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REPORT ON

Faro Mine Complex Annual Pit Slope Stability Inspection

Submitted to:
Ms. Karen Furlong
Faro Mine Remediation Project
Assessment and Abandoned Mines
Government of Yukon
Room 2C, 2nd Floor Royal C
P.0. Box 2703, Whitehorse, YT Y1A 2C6

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REPORT

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1.0 INTRODUCTION

The Faro Mine Complex is located approximately 360 km northwest of Whitehorse, Yukon. The Faro Mine Complex consists of the Faro Mine and the Vangorda Plateau Mine. The Faro Mine was active from 1969 to 1992, and consists of the Faro Pit and the associated waste and water facilities. The Vangorda Plateau Mine was active from 1986 to 1998, and consists of the Grum and Vangorda Pits and the associated waste and water facilities.

In 1998, all mining was halted at the Faro Mine Complex when the mining operator was placed into receivership. The Government of Canada took over the care and maintenance of the site from 1998 until March 1, 2009. The Faro Mine Complex was managed for the Government by Deloitte & Touche Inc., the court-appointed interim receiver, from 1998 to March 1, 2009. On March 1, 2009, the Government of Yukon (YG) took over the care and maintenance responsibilities of the site, and Denison Environmental Services provided ongoing care, maintenance, and environmental protection services on behalf of YG until March 2012. As of April 1, 2012, Tlicho Engineering and Environmental Services Ltd. (TEES) has been contracted to provide care & maintenance services of the facility on behalf of YG.

As the care and maintenance providers of the Faro Mine Complex, YG has requested that Golder Associates Ltd. (Golder) carry out a pit slope inspection to assess the stability conditions of the Faro, Grum and Vangorda Pits for 2012. Golder has previously carried out slope stability reviews for the Faro Pit from 2002 to 2010 and for the Grum Pit in 2009.

This report summarizes the observations made and discussions held with site staff during the site visit carried out by Ms. Jennifer Ramesch on September 12 to 14, 2012. In particular, the following items are covered by this report.

- The site geology is summarized.
- The Faro Pit, Faro Creek Diversion, Grum Pit, Grum Creek Diversion Channel and Vangorda Pit are described.
- The stability condition of the Faro Pit is discussed, including a discussion of the North and South Instabilities on the east wall of the pit.
- The stability condition of the Grum Pit is discussed, including a discussion of the instability zone on the east wall of the pit.
- The current Faro Pit and Grum Pit stability monitoring programs are described and reviewed.
- The 2012 Faro Pit stability monitoring data (reference bars and monitoring survey points) and 2012 Grum Pit monitoring data (monitoring pins) are reviewed and discussed.
- A visual comparison of annual photos of the Faro Pit and Grum Pits is discussed.
- The stability condition of the Vangorda Pit is discussed, including a discussion of the geologic structures that were mapped during the site visit.
- Finally, recommendations are provided with respect to improvements to the current Faro Pit and Grum Pit monitoring programs and procedures, the requirement of a monitoring program in the Vangorda Pit, and remediation work in areas of concern with respect to slope stability.

2.0 SITE GEOLOGY

The ore bodies of the Faro, Grum and Vangorda deposits lie along the western margin of the Selwyn Basin, in sedimentary and volcanic/plutonic rocks that have been variably metamorphosed and have undergone several phases of deformation. The walls of the three pits have been excavated in the Mt. Mye Formation and the overlying Vangorda Formation. These are described below.

- The Vangorda Formation consists of mostly soft, highly fissile, calcareous phyllites. At a higher metamorphic grade (amphibolite facies), the calcareous phyllite is transformed to calc-silicate rocks. This unit also includes, to a lesser degree, mafic meta-igneous rocks occurring as highly foliated chlorite phyllite and carbonated chlorite phyllites that are widespread near the ore zones. An important mineralized sulphide zone is associated with a basal carbonaceous member of this formation, with the carbonaceous rocks being soft, highly sheared and gouged immediately below this zone. Elsewhere, these rocks are described to exist as moderately hard, highly fractured, black siliceous phyllites. The Vangorda Formation varies from 0.5 to 2 km in apparent thickness.
- The Mt. Mye Formation consists of schists, and predominantly grey, noncalcareous, weakly carbonaceous phyllite. The phyllites are interlayered with black carbonaceous phyllite and schists. Amphibolite is a minor rock type in the formation. A white, calc-silicate and marble marker horizon is located about 500 to 700 metres below the top of the Mt. Mye Formation. The formation has a minimum thickness of 2,000 metres, but the base has not been exposed.

