams, Little Creek Dam and Rose Creek Diversion. The results of this review are presented in KCB 2016c. Recommendations were made for repair and replacement of instruments which are summarized in Section 6. The operating status of instruments and the monitoring program recommended for 2017 is provided in Appendix III.

# 2 NOTABLE OCCURENCES IN 2016

## 2.1 Intermediate Dam Emergency Site Visit

The Intermediate Dam experienced some sloughing and erosion on the downstream slope in 2016. The response for this is documented in KCB 2016b and KCB 2016d. This was determined to have resulted from a combination of continuing rill erosion and placing wet, poorly compacted material during the last repair. Preliminary repairs were completed.

## 2.2 Little Creek Dam Repairs

The erosion on the downstream slope of Little Creek Dam was repaired and the trees removed but erosion quickly started again. A second round of repairs was done which involve improving drainage at the crest and on the small benches on the downstream dam face. Plans are underway to vegetate the slope to control erosion. This is expected to take significant effort given the difficult growing conditions.

## 2.3 Earthquake

On August 23, 2016 at about 4:30 PM an earthquake with a magnitude of 4.3 occurred 16 km west of Faro. The earthquake was felt in the town of Faro, at the Faro site, and at the Vangorda site. Parsons notified YG and KCB promptly and carried out instrument readings over several days as well as visual inspections of the structures. No evidence of damage to the dams or other structures was noted.

# 3 FARO SITE FACILITIES

## 3.1 Faro Pit and Faro Creek Diversion Channel

The Faro Pit (Figure 2) is an inactive, inundated open pit, roughly elliptical in shape with the major axis oriented to the northwest/southeast. The east wall is roughly 375 m high and has two main instability zones (North and South) which are separated by a more stable calc-silica rich rock slope.

The Faro Creek Diversion Channel (FCDC) diverts flow from the headwaters north of the Faro Pit around the east side of the Faro mine site and discharges into the North Fork of Rose Creek. The minimum distance between the Faro Pit east wall and the diversion channel are 18.5 m and 93 m, respectively, in the North and South instability zones. Flow station locations are shown on Figure 3.1.

**Figure 3.1 FCDC Flow Station Locations**


### 3.1.1 Observations

#### Faro Pit

- Pit wall condition is similar to that observed in 2015.

- Faro pit is currently used to store water pumped back from Intermediate Pond and seepage interception systems.
- As treatment of water stored in the Faro Pit was suspended in 2013 and most of 2014, the pit-lake level has risen above the maximum recommended level to within the range of the fractured/competent bedrock contact elevation. Treatment has since resumed and the water level is slowly being drawn down.
- Golder was onsite setting up photogrammetry stations to improve monitoring in terms of accessibility, safety, and being able to visualize the pit wall from different angles.

#### Faro Creek Diversion Channel

- Some cracking, likely related to annual freeze-thaw condition, was noticed near the top of the channel hillside slope occurring sporadically between FCD 1 and FCD 3 during spring 2014, 2015 and 2016 visit. This cracking was not evident in fall of 2015 or 2016. The cracking appears to be localized and not a concern for the safety of the FCDC.
- Minor vegetation growth along channel.
- Overhead wires for the Streamflo flow measurement device are in good condition. Parsons report that these flow stations are often destroyed during the winter and new stations and rating curves need to be established in the spring.
- Minor slumps on the channel hillside slope have not been repaired in recent years due to safety concerns and access limitations.
- There is a waste rock pile that acts as a dam containing the Faro Creek Overflow (FCO) Sump that collects the seepage from the upper reaches of the FCDC and would possibly overtop during a flood event that breached the FCDC. We understand that the Faro Creek Overflow Sump captures flow from the diversion in the event of a breach and provides a sump that can be pumped out. YG reports that the risk from potential overtopping of the dam of this impounded water has been considered by Golder and the Technical Review Committee.
- Minor sloughing of side slopes.

### 3.1.2 Instrumentation

#### Faro Pit

Instrumentation at the Faro Pit includes one pond level indicator at the Faro Pit, nine reference bars to monitor pit wall regression and nine prisms to monitor pit wall movements (Golder 2009b and 2014). Pit wall movement measurements are currently taken via a photogrammetry system which was installed in 2016. Survey of the reference bars has been discontinued since 2014 due to unsafe access to the other instruments (reference bars and prisms). Monitoring data for the pit water level is presented in Appendix II-A.

In December 2016 Faro Pit lake level was about El. 1149.1 m, 4.8 m above the maximum recommended level of approximately El. 1144.3 m, established by Others. A key concern is that this

reduces the available storage in the pit and subsequently the time the mine has to respond if the FCDC flows into the pit due to a pit wall failure of Faro Pit or an overtopping or failure of the FCDC. If the pit were to overflow, there would be environmental impacts from the contaminated water. There could also be dam safety or water management consequences depending on the flow rate, since the overflow would eventually report to the Intermediate Pond. YG is working to draw down the pit lake but is limited by the requirement to treat the water and the achievable treatment rate. The pit lake elevation has been reduced from a 2015 high of about El. 1153.2 m near the end of April to a 2016 high of about El. 1152.6 m at the beginning of May. Current efforts appear to be effective at drawing down the pit lake level. The effects of the current efforts should become more apparent as a trend in pit lake elevation develops over subsequent years.

### Faro Creek Diversion Channel

Instrumentation at the Faro Creek Diversion Channel includes four staff gauges (FCD-1 to FCD-4) used for flow measurements.

Discharge rating curves for the staff gauges are shown in Section II-B1 of Appendix II. Two rating curves are shown for FCD-3 and FCD-4, one for the period 2008 to 2010; and the other for the period 2011 onwards. Different staff gauge calibration equipment was used during these two periods, and it is believed that the equipment used after 2010 (StreamPro) is more accurate.

Plots of channel discharges estimated from the rating curves shown in Section II-B1 are presented in Section II-B2 (Appendix II). High flows shown in the plots are based on the extrapolation of the rating curves beyond their calibrated range therefore not as reliable. These flows should be recalculated when the rating curves are re-calibrated with high flow measured with the StreamPro.

Recorded historical and 2016 flows in the Faro Creek Diversion Channel are shown in Table 3.1.

**Table 3.1 Faro Pit Lake Level and Faro Creek Diversion Channel Flow**

| Structure | Monitor Location | Historical | | 2016 (Note 1) | |
|---|---|---|---|---|---|
| | | Max | Min | Max | Min |
| Faro Pit – Pond El. (m) | FP | 1153.2 | 1140.7 | 1152.6 | 1148.9 |
| Faro Creek Diversion Channel Flow (L/s) | FCD-1 | 2,213 | 44.5 | 1188 | 99 |
| | FCD-2 | 6,178 | 7 | 372 | 121 |
| | FCD-3 | 1,366 | 47 | 457 | 209 |
| | FCD-4 | 6,018 | 30 | 458 | 201 |

Notes:
1. Values are based on periodic spot measurements and may not provide an accurate indication of the range of flows experienced during the reporting period.

### 3.1.3 Recommendations

- The pit lake level exceeds maximum recommended elevation (≈El. 1144.3 m, established by Others). Continue procedures described in our technical memo dated February 10, 2015 titled “Faro Pit East Rim Slope Stability Monitoring during Elevated Lake Level”. Draw down pit lake as soon as practical. The current efforts to draw down the pit lake appear to be effective and the pit lake should be below the maximum recommended elevation within several years.

- Develop a contingency plan for potential blockage.
- Develop staff gauges that aren't destroyed every winter. This could occur after the FCDC is realigned. Once more permanent staff gauges are developed, take flow readings to re-establish calibration curves.

## 3.2 North Wall Interceptor Ditch

The North Wall Interceptor Ditch (NWID) (sometimes referred to as the North Valley Wall Interceptor Ditch) (Figures 1 and 2) diverts creek flow from the north valley wall around the tailings impoundment area. It is approximately 3 km long and includes constructed and natural stream channel reaches. The ditch has relatively flat channel gradients along the constructed reaches and steep gradients along the natural stream reaches. The constructed channel reaches include:

- 920 m long upper reach;
- 430 m long middle reach; and
- 500 m long lower reach.

### 3.2.1 Observations

- Partial vegetation removal for access and along channel side slopes has been completed, but portions of the mid- and lower channel have not been cleared. Heavy vegetation growth remains in the mid-channel reach.
- Vegetation that was previously cleared in the upper channel was removed using an excavator which also removed the roots. The areas that were cleared are subject to erosion.
- Culverts were reinstalled in 2015 and are performing satisfactorily.
- There is evidence of overtopping of the weir in the upper channel reach.
- Flow from the Faro Interim Water Treatment System and siphons from the Polishing Pond are discharging into the lower channel reach.
- The channel and side slopes appeared to be stable.

### 3.2.2 Instrumentation

Instrumentation at the North Wall Interceptor Ditch includes one flow monitoring location, NWID, within the diversion channel. A weir was installed at this station in July 2015. Flow data for the NWID is shown in Section II-C1 of Appendix II and Table 3.2. Readings prior to July 2015 were made either by visual estimation or Global Water Flow Meter. Readings after July 2015 used the newly installed weir to measure the flow. No flow data was reported for 2016.

**Table 3.2 North Valley Wall Interceptor Ditch - Flow**

| Structure | Monitoring Location | Historical[1] Flow (L/s) | | 2016 Flow (L/s) | |
|---|---|---|---|---|---|
| | | Maximum | Minimum | Maximum | Minimum |
| North Wall Interceptor Ditch | NWID | 554 | 0.1 | 22.9 | 1.9 |

Notes:
1. Historical data was taken from the 2015 Annual Geotechnical Review (KCB 2016a).
2. Values are based on periodic spot measurements and may not provide an accurate indication of the range of flows experienced during the reporting period.

### 3.2.3 Recommendations

- Continue clearing vegetation along the upper and middle channel reaches as per guidelines in KCB brushing letter dated August 5, 2016. Clearing should also include the access road and Canal Dyke to facilitate future inspection.
- Implement erosion control measures on slopes where vegetation has been removed. May require experimenting with reseeding, straw mats, and riprap to determine the most appropriate measures.
- Extend the weir such that it does not overtop during the spring freshet i.e. the freshet flow is contained within the v-notch and does not overtop the sides.

## 3.3 Rose Creek Diversion Channel and Canal Dyke

The Rose Creek Diversion Channel (RCDC) (Figures 1 and 2) diverts Rose Creek flow around the south side of the tailings impoundment. It is approximately 3.8 km long with, typically flat to moderate channel gradients along the upper reaches and steep gradients along the lower reaches. The upper reach of the diversion channel has three areas that are of geotechnical significance:

- Canal Dyke (CD): The dyke flanks the north side of the channel along the upper reach of the diversion channel and separates the channel from the tailings deposit, the Intermediate Pond, Intermediate Dam, Polishing Pond and Cross Valley Dam, see Figures 1 and 2.
- Spoil Piles (SP): The spoil piles are wastes generated by the construction of the Canal Dyke. They are downslope of the Canal Dyke and located at various spots along the southern periphery of the tailings impoundment.
- Back Slope (BS): The Back Slope is the hillside slope of the Diversion Channel excavation.

### 3.3.1 Observations

- Moderate flow in channel at time of inspections.
- The channel and side slopes are generally stable; rock armour conditions appear satisfactory.
- Trees impede access to the Back Slope.
- Trees are growing in the diversion channel.
- Several instruments appear to be abandoned or overgrown (limited access).

- Three to four areas of the deformed back slope were flagged (with stakes or flagging tape) or noted. These areas are shown on Figure 7. Slope slump activity has progressed since 2015 and a new area has been identified.
- Overhead wires were installed across the channel by TEES in 2014 at existing staff gauges for measurement of high flows for calibration of the gauges. Only one remains standing. Not all overhead wire locations have a staff gauge for daily measurement.
- Minor seepage was observed from the RCDC onto the tailings beach above the Intermediate Pond.
- Flow stations are in poorly suited location for flow measurement and result in inconsistent readings for NFRD-2B.

### 3.3.2 Instrumentation

#### Rose Creek Diversion Channel

There is one in-stream flow monitoring location in the RCDC: RCDC-4. There are two flow monitoring locations along the North Fork of Rose Creek, upstream of the RCDC: NFRD-2B, and X2. There are two monitoring locations in Rose Creek downstream of the RCDC: X10 and X14.

- Historical and 2016 maximum and minimum flows for the stream flow stations are shown in Table 3.3.
- Discharge rating curves for the staff gauges NFRD-2B, RCDC-4 and X14 are shown in Section II-D1 of Appendix II-D. Discharge curves have not been developed for X2 and X10 as flow data is unavailable for X2 while staff gauge readings are unavailable for X10.
- Plots of channel discharges estimated from the rating curves shown in Appendix II-D2.

**Table 3.3 Flow in North Fork Rose Creek and Rose Creek Diversion Channel**

| Location | Name | Historical[1] Flow (L/s) | | 2016 Flow (L/s) | |
|---|---|---|---|---|---|
| | | Maximum | Minimum | Maximum | Minimum |
| North Fork Rose Creek | NFRD-2B | 8,000 | 0 | 1,660 | 1,370 |
| | X2[3] | 1,538 | 207 | - | - |
| Rose Creek Diversion Channel | RCSG4/RCDC-4[2] | 38,000 | <500[5] | 5,410 | 1,440 |
| Rose Creek | X10[4] | - | - | 5,290 | 1,630[7] |
| | X14 | 99,000[5] | 210 | 10,200 | 1,150 |

Notes:
1. Historical data from the 2015 Annual Geotechnical Review (KCB 2016a).
2. RCDC-4 is a replacement of RCSG4 in 2012.
3. No calibration curve or flow data available for X2.
4. No staff gauge readings available for X10.
5. Flow value is unreliable as it is outside of the calibrated range of staff gauge readings.
6. Values are based on periodic spot measurements and may not provide an accurate indication of the range of flows experienced during the reporting period.
7. Minimum value is higher than the minimum value for X14 due to different sampling dates. If measured at the same time, X14 will have a larger flow than X10 since X10 plus other stations report to X14.

## Canal Dyke, Spoil Piles, and Back Slope

A summary of existing instrumentation on the Canal Dyke, Spoil Piles and Back Slope of the diversion channel is shown in Table 3.4. Plots and recorded data for these instruments are given in Appendix II-E: (Piezometers in Section II-E1, Thermistors in Section II-E2 and Inclinometers in Section II-E3).

- Some thermistor beads are not functioning:
  - CD-10: 10 of 12 beads functioning;
  - CD-15: 4 of 12 beads functioning;
  - CD-26: Not functioning;
  - BGC-05-04: Not functioning;
  - SP-2: 7 of 12 beads functioning;
  - SP-3: 4 of 10 beads functioning;
  - BS-5: 6 of 10 beads functioning;
  - BS-9: 2 of 10 beads functioning;
  - BS-10: 9 of 10 beads functioning; and
  - BS-12: 9 of 10 beads functioning.
- In 2015 we reviewed the Back Slope instrumentation and could not determine conclusively the cause of the slumping; however, we believe the slumping is due to the melting of the underlying permafrost as shown in the general warming trend of BS-5 and BS-10 which correspond to the areas of slumping. Other possible causes include infiltration of surface water from upslope, and/or freeze-thaw action on the loose sand and gravel cover. We believe that this can be managed through a program of monitoring and maintenance.
- No instability of the Canal Dyke or Spoil Piles was observed in 2016.

**Table 3.4 Instrumentation for RCDC Canal Dyke, Spoil Piles and Back Slope**

| Structure | Instrumentation |
|---|---|
| Canal Dyke | 5 Paired pneumatic piezometers (BGC05-02 & BGC05-03, BGC05-06, CD-13, CD-15, and CD-26) and one single pneumatic piezometer (CD-21-S) |
| | 4 Thermistors (BGC05-07, CD-10, CD-15, CD-21 and CD-26) |
| | 6 Inclinometers (BGC05-05, BGC05-08, CD-10, CD-15, CD-21 and BH91-CD-1) |
| Spoil Piles | 3 Thermistors (SP-2, SP-3 and SP-5) |
| | 1 Inclinometer (SP-2) |
| Back Slope | 2 Single pneumatic piezometers (BS-5 and BS-9) |
| | 4 Thermistors[2] (BS-5, BS-9, BS-10 and BS-12) |
| | 3 Inclinometers (BS-5, BS-9 and BS-10) |

Notes:
1. Non-functioning instrumentation is not shown in this table. See Appendix III for a status summary of instrumentation.
2. Some of the thermistor beads are not functioning.

### 3.3.3 Recommendations

- Take calibration flow measurements at the staff gauges in 2017 during high flows, using the overhead StreamPro guidance wires. Extend staff gauges, if required, such that they can be read during high flows.
- Rehabilitate or replace malfunctioning thermistors installed along the Back Slope. We suggest that a thermistor supplier such as RST be engaged to carry out the assessment.
- Monitor condition of slope slump scarps from the four new standard photograph locations supplied by KCB at the Back Slope, and continue instrumentation monitoring along the Back Slope. This has now been included in the ongoing monitoring.
- Explore permit requirements regarding investigation and repair of the above slope slumps. RCDC is the main diversion channel at the Faro site; prevention of a major slump and blockage is a high priority.
- Establish a means to access the Back Slope area with equipment for maintenance and potential repair activities, which may be required during periods of medium to high flow. May involve an improved crossing location or constructing a bridge.
- Develop an emergency response plan for failure of the Back Slope and blockage of the Rose Creek Diversion.
- Clear vegetation from the diversion and access path along the Back Slope as per guidelines in KCB brushing letter dated August 5, 2016. YG reports that Minnow Environmental Inc. are developing environmental considerations and measures for this work.
- Take flow measurements to develop a rating curve for staff gauge X2.
- Locate the missing annual review reports by Golder (1983 to 1999) and BGC (2000, 2001, and 2003), when repair works in the Back Slope area were conducted. Past successful repair experiences could provide guidance for current and future care and maintenance activities in the Back Slope area.
- Identify and install a new monitoring point on the North Fork of Rose Creek that allows use of a flow station and staff gauge that will provide consistent readings and not be easily destroyed in winter. KCB suggests placing the station in the culvert if access can be maintained.

## 3.4 North Fork Rock Drain

The North Fork Rock Drain (NFRD) (Figure 1) is a mine haul road stream crossing constructed of coarse waste rock fill. It functions as a conduit for the North Fork of Rose Creek flow to cross the haul road, see Figures 1 and 2. The haul road at stream crossing is approximately 55 m high with a 25 m crest width. Downstream of the haul road, the North Fork of Rose Creek crosses the Main Access Road to the mine via a culvert which is supplemented by an auxiliary culvert at a slightly higher elevation.

Construction of a new seepage interception system downstream of the NFRD was carried out from October 8, 2014 to January 30, 2015 (BGC 2015). The system pumps some of the seepage (approximately 5 L/s) from the NFRD to the Faro Pit during the winter months.

### 3.4.1 Observations

- Water level in the upstream pond is similar to previous years.
- The mine haul road crest and side slope are generally stable.
- Downstream drainage condition is acceptable with three braided channels combined to one channel at water-level monitor and sample location.
- Erosion washouts of upstream and downstream road shoulder and embankment slope appear to be filled in and a new low point is cut in the crest for road drainage. Remediation areas are performing well.

### 3.4.2 Instrumentation

Instrumentation at the North Fork Rock Drain consists of water level readings surveyed periodically throughout the year to record the upstream pond elevation (NF1) and downstream discharge (NF2). Before 2016, water elevation was recorded at NF2, however this was discontinued as it was not very meaningful due to turbulence of the flow at this location. Historical and 2016 maximum and minimum values are shown in Table 3.5. Plots of water level and flow are presented in Appendix II-F.

**Table 3.5 North Fork Rock Drain - Water Level**

| Name | Historical[1] | | 2016 | | Comments |
|---|---|---|---|---|---|
| | Maximum | Minimum | Maximum | Minimum | |
| NF-1 (Elevation, m) | 1094.35 | 1088.83 | 1091.5 | 1089.3 | Upstream of haul road |
| NF-2 (Flow, L/s) | – | – | 542 | 3598 | Downstream of haul road |

Notes:
1. Historical data is from the 2015 Annual Geotechnical Review (KCB, 2016a). No historical data was available for flows at NF2 available.
2. Values are based on periodic spot measurements and may not provide an accurate indication of the range of flows experienced during the reporting period.

### 3.4.3 Recommendations

None.

## 3.5 K8 Creek Rock Drain

The K8 Creek Rock Drain (K8CRD) (Figure 1.1) is a mine haul road stream crossing constructed of coarse waste rock fill. It functions as a conduit for the K8 Creek to cross the main mine haul road. The haul road at the creek crossing is approximately 40 m high on the downstream side with a 25 m crest width. There is currently no instrumentation or monitoring program at this creek crossing.

### 3.5.1 Observations

- The crest and side slope of the mine haul road are generally stable.
- Drainage condition is acceptable downstream of the rock drain.
- Road surface runoff drains through a cut in the haul road berm. There appears to be recent placement of riprap to control erosion. It appears to be performing well.

### 3.5.2 Recommendations

- None.

## 3.6 Secondary Dam

The Secondary Dam contains the Secondary Impoundment, which is located on the north side of Rose Creek Valley. The dam crest is approximately 2300 m long, 6 m wide, with the crest level varying from El. 1060.2 m to El. 1063.3 m. The West Limb of the Secondary Dam is defined as that curved portion which crosses the valley roughly north to south. The East Limb is the portion of the Secondary Dam aligned parallel to the south valley wall. The West Limb of the Secondary Dam is approximately 27 m above original ground; however, the downstream slope of the dam is partially inundated by tailings deposited in the Intermediate Pond. The dam crest is approximately 14 m above the tailings surface in the Intermediate Pond. The East Limb is a low retention dyke (typically 4 m high).

The Secondary Impoundment does not have capacity to store water; the tailings surface is sloped such that surface water from the impoundment flows to a ditch in the tailings along the upstream side of the dam and routed to the spillway. Since the tailings stored behind the Secondary Dam is partially saturated, a portion of the tailings could flow out if the dam were breached, resulting in environmental impacts if failure occurred into Rose Creek.

The Secondary Dam was not reviewed as part of the 2014 DSR by Worley Parsons since it was not included in the scope of work. This dam should be included with the next DSR.

### 3.6.1 Observations

- Stable crest, upstream and downstream slopes.
- Minor amount of water ponding on lower downstream-berm road.
- The annual appearance of longitudinal cracks along the downstream berm road surface in the spring and their subsequent disappearance appear to be related to seasonal freezing and thawing. A crack was evident in the spring 2016, approximately paced out to be 180 m long.
- Some small trees on downstream slope.
- A ditch was constructed upstream of the dam crest. The ditch drains into the lower impoundment via a spillway cut on the north side of the impoundment. The ditch and spillway cut appear to be field fit and have no armouring. Erosion would likely occur under an extreme flood condition; however, any materials eroded would end up in the Intermediate Impoundment. Overtopping of the Secondary Dam is also a concern if the ditch capacity were to be exceeded.

- No seepage was observed from the Secondary Dam toe to the Intermediate Pond. However, there is seepage from the RCDC into the Intermediate Pond just downstream of the Fuse Plug.
- There is evidence of seepage out of the toe of the east limb of the Secondary Dam near the Rose Creek Diversion water level along the upper approximately 800 m of the RCDC, and into the Fuse Plug. This is evidenced by iron-rich precipitates. The amount of the orange precipitates suggest that this seepage has been occurring for several years or more.

### 3.6.2 Instrumentation

Instrumentation at the Secondary Dam (see Figure 8) consists of 3 standpipe piezometers installed in 1981 on the dam crest and 4 standpipe piezometers installed in 2003 in the tailings pond. Historical and 2016 maximum and minimum values are shown in Table 3.6. Plots of piezometric levels are included in Appendix II-G. Piezometers P81-6 to P81-8 are dry, while P03-1 to P03-3 are typically 5 m to 6 m below ground surface and show a variation less than 1 m to 2 m when not dry.

**Table 3.6 Secondary Tailings Impoundment – Pond and Piezometer Levels**

| Location | Piezometer | Historical[1] El. (m) | | 2016 El. (m) | |
|---|---|---|---|---|---|
| | | Maximum | Minimum | Maximum | Minimum |
| Dam Crest | P81-06 | Dry | Dry | Dry | Dry |
| | P81-07 | Dry | Dry | Dry | Dry |
| | P81-08 | Dry | Dry | Dry | Dry |
| Tailings Pond | P03-01 | 1055.60 | 1054.29 | 1054.75[3] | 1054.75[3] |
| | P03-02 | 1056.41[2] | 1053.72 | 1054.35[3] | 1054.35[3] |
| | P03-03 | 1057.48[2] | 1052.28 | 1055.32 | 1055.17 |

Notes:
1. Historical data is from the 2015 Annual Geotechnical Review (KCB, 2016a).
2. Maximum historical reading is near ground level and is likely due to blockage.
3. Only one valid reading taken.

### 3.6.3 Recommendations

- Clear trees from downstream slope of secondary tailings dam as per guidelines in KCB brushing letter dated August 5, 2016.
- Monitor the longitudinal cracks in a quantitative way, using pins and measuring tape. Visually monitor the condition of the road as part of routine inspections.
- Grade lower downstream berm road.
- Include the Secondary Tailings Dam in the next DSR.

## 3.7 Intermediate Dam

The Intermediate Dam (ID) (Figures 1, 2, and 9) is located at the west end of the Intermediate Pond. It retains tailings, supernatant, and run-off water. The toe of the ID is inundated by the Polishing Pond. The dam is approximately 650 m long, 7 m wide at the crest and 32 m high. The dam crest is at El. 1048.8 m, and the spillway invert elevation is at El. 1047.7 m. There is a 7 m wide berm on the downstream face above the Polishing Pond at approximately El. 1031.7 m. The Starter Dam has a

vertical core, which was modified to an upstream sloping core during subsequent dam raises. The remainder of the dam consists of gravel shells and filter zones.

### 3.7.1 Observations

- Stable crest, upstream slope and spillway channel, in general.
- Downstream rill erosion was repaired in some areas. Some repaired areas have sloughed and continue to erode.
- There is vegetation along crest, spillway and abutments.
- Spillway has a pipeline in the lower reaches for mixing lime into the Polishing Pond.
- A pipeline crosses the upper reach of the spillway and is supported by metal stands which appear to be designed to allow flow under the pipeline.
- A small excavation for a sea container was completed on the berm.

### 3.7.2 Instrumentation

Instrumentation at the Intermediate Dam (see Figures 7 and 9) consists of recording pond level; 15 standpipe piezometers at 10 locations; and 7 pneumatic piezometers at 4 locations. The piezometers are installed in the embankment zones downstream of the core above, in and below the horizontal drain at the downstream berm elevation as well as in the dam foundation. They are distributed from the northeast dam segment to the southwest abutment (see Figure 9). There is also one standpipe piezometer within the intermediate impoundment.

Historical and 2016 maximum and minimum values are shown in Table 3.7. Plots of pond and piezometric levels are included in Appendix II-H. The pond and piezometric levels in 2016 were consistent with previous years.

**Table 3.7 Intermediate Dam - Pond and Piezometer Levels**

| Location | Name | Historical[1] El. (m) | | 2016 El. (m) | | Comments |
|---|---|---|---|---|---|---|
| | | Maximum | Minimum | Maximum | Minimum | |
| **Water Elevation Readings** | | | | | | |
| Intermediate Pond | | 1048.1 | 1042.2 | 1046.7 | 1044.6 | |
| **Standpipe Piezometers** (Nested piezometers at P01-4, BH96-3 and BH96-4) | | | | | | |
| Dam Crest | BH96-1 | 1031.65 | 1027.37 | 1030.36 | 1029.81 | |
| | BH96-2 | 1031.94 | 1028.87 | 1030.84 | 1030.34 | Only 1 reading. |
| | BH94-IDC-1 | Dry | Dry | Dry | Dry | |
| | BKS04-06 | Dry | Dry | Dry | Dry | |
| | BKS04-07 | Dry | Dry | Dry | Dry | |
| Dam Toe | P01-3 | 1030.63 | 1027.48 | 1030.36 | 1029.12 | |
| | P01-4A | 1032.59 | 1029.27 | 1032.59 | 1031.37 | Shallow |
| | P01-4B | 1032.17 | 1029.06 | 1031.96 | 1031.05 | Deep |
| | BH96-3A | 1031.38 | 1026.62 | 1030.98 | 1029.70 | Shallow |
| | BH96-3B | 1031.45 | 1027.48 | 1030.29 | 1029.77 | Deep |
| | BH96-4A | 1032.04 | 1027.61 | 1030.34 | 1029.79 | Shallowest |
| | BH96-4B | 1032.28 | 1028.39 | 1030.35 | 1029.08 | |
| | BH96-4C | 1031.64 | 1026.9 | 1030.38 | 1029.85 | |
| | BH96-4D | 1031.75 | 1027.62 | 1030.64 | 1029.34 | Deepest |
| **Pneumatic Piezometers** (BH91-ID3 to ID6 are nested piezometers with one tip deep and one shallow) | | | | | | |
| South Abutment | BH91-ID3 | 1039.23 | 1036.33 | 1038.16 | 1036.87 | Shallow |
| | | 1038.04 | 1029.95 | 1034.74 | 1032.06 | Deep |
| Dam Toe | BH91-ID4 | 1035.91 | 1028.28 | 1031.64 | 1031.64 | Shallow, only 1 reading |
| | | 1031.85 | 1026.74 | 1030.02 | 1029.52 | Deep |
| | BH91-ID6 | 1030.95 | 1026.62 | - | - | Reported Damaged in 2015 |
| | | 1034.96 | 1020.82 | - | - | |
| | BH91-ID7 | 1035.2 | 1028.82 | - | - | Destroyed in winter of 2011/2012 |

Notes:
1. Historical data is from the 2015 Annual Geotechnical Review (KCB, 2016a).

### 3.7.3 Recommendations

- Repair the ruts on the downstream slope and the toe area.
- Upgrade spillway to meet CDA 2013/2014 dam safety criteria for Inflow Design Flood (IDF) for the high consequence classification dam. This is a key risk to the facility and should be addressed as a priority.
- Remove pipelines and equipment that may impede flow from the spillway.
- Remove vegetation from crest, slope, spillway and abutments as per guidelines in KCB brushing letter dated August 5, 2016.

## 3.8 Cross Valley Dam

The Cross Valley Dam (CVD) (Figures 1, 2, 7, and 10) impounds the Polishing Pond (also known as the Cross Valley Pond) at the downstream limit of the Rose Creek Tailings Facility. The Polishing Pond receives seepage from the Intermediate Impoundment and Rose Creek Diversion Channel, and

discharge from the Faro Water Treatment Plant. The Cross Valley Dam is 500 m long, 7 m wide at the crest and 17 m high. The dam crest elevation is at 1032.7 m, while the spillway channel invert is at El. 1030.8 m. The dam has a central silty till core with gravel shells and filters, an upstream impervious blanket and a downstream drainage blanket.

### 3.8.1 Observations

- A depression on the crest, close to the left abutment and upstream side was evident in spring of 2016 (coordinates: 580037E, 6914287N). This does not appear to be an indication of instability and may be related to dam construction or settlement.
- The annual appearance of longitudinal cracks along the dam crest in the spring and their subsequent disappearance seem to be related to freezing and spring thawing. This phenomenon was repeated in 2016 with only barely visible signs of spring cracks in the fall. The crack was visible in the spring of 2016 and was evident along the entire length of the dam. The crack was most prominent close to the left abutment. KCB installed five twin-pin locations to monitor the crack width.
- Upward seepage (with bubbles) on the low spot of the Down Valley Road was not evident in the fall. It was observed in spring 2016 and site staff indicate that this seepage is evident every spring/summer. This was determined to be an old well that Parsons exposed and subsequently covered in spring 2016.
- Downstream Weir No. 3 has been repaired and the culvert replaced; however, water is reportedly still bypassing the weir.
- X12 weir staff gauge is crooked, readings will be inaccurate. X13 weir staff gauge is unreadable and rocks downstream of the weir will affect the measurements.
- There is tree growth on the upstream and downstream slopes of the dam as well as within the spillway channel and on the dam abutments.
- Some erosion of downstream dam face.

### 3.8.2 Instrumentation

Instrumentation at the Cross Valley Dam (see Figures 7 and 10) consists of recording pond level, 12 standpipe piezometers, four pneumatic piezometers and two thermistors. Except for one piezometer installed in the embankment zone downstream of the core, piezometers are installed in the dam foundation at and beyond the downstream toe and beneath the dam crest. In addition, four weirs are installed downstream of the dam, Weir X11, X12, X13, and Weir 3.

One functional shallow thermistor string (BH88-4) is installed in the dam fill zone upstream of the dam core, and one deep thermistor string is installed in the dam foundation underneath the upstream dam crest shoulder (CVDC-6). Permafrost condition no longer exists at these locations and thermistor data is not required.

Plots of Polishing Pond and piezometric levels, ground temperature profiles, and downstream weir flows are included, respectively, in Sections II-I1 to II-I4 of Appendix II. Historical and 2016 maximum

and minimum piezometric and pond levels are shown in Table 3.8. Historical and 2016 maximum and minimum weir flows are shown in Table 3.9.

**Table 3.8 Cross Valley Dam – Pond and Piezometer Levels**

| Structure | Name | Historical[1] El. (m) | | 2016 El. (m) | | Comments |
|---|---|---|---|---|---|---|
| | | Maximum | Minimum | Maximum | Minimum | |
| **Water Elevation Readings** | | | | | | |
| Polishing Pond | | 1031.20 | 1025.88 | 1030.36 | 1027.99 | Target El. 1027 m |
| **Standpipe Piezometers** | | | | | | |
| Dam Toe | CVDT-1 | 1018.57 | 1017.13 | 1017.96 | 1017.73 | |
| | CVDT-2 | 1019.50 | 1015.40 | 1016.68 | 1016.18 | |
| | P01-02[2] | 1018.30 | 1017.42 | Not reported | Not reported | Shallow |
| | | 1019.73 | 1017.86 | Not reported | Not reported | Deep |
| | P01-11 | 1017.83 | 1016.17 | 1016.81 | 1016.77 | |
| Dam Crest | CVDC-4 | 1019.05 | 1016.72 | 1019.10 | 1018.92 | Deep |
| | CVDC-7 | 1017.74 | 1015.14 | 1015.87 | 1015.75 | Shallow |
| | | 1019.21 | 1015.27 | 1018.14 | 1018.00 | Deep |
| | 94CVDC-1 | 1024.58 | 1022.71 | 1024.00 | 1023.83 | |
| | CVDC-9 | 1024.74 | 1019.91 | 1021.43 | 1021.21 | Shallow |
| | | 1025.61 | 1021.18 | 1024.74 | 1024.40 | Deep |
| **Pneumatic Piezometers** | | | | | | |
| Dam Toe | CVDP-1 | 1019.83 | 1016.82 | 1018.59 | 1018.47 | |
| | CVDP-3 | 1017.65 | 1016.11 | Not reported | Not reported | |
| | CVDP-5 | 1022.05 | Dry | 1020.91 | 1020.75 | |
| | CVDP-6 | 1019.55 | 1014.86 | 1017.61 | 1017.53 | |

Notes:
1. Historical data is from the 2015 Annual Geotechnical Review (KCB 2016a).
2. No readings for Piezometers P01-02 were given. (The piezometer is cracked at the base and flowing. It should be repaired.)

**Table 3.9 Cross Valley Dam - Weir Flows**

| Weir Number | Historical[1] Flow (L/s) | | 2016 Flow (L/s) | |
|---|---|---|---|---|
| | Maximum | Minimum | Maximum | Minimum |
| X11 (North) | 24.38 | 2.56 | 24.38 | 7.38 |
| Weir 3 (Central) | 7.1 | 0.03 | 3.40 | 0.53 |
| X12 (South) | 2.03 | 0.02 | 0.72 | 0.08 |
| X13 (Combined) | 123 | 7.45 | 51.55 | 18.79 |

Notes:
1. Historical data is from the 2015 Annual Geotechnical Review (KCB 2016a).
2. Values are based on periodic spot measurements and may not provide an accurate indication of the range of flows experienced during the reporting period.

### 3.8.3 Recommendations

- Repair erosion on the downstream dam face.
- Remove vegetation from crest, slope, spillway and abutments as per guidelines in KCB brushing letter dated August 5, 2016.
- Remove siphon pipeline from the spillway.

- Upgrade spillway to meet CDA 2013/2014 dam safety criteria for the Inflow Design Flood (IDF) for the high consequence classification dam. This is a key risk to the facility and should be addressed as a priority.
- Monitor longitudinal tension cracks on dam crest and grade these cracks to minimize water ingress to the embankment dam.
- Repair Weir No. 3 such that water no longer bypasses the weir.

# 4 VANGORDA PLATEAU SITE FACILITIES

## 4.1 Grum Pit

The Grum Pit (GP) (Figures 3 to 5) is the northernmost major structure at the Vangorda Plateau Site, which is approximately 12 km southeast of the Faro Pit. Grum Pit is an inundated, inactive open pit with a roughly elliptical shape, extending 850 m in the north/south direction and 600 m in the east/west direction. The highwall of the pit is the east pit wall which is 160 m high. Instability of the east wall appears to be still evolving (Golder 2009a, 2013, and 2014), and ongoing monitoring of potential pit-wall rim movement started in the summer of 2010. Since August 2013, a pump barge has been used in the summer and fall to transfer water from Grum Pit to Vangorda Pit for treatment.

### 4.1.1 Observations

- East wall instability appears to be similar to spring 2015.
- The Survey Rods are no longer inspected due to safety concerns. Vegetation has grown around the Survey Rods. We understand that monitoring of these pins has been discontinued. Photogrammetry will be performed instead.
- Several nearby power poles tilt towards the pit.
- Water was ponding in the elevated portion of the pit (the Slot Cut).
- Ponding of surface water above the north pit rim across the road from Wes' Pond has been observed in the spring of 2014 and 2015 and the fall of 2016. This area is marshy and difficult/unsafe to access.
- Pumping and treatment rates since 2014 are drawing down the water level. Pit lake level remains above the maximum recommended level of El. 1144.34 m (established by others). At the current rate of drawdown, the pit lake will fall below the maximum recommended level in two to three years.
- Golder was onsite setting up photogrammetry stations to improve monitoring.

### 4.1.2 Instrumentation

Instrumentation at Grum Pit (see Figure 11) includes reference rods which are no longer read due to safety concerns, a pit lake-level measurement point, and two piezometers installed in the Grum Pit slot cut.

Plots showing pond elevation and piezometric levels in the slot cut piezometers (SRK09-GSA and SRK09-GSB) are included in Appendix II-J. The recurring seasonal fluctuation of the piezometers may be due to freezing or seasonally fluctuating ground water levels.

### 4.1.3 Recommendations

- Prepare a contingency plan for providing power in the area in case progressive failure of the pit wall disrupts the remaining two rows of power poles carrying live wires. We understand that this will be looked at as part of the upcoming electrical risk assessment.

- Dig a sump in the marsh on the opposite site of the road from Wes' Pond and experiment with pumping water out of the marsh to reduce the water near the pit rim.
- Continue drawing down the pit lake until it is less than the maximum recommended level.

## 4.2 Vangorda Pit

Vangorda Pit (VP) (Figures 3 to 5) is approximately 1.8 km southeast of Grum Pit, just to the north of Vangorda Waste Rock Dump. It is an inactive, inundated open pit with an approximate elliptical shape, with the long axis oriented in the northwest to southeast direction. Water pumped from Grum Pit flows into Vangorda Pit via a pipeline located on the northwest pit wall. Water in Vangorda pit is pumped to the Vangorda Water Treatment Plant.

### 4.2.1 Observations

- The pit lake level is consistent with historic trends.
- A sinkhole in fill material on the pit rim was observed on the south side of the pit in 2015. The hole was repaired in 2015, although signs of settlement were observed in 2016.
- Golder was onsite setting up photogrammetry stations to improve monitoring.

### 4.2.2 Instrumentation

- There is one pit lake level measurement point at the Vangorda Pit. A plot of pit lake level is included in Section II-K1 of Appendix II. The pit lake level fluctuated between El. 1083 m and El. 1089 m, which is consistent with historic patterns.

### 4.2.3 Recommendations

- Ask Golder to inspect the sinkhole. YG reports that this was completed in September 2016.

## 4.3 Vangorda Waste Rock Dump

Vangorda Waste Rock Dump (VWRD), located to the south of Vangorda Pit and Little Creek Dam, has six transverse basal drains installed beneath a glacial till starter dyke to direct dump seepage into a collection ditch. The collection ditch drains into Little Creek Pond, which is retained by Little Creek Dam, see Figures 3 to 5 (SRK-Robinson 1994).

### 4.3.1 Observations

- There was vegetation along the collection ditch.
- Some repairs have been completed on the drain weirs. Conditions of weirs are noted below.
- Drain 1 (V28) – No weir and no sign of seepage.
- Drain 2 (V29) – Weir is in satisfactory condition, minor flow. There is a sump downstream of weir.
- Drain 3 (V30) – Weir is in satisfactory condition, minor flow.

- Drain 4 (V31) – Weir is in satisfactory condition, minor flow.
- Drain 5 (V32) – Ponding downstream of weir, minor flow.
- Drain 6 (V33) – Weir is in satisfactory condition, minor flow.

### 4.3.2 Instrumentation

Instrumentation at the Vangorda Waste Dump (see Figures 4, 5, and 12) consists of five V-notch weirs, V29 to V33, for flow measurement from base drains, 14 piezometers and 4 groundwater monitoring wells in the dump area. Plots of base drain flows and piezometric levels are included in Section II-L of Appendix II. The weir flow data in 2016 are summarized in Table 4.1. The minimum and maximum piezometric levels in 2016 for the piezometers as well as alert levels as provided by SRK (2011b) are shown in Table 4.2.

**Table 4.1 Vangorda Waste Dump - 2016 Drain Flow**

| Drain/Weir No. | 2016 | |
|---|---|---|
| | Flow (L/s) | Date Read |
| Drain No. 1 (V28) | - | - |
| Drain No. 2 (V29) | - | - |
| Drain No. 3 (V30) | 0.335 | 2016-06-08 |
| Drain No. 4 (V31) | 0.195 | 2016-06-08 |
| Drain No. 5 (V32) | 0.017 | 2016-06-08 |
| Drain No. 6 (V33) | 0.163 | 2016-06-08 |

Note:
1. Values are based on periodic spot measurements and may not provide an accurate indication of the range of flows experienced during the reporting period.
2. Only one reading is available for 2016. V28 and V29 do not have data available for 2016.

**Table 4.2 Vangorda Waste Dump - 2016 Piezometer Levels**

| Groundwater Monitoring Well/Piezometer | | 2016 El. (m) | | Alert Level[1] (m) | Above Alert Level? |
|---|---|---|---|---|---|
| | | Maximum | Minimum | | |
| V34 | GW-94-01 | Not reported | Not reported | 1115 | No |
| V35 | GW-94-02 | Not reported | Not reported | 1115 | No |
| V36 | GW-94-03 | Not reported | Not reported | 1113 | No |
| V37 | GW-94-04 | Not reported | Not reported | 1109 | No |
| V39 | P-94-01A | 1126.37 | 1126.25 | 1131 | No |
| V40 | P-94-01B | 1131.56 | 1131.47 | 1133 | No |
| V41 | P-94-02A | 1130.92 | 1130.84 | 1133 | No |
| V42 | P-94-02B | 1132.51 | 1132.44 | 1134 | No |
| V43 | P-94-02C | 1121.64 | 1121.60 | 1125 | No |
| V44 | P-94-03A | 1121.17 | 1120.82 | 1126 | No |
| V45 | P-94-03B | 1124.68 | 1124.62 | 1126 | No |
| V47 | P-94-04B | 1125.50 | 1125.46 | 1126 | No |
| DH1 | PW-10-01 | 1127.50 | 1127.31 | 1135 | No |
| DH2 | PW-10-02 | 1128.16 | 1128.07 | 1131 | No |
| DH3 | PW-10-03 | 1123.49 | 1123.47 | 1130 | No |
| DH4 | PW-10-04 | 1132.78 | 1132.59 | 1133[3] | No |

| Groundwater Monitoring Well/Piezometer | | 2016 El. (m) | | Alert Level[1] (m) | Above Alert Level? |
|---|---|---|---|---|---|
| | | Maximum | Minimum | | |
| DH5 | PW-10-05 | 1138.53 | 1138.29 | 1139 | No |
| - | P2001-02A | Not reported | Not reported | - | - |
| - | P2001-02B | Not reported | Not reported | - | - |
| - | P2001-03 | Not reported | Not reported | - | - |

Notes:
1. Alert levels are from SRK (2011b)

### 4.3.3 Recommendations

- remove trees from along the road running along the collection ditch and on the banks of the collection ditch; and
- improve drainage downstream of V32 by widening the outlet of the small pool downstream of the weir so that the water does not back up to the v-notch.

## 4.4 Grum Pit Interceptor Ditch

The Grum Interceptor Ditch diverts water around Grum Pit and the Grum Overburden Dump. It consists of three reaches:

- 900 m long ditch upslope of Grum Pit to divert clean water away from the pit;
- 900 m long ditch along the northeast toe of the Grum Overburden Dump; and
- 650 m long ditch to convey flow downhill to Tributary B of Vangorda Creek.

### 4.4.1 Observations

- Minimal flow in the upper ditch; Low to moderate flow in the middle ditch, most flow is coming from Vangorda Water Treatment Plant Sludge Pond.
- Stable channel side slopes, minor erosion in areas.
- Vegetation has been cleared using an excavator. This method disturbed the riprap and cleared all vegetation roots which will leave the slope susceptible to erosion.
- Rill erosion on the Till Overburden Dump slope. Silt fences for surface runoff sediment control on the Till Overburden Dump slope, have fallen over in sections.
- One culvert was removed (close to Fresh Water Pond).
- Culvert under road to Fresh Water Pond is dented in the center with rocks on the bottom.

### 4.4.2 Recommendations

- Use riprap, vegetation, straw mats, or other means to control erosion of the side slopes.
- Repair or replace:
  - The culvert under the road to the Fresh Water Pond.
  - The culvert at the road to the Vangorda Water Treatment Plant.

## 4.5 Vangorda North East Interceptor Ditch

The Vangorda North East Interceptor Ditch (Figures 4 and 5) diverts surface runoff away from the Vangorda Pit. There is currently no instrumentation in place to monitor the ditch flow.

### 4.5.1 Observations

- No flow in ditch along the upper (50%) reach of the ditch; increased flow along the reach downstream of the tributary confluence.
- Multiple side-slope slumps were observed along the lower reach: one at the road embankment slope was partially repaired in 2013 with large boulders, and remaining slumps are to be repaired as required before spring freshet including two on the back slope on the opposite side from the road. Additional slumping in multiple areas has been observed in 2015 and 2016.
- Cracking along the access road has progressed since fall 2015.
- Moderate vegetation growth in channel and along access road.
- At the main bend in road, slumping failures have occurred on both sides of the ditch, causing water to back-up. In ponded area upstream of the slumping, substantial algae growth has occurred.

### 4.5.2 Recommendations

- Repair slumps in side slopes with riprap. Sand and gravel should be placed between the riprap and the side slopes. If sand and gravel is not available, non-woven geotextile could be used but would likely not last as long. The maintenance should focus on ensuring access to ditch and adequate flow capacity of the Interceptor Ditch during the next spring freshet.
- Clear vegetation in channel and along access road.

## 4.6 Vangorda Creek Diversion Flume

The Vangorda Creek Diversion Flume diverts flow from Vangorda Creek around the Vangorda Pit via a Corrugated Steel Pipe (CSP) half-pipe, or flume. Headworks for the flume include: a main culvert under the road at the upstream end of the flume with a trash rack at the culvert inlet and two emergency spillway culverts under the road at a higher level, also with a trash rack. At the end of the diversion, the flume discharges to a plunge pool west of the Vangorda Pit and the flow is carried across the haul road via a CSP culvert and drop box to the Vangorda Creek. There is no instrumentation for the flume.

A flash flood occurred in June 2012 causing the flume to overflow. The flood flow was barely contained by the ditch bank slopes above the flume without spilling into the Vangorda Pit. During repair after the flood, the road surface adjacent to the flume ditch was raised in the area to help contain the flood flow. This flood and its impact were similar to an event in June 2004 (SRK 2004). Site staff indicate the flume overtops into the riprap channel every year.

### 4.6.1 Observations

- Moderate flow in the flume.
- Some sediments were observed at the bottom of the twin emergency culverts. Some of the sediment at the ends of the culverts has been cleaned out.
- Some galvanized flume braces have buckled under lateral pressure from riprap around the flume or been damaged during ice clearing operations. Flume has deformed in places as the result. Condition appears to be worsening.
- Several sections along the flume are being pinched/narrowed due to lateral earth pressure.
- CSP segments are not always connected, causing some water to flow under the CSP.
- Old truck beds are in place over the CSP in some places where the anchors are broken to anchor the flume.
- There appears to be a buildup of sediment in the flume plunge pool.
- Woody debris appears to have been removed from the trash rack at the outlet of the Flume Plunge Pool; however, there is minor build-up again. Debris should be removed monthly when water is flowing.
- At the upstream end of the flume main culvert, large boulders were added as riprap but no filter materials appeared to be present between the riprap and road embankment fill. A small steel trashrack, tied to a few boulders by ropes, has been installed to prevent unravelling of the boulders over the culvert entrance.

### 4.6.2 Recommendations

- Clear the twin emergency spillway culverts and lower the spillway channel invert at the discharge end of the culverts. The culverts should be cleared any time sediment buildup in the bottom of the culvert exceeds 150 mm.
- Develop a design criteria and design concept for the replacement or realignment of the flume. Meanwhile repair damaged sections of the flume and backfill any low areas along the adjoining road. Damaged sections of the flume should be repaired or replaced with an engineered open channel. The section of the flume that should be repaired first is located between Station 0+440 and Station 0+640, i.e. the section approximately 200 m upstream of the truck beds. YG reports that SRK has indicated that the lower section of the flume also requires repair.

## 4.7 Little Creek Dam

Little Creek Dam (LCD) (Figures 3 to 5, and 14) was completed in 1991 and impounds Little Creek Pond. The dam is located just northwest of the Vangorda Waste Rock Dump, and currently collects seepage and surface runoff contact water from the dump. Water collected in Little Creek Pond is pumped to Vangorda Pit for treatment at the Vangorda Water Treatment Plant, see Figures 3 to 5.

Little Creek Dam is a homogeneous embankment dam constructed of local glacial till. It has a cutoff trench and a granular base drains downstream under the downstream slope. The crest is about 10 m above natural ground, ranging in elevation from about 1114.3 m to 1120.0 m. The downstream slope is 2H:1V and the upstream slope is 2.5H:1V. A zone of permafrost encountered at the south abutment was excavated prior to till placement. A 900 mm diameter Corrugated Steel Pipe (CSP) emergency spillway located at the south abutment added in 1998 has capacity to route the 1 in 200-year flood. The emergency spillway appears to be undersized for the design flood (Worley Parsons 2015).

### 4.7.1 Observations

- Vegetation removal and repair of erosion was completed in the summer; however, there has been some erosion on the downstream slope since the summer repairs. This was repaired again in October 2016, with improvements to drainage on the crest and dam face.
- Culvert spillway is in good condition.
- Pond level is relatively low.
- The cracks in the ground at the downstream end of the spillway outfall channel appear to be similar to previous years.
- Some trees remain on upstream slope.
- Wet, soggy ground at the toe of the dam (possible seepage) was observed prior to 2016. No evidence of this during the spring 2016 site visit, fall site visit, or from Parsons.

### 4.7.2 Instrumentation

Instrumentation at Little Creek Dam (see Figures 13 and 14) consists of a pond level measuring point; three pared pneumatic piezometers (P94-LCD-1 to P94-LCD-3) with tips at both shallow and deep depths; and seven piezometers (P09-LCD-1 to P09-LCD-7) installed in 2010 along the downstream toe for monitoring groundwater quality (SRK 2011b). Pond and piezometric levels are included in Section II-M of Appendix II. Historical and 2016 maximum and minimum values are shown in Table 4.3. We have limited information on the installation details of the P09- series piezometers. This information would be useful in interpreting the readings.

Three thermistor strings were installed in 1994 on the dam crest (94LCD-4T to 94LCD-6T) to a depth ranging from 13 m to 17 m. As permafrost condition no longer exists at these locations, thermistor data is not required.

**Table 4.3 Little Creek Dam - Pond and Piezometer Levels**

| Location | Name | Historical[1] El. (m) | | 2016 El. (m) | | Comments |
|---|---|---|---|---|---|---|
| | | Maximum | Minimum | Maximum | Minimum | |
| **Water Elevation Readings** | | | | | | |
| Little Creek Pond | | 1111.70 | 1106.48 | 1110.05 | 1108.40 | Licence Limit = 1111.80 |
| **Standpipe Piezometers** | | | | | | |
| Downstream Toe | P09-LCD-1 | 1094.23 | 1093.45 | 1093.76 | 1093.75 | |
| | P09-LCD-2 | 1095.40 | 1093.26 | 1093.37 | 1093.37 | |
| | P09-LCD-3 | 1092.10 | 1091.83 | 1091.81 | 1091.80 | |
| | P09-LCD-4 | 1091.98 | 1082.00 | 1092.51 | 1090.84 | |
| | P09-LCD-6 | 1090.91 | 1087.47 | 1090.30 | 1090.29 | |
| | P09-LCD-7 | 1097.50 | 1096.93 | 1097.28 | 1097.26 | |
| **Pneumatic Piezometers** | | | | | | |
| Dam Crest | BH94-LCD1 | 1105.77 | 1104.02 | 1105.08 | 1104.87 | Shallow |
| | | 1105.82 | 1103.79 | 1105.08 | 1105.01 | Deep |
| | BH94-LCD2 | 1101.76 | 1100.50 | 1101.27 | 1100.99 | Shallow |
| | | 1102.39 | 1098.54 | 1099.33 | 1099.26 | Deep |
| | BH94-LCD3 | 1106.77 | Dry | 1106.77 | 1105.93 | Shallow |
| | | 1108.69 | 1102.89 | 1104.15 | 1103.92 | Deep |

Notes:
1. Historical data is from the 2015 Annual Geotechnical Review (KCB 2016a).

### 4.7.3 Recommendations

- Repair downstream slope erosion. See KCB guidance letter issued October 3, 2016. These repairs were completed in October 2016. YG reported that the material was not track packed so there are still some ruts from the machinery. The dam face should be assessed again in the spring.
- Confirm if the IDF can be stored or routed by conducting a hydrological assessment to confirm the design flood, and if it can be stored and/or whether the spillway should be resized.
- Complete clearing trees from dam crest and upstream slope as per guidelines in KCB brushing letter dated August 5, 2016.
- Check water quality of ponded water at toe to determine if water originates from Little Creek Pond. YG reported that the site was visited several times in 2016 but no water was present. It may be that the dam repairs have improved drainage and that water will no longer pond at the toe. This recommendation should be re-assessed in 2017.

## 4.8 Sheep Pad Sediment Ponds

The Sheep Pad Sediment Ponds (Figures 3 to 5) are located between the Grum and Vangorda pits along the main haul road. The facility consists of two ponds which collect surface runoff via the Grum Interceptor Ditch from upslope areas, including the Grum Overburden Dump and the Grum Water Treatment Plant. The upper pond discharges to the lower pond via a CSP half-round pipe. The lower pond discharges towards the plunge pool for the Vangorda Creek Diversion Flume via a riprap lined spillway channel. We have not reviewed construction documents for the Sheep Pad Sediment Ponds;

however, the ponds appear to be retained behind small man-made embankments rather than in natural depression and as such may be classified as dams as per the Canadian Dam Association guidelines (defined as capable of retaining 30,000 $m^3$ of water and being at least 2.5 m high, CDA 2013). This is more likely to apply to the lower pond; but both ponds should be checked.

### 4.8.1 Observations

- Freeze-and-thaw longitudinal cracks were observed along dyke crest and upstream slope during the spring 2016 site visit, these were not evident in fall 2016.
- Upper and Lower ponds have high water levels with only about 0.3 m freeboard. There is potential for overtopping during a peak storm event.
- Large boulders weighing down the half-round CSP between the Upper and Lower ponds near the entrance are restricting flow. There are no stiffening braces across the top of the half-round CSP and the CSP sections are not tied together. The entrance CSP section appeared to have shifted.
- A silt fence has been added to the inlet of the upper pond.
- An old survey pin is located on the dyke crest of the Lower Pond.
- There is exposed geofabric at the Lower Pond Spillway.

### 4.8.2 Recommendations

- The spillway between the upper and lower ponds should be upgraded to improve flow and freeboard in the upper pond.
- Cover exposed geofabric, as required, with riprap materials, on the berm separating the Lower and Upper Pond spillway.
- Assess the flood routing capacity of the pond to ensure berms are high enough with adequate freeboard.
- Remove vegetation from crest and downstream slopes as per guidelines in KCB brushing letter dated August 5, 2016.
- Confirm storage capacity and height of impoundment to determine if the pond should be classified as a dam.

## 4.9 Fresh Water Pond for Vangorda Water Treatment Plant

The Fresh Water Pond (FWP) for Vangorda Water Treatment Plant, located just northwest of Grum Pit (Figure 4 and Figure 5), supplies fresh process water to the Vangorda Water Treatment Plant. Water from the pond discharges to the Grum Interceptor Ditch via a riprap lined spillway channel. There is no instrumentation for the FWP. We have not reviewed any construction documents for the FWP; however, the pond appears to be retained behind a small man-made embankment rather than a natural depression and as such, may be classified as a dam as per the Canadian Dam Association (defined as capable of retaining 30,000 $m^3$ of water and being at least 2.5 m high, CDA 2013).

### 4.9.1 Observations

- Spillway channel appeared to be in good condition, with considerable vegetation growth.
- Vegetation growth on the dyke crest and downstream slope was overgrown in places.

### 4.9.2 Recommendations

- Clear trees from embankment slopes and spillway channel as per guidelines in KCB brushing letter dated August 5, 2016.
- Confirm the storage capacity and height of impoundment and embankment to determine if the embankment should be classified as a dam.

## 4.10 V-15 Seep Ditch and Moose Pond

The V-15 Seep Ditch and Moose Pond are located between the Grum Waste Rock Dump and the Vangorda Waste Dump (see Figures 3 to 5). The V-15 Seep Ditch is a bentomat lined ditch that collects Grum Waste Rock Dump seepage water from the V-15 Pond. Most of this seepage water is pumped to Vangorda Pit with a small amount of seepage flowing to Moose Pond. A small dyke of sandbags and bentonite is used to contain the flow in the V-15 Seep Ditch. Moose Pond is a natural pond that retains water in a geomorphic depression in coarse-grained glaciofluvial surficial deposits. The water is retained by a narrow natural landform. Water flows out of Moose Pond via seepage through the landform at Moose Seep. Moose pond was previously used as a natural exfiltration structure which is beneficial for the downstream water quality. The landform that contains the pond has a steep downstream slope and is eroding and raveling, therefore, flows from V15 and Grum Creek are redirected to Vangorda Pit except in the winter.

### 4.10.1 Observations

- Moose Pond was essentially dry during the spring and fall site visits. Slope erosion is progressing.

### 4.10.2 Recommendations

- None.

## 4.11 Vangorda Water Treatment Plant Clarifier Pond Dyke

The Vangorda Water Treatment Plant Clarifier Pond Dyke (also known as the Sludge Pond) (Figures 3 to 5), located just east of the Grum Pit, is a rectangular shaped pond retained by an embankment dyke. There appears to be no instrumentation at this pond or its periphery dyke. We have not reviewed construction documents for the pond; however, the pond is retained behind an embankment and as such, may be classified as a dam as per the Canadian Dam Association (defined as capable of retaining 30,000 $m^3$ of water and being at least 2.5 m high, CDA 2013).

### 4.11.1 Observations

- Freeze-and-thaw longitudinal cracks (three cracks each about 6 m long) were observed on the dyke crest in the spring of 2016 but were not visible in the fall.
- Decommissioned lamp posts are sloping (progressed since the fall of 2015).
- Vegetation growth on the dyke crest and slopes.
- No engineered spillway.
- Minor erosion on upstream road.

### 4.11.2 Recommendations

- Clear trees from embankment crest and slopes as per guidelines in KCB brushing letter dated August 5, 2016.
- Confirm the storage capacity and height of impoundment and embankment to determine if the embankment should be classified as a dam.
- Assess the need for a spillway.
- Control erosion of the upstream road.

# 5 MONTHLY MONITORING REPORTS

KCB has reviewed monthly monitoring reports submitted by Parsons. Our monthly observations are noted in Table 5.1.

**Table 5.1 Monthly Observations**

| Month | Observations |
|---|---|
| January | ▪ No new dam safety concerns identified. |
| February | ▪ No new dam safety concerns identified. |
| March | ▪ No new dam safety concerns identified. |
| April | ▪ No new dam safety concerns identified. |
| May | ▪ Vangorda Flume overflowing does not appear to be an immediate cause for concern since it overtops the half-round CSP but stays within the channel. However, it should be repaired to prevent further erosion.<br>▪ Sloughing observed May 4, 2016 and inspected during site visit by KCB was performing adequately (KCB 2016d).<br>▪ RCDC water levels above the creek banks in the North Fork of Rose Creek is not a dam safety concern as long as it is still contained within the terrain, however it may post a hazard to infrastructure in low lying areas in the vicinity.<br>▪ Slumping in North West Interceptor Ditch may reduce flow capacity. |
| June | ▪ No new dam safety concerns identified. |
| July | ▪ No new dam safety concerns identified. |
| August | ▪ No new dam safety concerns identified. |
| September | ▪ No new dam safety concerns identified. |
| October | ▪ Despite no longer being used as an exfiltration pond, Moose Pond still occasionally contains water which could accelerate slope failure downstream of Moose Pond and increase the consequence should the embankment breach. |
| November | ▪ No new dam safety concerns identified. |
| December | ▪ No new dam safety concerns identified. |
| January 2017 | ▪ No new dam safety concerns identified. IP levels dropping more than normal. Parsons believe this to be due to the unusually small amount of snow cover and ice forcing some of the inflows to the IP to be shifting paths. |
| February 2017 | ▪ No new dam safety concerns identified. |

Our general observations are:

- To aid in interpreting site data, unusual instrument readings (i.e. inconsistent with previous readings, dry piezometers, no bubbles from return line for pneumatic piezometers, unstable readings, weirs with downstream water backed up to weir, etc.) should be accompanied by notes describing the abnormality. Any apparent potential causes for the unusual behavior should be noted.
- Beaver dams should be removed from weirs as they are encountered and before taking readings. It is not clear from the daily reports and reported readings if this is being done and the dams are being rebuilt by beavers after they are removed, or if the dams are not being removed and the weir levels are being reported with the dams in place.

# 6 SUMMARY OF RECOMMENDATIONS

Table 6.1 summarizes the recommendations in this report and relevant recommendations from our previous reports. The recommendations are prioritized into subjective categories of High, Medium, and Low which are described as follows:

- High – Should be completed as soon as possible. Critical infrastructure or instrumentation. Current environmental, H&S, or dam safety risk.
- Medium – Should be completed within a year. Important infrastructure or instrumentation. Could lead to environmental, H&S, or dam safety risk.
- Low – Should be completed within 2 years. Useful infrastructure or instrumentation. Affects quality of long term performance or monitoring.

The priorities and timelines for the recommendations should be developed further in consultation with YG in 2017.

## Table 6.1 Summary of Recommendations

| Structure/Item | Condition | Recommendation | Number | Priority<br>**Priority Key:**<br>H - High Priority<br>M - Medium Priority<br>L - Low Priority<br>In Progress | Action by | Timeline/Progress<br>**Timeline key:**<br>(I) - Immediate, can action now<br>(S) - Short-term, before end of 2017<br>(L) - Long-term, before end of Fiscal Year 2018 (FY18)<br>(ND) - Not determined, reliant on other parties' planning |
|---|---|---|---|---|---|---|
| General | Tool required for efficient vegetation removal. | Purchase brush cutter extension for vegetation removal. | KCB-2016-2 | M | YG to authorize. | (S) - YG to provide cost estimate. |
| | OMS is out of date. | Update KCB Operations, Maintenance and Surveillance Manual (include Parsons contact information). | KCB-2016-3 | In Progress | KCB preparing draft. | (I) - Actioned from site. In progress. |
| | ERP is out of date. | Update KCB Emergency Response Plan (include Parsons Emergency Response Plan and contact information). | KCB-2016-5 | In Progress | KCB (issued in draft. Waiting on review board comments). | (L) - In progress. |
| | No site wide water management plan. | Complete a site wide water management assessment and plan, including:<br>- Site wide hydrology monitoring program (assess locations and method for collecting flow data).<br>- Flood management assessment for all structures (recommended design event, structure assessment).<br>- Water balance (risk scenario assessments).<br>- Develop a systematic approach for maintaining the rating curves at flow measurement stations. | KCB-2016-9 | M | YG to assess timing. | (ND) - This should be performed in conjunction with the retention of an engineer of record. Some preliminary work can be prepared up-front. |
| Brush Cutting and Vegetation Removal | Vegetation growth impairing function, inspection and accessibility of site infrastructure. | North Wall Interceptor Ditch: Continue vegetation clearance along the upper and middle channel reaches. Clearing should include the access road and berm along the channel to facilitate future inspection. Some clearing has been complete, but portions of the mid and lower channel have not been cleared. | KCB-2014-2 | L | Parsons. See KCB guidance letter issued August 5, 2016. YG to approve method for appropriate environmental protection. | (S) - To be completed when brush cutter is purchased. |
| | | Rose Creek Diversion Channel: Clear vegetation along lower channel reaches and access path along Back Slope. | KCB-2014-4 | M | | |
| | | Secondary Dam: Clear trees from the downstream dam slope. | KCB-2015-20 | M | | |
| | | Intermediate Dam: Remove vegetation from the dam, dam abutments and spillway channel. | KCB-2015-33 | M | | |
| | | Cross Valley Dam: Remove vegetation from the dam, dam abutments and spillway channel. | KCB-2014-8 | M | | |
| | | Vangorda Waste Rock Dump: Clear trees along road and collection ditch. | KCB-2016-13 | L | | |
| | | Vangorda Northeast Interceptor Ditch: Clear vegetation in channel and along access road. | KCB-2016-29 | L | | |
| | | Little Creek Dam: Complete clearing of trees from dam crest and upstream slope. | KCB-2015-45 | M | | |
| | | Sheep Pad Sediment Ponds: Remove vegetation from crest and downstream slopes of pond berms. | KCB-2016-30 | M | | |
| | | Fresh Water Pond for Vangorda Water Treatment Plant: Clear trees from embankment slopes and spillway channel. | KCB-2015-53 | M | | |
| | | Vangorda Water Treatment Plant Clarification Pond Embankment: Clear trees from embankment crest and slopes. | KCB-2015-56 | M | | |
| Instrumentation (See KCB 2016c for further details) | Instruments missing cap | Rose Creek Diversion Channel: CD-10, CD-15, CD-19, BH91-CD-1, BS-9, BS-70 (add 70 mm inclinometer cap) | KCB-2016-31 | L | Parsons | (I) - 2017 |
| | | Secondary Dam: P03-01, P03-02, P03-03 (add PVC cap with vent hole drilled on the side) | | | | |
| | | Intermediate Dam: BH91-ID3 (plastic cap is missing, can be replaced with tape) | | | | |
| | | Cross Valley Dam: CVDC-4-D, CVDT-2, 94-CVDC-1, CVDC-7-S (add PVC cap with vent hole drilled on the side) | | | | |
| | | Vangorda Waste Rock Dump: V39, V40, V41, V42, V43, V45 (add PVC cap with vent hole drilled on the side) | | | | |
| | Damaged instrument | Cross Valley Dam: P01-02 (repair casing and PVC pipe, sound hole) | KCB-2016-32 | L | Parsons | (I) - 2017 |
| | | Secondary Dam: P81-6 (extend piezometer pipe to top of casing) | | | | |
| | | Little Creek Dam: P09-LCD-1, P09-LCD-2, P09-LCD-3, P09-LCD-4, P09-LCD-6, P09-LCD-7 (seal around piezometer at surface with bentonite) | | | | |
| | Unprotected instrument | Cross Valley Dam: CVDP-1 & CVDP-3, CVDP-5 & CVDP-6 (install outer protective casing, 1 casing for each pair of instruments) | KCB-2016-33 | L | Parsons | (I) - 2017 |
| | | Intermediate Dam: BH91-ID7 (re-install protective casing) | | | | |
| | Missing labels or mislabeled | Rose Creek Diversion Channel: BS-10 (re-label with correct A+ axis (south)), BGC05-05 (re-label with correct A+ axis (north)), BGC05-06 (labels are swapped with thermistor labels) | KCB-2016-34 | L | Parsons | (I) - 2017 |
| | | Intermediate Dam: P01-04 (A and B labels appear to be swapped) | | | | |
| | | Cross Valley Dam: CVDP-1 & CVDP-3 (missing labels, at the same location), CVDP-5 & CVDP-6 (add tip label) | | | | |
| | | Vangorda Waste Rock Dump: V39, V40, V44, V45 (confirm labels) | | | | |
| | Instrument and ground surface survey elevation missing | Intermediate Dam: BH96-4 A/B/C/D, P01-04 A/B, BKS04-06, BKS04-07, BH91-ID5 (resurvey top of casing and ground surface elevation) | KCB-2016-35 | L | YG to commission | (S) - 2017. May wish to combine with other survey activities. |
| | | Rose Creek Diversion Channel: All inclinometers (CD, BGC-05, SP, and BS series) (resurvey top of casing and ground surface elevation) | | | | |
| | Pneumatic piezometer tips require replacement | Rose Creek Diversion Channel: CD-13-S (replace tips) | KCB-2016-36 | L | Parsons | (S) - 2017 |
| | | Intermediate Dam: BH91-ID6-S, BH91-ID6-D, BH91-ID7 (replace tips) | | | | |
| | | Cross Valley Dam: CVDP-3 (replace tips) | | | | |
| | Thermistors inoperable | Rose Creek Diversion Channel: SP-2, SP-3, BS-5, BS-9, BS-12, BGC05-04, CD-26, CD-10, CD-15, BGC05-07 (acquire RST Instruments Ltd. to assess thermistor operability and repair potential) | KCB-2016-38 | L | YG to commission | (S) - 2017 |
| | Missing thermistor calibration and conversion data | Rose Creek Diversion Channel: CD-10, BGC05-07, SP-2 | KCB-2016-39 | L | YG | (I) - 2017 |
| | Inclinometer not functioning | Rose Creek Diversion Channel: SP-5 (replace inclinometer) | KCB-2016-40 | M | YG to commission | (S) - 2017 |
| | No inclinometer coverage for dams | Install one inclinometer in each of the Little Creek Dam, Cross Valley Dam and Intermediate Dam | KCB-2016-41 | M | YG to commission | |

| Structure/Item | Condition | Recommendation | Number | Priority<br>**Priority Key:**<br>H - High Priority<br>M - Medium Priority<br>L - Low Priority<br>In Progress | Action by | Timeline/Progress<br>**Timeline key:**<br>(I) - Immediate, can action now<br>(S) - Short-term, before end of 2017<br>(L) - Long-term, before end of Fiscal Year 2018 (FY18)<br>(ND) - Not determined, reliant on other parties' planning |
|---|---|---|---|---|---|---|
| Faro Pit | Pit lake exceeds maximum recommended elevation established by Golder 2009. | Continue procedures described in KCB's technical memo dated February 10, 2015 titled "Faro Pit East Rim Slope Stability Monitoring During Elevated Lake Level". Draw down pit lake as soon as practical. | KCB-2014-11 | In Progress | YG | (I) - Review of these procedures should take place between Parsons/YG, to ensure information is communicated clearly. Pit lake is falling but is still above the maximum recommended level. |
| Faro Creek Diversion Channel | Pit wall is regressing towards Faro Creek Diversion Channel and may eventually undercut channel resulting in flow into the pit. | Develop a contingency plan for potential blockage. | KCB-2015-4 | M | INAC | (ND) - Follow-up to take place with Technical Review Committee, as to a timeline. |
| | Staff gauges are destroyed every winter and must be reinstalled each year. | Develop staff gauges that aren't destroyed every winter. | KCB-2016-24 | L | Parsons | (L) – After realignment of the FCDC |
| North Wall Interceptor Ditch | Vegetation that was previously cleared in the upper channel was removed using an excavator which also removed the roots. The areas that were cleared are subject to erosion. | Grass, erosion control blankets (straw mats), or riprap should be placed to control erosion prior to snow fall and melt. May require some experimentation to determine the most appropriate means of controlling erosion. | KCB-2016-16 | M | Parsons | (L) - Summer 2017. |
| | Evidence of weir overtopping during freshet. | Extend the weir such that it does not overtop during the spring freshet i.e. the freshet flow is contained within the v-notch and does not overtop the sides. | KCB-2015-9 | L | Parsons | (L) - Spring 2017. |
| Rose Creek Diversion Channel | No calibration data has been collected for staff gauges at high flows. | Take calibration flow measurements at the staff gauges in 2017 during high flows, using the overhead StreamPro guidance wires. Extend staff gauges, if required, such that they can be read during high flows. | KCB-2015-10 | In Progress | Parsons | (L) - In progress. |
| | Poor access conditions to Back Slope. May not be able to access with equipment during emergencies. | Develop an access plan for the back slope:<br>- required permits regarding investigation and repair of the above slope slumps; and<br>- general access (improved crossing and road, remove vegetation). | KCB-2014-3 | M | YG to explore permits, Parsons to review access | (L) - YG to action. |
| | Slumping in areas of Back Slope. | Monitor condition of slope slump scarps from four new standard photograph locations supplied by KCB at the Back Slope, and continue instrumentation monitoring along the Back Slope. | KCB-2016-42 | Complete | Parsons | Added to regular monitoring program. |
| | No calibration data has been collected at flow stations X2 and X10. | Take flow measurements and staff gauge readings to develop rating curves for X2 and X10. | KCB-2016-43 | L | Parsons | (S) - 2017 |
| | Reports potential describing previous Back Slope repairs are unavailable. Past successful repair experiences could provide guidance for current and future care and maintenance activities in the Back Slope area. | Locate annual review reports by Golder (1983 to 1999) and BGC (2000, 2001, and 2003), when repair works in the Back Slope area were conducted. | KCB-2014-6 | L | YG | (I) - Some reports were located at the EMR map library; others to be further followed up on. |
| | No emergency response plan for failure of the Back Slope and blockage of Rose Creek Diversion. | Develop an emergency response plan for failure of the Back Slope and blockage of the Rose Creek Diversion. | KCB-2016-10 | H | Parsons to develop incident plan to be reviewed and accepted by YG | (S) - YG to discuss with Parsons. |
| | Flow stations routinely destroyed in winter; NFRD-2B and X2 have inconsistent readings. | Identify and install a new monitoring point that allows use of a flow station and staff gauge that will provide consistent readings and not be easily destroyed in winter. KCB suggests placing the station in the culvert if access can be maintained. | KCB-2016-19 | L | Parsons | (L) - Spring 2017. |
| North Fork Rock Drain | Acceptable. | None. | N/A | N/A | N/A | N/A |
| K8 Creek Rock Drain | Acceptable. | None. | N/A | N/A | N/A | N/A |
| Secondary Dam | Cracks along dam crest on Secondary Dam Downstream Berm road. | Monitor cracks using quantitative measures (pins for length and width). | KCB-2016-25 | M | Parsons | (I) - To be actioned by site. |
| | Downstream berm road is rough and ponding water. | Grade lower downstream berm road. | KCB-2016-26 | L | Parsons | (I) - To be actioned by site. |
| | Secondary Dam not included in DSR, OMS or ERP | Include the Secondary Dam in the next DSR, OMS and ERP. | KCB-2015-25 | H | YG to include in scope | (ND) - YG to follow up with KCB. |
| Intermediate Dam | Erosion on dam face. | Repair latest erosion as per technical direction from KCB. | KCB-2016-20 | In Progress | Parsons | (L) - Spring 2017 (Fall repairs are complete). |
| | Spillway inadequately sized for extreme flood events. | Upgrade spillway to meet CDA dam safety criteria for Inflow Design Flood (IDF) for the high consequence classification dam. | KCB-2015-27<br>WSR-2014 | H | INAC | (ND) - Follow-up to take place with Technical Review Committee, as to a timeline, and comments as to short-term mitigation, if there are no plans to address this in the next year. |
| | Pipelines and operational equipment in spillway, potentially impeding flow. | Remove pipelines and operational equipment that may impede spillway flow from the spillway | KCB-2016-27 | M | Parsons | (I) - To be actioned by site. |
| Cross Valley Dam | Rill erosion on downstream slope. | Repair rill erosions in local areas of the downstream slope near the dam crest. | KCB-2015-36 | M | Parsons | (L) - YG to follow up with KCB for protocol, then actioned by site. |
| | Tension cracks longitudinally along dam crest. | Monitor using quantitative measures (pins for length and width), and seal to minimize water ingress to the embankment dam. | KCB-2015-37 | In Progress | Parsons is monitoring the cracks. Parsons/KCB to discuss how to seal. | (S) - To be actioned by site. |
| | Siphon pipeline partially obstructing spillway. | Remove siphon pipeline from the spillway. | KCB-2015-38<br>WSR-2014 | H | Parsons to discuss with YG/KCB | (S) - To be discussed between YG/Parsons/KCB. |
| | Water bypassing Weir No. 3. | Repair weir such that water no longer bypasses it. | KCB-2016-28 | L | Parsons | (L) - Spring 2017. |
| | Spillway inadequately sized for extreme flood events. | Upgrade spillway to manage the design flood. | KCB 2015<br>WSR-2014 | H | INAC | (ND) - Follow-up to take place with Technical Review Committee, as to a timeline, and comments as to short-term mitigation, if there are no plans to address this in the next year. |

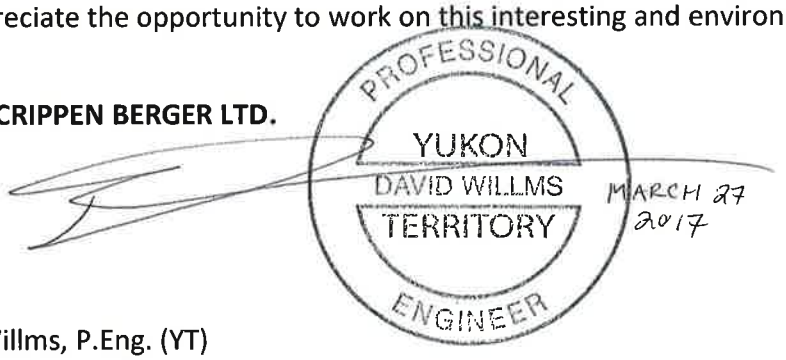
| Structure/Item | Condition | Recommendation | Number | Priority<br>**Priority Key:**<br>H - High Priority<br>M - Medium Priority<br>L - Low Priority<br>In Progress | Action by | Timeline/Progress<br>**Timeline key:**<br>(I) - Immediate, can action now<br>(S) - Short-term, before end of 2017<br>(L) - Long-term, before end of Fiscal Year 2018 (FY18)<br>(ND) - Not determined, reliant on other parties' planning |
|---|---|---|---|---|---|---|
| Grum Pit | Power supply may be cut off by pit wall failure. We consider a loss of power to be related to water management as it would disrupt pumping. | Prepare a power supply contingency plan in case progressive failure of the pit wall endangers the remaining two rows of power poles carrying live wires. | KCB-2014-11 | In Progress | YG | (L) - To be discussed between YG/Parsons/KCB. |
| | Area between the road near Wes' Pond and Grum Pit is flooded. | Dig a sump in the marsh on the opposite site of the road from Wes' Pond and experiment with pumping water out of the marsh to reduce the water near the pit rim. | KCB-2016-21 | M | Parsons | (L) - To be discussed between YG/Parsons/KCB. |
| | Grum Pit Lake is above maximum recommended level. | Draw down the Grum Pit Lake as soon as practical such that it is below the maximum recommended level. | KCB-2014-13 | In Progress | Parsons | (L) - To be actioned by site. |
| Vangorda Pit | Sinkhole repaired in 2015 appears to be settling. | Assess the depression at the sinkhole. | KCB-2016-22 | Completed | YG to request | (S) - YG to ask Golder to look at the sinkhole. |
| Vangorda Waste Rock Dump | Water ponding downstream of seepage weir V32 potentially inhibiting function during high flows. | Improve drainage downstream of seepage weir V32. | KCB-2016-23 | L | Parsons | (L) - To be actioned by site. |
| Grump Pit Interceptor Ditch | Erosion on side slopes. | Use riprap, vegetation, straw mats, or other means to control erosion of the side slopes. | KCB-2016-14 | H | Parsons | (L) - To be actioned by site. |
| | Damaged culverts. | Repair or replace:<br>- The culvert under the road to the Fresh Water Pond.<br>- The culvert at the road to the Vangorda Water Treatment Plant. | KCB-2012-2 | L | YG to commission | (L) - 2017. Culvert to be repaired/replaced. |
| Vangorda North East Interceptor Ditch | Multiple side-slope slumps were observed along the lower reach. | Repair slumps in side slopes with riprap and place filter materials between existing slope and newly added riprap materials. The maintenance activity should focus on maintaining adequate flow capacity of the Interceptor Ditch during the next spring freshet. Side slope repairs could use a simple design with coarse rock placed over filter cloth such that the side slopes and the channel capacity are maintained. Need to maintain access (clear vegetation and make sure the road doesn't slump away) and maintain positive drainage in the ditch. | KCB-2015-40 | L | Parsons | (L) - To be actioned by site. |
| Vangorda Creek Diversion Flume | Bottom of twin emergency spillway culverts is filled with sediment. | Clear the twin emergency spillway culverts and lower the spillway channel invert at the discharge end of the culverts. The culverts should be cleared any time sediment buildup in the bottom of the culvert exceeds 150 mm. | KCB-2015-41 | L | Parsons | (L) - To be discussed between YG/Parsons/KCB. |
| | Several damaged portions of flume render it less effective for containing flow. | Replace the flume with a new structure as early as practical. This is nearing high priority. | KCB-2014-14 | M | INAC | (ND) - Follow-up to take place with Technical Review Committee, as to a timeline, and comments as to short-term mitigation, if there are no plans to address this in the next year. |
| Little Creek Dam | Erosion on downstream slope. | Repair erosion on the downstream dam slope. These repairs were completed in October. YG reported that the material was not track packed so there are still some ruts from the machinery. Dam face should be assessed again in the spring. | KCB-2015-42 | Completed (to be assessed in Spring) | Parsons | (L) - To be completed in spring 2017. Fall repairs complete. |
| | Spillway is undersized. | Conduct a hydrological assessment to confirm the design flood, and if it can be stored and/or whether the spillway should be resized. | KCB-2015-44 (Worley 2014) | H | YG to commission | (ND) - Follow-up to take place with Technical Review Committee, as to a timeline, and comments as to short-term mitigation, if there are no plans to address this in the next year. |
| | Intermittent seepage at toe of dam. | If seeps return, check water quality of seeps to determine if they originate from Little Creek Pond. YG reported that the site was visited several times in 2016 but no water was present. It may be that the dam repairs have improved drainage and that water will no longer pond at the toe. This recommendation should be re-assessed in 2017. | KCB-2015-46 | L | Parsons | (L) - To be actioned by site. |
| Sheep Pad Sediment Ponds | Spillway for Upper Pond is partially obstructed by boulders and is not effective for maintaining adequate freeboard under flood events. | Reduce the size of the large boulders weighing down the half-round CSP spillway between the Upper and Lower Ponds. Add stiffening braces to the top of the CSP to prevent further pipe deformation due to lateral pressure from riprap materials around the pipe. | KCB-2015-48 | H | Parsons | (L) - To be actioned by site. |
| | Low freeboard in Upper Pond. | Review design of ponds and if existing ponds are adequate. Consider options for lowering the invert elevation of CSP half round between upper and lower Sheep Pond. This should help to maintain more freeboard in the upper pond. | KCB-2015-49 | M | YG to commission | (L) - To be discussed between YG/KCB. |
| | Exposed geofabric. | Cover exposed geofabric, as required, with riprap materials, on the berm separating the Lower and Upper Pond spillway. | KCB-2015-50 | L | Parsons | (L) - To be actioned by site. |
| | Containment berm may be large enough to be classified as a dam. | Confirm storage capacity and height of impoundment to determine if the pond should be classified as a dam. | KCB-2015-52 | M | YG to commission | (S) - To be discussed between YG and KCB. |
| Fresh Water Pond for Vangorda Water Treatment Plant | Containment berm may be large enough to be classified as a dam. | Confirm storage capacity and height of impoundment to determine if the pond should be classified as a dam. | KCB-2015-54 | M | YG to commission | (S) - To be discussed between YG and KCB. |
| V-15 Seep Ditch, GC Weir and Moose Pond | Acceptable. | None. | N/A | N/A | N/A | N/A |
| Vangorda Water Treatment Plant Clarification Pond | Containment berm may be large enough to be classified as a dam. | Confirm storage capacity and height of impoundment to determine if the pond should be classified as a dam. | KCB-2015-57 | M | YG to commission | (S) - To be discussed between YG and KCB. |
| | No spillway. | Assess the need for a spillway on the pond (can be included in the assessment of the dam classification). | KCB-2015-58 | M | YG to commission | (S) - To be discussed between YG and KCB. |
| | Minor erosion on upstream road | Control erosion of the upstream road. | KCB-2016-44 | L | Parsons | (I) - 2017 |

# 7 CLOSING

This report is an instrument of service of Klohn Crippen Berger Ltd. (KCB) and has been prepared for the exclusive use of the Yukon government. The content of this report reflects Klohn Crippen Berger's best judgment in light of the information available to it at the time of preparation. Any use which a third party makes of this report, or any reliance on or decisions to be made based on it are the responsibility of such third parties. KCB accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

We appreciate the opportunity to work on this interesting and environmentally important project.

**KLOHN CRIPPEN BERGER LTD.**




David Willms, P.Eng. (YT)
Project Manager / Geotechnical Engineer

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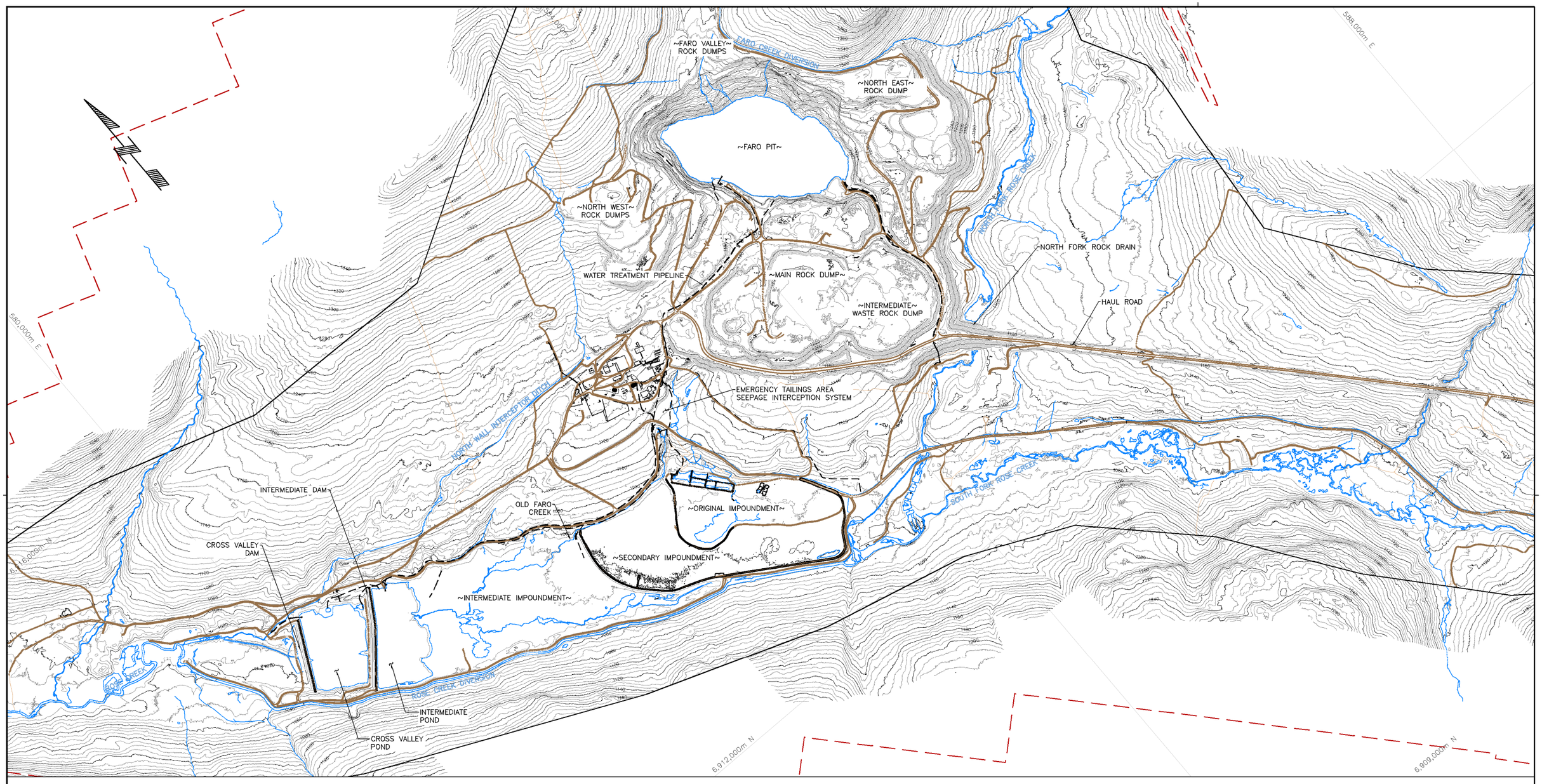
# FIGURES

Figure 1 Faro Site – General Layout
Figure 2 Faro Site – Air Photo
Figure 3 Vangorda Plateau Mine – Site Overview
Figure 4 Vangorda Plateau Site – General Arrangement Plan
Figure 5 Vangorda Plateau Site – Air Photo
Figure 6 Faro Pit Brim – Reference Bars and Survey Prisms
Figure 7 Down Valley Tailings Containment Instrument Location – 1 of 2
Figure 8 Down Valley Tailings Containment Instrument Location – 2 of 2
Figure 9 Section View of Intermediate Dam
Figure 10 Section View of Cross Valley Dam
Figure 11 Grum Pit Brim – Reference Rods and Survey Prisms
Figure 12 General Arrangement Plan – Vangorda Waste Rock Dump
Figure 13 Little Creek Dam – General Arrangement Plan
Figure 14 Little Creek Dam – Section B-B




## LEGEND

- IMPACTED AREA BOUNDARY
- ACESS ROADS
- STREAMS

NOT FOR CONSTRUCTION

To be read with Klohn Crippen Berger report dated

SCALE 0 1000m



CLIENT: YUKON GOVERNMENT

Klohn Crippen Berger

PROJECT: FARO MINE COMPLEX
2012 ANNUAL GEOTECHNICAL REVIEW

TITLE: FARO SITE GENERAL LAYOUT

PROJECT No. M09770A02 02

FIG. No. FIGURE 1

KCB-R-MLD

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Filename:\\INT.KLOHN.COM\PROJDATA\M\VCR\M09770A02 - GOVT YUKON-FARO COMPLEX\400 DRAWINGS\CAD\2012 ANNUAL GEOTECHNICAL REVIEW\FIG 1-2.DWG
Xref File(s): bm-faro-130221; for insert-by others-faro site plan-130221
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**LEGEND**

- Pit
- Tailings
- Pond
- Diversion

**NOTE**

Refer to Figures 3-1 and 3-2 for Down Valley Tailings Containment instrument location details.

**REFERENCE**

Ortho-image obtained from Google © 2007 Data SIO, NOAA, U.S. Navy, NGA, GEBCO Image © 2011 DigitalGlobe.
Projection: UTM Zone 8 Datum: NAD 83

500 0 500
SCALE 1:20,000 METRES

Fig. 2 Original Source: Figure 2-1 General Arrangement Plan Golder 2011. 2010 Annual Geotechnical Dam Inspection, Faro Mine Complex, Faro, Yukon

# FIGURE 2

PROJECT
DENISON ENVIRONMENTAL SERVICES
FARO MINE COMPLEX
YUKON

TITLE
FARO SITE AIR PHOTO

Golder Associates
Greater Vancouver Office, B.C.

| | | | | |
|---|---|---|---|---|
| PROJECT No. 10-1427-0032 | | | PHASE No. 2000 | |
| DESIGN | WJP | 08FEB11 | SCALE AS SHOWN | REV. 0 |
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| CHECK | WJP | 28FEB11 | FIGURE 2-1 | |
| REVIEW | JAH | 28FEB11 | | |

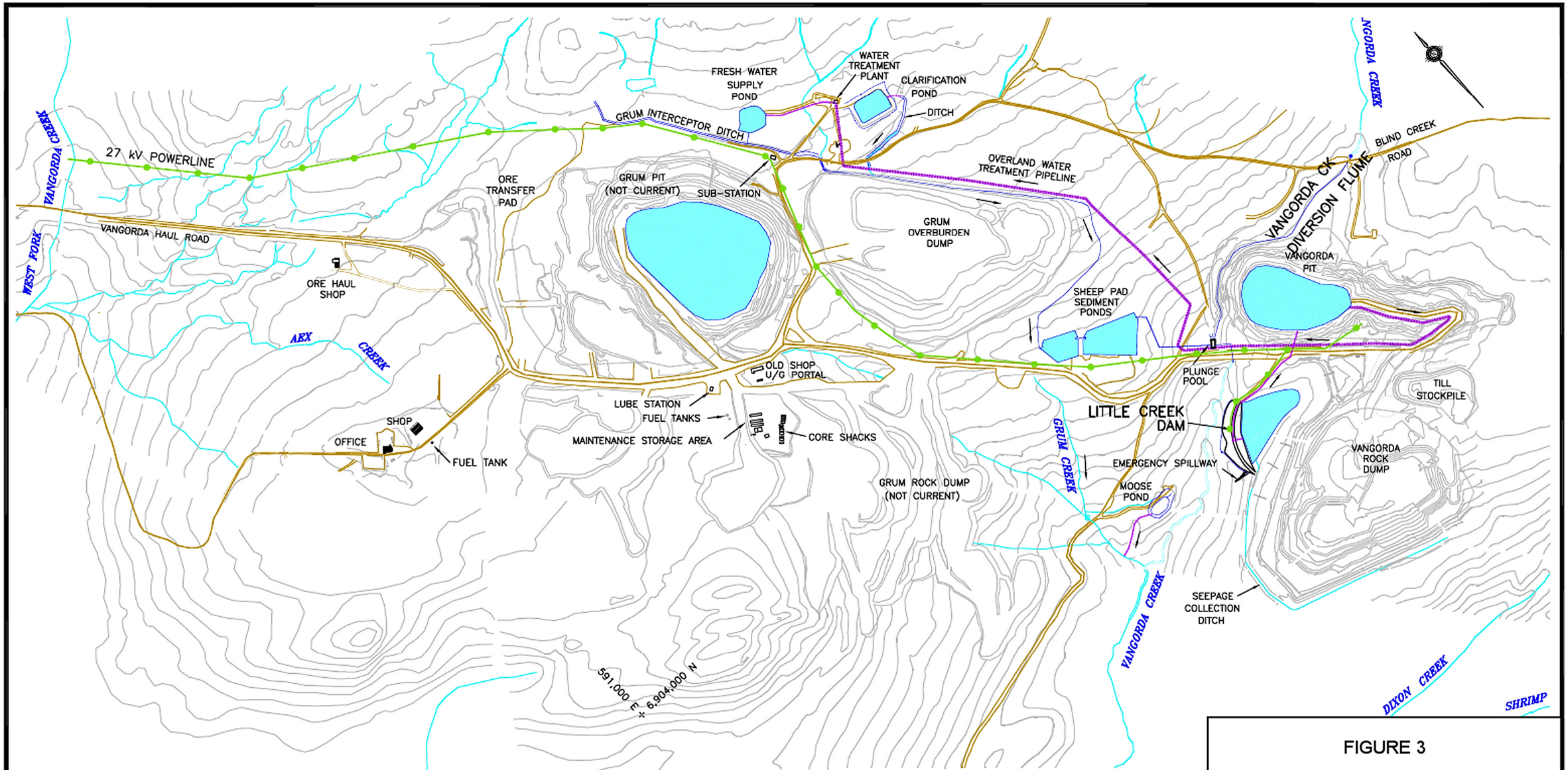



Fig. 3 Original Source: Figure 3 Vangorda Plateau Mine Site – Overview BGC 2003. Report on Emergency Preparedness Plan for Selected Dams and Water Diversion Structures

CLIENT: **Deloitte & Touche**

NOTE: BASE MAP FIGURE PROVIDED BY GARTNER LEE LTD.



LEGEND:
- ROADS
- EXISTING SURFACE DRAINAGE
- PRE-MINE DRAINAGE
- EFFLUENT PIPELINE
- PIPELINE
- POWERLINE
- WATER TREATMENT PIPELINE
- SURFACE WATER

| REV. | DATE | REVISION NOTES | DRAWN | CHECKED | APPROVED |
|---|---|---|---|---|---|
| | | | | | |
| | | | | | |

| | |
|---|---|
| SCALE: | AS SHOWN |
| DATE: | OCTOBER 2003 |
| DRAWN: | GEJ |
| DESIGNED: | KM |
| CHECKED: | HHH/JWC |
| APPROVED: | JWC |

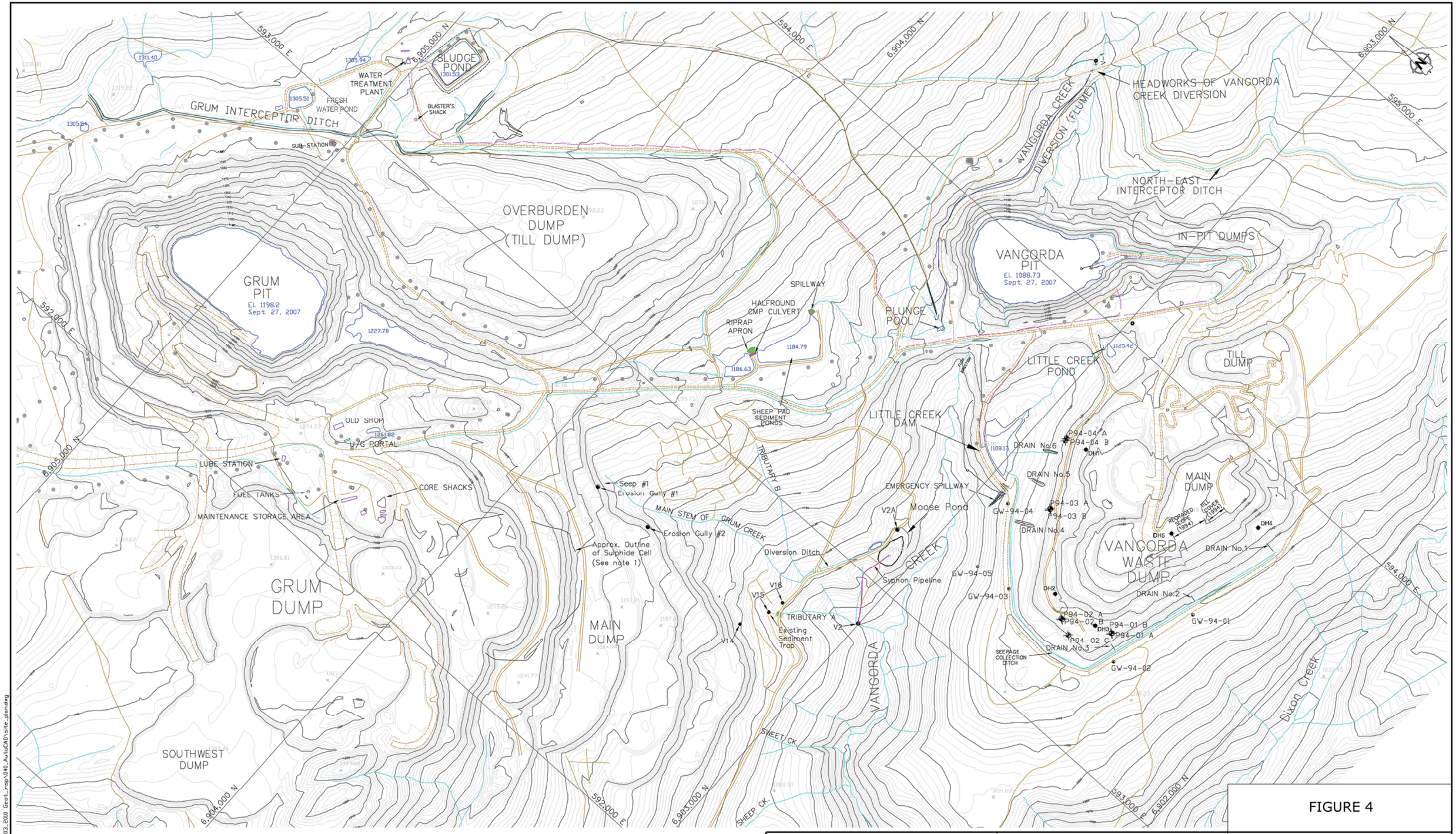
# FIGURE 3

PROJECT: ANVIL RANGE
EPP FOR DAMS & WATER DIVERSION STRUCTURES

TITLE: VANGORDA PLATEAU MINE
SITE OVERVIEW

| PROJECT No. | FIGURE No. | REV. |
|---|---|---|
| 0257-018-02 | 3 | 0 |

BGC ENGINEERING INC.
AN APPLIED EARTH SCIENCES COMPANY
Calgary, AB Phone: (403) 250 5185

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Contour Interval: 2m
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Scale of Photography: 1:20000
Survey control derived from existing 1:20000 photography
Survey control based on: UTM Projection, NAD27
Compiled by The ORTHOSHOP, Calgary, September 2003
WO 8856

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Scale 1:10,000

Fig 4. Original Source: Figure 2 2011 Geotechnical Inspection. Waste and Water Management Facilities Vangorda/Grum

SRK Consulting
Engineers and Scientists
Vancouver

SRK JOB NO.: 1CD009.003
FILE NAME: site_plan.dwg

Denison Environmental Services

FARO MINE COMPLEX

# FIGURE 4

2010 Vangorda Annual Inspection

General Arrangement Plan

| DATE: | APPROVED: | FIGURE: |
|---|---|---|
| Feb. 2011 | | 2 |

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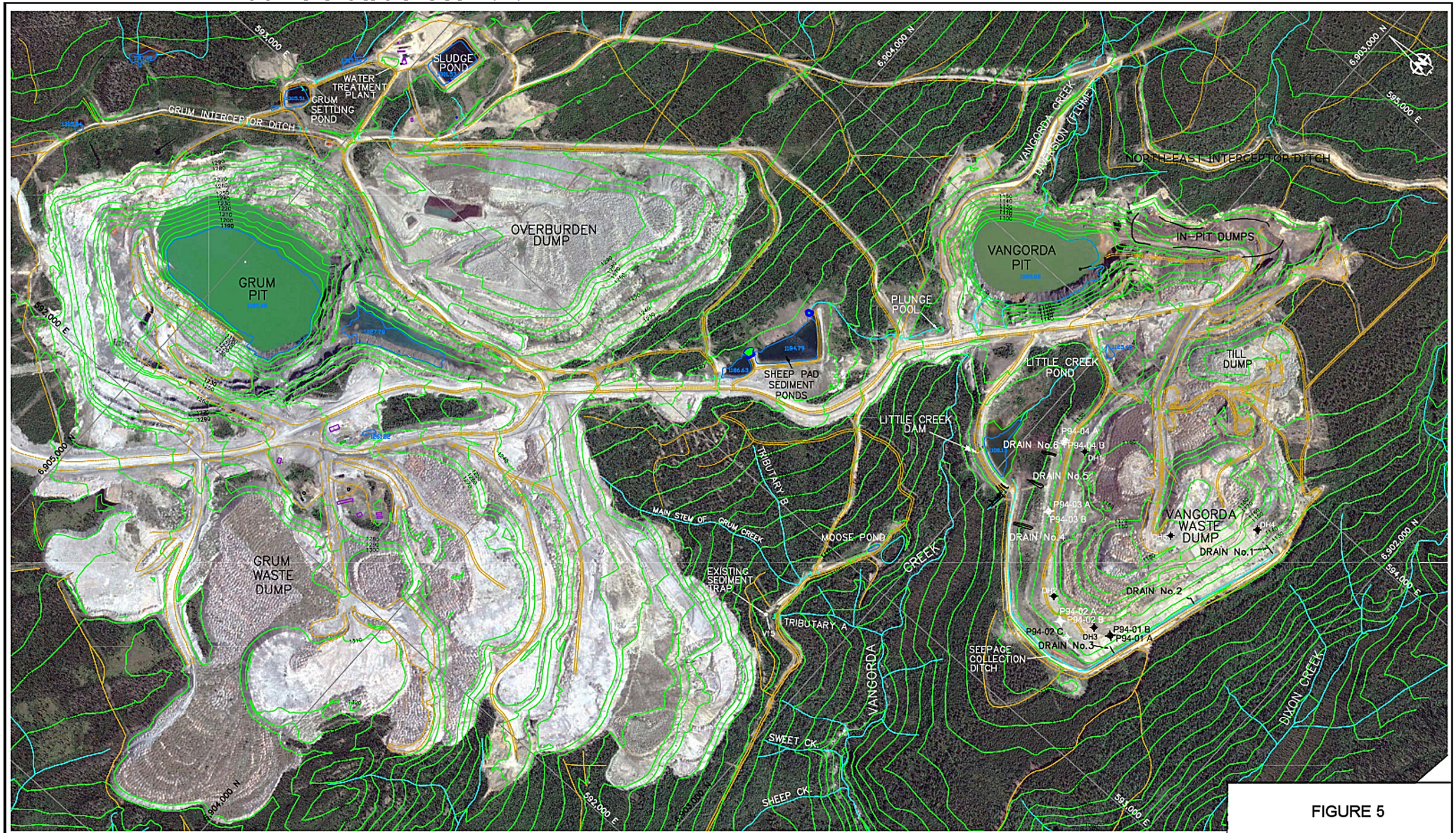


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Survey control based on: UTM Projection, NAD27

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Scale 1:10,000

Fig. 5 Original Source: Figure 3 Photo-Rectified Mosaic, with Contours, of Vangorda Plateau Area SRK 2011. 2010 Annual Inspection – Waste and Water Management Facilities – Vangorda/Grum

srk consulting

SRK JOB NO.: 1CD009.005
FILE NAME: site_plan_photo.dwg

Denison Environmental Services

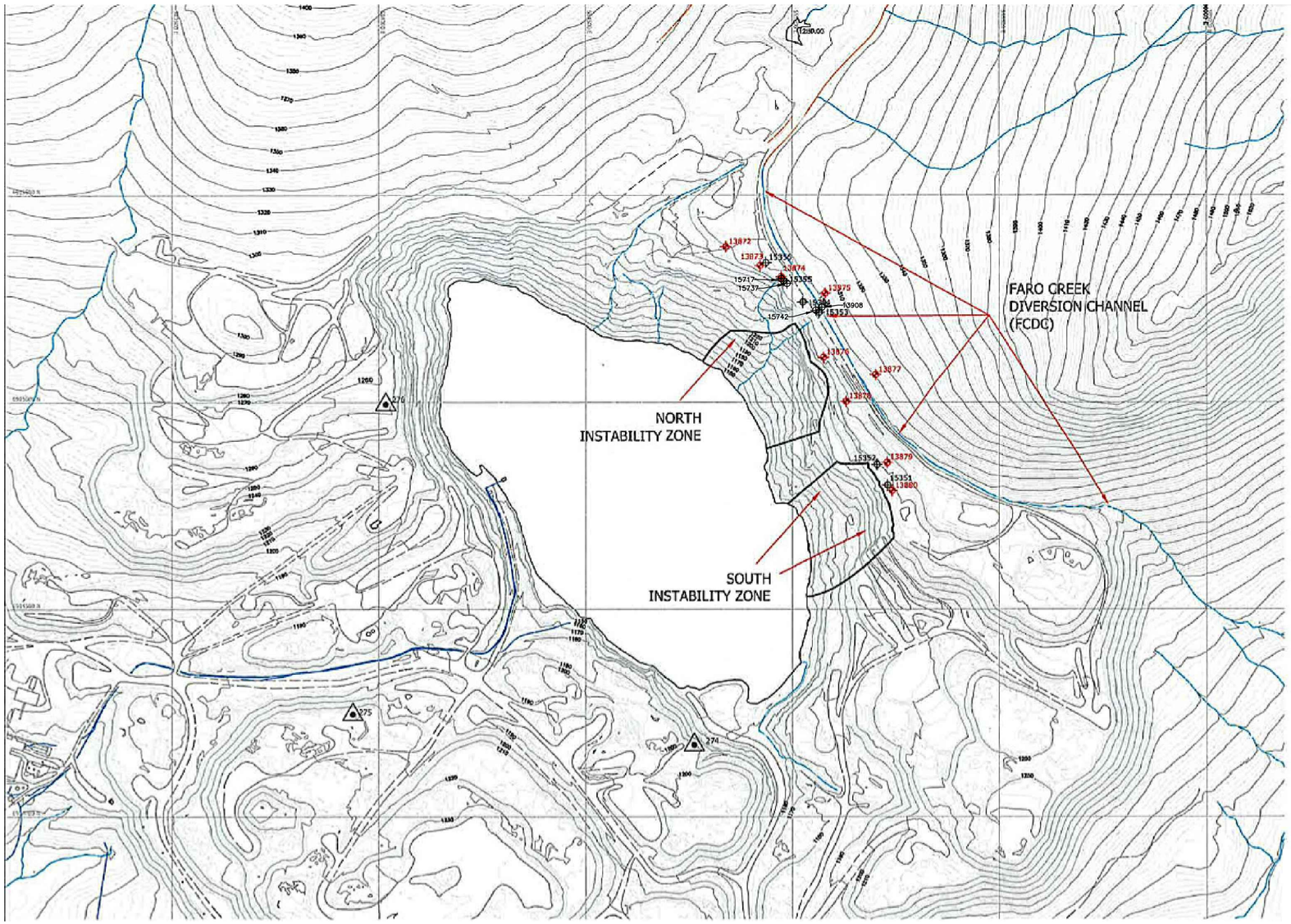
FARO MINE COMPLEX

# FIGURE 5

2011 Vangorda Geotechnical Inspection

VANGORDA PLATEAU SITE AIR PHOTO

| DATE: | APPROVED: | FIGURE: |
|---|---|---|
| July 2011 | PMH | 3 |




**NOTES:**

1) ALL DIMENSIONS AND ELEVATIONS ARE IN METRES UNLESS OTHERWISE NOTED.

**LEGEND:**

- 13878 — MONITORING SURVEY PRISMS
- 13912 — SLOPE MOVEMENT OBSERVATIONS - REFERENCE BARS
- 274 — OBSERVATION POINTS-FIXED LOCATION

NOTES:
1. ORIGINAL FIGURE PROVIDED BY GOLDER ASSOCIATES.
2. SLOPE MOVEMENT OBSERVATIONS 15717, 15737, 15742 AND 13908 APPROXIMATELY LOCATED.

To be read with Klohn Crippen Berger report dated

SCALE



CLIENT: Yukon Government

Klohn Crippen Berger

PROJECT: FARO MINE COMPLEX
ANNUAL REVIEW

TITLE: FARO PIT BRIM
REFERENCE BARS AND SURVEY PRISMS

PROJECT No.: M09770A03 01

FIGURE 6

KCB-R-MLD

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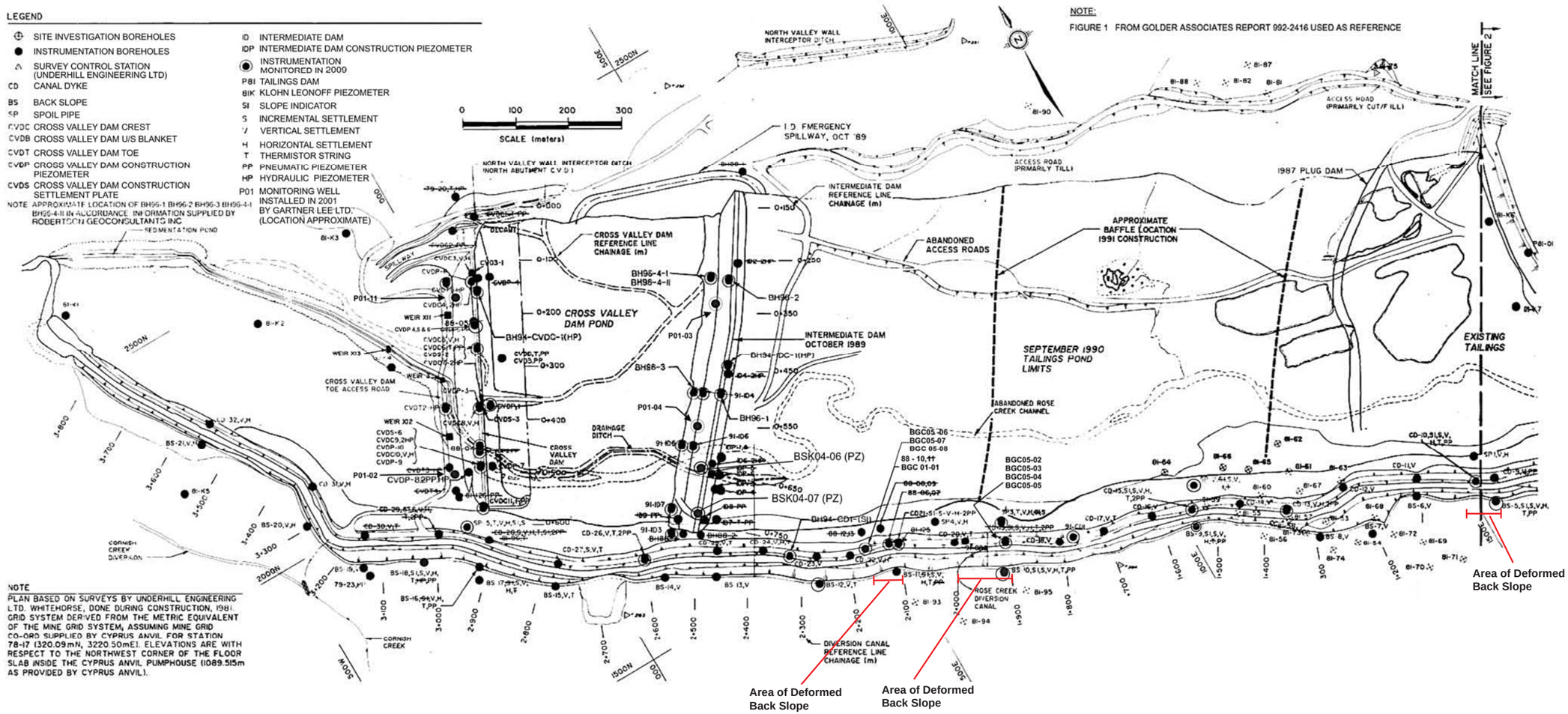


Fig. 7 Original Source: Figure 2 - 2009 Geotechnical Evaluation and Instrumentation Review, Volume 1

# FIGURE 7



| REV. | DATE | REVISION NOTES | DRAWN | CHECK | APPR. |
|---|---|---|---|---|---|

| | |
|---|---|
| SCALE: | N/A |
| DATE: | FEB 2010 |
| DRAWN: | TMW |
| DESIGNED: | TMW |
| CHECKED: | HHH |
| APPROVED: | GWF |

PROFESSIONAL SEAL:

BGC ENGINEERING INC.
AN APPLIED EARTH SCIENCES COMPANY

CLIENT: Denison Environmental Services

PROJECT: 2009 ANNUAL GEOTECHNICAL EVALUATION AND INSTRUMENTATION REVIEW

TITLE: DOWN VALLEY TAILINGS CONTAINMENT INSTRUMENT LOCATION 1 OF 2

| PROJECT No.: | FIGURE No.: | REV.: |
|---|---|---|
| 0762-002-05 | 2 | 0 |

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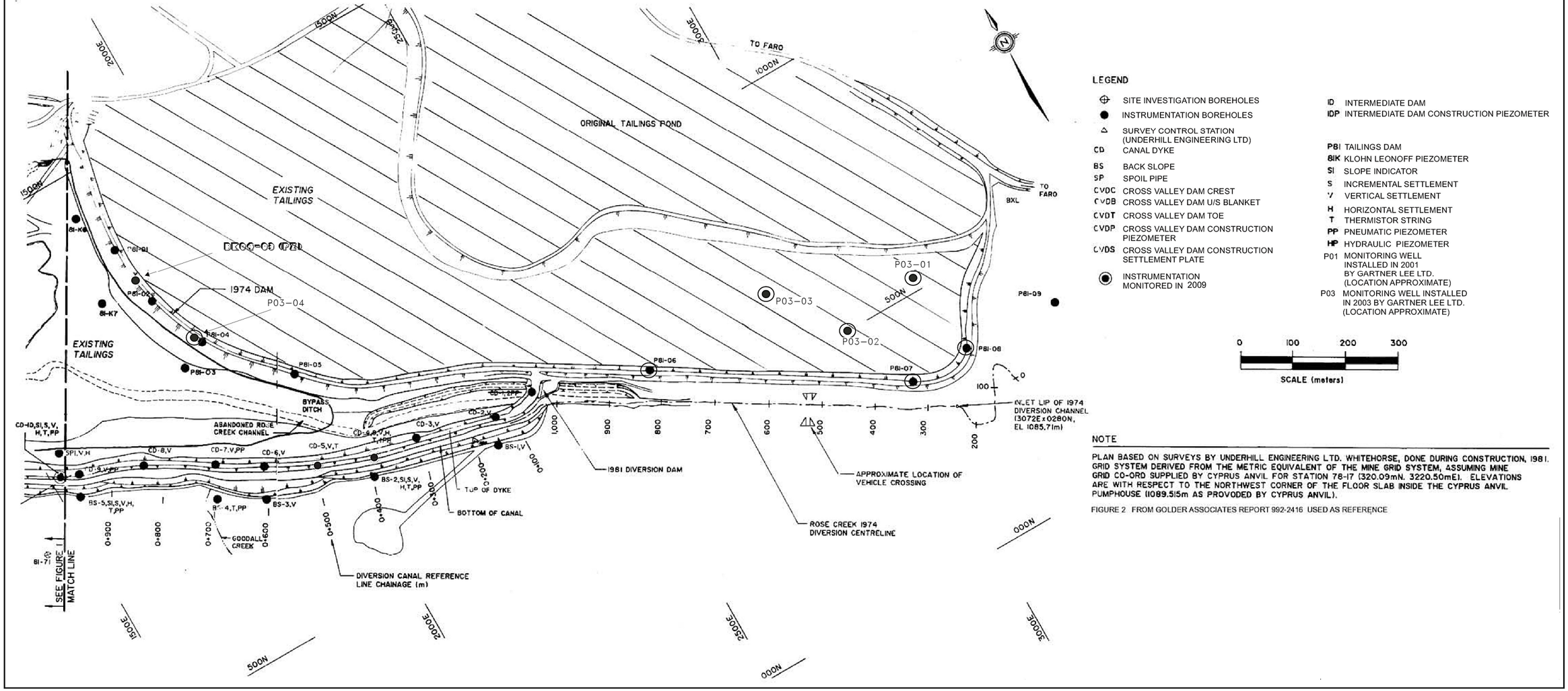


LEGEND

- SITE INVESTIGATION BOREHOLES
- INSTRUMENTATION BOREHOLES
- SURVEY CONTROL STATION (UNDERHILL ENGINEERING LTD)
- CD CANAL DYKE
- BS BACK SLOPE
- SP SPOIL PIPE
- CVDC CROSS VALLEY DAM CREST
- CVDB CROSS VALLEY DAM U/S BLANKET
- CVDT CROSS VALLEY DAM TOE
- CVDP CROSS VALLEY DAM CONSTRUCTION PIEZOMETER
- CVDS CROSS VALLEY DAM CONSTRUCTION SETTLEMENT PLATE
- INSTRUMENTATION MONITORED IN 2009
- ID INTERMEDIATE DAM
- IDP INTERMEDIATE DAM CONSTRUCTION PIEZOMETER
- PBI TAILINGS DAM
- BIK KLOHN LEONOFF PIEZOMETER
- SI SLOPE INDICATOR
- S INCREMENTAL SETTLEMENT
- V VERTICAL SETTLEMENT
- H HORIZONTAL SETTLEMENT
- T THERMISTOR STRING
- PP PNEUMATIC PIEZOMETER
- HP HYDRAULIC PIEZOMETER
- P01 MONITORING WELL INSTALLED IN 2001 BY GARTNER LEE LTD. (LOCATION APPROXIMATE)
- P03 MONITORING WELL INSTALLED IN 2003 BY GARTNER LEE LTD. (LOCATION APPROXIMATE)

0 100 200 300

SCALE (meters)

NOTE

PLAN BASED ON SURVEYS BY UNDERHILL ENGINEERING LTD. WHITEHORSE, DONE DURING CONSTRUCTION, 1981. GRID SYSTEM DERIVED FROM THE METRIC EQUIVALENT OF THE MINE GRID SYSTEM, ASSUMING MINE GRID CO-ORD SUPPLIED BY CYPRUS ANVIL FOR STATION 78-17 (320.09mN, 3220.50mE). ELEVATIONS ARE WITH RESPECT TO THE NORTHWEST CORNER OF THE FLOOR SLAB INSIDE THE CYPRUS ANVIL PUMPHOUSE (1089.515m AS PROVODED BY CYPRUS ANVIL).

FIGURE 2 FROM GOLDER ASSOCIATES REPORT 992-2416 USED AS REFERENCE

Fig. 8 Original Source: Figure 3 - 2009 Annual Geotechnical Evaluation and Instrumentation Review, Volume 1

# FIGURE 8



| REV. | DATE | REVISION NOTES | DRAWN | CHECK | APPR. |
|---|---|---|---|---|---|
| | | | | | |

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|---|---|
| SCALE: | N/A |
| DATE: | FEB 2010 |
| DRAWN: | TMW |
| DESIGNED: | TMW |
| CHECKED: | HHH |
| APPROVED: | GWF |

PROFESSIONAL SEAL:

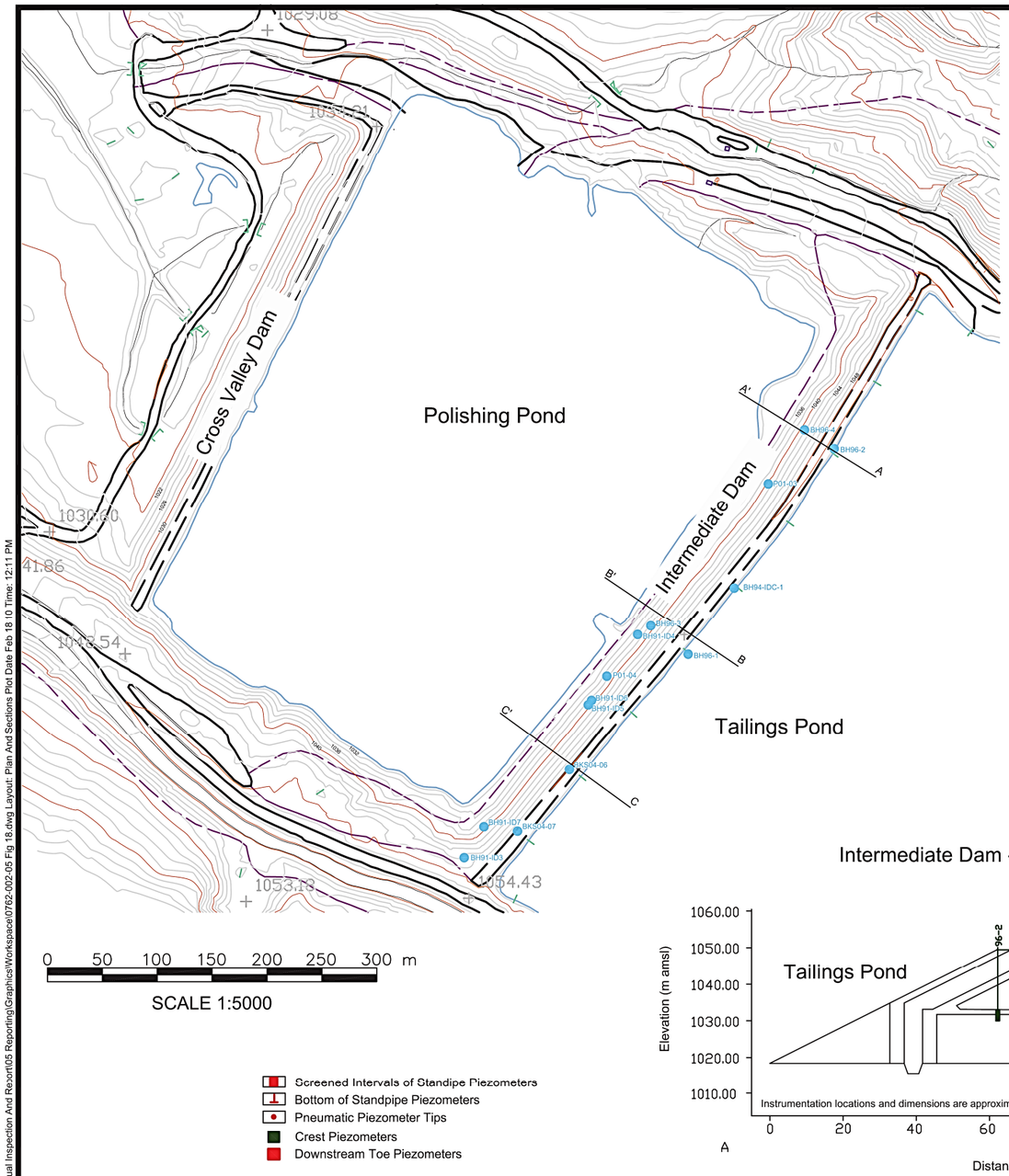
BGC ENGINEERING INC.
AN APPLIED EARTH SCIENCES COMPANY

CLIENT: Denison Environmental Services

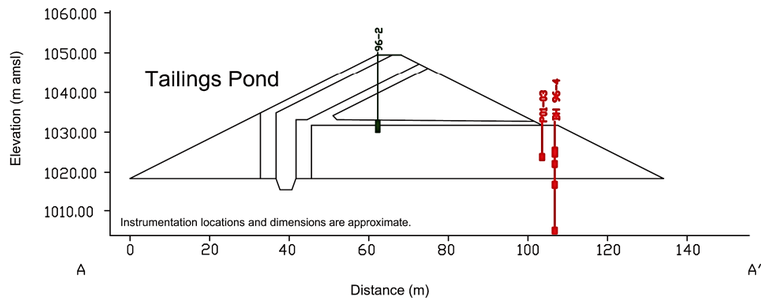
PROJECT: 2009 ANNUAL GEOTECHNICAL EVALUATION AND INSTRUMENTATION REVIEW

TITLE: DOWN VALLEY TAILINGS CONTAINMENT INSTRUMENT LOCATION 2 OF 2

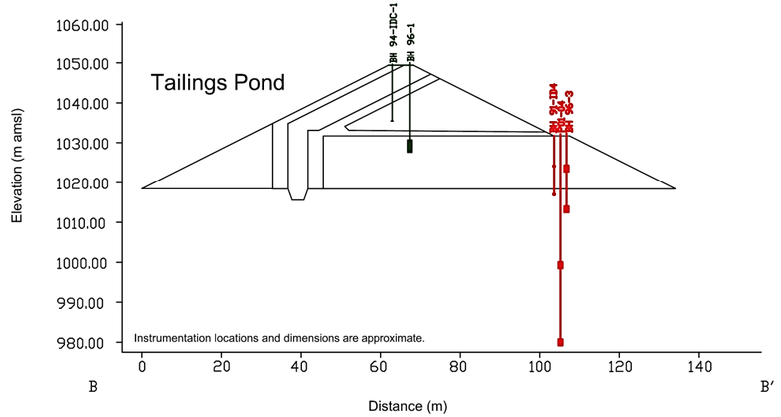
| PROJECT No.: | FIGURE No.: | REV.: |
|---|---|---|
| 0762-002-05 | 3 | 0 |




Intermediate Dam - Cross-Section A - A'




Intermediate Dam - Cross-Section B - B'




Intermediate Dam - Cross-Section C - C'

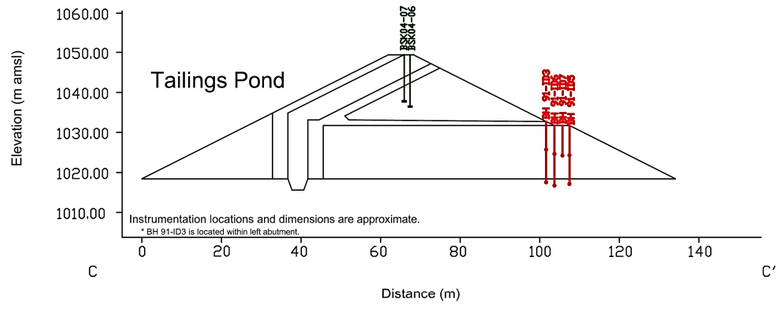



Fig. 9 Original Source: Figure 18 - 2009 Annual Geotechnical Evaluation and Instrumentation Review, Volume 1

# FIGURE 9



| REV. | DATE | REVISION NOTES | DRAWN | CHECK | APPR. |
|---|---|---|---|---|---|
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| SCALE: | AS SHOWN |
| DATE: | FEB 2010 |
| DRAWN: | JL |
| DESIGNED: | TMW |
| CHECKED: | HHH |
| APPROVED: | GWF |

PROFESSIONAL SEAL:

BGC ENGINEERING INC.
AN APPLIED EARTH SCIENCES COMPANY

CLIENT: Denison Environmental Services

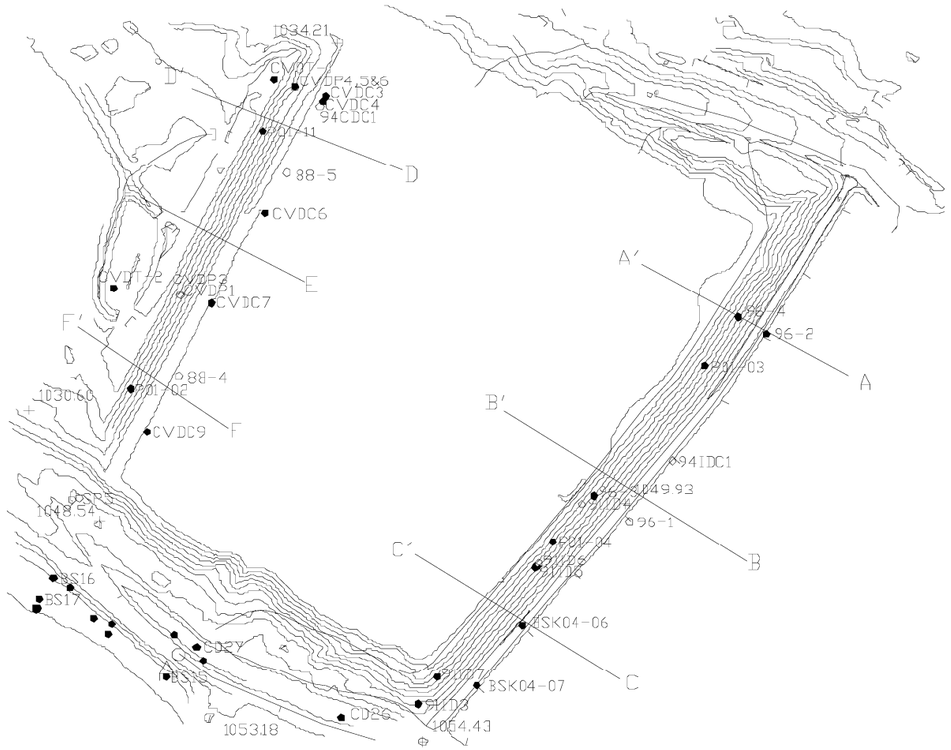
PROJECT: 2009 ANNUAL GEOTECHNICAL EVALUATION AND INSTRUMENTATION REVIEW

TITLE: SECTION VIEW OF INTERMEDIATE DAM

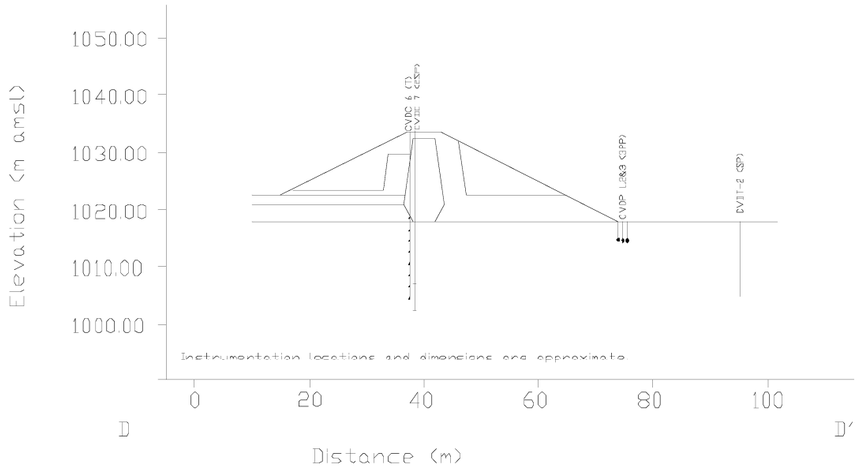
| PROJECT No.: | FIGURE No.: | REV.: |
|---|---|---|
| 0762-002-05 | 18 | 0 |

K:\Projects\0762 Denison Environmental\02 2009 Annual Inspection And Report\05 Reporting\Graphics\Workspace\0762-002-05 Fig 18.dwg Layout: Plan And Sections Plot Date Feb 18 10 Time: 12:11 PM

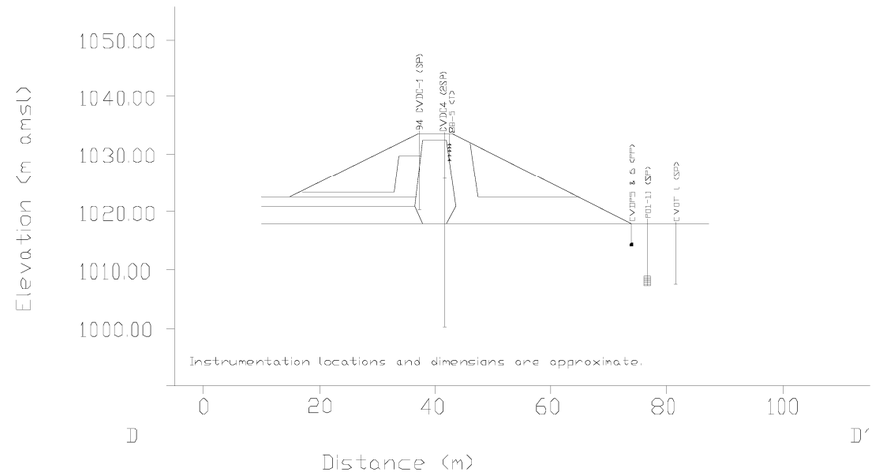
DWG TO BE READ WITH BGC REPORT TITLED " 2009 ANNUAL GEOTECHNICAL EVALUATION AND INSTRUMENT REVIEW" DATED FEB 2010



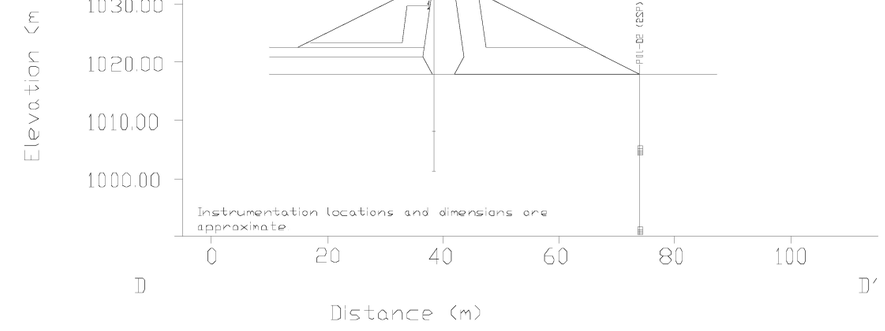

Cross Valley Dam - Cross-Section E - E′




Cross Valley Dam - Cross-Section D - D′




Cross Valley Dam - Cross-Section F - F′




SP Standpipe Piezometers
PP Pneumatic Piezometers
T Thermistor Cables
Screened Intervals of Standpipe Piezometers
Bottom of Standpipe Piezometers
Pneumatic Piezometer Tips
Thermistor Nodes

Fig. 10 Original Source: Figure 24 - 2009 Geotechnical Evaluation and Instrumentation Review, Volume 1

# FIGURE 10



| REV. | DATE | REVISION NOTES | DRAWN | CHECK | APPR. |
|---|---|---|---|---|---|
| | | | | | |

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| SCALE: | N/A |
| DATE: | FEB 2010 |
| DRAWN: | TMW |
| DESIGNED: | TMW |
| CHECKED: | HHH |
| APPROVED: | GWF |

PROFESSIONAL SEAL:

BGC ENGINEERING INC.
AN APPLIED EARTH SCIENCES COMPANY

CLIENT: Duncan Environmental Services

PROJECT: 2009 ANNUAL GEOTECHNICAL EVALUATION AND INSTRUMENTATION REVIEW

TITLE: SECTION VIEW OF CROSS VALLEY DAM

| PROJECT No.: | FIGURE No.: | REV.: |
|---|---|---|
| 0762-002-05 | 24 | 0 |

592,500m E
593,000m E
593,500m E
592,000m E
6,905,500m N
6,905,000m N
6,904,500m N
6,904,000m N

GRUM SETTLING POND
SLUDGE POND
OVERLAND WATER TREATMENT PIPELINE
~GRUM OVERBURDEN DUMP~
~GRUM PIT~ (NOT CURRENT)
~VANGORDA PIT~
SLOT CUT
LITTLE CREEK POND

GP-N1
GP-N2
GP-N3
GP-N4
GP-N5
GP-N6
GP-S1
GP-S2
GP-S3
GP-S4

MP001
MP002
MP003
MP004
MP005
MP006
MP007
MP008
MP009
MP010
MP011
MP012
MP013
MP014

## LEGEND

- ACESS ROADS
- STREAMS
- POWER POLE
- MP014 — 2014 SURVEY PRISM
- MP005 — 2013 SURVEY PRISM
- GP-N1 — REFERENCE ROD

To be read with Klohn Crippen Berger report dated

SCALE 0 750m



CLIENT: Yukon Government

Klohn Crippen Berger

PROJECT: FARO MINE COMPLEX ANNUAL REVIEW

TITLE: GRUM PIT BRIM REFERENCE RODS AND SURVEY PRISMS

PROJECT No. M09770A03 01

FIGURE 11

KCB-F-MD

Date: 1/29/2013 Time: 13:25:10 Scale: 1:2,585
Filename: \\NT.KLOHN.COM\PROJDATA\M\VCR\M09770A03-GOVTYUKON-2013 FARO\400 DRAWINGS\ANNUALREVIEW\FIG_11.DWG


## LEGEND

- Piezometer Location
- Monitoring Well Location (1994)
- Monitoring Well Location (2010)
- Monitoring Well Location (2009)

Contour Interval: 2m
Survey control based on: UTM Projection, NAD83
Based on The ORTHOSHOP, Calgary, September 2003

0 50 100 150 200 250
Scale in Metres

Fig. 12 Original Source: Figure 4 - 2011 Geotechnical Inspection Waste and Water Management Facilities Vangorda/Grum

srk consulting

SRK JOB NO.: 1CD009.005
FILE NAME: site_plan nad 83.dwg

Denison Environmental Services

FARO MINE COMPLEX

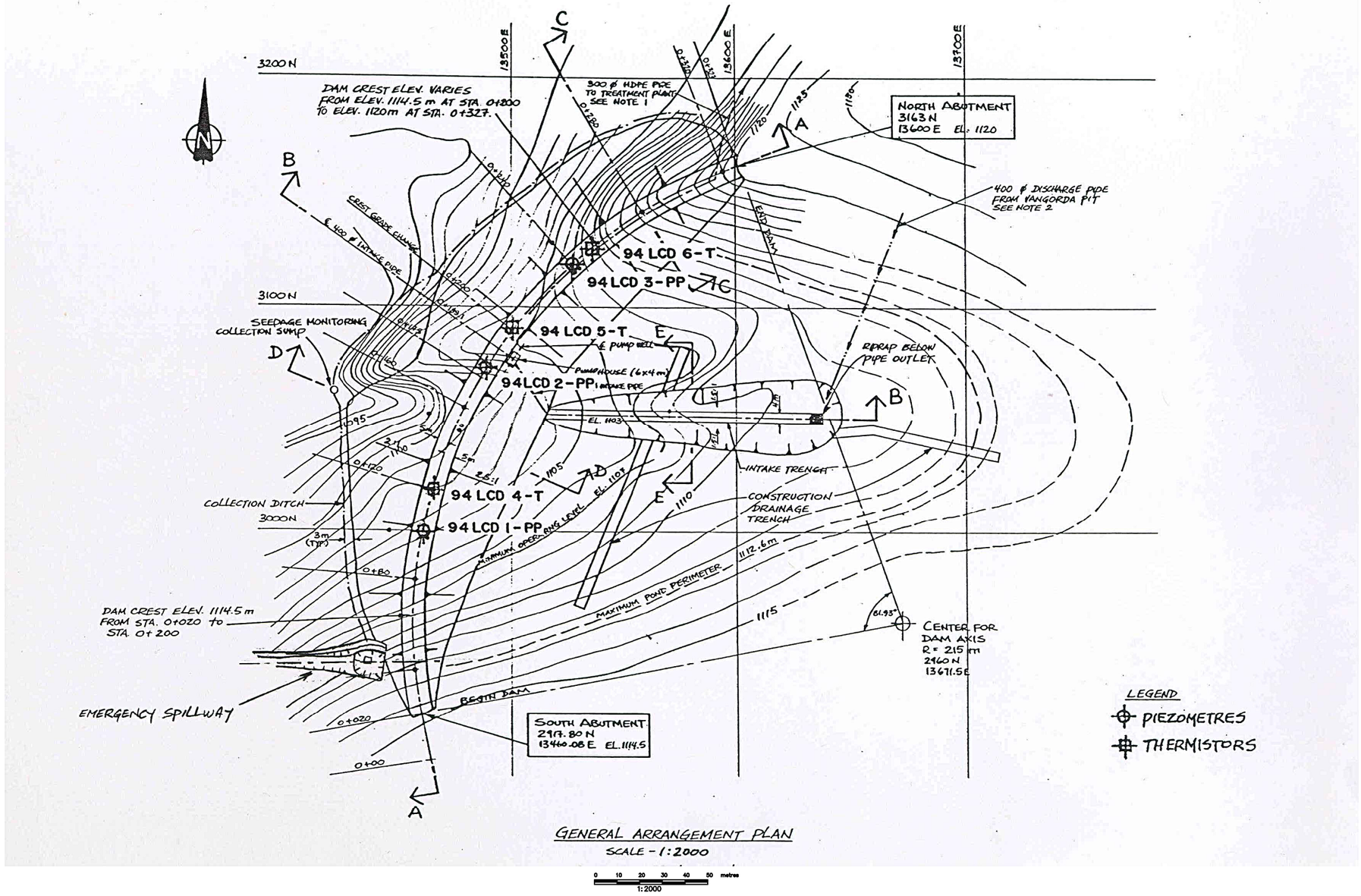
FIGURE 12

2011 Vangorda Geotechnical Inspection

General Arrangement Plan
Vangorda Waste Rock Dump

| DATE: | APPROVED: | FIGURE: |
|---|---|---|
| July 2011 | JK | 4 |

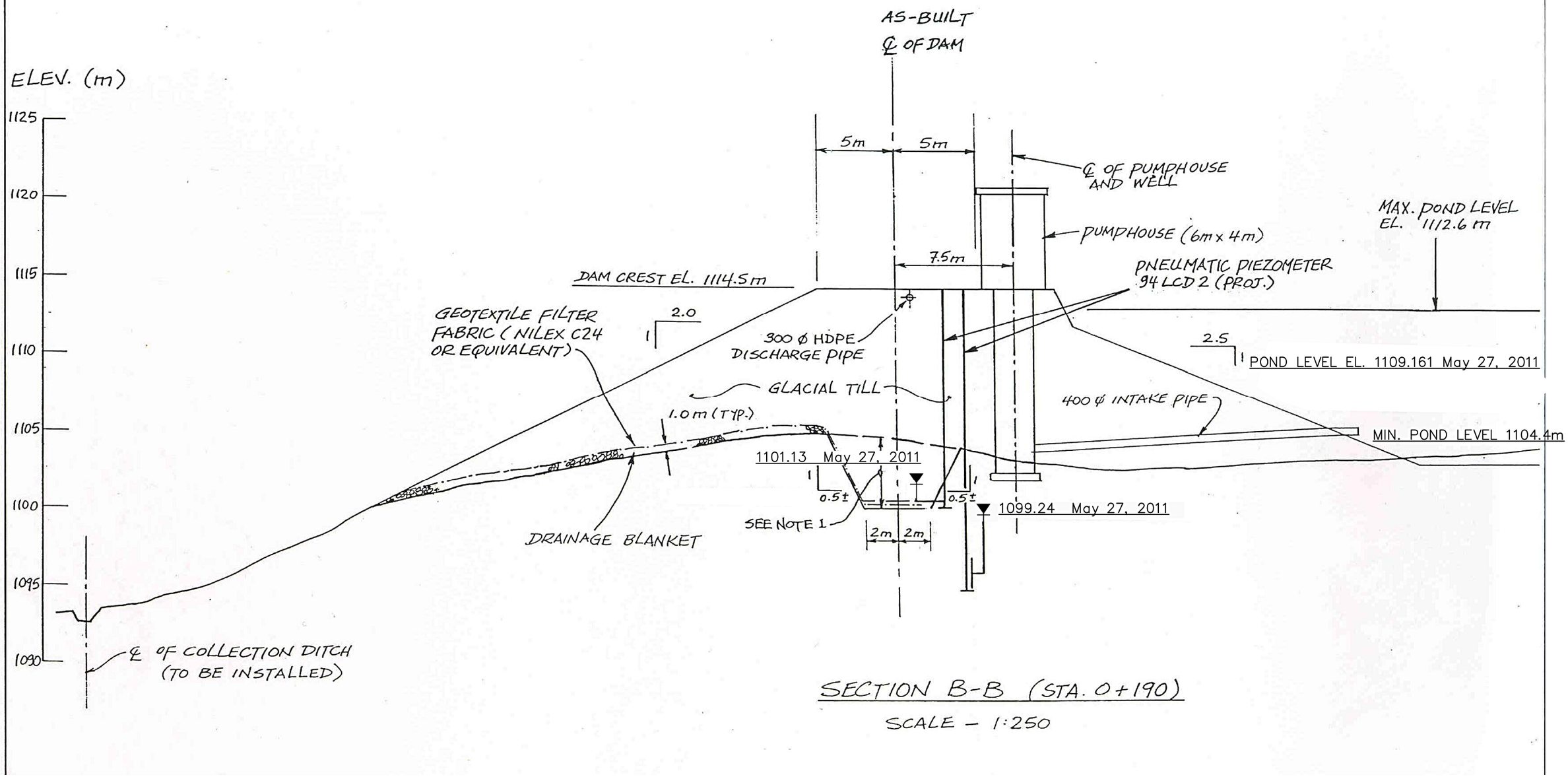
J:\01_SITES\FARO\22I0_1CD009.005 _Vangorda 2011 Geotech Inspection\C40_AutoCad\site_plan nad 83.dwg




GENERAL ARRANGEMENT PLAN
SCALE - 1:2000

Fig. 13 Original Source: Figure 10 - 2011 Geotechnical Inspection Waste and Water Management Facilities Vangorda/Grum

| | | |
|---|---|---|
| srk consulting | Denison Environmental Services | FIGURE 13 |
| SRK JOB NO.: 1CD009.005 | FARO MINE COMPLEX | 2011 Vangorda Geotechnical Inspection |
| FILE NAME: FIG-10.dwg | | LITTLE CREEK DAM GENERAL ARRANGEMENT PLAN |
| | | DATE: July 2011 / APPROVED: PMH / FIGURE: 10 |




SECTION B-B (STA. 0+190)

SCALE – 1:250

0 2 4 6 8 10 METRES

1:250

Fig. 14 Original Source: Figure 11 - 2011 Geotechnical Inspection Waste and Water Management Facilities Vangorda/Grum

J:\01_SITES\FARO\2210_1CD009.005 _Vangorda 2011 Geotech Inspection\340_AutoCad\FIG-11.dwg

| | | |
|---|---|---|
| srk consulting | Denison Environmental Services | FIGURE 14 |
| SRK JOB NO.: 1CD009.005 | | 2011 Vangorda Geotechnical Inspection |
| FILE NAME: FIG-11.dwg | FARO MINE COMPLEX | LITTLE CREEK DAM SECTION B-B |
| | | DATE: July 2011 / APPROVED: PMH / FIGURE: 11 |

# APPENDIX I

## 2016 Select Site Photographs

**Faro Pit**

Spring 2016

Fall 2016

**Photograph 1 Faro Pit from "eye-in-the-sky" (Looking at the North and East Walls). Similar conditions in spring and fall.**

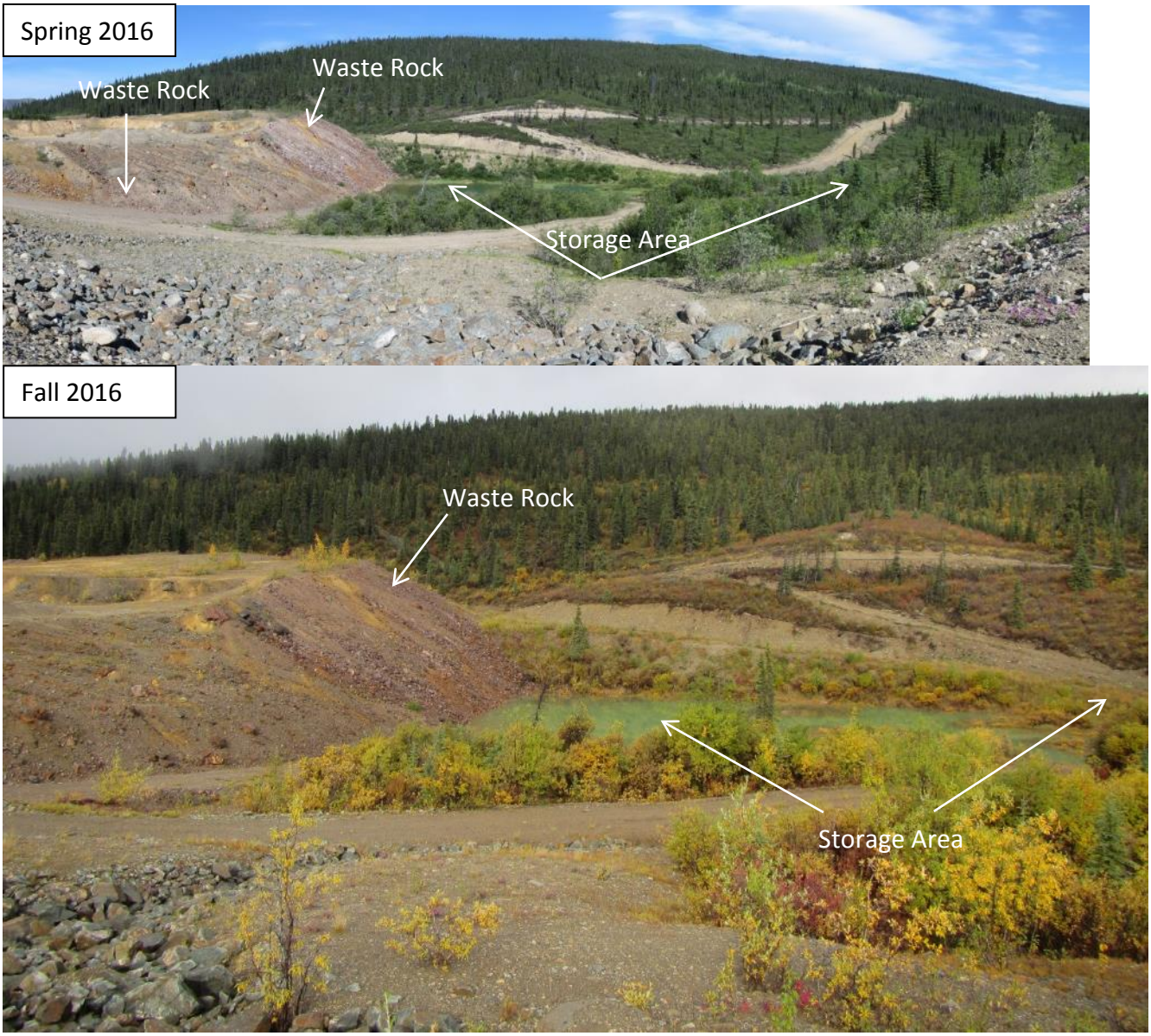
**Faro Pit**

Spring 2016

Fall 2016

**Photograph 2 Faro Pit Northwest Wall and West Wall (from the Faro Creek Diversion Channel). Similar conditions in spring and fall.**

**Faro Creek Diversion Channel**




**Photograph 3 Faro Creek Diversion Overflow (FCO) Sump (looking west)**

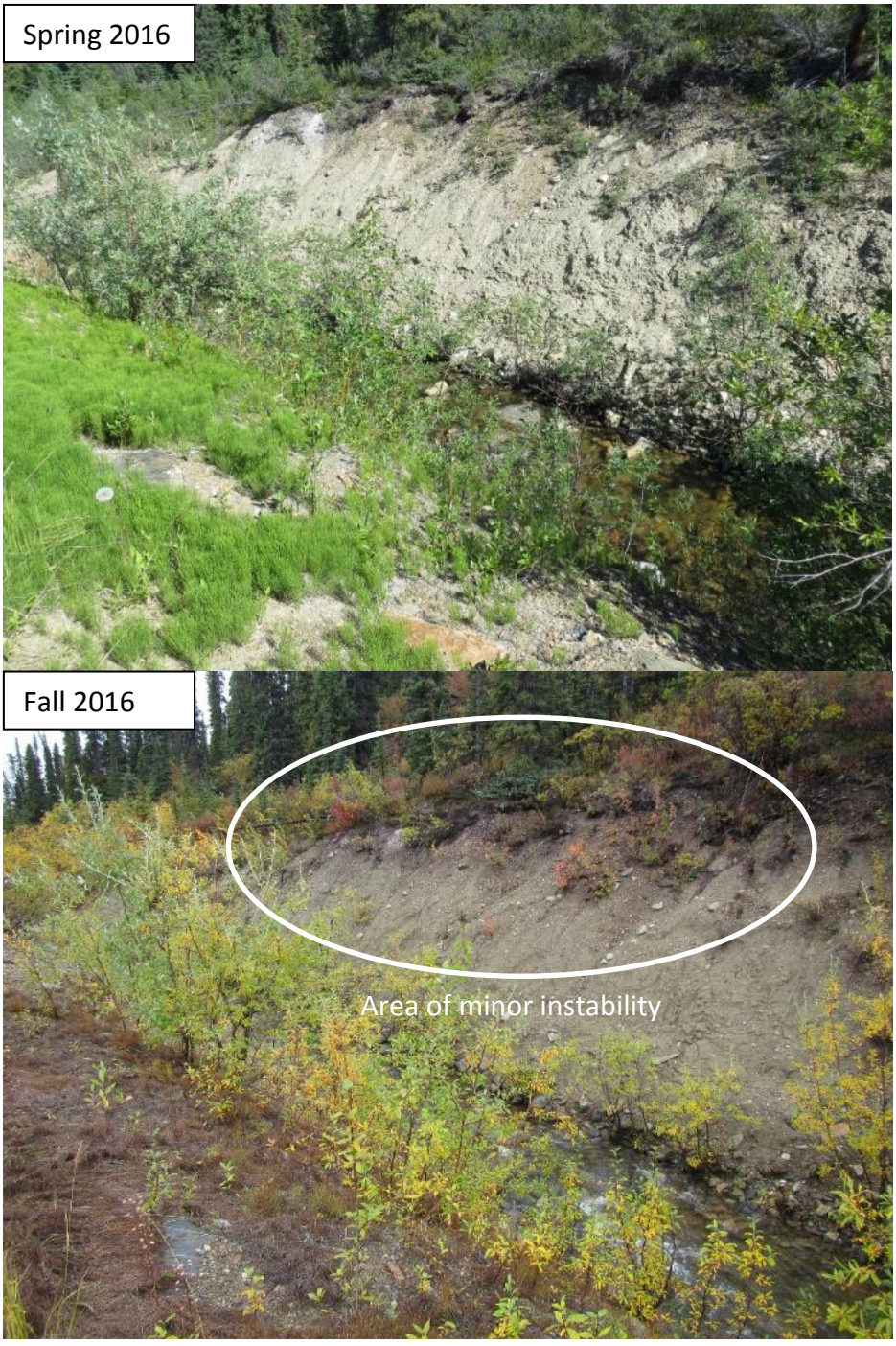
**Faro Creek Diversion Channel**

Spring 2016

Fall 2016

**Photograph 4 Upper Faro Creek Diversion. Satisfactory conditions.**

**Faro Creek Diversion Channel**




**Photograph 5** **Vegetation and Slumping on the Faro Creek Diversion Ditch (Upstream of the FCD-4 Stream Gauge Station)**

**North Valley Wall Interceptor Ditch**


**Photograph 6** **Interceptor Ditch upstream of upper man-made reach at new weir location. Evidence of overtopping on right abutment.**

**North Valley Wall Interceptor Ditch**

Spring 2016

Fall 2016

**Photograph 7** **Interceptor Ditch upper man-made reach - vegetation roots were removed in fall 2016. Erosion control measures should be implemented in spring 2017. Approximately 565 m from the diversion inlet.**

**North Valley Wall Interceptor Ditch**

Spring 2016

Fall 2016

**Photograph 8** **Interceptor Ditch (Faro Creek) upstream side of the well access road. Satisfactory conditions. Approximately 255 m from the diversion inlet.**

**North Valley Wall Interceptor Ditch**

Spring 2016

Fall 2016

**Photograph 9** **Middle reach of ditch – vegetation along ditch and dyke, vegetation to be cleared for capacity and visibility. Fall photo looking east. Similar conditions in spring and fall. Approximately 2000 m from the diversion inlet.**

**North Valley Wall Interceptor Ditch**

Spring 2016

Fall 2016

**Photograph 10 Slumping at the End of the Middle Reach. Similar conditions in spring and fall. Approximately 2150 m from the diversion inlet.**

**North Valley Wall Interceptor Ditch**

Spring 2016

Fall 2016

**Photograph 11** **Culvert between middle reach to lower reach of ditch – water treatment release pipeline. Direct discharge in fall. Approximately 2600 m from the diversion inlet.**

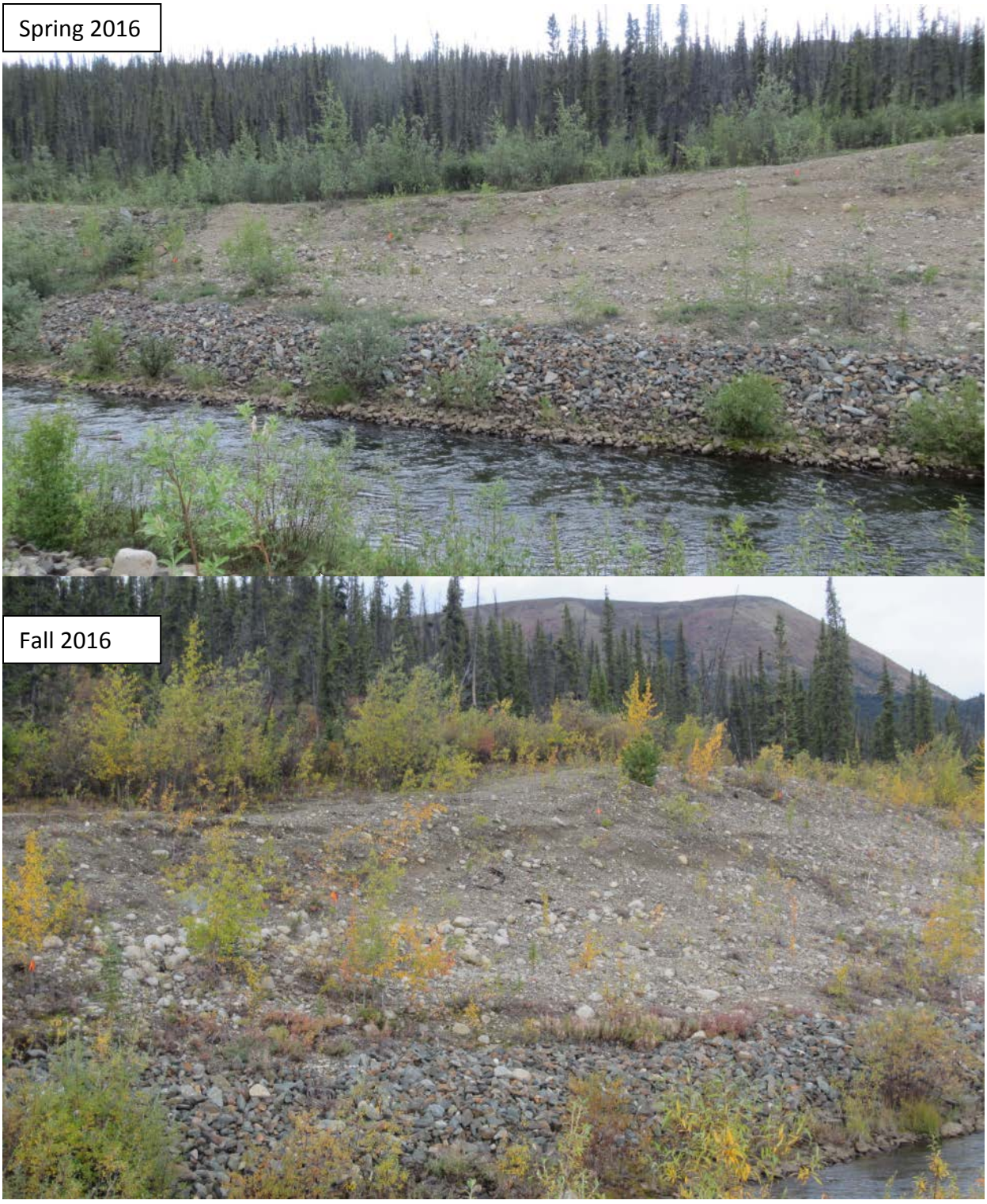
**Rose Creek Diversion Channel**

Spring 2016

Fall 2016

**Photograph 12 Rose Creek Diversion Channel near Secondary Tailings Dam, looking downstream. Similar conditions in spring and fall.**

**Rose Creek Diversion Channel**




**Photograph 13** **Rose Creek Diversion Channel back-slope slumping. Similar conditions in spring and fall.**

**Rose Creek Diversion Channel**

Spring 2016

Fall 2016

**Photograph 14 Rose Creek Diversion Channel flow gauge station downstream of Tailings Facility. Satisfactory conditions.**

**Rose Creek Diversion Channel**

Spring 2016

Fall 2016

**Photograph 15 Rose Creek Diversion Channel Back Slope Observation Location A.**

**Rose Creek Diversion Channel**

Spring 2016

Fall 2016

**Photograph 16** **Rose Creek Diversion Channel Back Slope Observation Location B. Conditions similar in spring and fall.**

**Rose Creek Diversion Channel**

Spring 2016


Fall 2016

**Photograph 17 Rose Creek Diversion Channel Proposed Back Slope Observation Location C. Conditions similar in spring and fall.**

**Rose Creek Diversion Channel**

Spring 2016

Fall 2016

**Photograph 18 Rose Creek Diversion Channel Proposed Back Slope Observation Location D. Conditions similar in spring and fall.**

**North Fork and K8 Rock Drains**

Spring 2016

Fall 2016

**Photograph 19 North Fork Rock Drain upstream pool at access road. Satisfactory condition.**

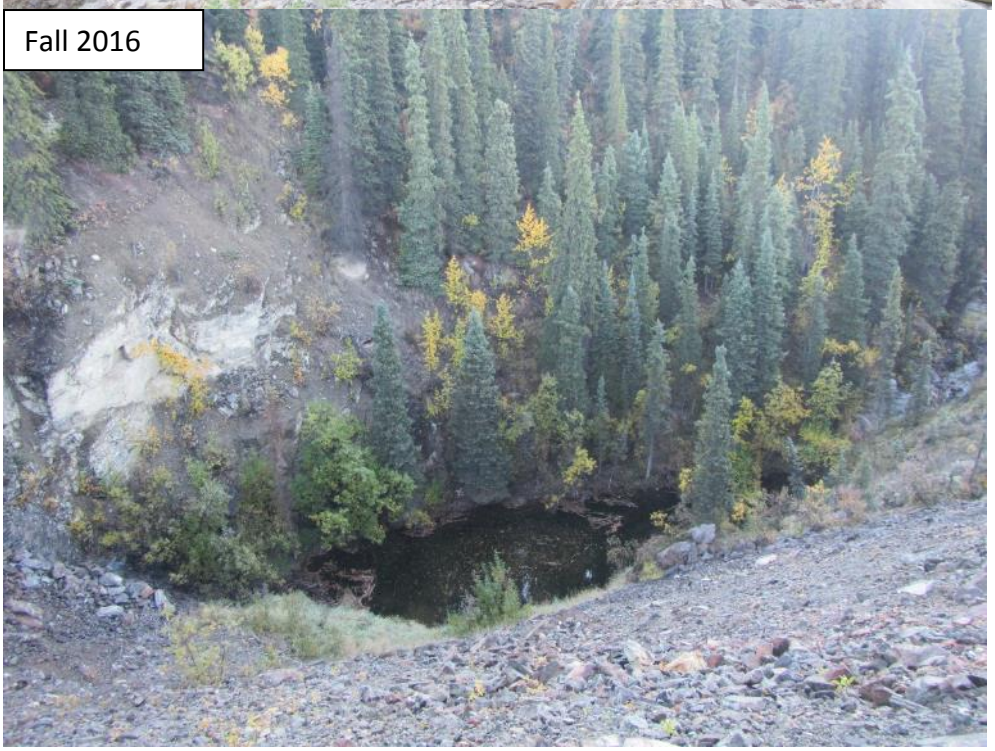
**North Fork and K8 Rock Drains**


**Photograph 20** **North Fork Rock Drain outlet, looking downstream. Satisfactory conditions. Possible location of new flow station shown.**

**North Fork and K8 Rock Drains**

Spring 2016

Fall 2016



**Photograph 21 K8 Rock Drain upstream pool. Satisfactory conditions.**

**North Fork and K8 Rock Drains**

Spring 2016

Fall 2016

**Photograph 22 K8 Rock Drain downstream outlet, looking down. Satisfactory conditions.**

**Secondary Tailings Dam**

Spring 2016

Fall 2016

**Photograph 23** **Secondary Tailings Dam upstream ditch looking south. Ditch appears deeper since spring.**

**Secondary Tailings Dam**

Spring 2016

Fall 2016

**Photograph 24** **Fuse plug of Canal Dyke, looking upstream. Vegetation on downstream slope of Secondary Tailings Dam should be removed.**

**Intermediate Dam**

Spring 2016

Fall 2016

**Photograph 25 Intermediate Dam from access road, looking south. Satisfactory conditions.**

**Intermediate Dam**

Spring 2016

Fall 2016

**Photograph 26** **Intermediate Dam crest and upstream slope, looking north. Satisfactory Conditions.**

**Intermediate Dam**


**Photograph 27 Repairs along downstream slope. Some surface erosion since spring.**

**Intermediate Dam**

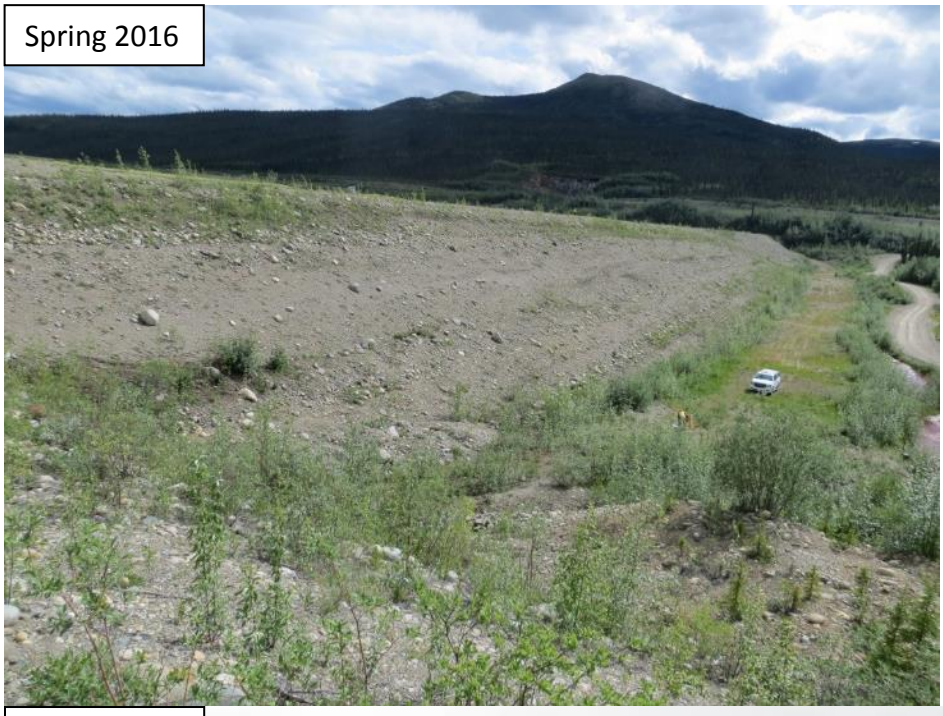
Spring 2016

Fall 2016

**Photograph 28 Spillway, looking downstream. Pipeline in the spillway was removed in Fall 2016.**

**Cross Valley Dam**

Spring 2016



Fall 2016

**Photograph 29** **Downstream slope of Cross Valley Dam looking south. Some minor rill erosion and vegetation on slope. Conditions are similar across the whole slope.**

**Cross Valley Dam**

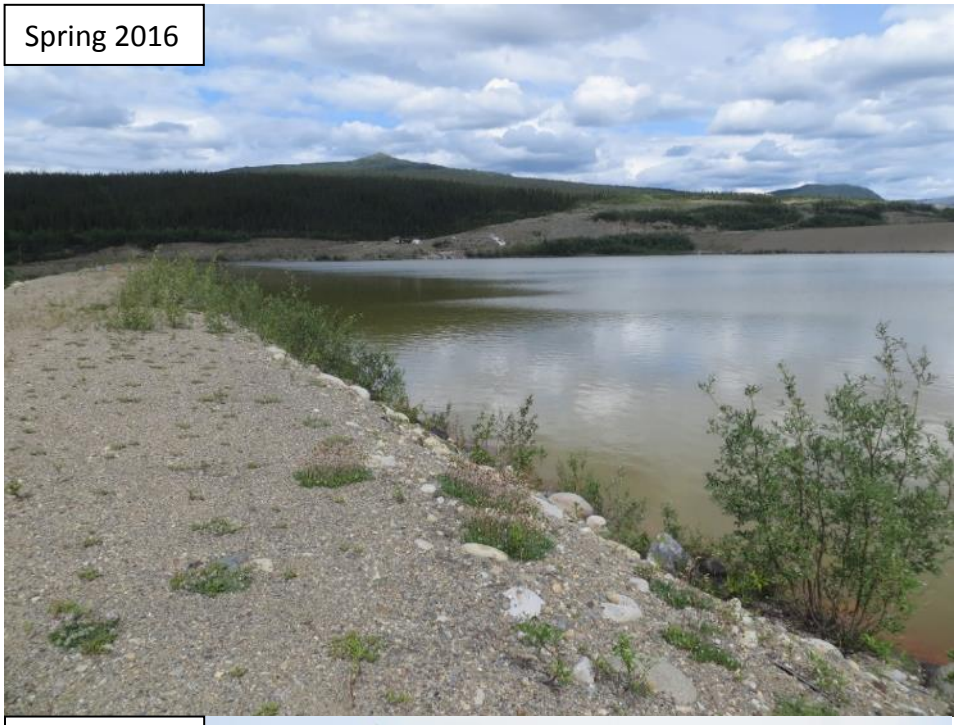
Spring 2016

Fall 2016

**Photograph 30** **Freeze-thaw longitudinal cracks closed along dam crest, looking south. Crack is closed (not visible in photo) in fall.**