3.0 FARO PIT SLOPE STABILITY INSPECTION

3.1 Faro Pit Description

The Faro Pit is an inactive open pit mine, roughly elliptical-shaped with the major axis striking northwest–southeast, as shown in Figure 1. The pit is approximately 1,675 metres long and approximately 975 metres wide at the crest (Deloitte & Touche Inc. 2002). Mining in the Faro Pit was completed in 1991. The pit is currently inactive and inundated to an elevation of approximately 1,144 metres. Photographs are presented in Appendix I.

The mined-out ore body consisted of en-echelon sulphide lenses striking northwest–southeast and dipping moderately toward the southwest.

The east and north walls of the Faro Pit represent the main slopes in terms of ultimate height. The east wall is the highest and longest wall, and is aligned with the major axis of the elliptical-shaped pit. The crest and toe of the east wall were located at approximately the 1,350 metre and 975 metre elevations, respectively. The height of the wall was approximately 375 metres (Golder 2011).

According to previous information, in 1992 approximately 3.4 million cubic metres of waste rock were placed on the pit floor below the 1,112 metre bench, from the underground mining operations. The location and the extent of the underground mining beneath the east wall are not known as as-built maps of this development are not available.

Since mining operations were discontinued, a pit lake has accumulated at the bottom of the pit. Water pumping and treatment facilities operated at the site control the water elevation in the pit. The water elevation as of September 2012 was at 1,144 metres above sea level (masl, NAD 83).

3.1.1 Faro Pit East Wall Engineering Geology

The mined-out ore body in the Faro Pit consists of sulphide lenses contained within metamorphosed, interbedded, non-calcareous phyllites, schist and calc-silicate rocks of the Vangorda and Mt. Mye Formations. Rocks immediately adjacent to the sulphide lenses have undergone intensive alteration, and are essentially massive, featureless muscovite/kaolinite clay envelopes. The east wall was excavated along the footwall of the sulphide lenses, i.e., the ore body. The following rock types have been exposed on the east wall (Photograph A-1 in Appendix A):

- westerly dipping biotite-muscovite schist;
- diorite intrusive in the upper wall;
- north–south trending calc-silicate band in the central portion of the wall; and
- quartzite at the upper end of the south wall.

A previous review by Golder of geologic cross sections (Golder 2011) indicated the presence of shallow to moderate, westerly dipping strata, and westerly dipping faults that are inclined at approximately 60 degrees.

The Big Indian Fault is the most dominant structural feature observed in the east wall (Photograph A-2). This fault strikes roughly north–south and dips toward the west at an inclination of approximately 60 degrees. The west boundary of the north–south trending band of calc-silicate rock in the east wall is defined by the Big Indian Fault.

Other westerly dipping faults have also been interpreted to exist. Smaller, east–west trending faults were also previously noted on geologic plans.

3.2 Faro Creek Diversion Channel (FCDC)

The Faro Creek Diversion Channel (FCDC) and Faro Valley Interceptor (FVI) were originally built as part of the mine development to divert the Faro Creek and surface runoff water from north of the pit area around the southeast side of the Faro Pit and the south side of the mill site, as shown in Figure 1. The diversion channel and valley interceptor collect water from upstream of the waste dumps and the Faro Pit, and direct it in a southeasterly direction to the north fork of Rose Creek.

The Faro Creek Diversion Channel (FCDC) was built as a cut/fill section, excavated in both overburden soil and rock, and a portion of the FCDC is located immediately behind the crest of the east wall of the Faro Pit.

The east wall of the Faro Pit experienced ongoing slope instability during and immediately following mining, and there was a concern that potential ongoing instability could threaten the integrity of the FCDC. Consequently, the stability conditions of the east wall were assessed by Golder in September 2002 (Golder 2002). In 2003, remedial works were carried out on the FCDC in an effort to reduce seepage losses, and some adjustments were made to the channel geometry. The road located behind the east wall crest and along the west side of the FCDC was also adjusted and levelled, and a safety berm was constructed along the road.