**Cross Valley Dam**

Spring 2016



Fall 2016

**Photograph 31 Upstream slope (looking north), vegetation growth. Trees should be removed.**

**Cross Valley Dam**

Spring 2016

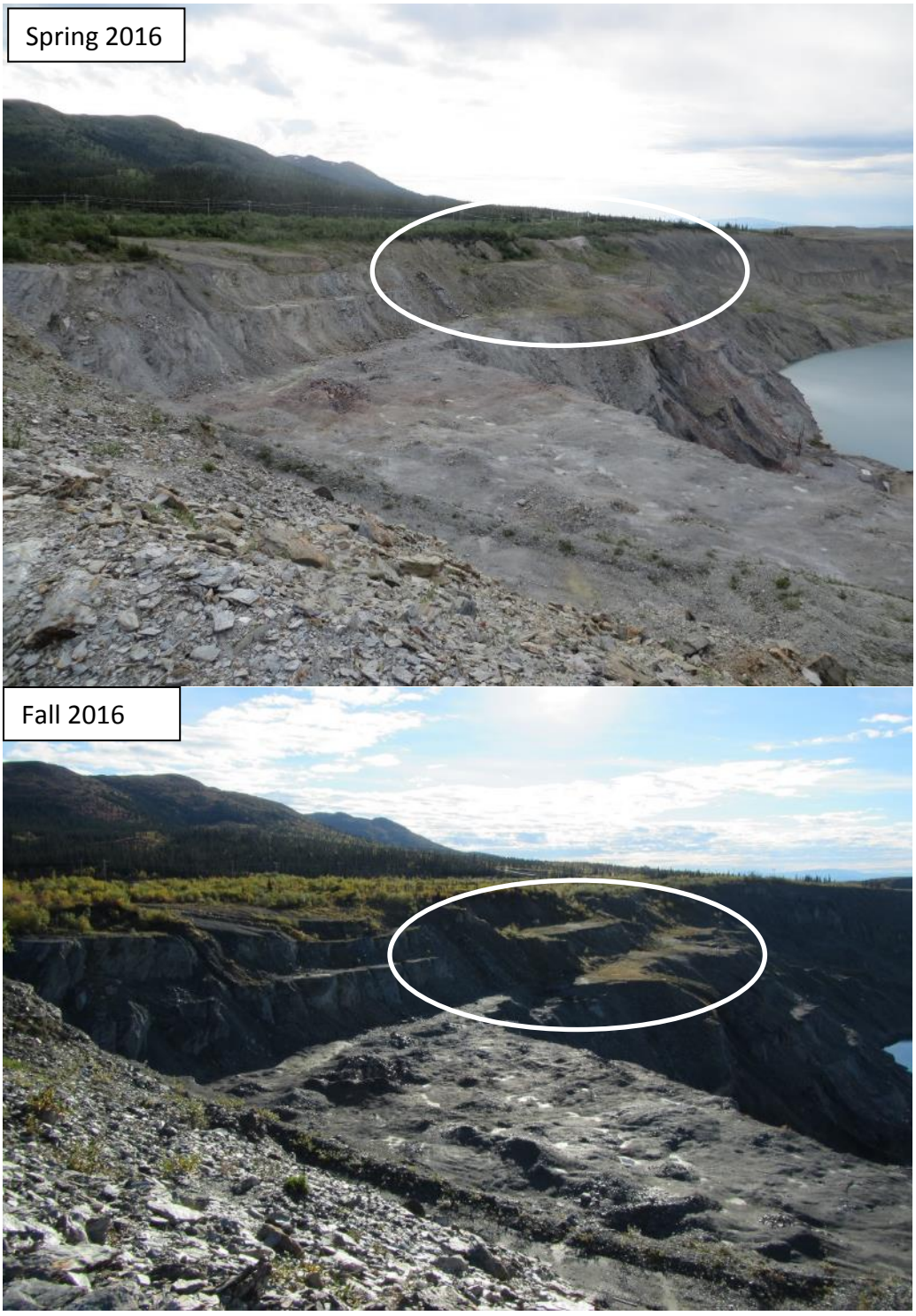
Fall 2016

**Photograph 32 Siphon pipelines in spillway, looking downstream**

**Grum Pit**

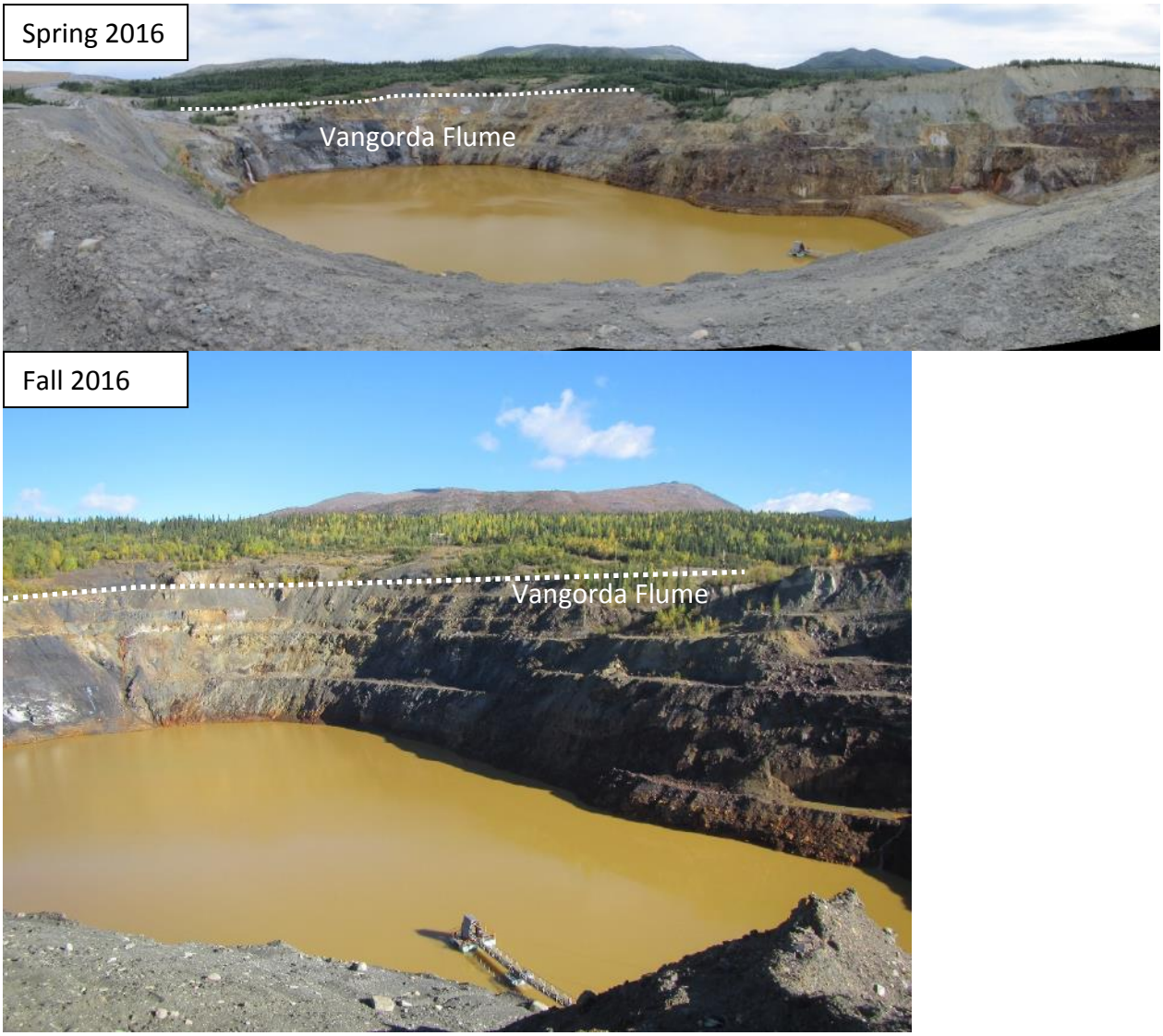

**Photograph 33 Grum Pit (looking south, southeast). Similar conditions in spring and fall.**

**Grum Pit**




**Photograph 34 East pit wall along instability zone. Similar conditions in spring and fall.**

**Vangorda Pit**




**Photograph 35 Northwest pit wall adjacent to Vangorda Diversion Flume**

**Vangorda Pit**

Fall 2016

**Photograph 36 Vangorda Diversion Sinkhole showing signs of settlement.**

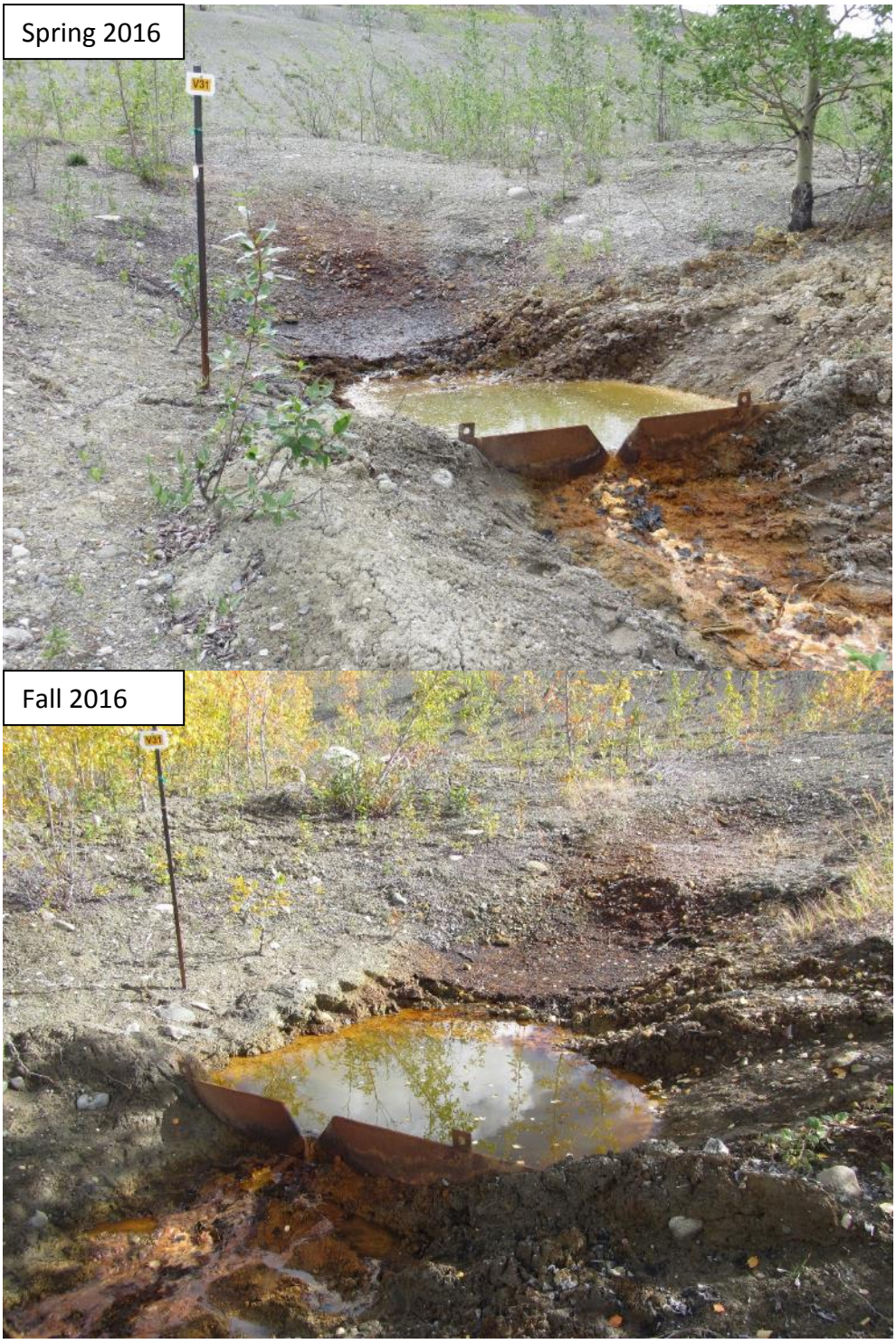
**Vangorda Rock Dump**

Spring 2016

Fall 2016

**Photograph 37 Drain No. 3 (V30). Satisfactory conditions.**

**Vangorda Rock Dump**




**Photograph 38 Drain No. 4 (V31). Satisfactory conditions.**

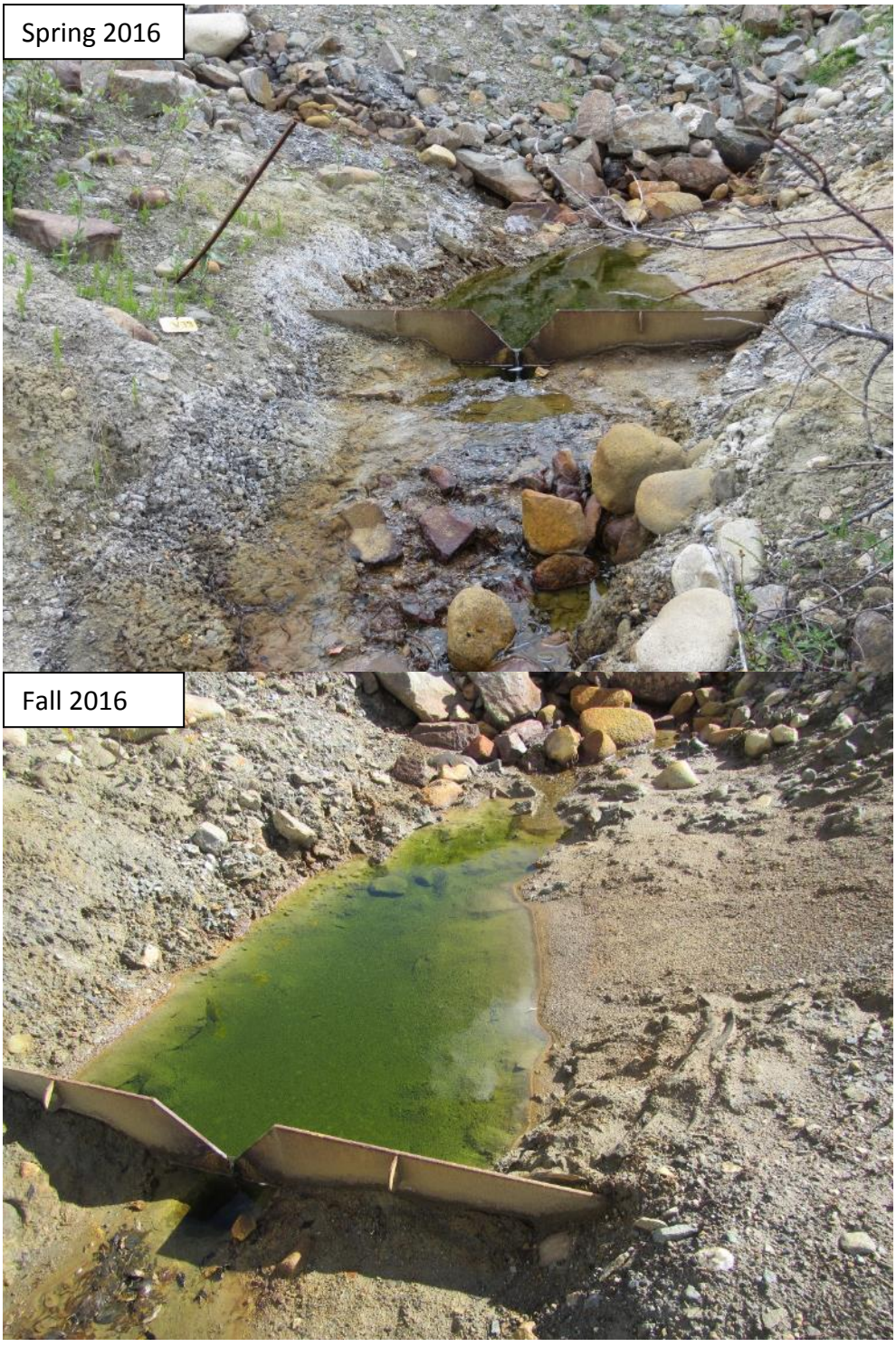
**Vangorda Rock Dump**

Spring 2016


Fall 2016


**Photograph 39** **Drain No. 5 (V32). Pooling downstream of weir. Pond should be cleaned out so it doesn't backwater the weir.**

**Vangorda Rock Dump**




**Photograph 40 Drain No. 6 (V33). Satisfactory conditions.**

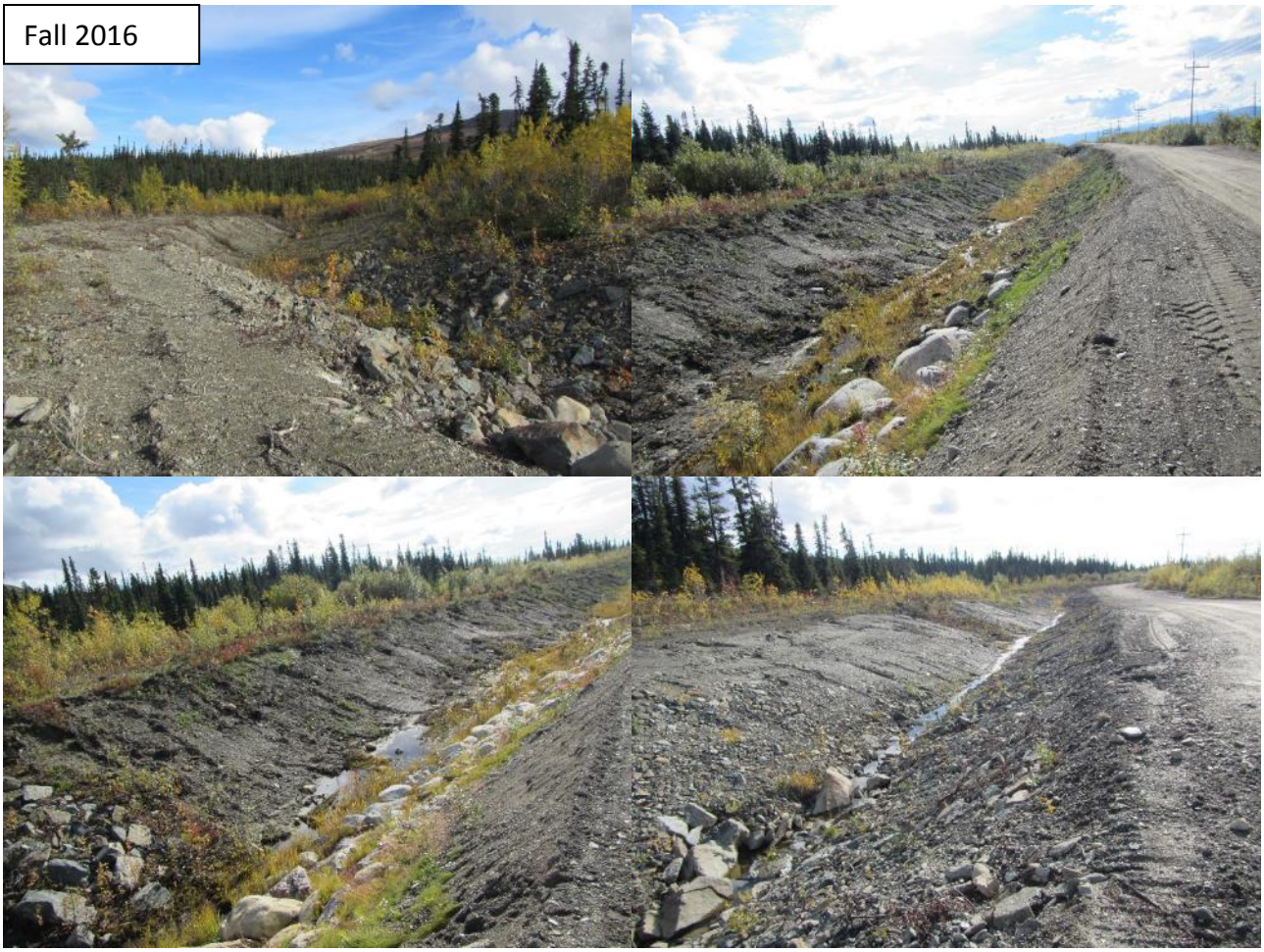
**Grum Pit Interceptor Ditch**

Spring 2016

Fall 2016

**Photograph 41 Wes' Pond. Satisfactory conditions.**

**Grum Pit Interceptor Ditch**




**Photograph 42** **Vegetation clearing in the upper reach of Interceptor Ditch (Fall 2016). Slopes are susceptible to erosion.**

**Grum Pit Interceptor Ditch**

Spring 2016

Fall 2016

**Photograph 43 Vegetation in the diversion**

**North East Interceptor Ditch**


**Photograph 44 Slumping on road slope. Progressed slightly since spring.**

**North East Interceptor Ditch**

Spring 2016

Fall 2016

**Photograph 45 Slumping of side slopes. Similar conditions in spring and fall.**

**Vangorda Creek Diversion Flume**

Spring 2016

Fall 2016

**Photograph 46** **Flume emergency spillway culvert entrance area (only one culvert shown). Sediment in culvert.**

**Vangorda Creek Diversion Flume**

Spring 2016

Fall 2016

**Photograph 47 Vangorda Flume intake culvert upstream trashrack. Satisfactory conditions.**

**Vangorda Creek Diversion Flume**

Spring 2016

Fall 2016

**Photograph 48 Damaged flume and bent bracing rods**

**Vangorda Creek Diversion Flume**

Spring 2016

Fall 2016

**Photograph 49 Weight added to flume for anchoring**

**Vangorda Creek Diversion Flume**

Spring 2016

Fall 2016

**Photograph 50 Damaged flume, flat slope, and constricted channel**

**Vangorda Creek Diversion Flume**

Spring 2016

Fall 2016

**Photograph 51 Flat slope section, overtops during high flow**

**Vangorda Creek Diversion Flume**

Spring 2016

Fall 2016

**Photograph 52** **Outlet to Flume Plunge Pool - trash rack. Leaves and woody debris accumulate on the trash rack and need to be removed as part of regular maintenance.**

**Little Creek Dam**

Spring 2016

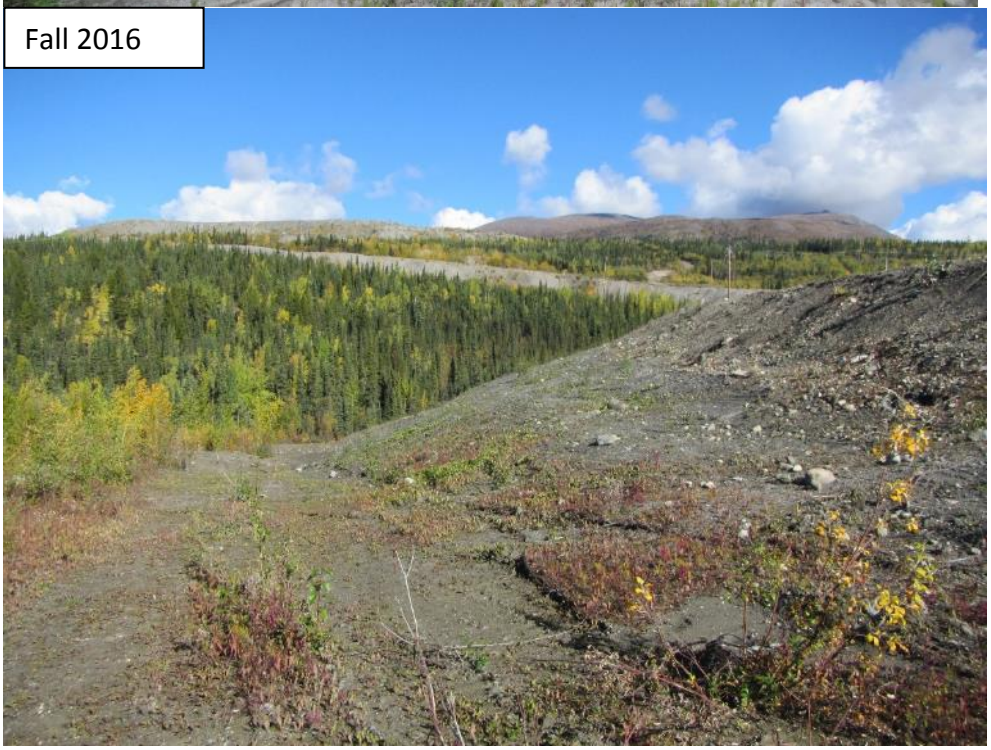
Fall 2016

**Photograph 53 Little Creek Dam from the access road (looking west). Satisfactory conditions.**

**Little Creek Dam**

Spring 2016

Fall 2016



**Photograph 54 Little Creek Dam downstream slope after vegetation removal (on left abutment, looking north).**

**Little Creek Dam**

Spring 2016 – looking north

Fall 2016 – looking south

**Photograph 55** **Little Creek Dam downstream toe. Vegetation has been removed since spring. Slope is subject to erosion and should be repaired and stabilized.**

**Little Creek Dam**


**Photograph 56 Little Creek Dam upstream slope, repaired rill erosion. Minor vegetation.**

**Little Creek Dam**

Spring 2016

Fall 2016

**Photograph 57** **Rill erosion on downstream berm slopes. To be graded in the fall and revegetated in the spring.**

**Little Creek Dam**

Spring 2016

Fall 2016

**Photograph 58** **Ground slope crack across downstream spillway channel near discharge end. Similar conditions in spring and fall.**

**Sheep Pad Sediment Ponds**


**Photograph 59 Upper end of spillway from the Upper to Lower Sediment Pond. Boulders impeding flow.**

**Sheep Pad Sediment Ponds**

Spring 2016

Fall 2016


**Photograph 60 Outflow of Sediment Pond upstream of Plunge Pool. Satisfactory conditions.**

**Freshwater Pond**

Spring 2016

Fall 2016

**Photograph 61** **Pond spillway channel, looking downstream towards Grum Interceptor Ditch. Trees on embankment and in spillway should be removed.**

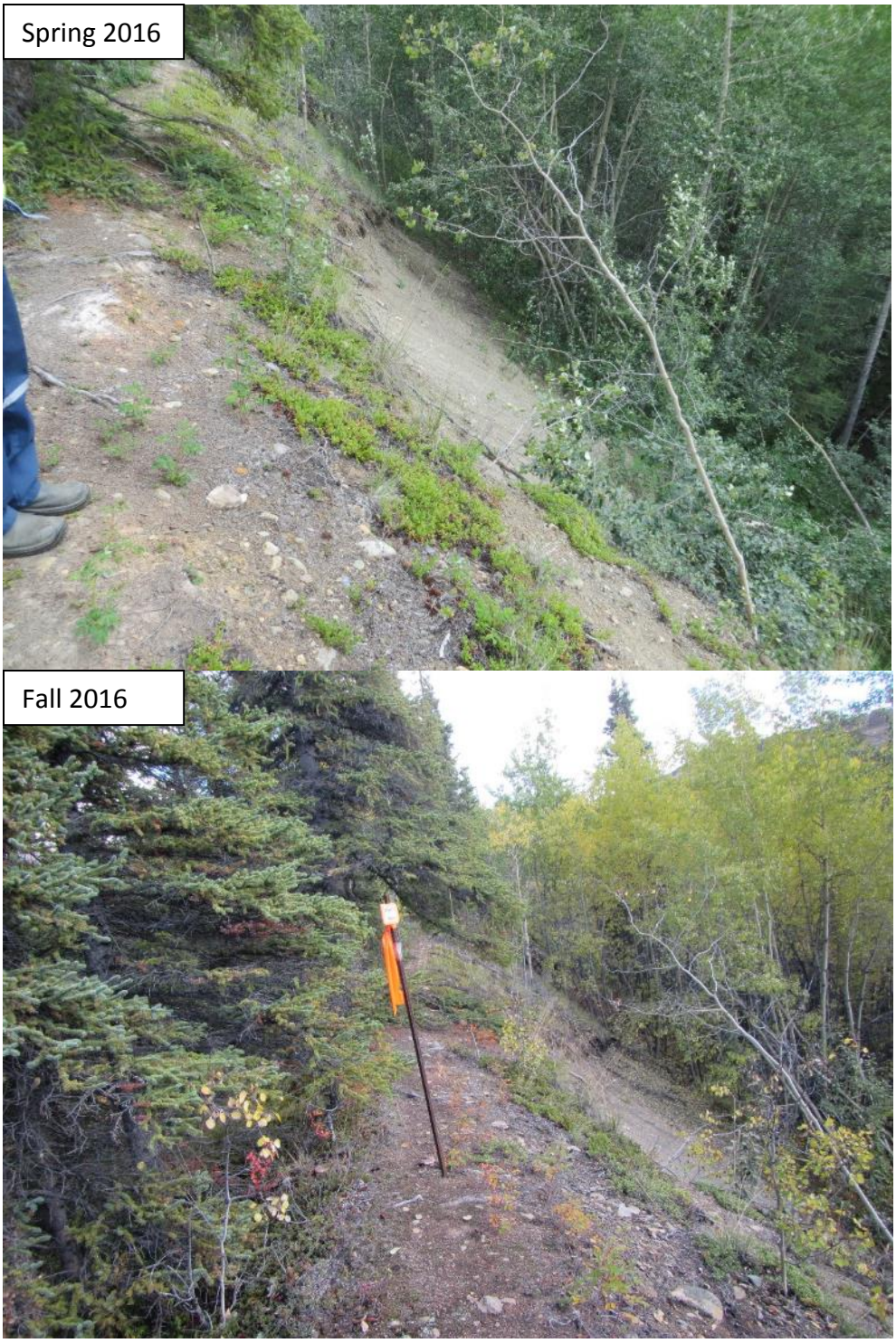
**V-15 Seepage Collection Ditch and Moose Pond**


**Photograph 62 Sand bags and bentonite are blocking most of the seepage to Moose Pond.**

**V-15 Seepage Collection Ditch and Moose Pond**

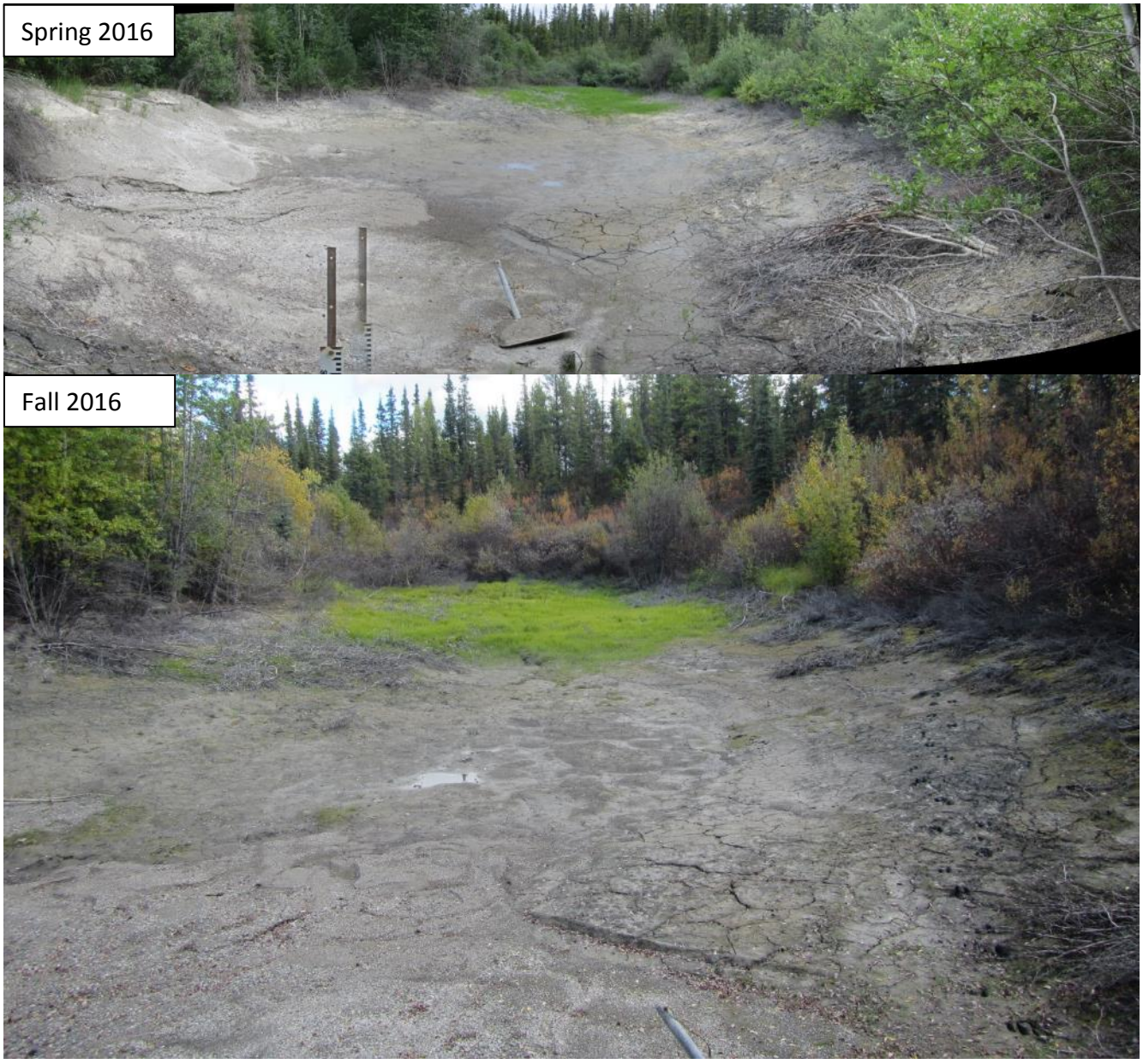

**Photograph 63 V-15 ditch and pumps, water pumped out before reaching Moose Pond**

**V-15 Seepage Collection Ditch and Moose Pond**




**Photograph 64 Moose Pond Esker downstream slope. Similar conditions in spring and fall.**

**V-15 Seepage Collection Ditch and Moose Pond**

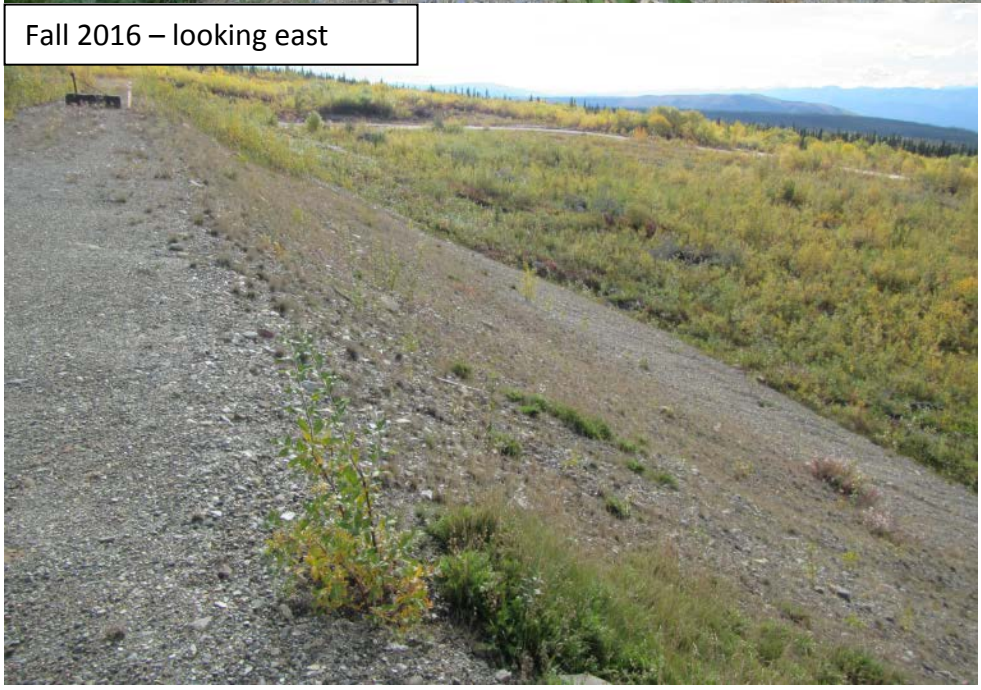



**Photograph 65 Moose Pond. Satisfactory conditions.**

**Vangorda Water Treatment Plant Clarification Pond**

Spring 2016 – Looking west

Fall 2016 – looking east



**Photograph 66 Clarification pond, dyke crest and downstream slope. Some trees to be removed.**

**Vangorda Water Treatment Plant Clarification Pond**

Spring 2016

Fall 2016

**Photograph 67 Clarification pond upstream slope (looking west)**

**Vangorda Water Treatment Plant Clarification Pond**


**Photograph 68 Clarification pond, longitudinal freeze-thaw cracks. Not as evident in the fall.**

# APPENDIX II

## Instrumentation Plots and Data

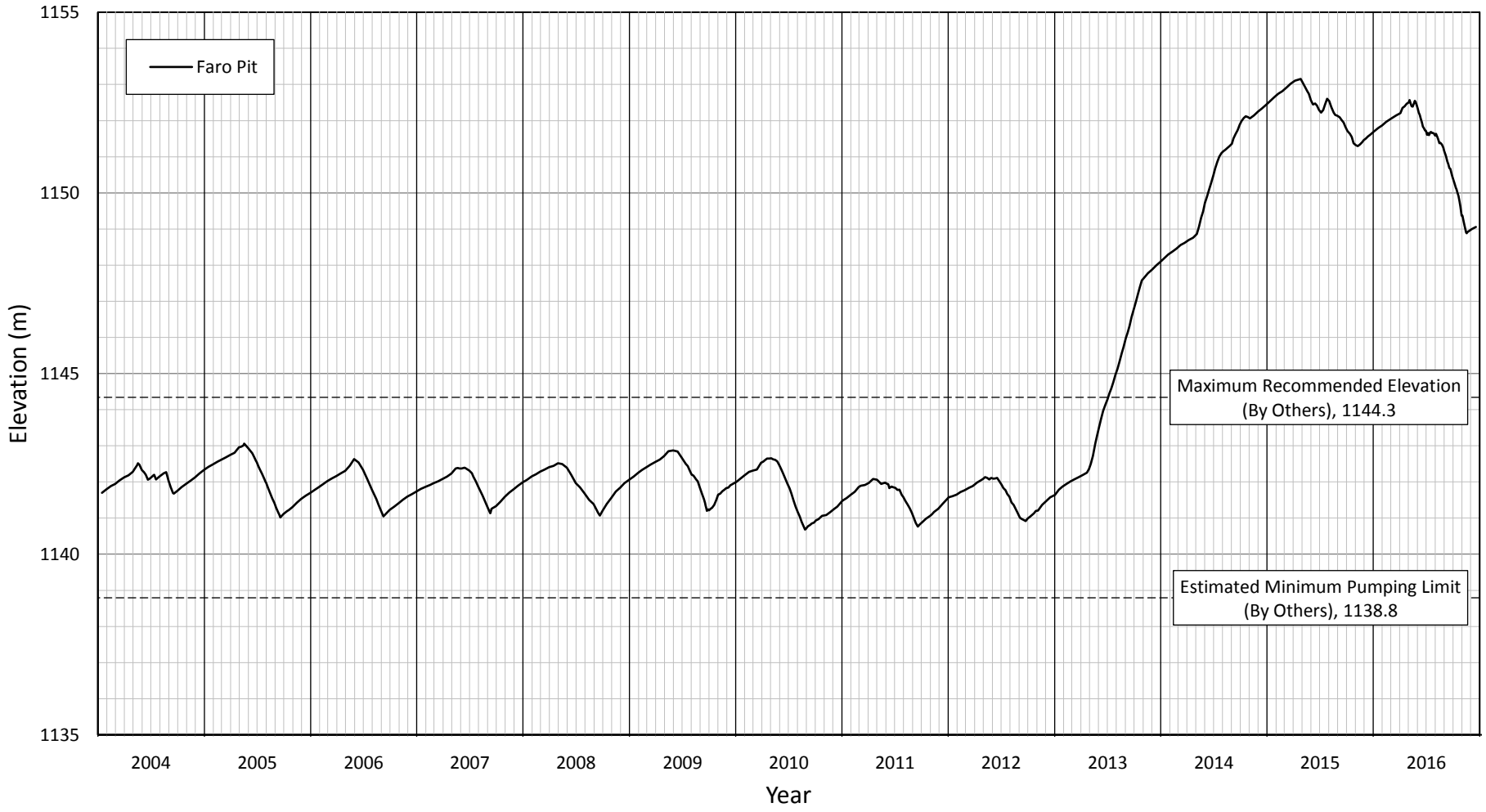
## Instrumentation Plots and Data

| Site | Appendix: Structure | Data | Section |
|---|---|---|---|
| Faro | II-A: Faro Pit | Pond Level | A1 |
| | II-B: Faro Creek Diversion Channel | Staff Gauge Calibrations | B1 |
| | | Staff Gauge Flows | B2 |
| | II-C: North Wall Interceptor Ditch | Staff Gauge Flows | C1 |
| | II-D: Rose Creek Diversion Channel | Staff Gauge Calibrations | D1 |
| | | Staff Gauge Flows | D2 |
| | II-E: Canal Dyke | Piezometers | E1 |
| | | Thermistors | E2 |
| | | Inclinometers | E3 |
| | II-F: North Fork Rock Drain | Water Level and Downstream Flow | F1 |
| | II-G: Secondary Dam | Piezometers | G1 |
| | II-H: Intermediate Dam | Pond Level | H1 |
| | | Piezometers | H2 |
| | II-I: Cross Valley Dam | Pond Level | I1 |
| | | Piezometers | I2 |
| | | Thermistors | I3 |
| | | Downstream Weir Flows | I4 |
| Vangorda Plateau | II-J: Grum Pit | Pond Level | J1 |
| | | Slot Cut Piezometers | J2 |
| | II-K: Vangorda Pit | Pond Level | K1 |
| | II-L: Vangorda Waste Rock Dump | Weir Flows | L1 |
| | | Piezometers | L2 |
| | II-M: Little Creek Dam | Pond Level | M1 |
| | | Piezometers | M2 |
| | | Thermistors | M3 |
| | II-N: Moose Pond | Pond Level | N1 |
| Faro Airport | II-O: Faro Airport Climate | Monthly Precipitation/Temperature | O1 |

# APPENDIX II-A

## Faro Pit

A1 - Pond Level




Notes:
1. Pit bottom is approximately El. 1050 m.



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TITLE: FARO PIT
WATER LEVEL

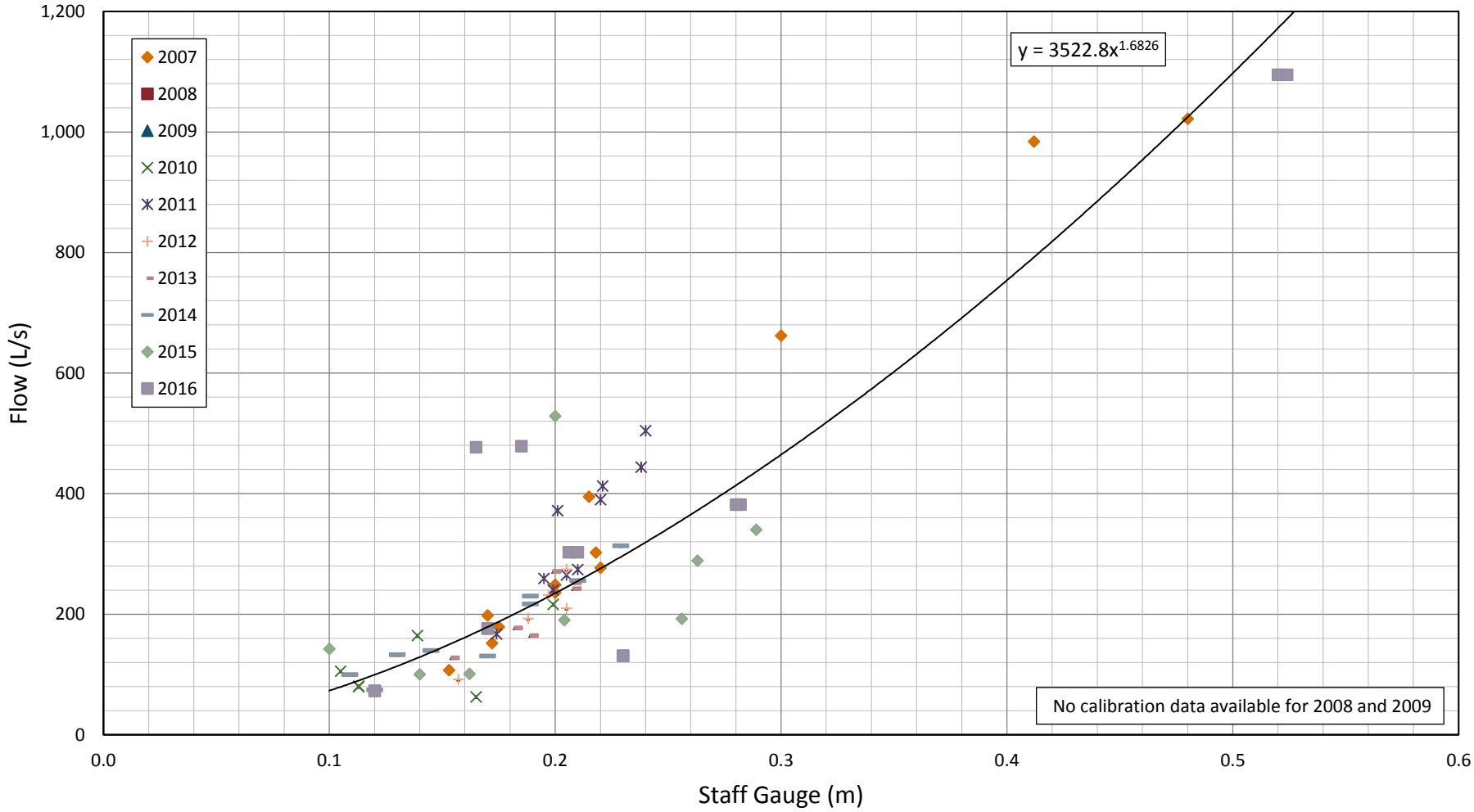
PROJECT No. M09770A06

FIG No. II-A1-1

# APPENDIX II-B

## Faro Creek Diversion Channel

B1 – Staff Gauge Calibrations
B2 – Staff Gauge Flows



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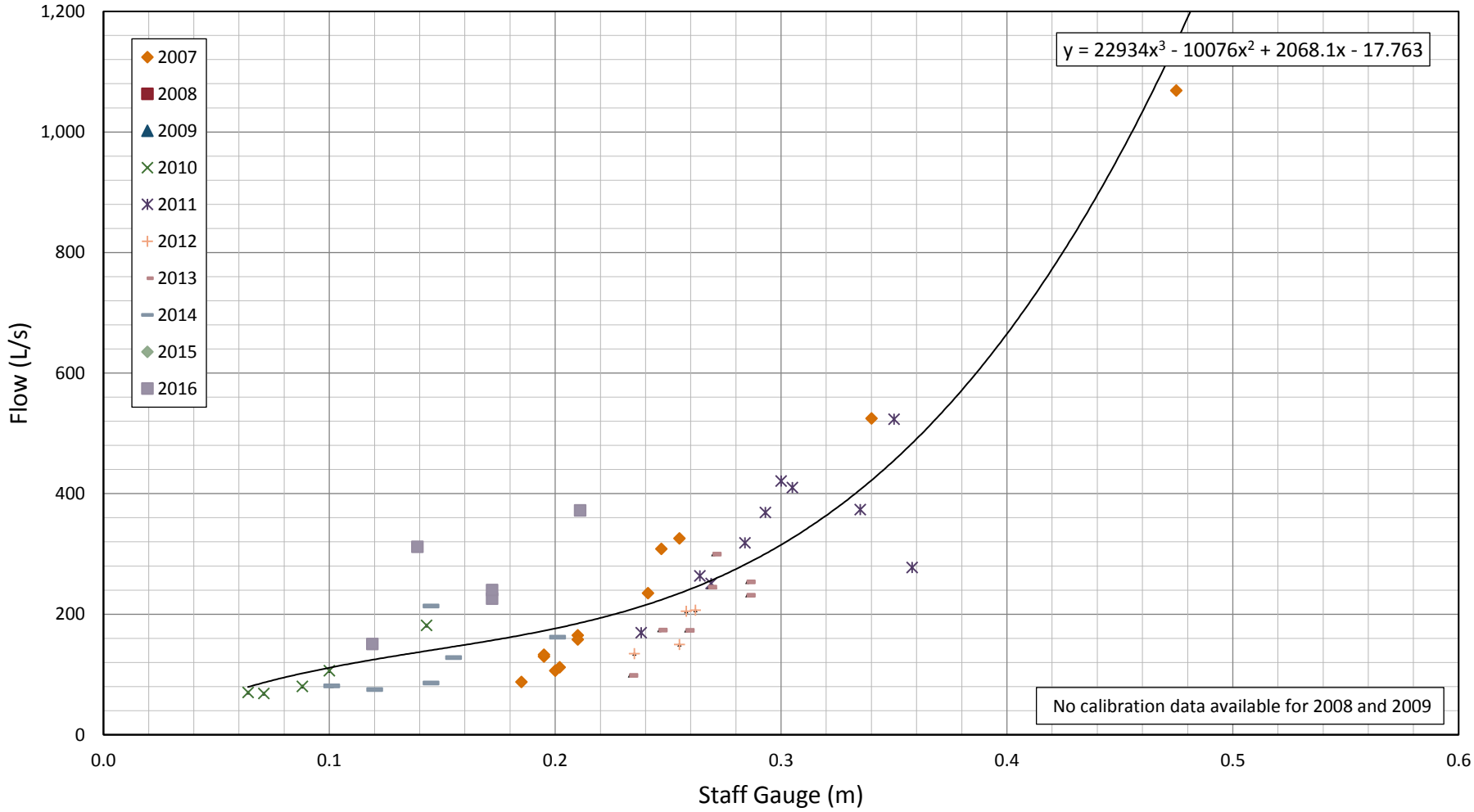
TITLE: FARO CREEK DIVERSION CHANNEL
FCD-1
RATING CURVE

PROJECT No. M09770A06

FIG No. II-B1-1



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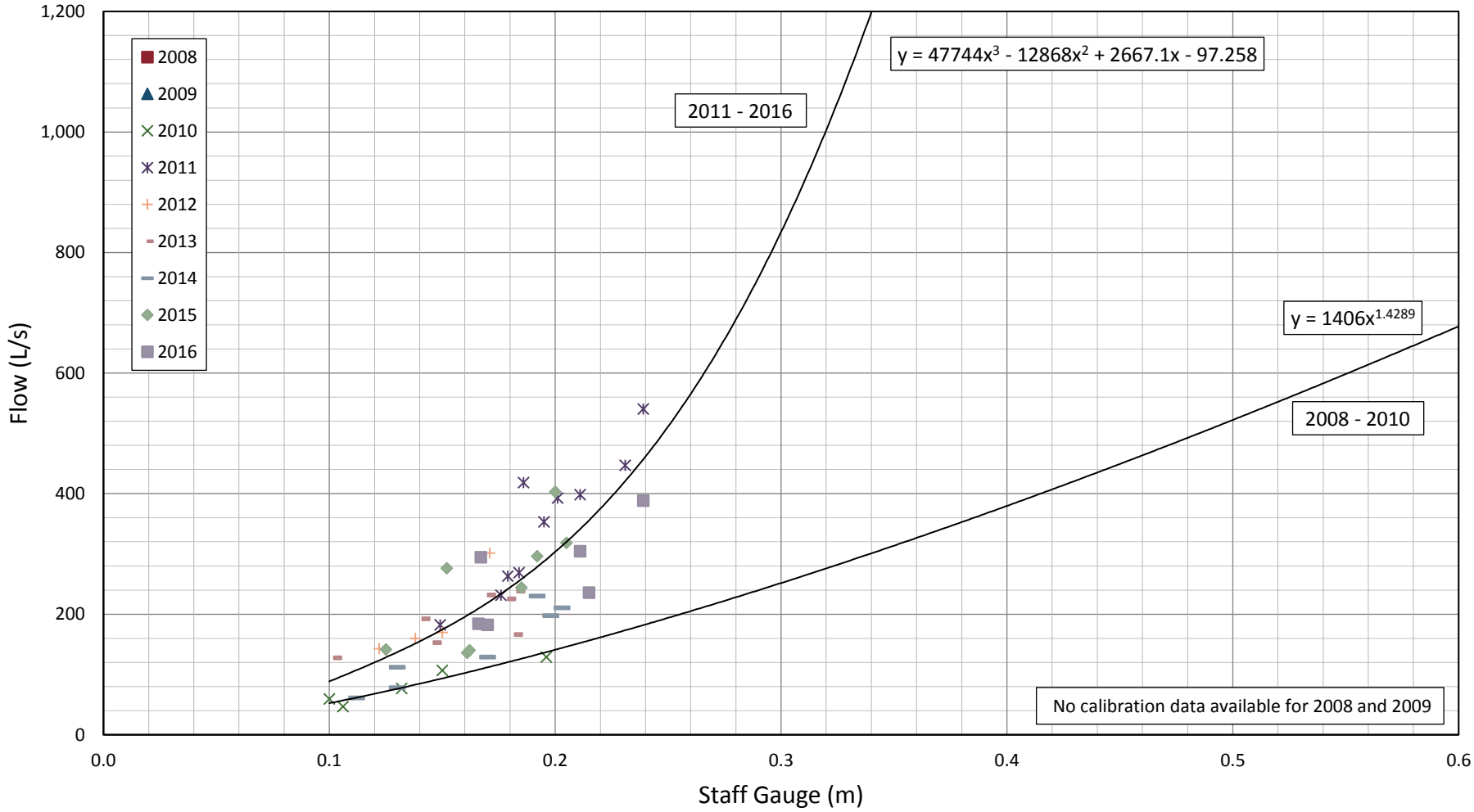
FCD-2
RATING CURVE

PROJECT No.: M09770A06

FIG No.: II-B1-2



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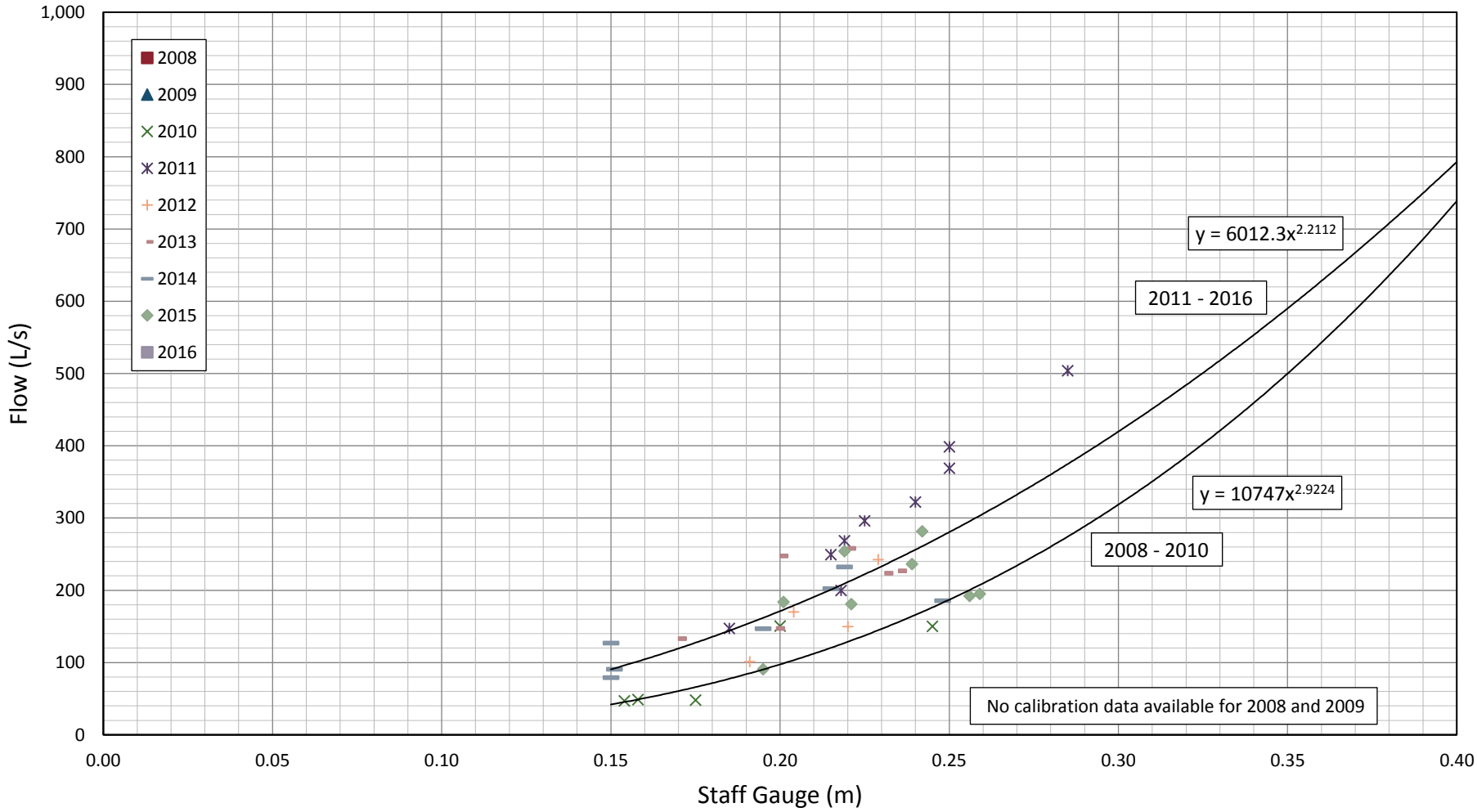
FARO CREEK DIVERSION CHANNEL
FCD-3
RATING CURVE

| PROJECT No. | FIG No. |
|---|---|
| M09770A06 | II-B1-3 |



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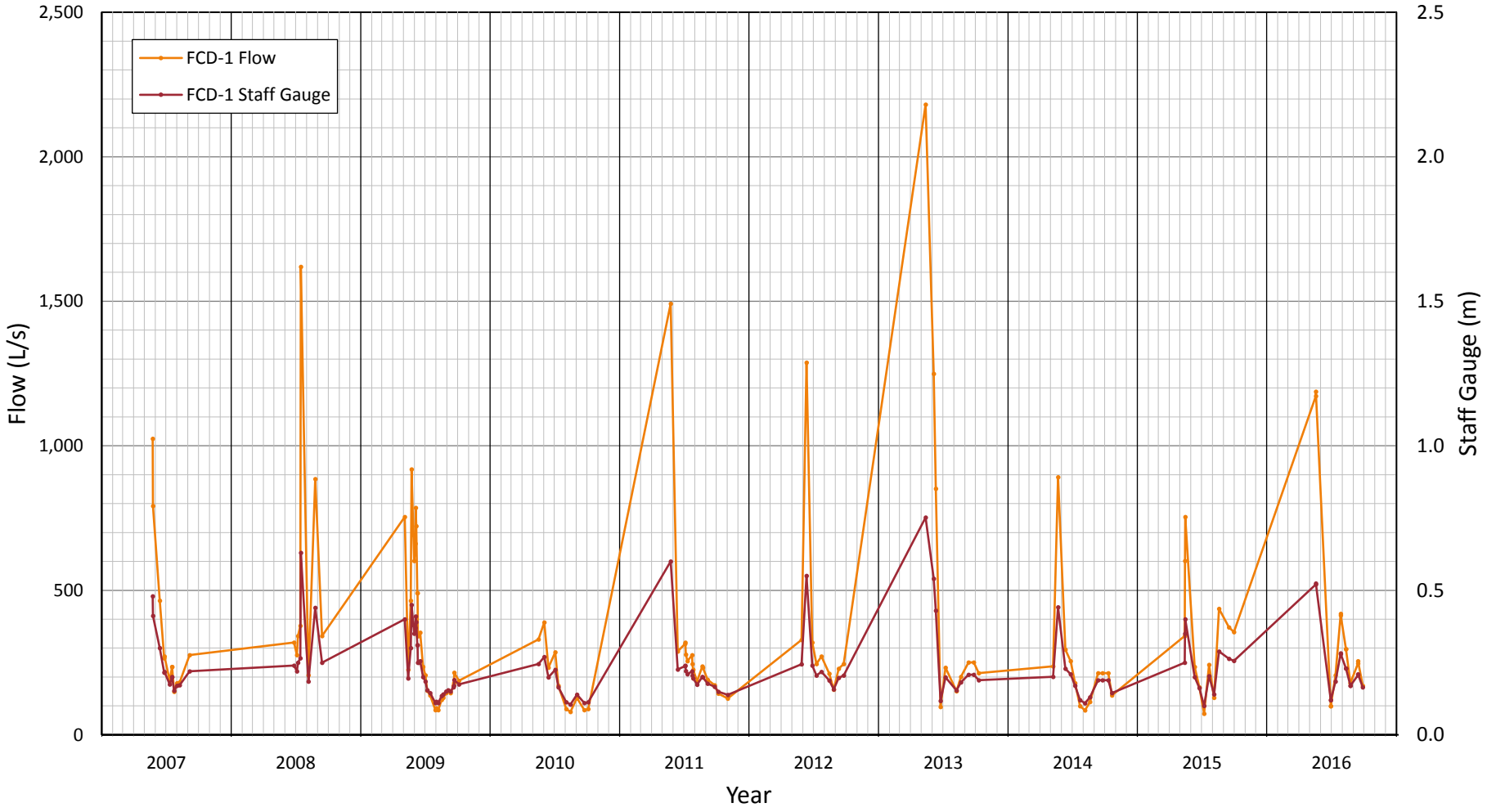
TITLE: FARO CREEK DIVERSION CHANNEL
FCD-4
RATING CURVE

PROJECT No.: M09770A06

FIG No.: II-B1-4



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FCD-1
CALCULATED DISCHARGE

PROJECT No. M09770A06

FIG No. II-B2-1

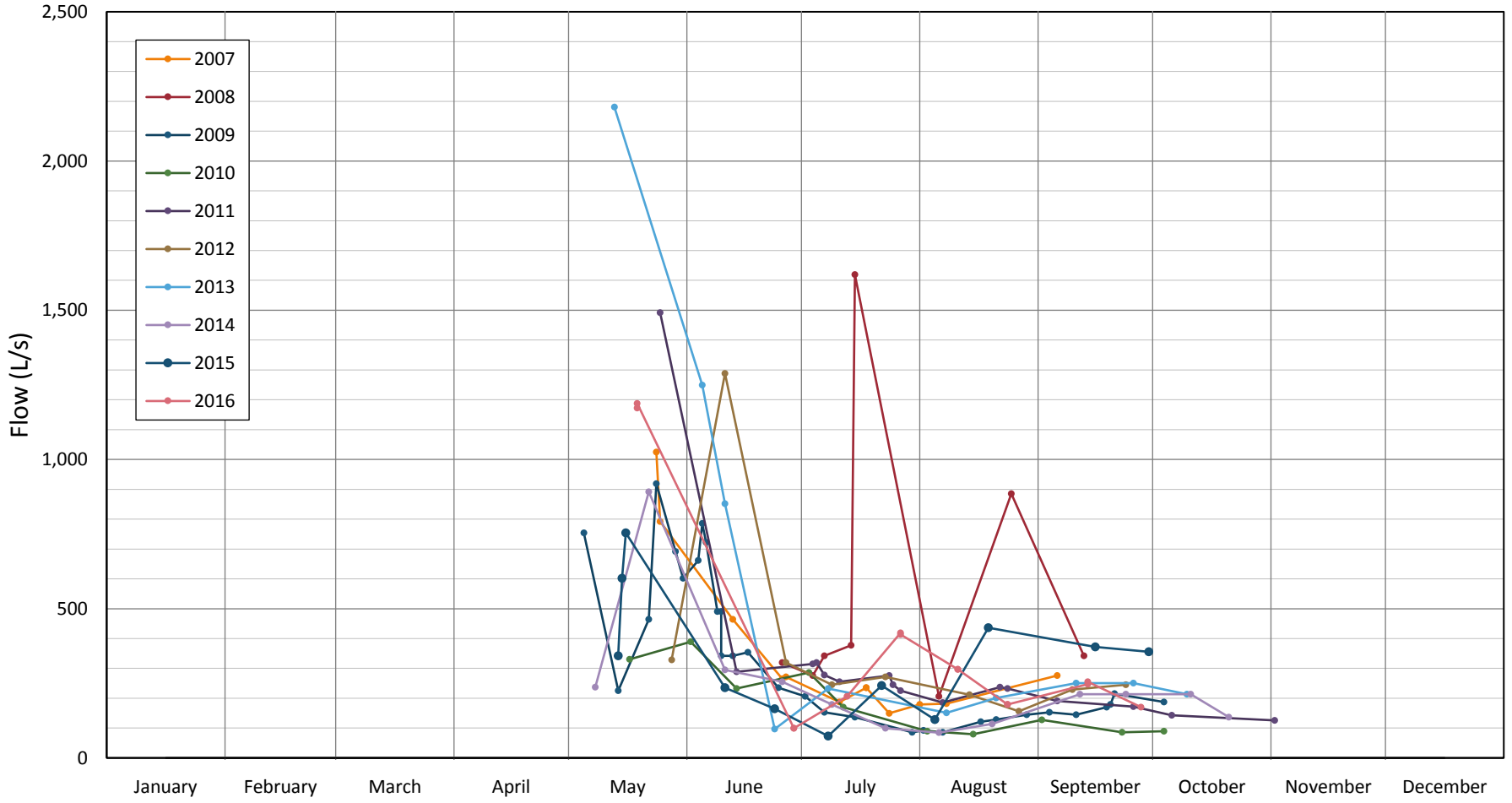




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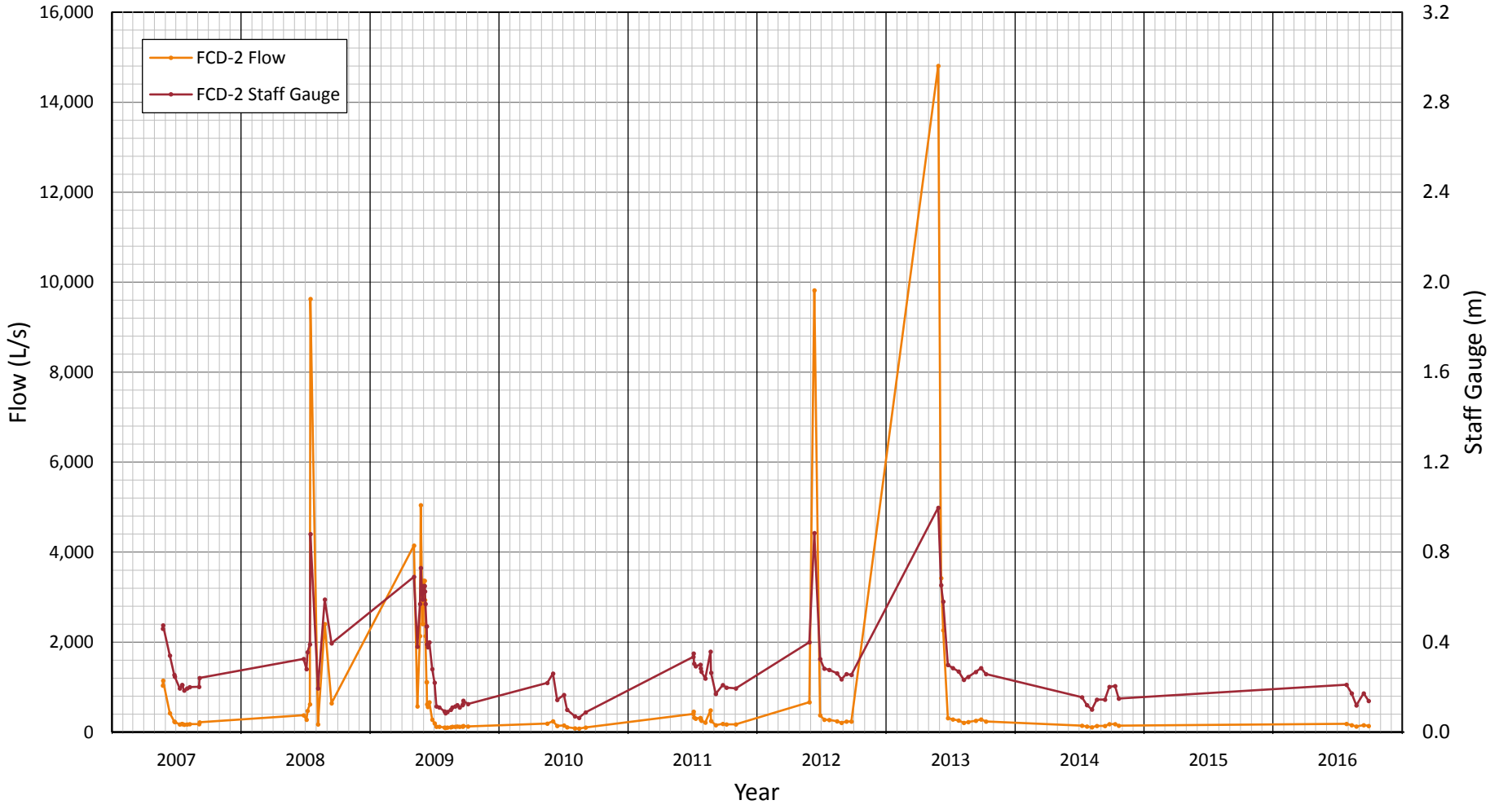
FIG No. II-B2-2



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FCD-2
CALCULATED DISCHARGE

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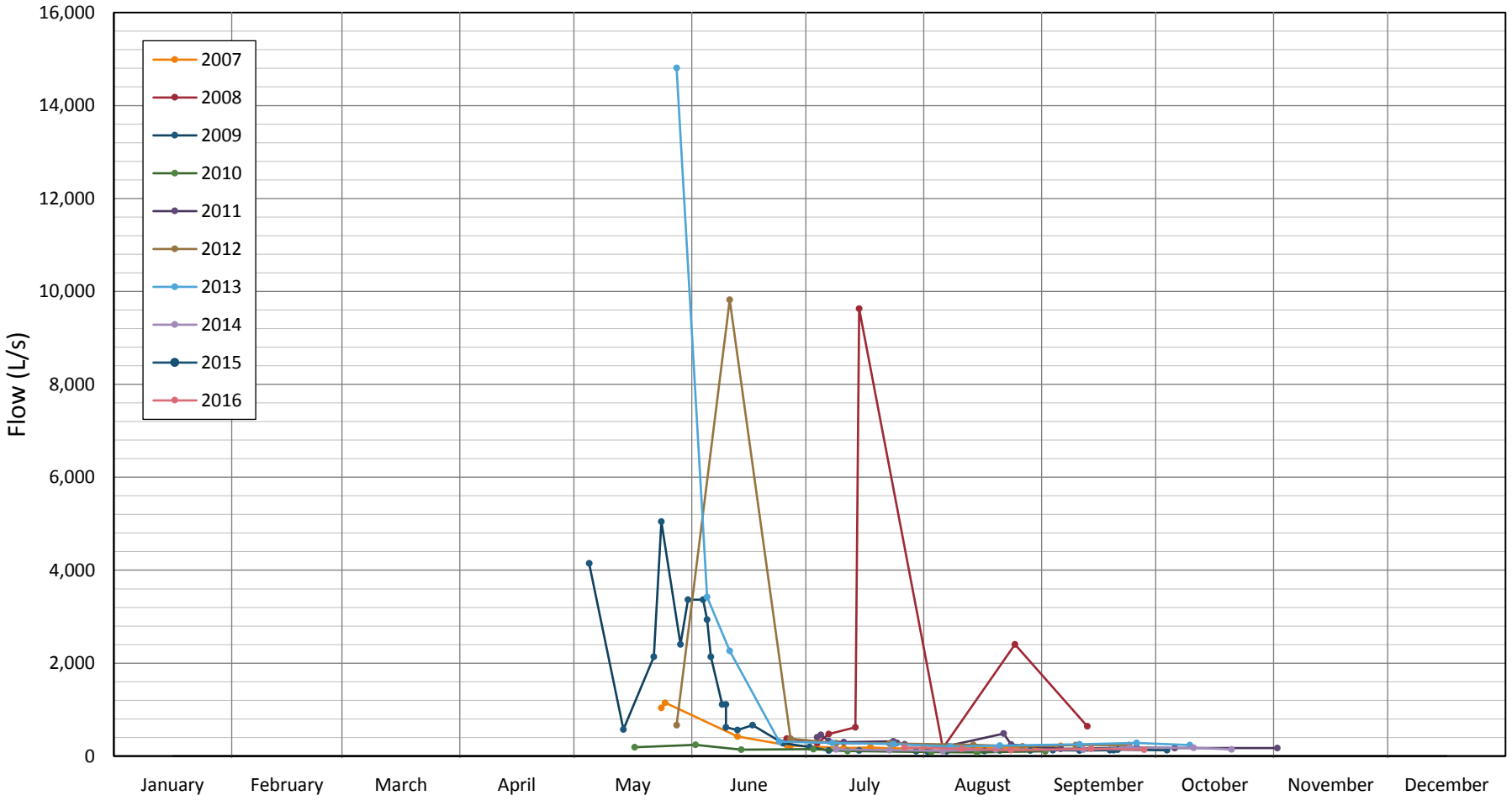
FIG No. II-B2-3

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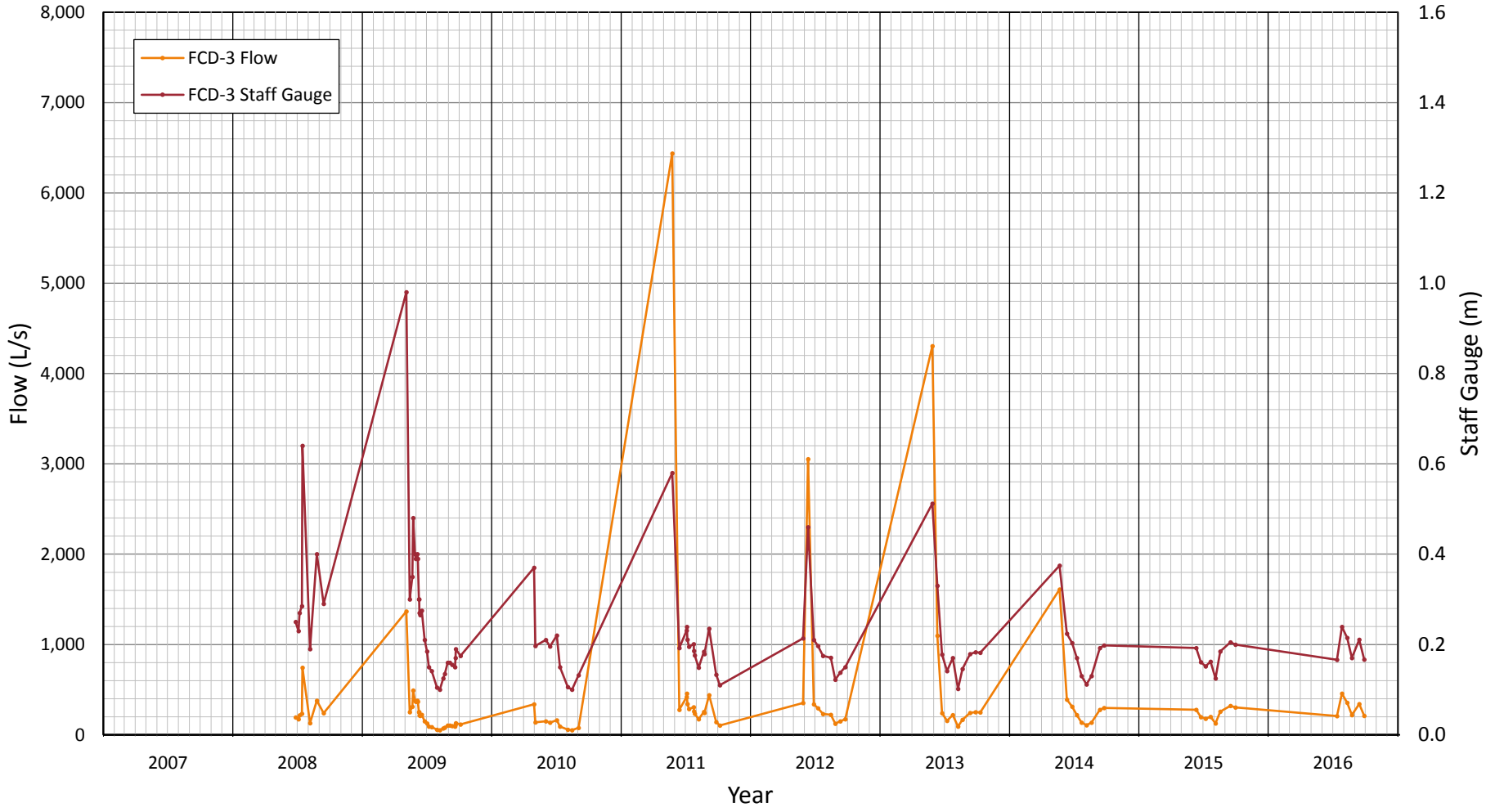
FCD-2
CALCULATED DISCHARGE

| PROJECT No. | FIG No. |
|---|---|
| M09770A06 | II-B2-4 |



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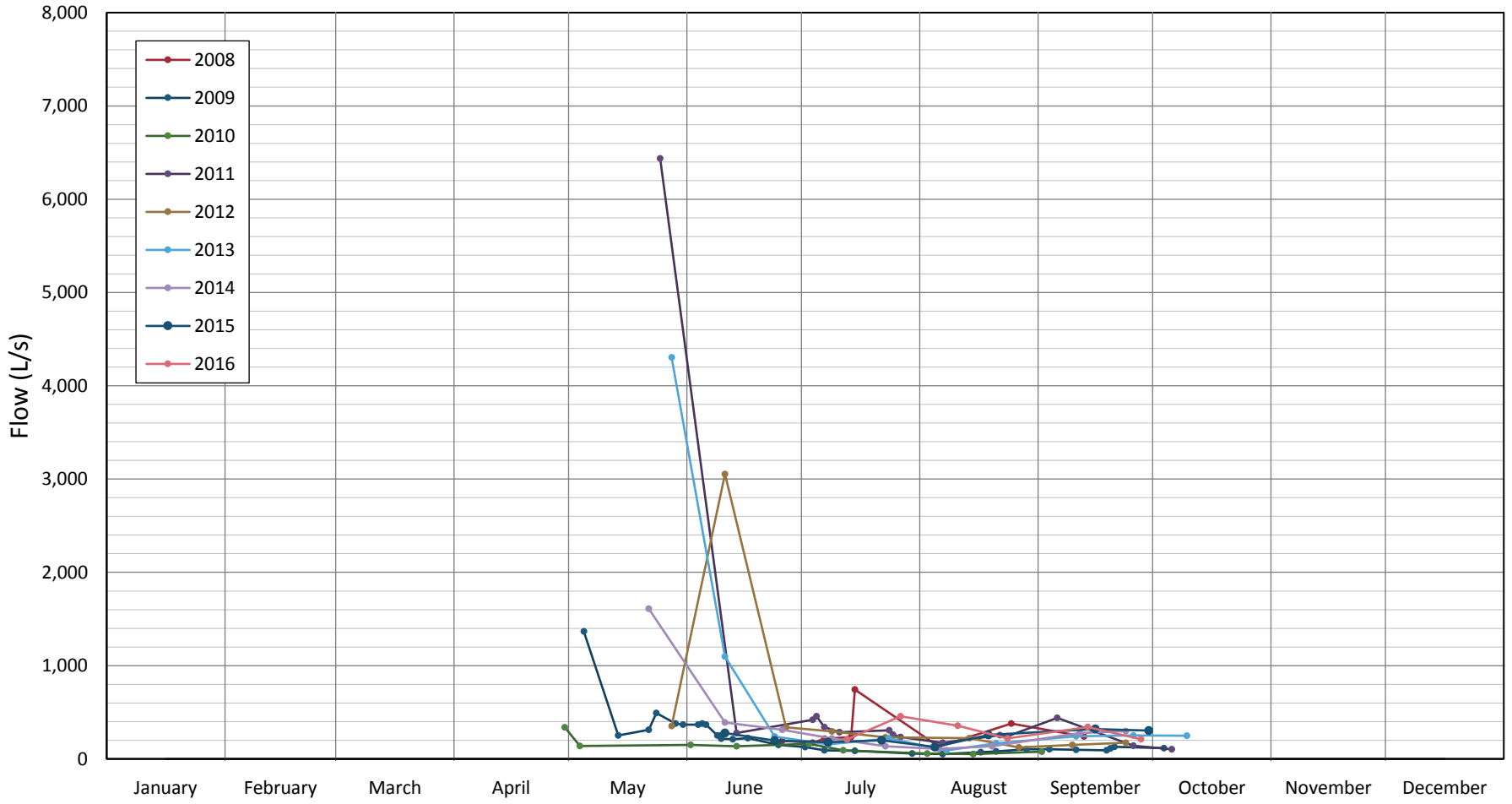
FCD-3
CALCULATED DISCHARGE

PROJECT No. M09770A06

FIG No. II-B2-5



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FCD-3
CALCULATED DISCHARGE

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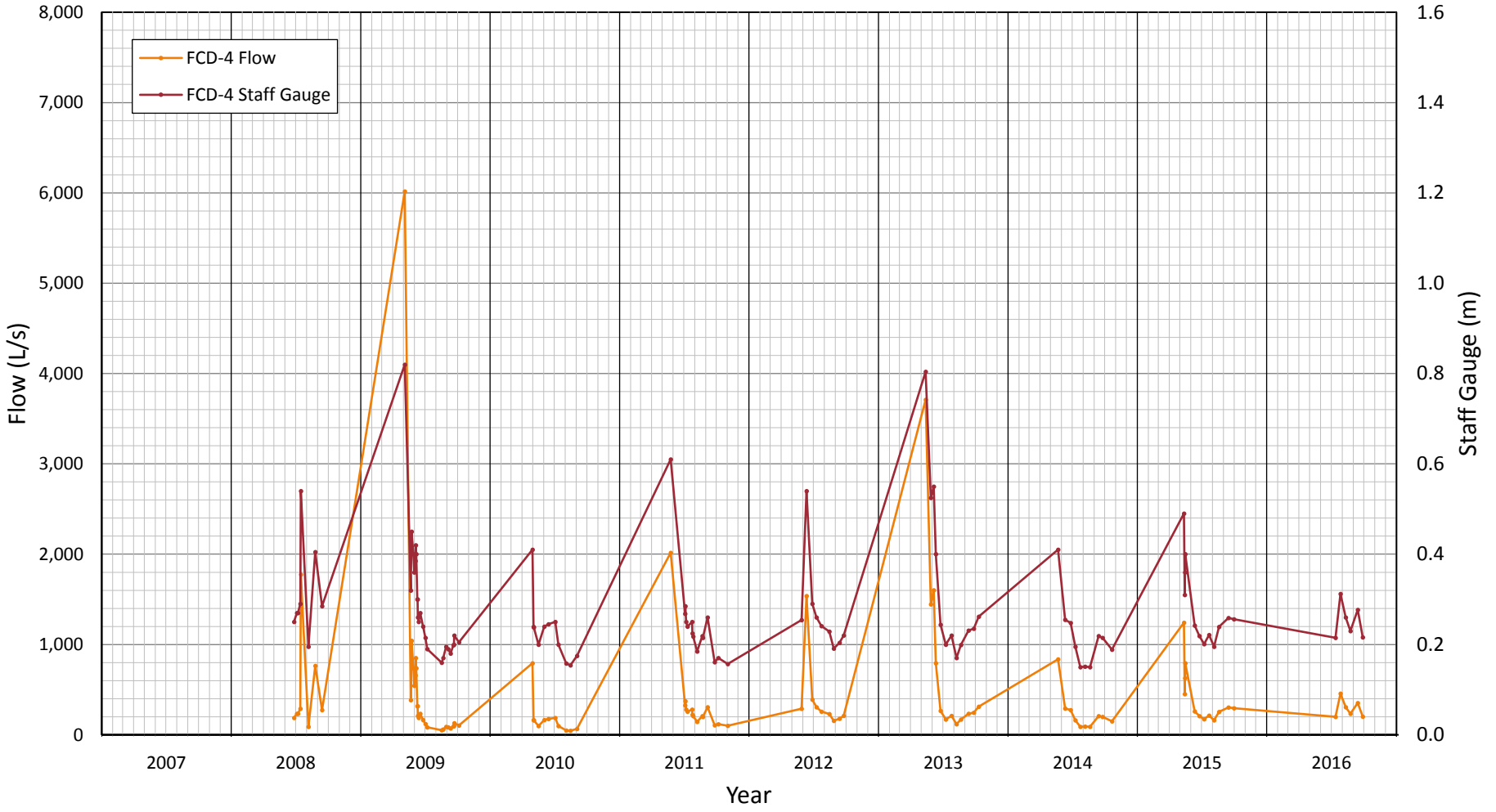
FIG No. II-B2-6



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FCD-4
CALCULATED DISCHARGE

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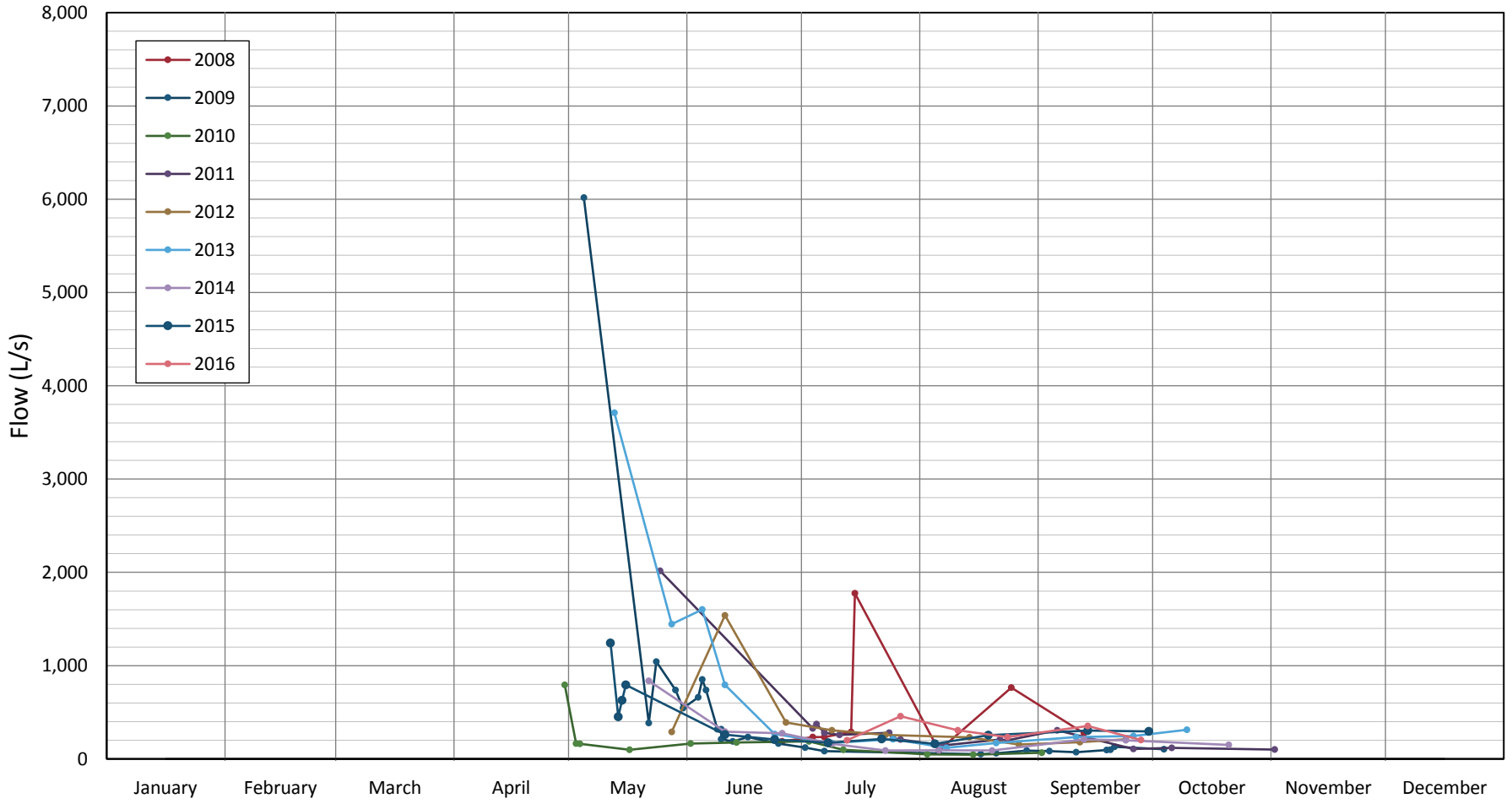
FIG No. II-B2-7



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CALCULATED DISCHARGE

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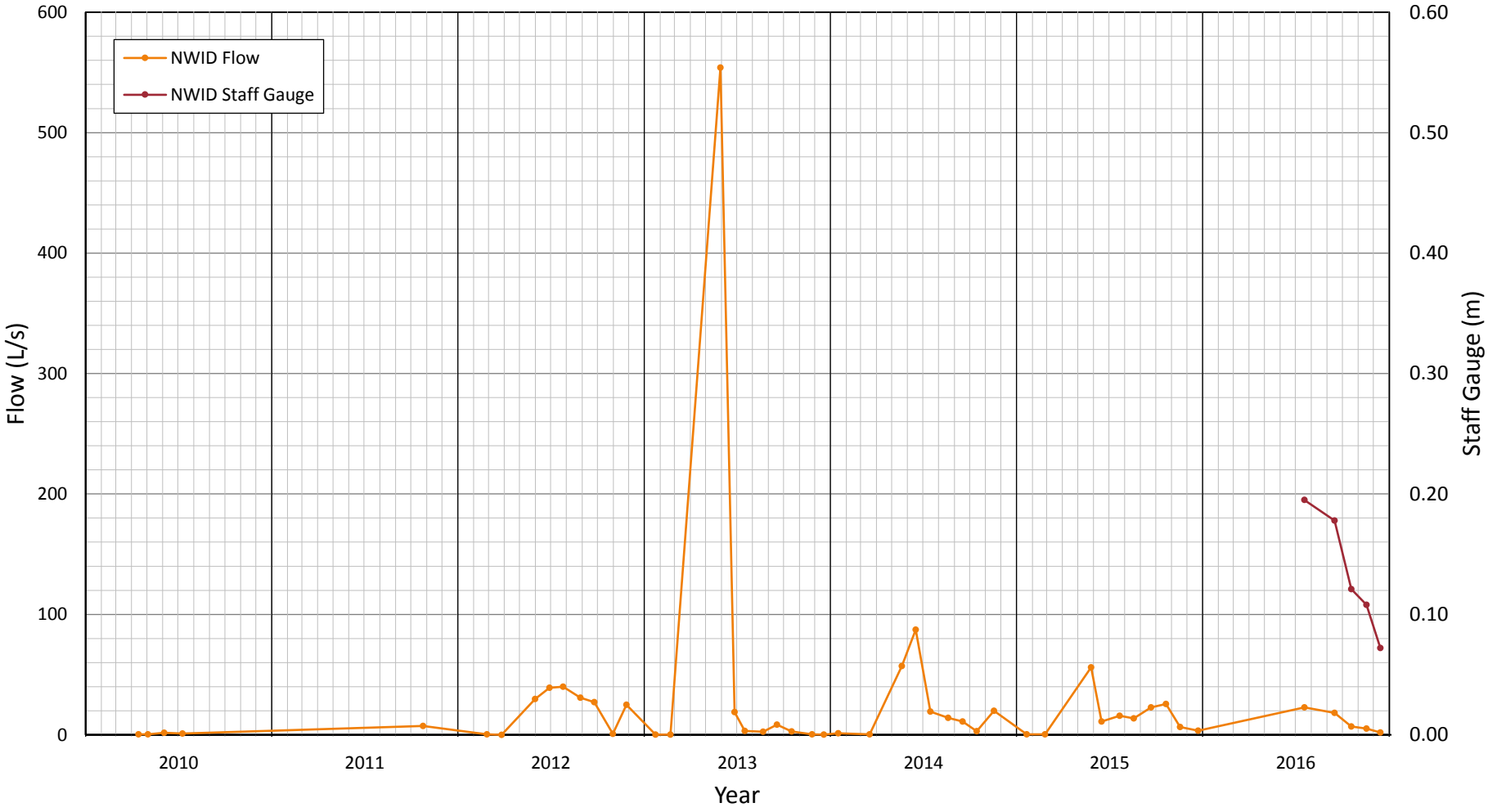
FIG No. II-B2-8

# APPENDIX II-C

## North Valley Wall Interceptor Ditch

C1 – Staff Gauge Flows



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NORTH WALL INTERCEPTOR DITCH
STAFF GAUGE FLOWS

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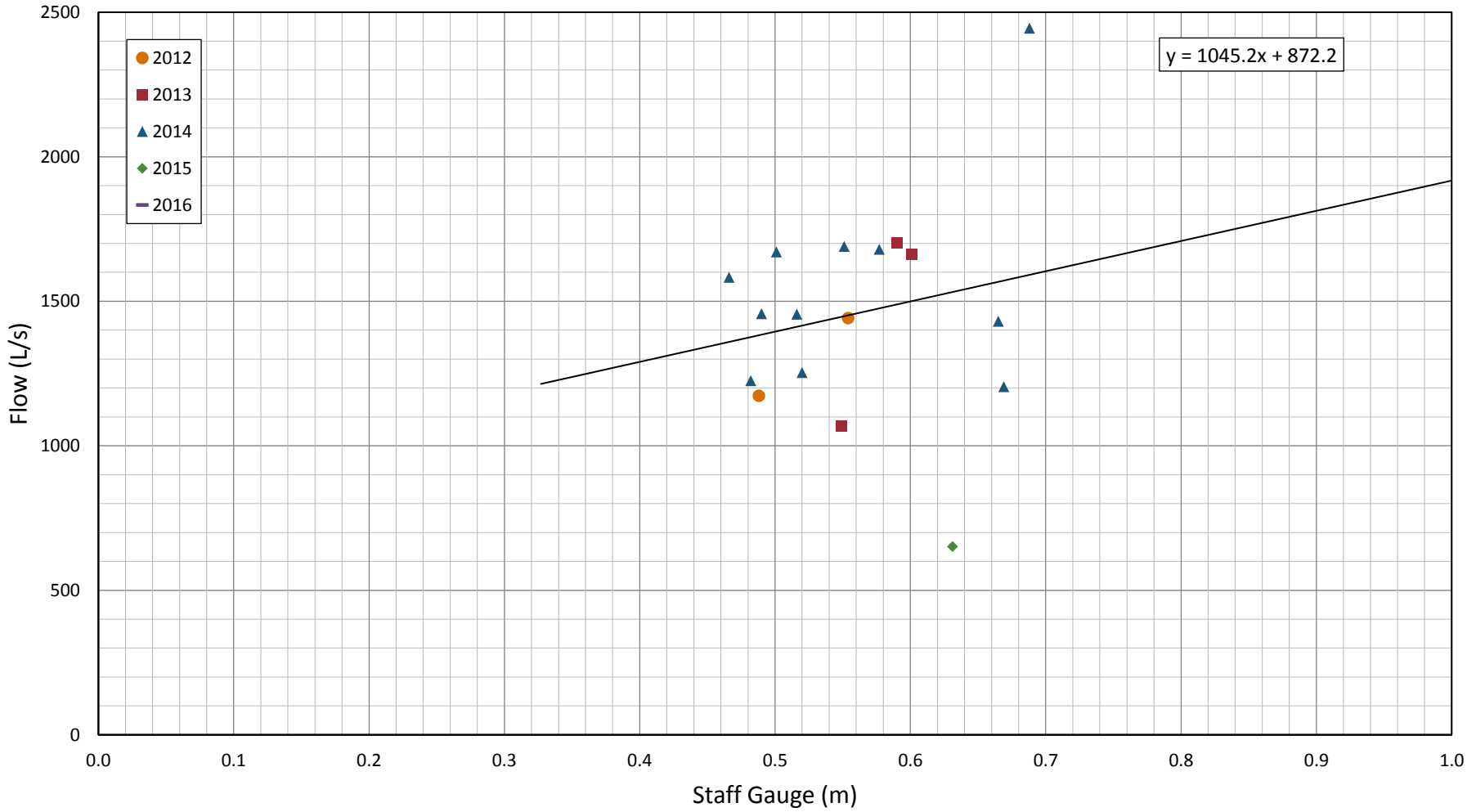
FIG No. II-C1-1

# APPENDIX II-D

## Rose Creek Diversion Channel

D1 – Staff Gauge Calibrations
D2 – Staff Gauge Flows



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NFRD-2B
RATING CURVE

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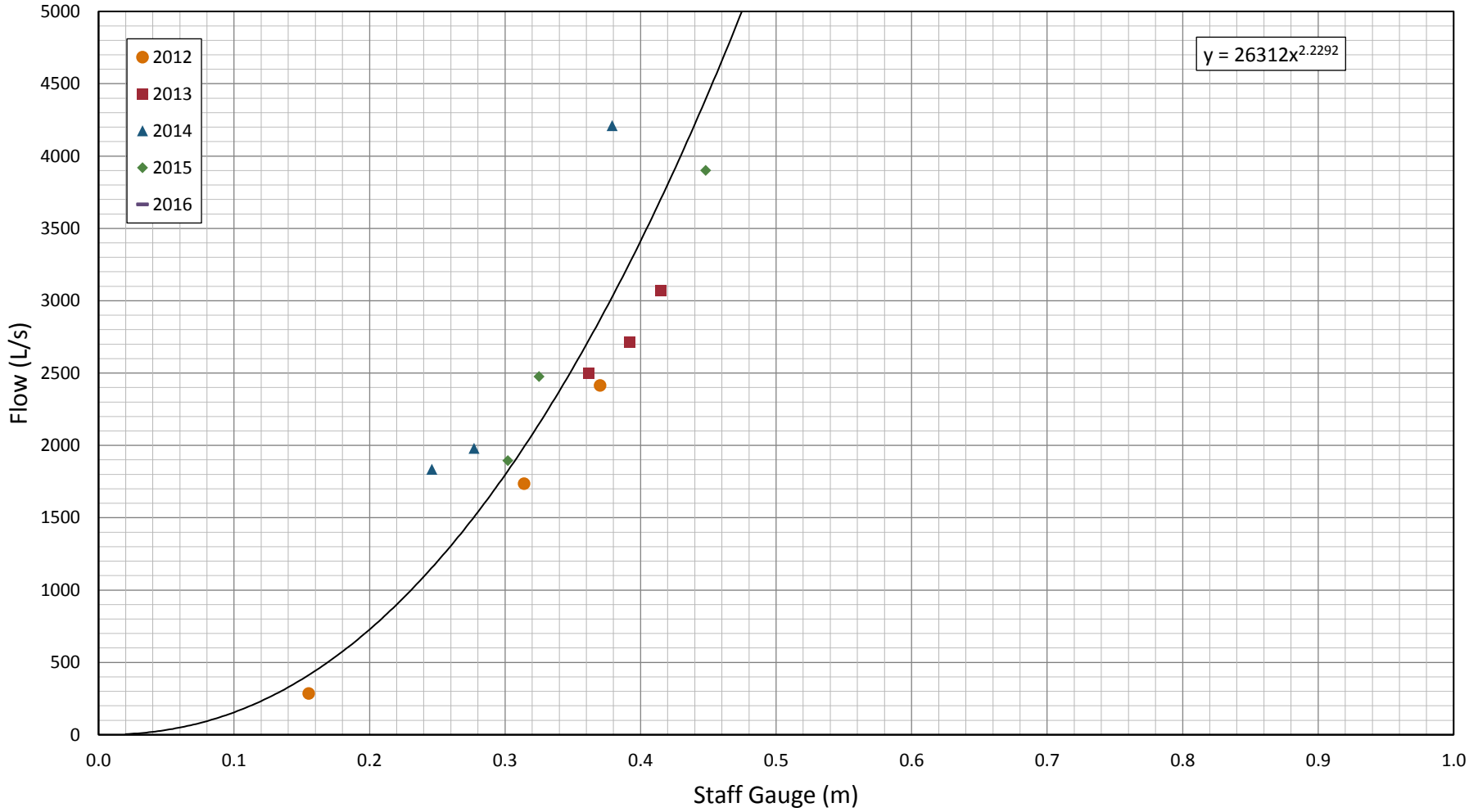
FIG No.: II-D1-1



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RCDC-4
RATING CURVE

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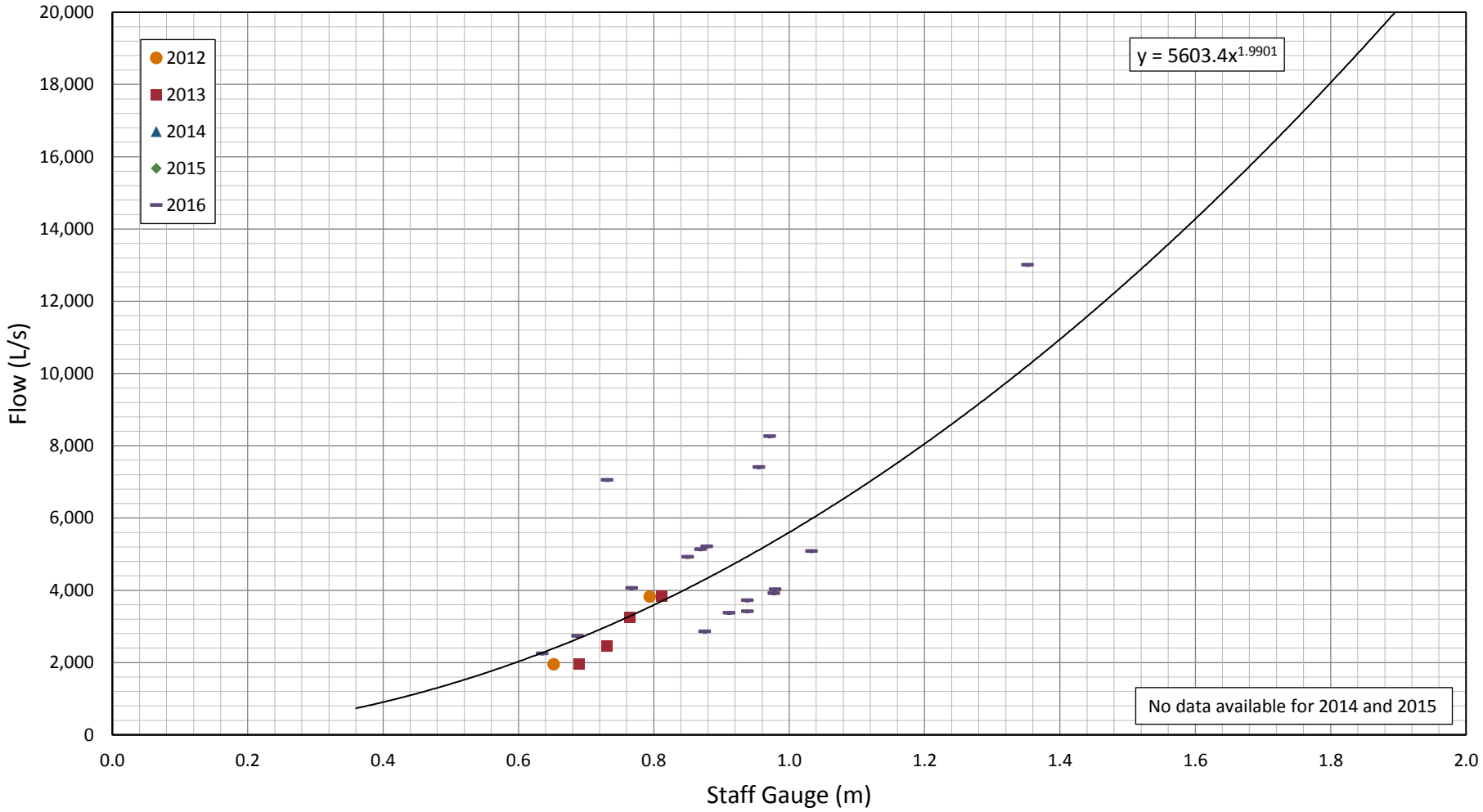
FIG No. II-D1-2



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ROSE CREEK
X14
RATING CURVE

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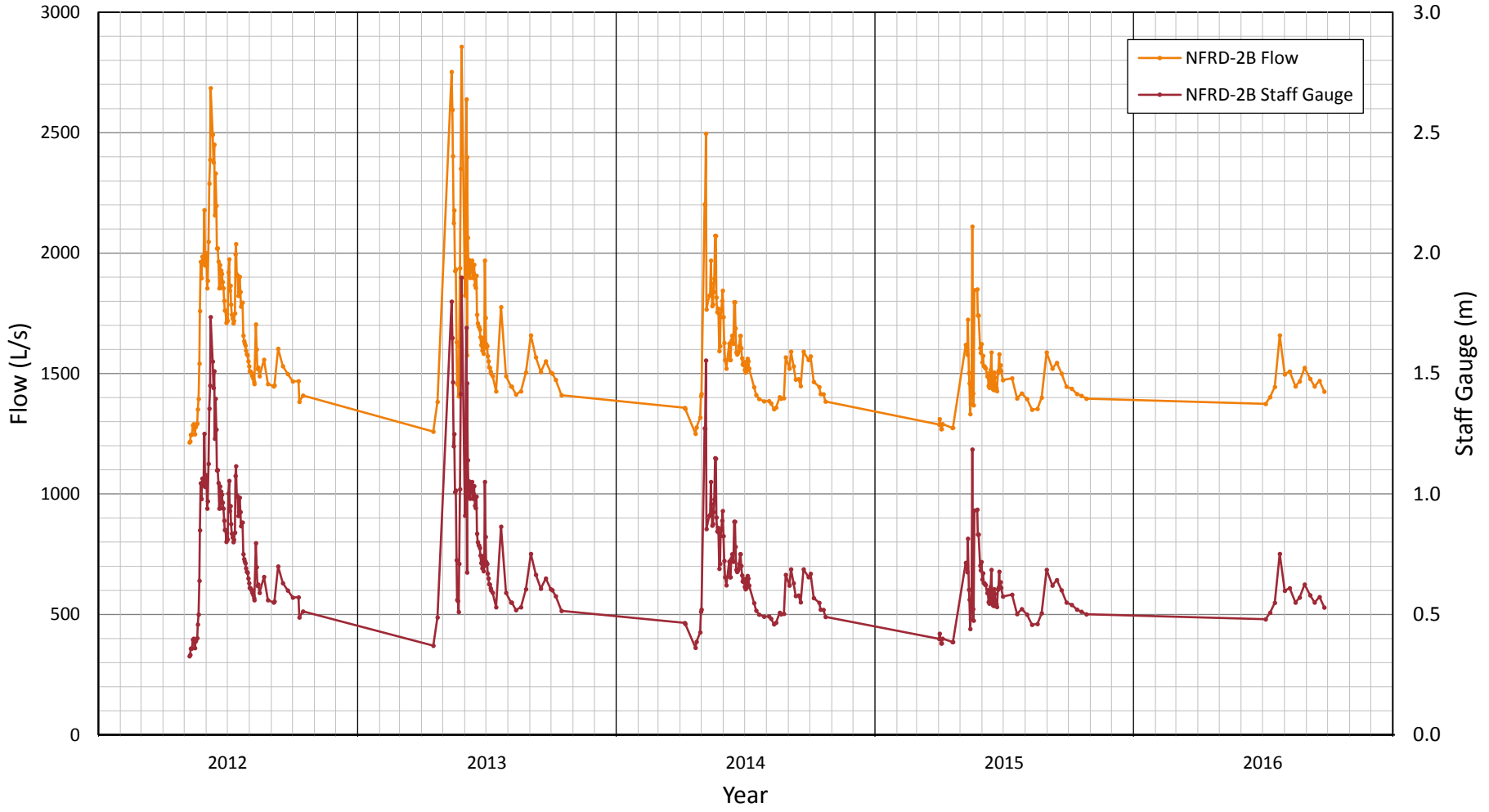
FIG No. II-D1-3



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NFRD-2B
CALCULATED DISCHARGE

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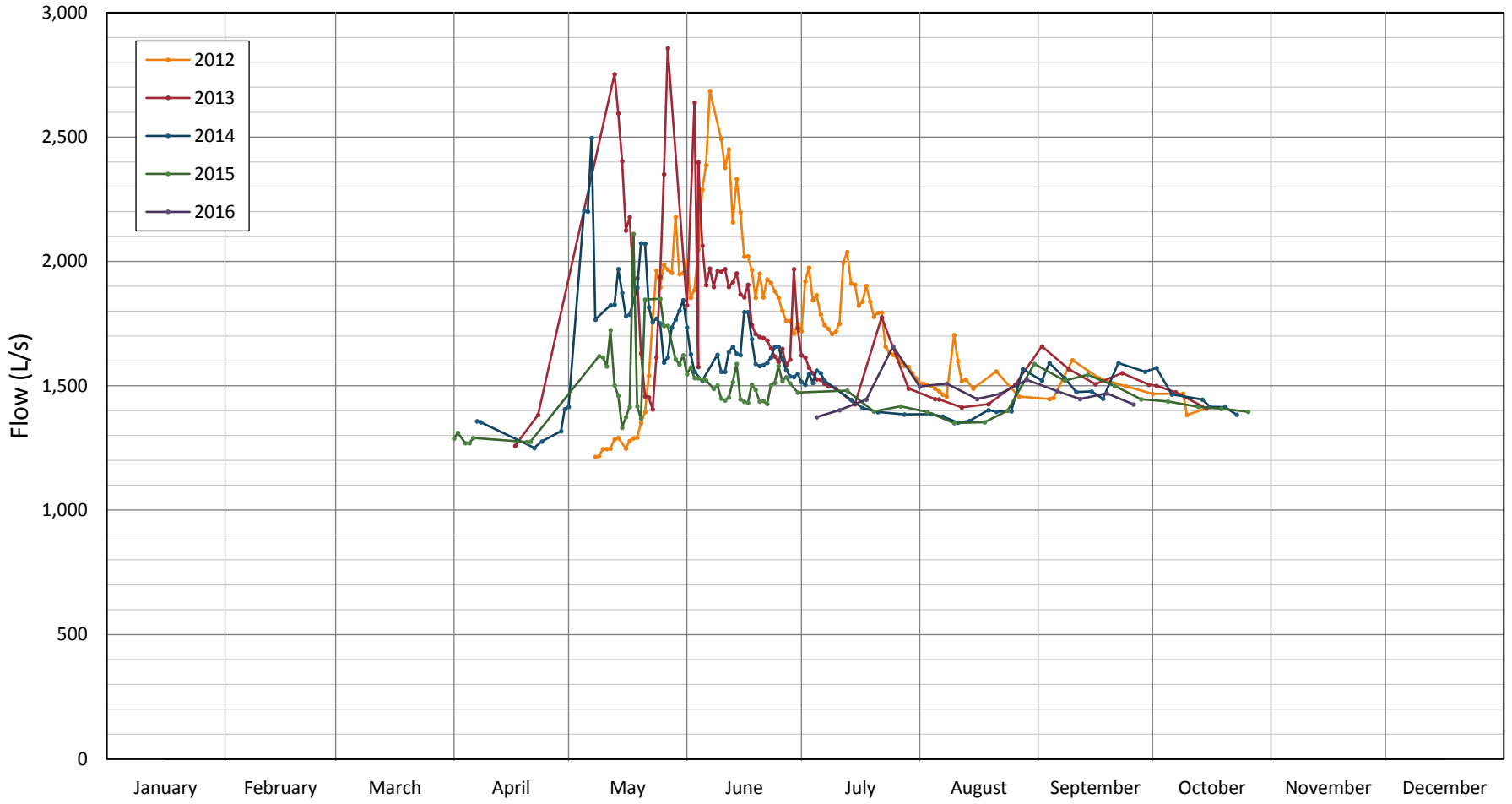
FIG No. II-D2-1



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NFRD-2B
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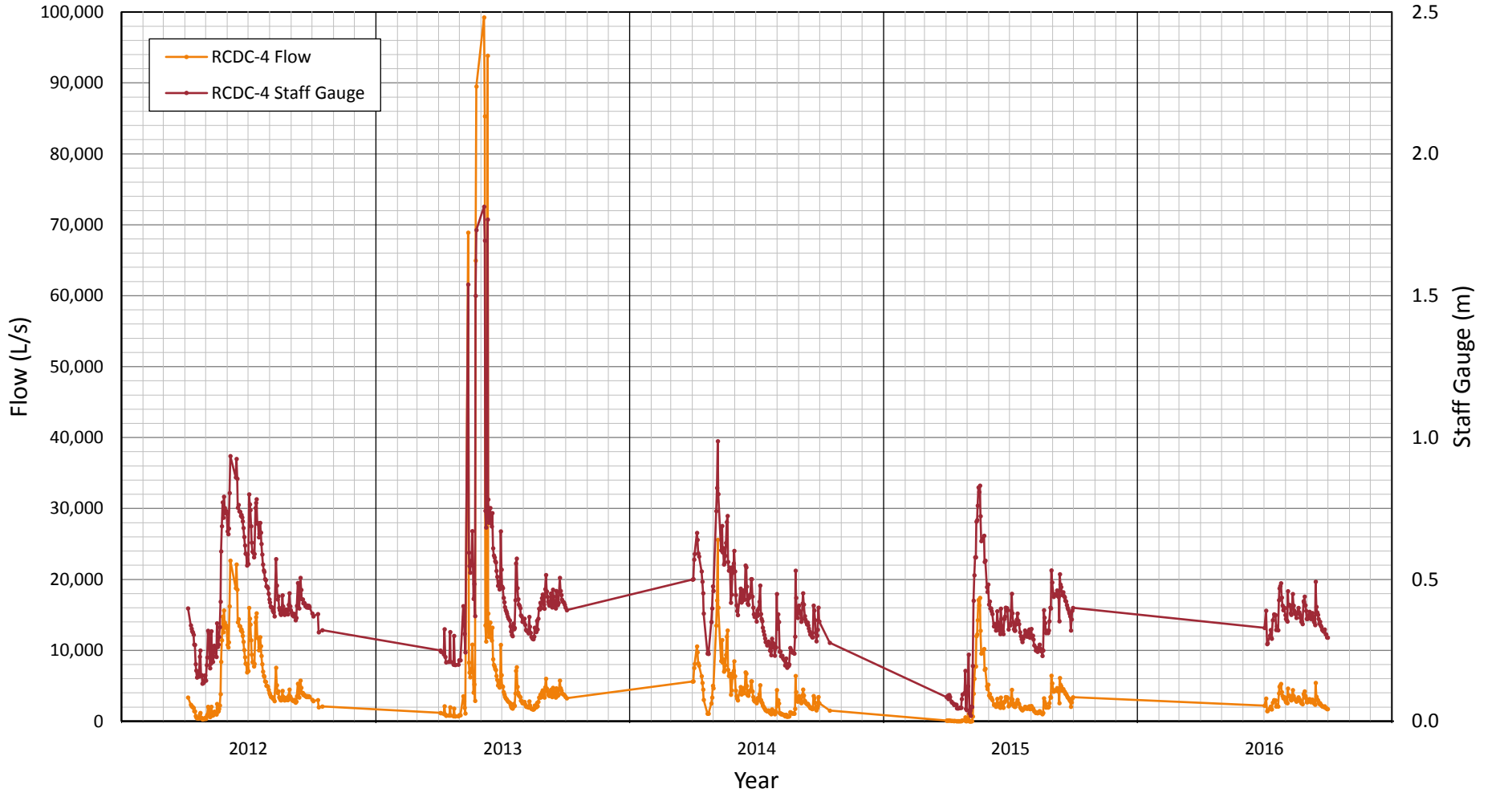
FIG No. II-D2-2



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CALCULATED DISCHARGE

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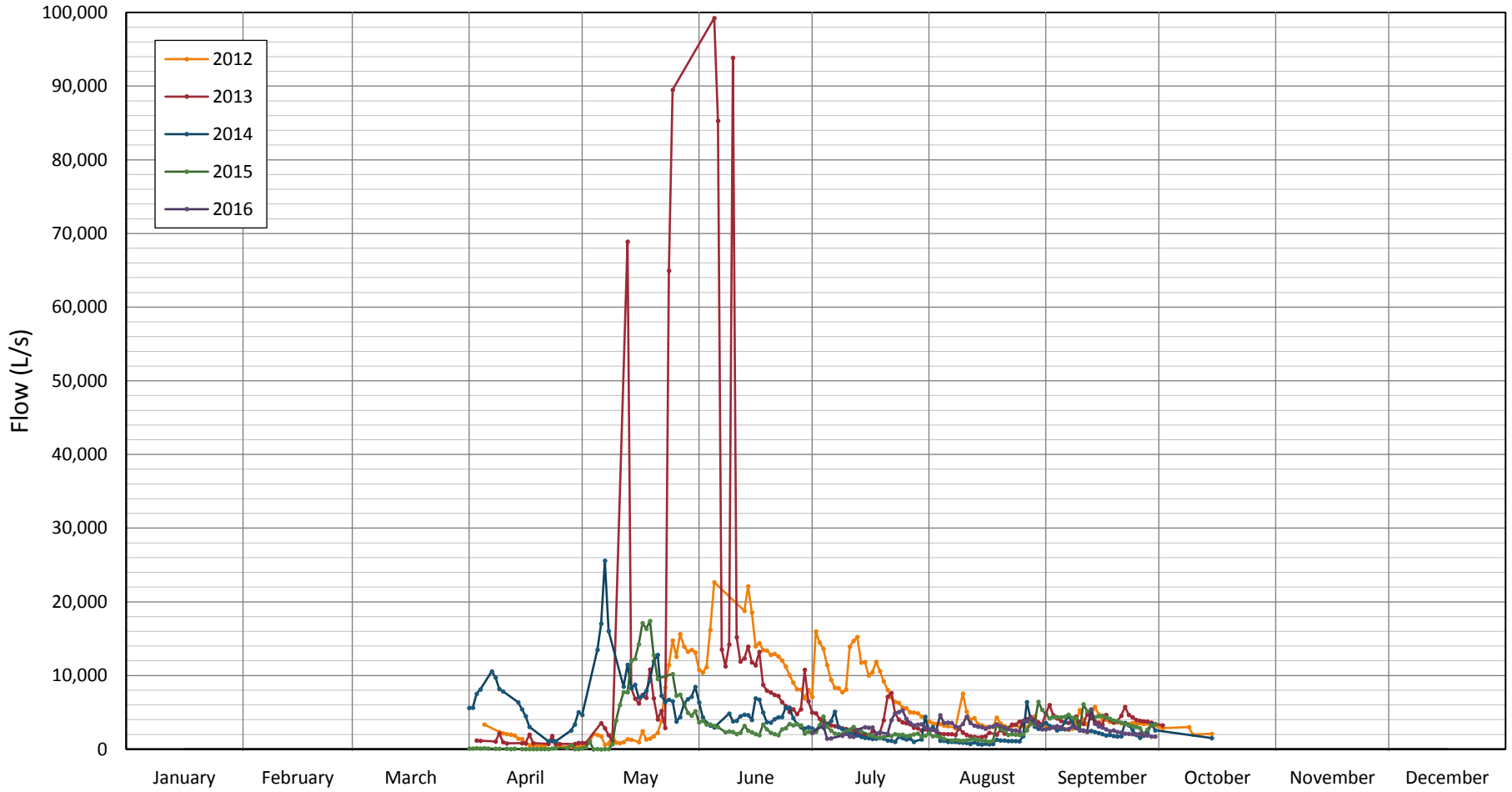
FIG No. II-D2-3



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RCDC-4
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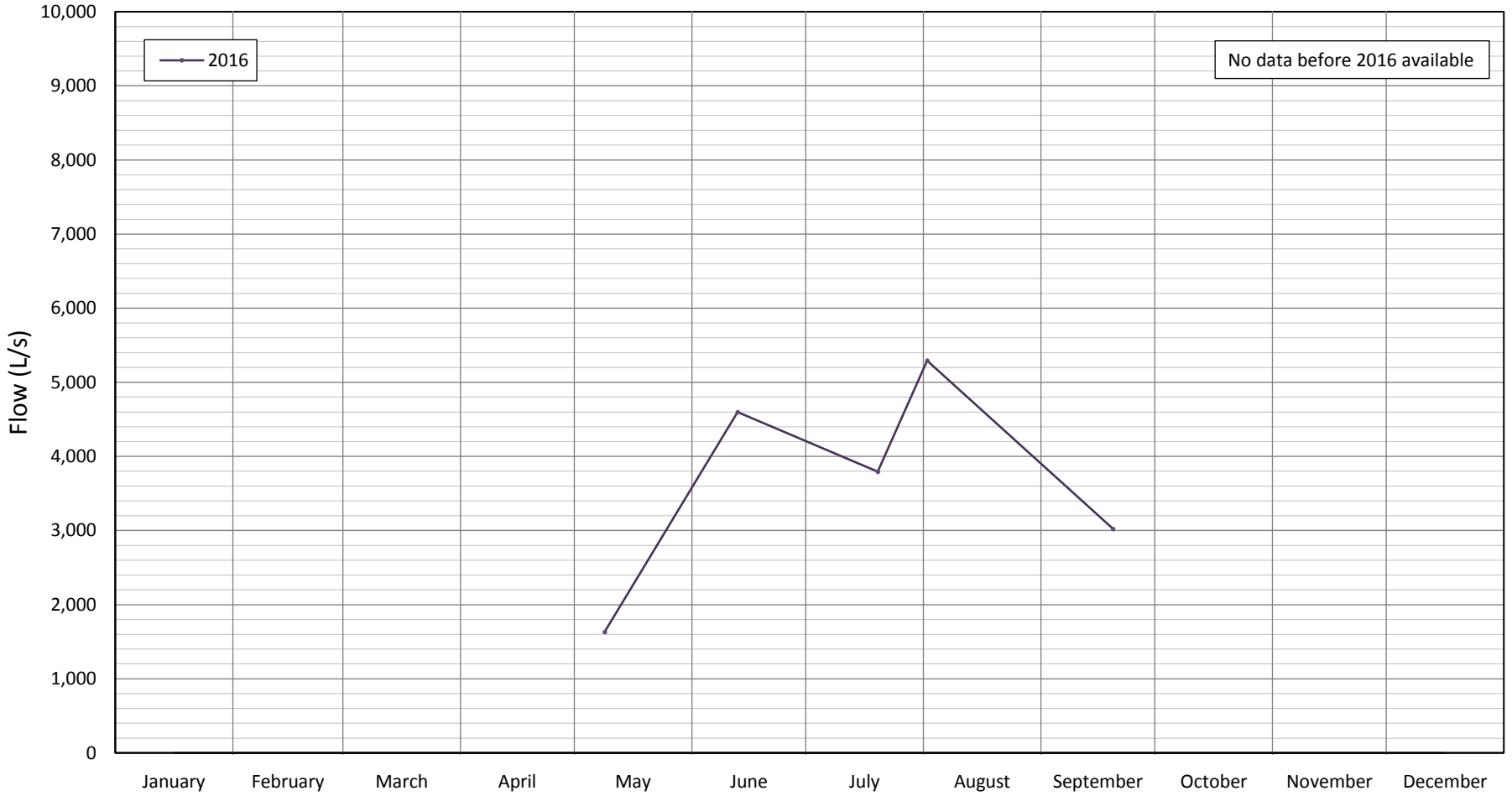
FIG No. II-D2-4



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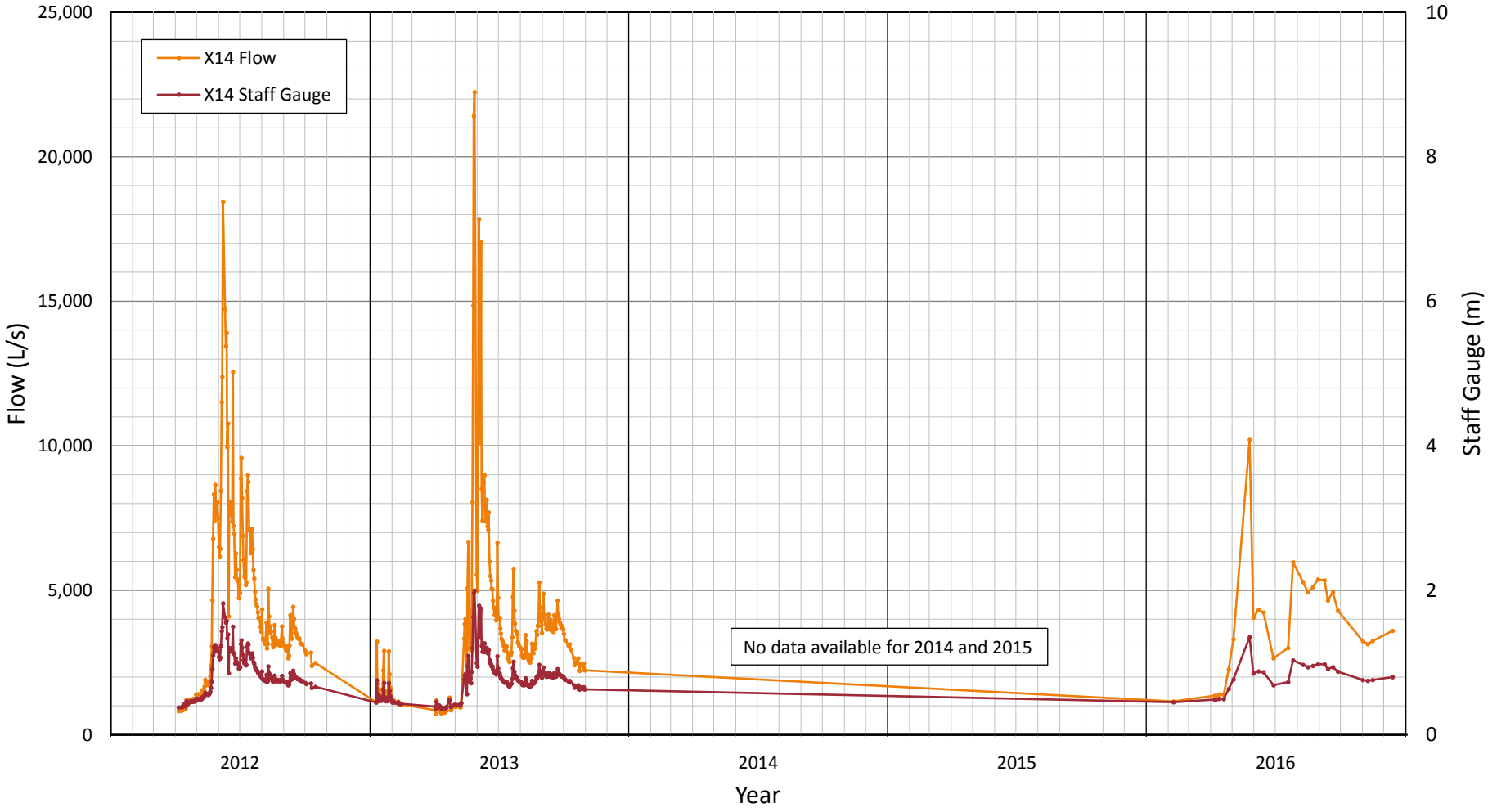
ROSE CREEK
X10
MEASURED DISCHARGE

PROJECT No. M09770A06

FIG No. II-D2-5



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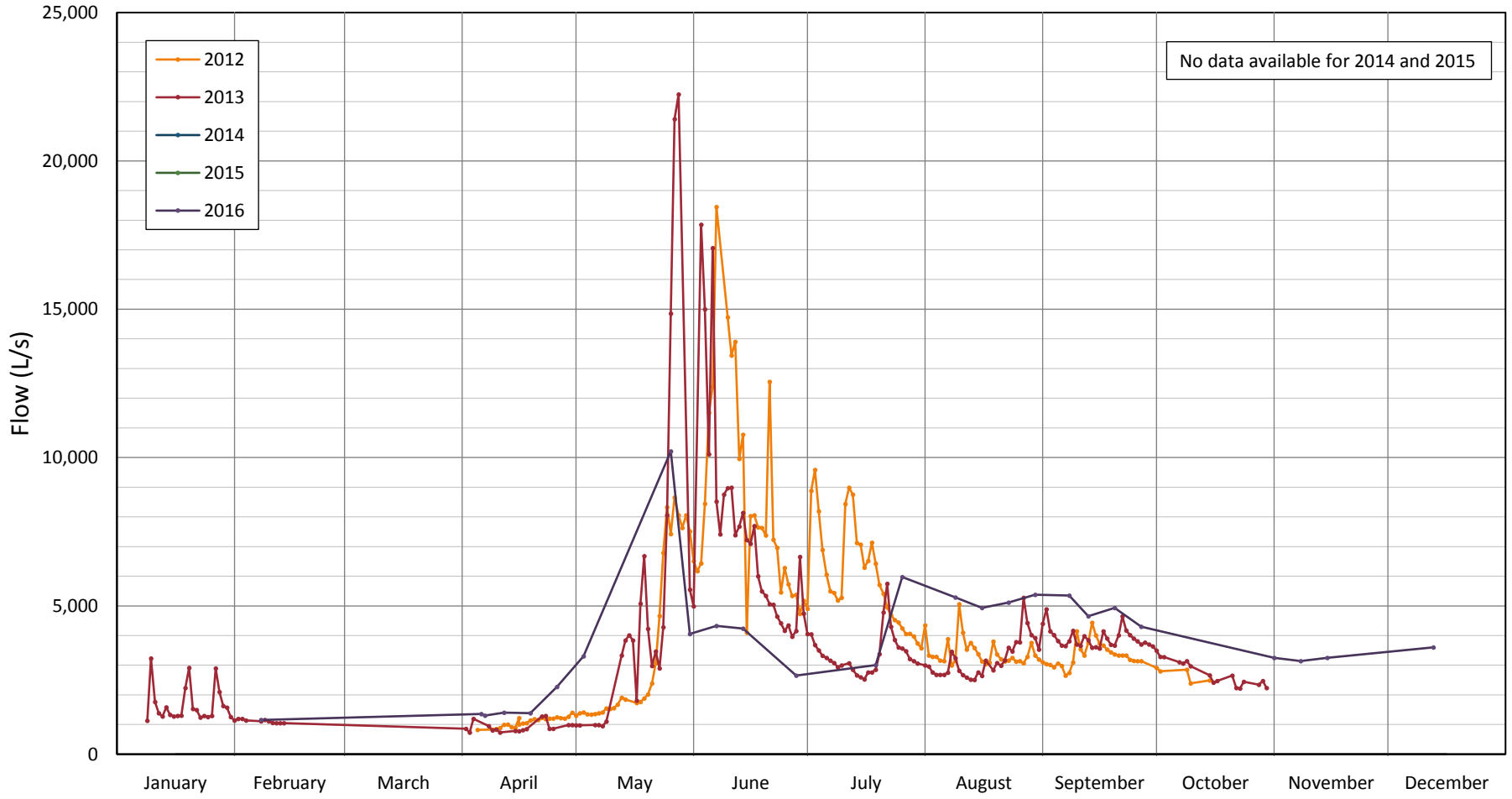
TITLE: ROSE CREEK
X14
CALCULATED DISCHARGE

PROJECT No. M09770A06

FIG No. II-D2-6



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ROSE CREEK
X14
CALCULATED DISCHARGE

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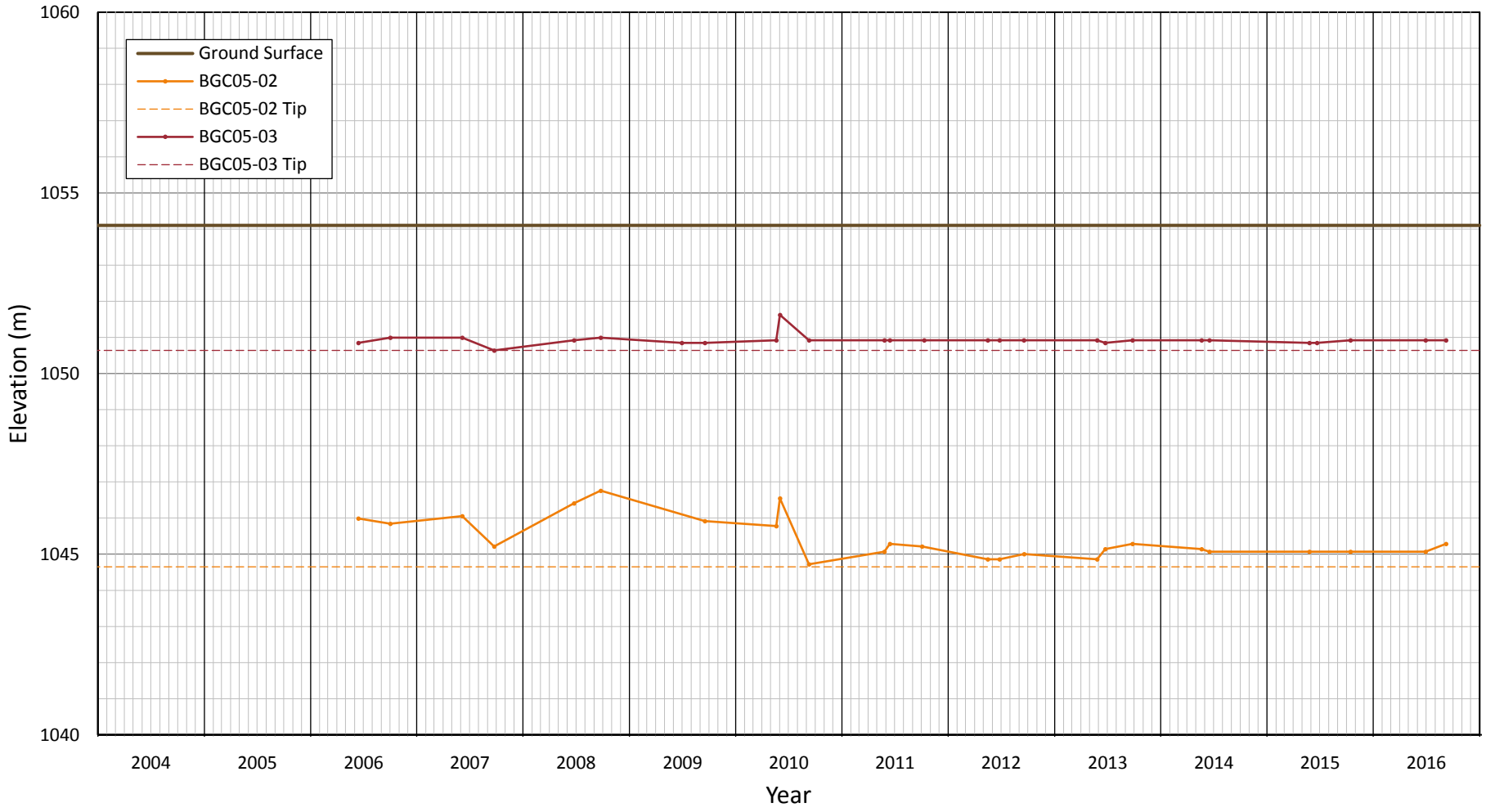
FIG No. II-D2-7

# APPENDIX II-E

## Canal Dyke

E1 – Piezometers
E2 – Thermistors (Thawed thermistors not included)
E3 – Inclinometers



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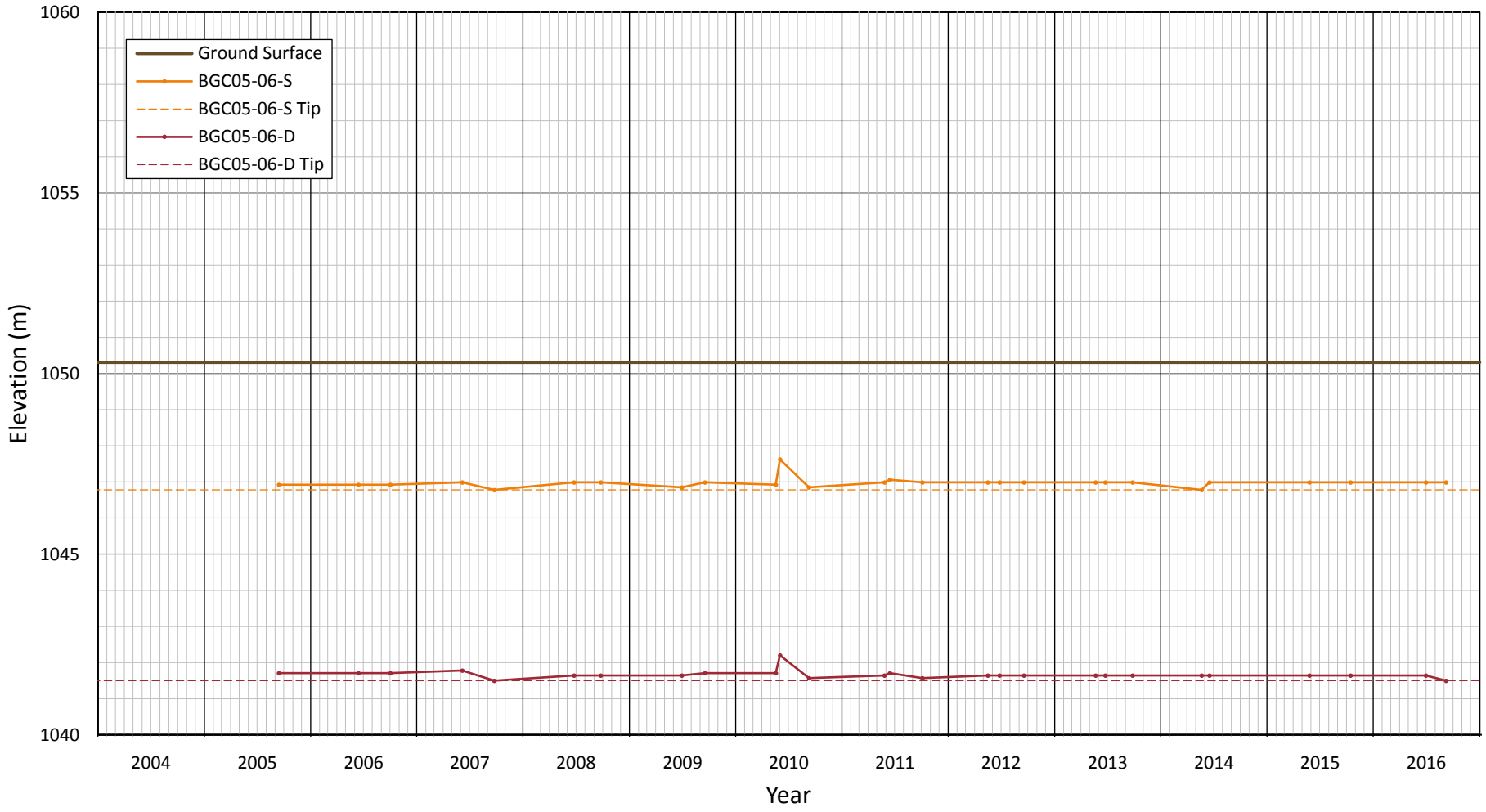
TITLE

ROSE CREEK DIVERSION CHANNEL
CANAL DYKE PIEZOMETERS
BGC05-02 & BGC05-03

PROJECT No. M09770A06

FIG No. II-E1-1



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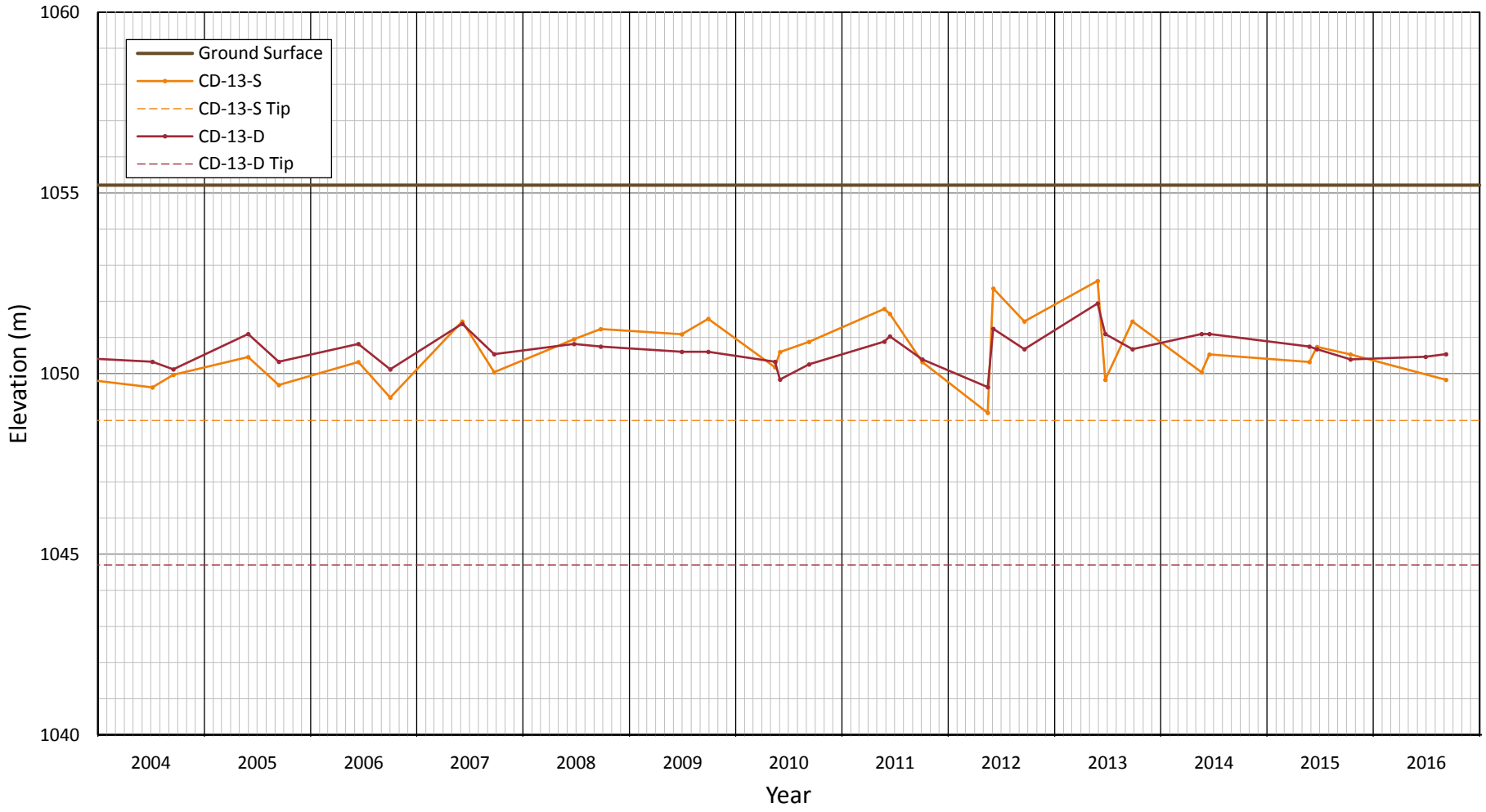
TITLE

ROSE CREEK DIVERSION CHANNEL
CANAL DYKE PIEZOMETERS
BGC05-06

PROJECT No. M09770A06

FIG No. II-E1-2



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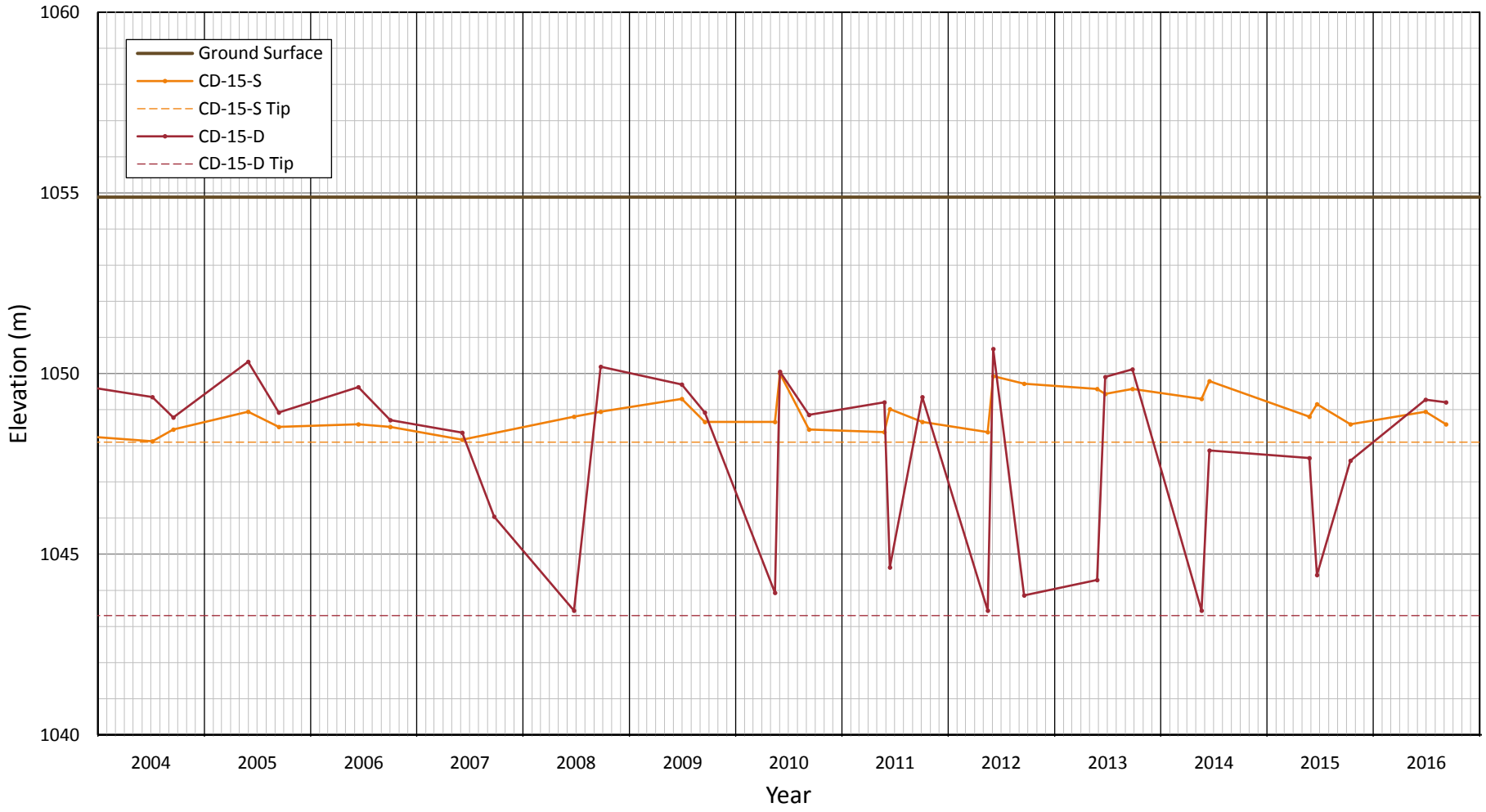
TITLE

ROSE CREEK DIVERSION CHANNEL
CANAL DYKE PIEZOMETERS
CD-13

PROJECT No. M09770A06

FIG No. II-E1-3



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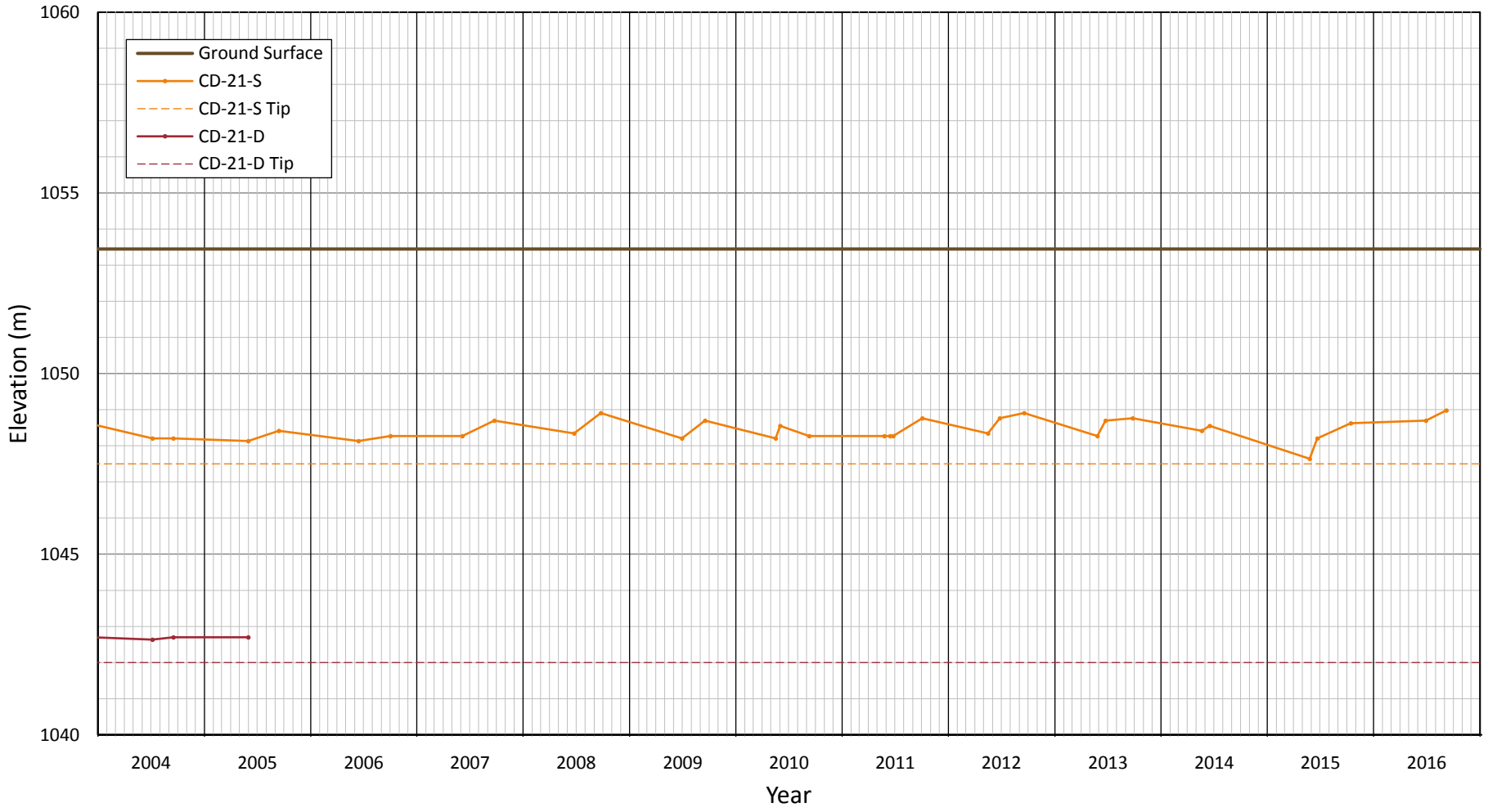
CANAL DYKE PIEZOMETERS
CD-15

PROJECT No. M09770A06

FIG No. II-E1-4




Notes:
1. CD-21-D destroyed in 2005.



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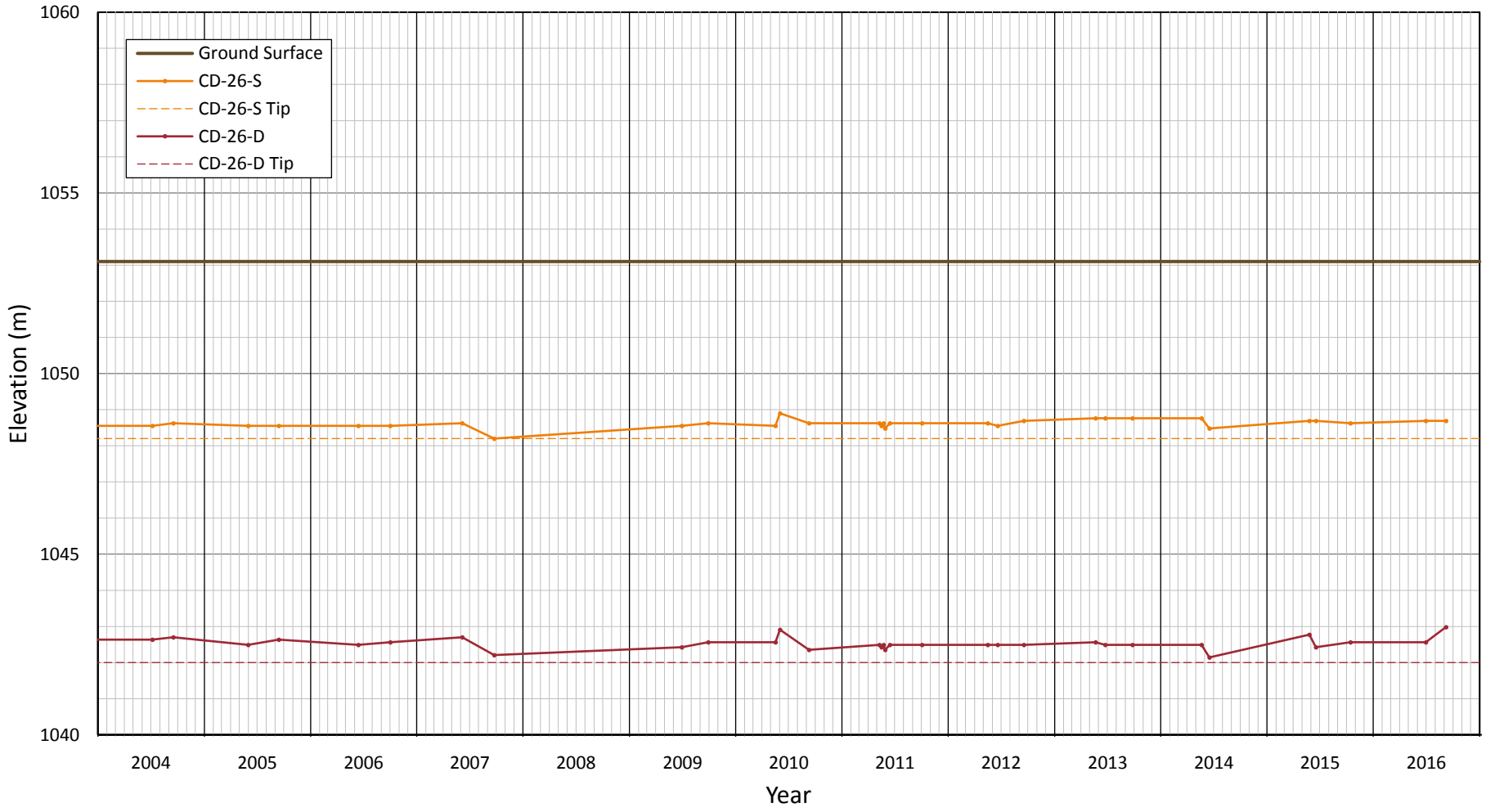
2016 ANNUAL GEOTECHNICAL REVIEW

TITLE: ROSE CREEK DIVERSION CHANNEL
CANAL DYKE PIEZOMETERS
CD-21

PROJECT No. M09770A06

FIG No. II-E1-5

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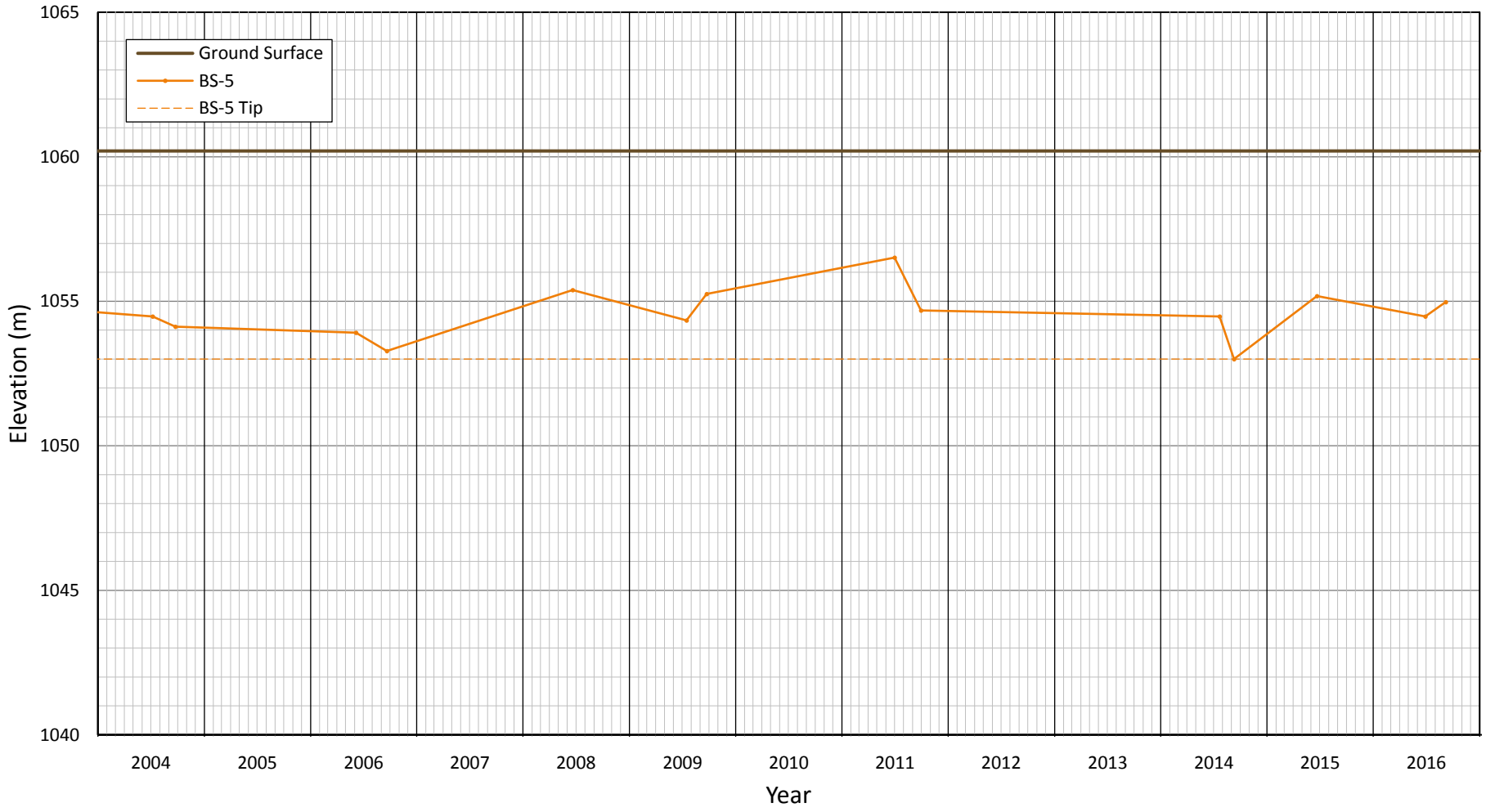
ROSE CREEK DIVERSION CHANNEL
CANAL DYKE PIEZOMETERS
CD-26

PROJECT No. M09770A06

FIG No. II-E1-6



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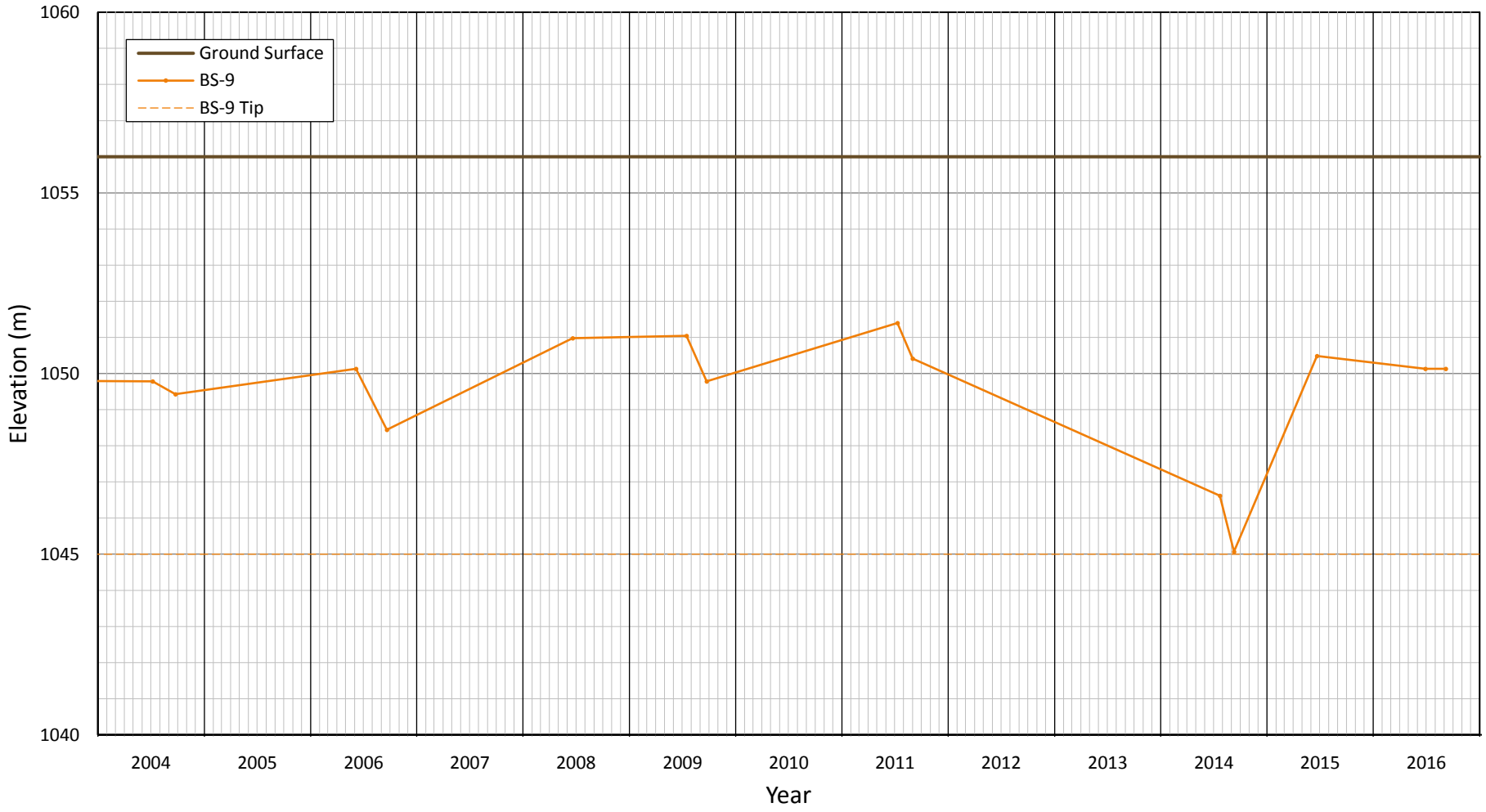
TITLE

ROSE CREEK DIVERSION CHANNEL
BACK SLOPE PIEZOMETERS
BS-5

PROJECT No. M09770A06

FIG No. II-E1-7



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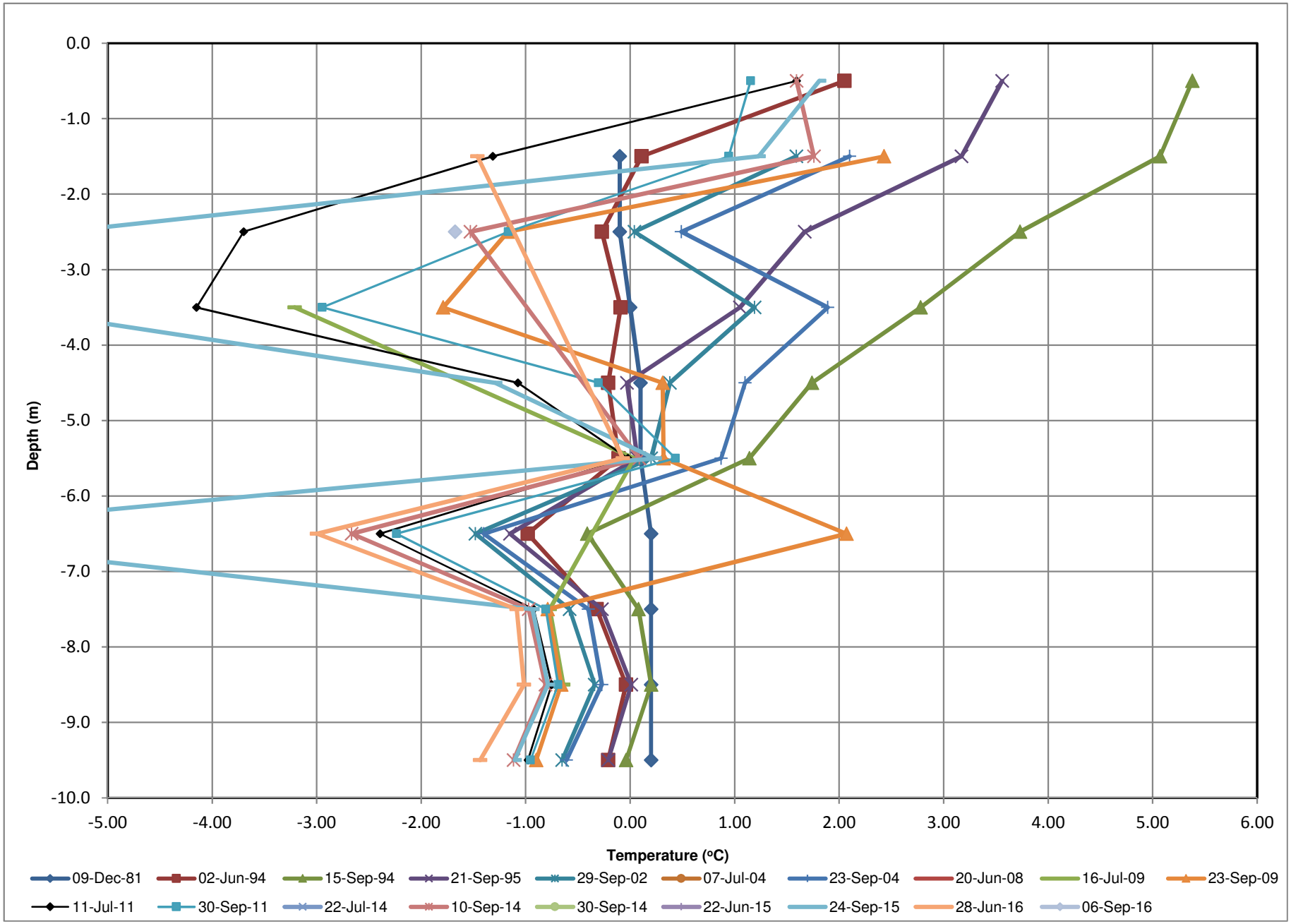
TITLE

ROSE CREEK DIVERSION CHANNEL
BACK SLOPE PIEZOMETERS
BS-9

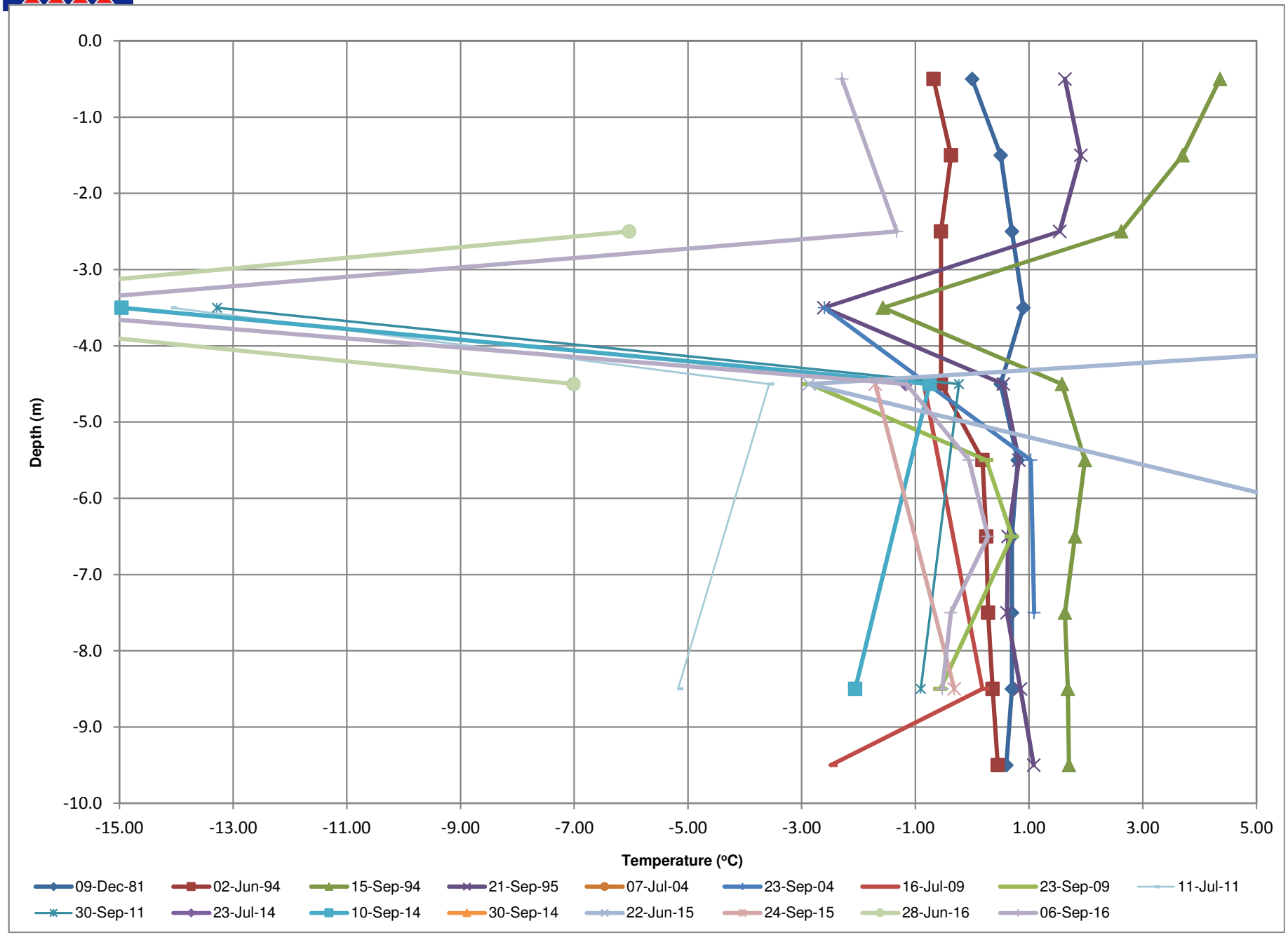
PROJECT No. M09770A06

FIG No. II-E1-8

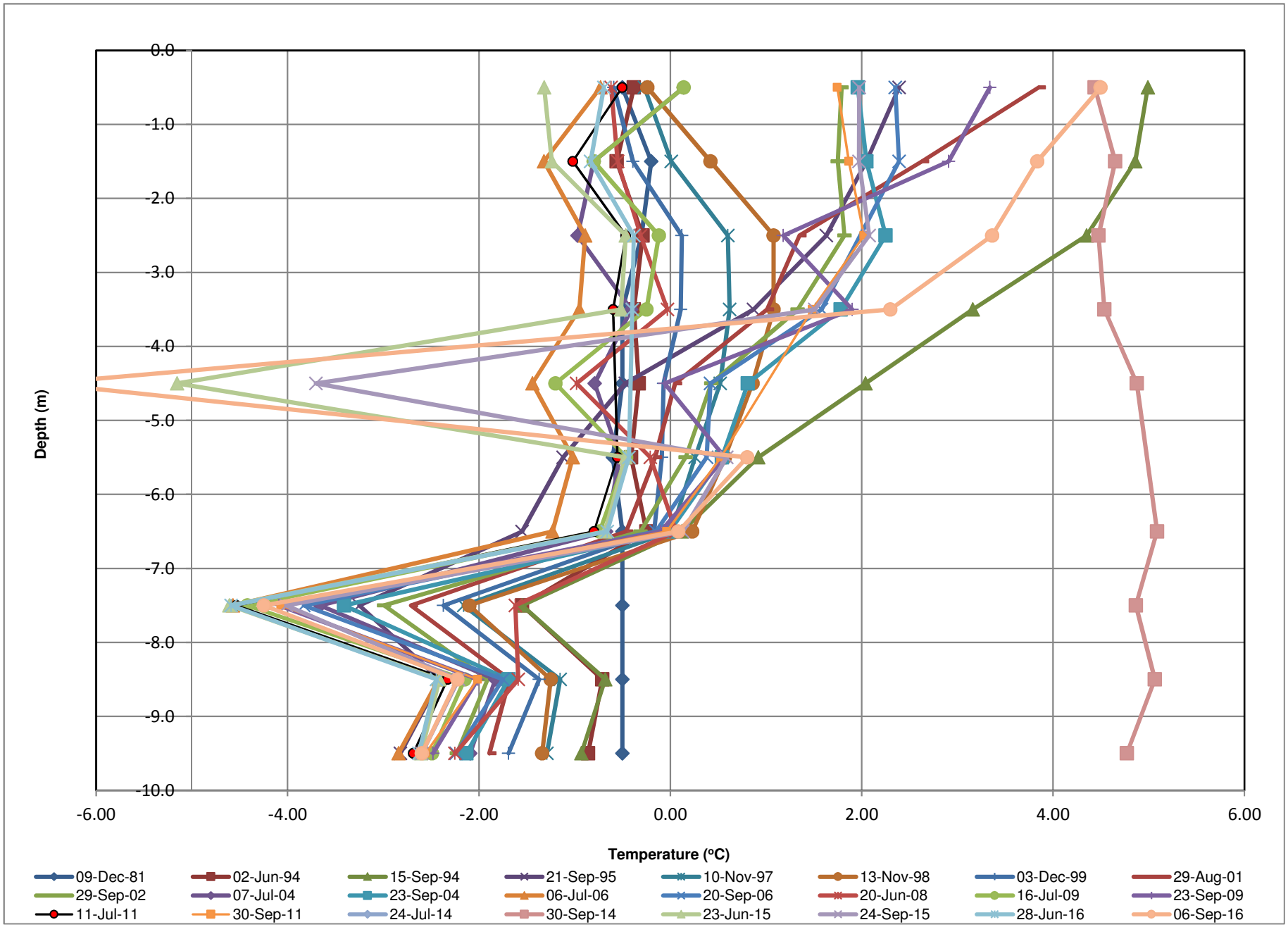
# Diversion Canal (Backslope)
# Thermistor BS-5



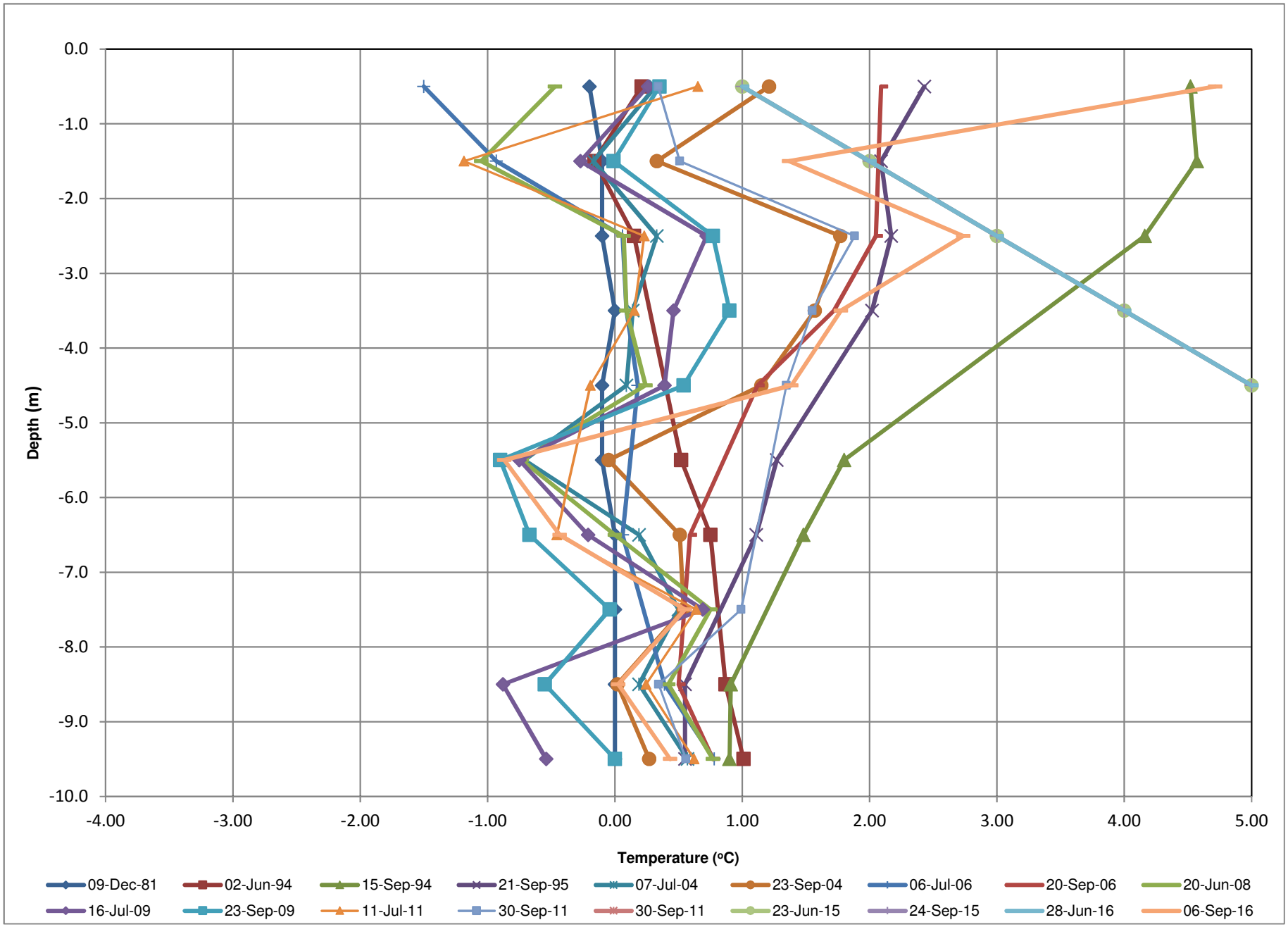
# Diversion Canal (Backslope)
# Thermistor BS-9



# Diversion Canal (Backslope)
# Thermistor BS-10



# Diversion Canal (Backslope)
# Thermistor BS-12



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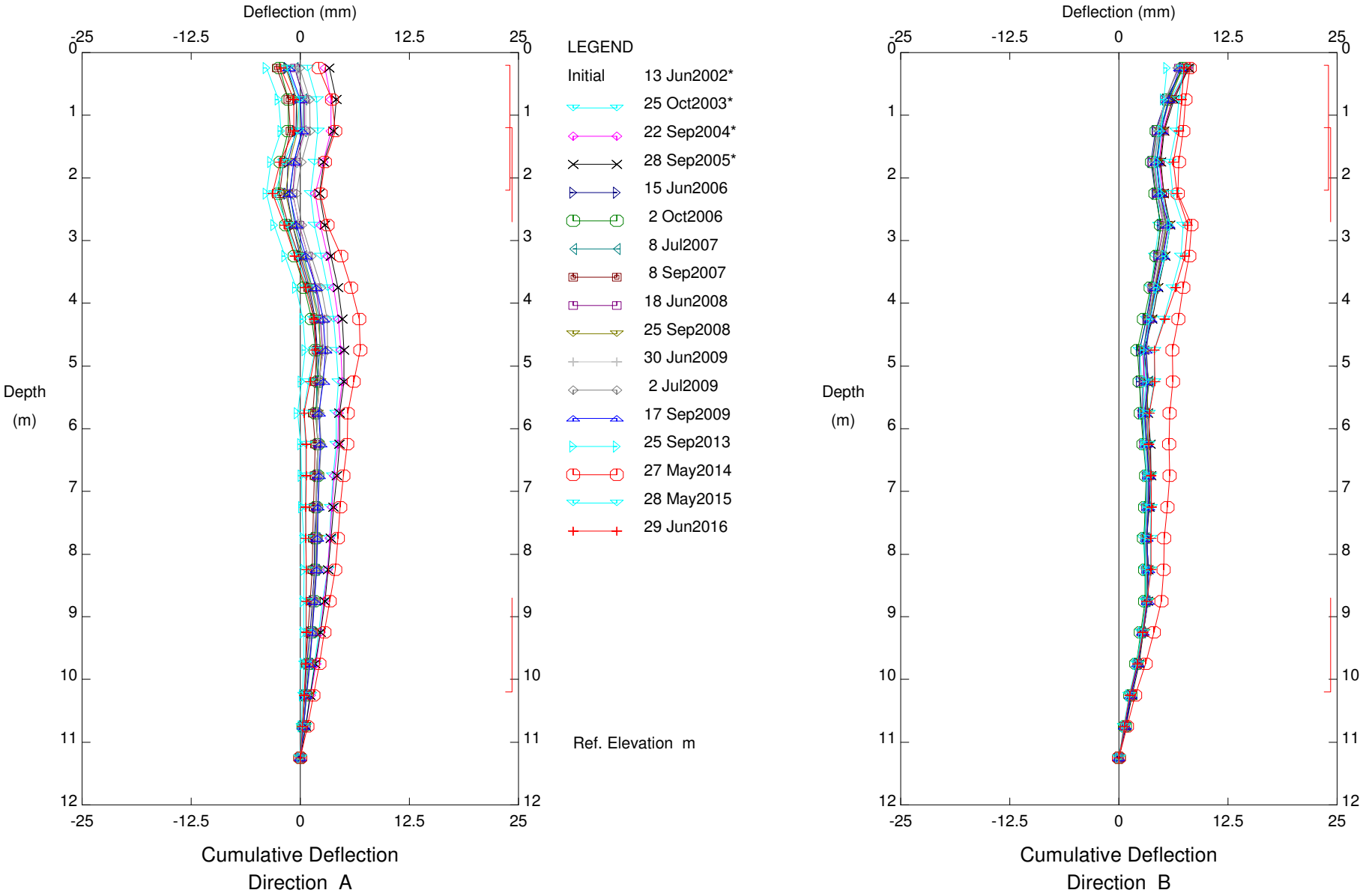


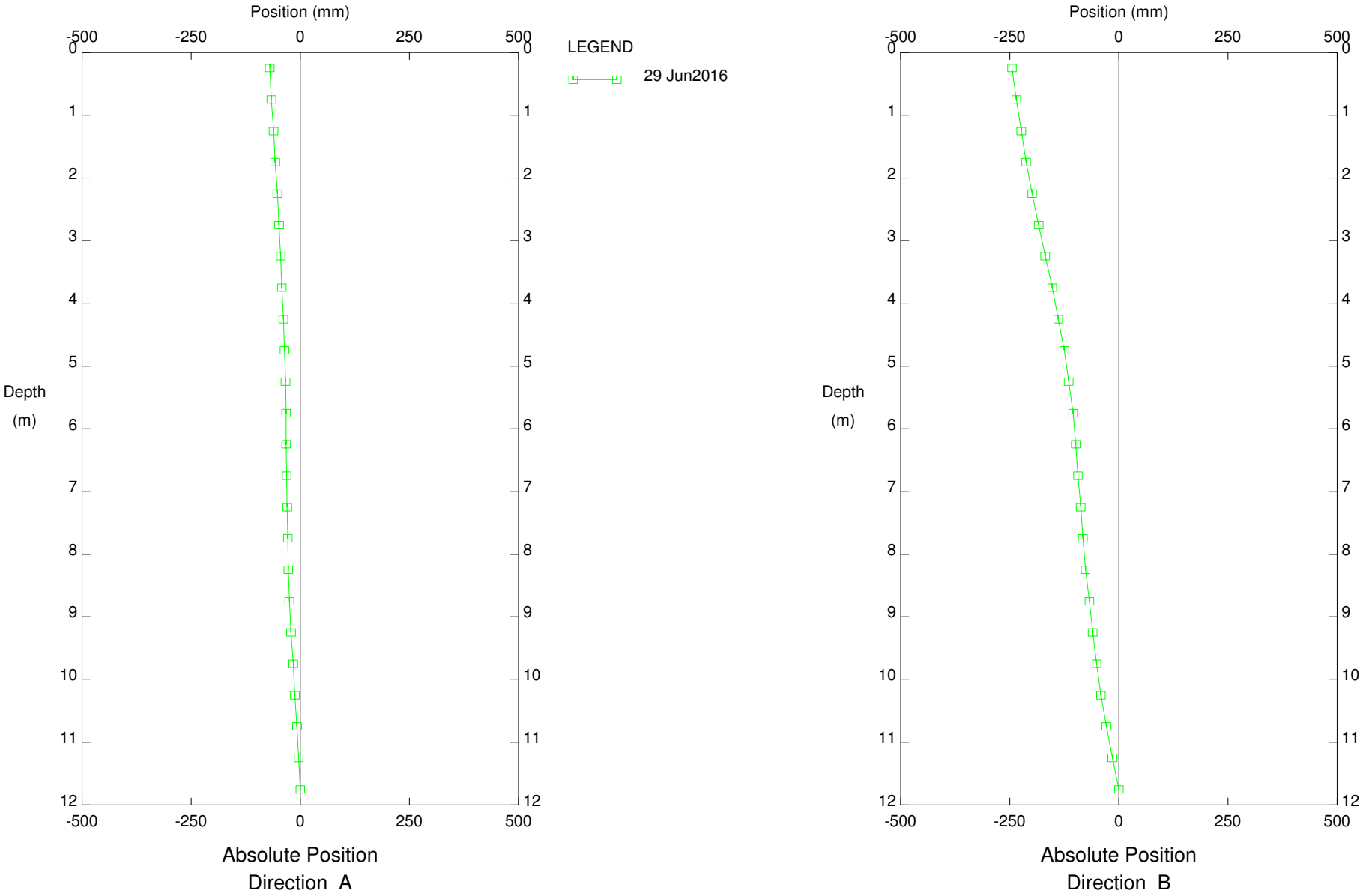

91CD-1, Inclinometer 1+767

Sets marked * include zero shift and/or rotation corrections.