Golder assessed the east wall of the Faro Pit again in 2005 (Golder 2006). Following the 2005 assessment, recommendations for a slope monitoring program were presented in the Golder report "Faro Pit Slope Movement Monitoring," dated February 8, 2006. The recommended slope stability monitoring procedures were put in place along the east wall of the Faro Pit. The 2006 and 2007 monitoring data were reviewed by Golder (Golder 2007, 2008a). In July 2008 and August 2009, site inspections were also carried out by Golder (Golder 2008b, 2009). The instability areas were inspected again and the monitoring procedures were reviewed to address deficiencies and uncertainties identified in the previous monitoring reviews. No further site visits to the Faro Pit were carried out until 2012, but the monitoring data were reviewed by Golder in 2010 (Golder 2011).

The stability conditions of the Faro Pit east wall are discussed in the following section.

3.3 Faro Pit East Wall Slope Stability Conditions

The previous stability assessments of the east wall indicated the presence of two separate instability areas, referred as the North and South Instability Zones (Photographs A-1 and A-2, and Figure 1). These zones appear to be separated by a north–south trending band of calc-silicate rock.

Instability along the east wall has been interpreted to have resulted from the following failure mechanisms that occurred during mining operations.

- Planar failure of the individual benches occurred along a variety of westerly dipping structures that were undercut by the steep bench faces, resulting in the loss of catchment and accumulation of ravel debris on the slope. Ultimately, the wall has come to resemble an unbenched talus slope.
- As the wall height increased with ongoing mining, the slope continued to deteriorate, as the accumulated failure debris slid down the face along the underlying westerly dipping structures. The material in the upper portion of the Instability Zone would push and plough under the material in the lower slope, forming obsequent ridges and graben-like features. Displacement rates increased with the mining of each bench, and would subsequently decrease to background rates of less than 5 mm/day soon after the removal of each bench. During the operating life of the mine, instability continued to creep in a progressive and predictable manner, without the development a catastrophic failure.

A summary of the previous Golder observations and recommendations for the Faro Pit is provided in the following section.

3.4 Summary of Previous Observations and Recommendations for the Faro Pit

The following is a summary of the observations and recommendations provided by Golder, based on the 2009 site visit and the 2010 monitoring data review.

- **Monitoring of Reference Bars** – No significant changes or recession of the east wall crest were evident at the locations of the reference bars above the South Instability Zone.

  Some crest recession was evident in 2009 adjacent to reference bars 15353, 15354 and 15355, located above the North Instability Zone. The monitoring results indicated crest recession distances of approximately 0.05 to 0.40 metres.

  In 2010, crest recession appeared to be occurring adjacent to reference bar 15355, located behind the North Instability Zone. The crest recession can be attributed to spalling of the crest of the back scarp and to localized erosion due to surface water run-off and to erosion of the slope where groundwater seepage occurs at the overburden/bedrock contact.

- **Monitoring of Survey Prisms** – The survey prisms did not appear to exhibit any actual movement, and on-going, large-scale deformation associated with major pit wall instability was not considered to be occurring on the east wall.

- **Crest Recession** – No significant changes or recession of the crest appears to have occurred above the South Instability Zone. The crest of the pit wall in the overburden soils in the area of North Instability Zone did not exhibit signs of significant recession or degradation. However, some erosion and ravelling was observed to have occurred in localized areas.
  - A variable degree of crest recession appeared to have occurred along the crest of the pit wall in the overburden soils as a result of erosion by surface water run-off running over the edge of the wall and from erosion from groundwater seepage at the overburden/bedrock contact.
  - The crest at reference bar 15355 exhibited a loss of crest of approximately 0.5 metres during the interval of 2006 to 2010. These observations appear to indicate that large-scale failure of the slope was not imminent, and there was no immediate threat to the FCDC.
  - No tension cracks were observed behind the crest of the wall in the areas affected by crest erosion. The rock backscarp at the North Instability Zone did not exhibit signs of perceptible or significant recession or degradation.
- **Overall Stability Conditions** - The absence of a significant increase of instability on the backscarps of the North and South Instability Zones, and no evidence of the development of tension cracks behind the crest of the pit wall indicated that large-scale deformation associated with major instability of the east wall did not appear to be occurring. The instability along the east wall appeared to be limited to minor ravelling of localized zones of the crest of the slope, largely due to surface erosion where surface water or groundwater seepage flows along the overburden/rock contact that is exposed on the slope.
- **Recommendations**
  - The recommended monitoring procedures including frequency of monitoring were considered to be adequate, and no changes were recommended with the exception of a control measurement for the location of reference bar 15351, which was indicating an inconsistent measurement.
  - It was also recommended that the crest area behind reference bar 15351 be examined for any evidence of tension cracks.
  - Photographs of the ground between the crest of the backscarp and the reference bars were recommended to be included in the data for the 2011 review, but a 2011 review was not carried out.
  - Last, two additional reference bars were recommended to be installed adjacent to reference bar 15355 to monitor the lateral extent of the crest regression that was occurring at this location. These reference bars were installed in 2011.
  - Recommendations were provided for improving the current prism monitoring system.