Z:\M\VCR\M09770A06 - GOY-Faro 2016-17 Geotech\300 Design\Inclinometer Data\2016 Spring Visit\June2016-91CD-1.gtl

Klohn Crippen Berger Ltd. - Vancouver BC




Canal Dyke, Inclinometer BGC05-05



Z:\M\VCR\M09770A06 - GOY-Faro 2016-17 Geotech\300 Design\Inclinometer Data\2016 Spring Visit\June2016-BGC05-05.gtl

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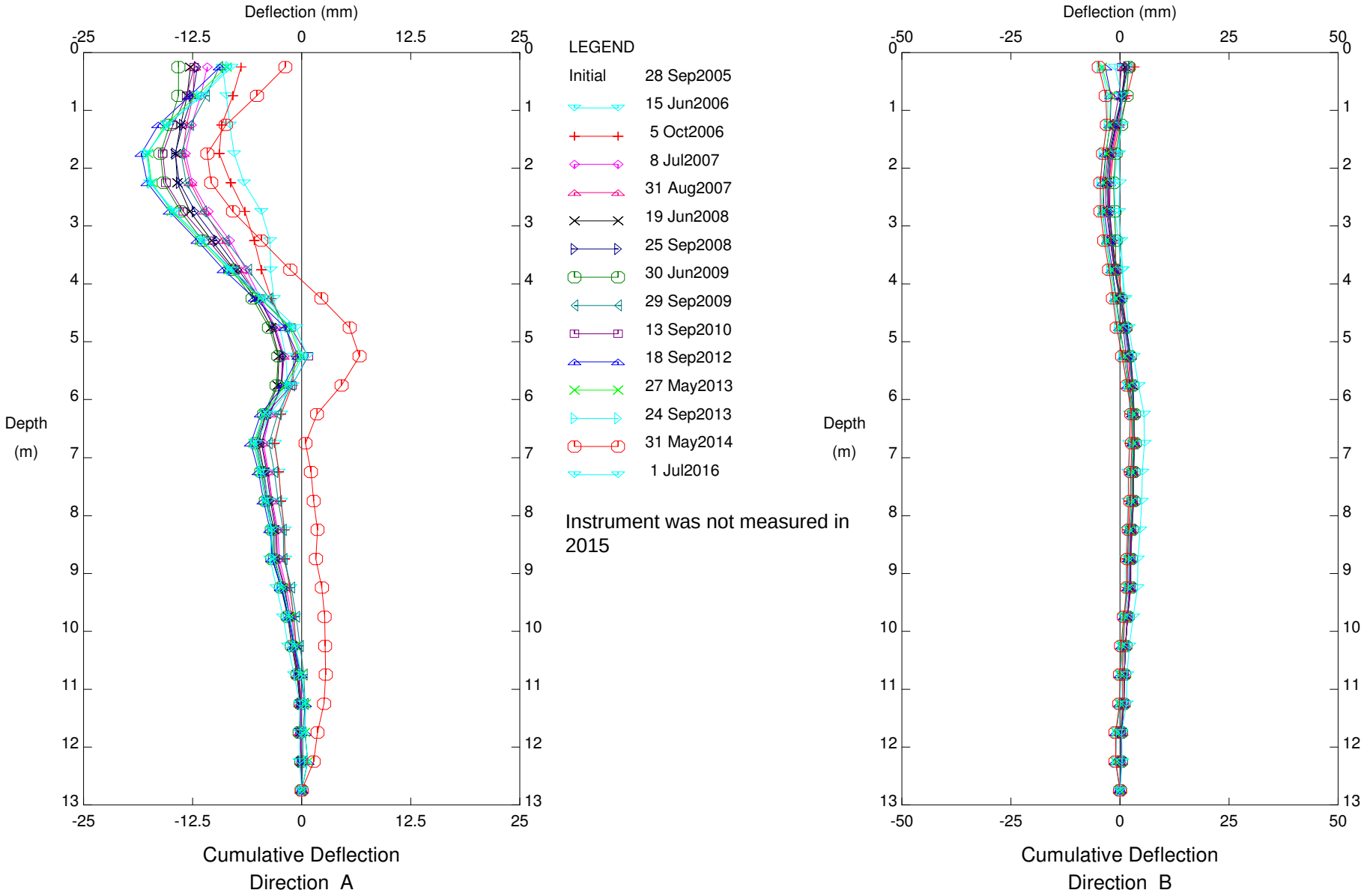


Canal Dike, Inclinometer BGC05-08



Z:\M\VCR\M09770A06 - GOY-Faro 2016-17 Geotech\300 Design\Inclinometer Data\2016 Spring Visit\July2016-BGC05-08.gtl

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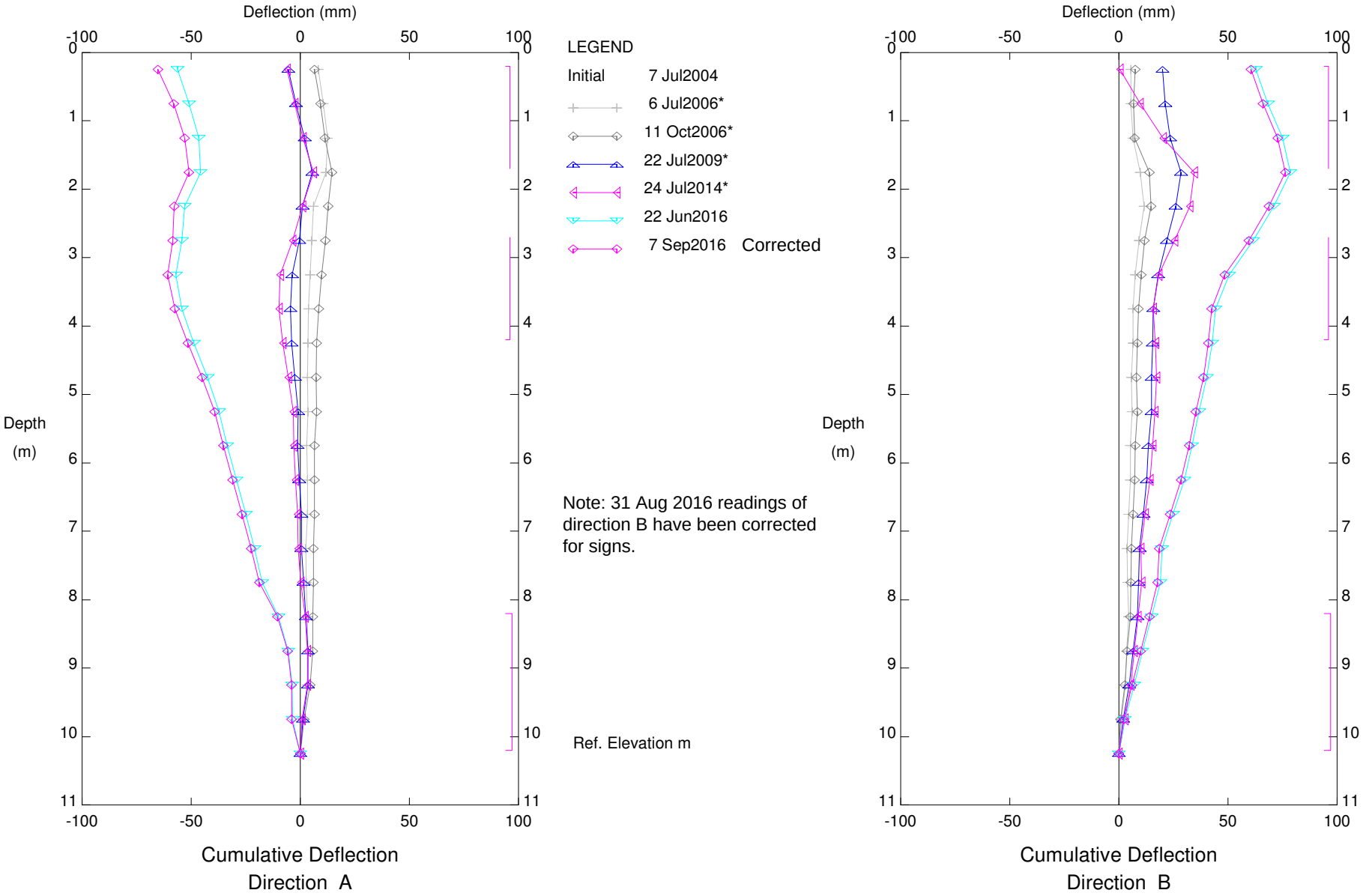
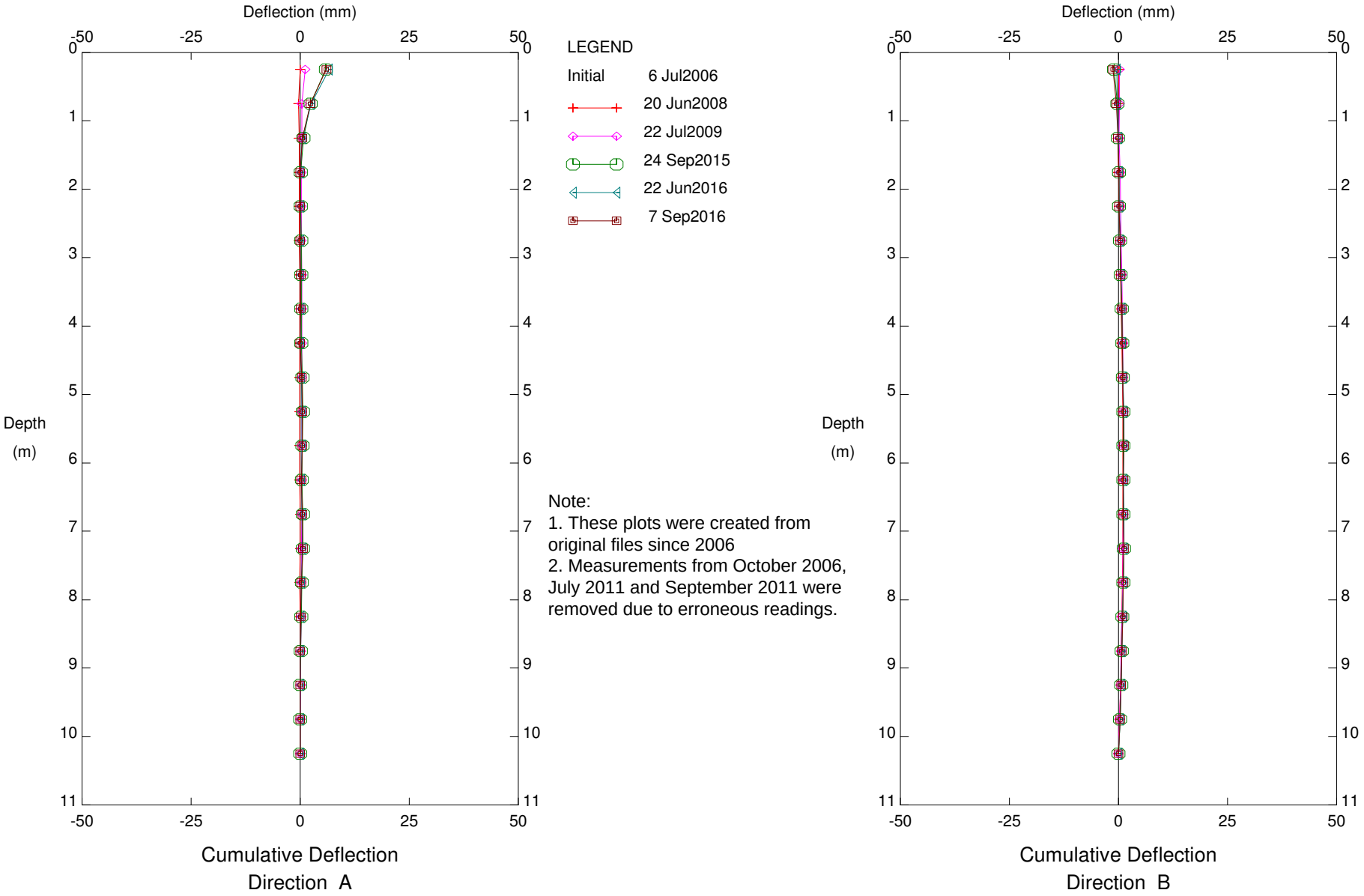



BS-10, Inclinometer 1+900

Denison Environmental Service

Sets marked * include zero shift and/or rotation corrections.

Klohn Crippen Berger Ltd. - Vancouver BC




Backslope, Inclinometer BS-5

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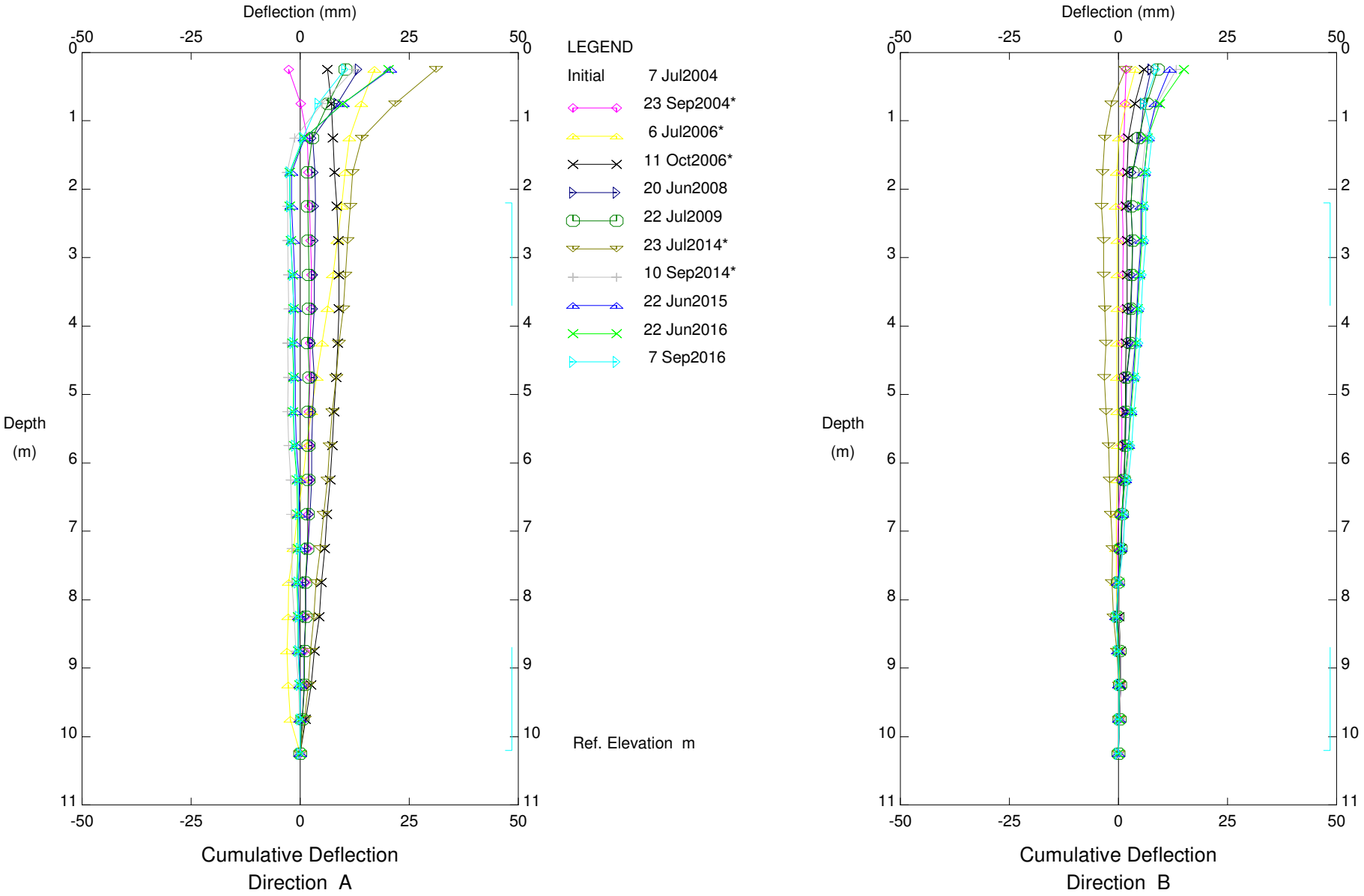


BS-9, Inclinometer 1+530

Denison Environmental Service

Sets marked * include zero shift and/or rotation corrections.

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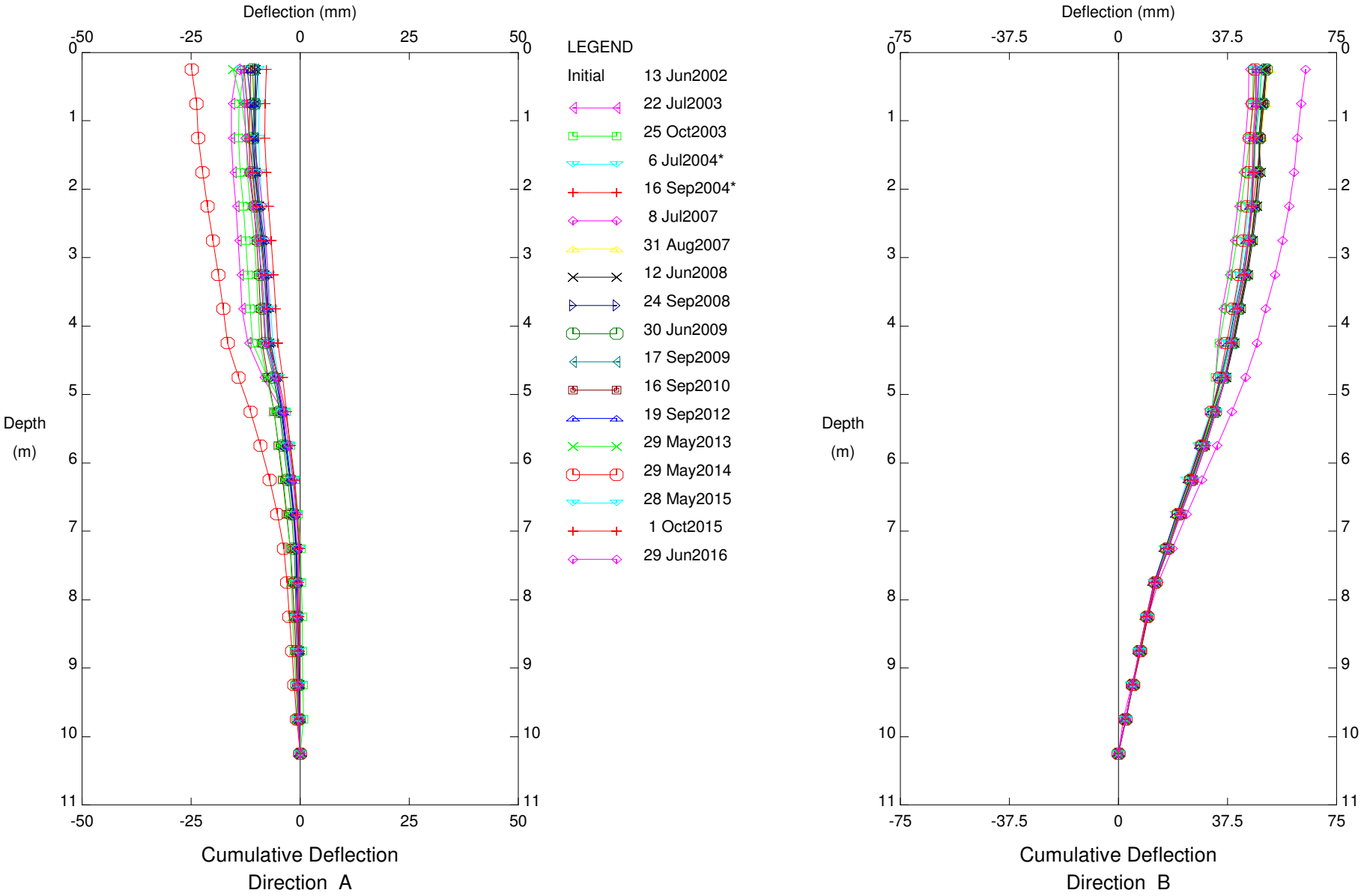
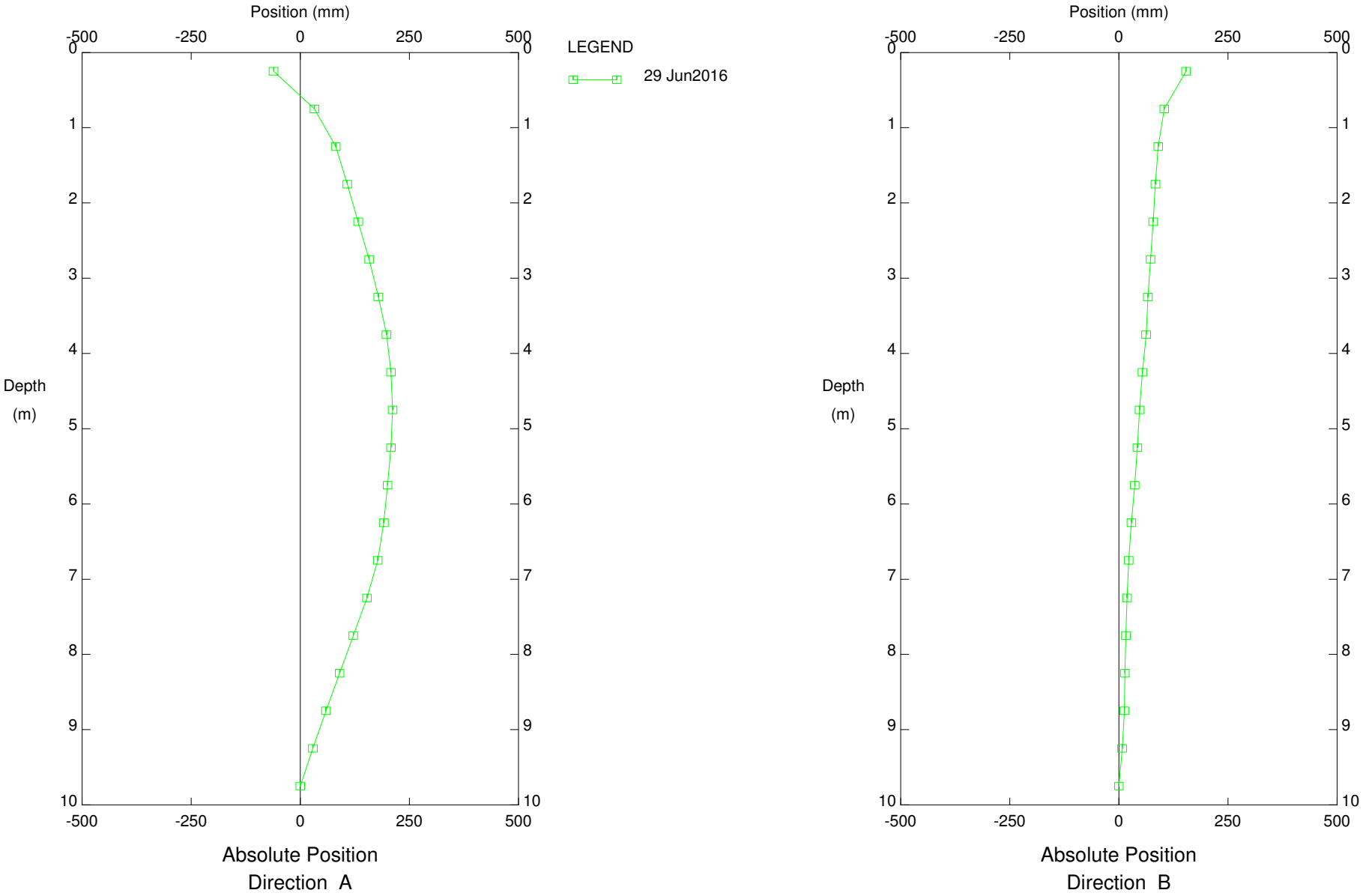



CD-10, Inclinometer 0+990

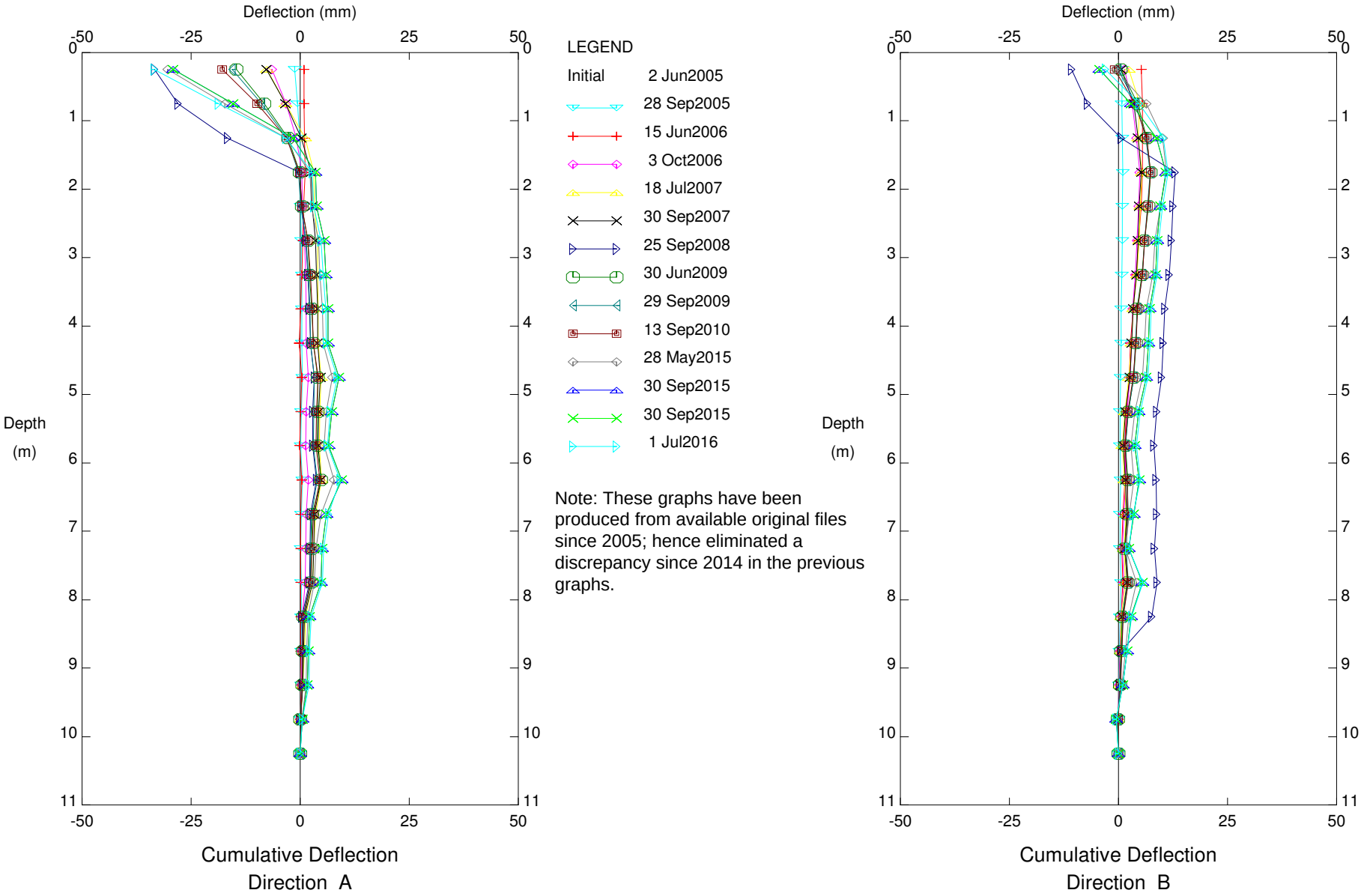
Sets marked * include zero shift and/or rotation corrections.

Klohn Crippen Berger Ltd. - Vancouver BC



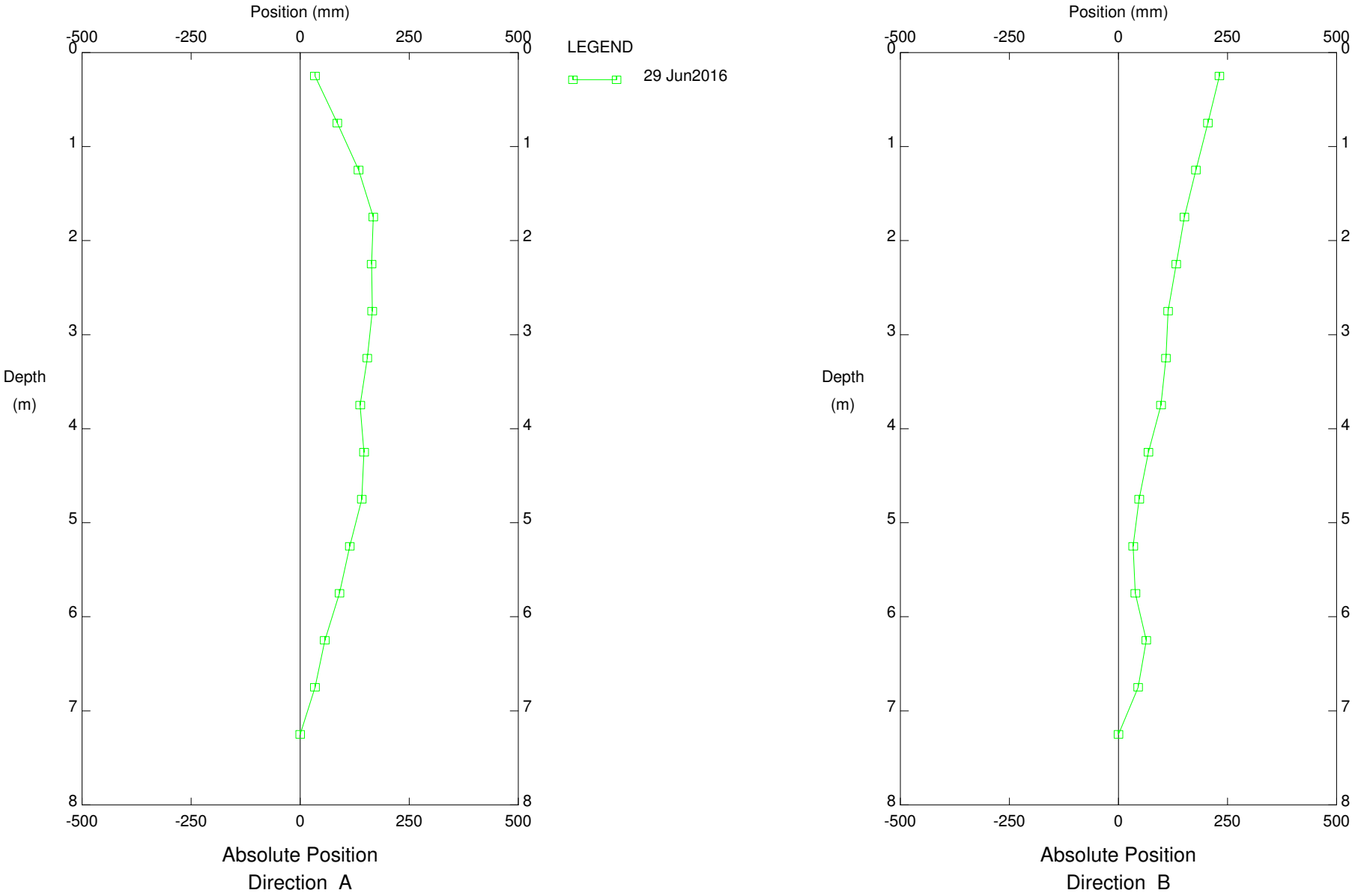

Canal Dyke, Inclinometer CD-15

Klohn Crippen Berger Ltd. - Vancouver BC




Canal Dyke, Inclinometer CD-21

Klohn Crippen Berger Ltd. - Vancouver BC

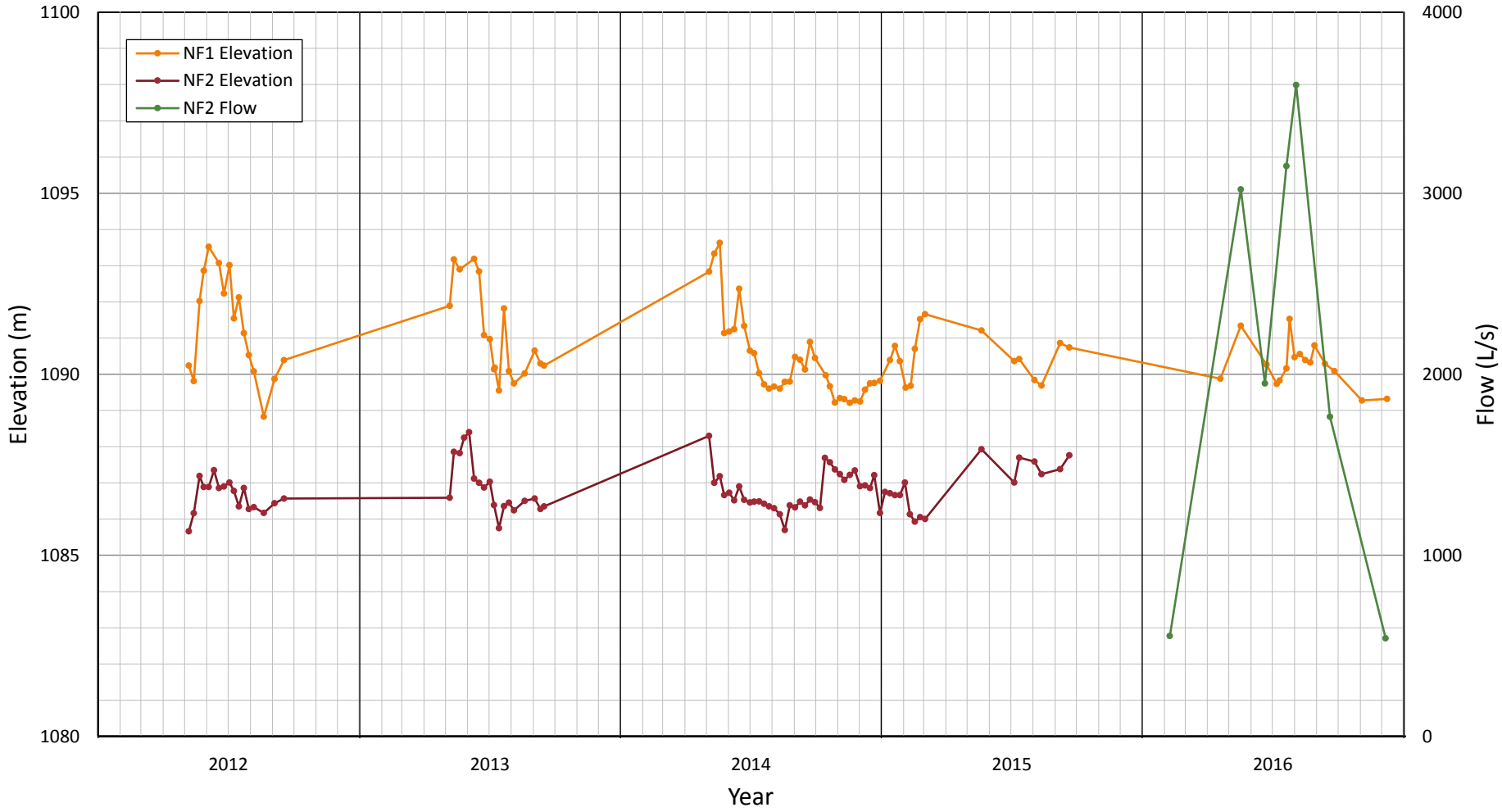



Spoil Pile, Inclinometer SP-2

# APPENDIX II-F

## North Fork Rock Drain

F1 – Water Level and Downstream Flow



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TITLE: NORTH FORK ROCK DRAIN
WATER LEVEL AND DOWNSTREAM FLOW

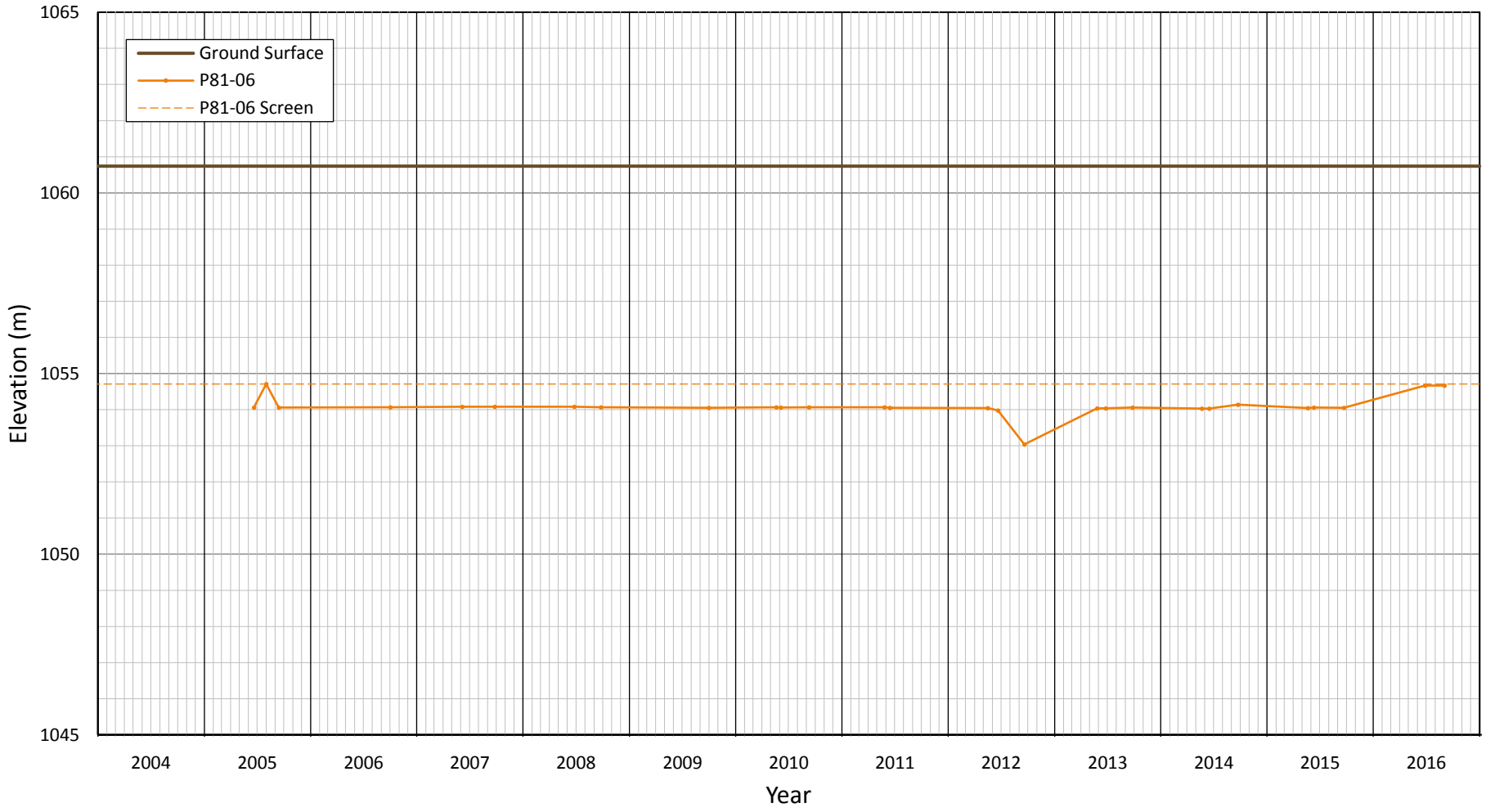
PROJECT No. M09770A06

FIG No. II-F1-1

# APPENDIX II-G

## Secondary Dam

G1 – Piezometers

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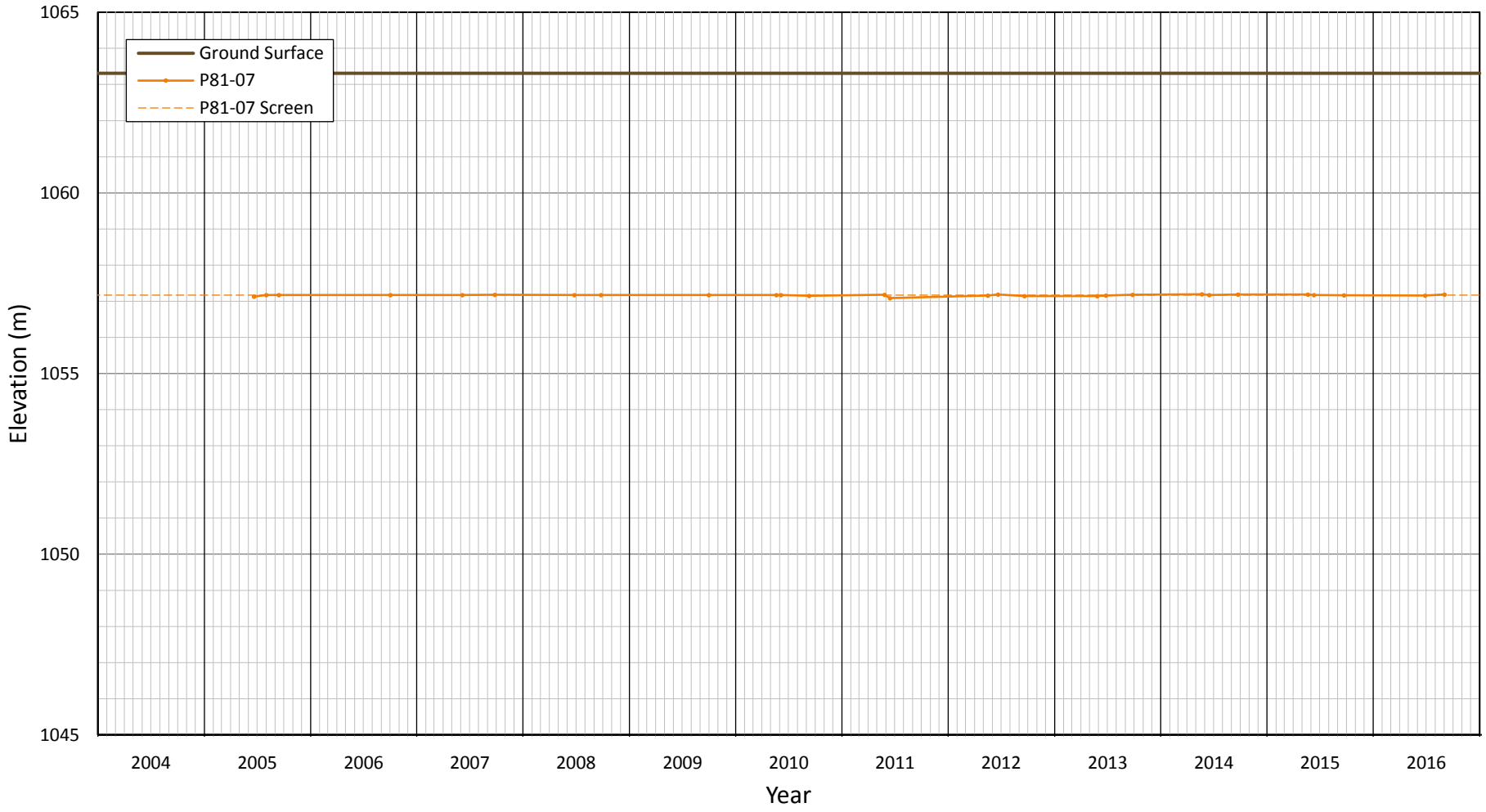
TITLE

SECONDARY DAM
PIEZOMETERS
P81-06

PROJECT No. M09770A06

FIG No. II-G1-1



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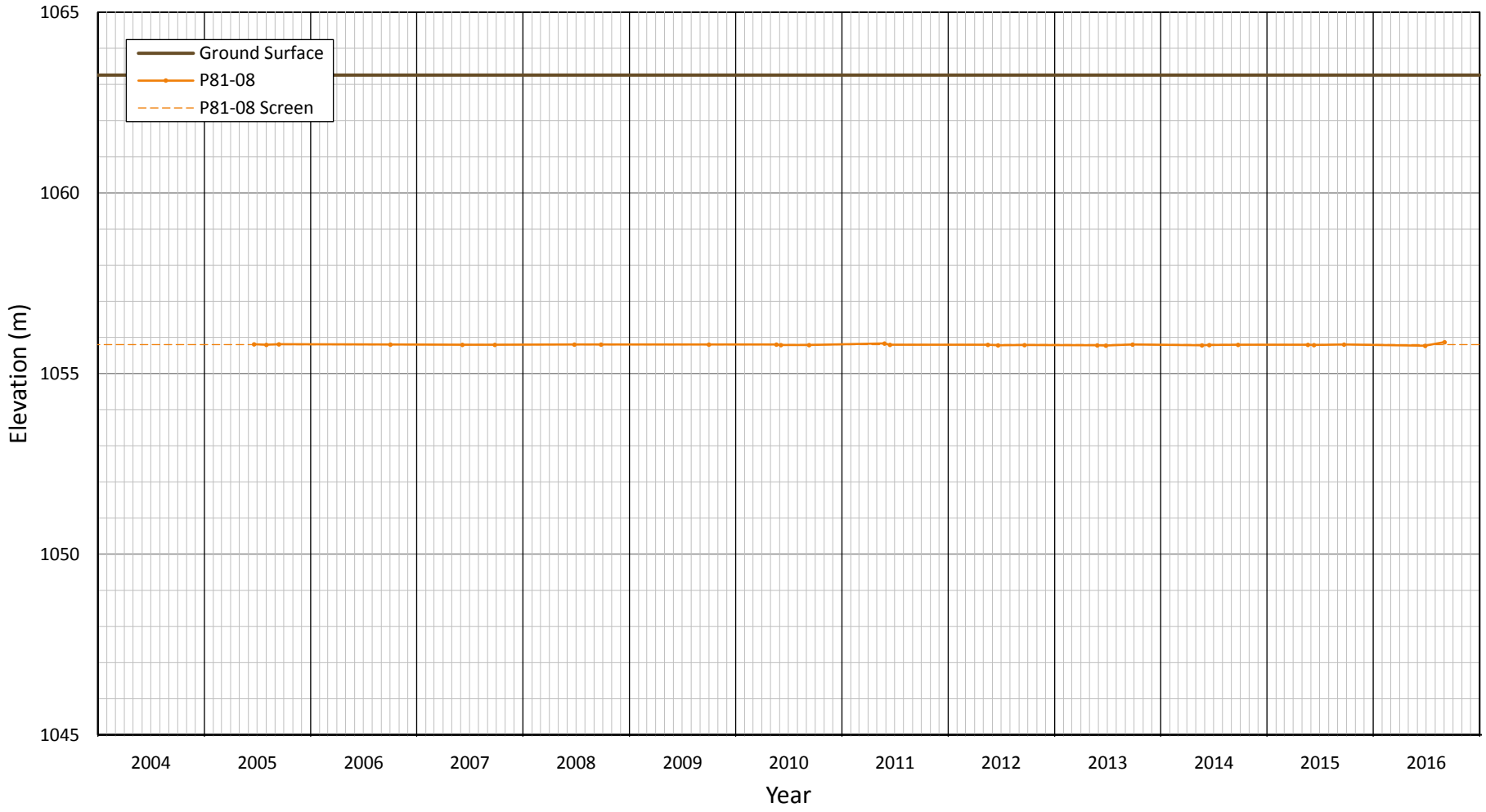
PIEZOMETERS
P81-07

PROJECT No. M09770A06

FIG No. II-G1-2



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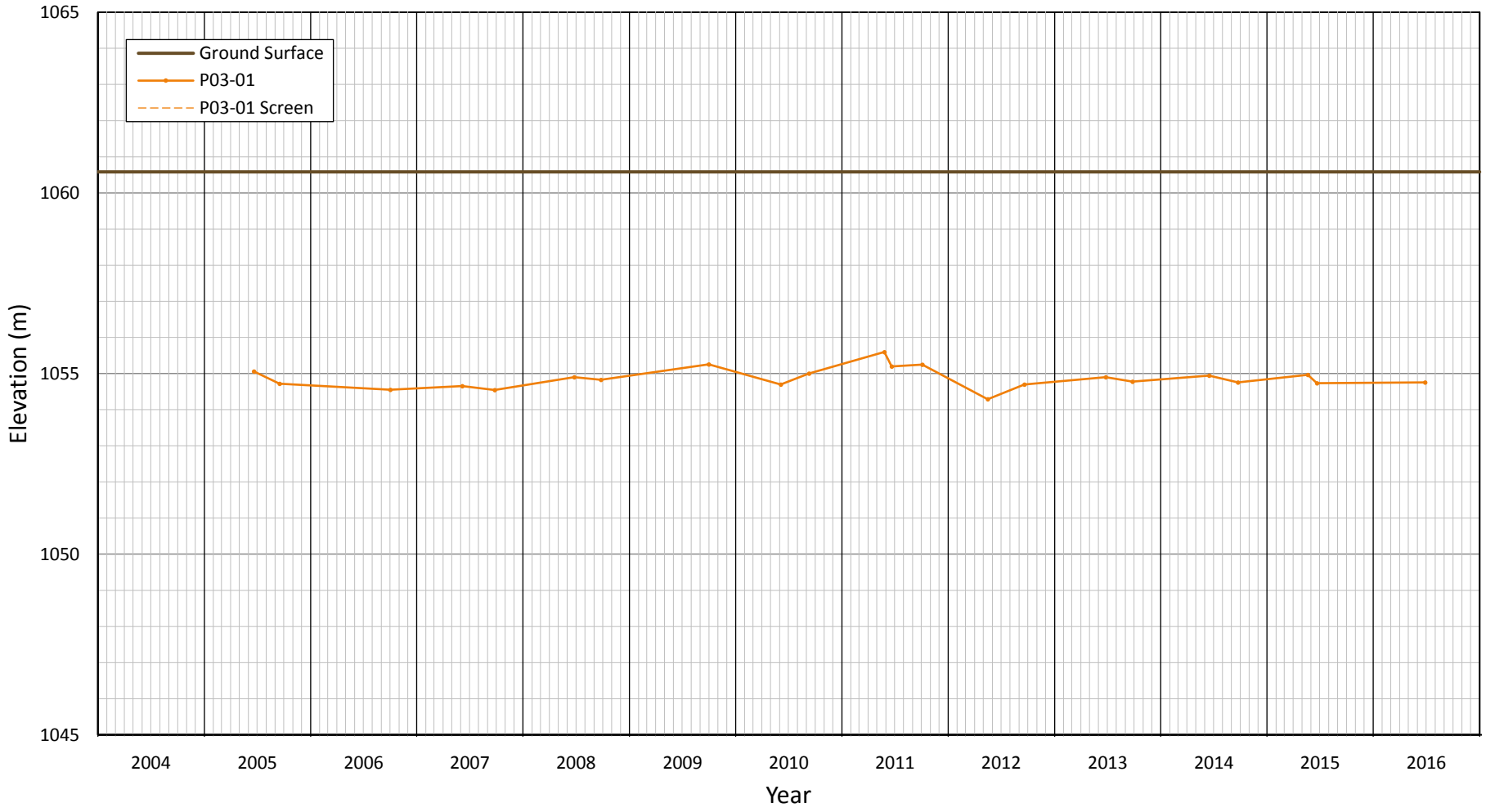
PIEZOMETERS
P81-08

PROJECT No. M09770A06

FIG No. II-G1-3



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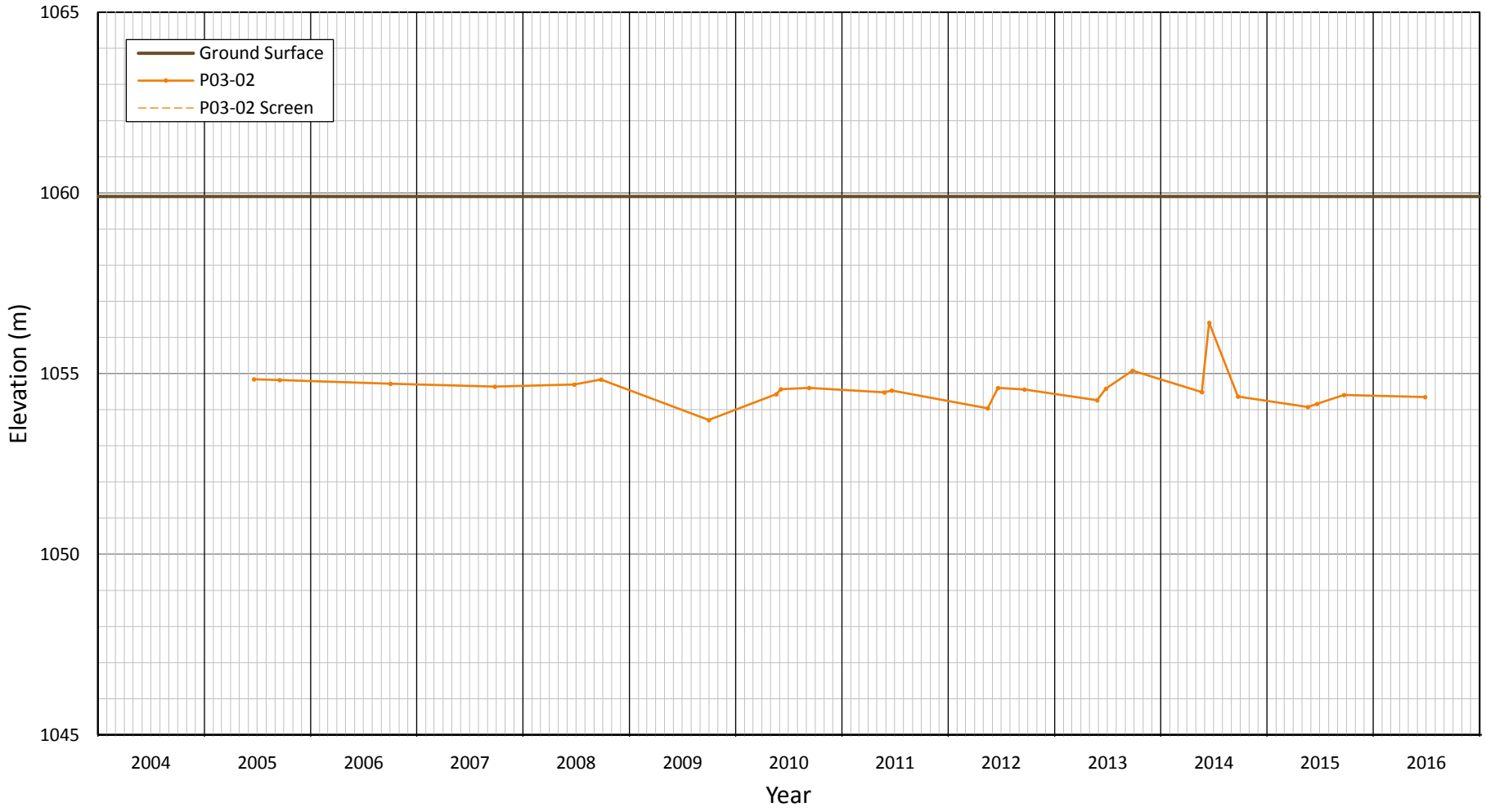
SECONDARY DAM
PIEZOMETERS
P03-01

PROJECT No. M09770A06

FIG No. II-G1-4



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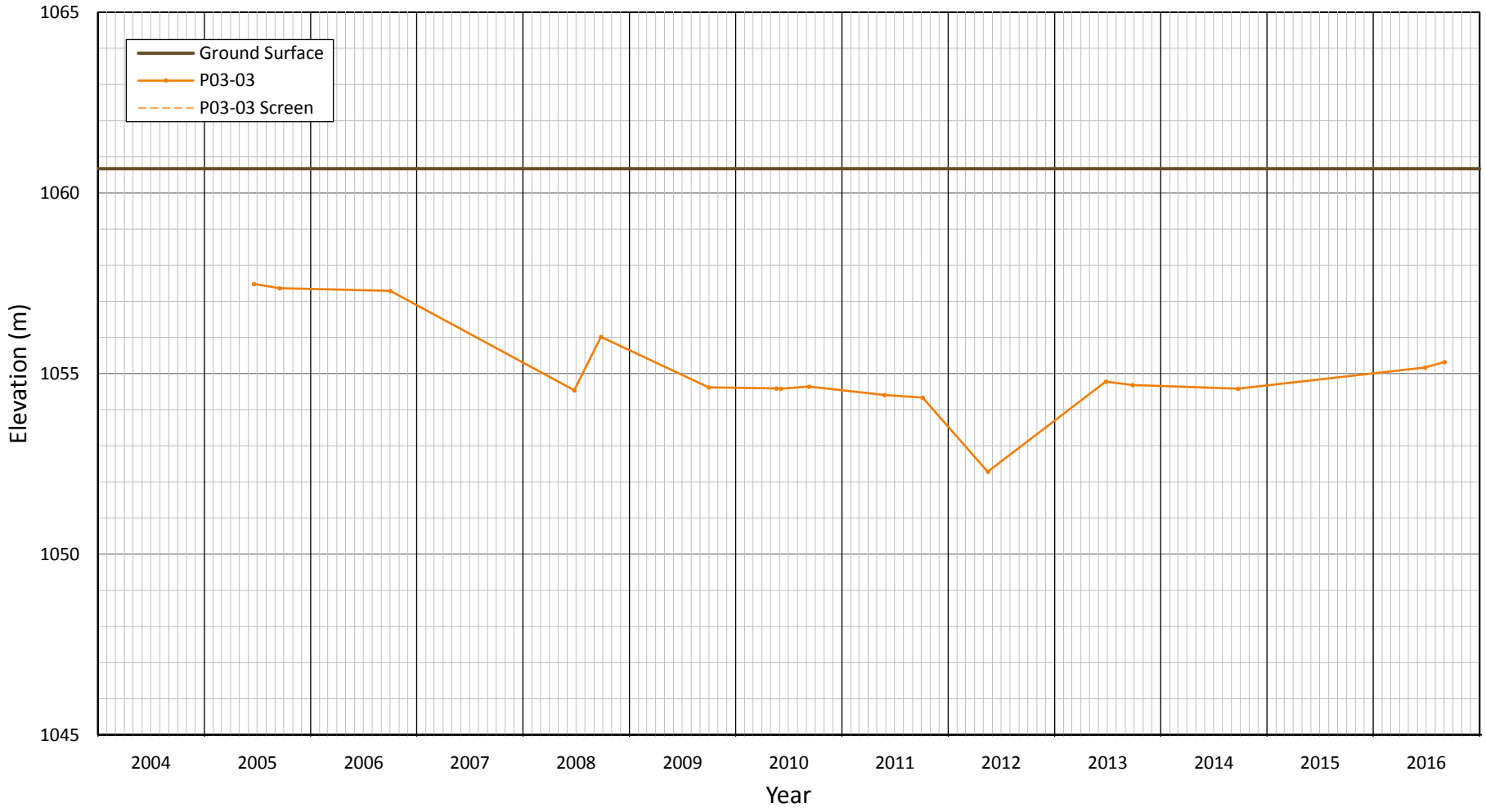
PIEZOMETERS
P03-02

PROJECT No. M09770A06

FIG No. II-G1-5



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SECONDARY DAM
PIEZOMETERS
P03-03

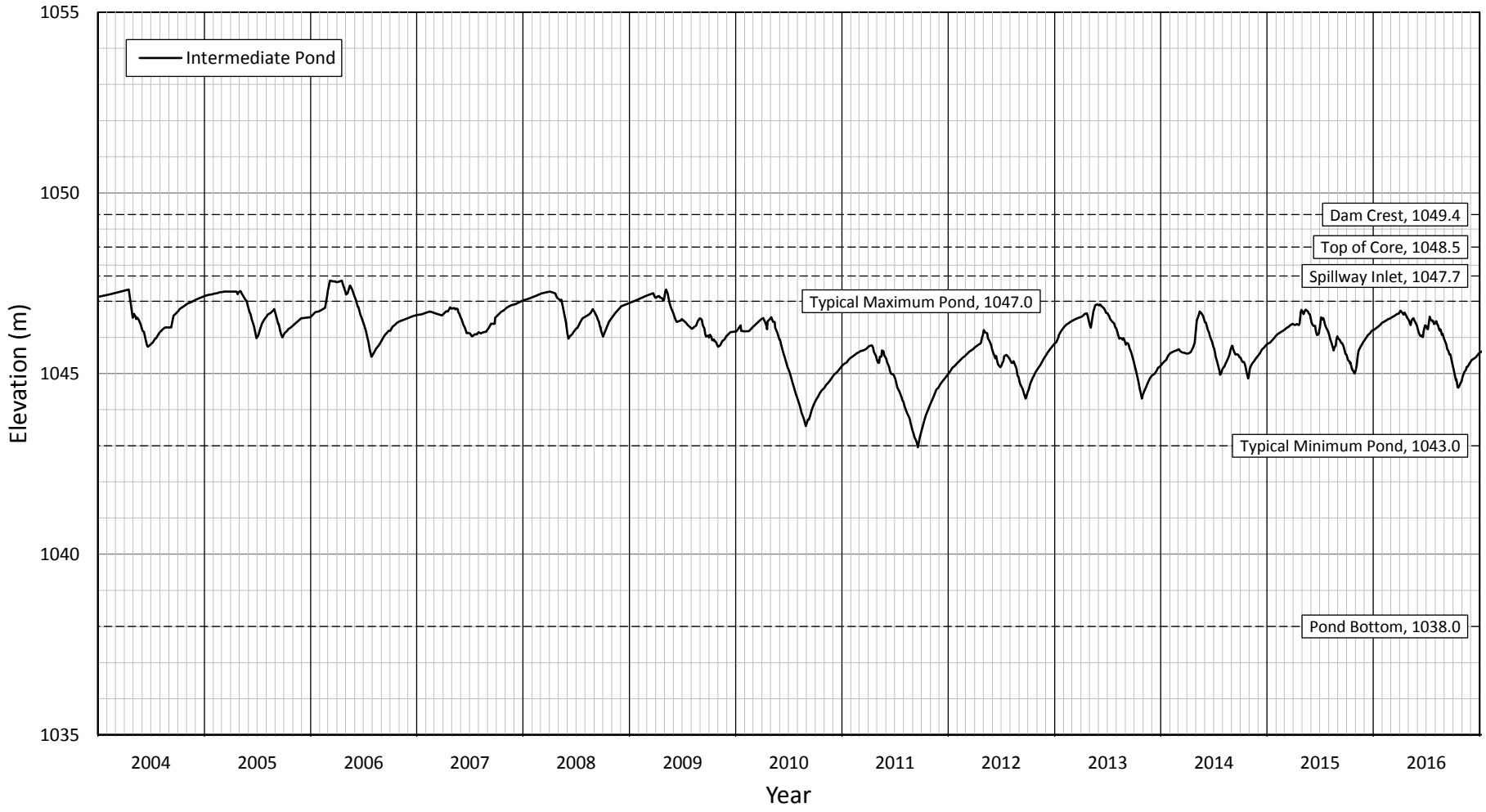
PROJECT No. M09770A06

FIG No. II-G1-6

# APPENDIX II-H

## Intermediate Dam

H1 – Pond Level (Intermediate Pond)
H2 – Piezometers



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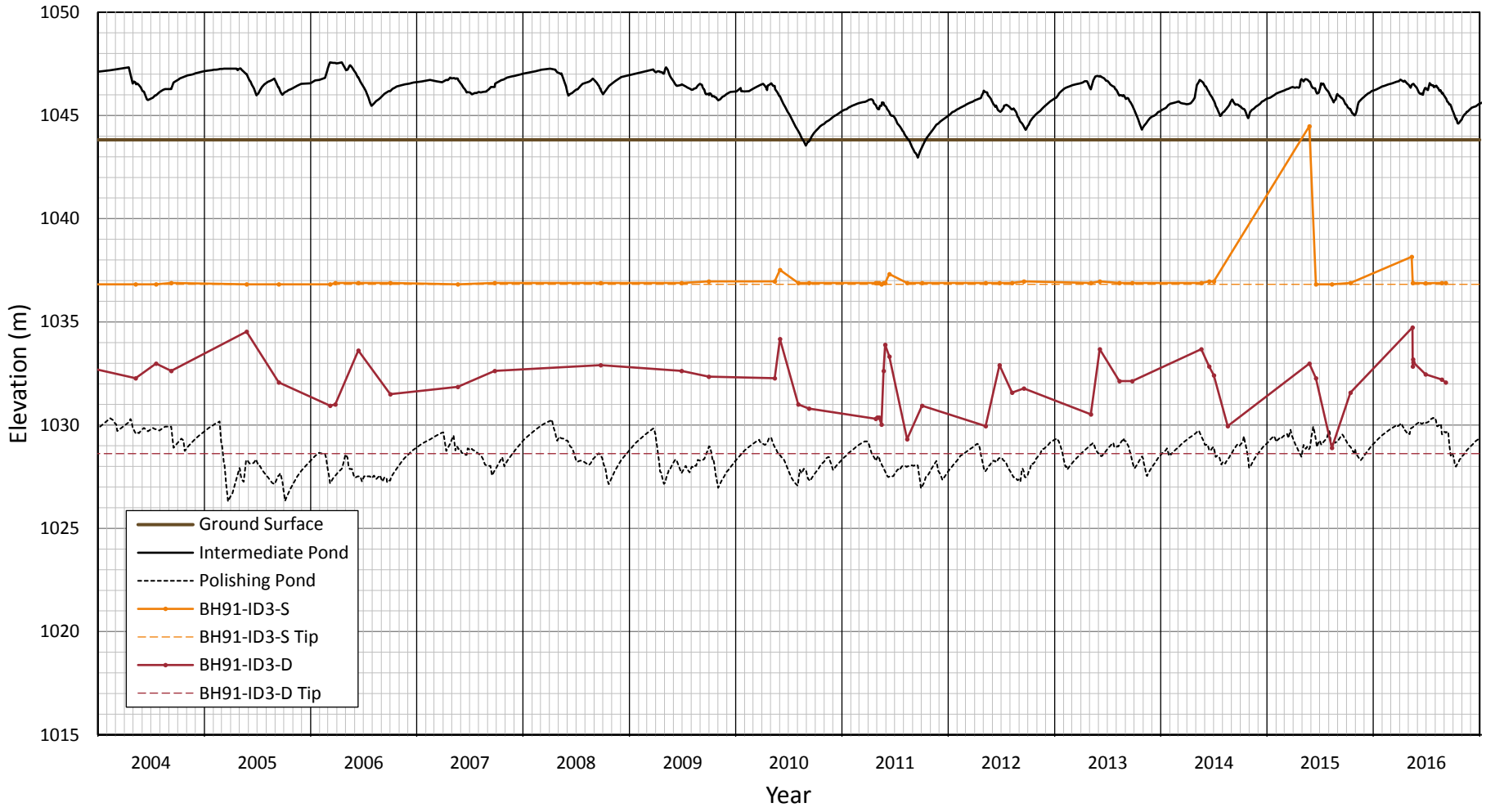
2016 ANNUAL GEOTECHNICAL REVIEW

TITLE

INTERMEDIATE DAM
POND LEVEL

PROJECT No. M09770A06

FIG No. II-H1-1



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INTERMEDIATE DAM
PIEZOMETERS
BH91-ID3

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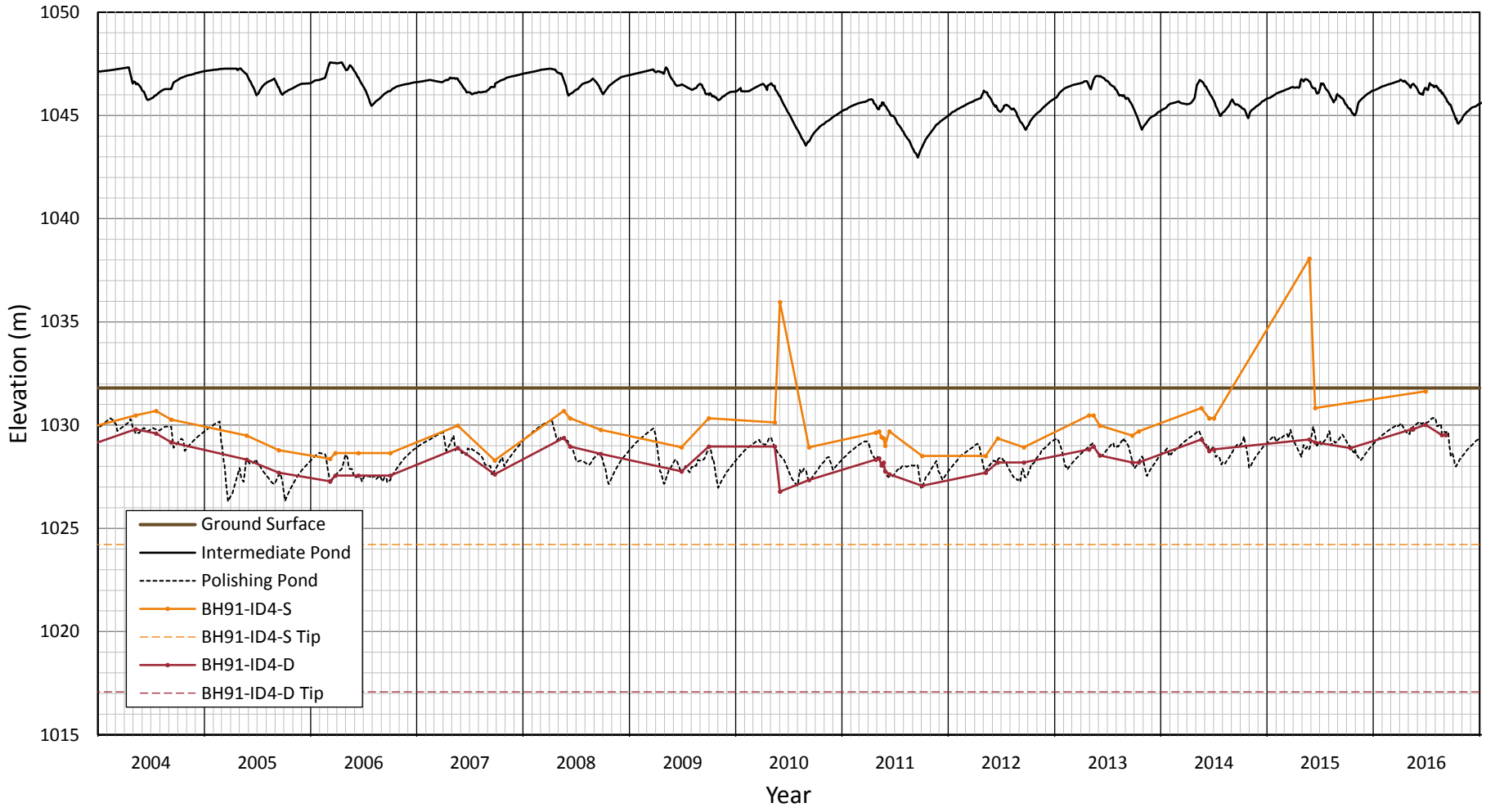
FIG No. II-H2-1



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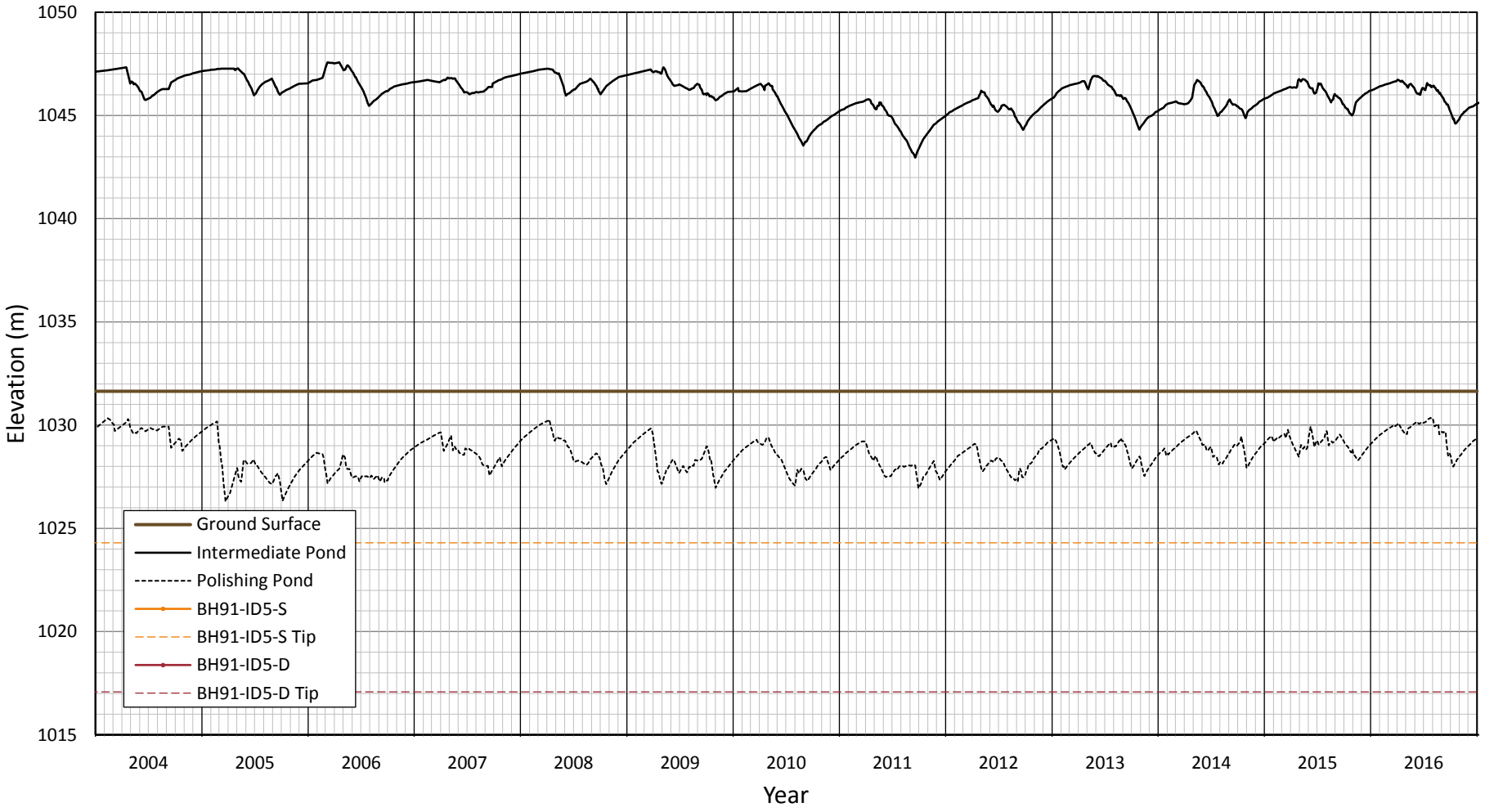
INTERMEDIATE DAM
PIEZOMETERS
BH91-ID4

PROJECT No. M09770A06

FIG No. II-H2-2




Notes:
1. Instruments not functioning. No valid readings have been reported.