The current stability conditions of the Faro Pit east wall are discussed in the following sections.

3.5 Faro Pit 2012 Slope Stability Review

During the 2012 site visit, the North and South Instability Zones were walked over and inspected for new cracks and ponded water. The following areas were walked over and inspected:

- behind the crest of the east wall;
- behind the backscarps of the instability zones;
- the road behind the crest;
- accessible benches on the slope;
- accessible prisms and reference bars; and
- sections of the Faro Creek Diversion Channel.

The following observations were made during the visual inspection:

- No recent cracks were observed either behind the crest of the east wall or behind the backscarps of the instability zones. Some old cracks were observed that did not indicate any recent activity (Photograph A-3).
- No cracks were observed along the road behind the crest of the east wall.
- No recent cracks were observed in the North Instability Zone (Photograph A-4).
- No recent cracks were observed in the South Instability Zone (Photograph A-5).
- Some small areas of ponded water were observed behind the crest of the east wall (Photograph A-6). However, the majority of the water appears to be draining either along the FCDC or along a creek to the north of the North Instability Zone that drains into the pit.
- A larger area of ponded water behind a small dam was observed (Photograph A-7), but this water is approximately 500 metres away from the pit crest and appears to be draining into a creek that drains into the pit.
- The FCDC was conveying water at the time of the site visit. The side slopes appeared to be in good condition and no cracks or offsets in the geometry were observed. The FCDC appears to be diverting the majority of the water away from the crest of the east wall (Photographs A-8 and A-9).
- The minimum distance between the crest of the east wall instability and the FCDC remains in the middle of the North Instability Zone. Crest recession at that location has not been sufficient to significantly reduce the minimum distance, and the actual distance remains in the same order as observed in the previous inspection, *i.e.,* approximately 18 metres. Only limited erosion and ravelling was observed to have occurred in this area, and is also likely due to sloughing and erosion of overburden soils by surface water run-off over the edge of the wall during the spring season, as well as to erosion from groundwater seepage at the overburden/bedrock contact. No tension cracks were observed behind the crest of the wall in this area.

- Groundwater seepage is still observed at the minimum distance location, and is emanating from the overburden/bedrock contact (Photograph A-10).
- The previously existing erosion gully developed in the talus debris on the lower slope below this area has slightly increased in size. The lateral extent of the erosion gully does not appear to have changed, but the depth of the erosion channel appears to have increased, mostly in the debris in the lower slope (Photograph A-11).
- The prisms and reference bars that were observed appear to be in good condition (Photographs A-12 to A-14). These are discussed further in Section 3.5.2 of this report.
- The north and west walls are exhibiting adequate stability performance. The bench crests are mostly intact and only localized raveling is occurring on the slopes, mainly in the altered zones. These zones appear to be raveling into talus slopes at angle of repose (Photographs A-15 and A-16). No stability concerns with these walls were identified during the site visit.
- The south side of the pit consists of waste material on the southwest side, benches excavated in rock on the southeast side with waste material on top, and an access ramp in between (Photograph A-17). The rock benches on the southeast side are raveling into talus slopes at angle of repose. Some bench crests are still visible, but it appears that waste material from above has also raveled onto some portions of the slope, leaving portions that are unbenched and at angle of repose. The waste material on the southwest side is at angle of repose and the waste dump slopes do not exhibit bulging at the toe or the face. No stability concerns with these slopes were identified during the site visit.

3.5.1 Photograph Comparison

Photographs taken of the instability zones during the site visit were compared to previous photographs to detect any changes in the location or shape of the failure debris, or the shape and size of the failures. As well, the current pit status maps were compared to previous status maps to look for changes in the topography of the instability zones or the location of the crest of the east wall. The instability zones are described in further detail and the results of the photograph and status map comparison for each zone are discussed in the following sections.

3.5.1.1 North Instability Zone

The North Instability Zone consists of much finer-grained and more bleached and altered failure debris at the base of the slope than the debris in the South Instability Zone. A steep backscarp has formed in more competent rock at the crest of the slope, defined by the Big Indian Fault. The north side of the North Instability Zone appears to be defined by a steep, south to southwesterly dipping diorite dyke. The south side of the North Instability is delineated by the calc-silicate band area that separates the North and South zones. In addition, a steep scarp also exists in the overburden deposits at the crest of the slope, unlike the South Instability Zone.

The calc-silicate band separating the South and North instabilities represents an area of improved stability relative to the instabilities in the schist to the north and south, and might be acting as a buttress on the north side of the South Instability Zone.

The current pit status has been compared with records from previous inspections of the North Instability Zone. Photographs taken between 2006 and 2012 were also reviewed and compared (Figure B-1 in Appendix B). The pit status and photo comparisons indicate the following.

- The south boundary of the North Instability Zone, i.e., along the north side of the calc-silicate band, appears to have not changed significantly since the previous assessments.
- The north boundary of the North Instability Zone appears to have not changed perceptibly since the previous assessment. Down slope displacement of the failure debris appears to have been limited.
- The backscarp of the North Instability Zone does not exhibit signs of significant erosion or regression.
- The crest of the pit wall in the overburden soils in the area of North Instability Zone does not exhibit signs of significant recession or degradation since 2006. Only limited erosion and ravelling has been observed in localized areas such as at the toe of the erosion gully (Figure B-1). This is likely due to erosion by surface water run-off over the edge of the wall during the spring season.
- The failure debris does not appear to exhibit significant displacements since the previous site visits.
- The minimum distance between the crest of the east wall instability and the FCDC remains in the middle of the North Instability Zone. Only limited erosion and ravelling was observed to have occurred in this area, which is likely due to sloughing and erosion of overburden soils by surface water run-off over the edge or seepage at the overburden/bedrock contact in the wall during the spring season.

3.5.1.2 South Instability Zone

The South Instability Zone is formed by highly blocky failure debris at the base of the slope, forming variable thickness talus that has undergone large displacement. The failure material had dropped downward along a westerly sloping backscarp that was formed by moderate to steep westerly dipping faults and joint sets. Generally massive rock outcrops behind the backscarp. Ravelling has affected the steep back scarp.

The current pit status has been compared with records from previous inspections of the South Instability Zone. Photographs taken between 2006 and 2012 were also reviewed and compared (Figure B-2 in Appendix B). The pit status and photo comparisons indicate the following.

- The north boundary of the South Instability Zone has not significantly changed.
- The south boundary of the South Instability Zone has not significantly changed. Only some ravelling from the backscarp and limited downward displacement of the accumulated failure debris appears to have occurred.

- The crest of the pit wall in the area of the South Instability Zone has not changed perceptibly since the previous assessments. The crest of the backscarp does not show any significant recession or degradation. Only some limited ravelling from the backscarp appears to have occurred.
- The failure debris does not appear to exhibit significant displacements since the previous site visit.

The 2012 monitoring data review is discussed in the following section.

3.5.2 Review of 2012 Slope Monitoring Data

Based on Golder's recommendation (Golder 2006), a slope monitoring program was implemented at the Faro Pit, with the following components.