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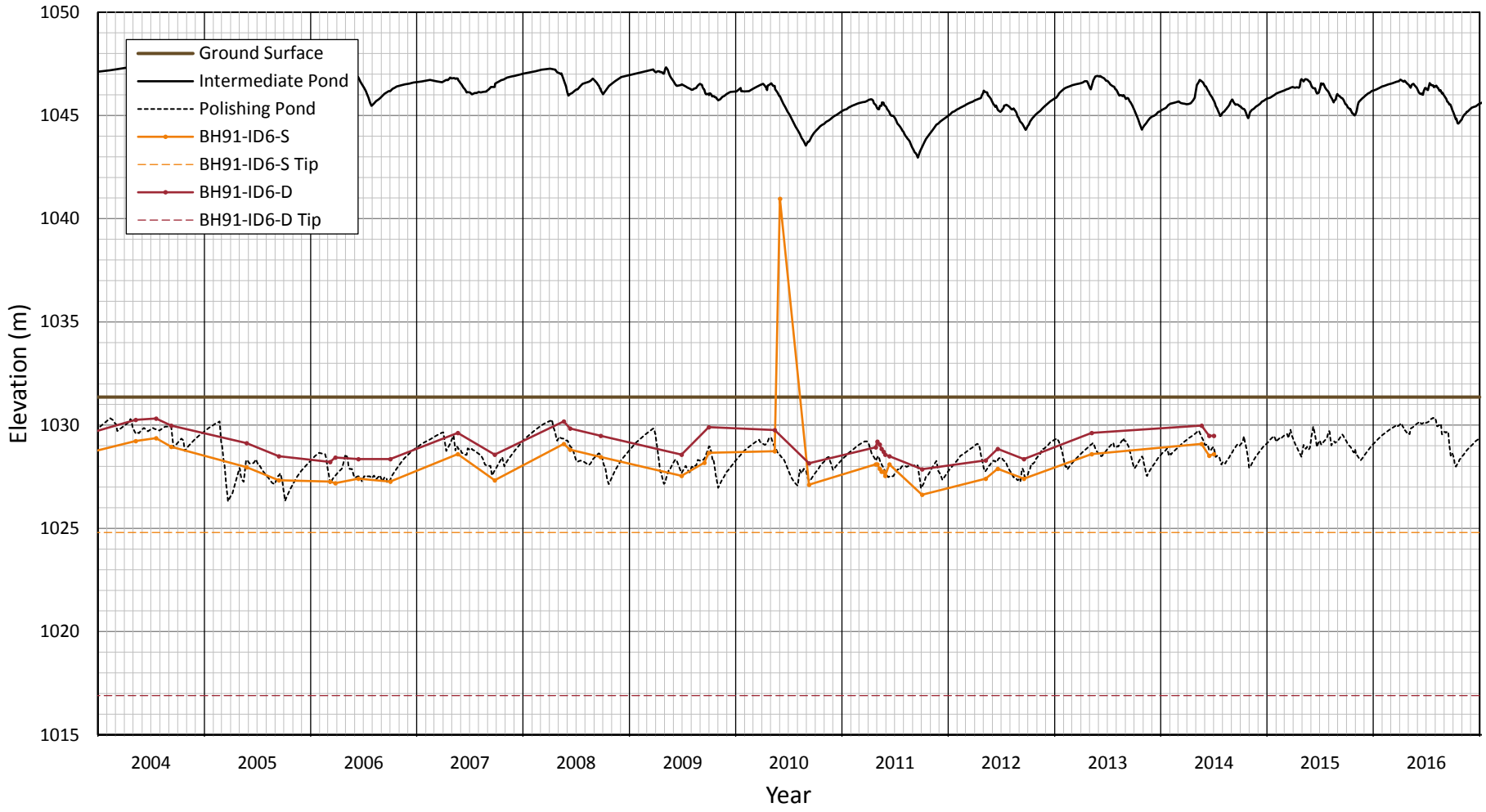
TITLE: INTERMEDIATE DAM
PIEZOMETERS
BH91-ID5

PROJECT No. M09770A06

FIG No. II-H2-3



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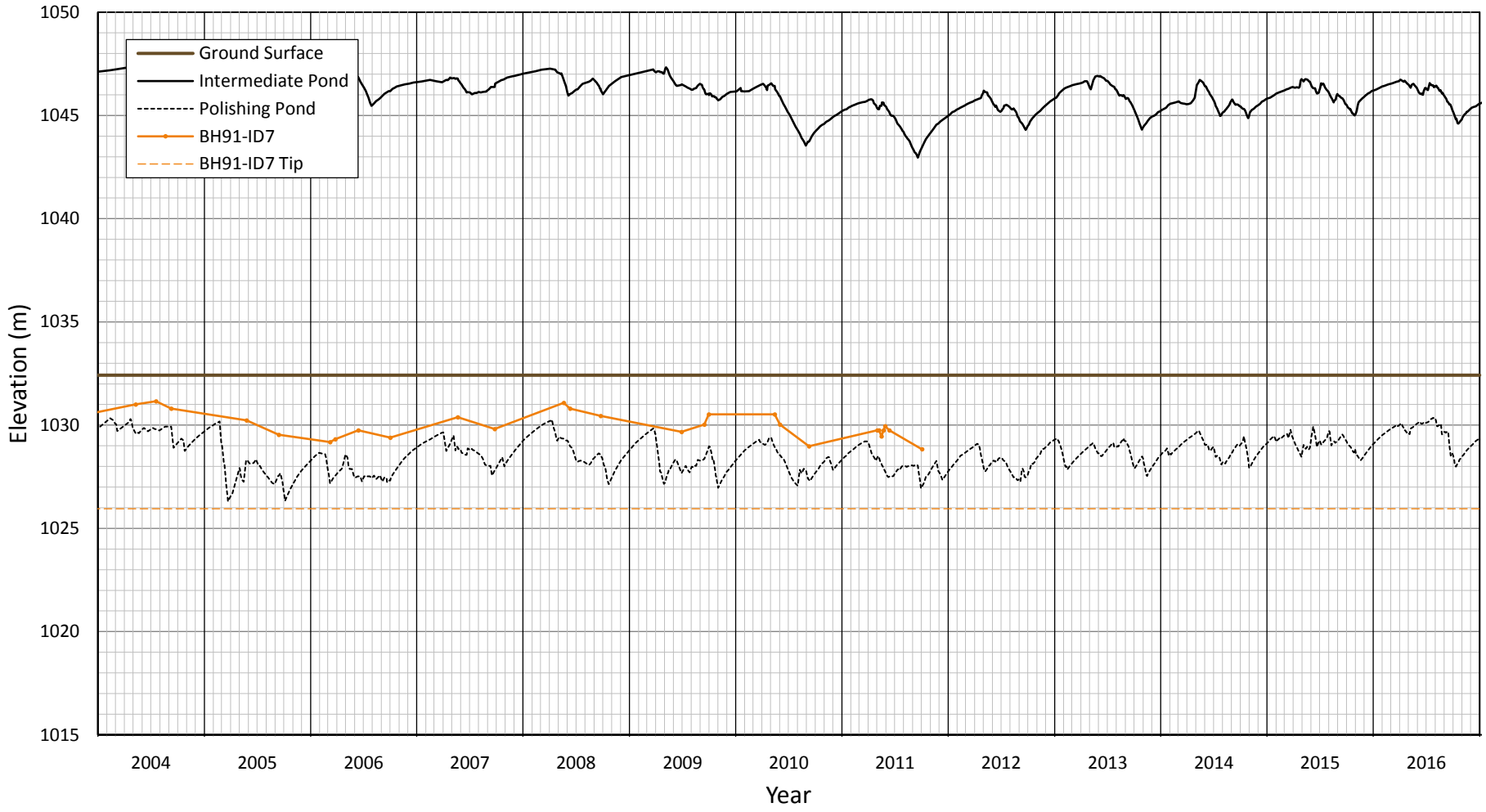
INTERMEDIATE DAM
PIEZOMETERS
BH91-ID6

PROJECT No. M09770A06

FIG No. II-H2-4



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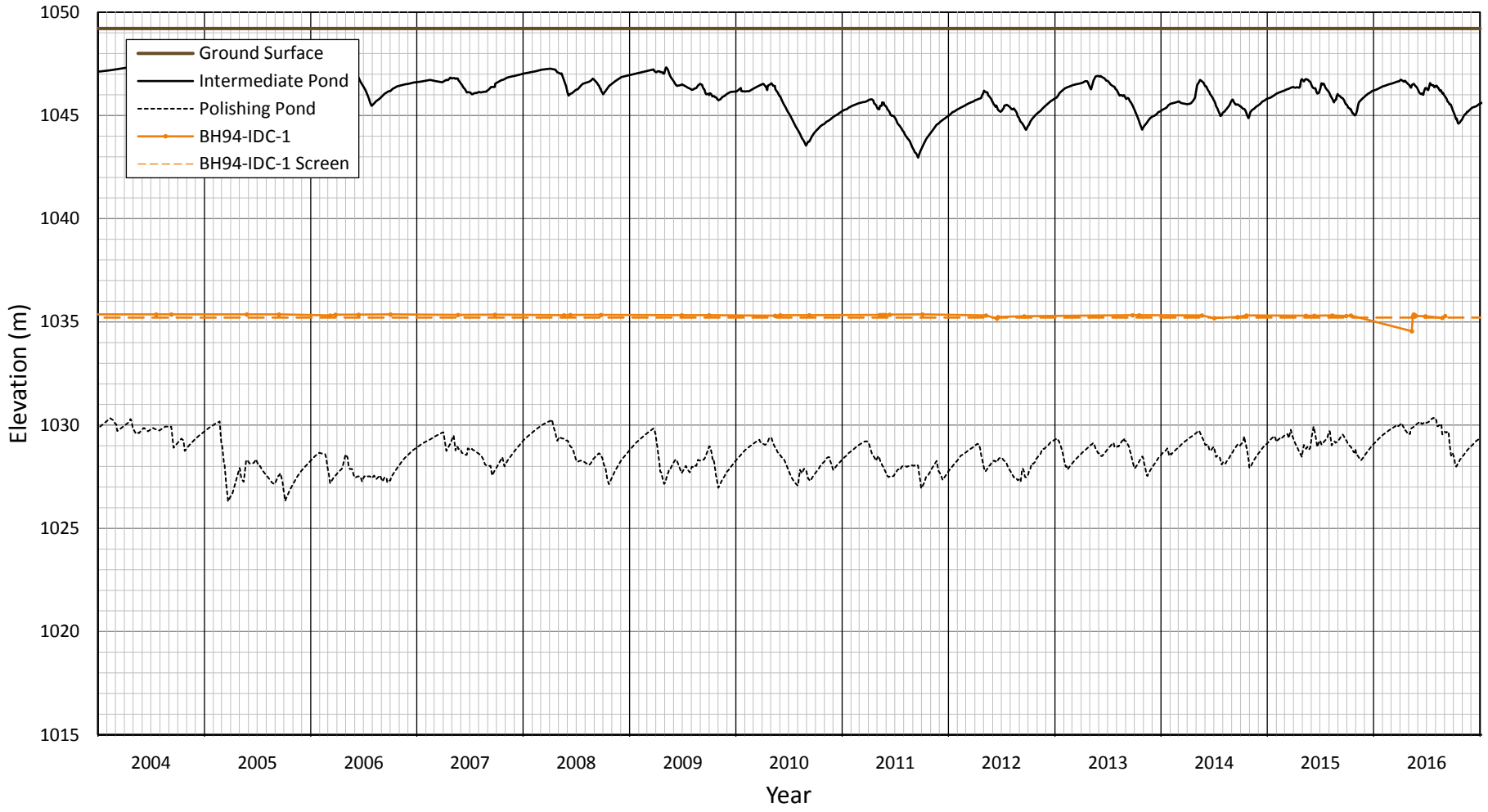
INTERMEDIATE DAM
PIEZOMETERS
BH91-ID7

PROJECT No. M09770A06

FIG No. II-H2-5



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2016 ANNUAL GEOTECHNICAL REVIEW

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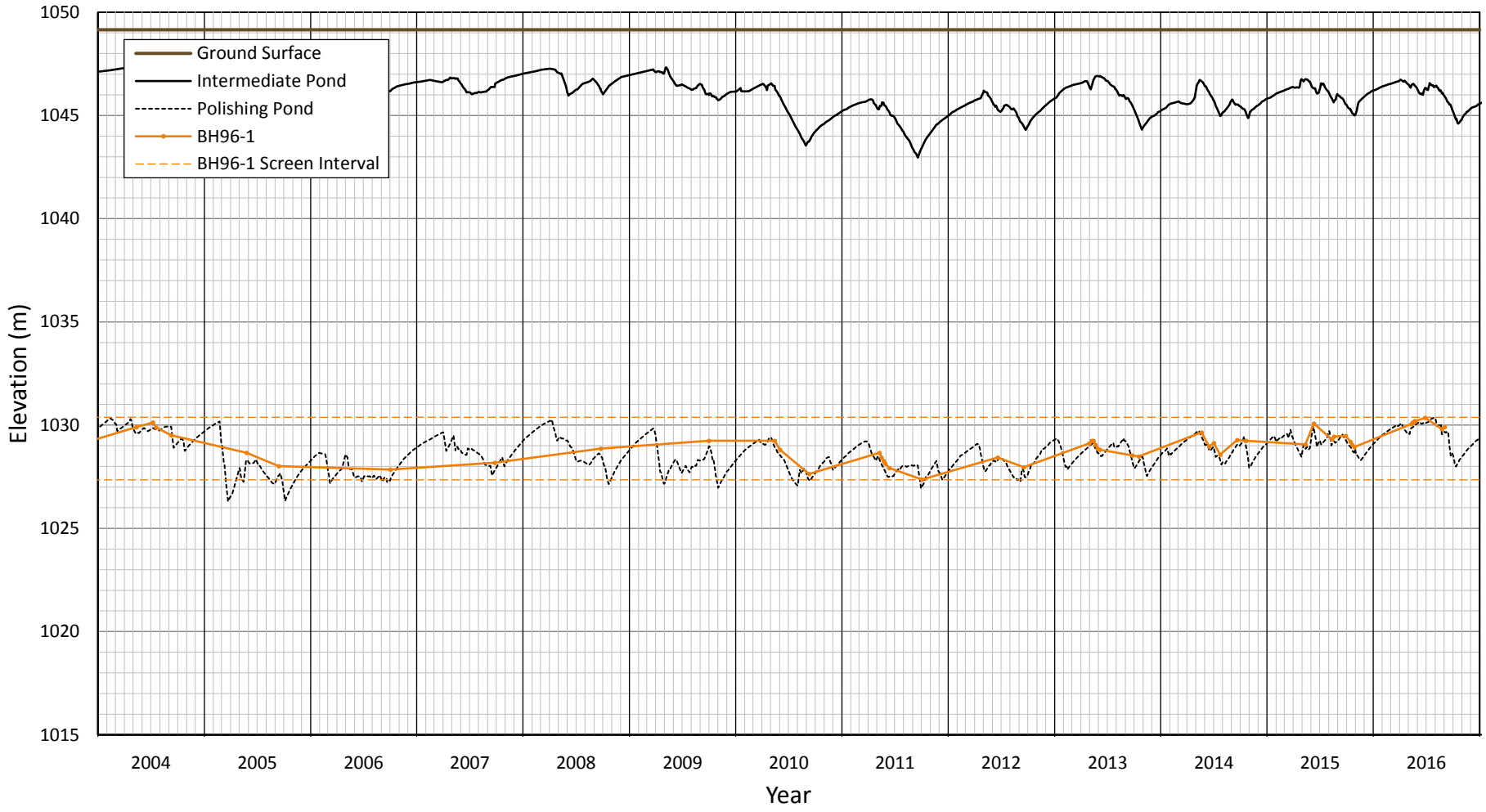
INTERMEDIATE DAM
PIEZOMETERS
BH94-IDC-1

PROJECT No. M09770A06

FIG No. II-H2-6



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2016 ANNUAL GEOTECHNICAL REVIEW

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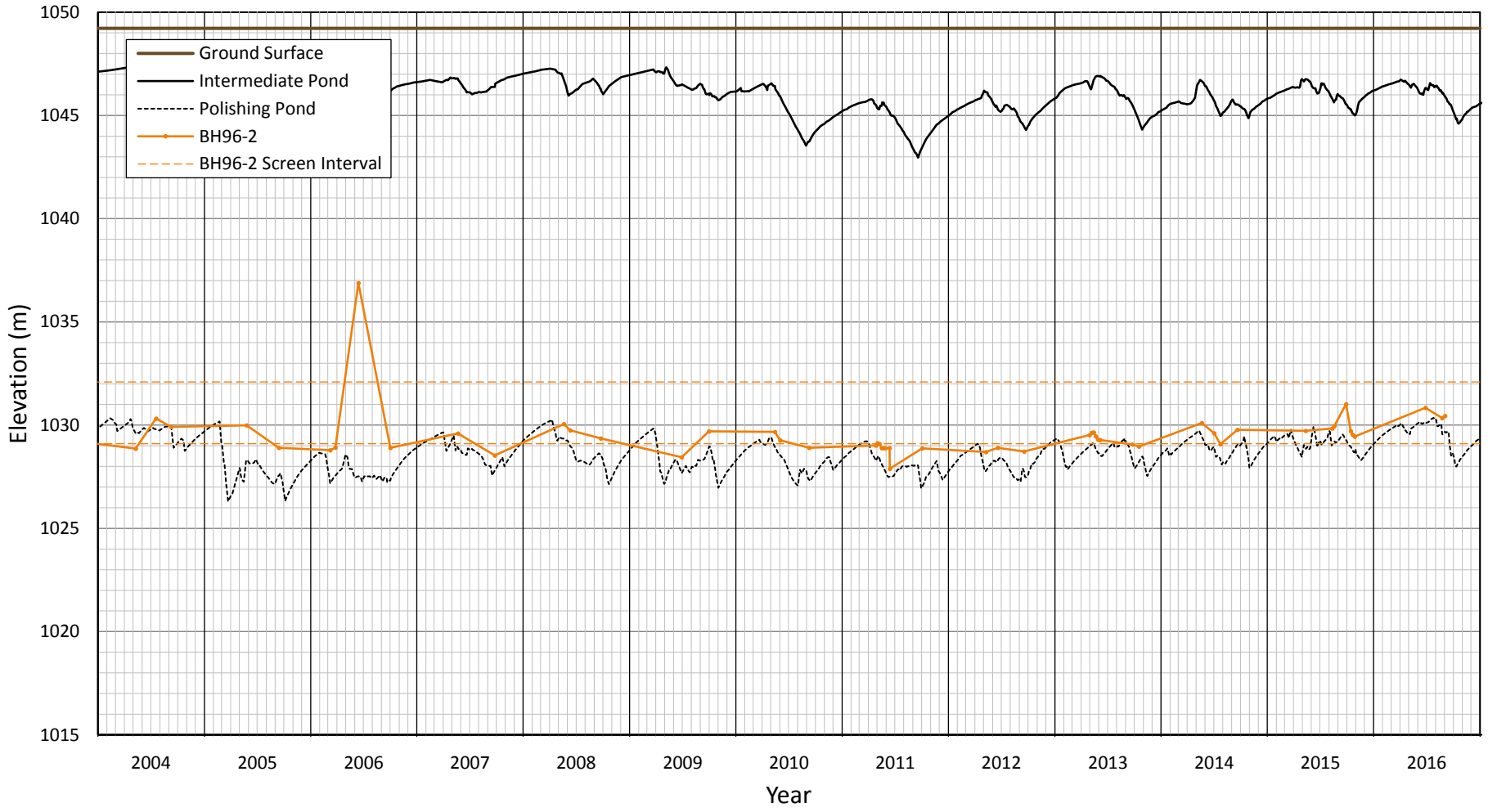
INTERMEDIATE DAM
PIEZOMETERS
BH96-1

PROJECT No. M09770A06

FIG No. II-H2-7



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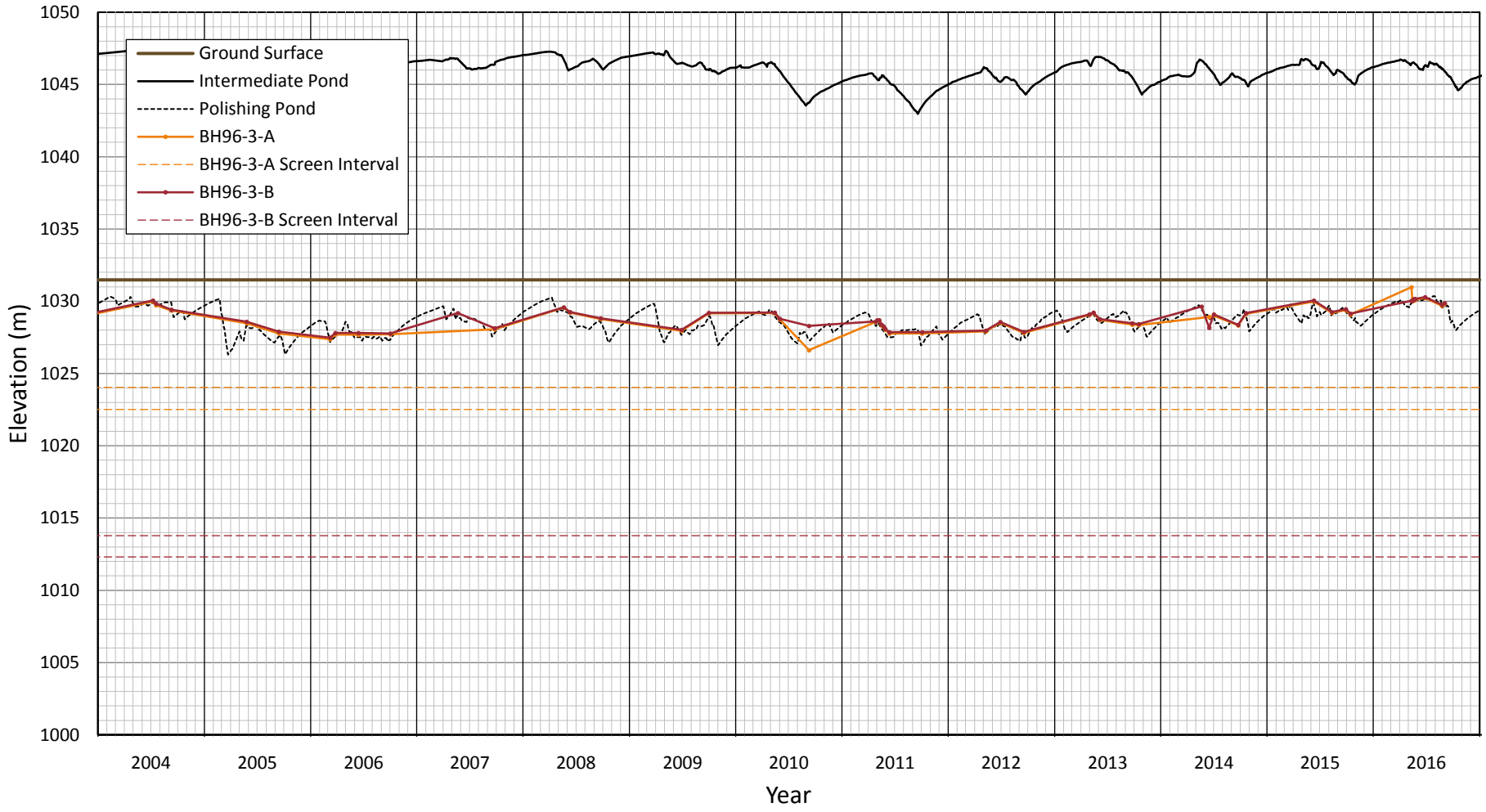
PIEZOMETERS
BH96-2

PROJECT No. M09770A06

FIG No. II-H2-8



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2016 ANNUAL GEOTECHNICAL REVIEW

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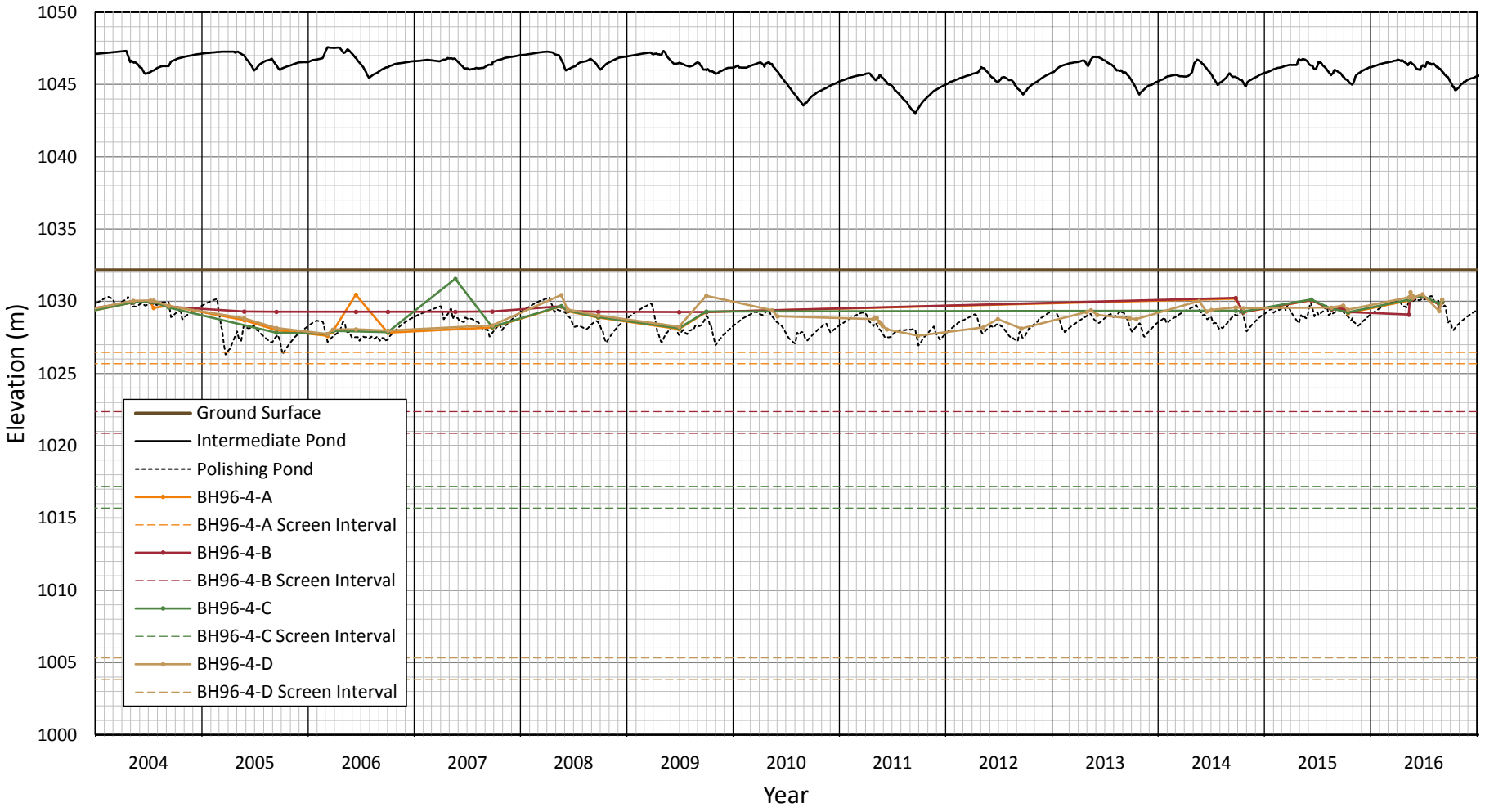
INTERMEDIATE DAM
PIEZOMETERS
BH96-3

PROJECT No. M09770A06

FIG No. II-H2-9



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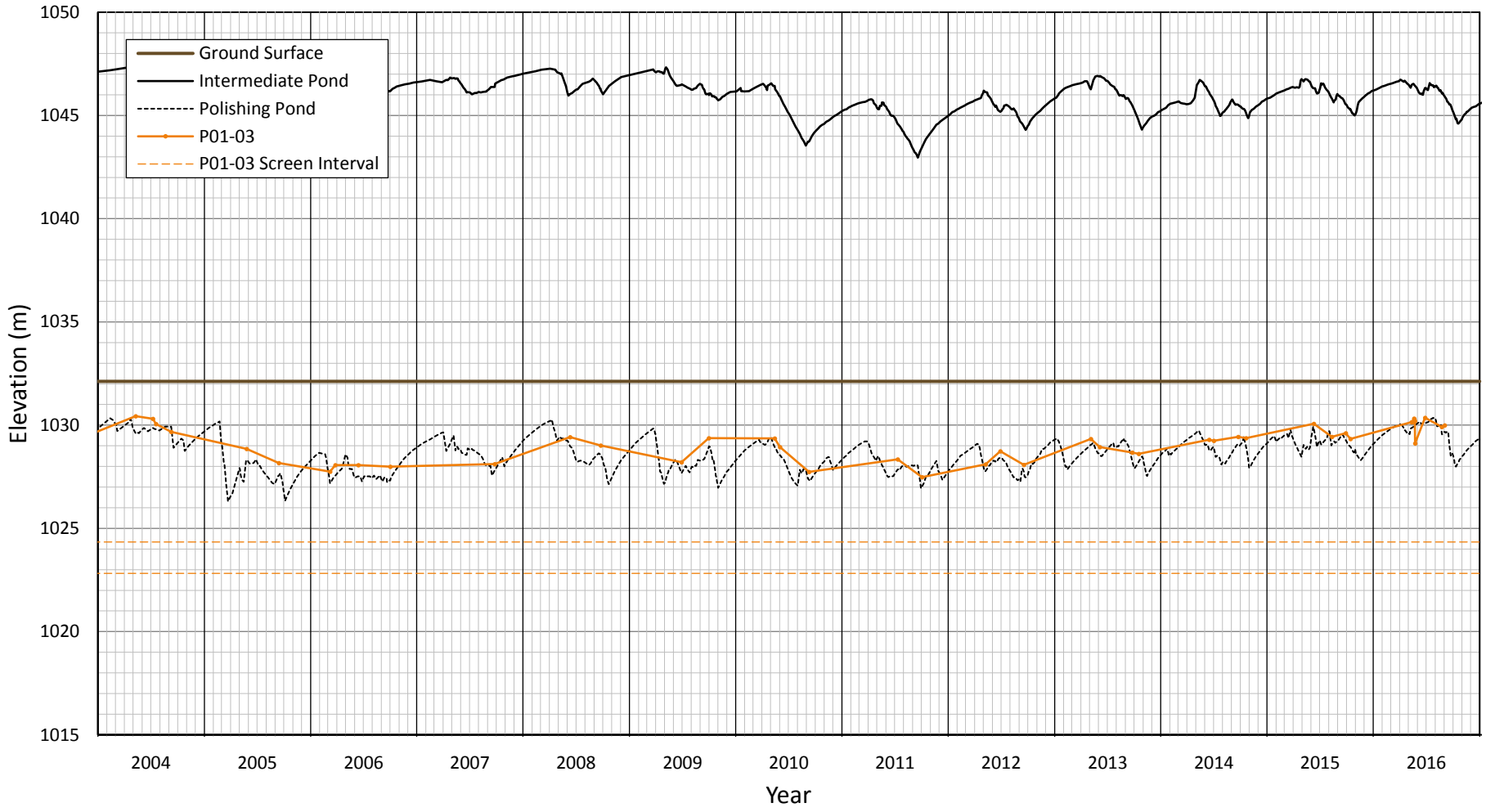
INTERMEDIATE DAM
PIEZOMETERS
BH96-4

PROJECT No. M09770A06

FIG No. II-H2-10



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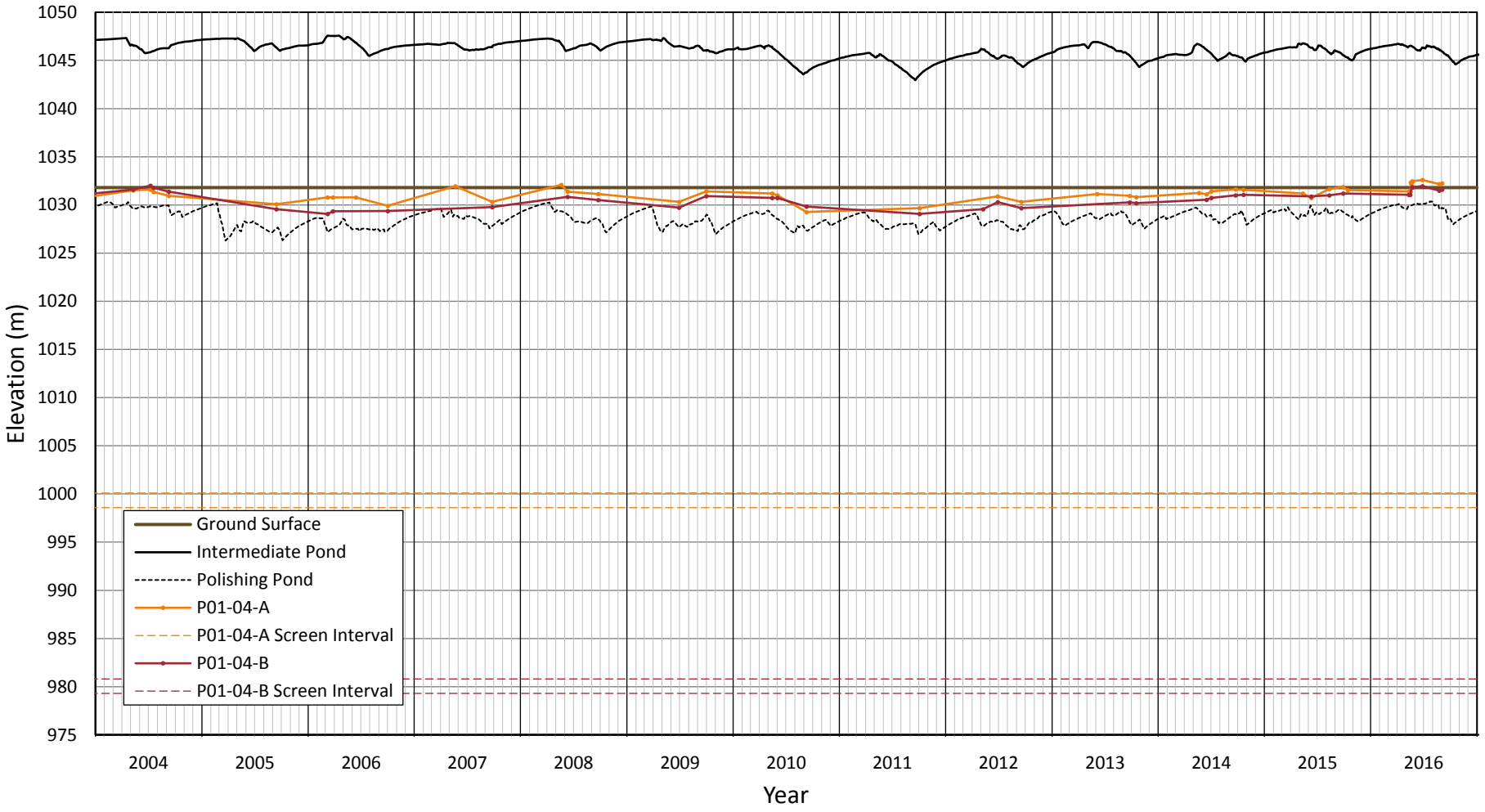
INTERMEDIATE DAM
PIEZOMETERS
P01-03

PROJECT No. M09770A06

FIG No. II-H2-11



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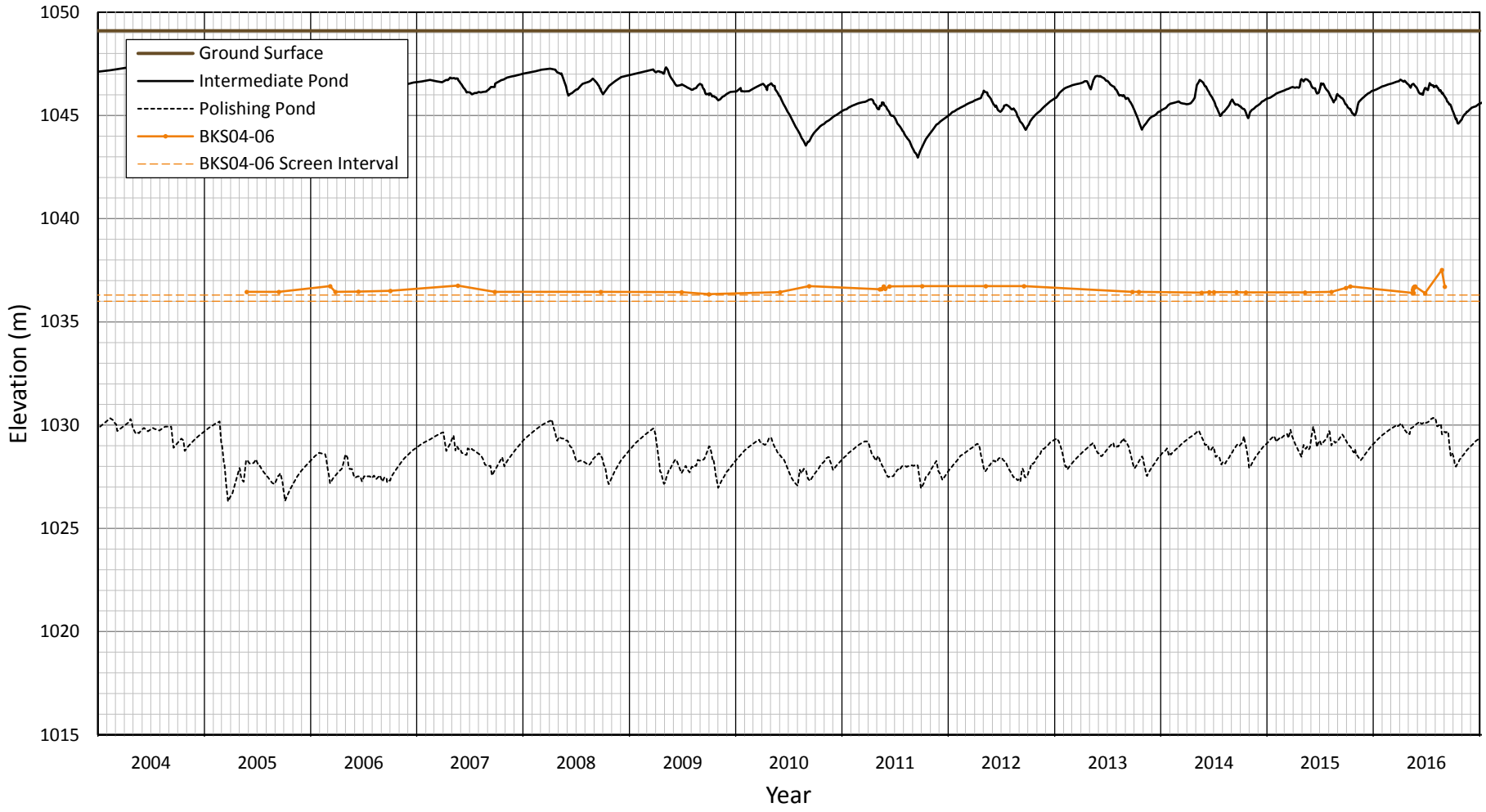
P01-04

PROJECT No. M09770A06

FIG No. II-H2-12



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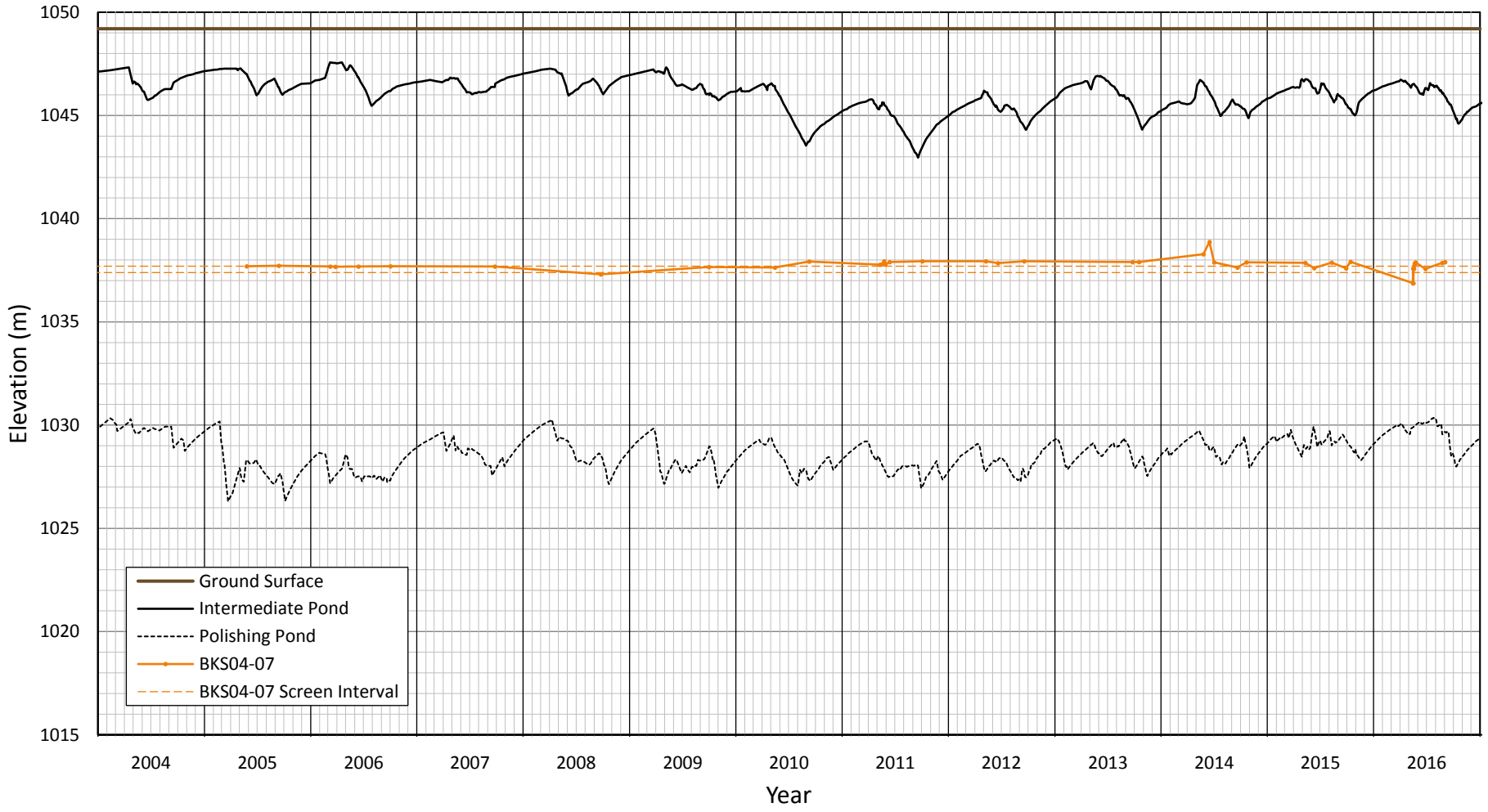
INTERMEDIATE DAM
PIEZOMETERS
BKS04-06

PROJECT No. M09770A06

FIG No. II-H2-13



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INTERMEDIATE DAM
PIEZOMETERS
BKS04-07

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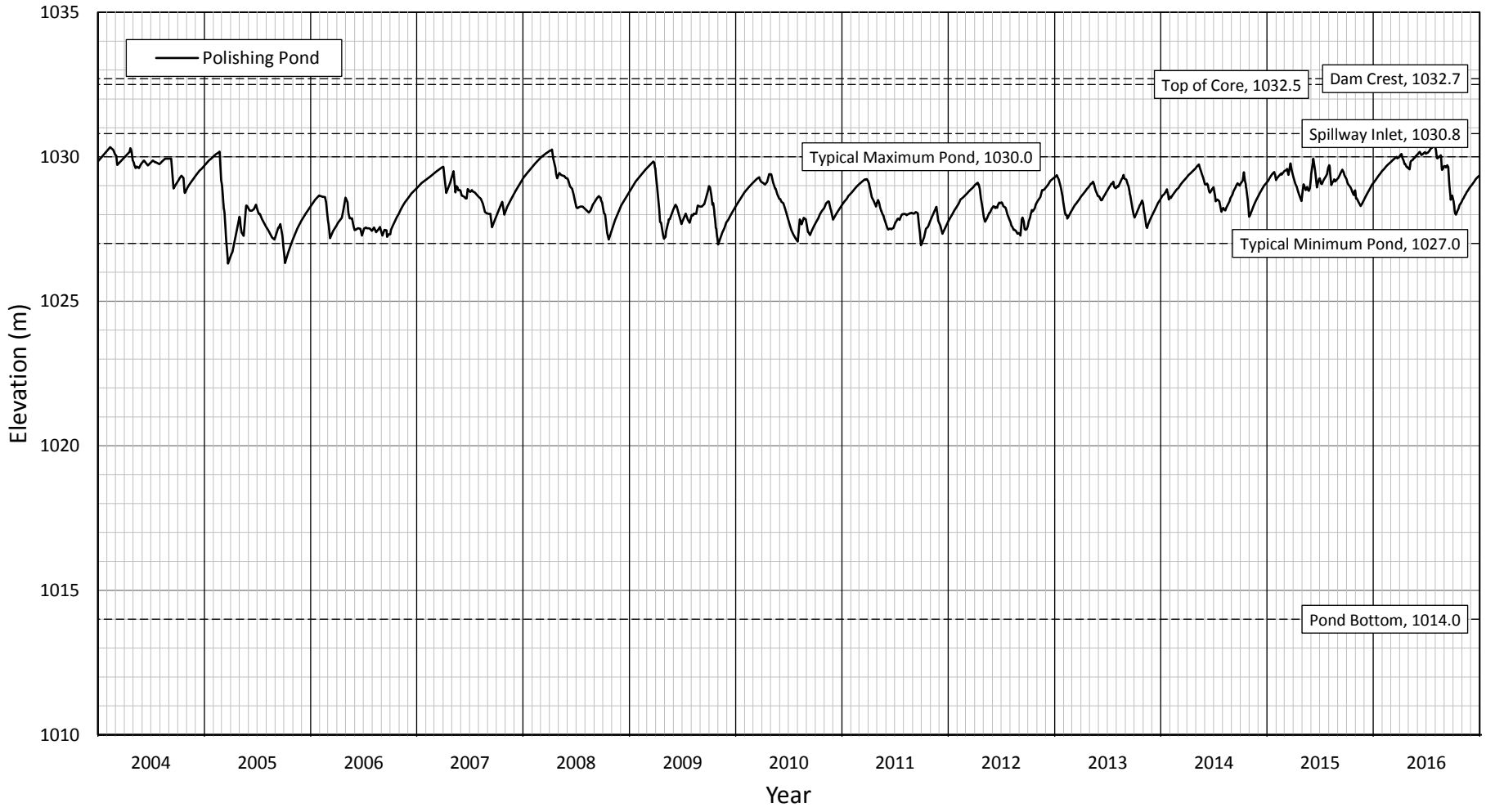
FIG No. II-H2-14

# APPENDIX II-I

## Cross Valley Dam

I1 – Pond Level
I2 – Piezometers
I3 – Thermistors (Not included)
I4 – Downstream Weir Flows



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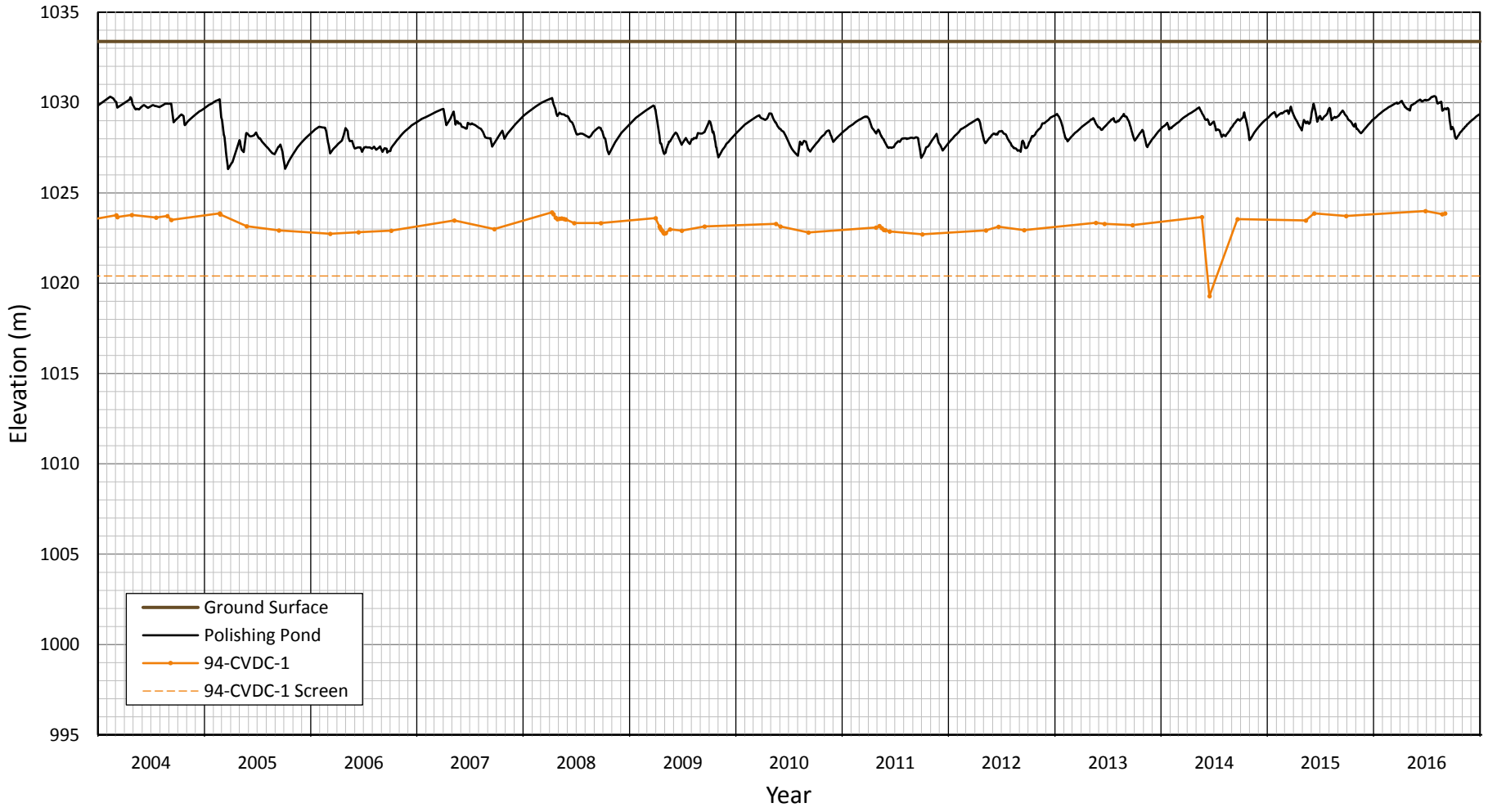
CROSS VALLEY DAM
POND LEVEL

PROJECT No. M09770A06

FIG No. II-I1-1



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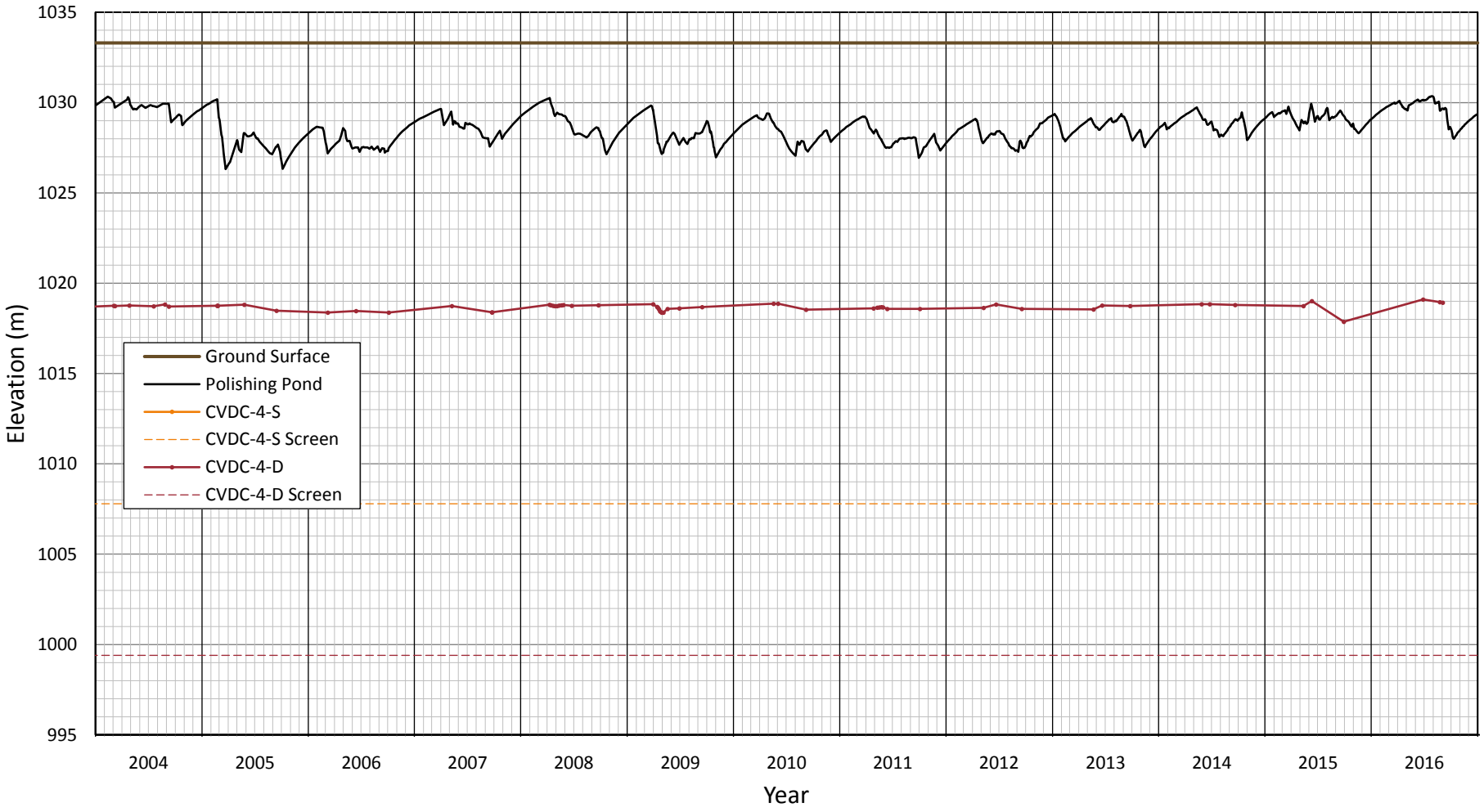
CROSS VALLEY DAM
PIEZOMETERS
94-CVDC-1

PROJECT No. M09770A06

FIG No. II-I2-1




Notes:
1. CVDC-4-S Blocked. No valid readings have been reported.



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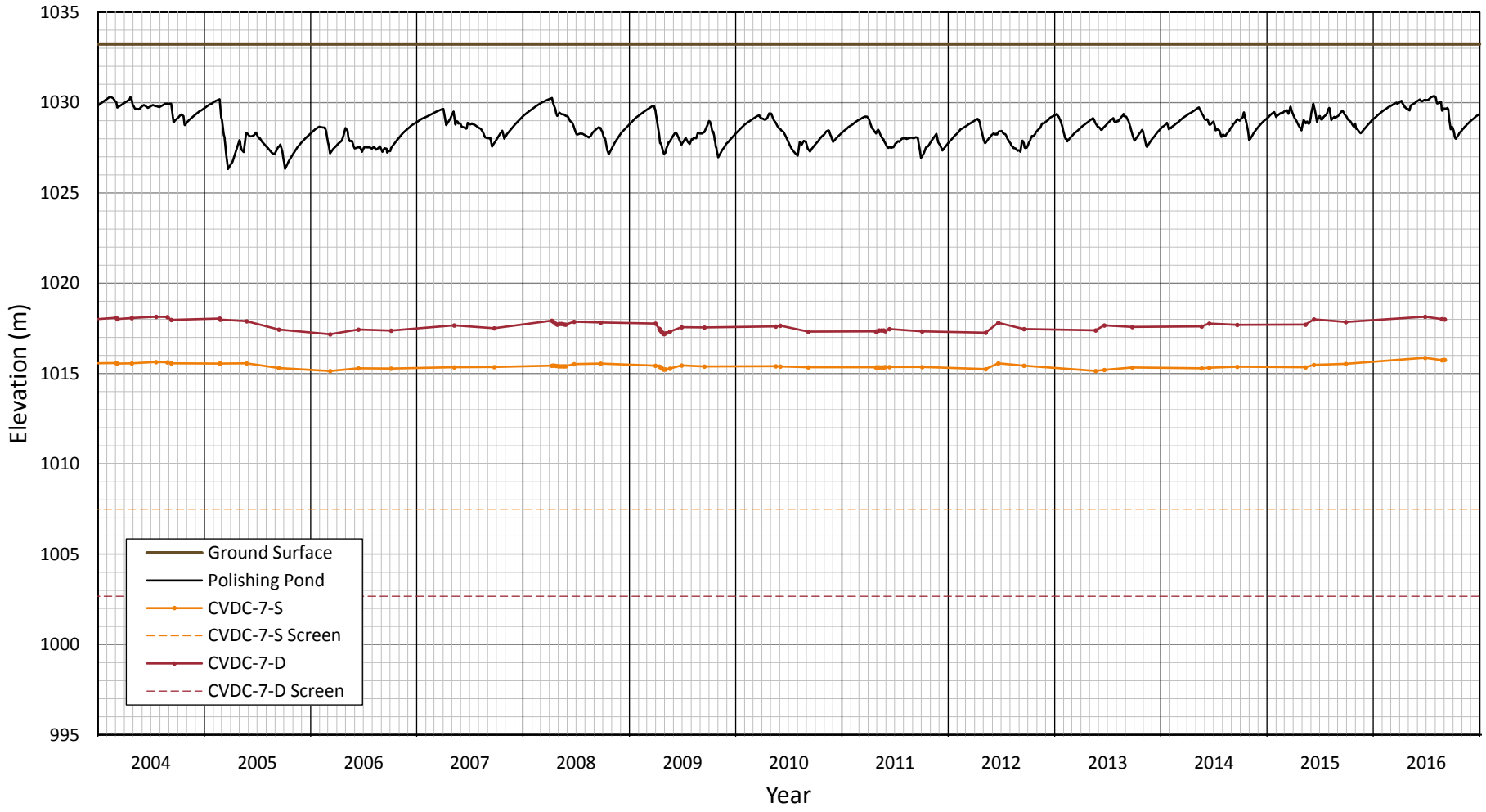
PIEZOMETERS
CVDC-4

PROJECT No. M09770A06

FIG No. II-I2-2



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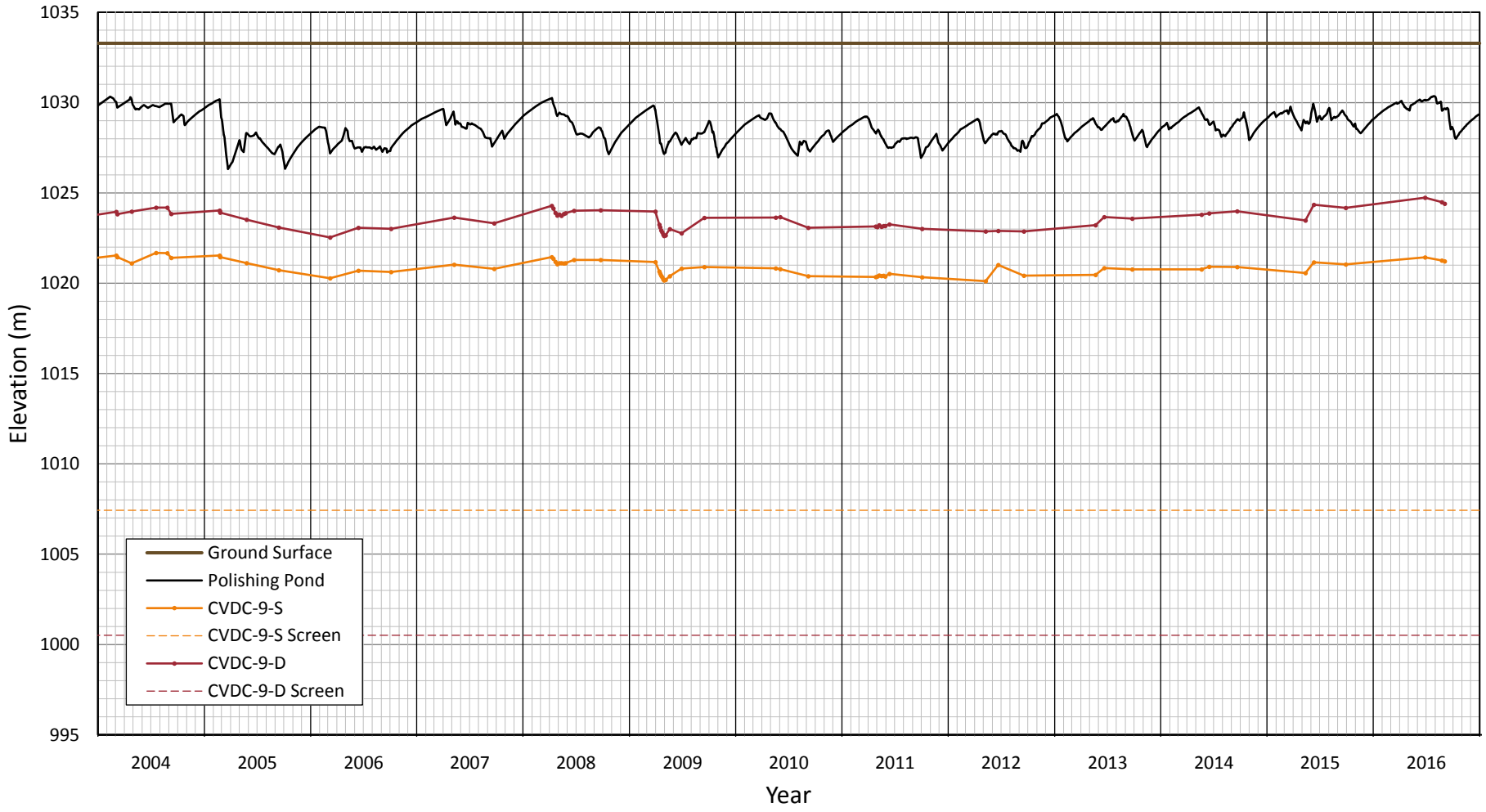
PIEZOMETERS
CVDC-7

PROJECT No. M09770A06

FIG No. II-I2-3



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PIEZOMETERS
CVDC-9

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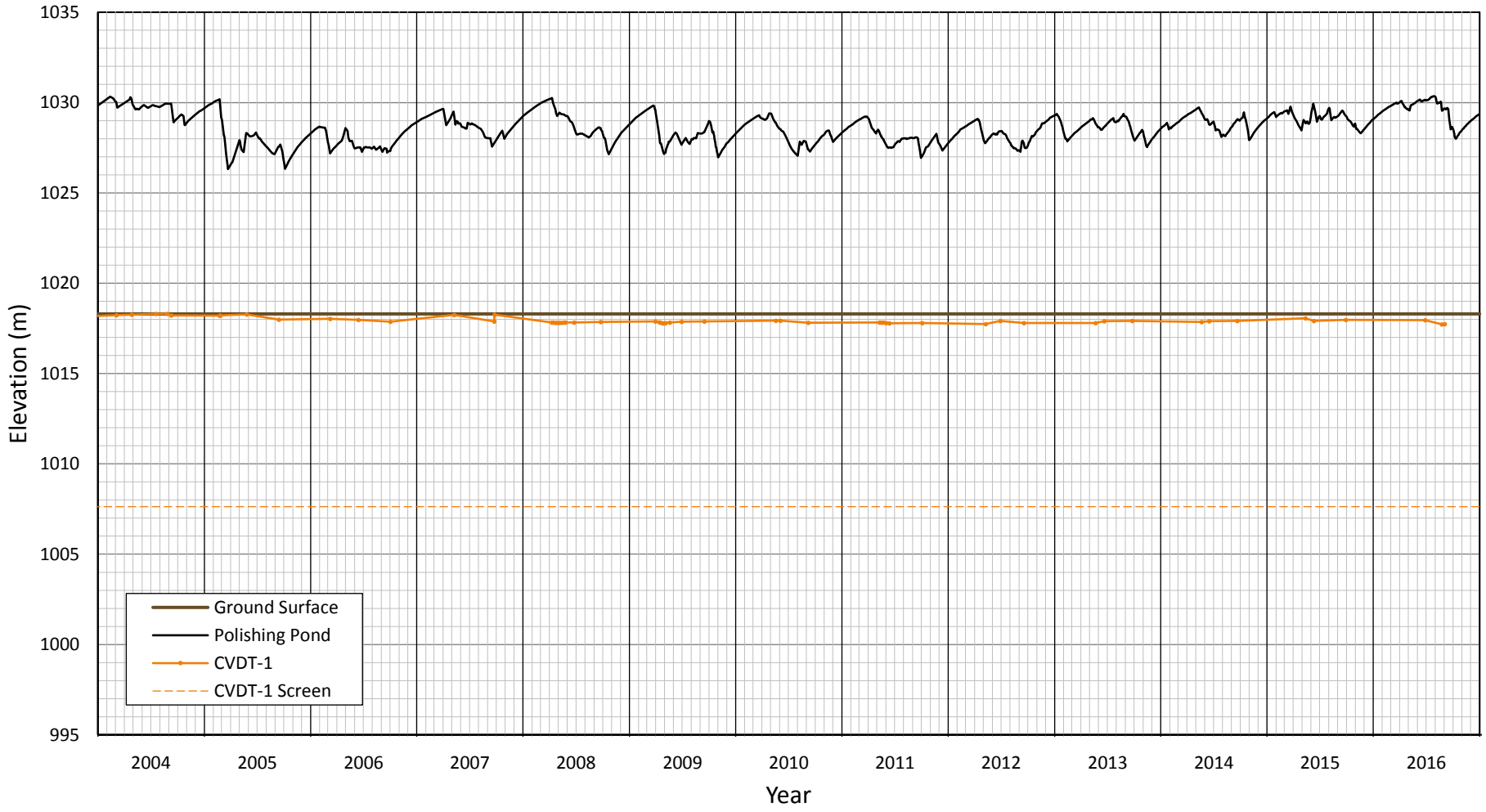
FIG No. II-I2-4



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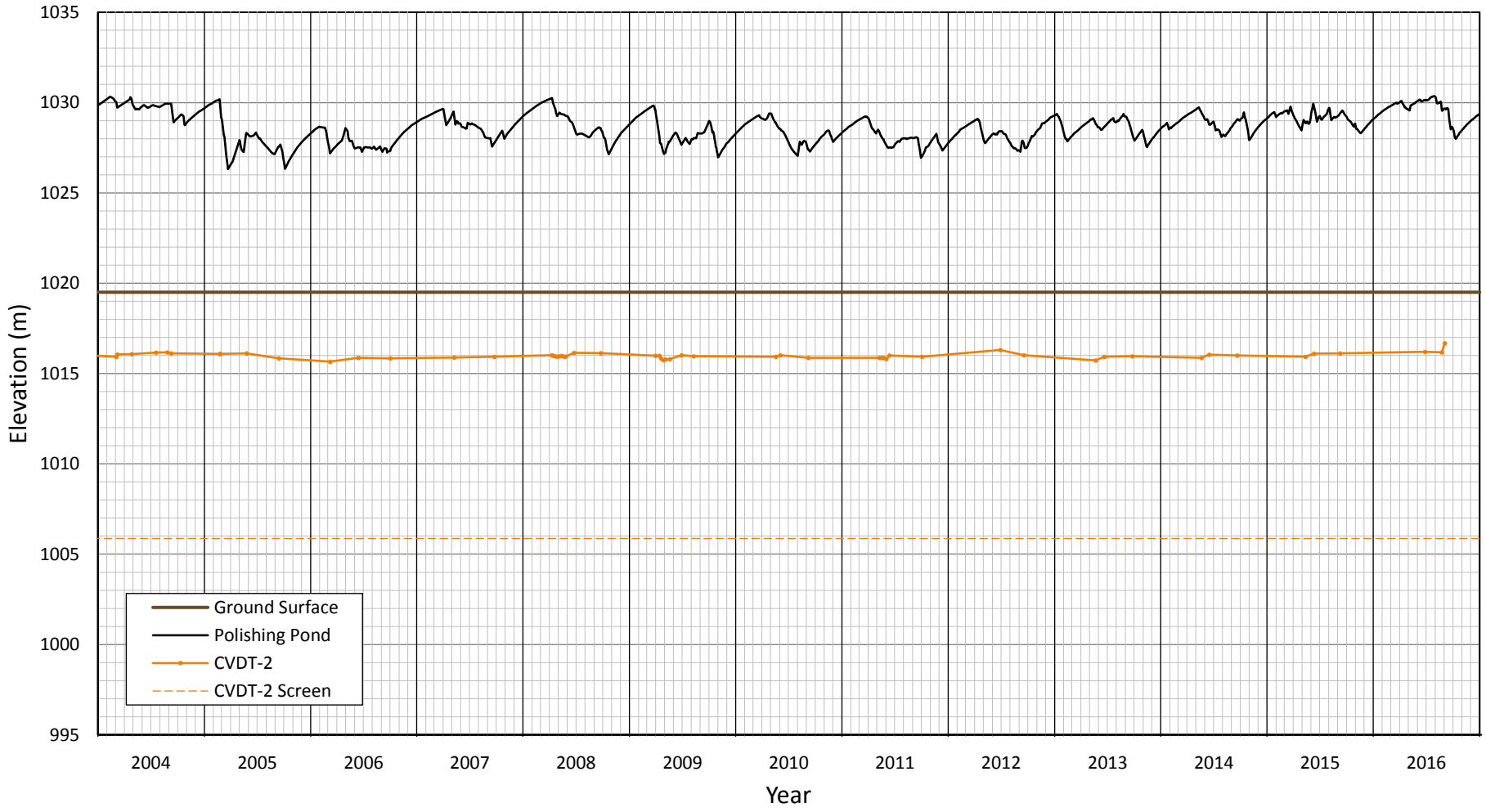
PIEZOMETERS
CVDT-1

PROJECT No. M09770A06

FIG No. II-I2-5



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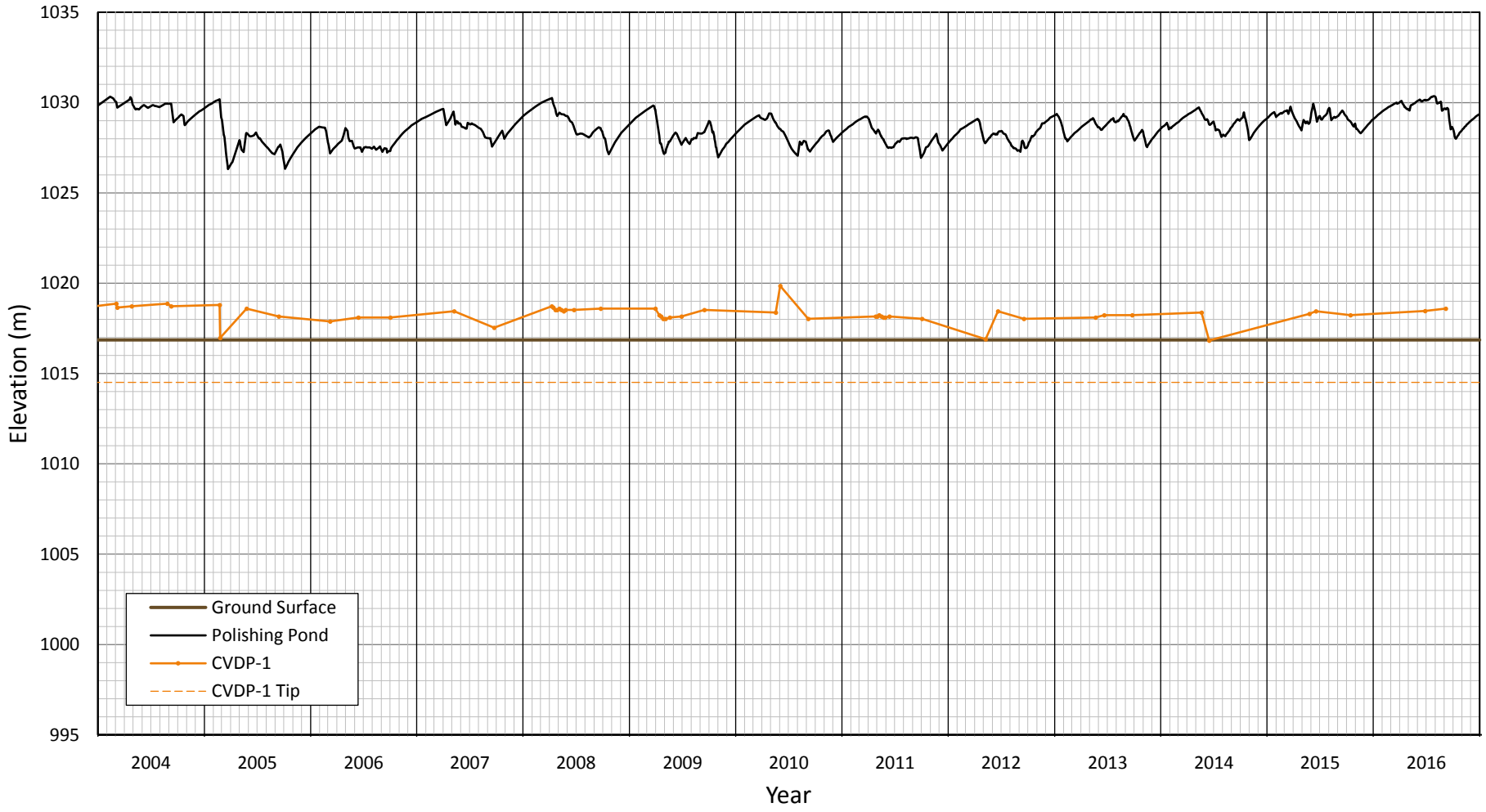
PIEZOMETERS
CVDT-2

PROJECT No. M09770A06

FIG No. II-I2-6



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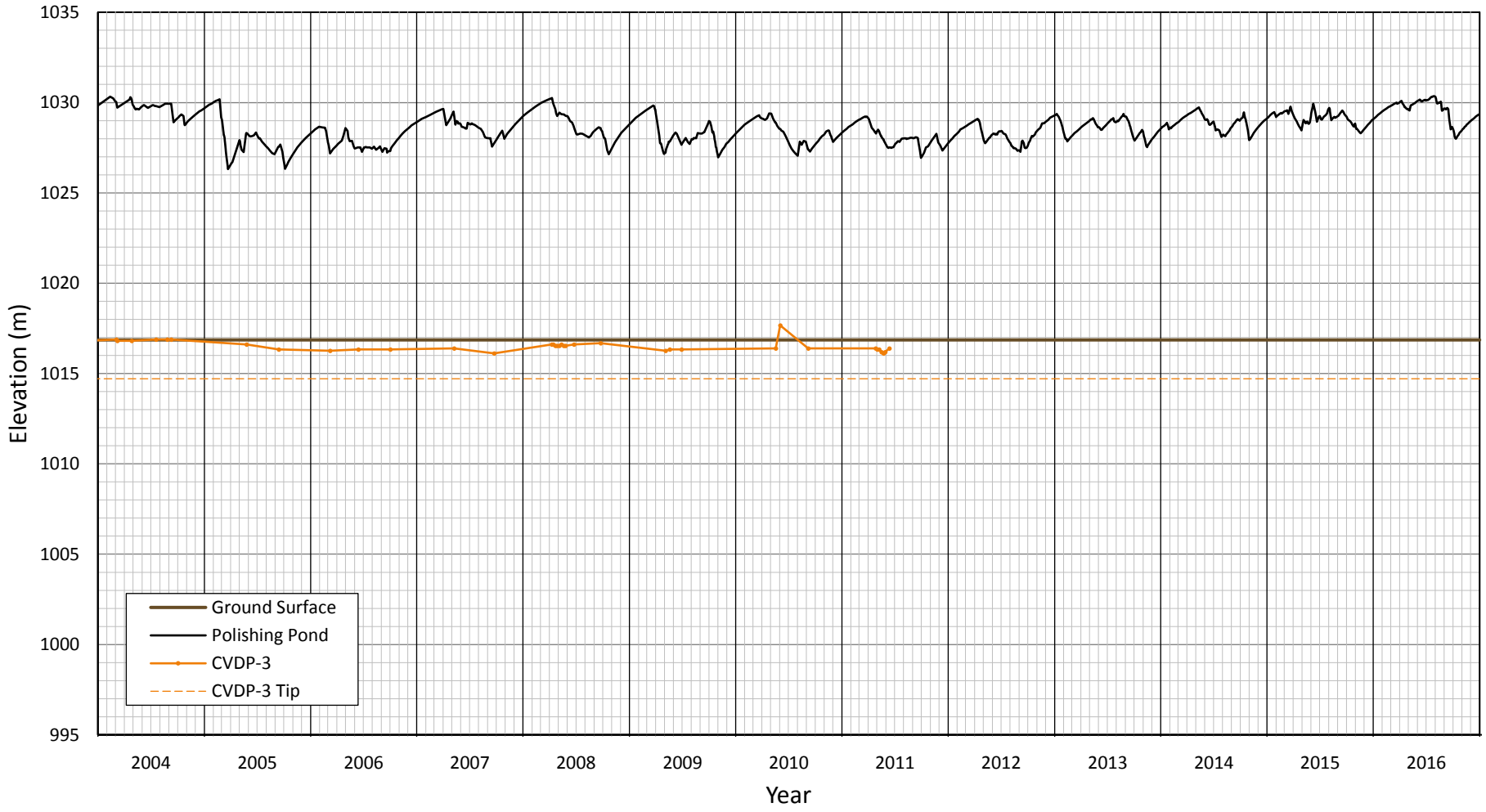
CVDP-1

PROJECT No. M09770A06

FIG No. II-I2-7



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PIEZOMETERS
CVDP-3

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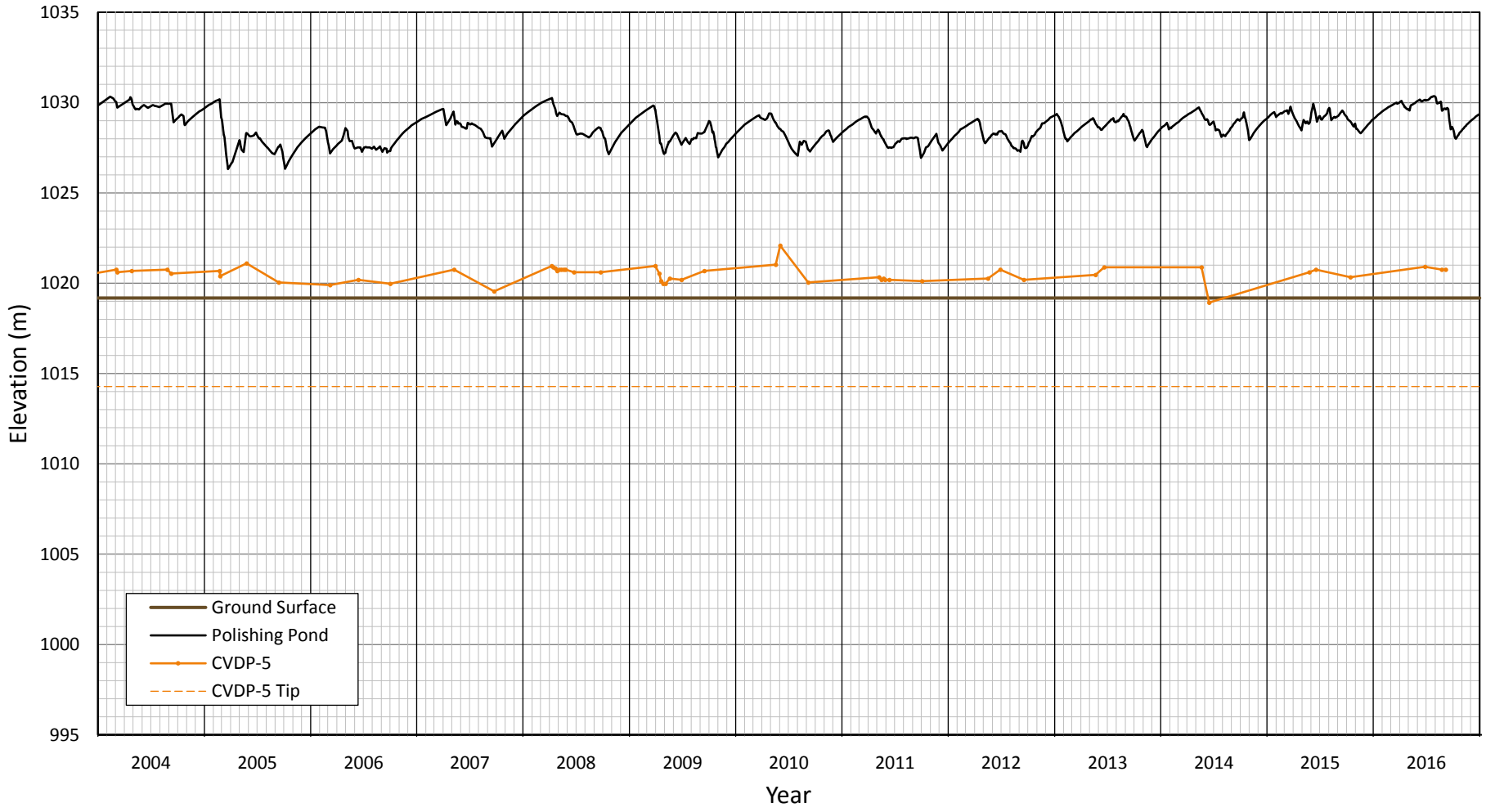
FIG No. II-I2-8



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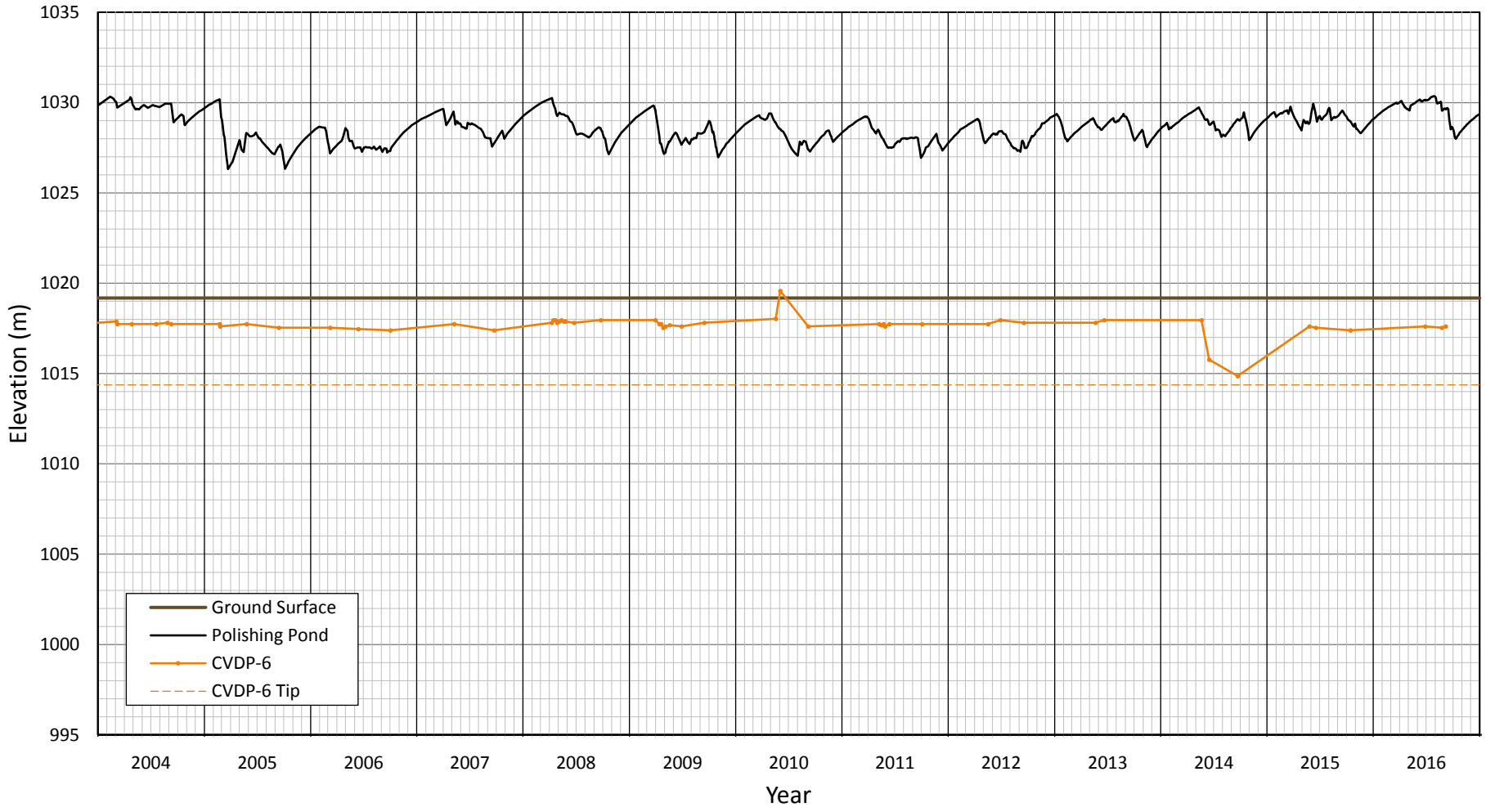
PIEZOMETERS
CVDP-5

PROJECT No. M09770A06

FIG No. II-I2-9



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CVDP-6

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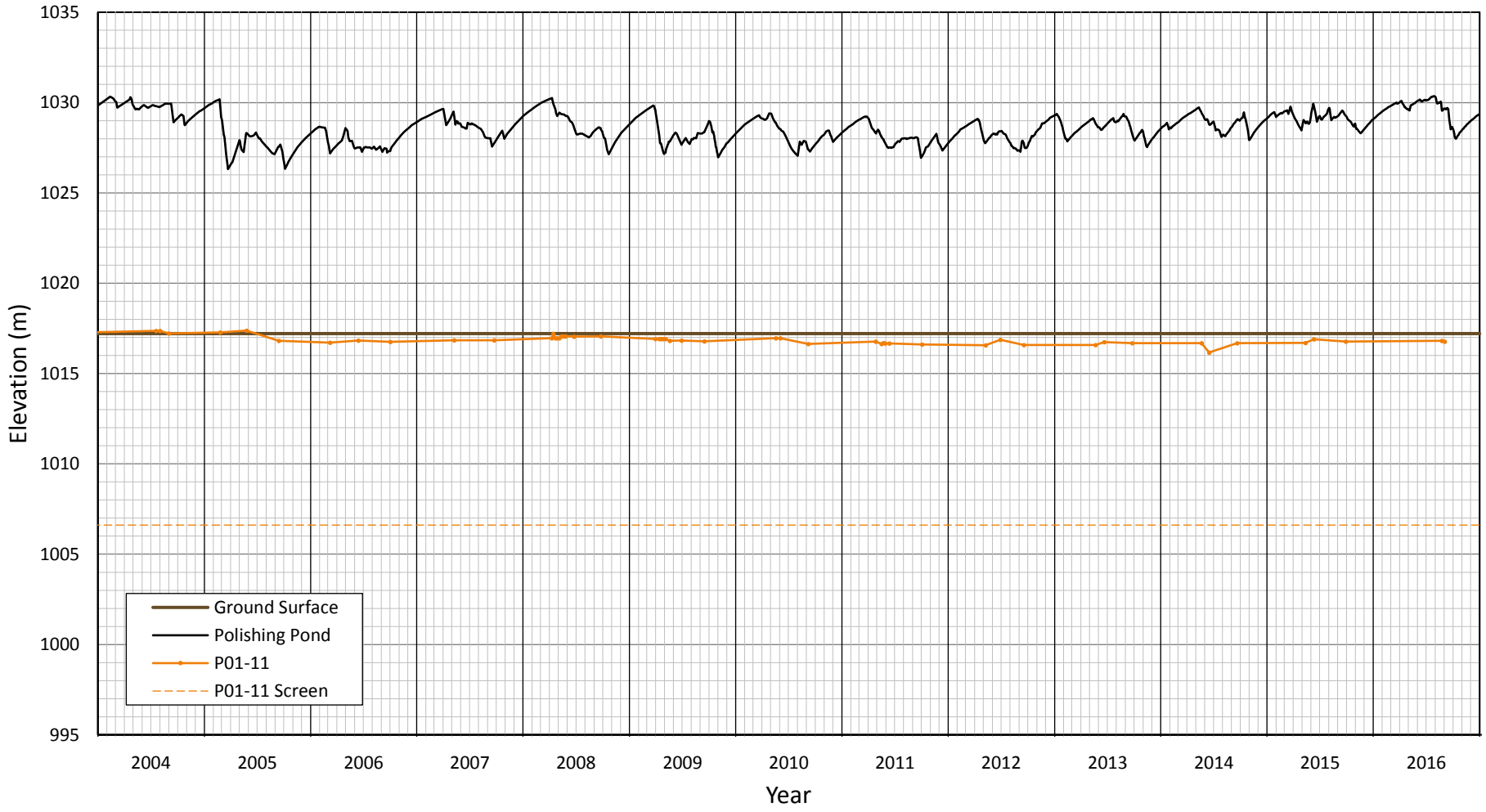
FIG No. II-I2-10



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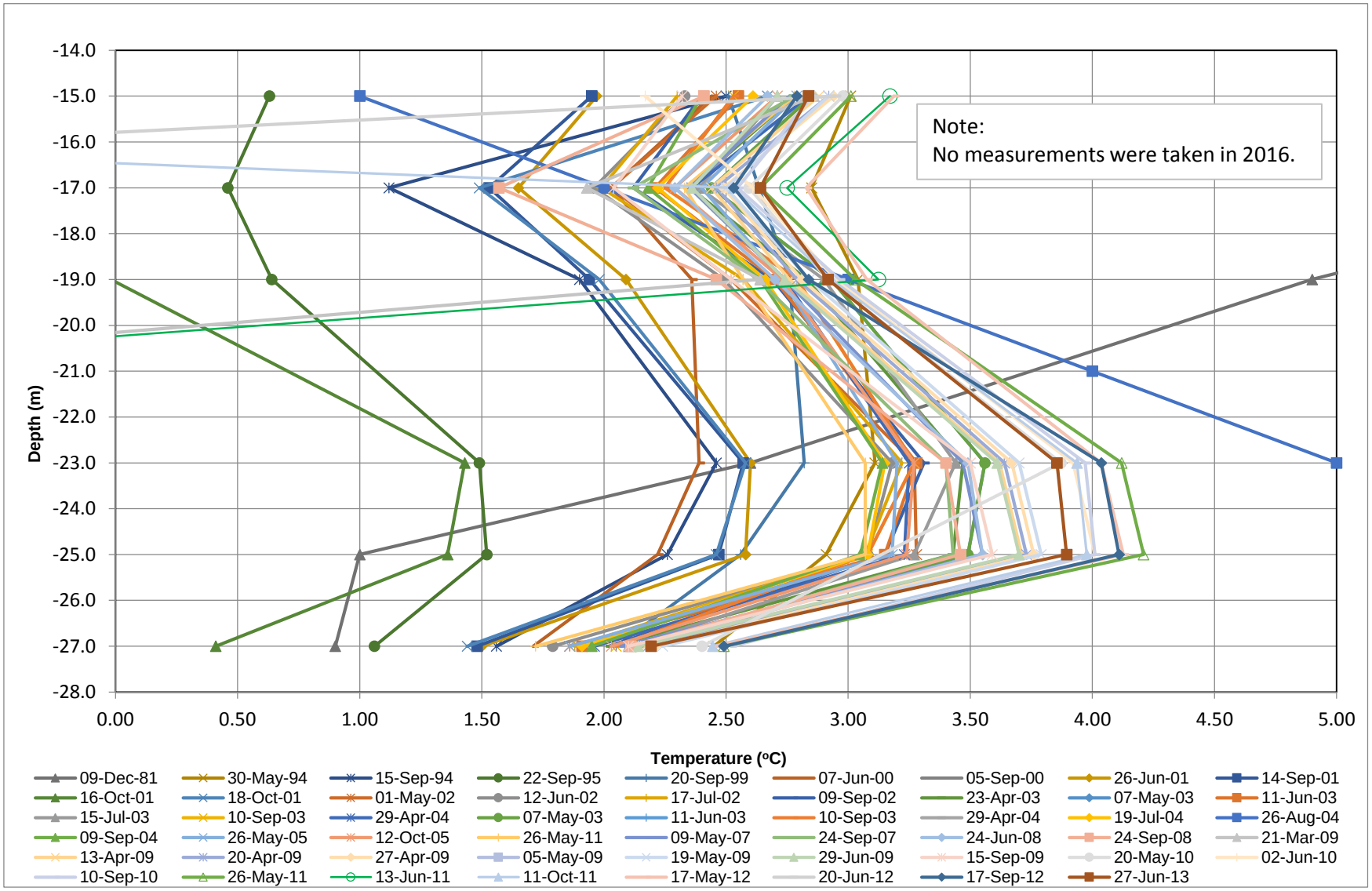
CROSS VALLEY DAM
PIEZOMETERS
P01-11

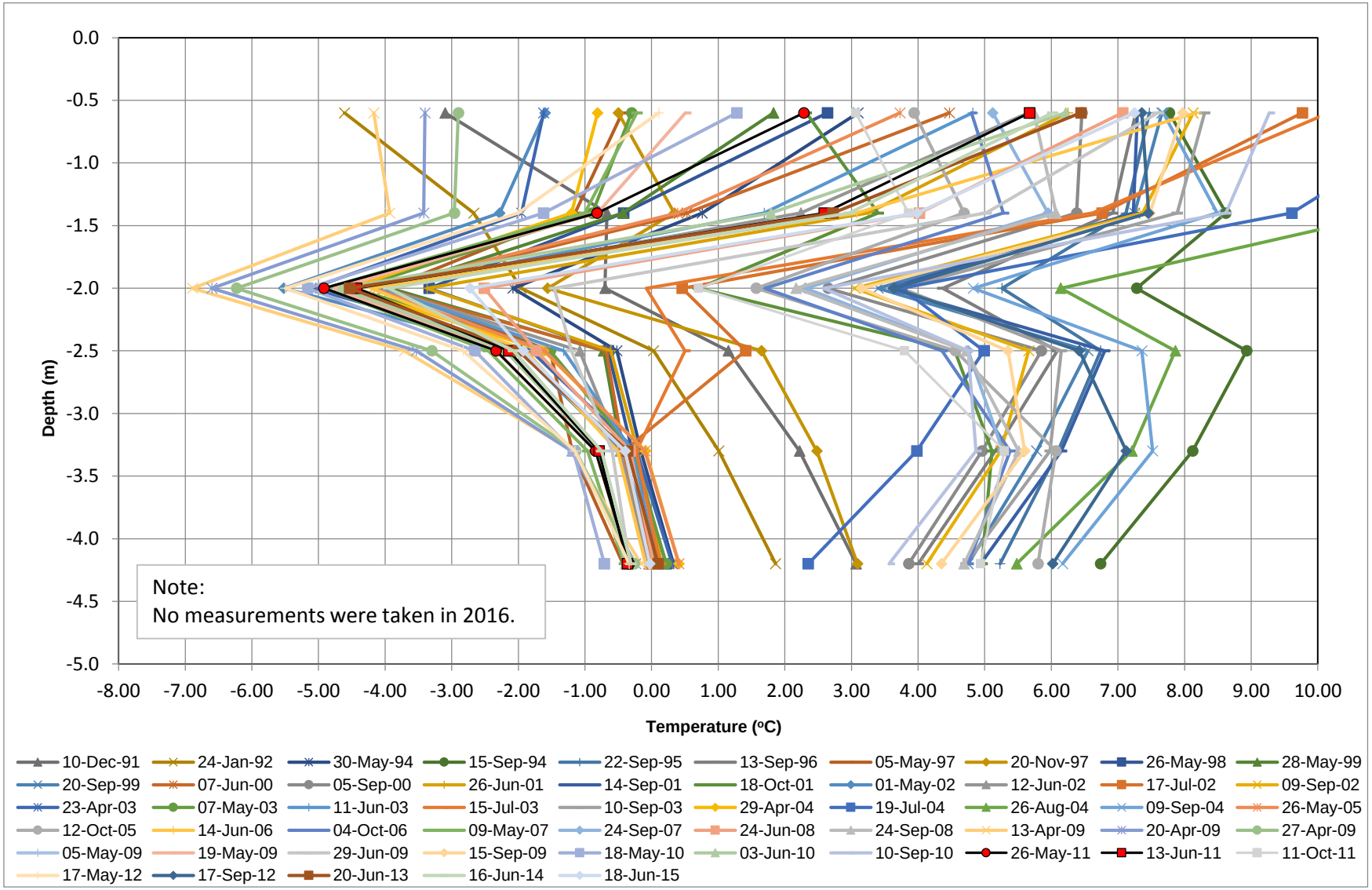
PROJECT No. M09770A06

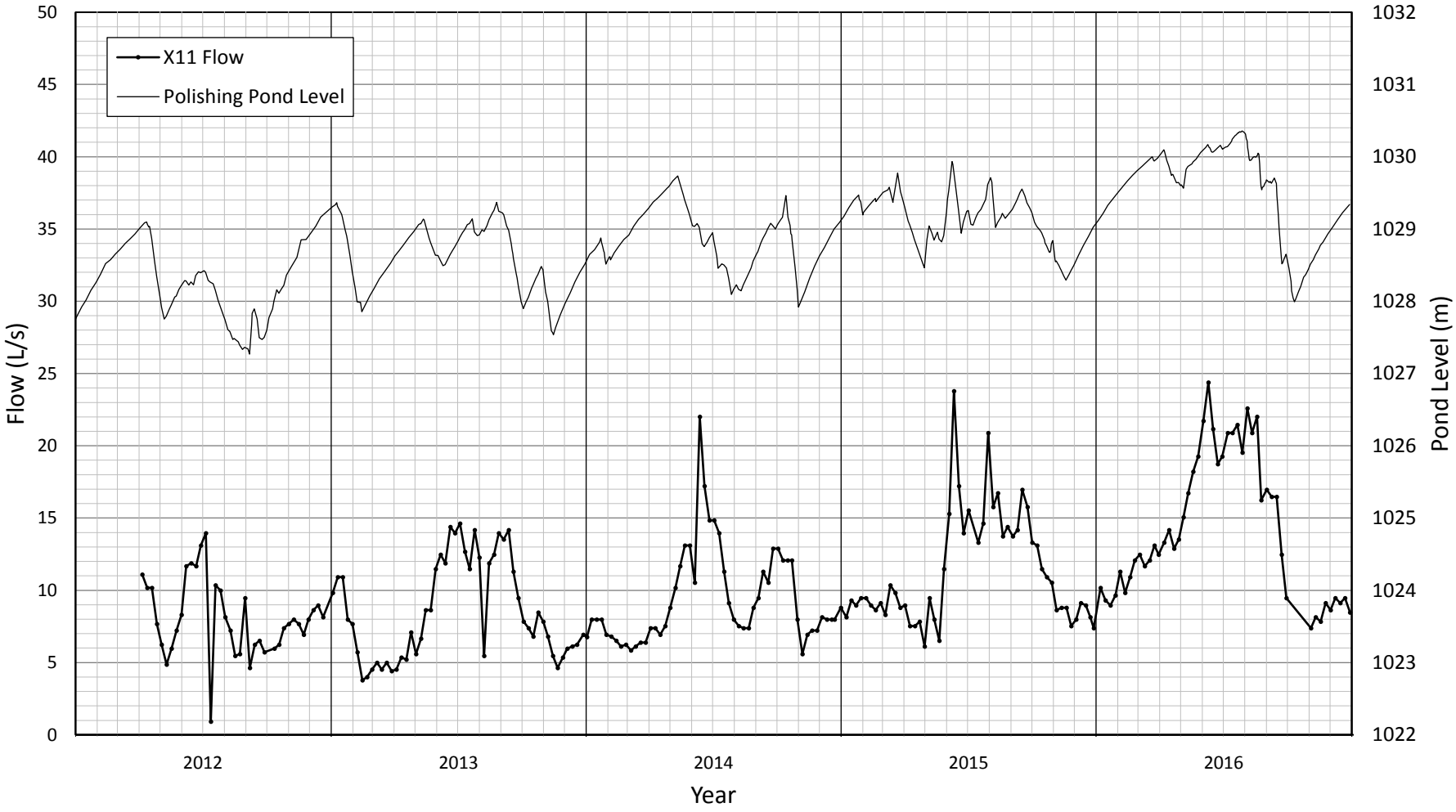
FIG No. II-I2-11

**Cross Valley Dam**
**Thermistor CVDC-6**



**Cross Valley Dam**
**Thermistor BH 88-4**





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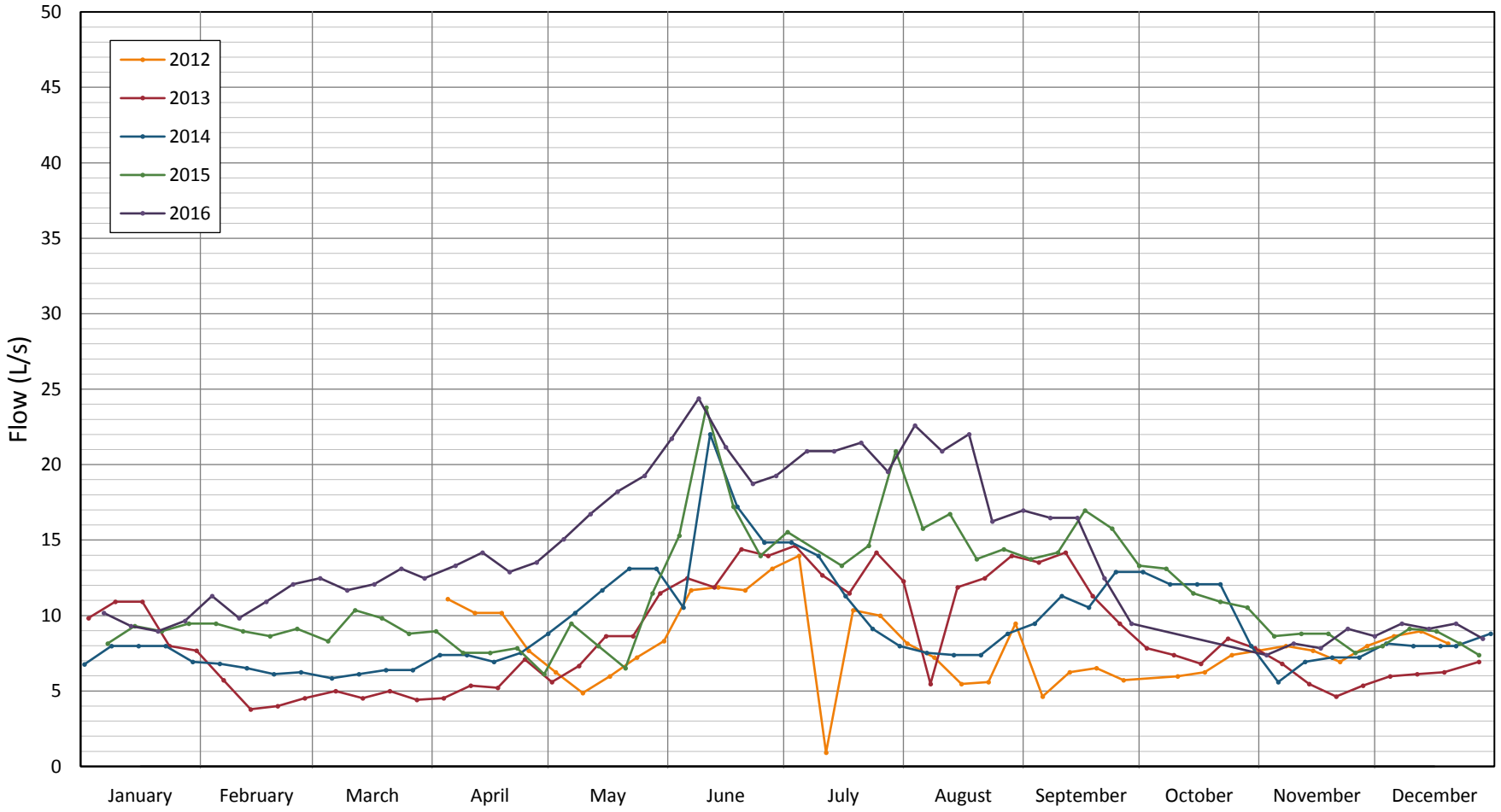
X11 DISCHARGE

PROJECT No. M09770A06

FIG No. II-I4-1



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X11 DISCHARGE

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FIG No. II-I4-2

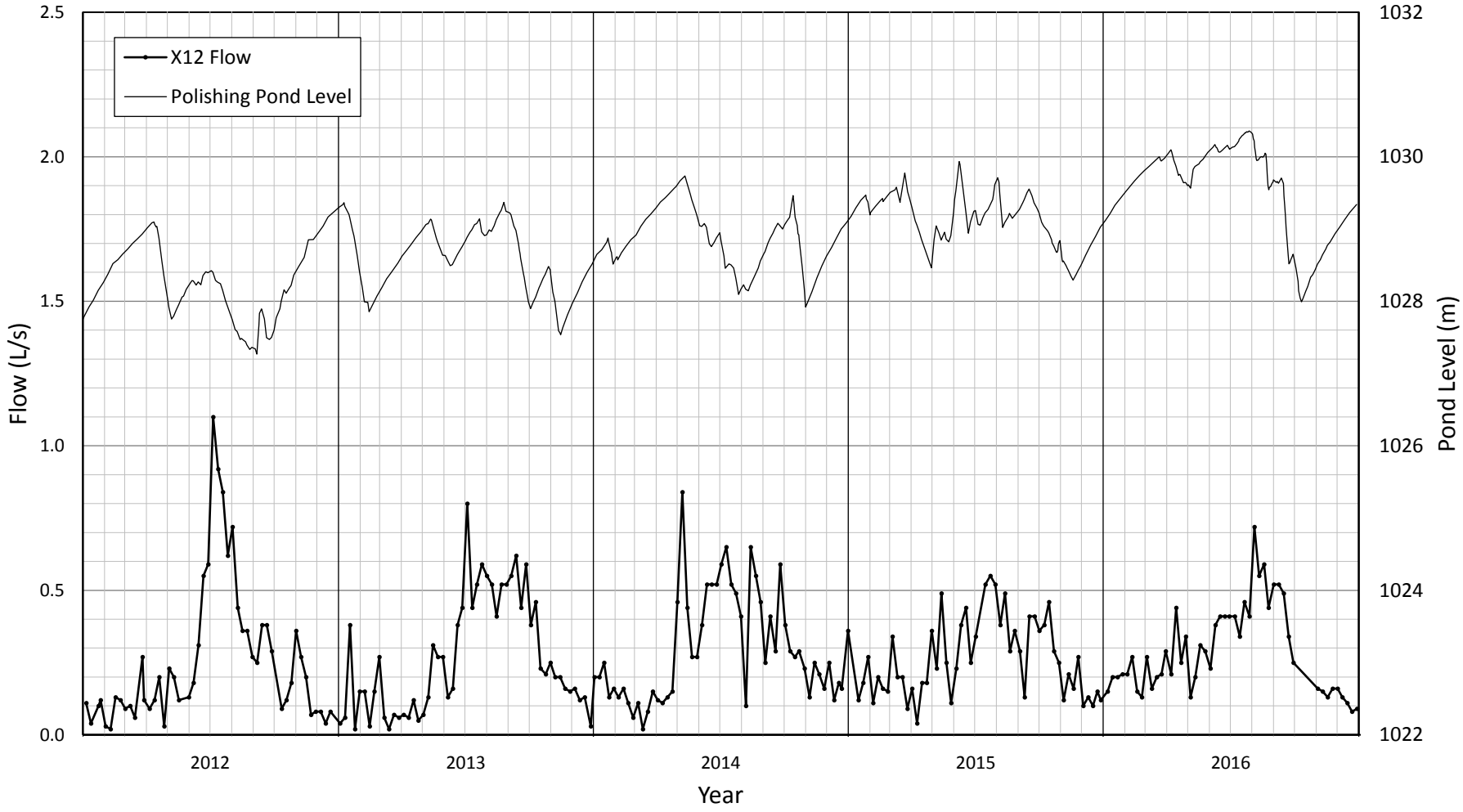




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FIG No. II-I4-3

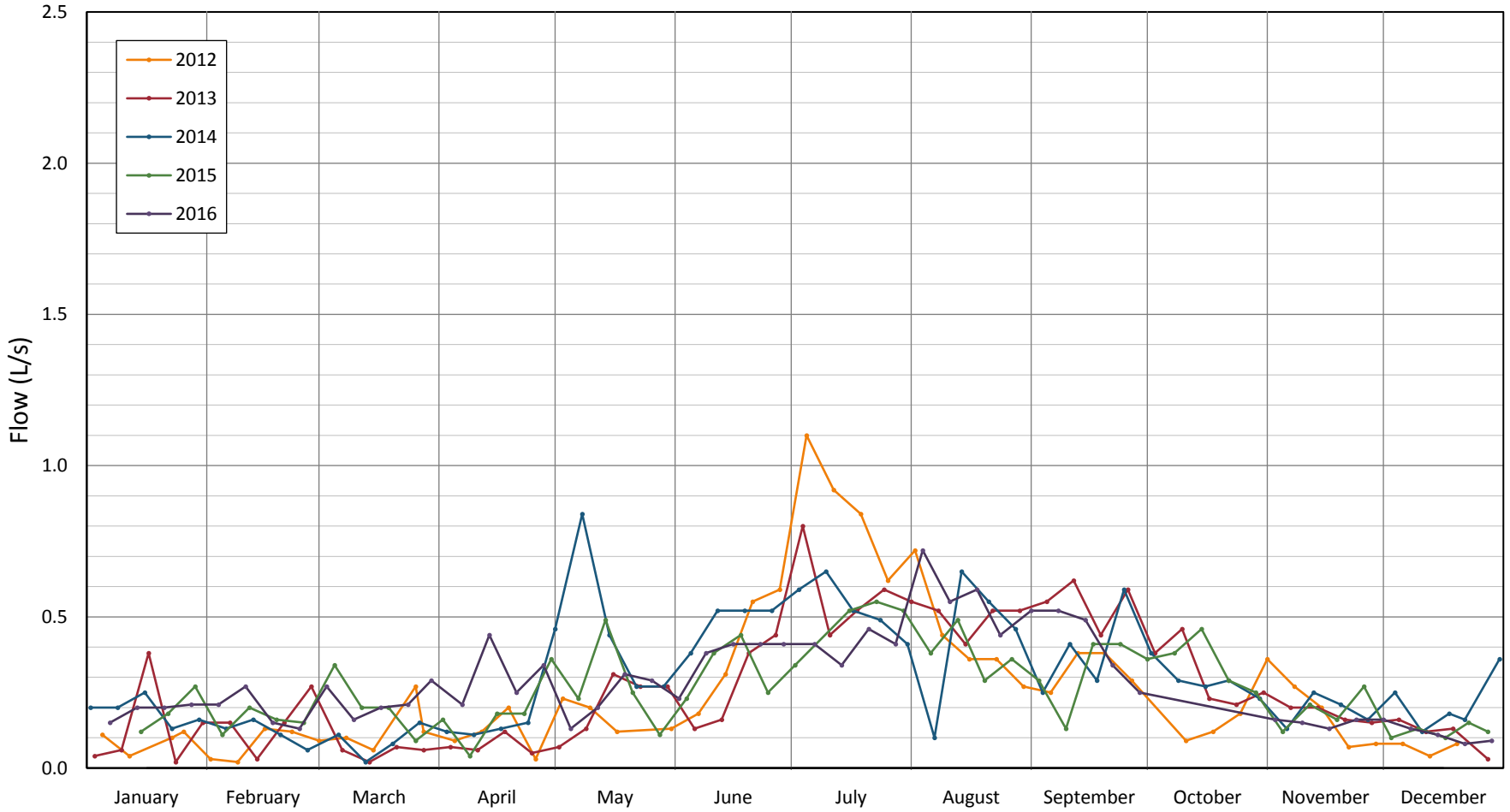




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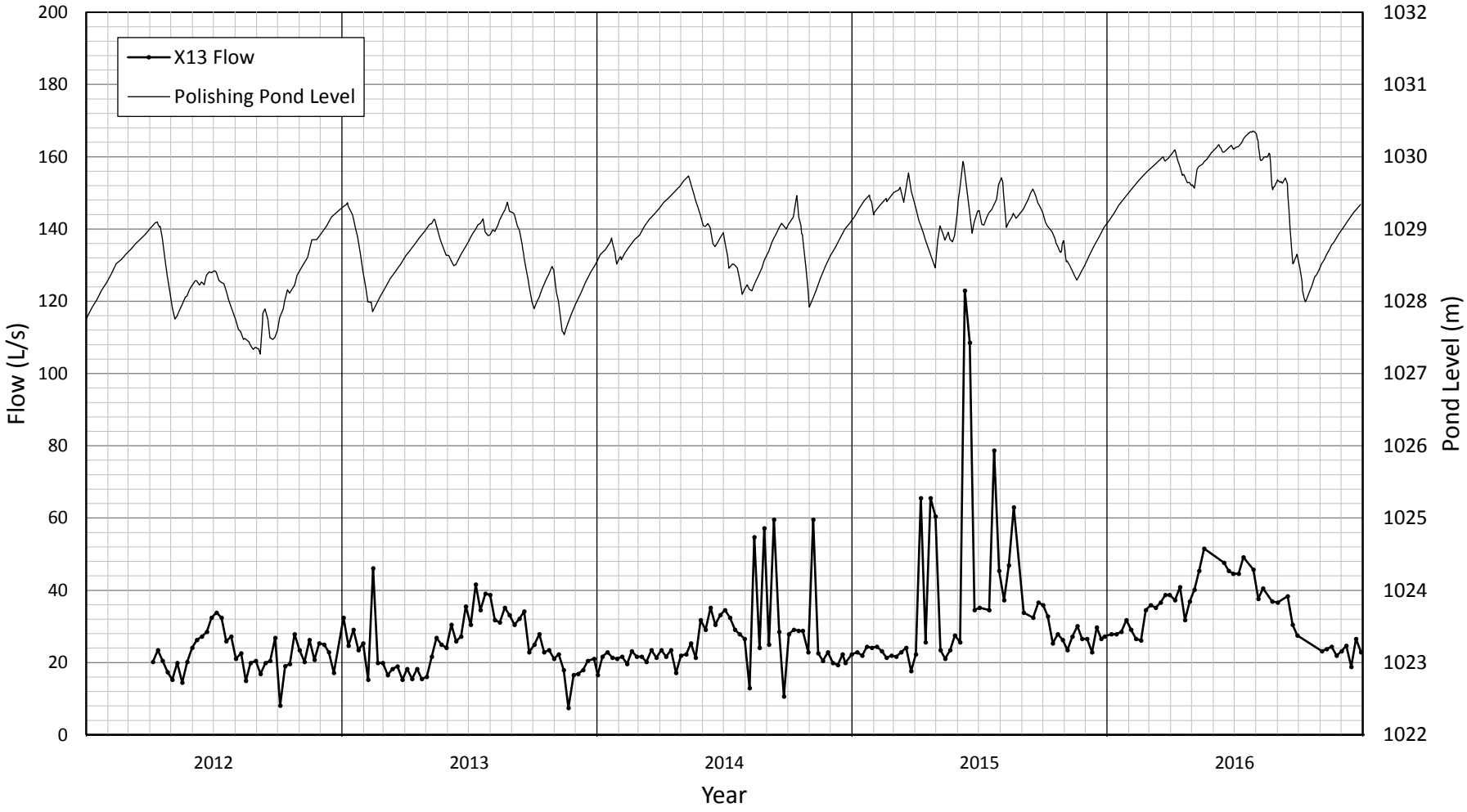
FIG No. II-I4-4



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X13 DISCHARGE

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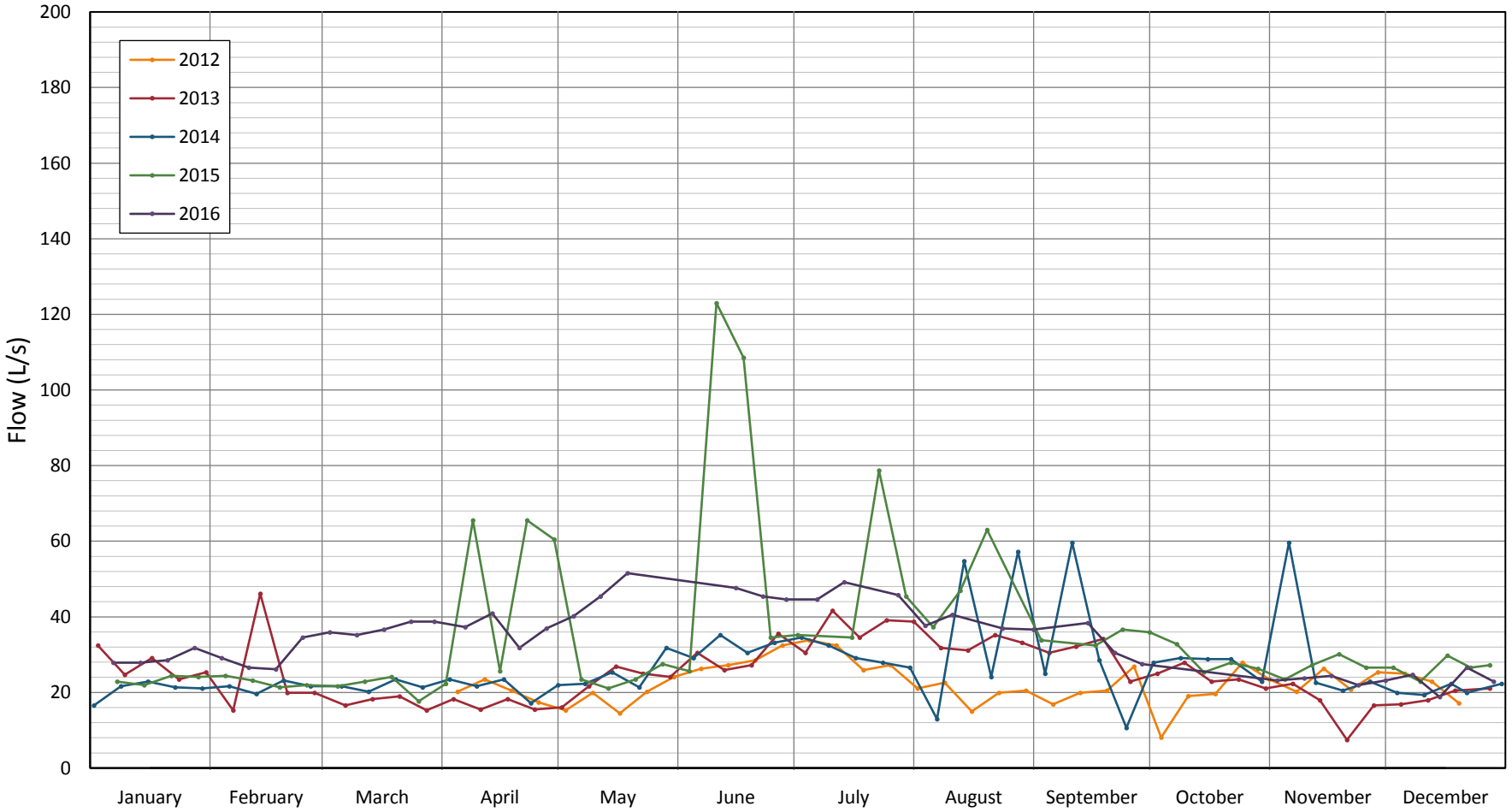
FIG No. II-I4-5



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CROSS VALLEY DAM
X13 DISCHARGE

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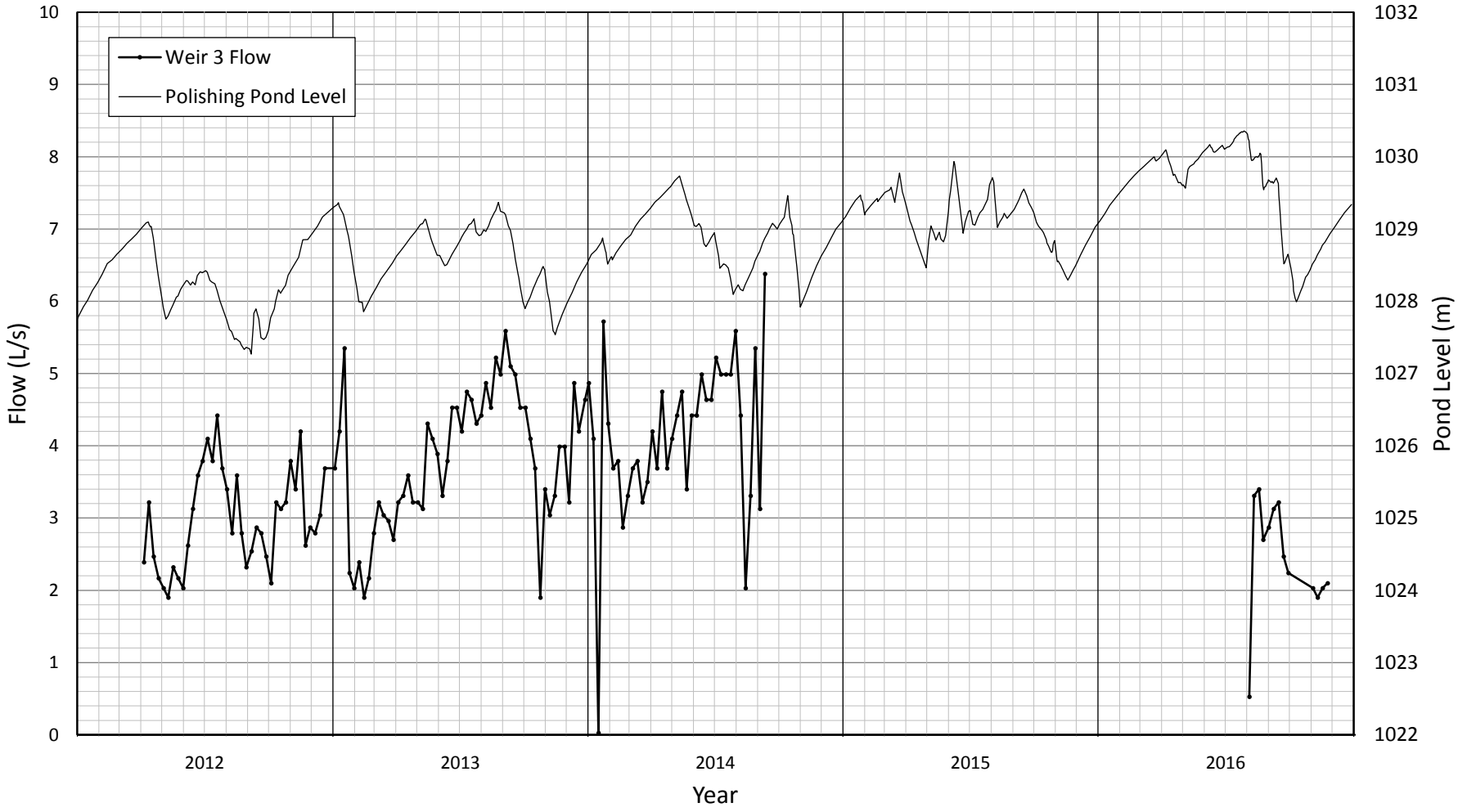
FIG No. II-I4-6



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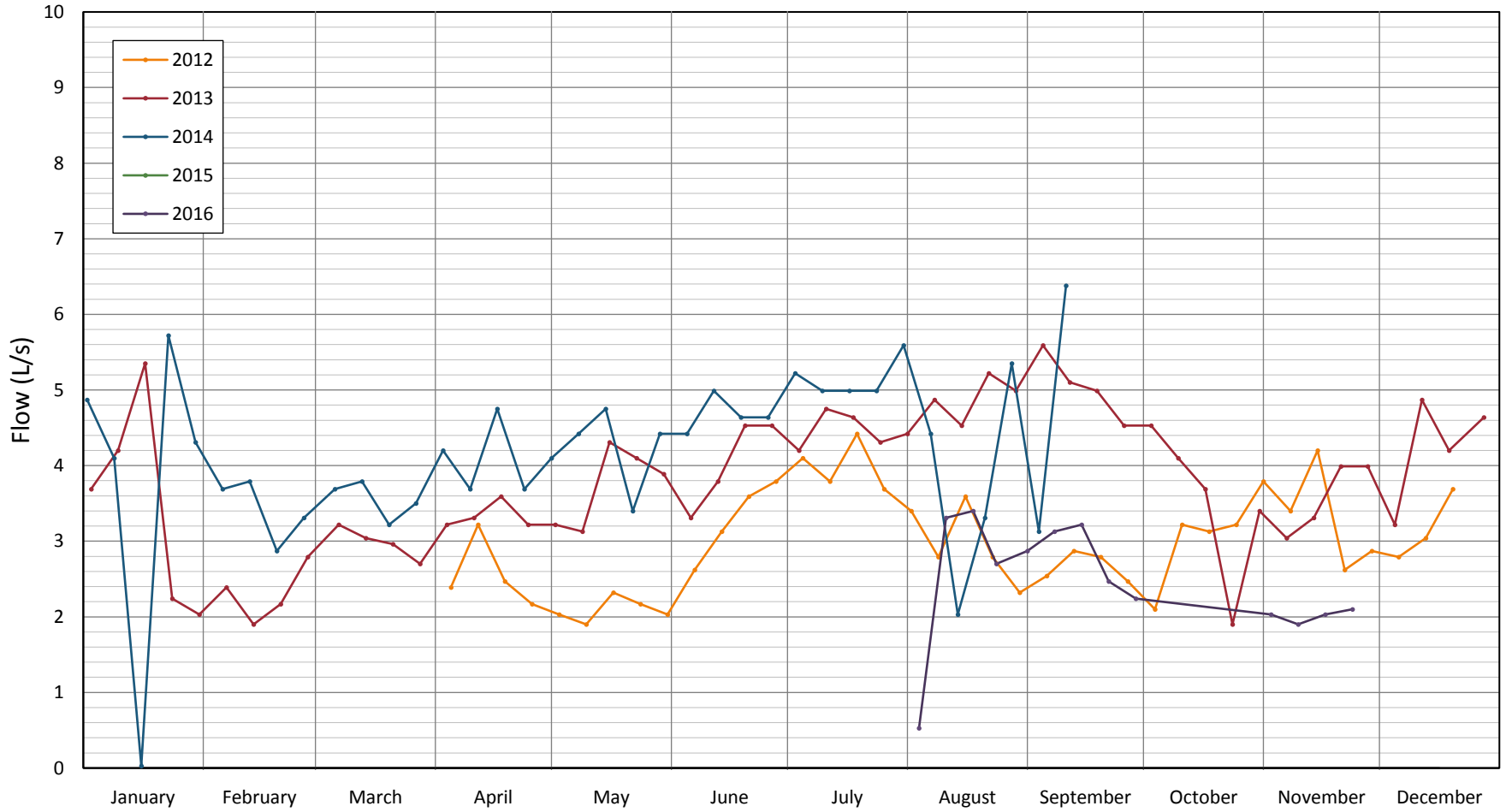
CROSS VALLEY DAM
WEIR 3 DISCHARGE

PROJECT No. M09770A06

FIG No. II-I4-7



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CROSS VALLEY DAM
WEIR 3 DISCHARGE

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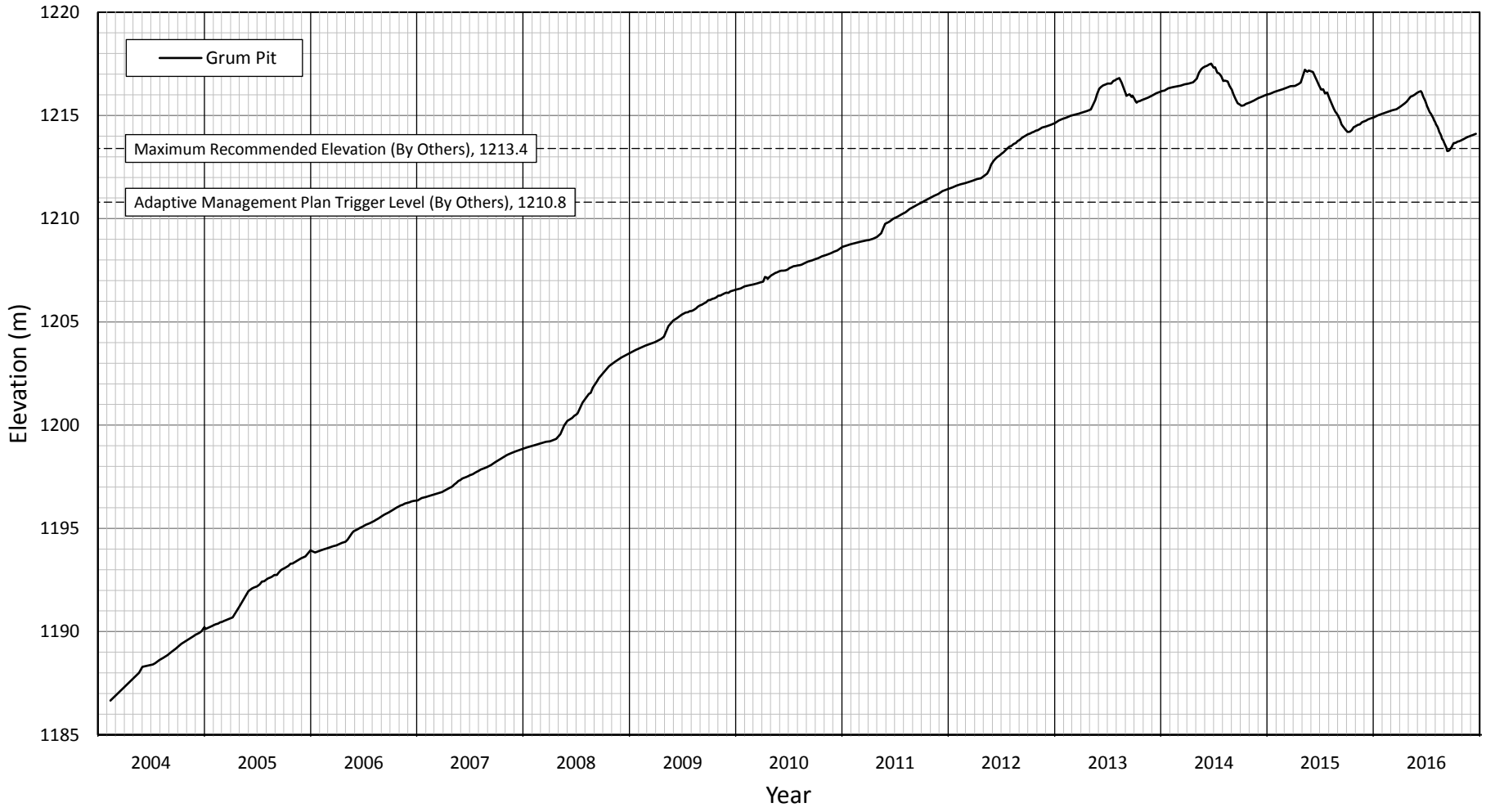
FIG No. II-I4-8

# APPENDIX II-J

## Grum Pit

J1 – Pond Level
J2 – Slot Cut Piezometers




Notes:
1. Pit bottom is approximately El. 1135 m.



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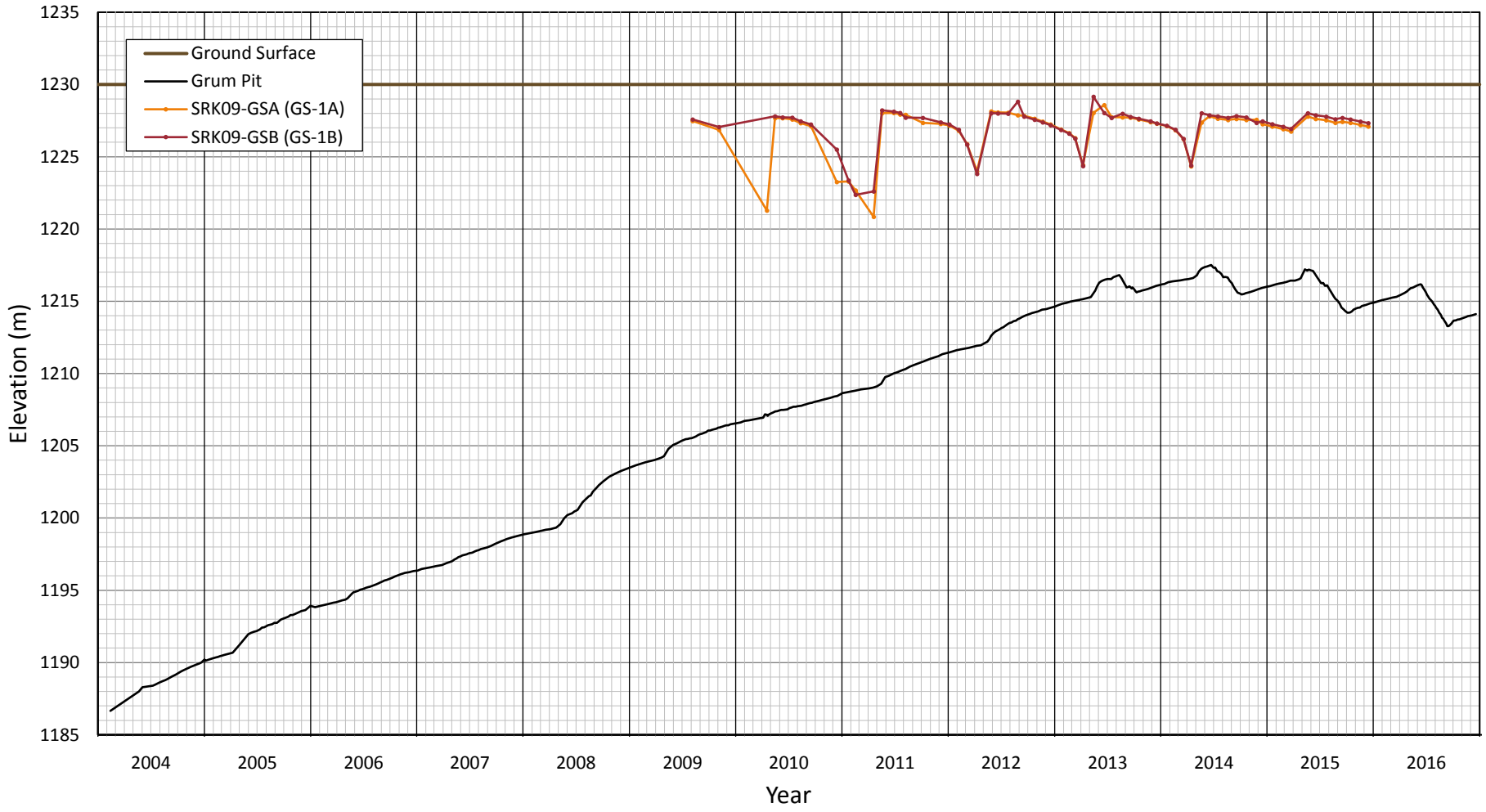
TITLE: GRUM PIT
POND LEVEL

PROJECT No. M09770A06

FIG No. II-J1-1



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TITLE

GRUM PIT
SLOT CUT PIEZOMETERS
SRK09-GS

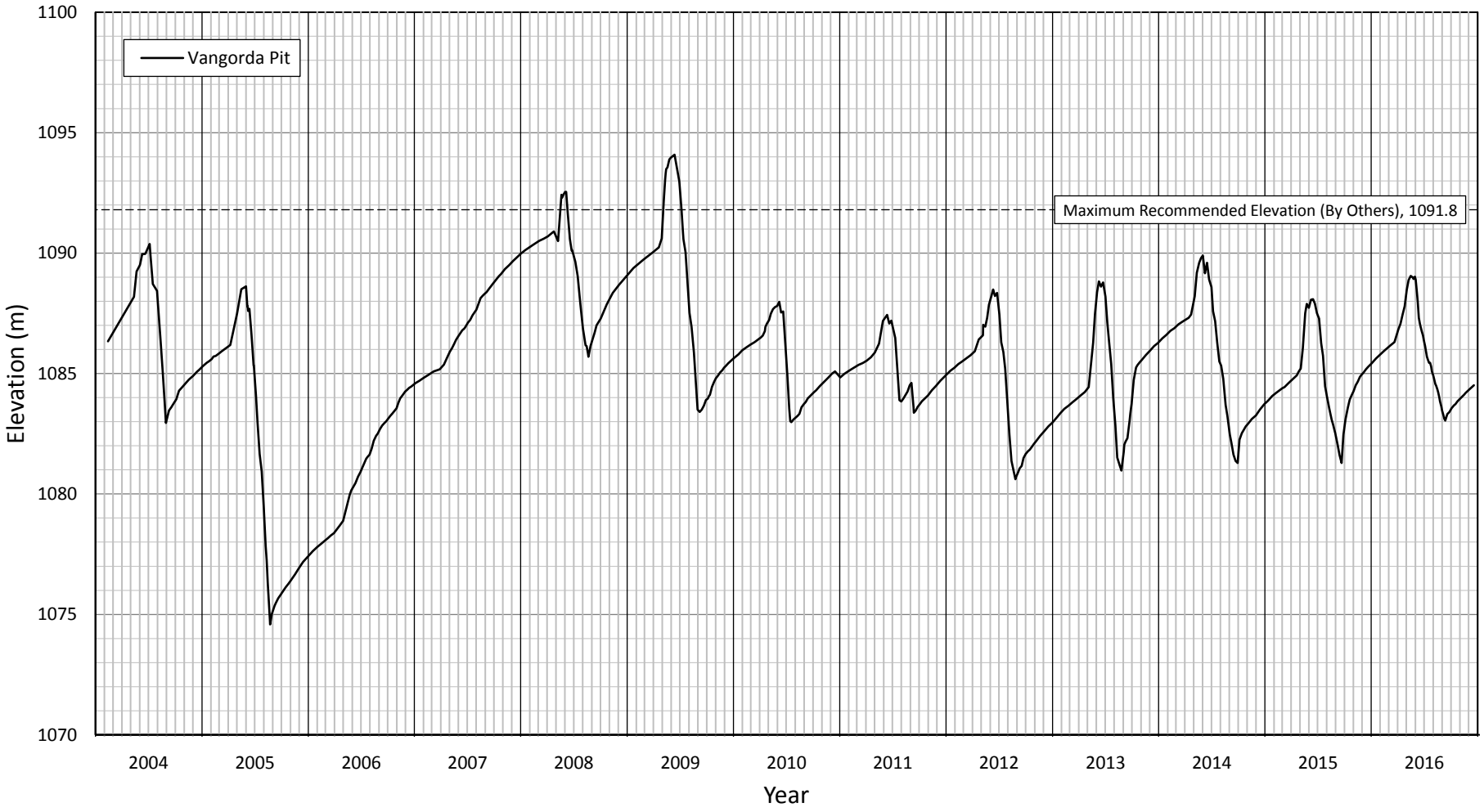
PROJECT No. M09770A06

FIG No. II-J2-1

# APPENDIX II-K

## Vangorda Pit

K1 – Pond Level




Notes:
1. Pit bottom is approximately El. 1040 m.



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TITLE: VANGORDA PIT
POND LEVEL

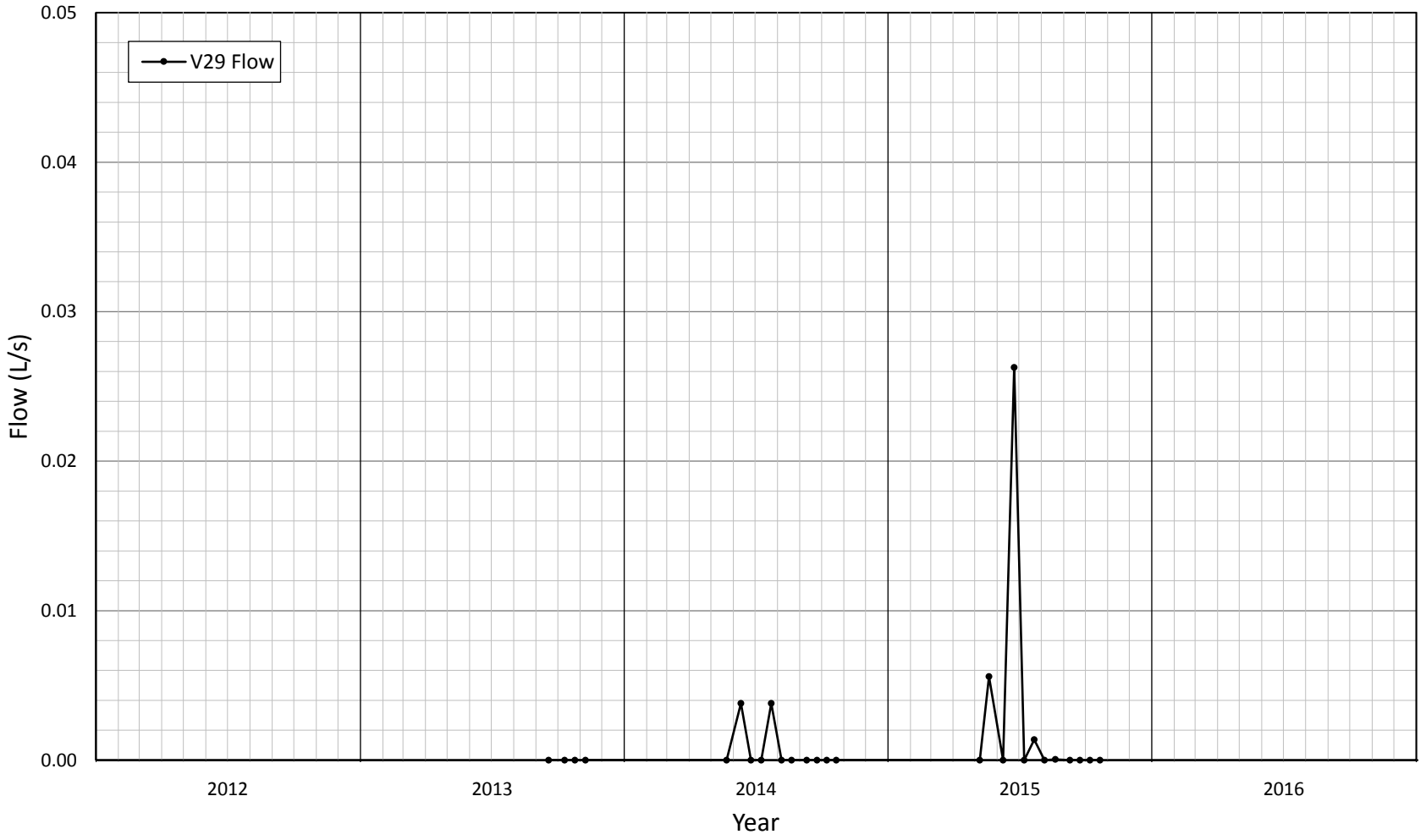
PROJECT No.: M09770A06

FIG No.: II-K1-1

# APPENDIX II-L

## Vangorda Waste Rock Dump

L1 – Weir Flows
L2 – Piezometers



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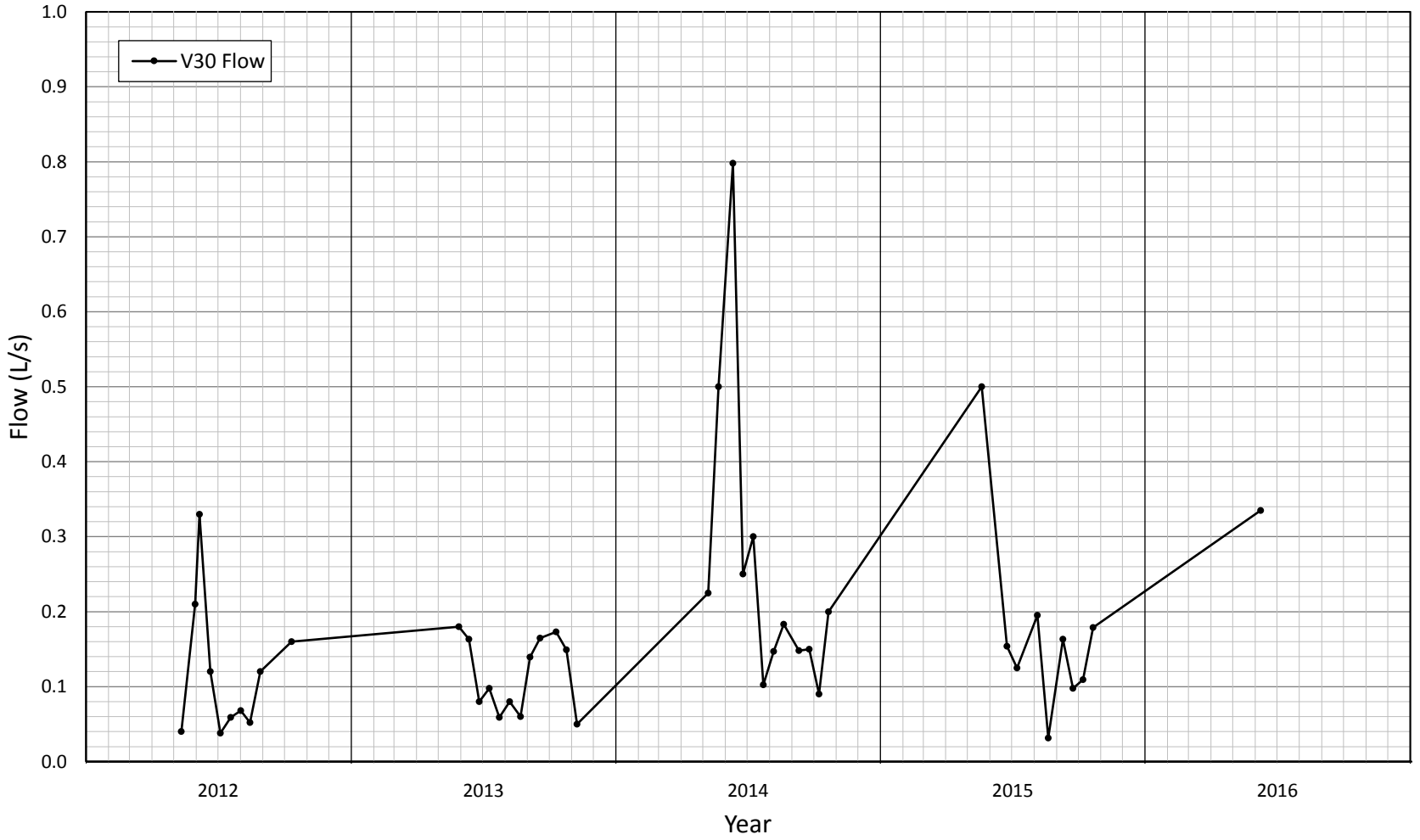
VANGORDA WASTE ROCK DUMP
V29 DISCHARGE

PROJECT No. M09770A06

FIG No. II-L1-1



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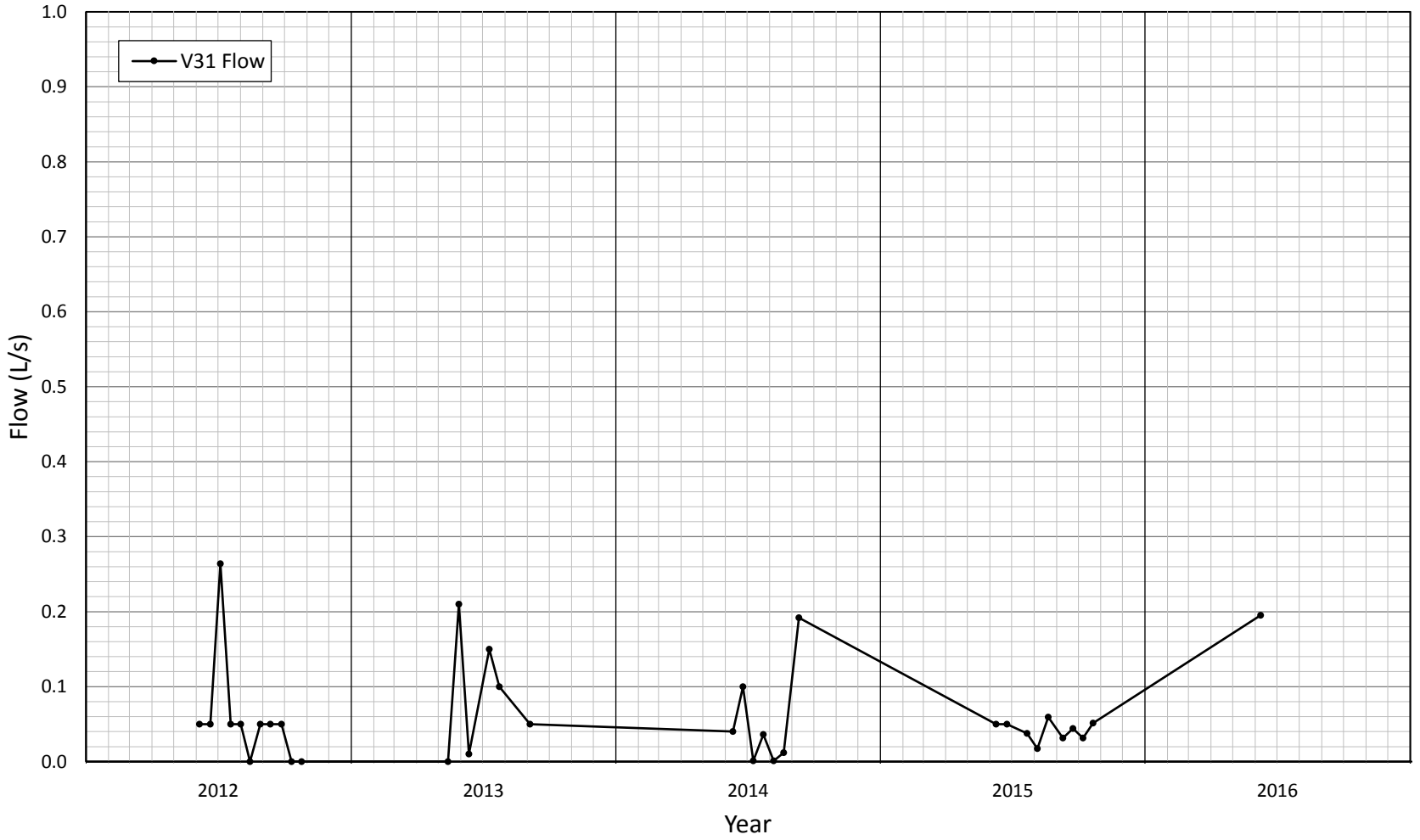
VANGORDA WASTE ROCK DUMP
V30 DISCHARGE

PROJECT No. M09770A06

FIG No. II-L1-2



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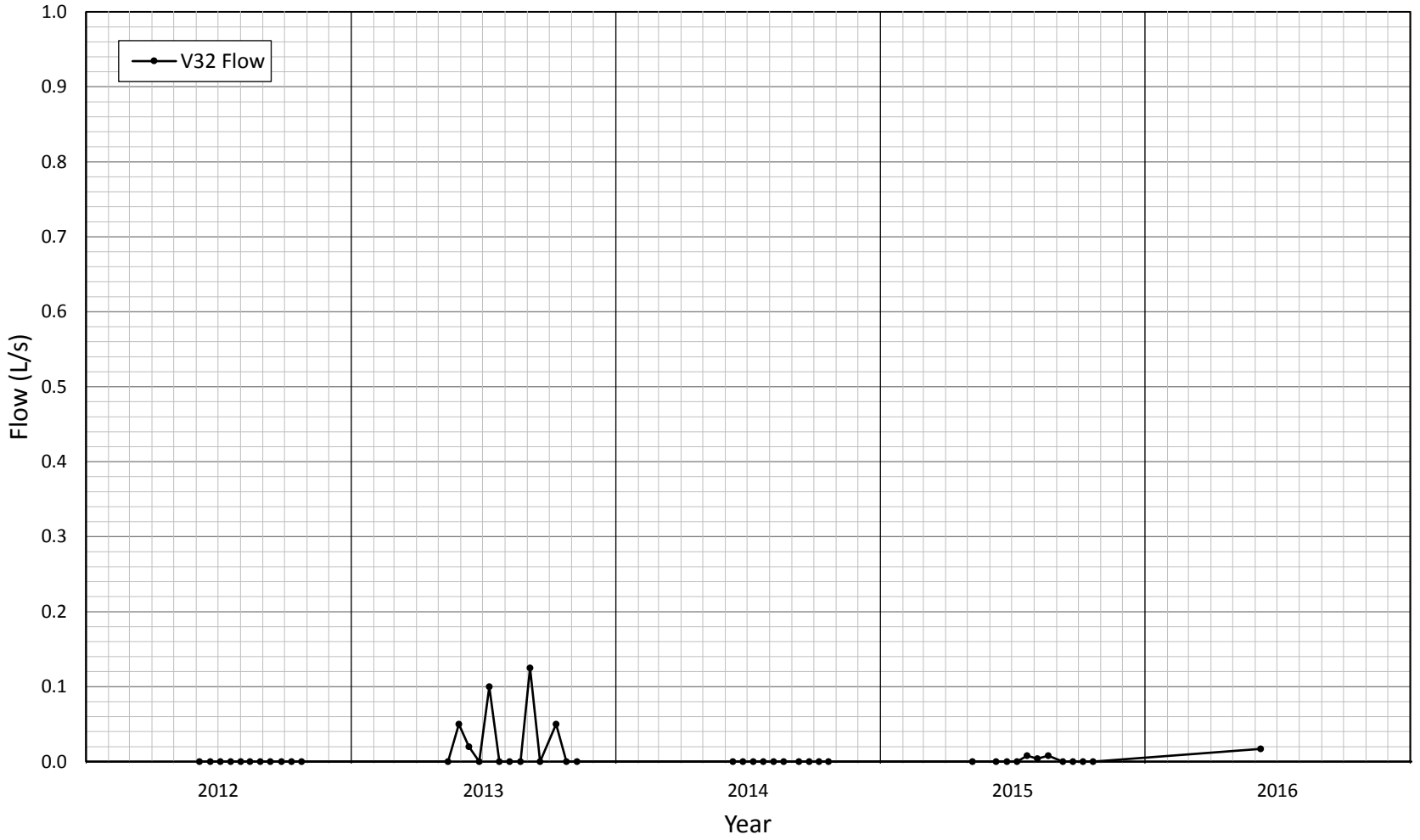
VANGORDA WASTE ROCK DUMP
V31 DISCHARGE

PROJECT No. M09770A06

FIG No. II-L1-3



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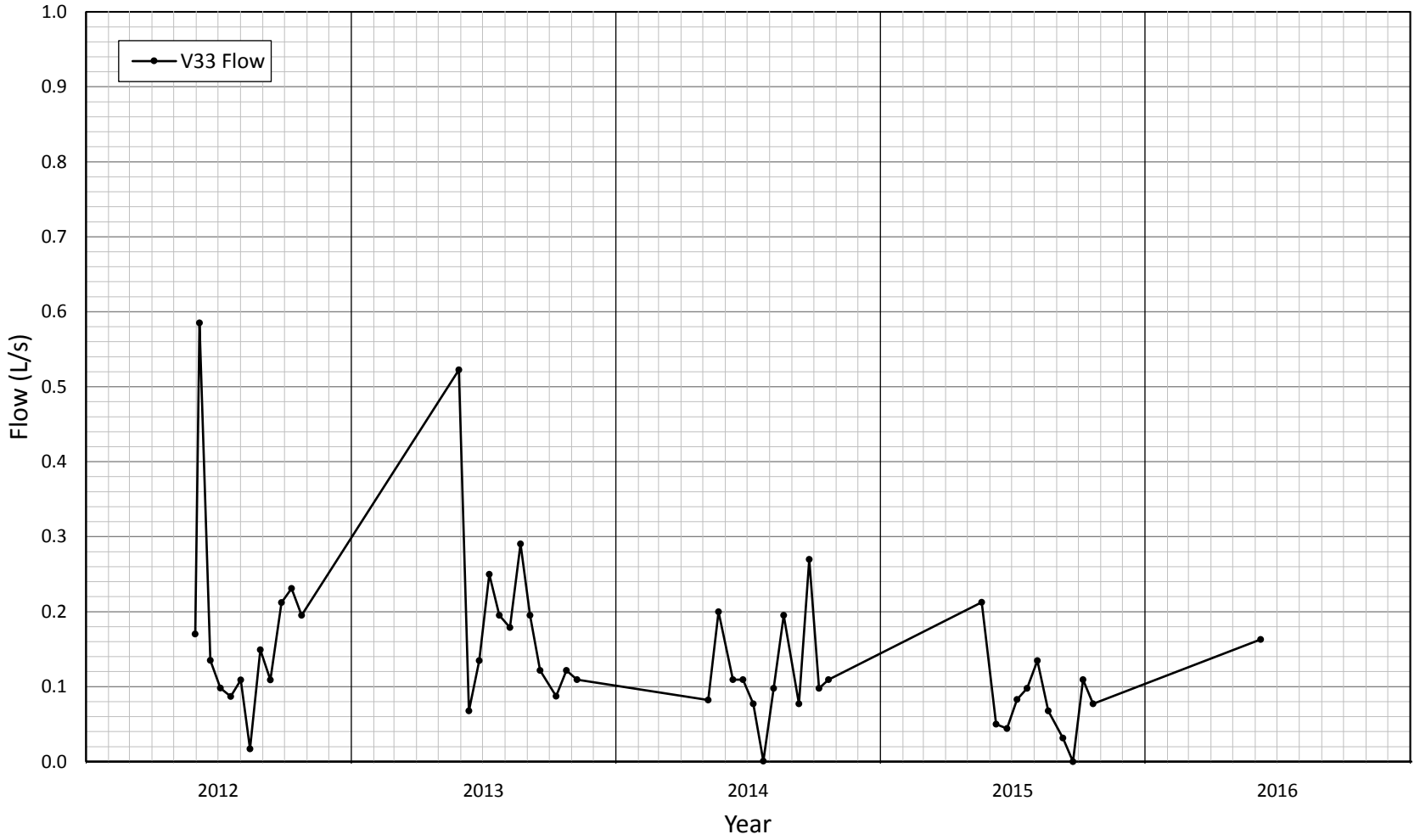
VANGORDA WASTE ROCK DUMP
V32 DISCHARGE

PROJECT No. M09770A06

FIG No. II-L1-4



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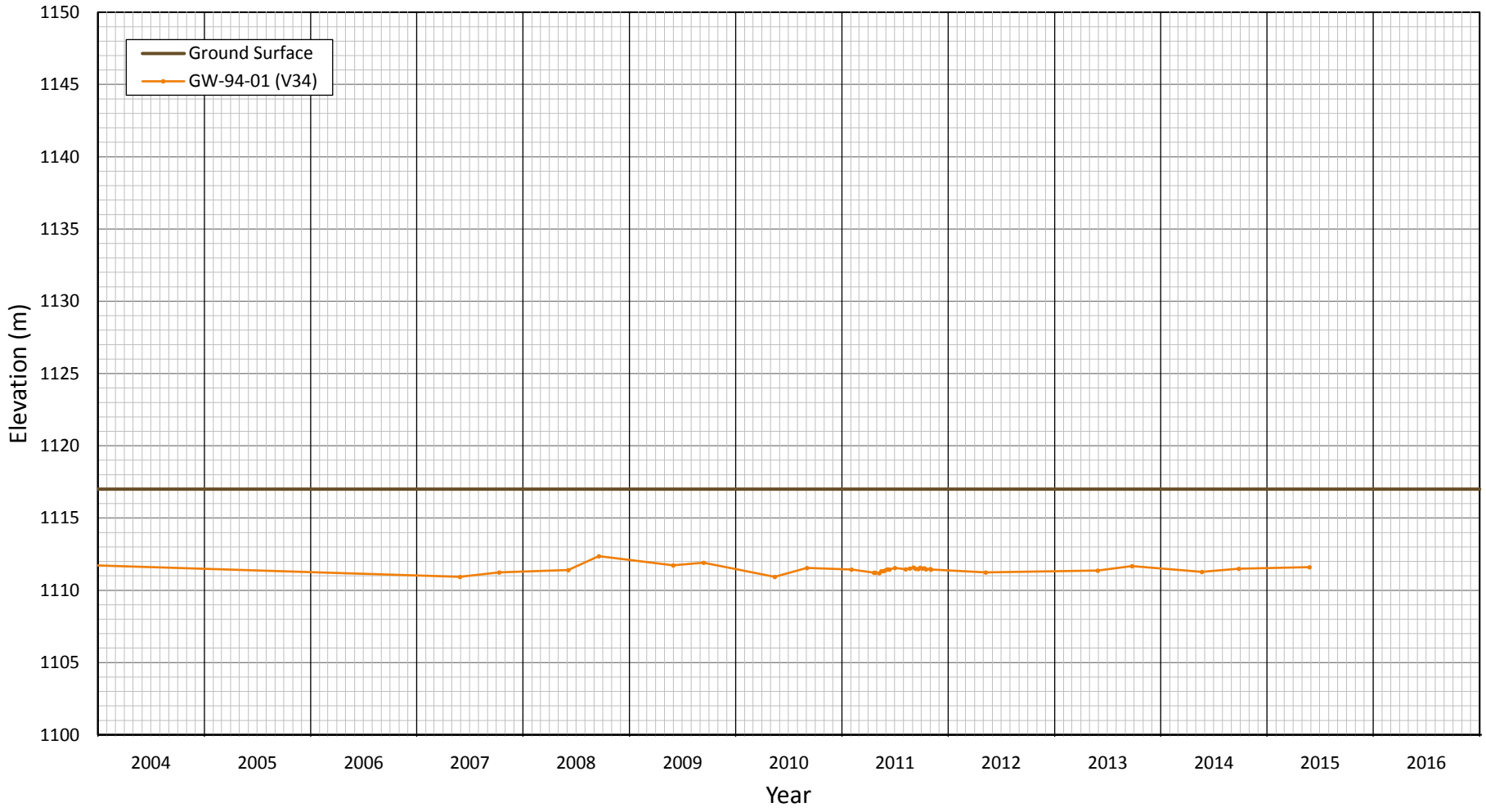
VANGORDA WASTE ROCK DUMP
V33 DISCHARGE

PROJECT No. M09770A06

FIG No. II-L1-5



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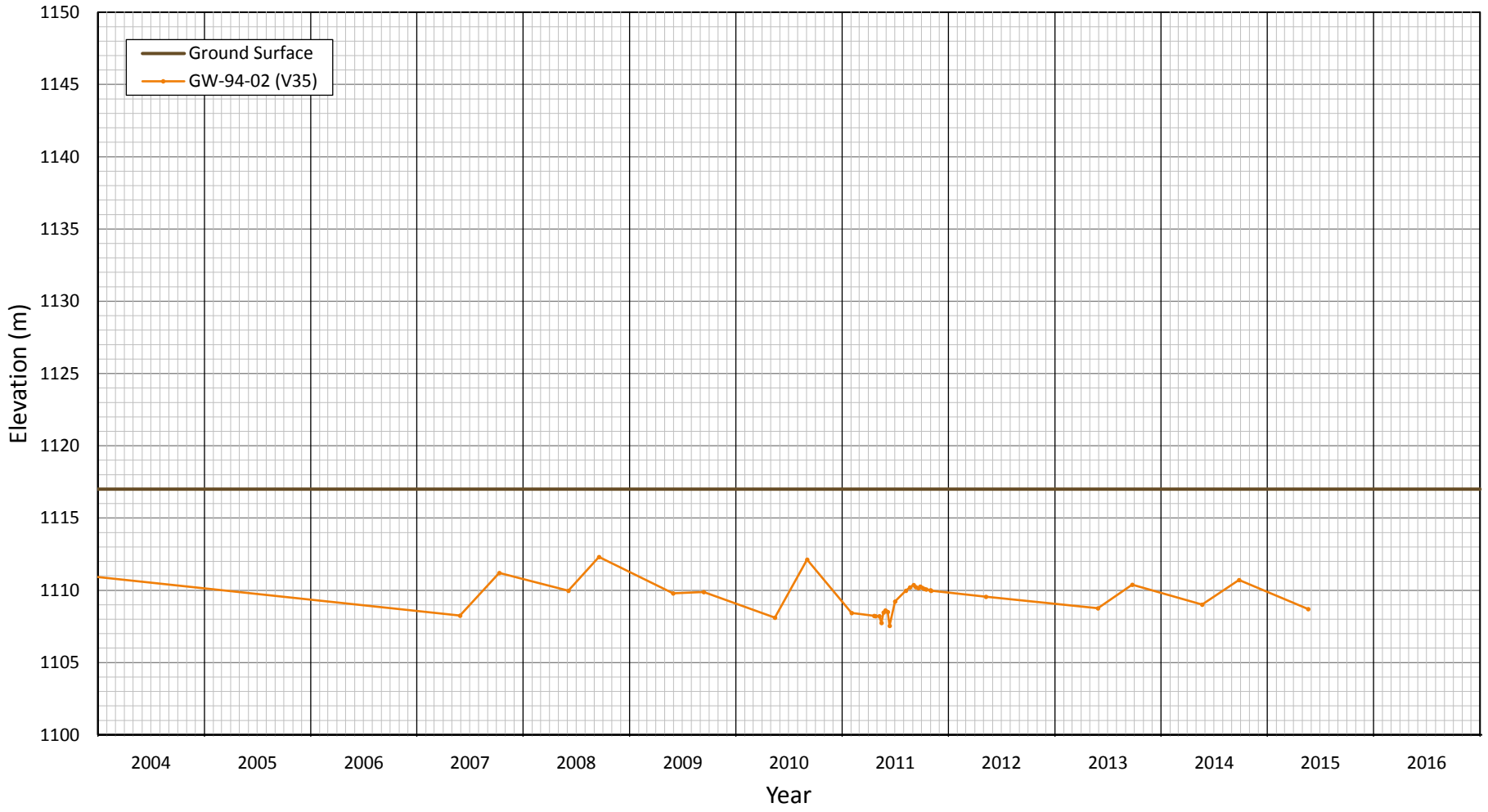
VANGORDA WASTE ROCK DUMP
PIEZOMETERS
GW-94-01 (V34)

PROJECT No. M09770A06

FIG No. II-L2-1



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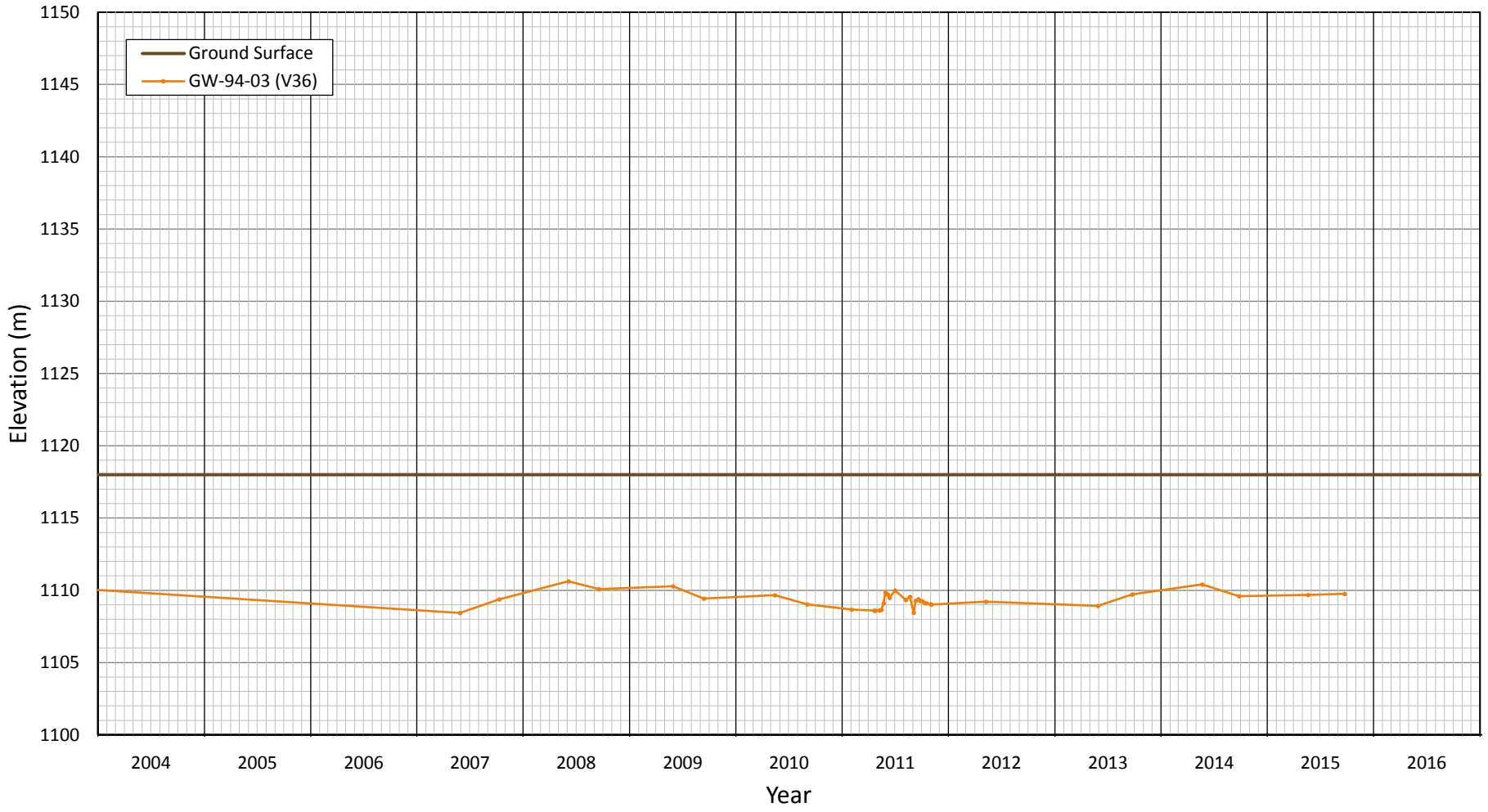
VANGORDA WASTE ROCK DUMP
PIEZOMETERS
GW-94-02 (V35)

PROJECT No. M09770A06

FIG No. II-L2-2



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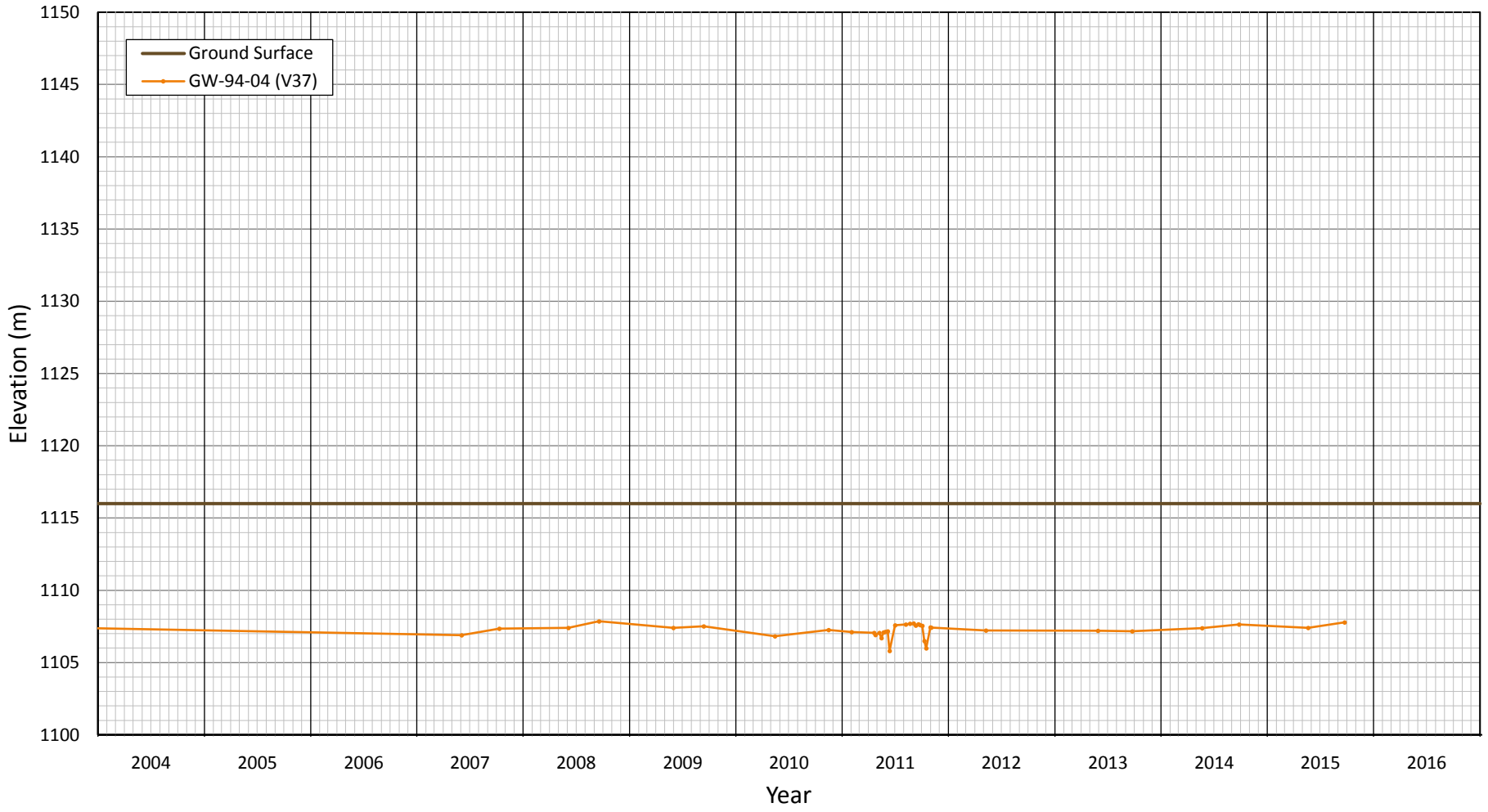
VANGORDA WASTE ROCK DUMP
PIEZOMETERS
GW-94-03 (V36)

PROJECT No. M09770A06

FIG No. II-L2-3



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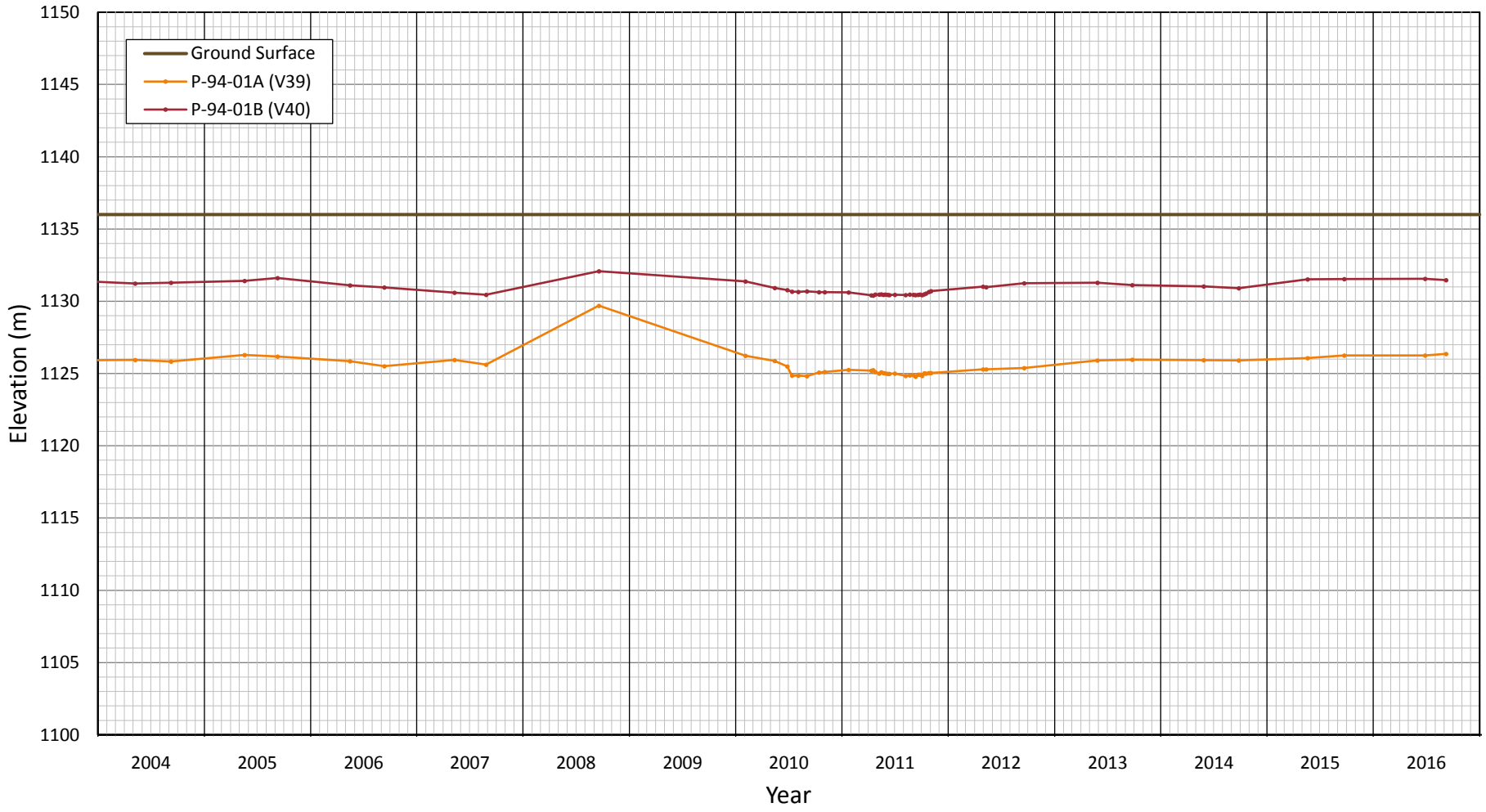
VANGORDA WASTE ROCK DUMP
PIEZOMETERS
GW-94-04 (V37)

PROJECT No. M09770A06

FIG No. II-L2-4



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2016 ANNUAL GEOTECHNICAL REVIEW

TITLE

VANGORDA WASTE ROCK DUMP
PIEZOMETERS
P-94-01 (V39, V40)

PROJECT No. M09770A06

FIG No. II-L2-5




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FARO MINE COMPLEX
2016 ANNUAL GEOTECHNICAL REVIEW

TITLE

VANGORDA WASTE ROCK DUMP
PIEZOMETERS
P94-02 (V41, V42, V43)

PROJECT No. M09770A06

FIG No. II-L2-6




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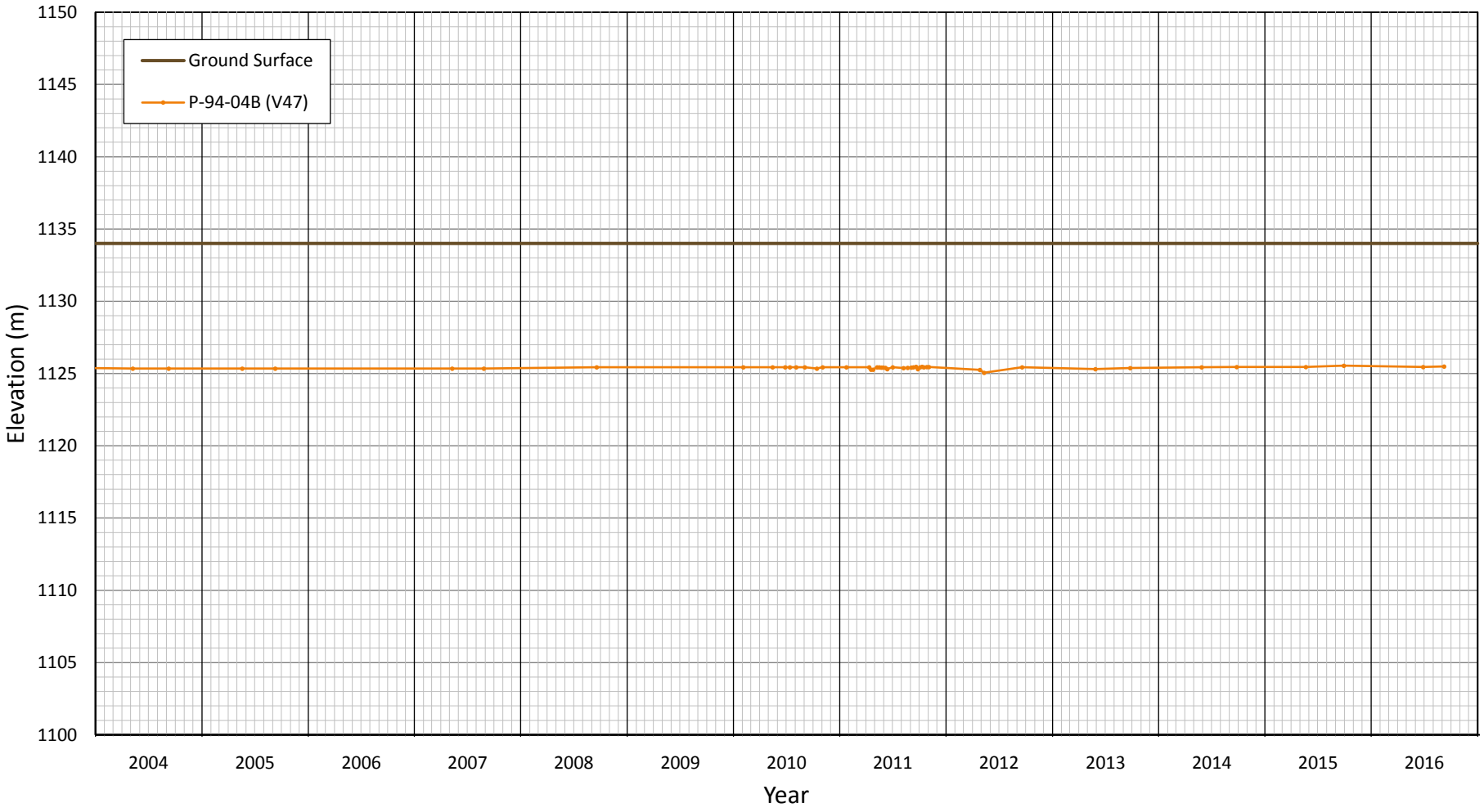
2016 ANNUAL GEOTECHNICAL REVIEW

TITLE

VANGORDA WASTE ROCK DUMP
PIEZOMETERS
P-94-03 (V44, V45)

PROJECT No. M09770A06

FIG No. II-L2-7




Notes:
1. P-94-04A (V46) broken. No records available.