- Slope Movement Observation Points – Reference Bars: Reference bars have been installed behind the crest of the east wall along the FCDC in order to provide fixed reference points for measurement of the shortest distance to the crest of the wall. The periodic measurement of distances provides a means to assess crest recession rates. These measurements are primarily carried out by staff on site.
- Monitoring Prisms: Survey monitoring prisms have been established closer to the crest of the east wall in order to provide monitoring of fixed points to assess displacement and ground movements in the areas that have a greater potential for deformation. In addition, survey monitoring prisms have also been installed uphill beyond the FCDC in natural ground. The periodic monitoring of survey points can provide indications of overall stability conditions as well as instability mechanisms should instability develop. The surveying of these monitoring points has been carried out by Yukon Engineering Services (YES).

In addition, site staff indicate that daily driving visual inspections are carried out in the Faro Pit, and photographs are taken of the walls on a monthly basis.

The reference bar and monitoring prism locations are shown on Figure 1, and the monitoring data are discussed in the following section.

3.5.2.1 Slope Movement Observation Points – Reference Bars

The purpose of the reference bars is to physically measure the rate of erosion or retreat of the crest of the wall, in order to determine if and when the FCDC may be undercut at some time in the future. Six reference bars have been installed just behind the crest of the slope, and the distance from the crest to each individual bar is measured on a regular basis.

The initial locations of the reference bars installed in 2008 are shown in Figure 1. The installation coordinates and the initial distance measurement data are presented in Table 1, below. After the installation of the reference bars in 2008 and the initial reading, distance measurements have been subsequently carried out by the site staff.

Table 1: Location of 2008 Faro Pit Reference Bars

Reference Bar Number	Installation Coordinates (UTM NAD 27)		Bearing of Distance Measurements from Reference Bar to Pit Crest (Azimuth)	Initial Distance Measurements (metres) (July, 2008)
	Northing	Easting		
15351	6,914,799.449	585,229.770	235º	11.19
15352	6,914,849.439	585,204.524	245º	11.25
15353	6,915,216.929	585,064.654	240º	17.41
15354	6,915,241.231	585,025.422	235º	8.06
15355	6,915,292.340	584,978.739	220º	5.59
15356	6,915,336.758	584,936.761	225º	17.55

The reference bar and prism coordinates were originally surveyed in NAD 27. The prism surveys continue to be surveyed with respect to NAD 27. However, Golder understands that the site recently converted to NAD 83 and the most recent topographical data was provided to Golder in NAD 83. In order to plot the locations of the monitoring bars and prisms, the topographical data was converted to NAD 27. However, Golder recommends that the reference bar and monitoring prism location spreadsheets be updated to NAD 83 coordinates, and that all subsequent prism readings be carried out in NAD 83. The old NAD 27 data should be retained in the same spreadsheets for historical purposes.

Three additional reference bars were installed in 2011 after a recommendation by Golder in the 2010 site visit report (Golder 2011). The reference bars are numbered as follows:

- 15717;
- 15737; and
- 15742.

Reference bars 15717 and 15737 were installed on either side of reference bar 15355 as recommended (Photograph 10). Reference bar 15742 was installed near reference bar 15354 and control point 13908 (Photograph 12). The coordinates of the 2011 reference bars have not been provided to Golder to date.

A summary of the distance readings is presented in Table 2, below. Plots of the horizontal distance measurements by date are presented in Figure C-1 in Appendix C.

Table 2: Faro Pit Reference Bars – Summary of Horizontal Distance Measurements

Date	Reference Bar Number								
	15356	15717	15355	15737	15354	15742	15353	15352	15351
	Horizontal Distance[1] (metres)								
8-Jul-08	17.55	-	5.59	-	8.06	-	17.41	11.25	11.19
20-Aug-08	17.55	-	5.58	-	8.04	-	17.40	11.25	11.19
22-Sep-08	17.55	-	5.58	-	8.01	-	17.39	11.25	11.18
2-Jul-09	17.55	-	5.42	-	7.44	-	17.38	11.25	11.18
16-Aug-09	17.60	-	5.32	-	7.83	-	19.10[3]	12.00	11.64
30-Sep-09	17.59	-	5.42	-	7.40	-	17.36	11.71	11.81
24-Jun-10	17.40	-	5.10	-	7.90	-	17.30	11.30	11.20
20-Jul-10	17.74	-	5.12	-	7.78	-	17.53	11.50	13.23[3]
20-Aug-10	17.55	-	5.02	-	8.00	-	16.75	10.89	13.11[3]
23-Sep-10	17.53	-	5.10	-	7.90	-	16.89	10.60	12.96[3]
24-Jul-11	17.54	-	4.98	-	7.84	-	-	11.05	13.13[3]
1-Aug-11[2]	17.25	3.70	3.92[3]	4.86	7.51[3]	6.90	-	11.80[3]	11.12
21-Aug-11	17.26	3.82	5.08	4.92	7.85	6.77	17.27	11.10	13.16[3]
6-Oct-11	17.57	3.75	5.07	4.89	7.80	6.82	17.29	10.91	13.13[3]
3-Nov-11	17.26	3.80	5.06	4.93	7.68	6.39	16.98	11.23	-
2-Oct-12[2]	17.55	3.91	3.91[3]	4.80	7.60	7.40[3]	-	11.60	13.30[3]
Δ Between Last and Initial Measurement	0.00	0.21	-0.53**[4]**	-0.06	-0.46	-0.38**[4]**	-0.43	0.07	-0.07**[5]**