CLIENT: Yukon Government

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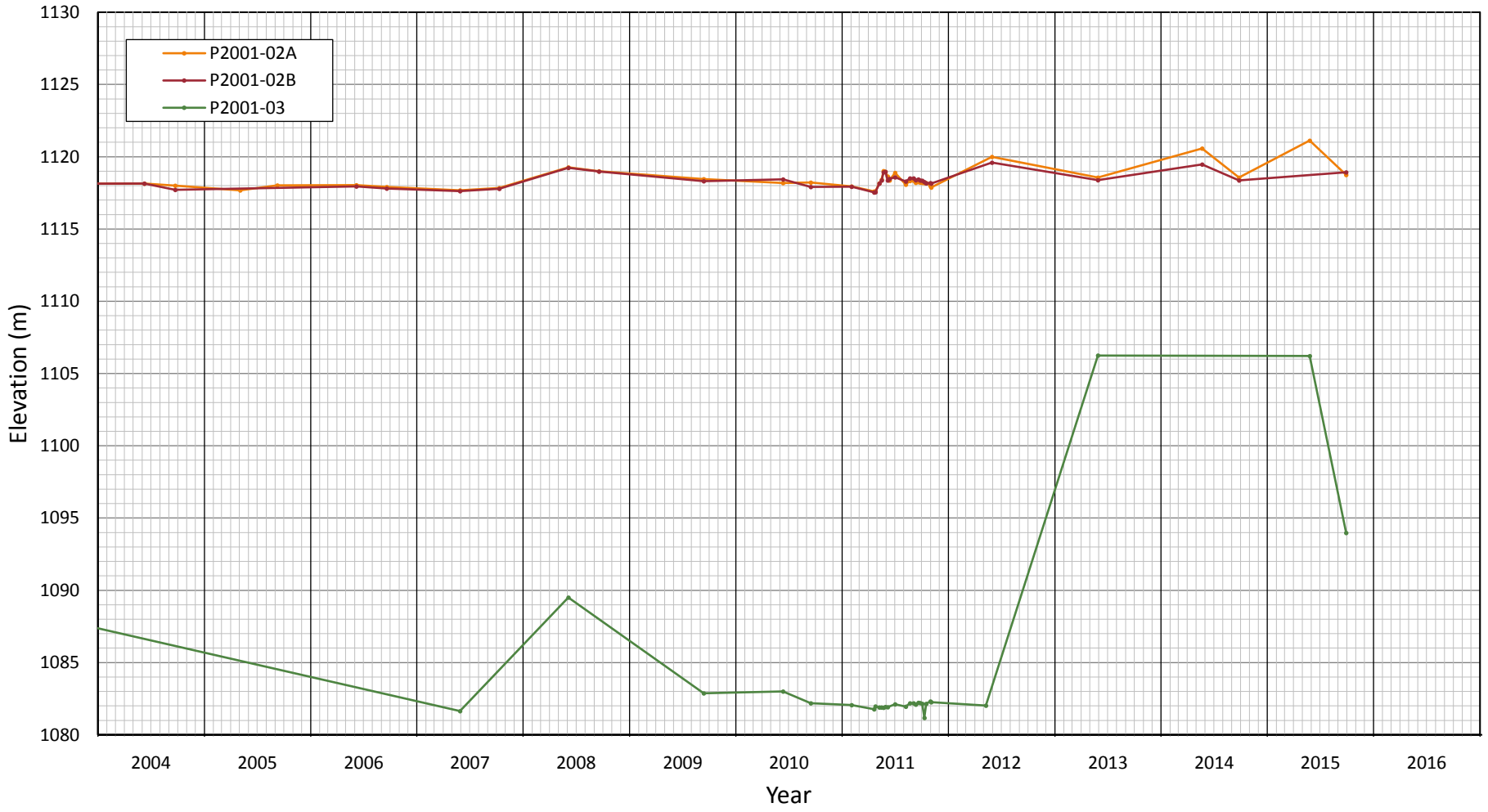
PROJECT: FARO MINE COMPLEX
2016 ANNUAL GEOTECHNICAL REVIEW

TITLE: VANGORDA WASTE ROCK DUMP
PIEZOMETERS
P-94-04 (V47)

PROJECT No.: M09770A06

FIG No.: II-L2-8



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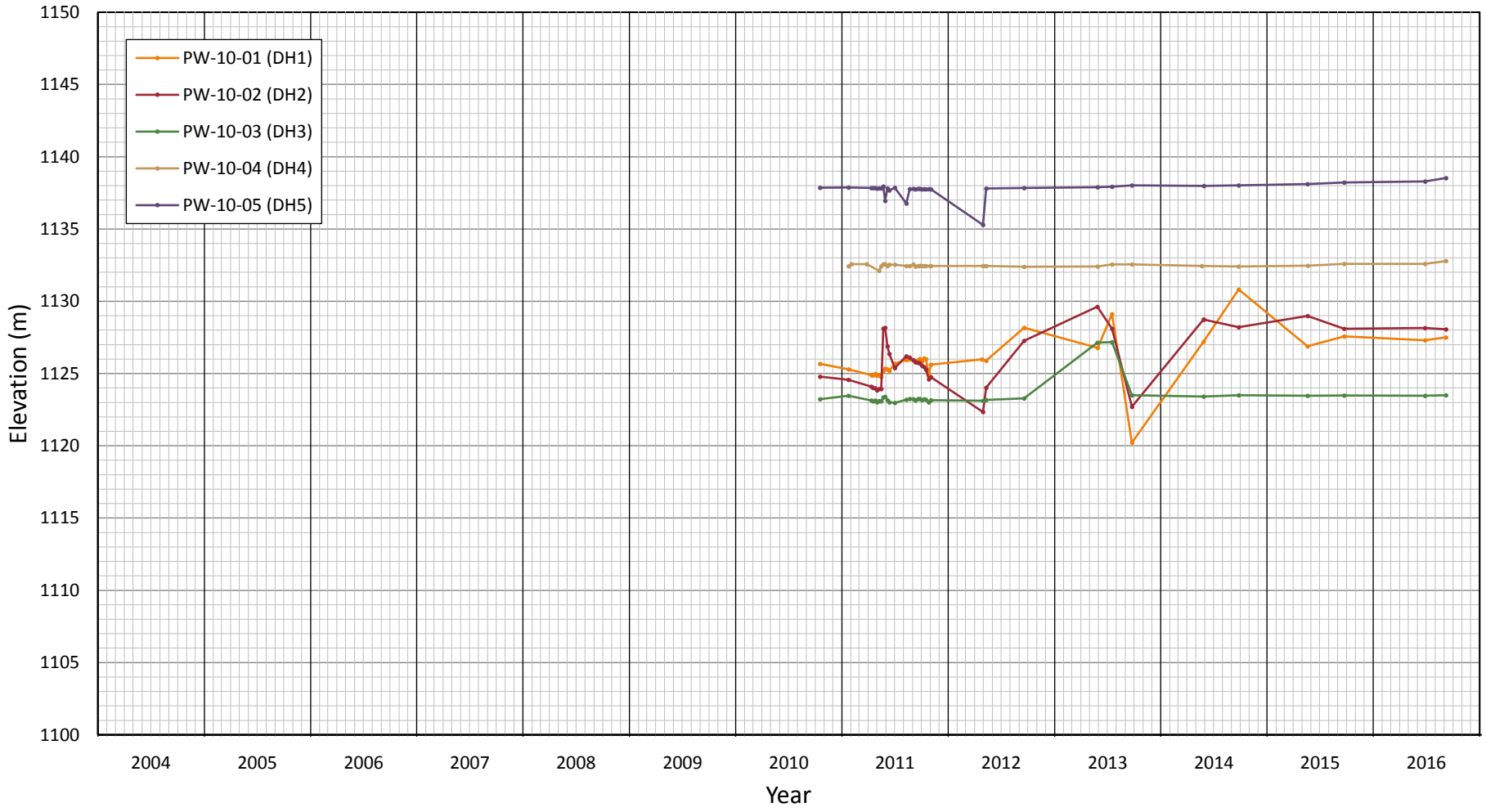
2016 ANNUAL GEOTECHNICAL REVIEW

TITLE

VANGORDA WASTE ROCK DUMP
PIEZOMETERS
P2001-02, P2001-03

PROJECT No. M09770A06

FIG No. II-L2-9



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2016 ANNUAL GEOTECHNICAL REVIEW

TITLE

# VANGORDA WASTE ROCK DUMP PIEZOMETERS PW-10-01 (DH1), PW-10-02 (DH2), PW-10-03 (DH3), PW-10-04 (DH4), PW-10-05 (DH5)

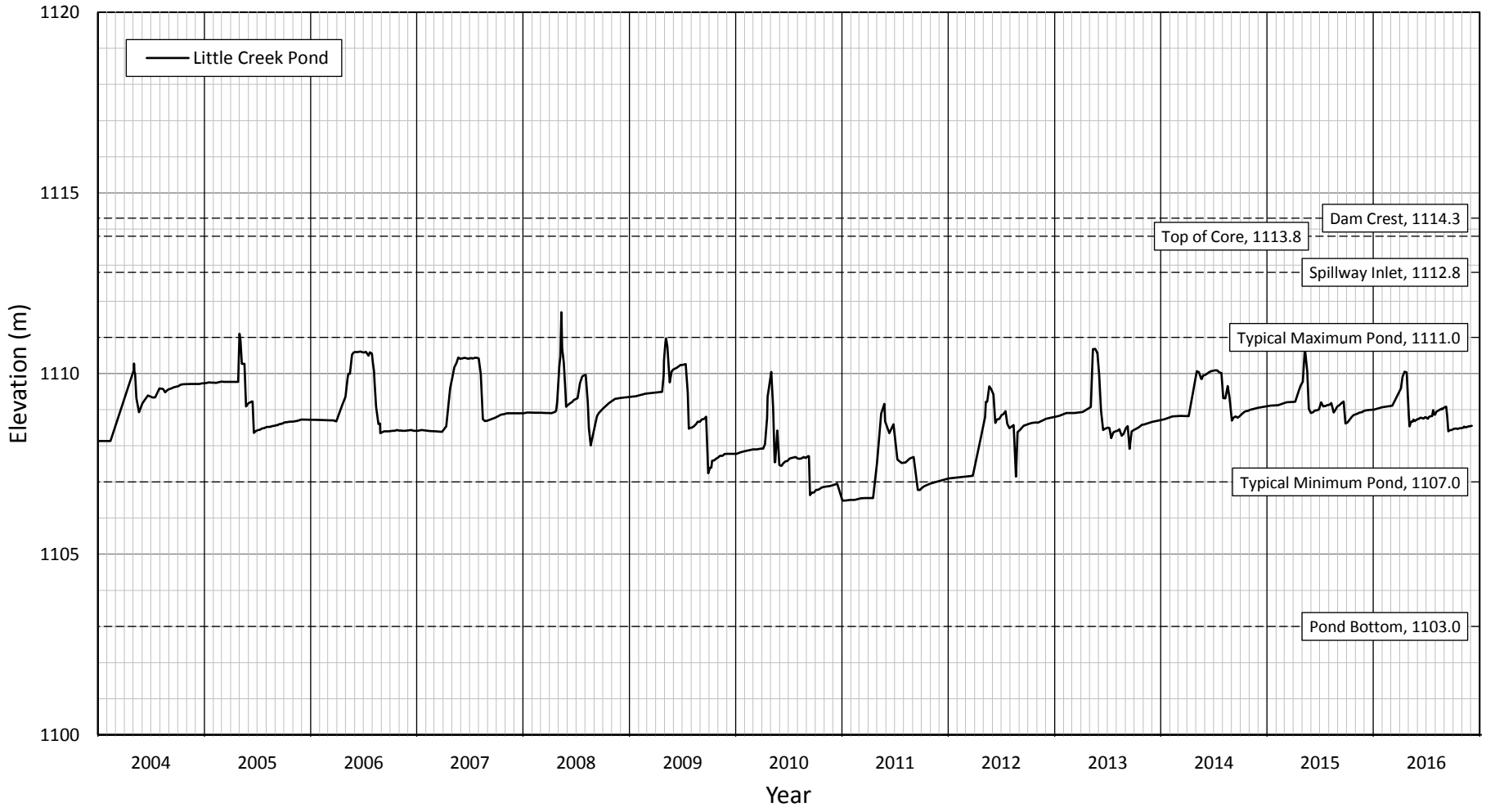
PROJECT No. M09770A06

FIG No. II-L2-10

# APPENDIX II-M

## Little Creek Dam

M1 – Pond Level
M2 – Piezometers
M3 – Thermistors



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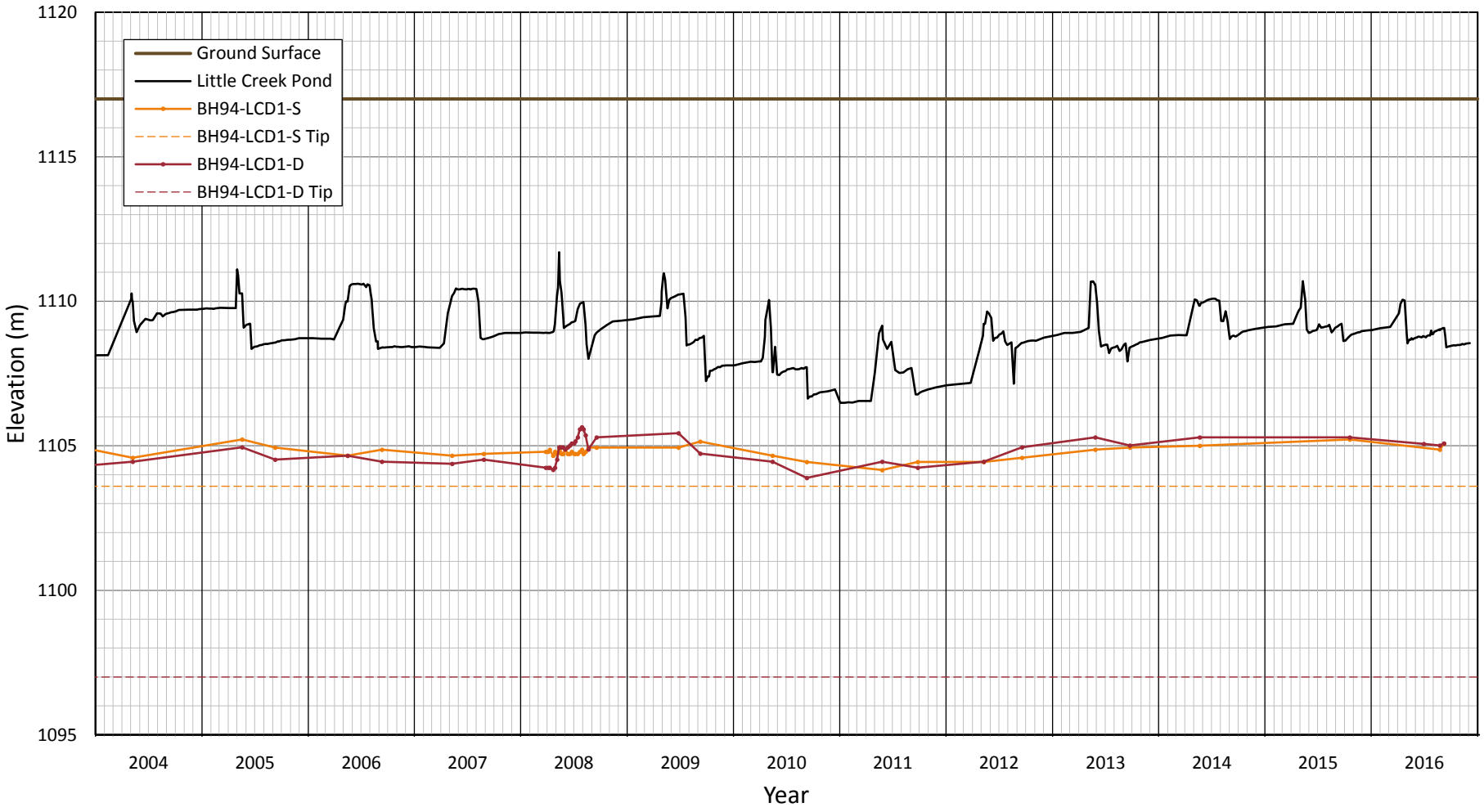
FARO MINE COMPLEX
2016 ANNUAL GEOTECHNICAL REVIEW

TITLE

LITTLE CREEK DAM
POND LEVEL

PROJECT No. M09770A06

FIG No. II-M1-1



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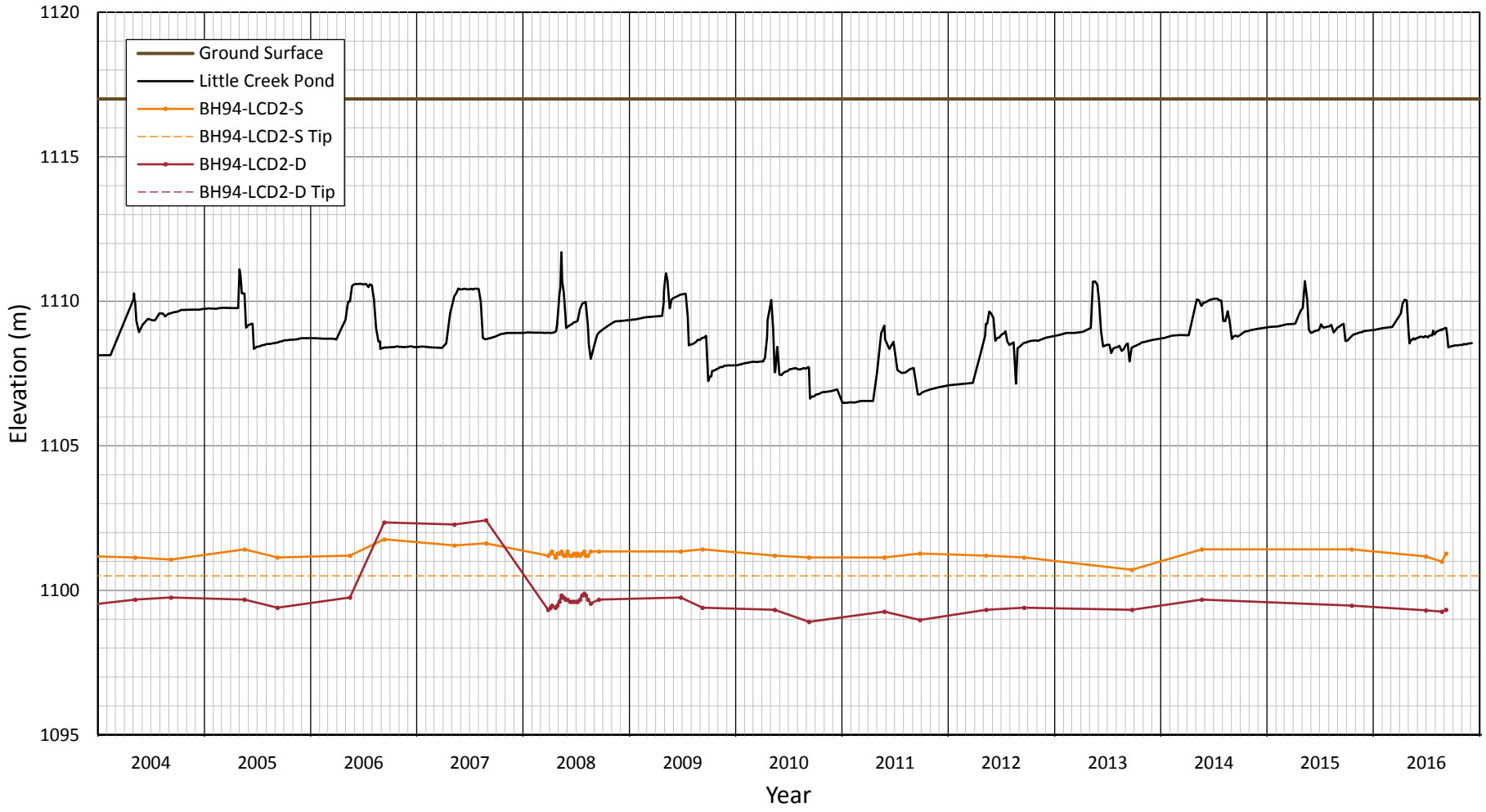
TITLE

LITTLE CREEK DAM
PIEZOMETERS
BH91-LCD1

PROJECT No. M09770A06

FIG No. II-M2-1






CLIENT: Yukon Government

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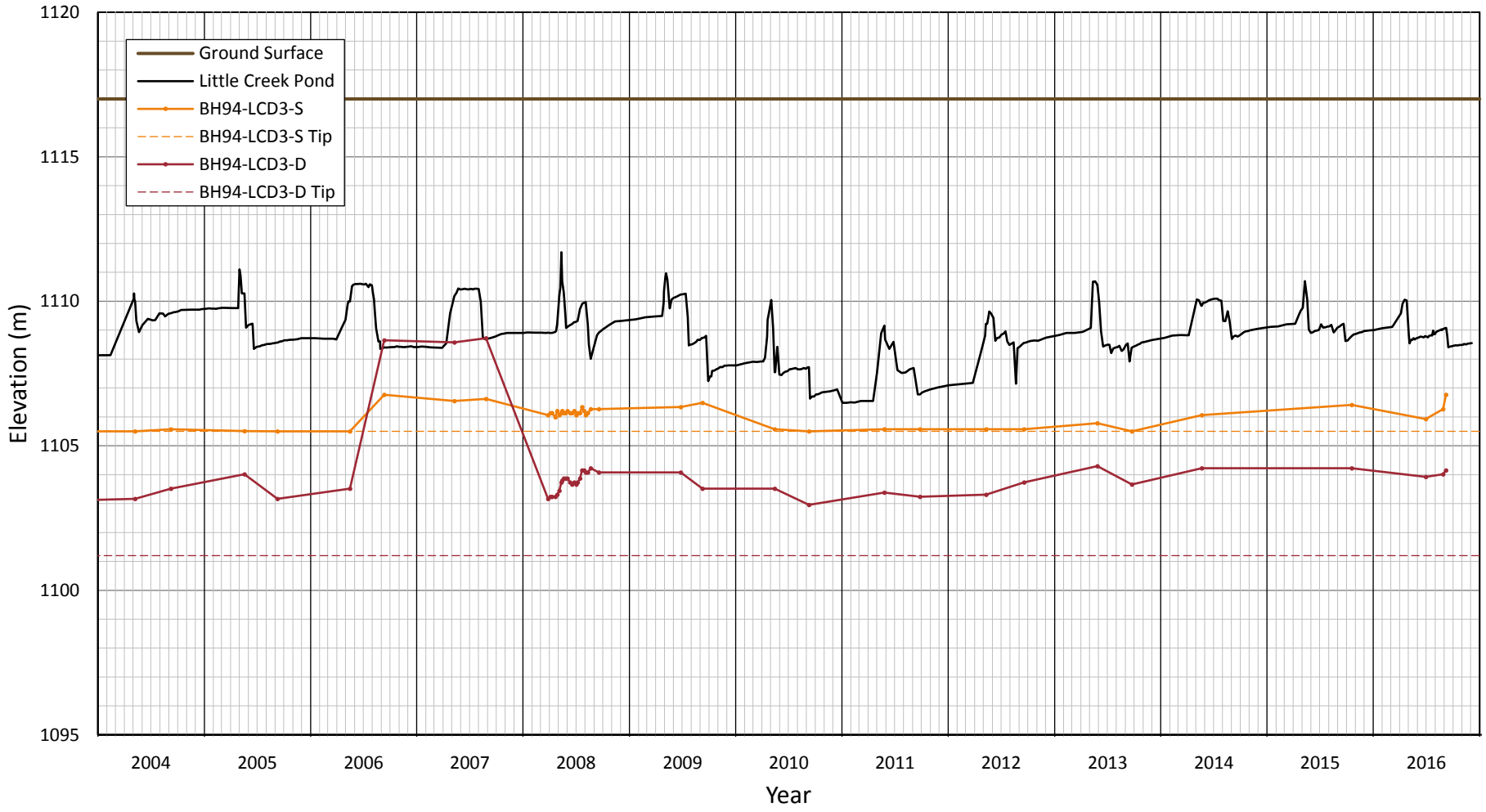
PROJECT: FARO MINE COMPLEX
2016 ANNUAL GEOTECHNICAL REVIEW

TITLE: LITTLE CREEK DAM
PIEZOMETERS
BH91-LCD2

PROJECT No. M09770A06

FIG No. II-M2-2



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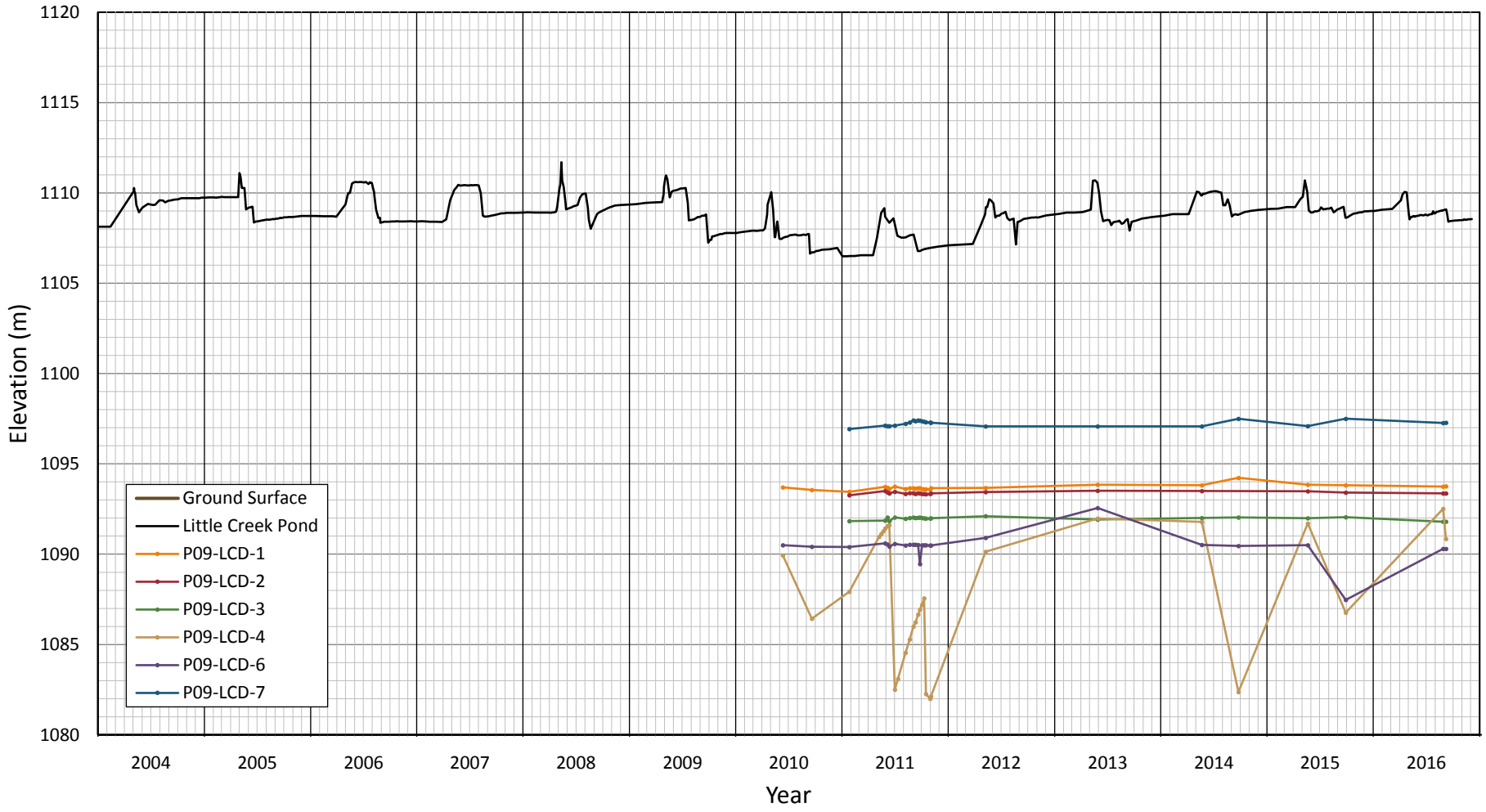
TITLE

LITTLE CREEK DAM
PIEZOMETERS
BH91-LCD3

PROJECT No. M09770A06

FIG No. II-M2-3



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2016 ANNUAL GEOTECHNICAL REVIEW

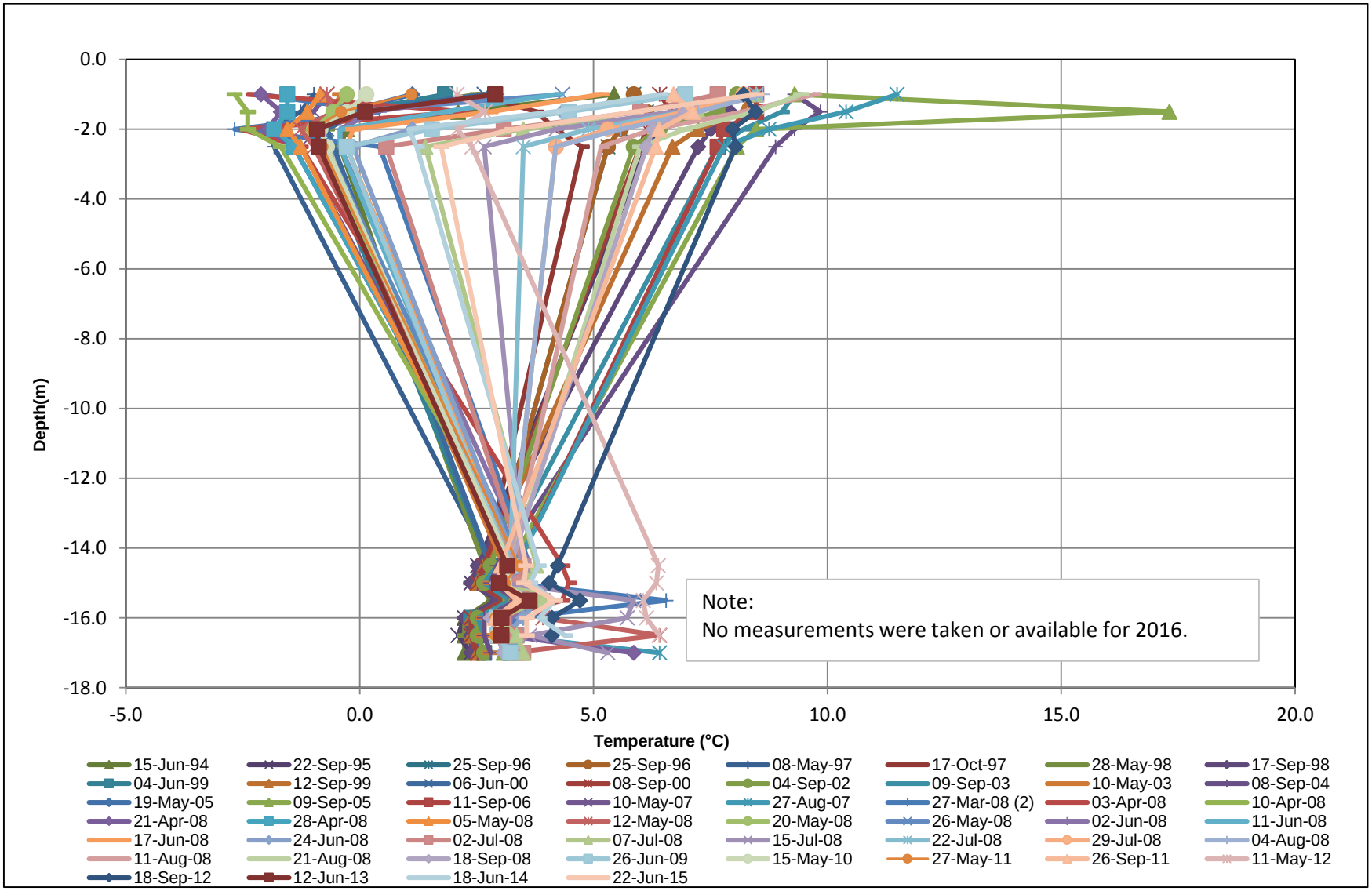
TITLE

LITTLE CREEK DAM PIEZOMETERS
P09-LCD-1, P09-LCD-2, P09-LCD-3,
P09-LCD-4, P09-LCD-6, P09-LCD-7

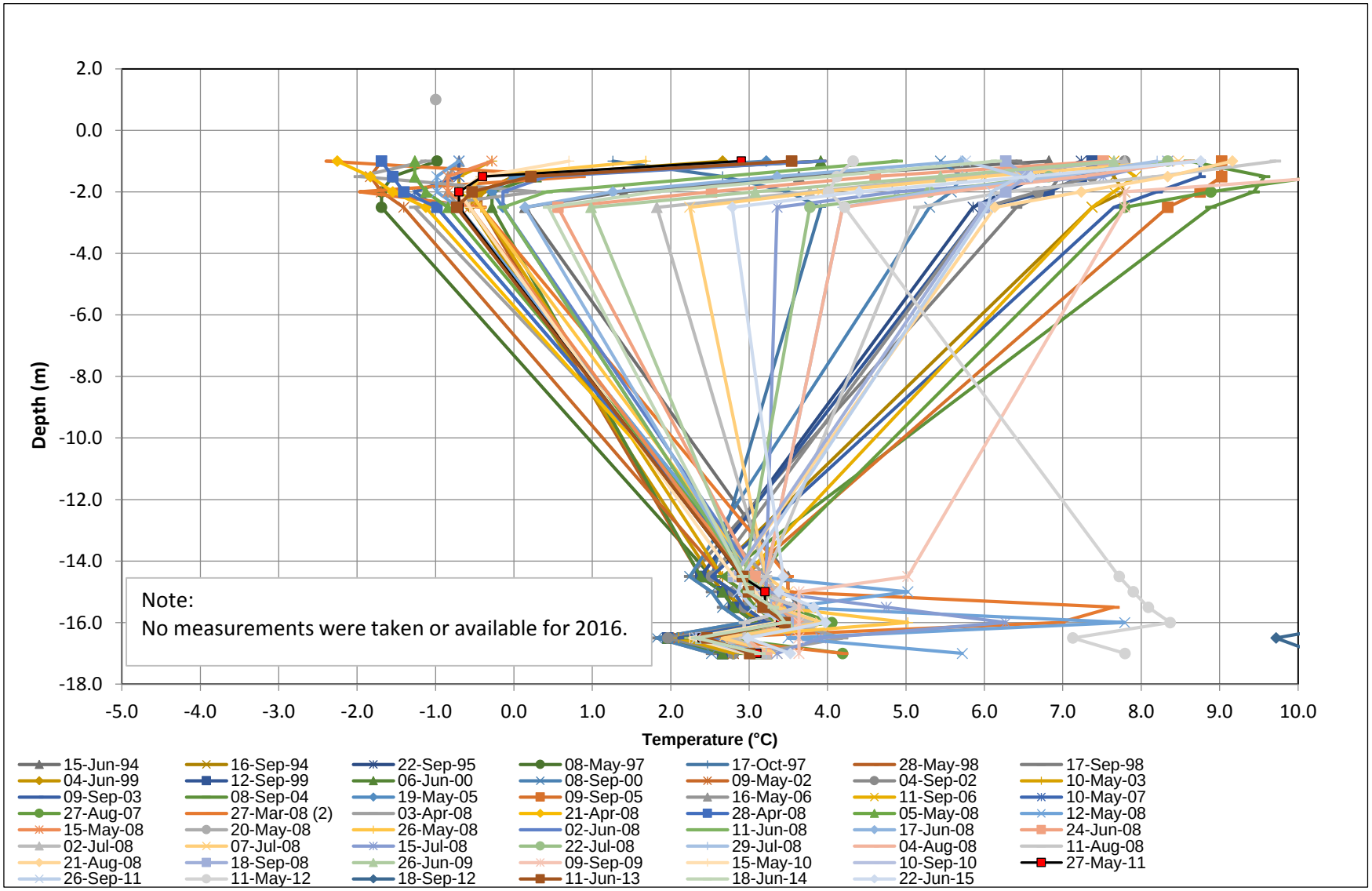
PROJECT No. M09770A06

FIG No. II-M2-3

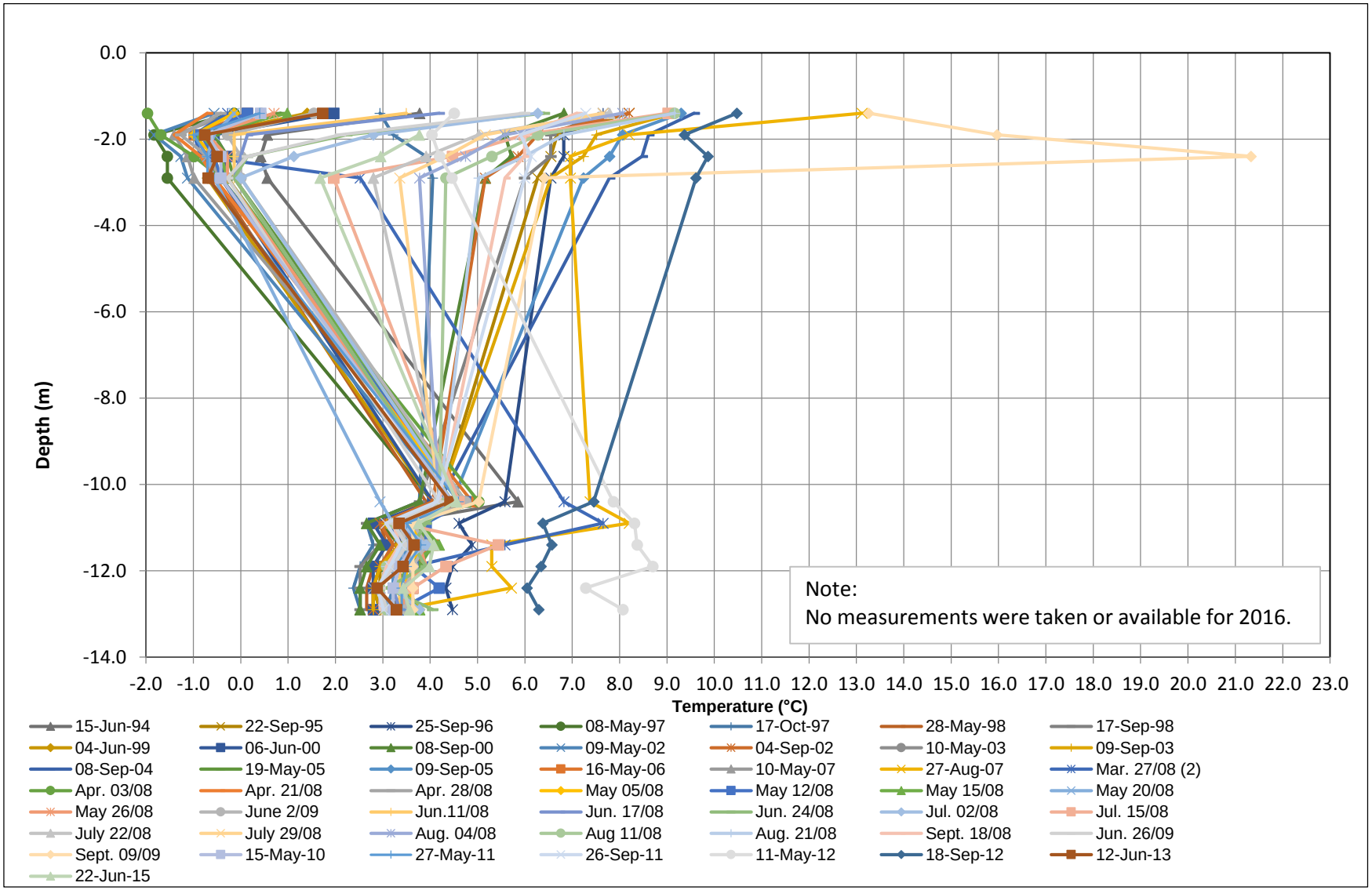
**Little Creek Dam**
**Thermistor BH94 LCD4**



**Little Creek Dam**
**Thermistor BH94 LCD5**



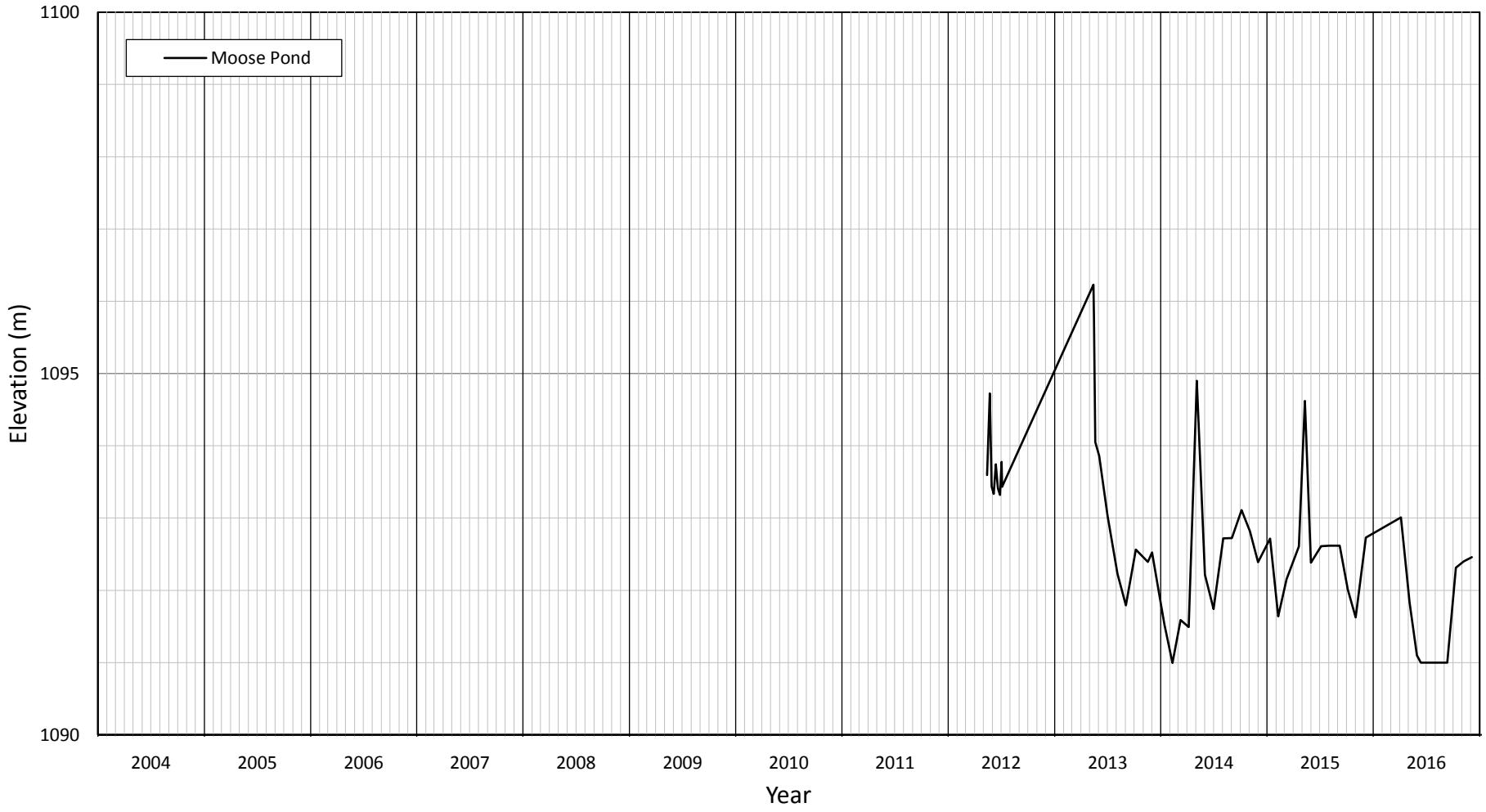
**Little Creek Dam**
**Thermistor BH94 LCD6**



# APPENDIX II-N

## Moose Pond

N1 – Pond Level



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2016 ANNUAL GEOTECHNICAL REVIEW

TITLE

MOOSE POND
POND LEVEL

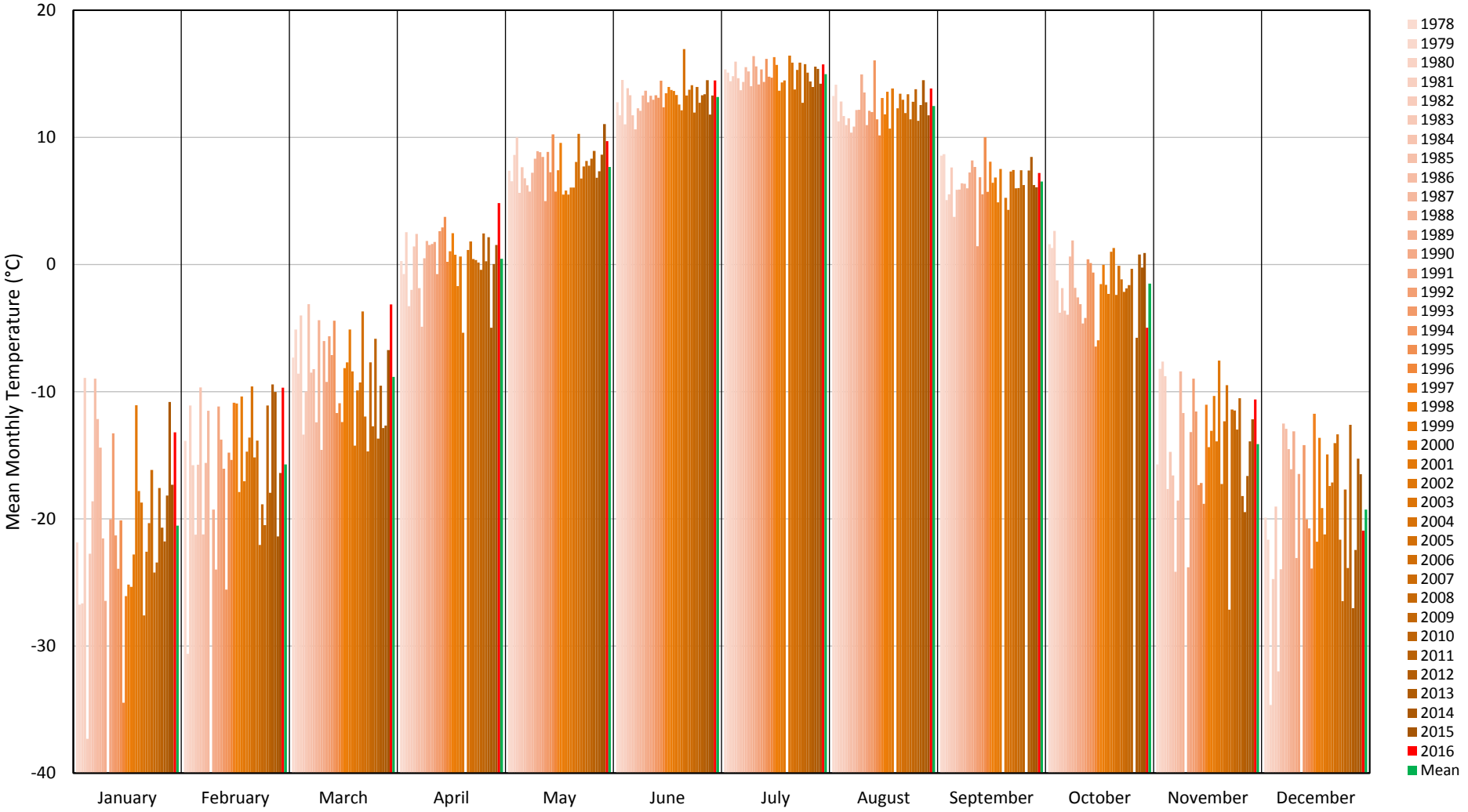
PROJECT No. M09770A06

FIG No. II-N1-1

# APPENDIX II-O

## Faro Airport Climate

O1 – Monthly Precipitation/Temperature



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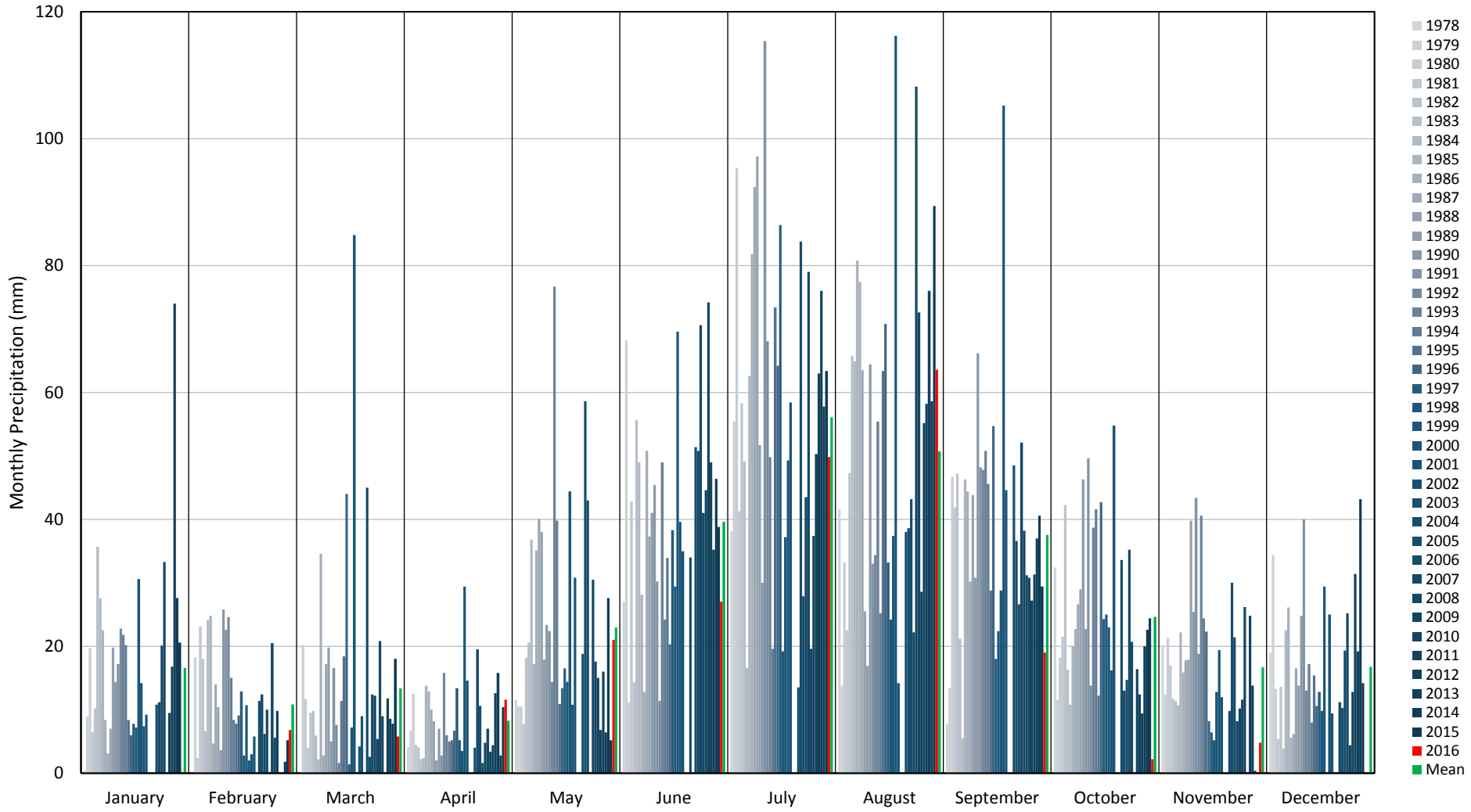
FARO MINE COMPLEX
2016 ANNUAL GEOTECHNICAL REVIEW

TITLE

# FARO AIRPORT CLIMATE STATION MEAN MONTHLY TEMPERATURE

PROJECT No. M09770A06

FIG No. II-O1-1



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FARO MINE COMPLEX
2016 ANNUAL GEOTECHNICAL REVIEW

TITLE

# FARO AIRPORT CLIMATE STATION MONTHLY PRECIPITATION

PROJECT No. M09770A06

FIG No. II-O1-2

# APPENDIX III

## Instrumentation Summary and Monitoring Frequency

# Appendix III
# Instrumentation Summary and Monitoring Frequency

This appendix summarizes the monitoring frequency for instruments at the Faro Mine Complex, as recommended in the 2016 Annual Review report. Also included are tables of known instruments and their status. Instrument locations for the Cross Valley Dam, Intermediate Dam, Secondary Dam, Rose Creek Diversion, Little Creek Dam and Vangorda Waste Rock Dump are shown in Figures III-1 to III-4.

## III-1 INSTRUMENTATION MONITORING FREQUENCY

**Table III-1 Instrumentation Monitoring Frequency**

| | | | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Rose Creek Diversion Channel** | | | | | | | | | | | | | | |
| | Thermistors | Canal Dyke: CD-10, CD-15, CD-21, CD-26, BGC05-04, BGC05-07 | | | | | | M | | | | | | |
| | | Spoil Pile: SP-2, SP-3, SP-5 | | | | | | M | | | | | | |
| | | Back Slope: BS-5, BS-9, BS-10, BS-12 | | | | | | M | | | M | | | |
| | Inclinometers | Canal Dyke: CD-10, -15, -21. BH91-CD1, BGC05-05, -08. | One successful reading for all inclinometers | | | | | | | | | | | |
| | | Spoil Pile: SP-2 | One successful reading for all inclinometers | | | | | | | | | | | |
| | | Back Slope: BS-5, BS-9, BS-10 | Two successful readings for all inclinometers: one in spring/summer, the other in fall | | | | | | | | | | | |
| | Piezometers | Canal Dyke: CD-13(D), -15, -21(S), -26. BGC05-02, -03, -06. | | | | | M | M | | | M | | | |
| | | Back Slope: BS-5, BS-9 | | | | | M | M | | | M | | | |
| | Staff Gauges | RCDC-4 | | | | Daily | Daily | Daily | W | W | W | | | |
| | Flows | RCDC-4 (Obtain one reading during high flow at freshet) | | | | M | M | M | M | M | M | M | | |
| **Cross Valley Dam** | | | | | | | | | | | | | | |
| | Piezometers | CVDC-4(D), -7(D), -9. CVDT-2. CVDP-1, -5, -6. 94 CVDC-1, P01-11 | | | | | M | M | | | M | | | |
| | Weir Flows | X11, X12, X13, Weir 3 | W | W | W | W | W | W | W | W | W | W | W | W |
| | Elevations | Polishing Pond | W | W | W | W | W | W | W | W | W | W | W | W |
| | Visual Inspection | Visual Inspections of dam and spillway as required in the water license. | W | W | W | W | W | W | W | W | W | W | W | W |
| **Intermediate Dam** | | | | | | | | | | | | | | |
| | Piezometers | 91ID-3, -4(D). 94-IDC-1, 96-1, -2, -3(A), -4(A, D). BKS04-06, -07. | | | | | M | M | | | M | | | |
| | Observe | Seepage observations near south abutment | | | | | M | M | | M | M | | | |
| | Elevations | Intermediate Pond | W | W | W | W | W | W | W | W | W | W | W | W |
| | Visual Inspection | Visual Inspections of the dam and spillway. | W | W | W | W | W | W | W | W | W | W | W | W |
| **Secondary Dam** | | | | | | | | | | | | | | |
| | Piezometers | P81-6, P81-7, P81-8, P03-01, P03-02, P03-03 | | | | | M | M | | | M | | | |
| **North Fork Rock Drain** | | | | | | | | | | | | | | |
| | Data Loggers | NFRD2B (Relocate NFRD2B or establish new staff gauge downstream) | | | | M | M | M | M | M | M | M | | |
| | Staff Gauges | NFRD2B, X2 (Relocate NFRD2B or establish new staff gauge downstream) | | | | Daily | Daily | W | W | M | M | M | | |
| | Flows | NFRD2B, X2 | | | | M | M | M | M | M | M | M | | |
| | Water Elevation | NF1 | | | | | W | W | W | TAM | TAM | | | |
| | Observe | NF1, NF2 | M | M | M | M | M | M | M | M | M | M | M | M |
| **K8 Rock Drain** | | | | | | | | | | | | | | |
| | Observe | | | | | | M | M | M | | | | | |
| **Faro Creek Diversion Channel** | | | | | | | | | | | | | | |
| | Staff Gauges | FCD-1, FCD-2, FCD-3, FCD-4 | | | | TAM | TAM | M | M | M | M | M | | |
| | Flows | FCD-1, FCD-2, FCD-3, FCD-4 | | | | TAM | TAM | M | M | M | M | M | | |
| **Faro Pit** | | | | | | | | | | | | | | |
| | Observe | Faro Pit | M | M | M | M | M | M | M | M | M | M | M | M |
| **Grum Pit** | | | | | | | | | | | | | | |
| | Observe | Grum Pit Wall | M | M | M | M | M | M | M | M | M | M | M | M |
| **Vangorda Pit** | | | | | | | | | | | | | | |
| | Observe | Vangorda Pit Wall | M | M | M | M | M | M | M | M | M | M | M | M |
| **Vangorda Waste Rock Dump** | | | | | | | | | | | | | | |
| | Observe | Weirs: V28, V29, V30, V31, V32, V33 | | | | | M | M | M | M | M | M | | |
| | | Drainage Ditch | | | | | | M | | | | | | |
| | | Northeast Dump Crest | | | | | | M | | | | | | |
| | Flows | V29, V30, V31, V32, V33 | | | | | M | M | M | M | M | M | | |
| | Piezometers | V39, 40, 41, 42, 43, 44, 45, 47. PW-10-01, -02, -03, -04, -05. | | | | | M | | | | M | | | |
| | Standpipe Data Loggers | PW-10-01, -02, -03, and -05 (DH1, DH2, DH3, DH5) | | | | | M | | | | M | | | |
| **Little Creek Dam** | | | | | | | | | | | | | | |
| | Piezometers | BH94 LCD-2, -3, P09-LCD-1, -2, -3, -4, -6, -7 | | | | | M | | | | M | | | |
| | Visual Inspection | Visual inspections of the dam and spillway. | W | W | W | W | W | W | W | W | W | W | W | W |
| **Vangorda Creek Diversion** | | | | | | | | | | | | | | |
| | Observe | Trash rack at headworks | | | | M | M | M | M | M | M | | | |
| | | Seepage collection pond | | | | M | M | M | | | | | | |
| | | Side Slopes Above Flume | | | | | M | M | | | | | | |
| **Sludge Pond Embankment** | | | | | | | | | | | | | | |
| | Observe | Downstream slopes and embankment | | | | M | M | | | | M | | | |
| **Fresh Water Pond** | | | | | | | | | | | | | | |
| | Observe | Spillway from Fresh Water Pond to Grum Interceptor Ditch | | | | | M | | | | M | | | |
| **Grum Interceptor Ditch and Sheep Pad Pond** | | | | | | | | | | | | | | |
| | Observe | Outlets / Inlets to Ditch | | | | M | M | | | | M | | | |
| | | Sheep Pad Pond Dyke | | | | M | M | | | | M | | | |

Note:
M – Monthly
W – Weekly
TAM – Twice a month

## III-2 KNOWN INSTRUMENTATION SUMMARY

**Table III-2 Inclinometer Summary**

| Area | Instrument Name | Easting (m) (NAD27 UTM) | Northing (m) (NAD27 UTM) | Bottom Depth (m) | Reading Start Depth (m) | Status | Comments |
|---|---|---|---|---|---|---|---|
| Cross Valley Dam | BH91-CD1 | 581,007 | 6,913,352 | 11.25 | 11 | Functioning | |
| | BH94CD-1 | 580,533 | 6,913,591 | 2.5 | | Not functioning | |
| Rose Creek Diversion Channel | BGC05-05 | 580,859 | 6,913,424 | 11.75 | 11.5 | Functioning | |
| | BGC05-08 | 580,701 | 6,913,521 | 12.75 | 13 | Functioning | Keep reading with bottom depth of 12.5 m. |
| | BS-5 | 581,740 | 6,913,008 | 10.4 | 10 | Functioning | |
| | BS-9 | 581,216 | 6,913,254 | 10.35 | 10 | Functioning | |
| | BS-10 | 580,856 | 6,913,363 | 10.4 | 10 | Functioning | |
| | CD-10 | 581,723 | 6,913,066 | 10.4 | 10 | Functioning | |
| | CD-15 | 581,218 | 6,913,289 | 9.6 | 9.5 | Functioning | |
| | CD-19 | 580,892 | 6,913,410 | 3.5 | 10 | Not functioning | |
| | CD-21 | 580,703 | 6,913,504 | 10.05 | 10 | Functioning | |
| | SP-2 | 581,263 | 6,913,326 | 7.25 | 7 | Functioning | |
| | SP-5 | 580,236 | 6,913,773 | | | Questionable | Pipe broken below ground surface. |

## Table III-3 Standpipe Piezometer Summary

| Area | Instrument | Easting (m) (NAD27 UTM) | Northing (m) (NAD27 UTM) | Top of Casing Elevation (m) | Screen Top Depth (m) | Screen Bottom Depth (m) | Status | Comment |
|---|---|---|---|---|---|---|---|---|
| Cross Valley Dam | 94-CVDC-1 | 580,253 | 6,914,336 | 1034.02 | | 13.0 | Functioning | |
| | CVDC-4-D | 580,256 | 6,914,340 | 1033.60 | | 33.9 | Functioning | |
| | CVDC-4-S | 580,256 | 6,914,340 | 1033.41 | | 25.5 | Not functioning | Blocked at 7.6 m |
| | CVDC-7-D | 580,149 | 6,914,132 | 1033.47 | | 30.6 | Functioning | |
| | CVDC-7-S | 580,149 | 6,914,132 | 1033.55 | | 25.8 | Questionable | Slow response to falling head test |
| | CVDC-9-D | 580,097 | 6,914,028 | 1033.47 | | 32.8 | Functioning | |
| | CVDC-9-S | 580,097 | 6,914,028 | 1033.55 | | 25.8 | Functioning | |
| | CVDT-1 | 580,208 | 6,914,362 | 1018.57 | | 10.7 | Not functioning | |
| | CVDT-2 | 580,091 | 6,914,157 | 1019.83 | | 13.6 | Functioning | |
| | P01-02 | 580,066 | 6,914,048 | | | | Questionable | Not measured recently |
| | P01-11 | 580,199 | 6,914,312 | 1017.87 | | 10.6 | Functioning | |
| | P03-09 | 580,059 | 6,914,210 | 1018.53 | | | Unknown | Not measured recently |
| Grum Pit | SRK09-GSA | 592,621 | 6,904,684 | | | | Functioning | |
| | SRK09-GSB | 592,631 | 6,904,684 | | | | Functioning | |
| Intermediate Dam | BH94-IDC-1 | 580,595 | 6,913,975 | 1049.48 | | 14.0 | Functioning | |
| | BH96-1 | 580,552 | 6,913,924 | 1049.83 | 18.8 | 21.8 | Functioning | |
| | BH96-2 | 580,686 | 6,914,105 | 1049.94 | 17.1 | 20.1 | Functioning | |
| | BH96-3-A | 580,520 | 6,913,947 | 1032.13 | 7.4 | 9.0 | Functioning | |
| | BH96-3-B | 580,520 | 6,913,947 | 1032.07 | 17.7 | 19.2 | Questionable | Slow response to falling head test |
| | BH96-4-A | 580,653 | 6,914,125 | 1033.11 | 5.7 | 6.5 | Functioning | |
| | BH96-4-B | 580,653 | 6,914,125 | 1033.03 | 9.8 | 11.3 | Questionable | Blocked at El. 1029 m |
| | BH96-4-C | 580,653 | 6,914,125 | 1033.07 | 15.0 | 16.5 | Questionable | Blocked at El. 1020 m |
| | BH96-4-D | 580,653 | 6,914,125 | 1033.04 | 26.8 | 28.3 | Functioning | |
| | BKS04-06 | 580,457 | 6,913,803 | 1050.61 | 12.8 | 13.1 | Functioning | |
| | BKS04-07 | 580,408 | 6,913,750 | 1050.71 | 11.5 | 11.8 | Functioning | |
| | P01-03 | 580,627 | 6,914,077 | 1032.13 | 7.8 | 9.3 | Questionable | Slow response to falling head test |
| | P01-04-A | 580,484 | 6,913,899 | 1032.77 | 31.7 | 33.2 | Not functioning | |
| | P01-04-B | 580,484 | 6,913,899 | 1032.77 | 51.0 | 52.5 | Questionable | Slow response to falling head test |

| Area | Instrument | Easting (m) (NAD27 UTM) | Northing (m) (NAD27 UTM) | Top of Casing Elevation (m) | Screen Top Depth (m) | Screen Bottom Depth (m) | Status | Comment |
|---|---|---|---|---|---|---|---|---|
| | P03-08 | 580,969 | 6,913,520 | 1048.42 | | | Unknown | Not measured recently |
| Little Creek Dam | P09-LCD-1 | 593,483 | 6,903,144 | 1097.53 | | | Functioning | |
| | P09-LCD-2 | 593,476 | 6,903,139 | 1097.69 | | | Functioning | |
| | P09-LCD-3 | 593,456 | 6,903,114 | 1093.71 | | | Functioning | |
| | P09-LCD-4 | 593,441 | 6,903,094 | 1093.68 | | | Functioning | |
| | P09-LCD-6 | 593,426 | 6,903,064 | 1096.21 | | | Functioning | |
| | P09-LCD-7 | 593,431 | 6,903,014 | 1101.68 | | | Functioning | |
| Secondary Dam | P03-01 | 583,288 | 6,912,588 | 1061.11 | | | Functioning | |
| | P03-02 | 583,121 | 6,912,578 | 1060.59 | | | Functioning | |
| | P03-03 | 583,056 | 6,912,705 | 1061.49 | | | Functioning | |
| | P03-04 | 582,066 | 6,913,189 | 1061.30 | | | Unknown | Not measured recently |
| | P03-06 | 582,561 | 6,913,314 | 1062.90 | | | Unknown | Not measured recently |
| | P81-06 | 582,790 | 6,912,686 | 1060.87 | | 6.0 | Questionable | Slow response to falling head test |
| | P81-07 | 583,221 | 6,912,421 | 1064.08 | | 6.1 | Functioning | |
| | P81-08 | 583,323 | 6,912,405 | 1064.00 | | 7.5 | Functioning | |
| Vangorda Waste Rock Dump | GW-94-01 (V34) | 593,538 | 6,902,300 | 1117.45 | | | Functioning | |
| | GW-94-02 (V35) | 593,287 | 6,902,379 | 1117.41 | | | Functioning | |
| | GW-94-03 (V36) | 593,244 | 6,902,741 | 1118.43 | | | Functioning | |
| | GW-94-04 (V37) | 593,425 | 6,902,906 | 1116.17 | | | Functioning | |
| | GW-94-05 (V38) | | | 1101.67 | | | Unknown | Not measured recently |
| | P2001-02A | 593,241 | 6,902,689 | 1122.78 | | | Unknown | |
| | P2001-02B | 593,241 | 6,902,689 | 1122.77 | | | Unknown | |
| | P2001-03 | 593,206 | 6,902,706 | 1120.00 | | | Unknown | |
| | P-94-01A (V39) | 593,356 | 6,902,429 | 1136.56 | | | Functioning | |
| | P-94-01B (V40) | 593,356 | 6,902,429 | 1136.49 | | | Functioning | |
| | P-94-02A (V41) | 593,278 | 6,902,572 | 1138.41 | | | Functioning | |
| | P-94-02B (V42) | 593,278 | 6,902,562 | 1138.33 | | | Functioning | |
| | P-94-02C (V43) | 593,255 | 6,902,528 | 1129.84 | | | Functioning | |
| | P-94-03A (V44) | 593,485 | 6,902,800 | 1134.37 | | | Functioning | |

| Area | Instrument | Easting (m) (NAD27 UTM) | Northing (m) (NAD27 UTM) | Top of Casing Elevation (m) | Screen Top Depth (m) | Screen Bottom Depth (m) | Status | Comment |
|---|---|---|---|---|---|---|---|---|
| | P-94-03B (V45) | 593,475 | 6,902,790 | 1134.46 | | | Questionable | Slow response to falling head test |
| | P-94-04A (V46) | 593,667 | 6,902,901 | | | | Not functioning | |
| | P-94-04B (V47) | 593,657 | 6,902,891 | 1134.33 | | | Functioning | |
| | PW-10-01 (DH1) | 593,683 | 6,902,847 | 1149.08 | | | Functioning | |
| | PW-10-02 (DH2) | 593,318 | 6,902,638 | 1139.30 | | | Functioning | |
| | PW-10-03 (DH3) | 593,327 | 6,902,494 | 1137.72 | | | Functioning | |
| | PW-10-04 (DH4) | 593,849 | 6,902,319 | 1141.69 | | | Questionable | Slow response to falling head test |
| | PW-10-05 (DH5) | 593,631 | 6,902,510 | 1180.39 | | | Functioning | |

## Table III-4 Pneumatic Piezometer Summary

| Area | Instrument | Easting (m) (NAD27 UTM) | Northing (m) (NAD27 UTM) | Tip Elevation (m) | Status | Comment |
|---|---|---|---|---|---|---|
| Cross Valley Dam | CVDP-1 | 580,115 | 6,914,145 | 1014.51 | Functioning | |
| | CVDP-3 | 580,115 | 6,914,145 | 1014.71 | Not functioning | |
| | CVDP-5 | 580,221 | 6,914,362 | 1014.28 | Functioning | |
| | CVDP-6 | 580,221 | 6,914,362 | 1014.37 | Functioning | |
| Intermediate Dam | BH91-ID3-D | 580,345 | 6,913,726 | 1028.62 | Functioning | |
| | BH91-ID3-S | 580,345 | 6,913,726 | 1036.82 | Functioning | |
| | BH91-ID4-D | 580,505 | 6,913,925 | 1017.08 | Functioning | |
| | BH91-ID4-S | 580,505 | 6,913,925 | 1024.22 | Questionable | |
| | BH91-ID5-D | 580,472 | 6,913,862 | 1017.08 | Not functioning | |
| | BH91-ID5-S | 580,472 | 6,913,862 | 1024.30 | Not functioning | |
| | BH91-ID6-D | 580,461 | 6,913,877 | 1016.90 | Not functioning | |
| | BH91-ID6-S | 580,461 | 6,913,877 | 1024.80 | Not functioning | |
| | BH91-ID7 | 580,374 | 6,913,779 | 1025.95 | Not functioning | |
| Little Creek Dam | BH94-LCD1-D | 593,453 | 6,902,995 | 1097.00 | Functioning | |
| | BH94-LCD1-S | 593,453 | 6,902,995 | 1103.60 | Questionable | No bubbles returned. |
| | BH94-LCD2-D | 593,476 | 6,903,064 | 1094.90 | Functioning | |
| | BH94-LCD2-S | 593,476 | 6,903,064 | 1100.50 | Functioning | |

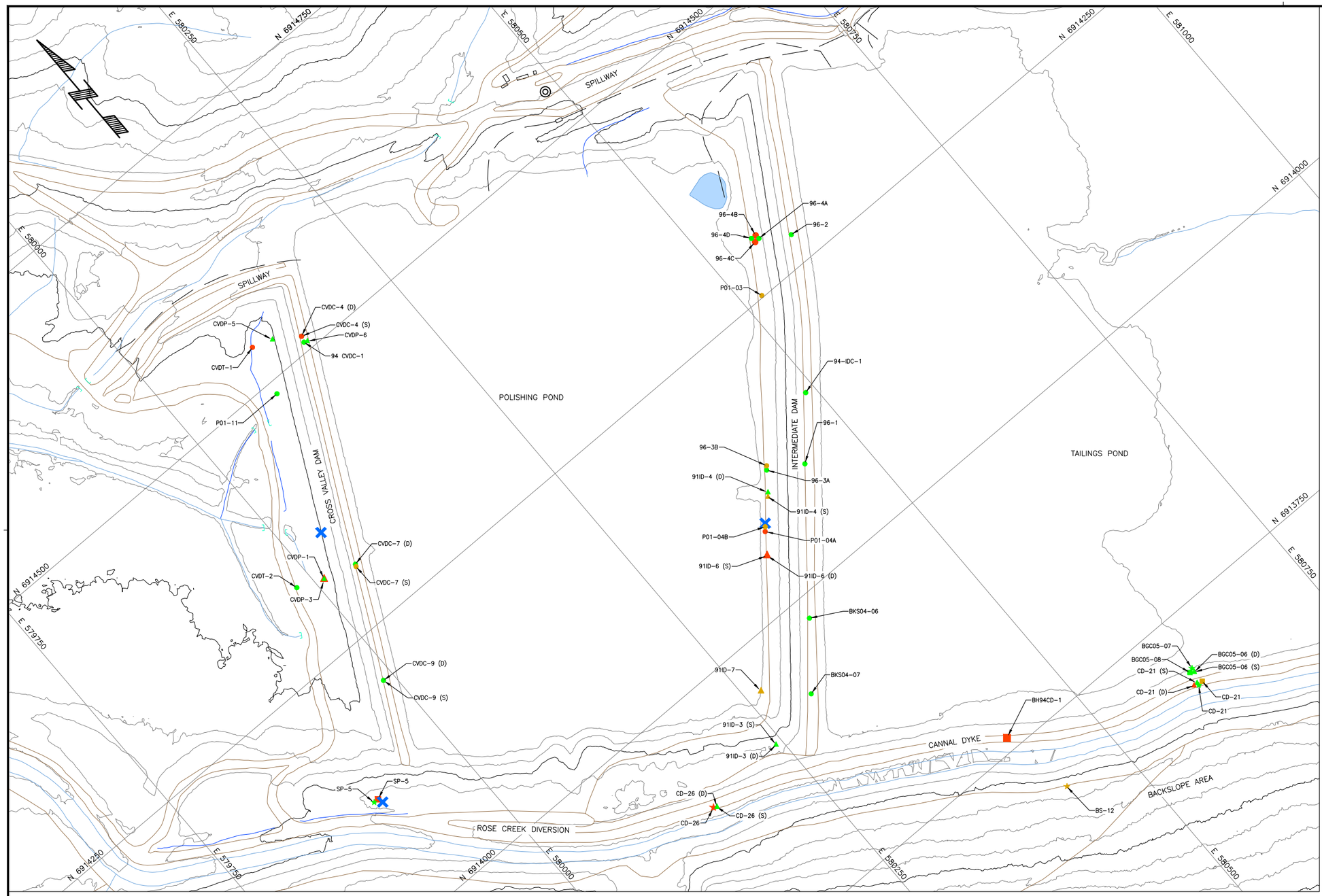
| Area | Instrument | Easting (m) (NAD27 UTM) | Northing (m) (NAD27 UTM) | Tip Elevation (m) | Status | Comment |
|---|---|---|---|---|---|---|
| | BH94-LCD3-D | 593,524 | 6,903,122 | 1101.20 | Functioning | |
| | BH94-LCD3-S | 593,524 | 6,903,122 | 1105.50 | Functioning | |
| Rose Creek Diversion Channel | BGC05-02 | 580,879 | 6,913,412 | 1044.65 | Functioning | |
| | BGC05-03 | 580,866 | 6,913,418 | 1050.64 | Functioning | |
| | BGC05-06-D | 580,709 | 6,913,519 | 1041.50 | Functioning | |
| | BGC05-06-S | 580,709 | 6,913,519 | 1046.78 | Functioning | |
| | BS-5 | 581,740 | 6,913,008 | 1053.00 | Functioning | |
| | BS-9 | 581,216 | 6,913,254 | 1045.00 | Functioning | |
| | CD-13-D | 581,386 | 6,913,197 | 1044.70 | Functioning | |
| | CD-13-S | 581,386 | 6,913,197 | 1048.70 | Questionable | |
| | CD-15-D | 581,218 | 6,913,289 | 1043.30 | Functioning | |
| | CD-15-S | 581,218 | 6,913,289 | 1048.10 | Functioning | |
| | CD-21-D | 580,703 | 6,913,504 | 1042.00 | Not functioning | |
| | CD-21-S | 580,703 | 6,913,504 | 1047.50 | Functioning | |
| | CD-26-D | 580,267 | 6,913,733 | 1042.00 | Functioning | |
| | CD-26-S | 580,267 | 6,913,733 | 1048.20 | Functioning | |

## Table III-5 Thermistor Summary

| Area | Instrument | Easting (m) (NAD27 UTM) | Northing (m) (NAD27 UTM) | Status | Comments |
|---|---|---|---|---|---|
| Cross Valley Dam | BH88-4 | 580,117 | 6,914,061 | Unknown | |
| | CVDC-6 | 580,197 | 6,914,225 | Unknown | |
| Little Creek Dam | BH94-LCD4 | 593,456 | 6,903,014 | Unknown | |
| | BH94-LCD5 | 593,497 | 6,903,095 | Unknown | |
| | BH94-LCD6 | 593,535 | 6,903,126 | Unknown | |
| Rose Creek Diversion Channel | BGC05-04 | 580,861 | 6,913,420 | Not functioning | |
| | BGC05-07 | 580,714 | 6,913,518 | Functioning | |
| | BS-5 | 581,740 | 6,913,008 | Functioning | |
| | BS-9 | 581,216 | 6,913,254 | Functioning | |
| | BS-10 | 580,856 | 6,913,363 | Functioning | |
| | BS-12 | 580,539 | 6,913,512 | Functioning | |
| | CD-10 | 581,723 | 6,913,066 | Functioning | |
| | CD-15 | 581,218 | 6,913,289 | Functioning | |
| | CD-21 | 580,703 | 6,913,504 | Functioning | |
| | CD-26 | 580,267 | 6,913,733 | Questionable | |
| | SP-2 | 581,263 | 6,913,326 | Functioning | |
| | SP-3 | 581,006 | 6,913,375 | Functioning | |
| | SP-5 | 580,236 | 6,913,773 | Functioning | |

## Table III-6 Weir and Staff Gauge Summary

| Area | Type | Instrument | Easting (m, NAD27 UTM) | Northing (m, NAD27 UTM) |
|---|---|---|---|---|
| Cross Valley Dam | Weir | Weir 3 | 580,112 | 6,914,203 |
| | | X11 | 580,102 | 6,914,276 |
| | | X12 | 580,076 | 6,914,111 |
| | | X13 | 580,070 | 6,914,260 |
| Faro Creek Diversion Channel | Staff Gauge | FCD-1 | 585,469 | 6,916,567 |
| | | FCD-2 | 585,026 | 6,915,674 |
| | | FCD-3 | 585,071 | 6,915,255 |
| | | FCD-4 | 585,346 | 6,914,854 |
| North Fork Rock Drain | Staff Gauge | NF1 | 584,999 | 6,913,119 |
| | | NF2 | 584,811 | 6,912,864 |
| | | NFRD-2B | 584,184 | 6,912,589 |
| | | X2 | 584,158 | 6,912,552 |
| North Wall Interceptor Ditch | Weir | NWID | | |
| Rose Creek Diversion Channel | Staff Gauge | RCDC-4 | 583,228 | 6,912,381 |
| Vangorda Waste Rock Dump | Weir | V28 | 593,834 | 6,902,242 |
| | | V29 | 593,579 | 6,902,327 |
| | | V30 | 593,322 | 6,902,404 |
| | | V31 | 593,430 | 6,902,811 |
| | | V32 | 593,537 | 6,902,869 |
| | | V33 | 593,623 | 6,902,911 |
| | Weir | GC Weir | 592,886 | 6,903,216 |




PLAN
SCALE A

SCALE A 0 100 m

**LEGEND**

- STANDPIPE PIEZOMETER
- PNEUMATIC PIEZOMETER
- INCLINOMETER
- THERMISTERS
- FUNCTIONING INSTRUMENT
- QUESTIONABLE INSTRUMENT
- DEFUNCT INSTRUMENT
- RECOMMENDED INCLINOMETER



CLIENT: Yukon Government

Klohn Crippen Berger

PROJECT: FARO MINE COMPLEX
2016 ANNUAL GEOTECHNICAL REVIEW

TITLE: CROSS VALLEY & INTERMEDIATE DAMS INSTRUMENTATION

PROJECT No. M09770A06

FIG. No. III-1

KCB-R-MLD

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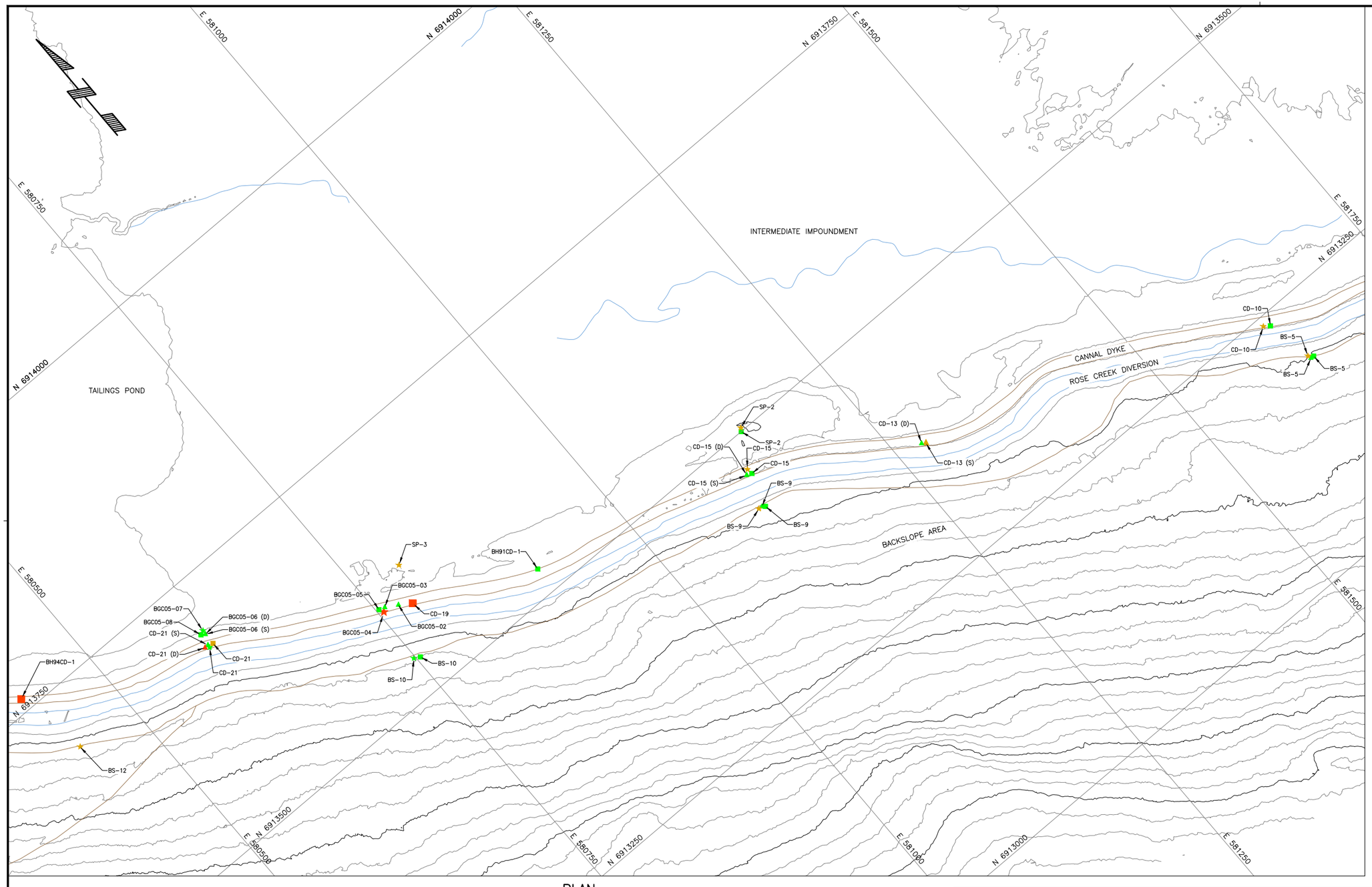


PLAN
SCALE A

SCALE A 0 100 m

**LEGEND**

- STANDPIPE PIEZOMETER
- PNEUMATIC PIEZOMETER
- INCLINOMETER
- THERMISTERS
- FUNCTIONING INSTRUMENT
- QUESTIONABLE INSTRUMENT
- DEFUNCT INSTRUMENT



CLIENT: Yukon Government

Klohn Crippen Berger

PROJECT: FARO MINE COMPLEX
2016 ANNUAL GEOTECHNICAL REVIEW

TITLE: ROSE CREEK DIVERSION & BACKSLOPE INSTRUMENTATION

PROJECT No. M09770A06

FIG. No. III-2

KCB-R-MLD

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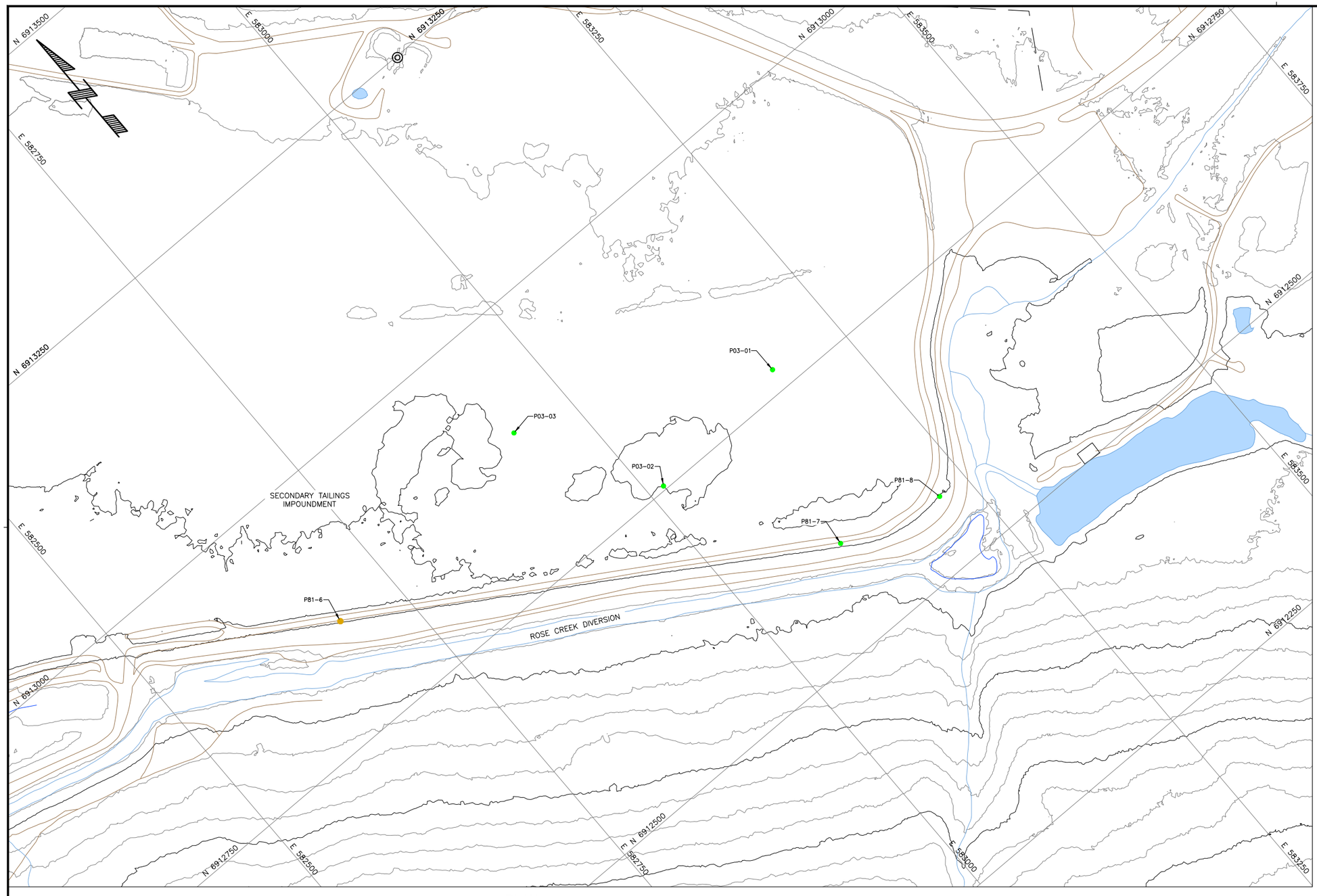


PLAN
SCALE A

SCALE A 0 100 m

**LEGEND**

- STANDPIPE PIEZOMETER
- FUNCTIONING INSTRUMENT
- QUESTIONABLE INSTRUMENT
- DEFUNCT INSTRUMENT



CLIENT: Yukon Government

Klohn Crippen Berger

PROJECT: FARO MINE COMPLEX
2016 ANNUAL GEOTECHNICAL REVIEW

TITLE: SECONDARY TAILINGS IMPOUNDMENT INSTRUMENTATION

PROJECT No. M09770A06

FIG. No. III-3

KCB-R-MLD

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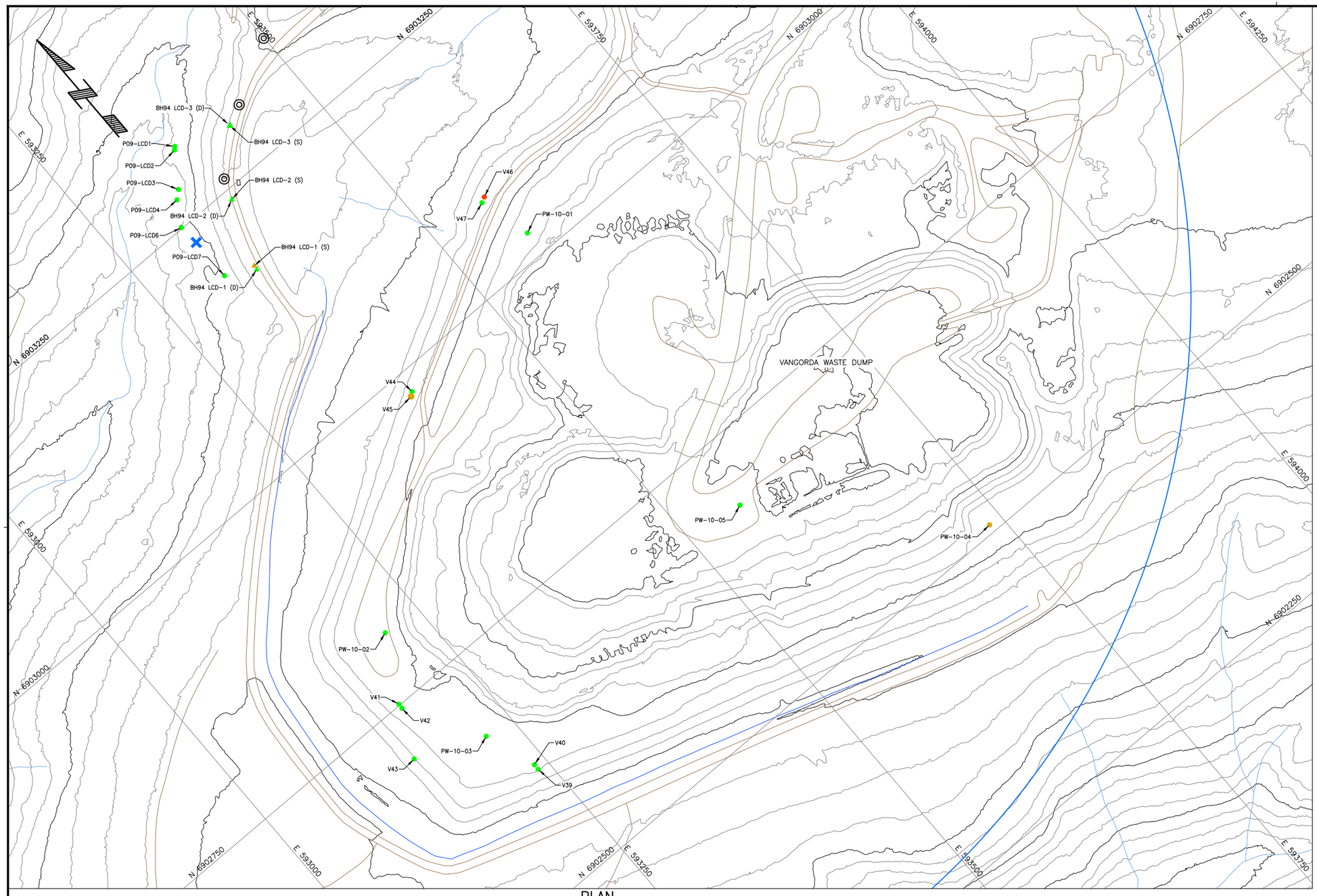


PLAN
SCALE A

SCALE A 0 100 m

**LEGEND**

- STANDPIPE PIEZOMETER
- PNEUMATIC PIEZOMETER
- FUNCTIONING INSTRUMENT
- QUESTIONABLE INSTRUMENT
- DEFUNCT INSTRUMENT
- RECOMMENDED INCLINOMETER



CLIENT
Yukon Government
Klohn Crippen Berger

PROJECT
FARO MINE COMPLEX
2016 ANNUAL GEOTECHNICAL REVIEW

TITLE
LITTLE CREEK & VANGORDA
WASTE ROCK DUMP
INSTRUMENTATION

PROJECT No. M09770A06

FIG. No. III-4

KCB-R-MLD

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