Notes:

1) All measurements are approximate as the crest surface is irregular.
2) August 1, 2011 and October 2, 2012 measurements were made by Yukon Environmental Services. The other measurements were made by site staff and reported separately.
3) These appear to be inconsistent readings.
4) The calculation for the change between the last and initial reading for reference bars 15355 and 15742 has been calculated with the penultimate reading instead.
5) The calculation for the change has been made with the August 1, 2010 measurement by YES, which appears to have been made along the correct bearing.

Figure C-1 in Appendix C shows the change in horizontal distance from the crest over time for each reference bar. A decrease in horizontal distance on the plot would indicate a loss of crest near that monitoring point. The plot indicates a degree of variability that is generally within the accuracy of the measurements, but there are a few measurements that are clearly inconsistent. It is likely that these inconsistent readings are due to different personnel taking measurements, where not all individuals are following the same measurement procedure and/or measuring along the correct bearing. Care should be taken to ensure that all personnel who are carrying out measurements, whether mine staff or consultants, are following the same measurement procedures to ensure that measurements are as accurate and error-free as possible. It is therefore recommended that YES and the site staff perform the measurements together at least once, to confirm that all personnel carrying out measurements are using the same reference points, bearings and procedure. Furthermore, a second bar should be added a short distance from each original reference bar, aligned along the bearing at which the measurement from the first bar to the crest should be made. This would greatly improve the measurement accuracy for the reference bars in the Faro Pit.

Finally, measurements should be plotted as soon as possible on a horizontal distance plot such as the one in Figure C-1 to quickly identify potentially inconsistent readings. If necessary, a second, confirmatory measurement should be taken and plotted in a timely manner.

The reference bar horizontal displacements are discussed individually below.

- Reference bar 15356 does not indicate any significant changes in horizontal distance. The distances appear to be within the accuracy of the measurement procedure.
- Reference bars 15717 and 15737 do not indicate any significant changes in horizontal distance for the four measurements that have been carried out.
- Reference bar 15355 indicates a trend of decreasing horizontal distance over time, of approximately 0.53 metres. The measurements taken within each year are similar, which indicates that this trend is not due to the variability in measurements and likely reflects a loss of crest at this location. There are two measurements that do not follow the trend and are likely inconsistent readings.
- Reference bar 15354 does not indicate any significant changes in horizontal distance. The distances appear to be within the accuracy of the measurements, but the last three measurements indicate a trending decrease in distance totalling approximately 0.46 metres from the initial 2008 measurement, which could indicate a loss of crest at this location.
- Reference bar 15742 has only been measured four times since installation in 2011. The measurements exhibit a degree of variability that makes it difficult to interpret any trends. Furthermore, the last reading in October 2012 appears to be inconsistent.
  - This reference bar should be measured again by site staff to confirm the actual horizontal distance.
- Reference bar 15353 was not read in 2012. The data indicate a decrease in distance of approximately 0.43 metres from the initial 2008 measurement. The measurement taken in August 2009 appears to be inconsistent with previous and subsequent measurements.
- Reference bar 15352 indicates a larger degree of variability between measurements, but the first and last measurements are within only a few centimetres. It is not clear if there is a loss of crest at this location or if the readings are not sufficiently accurate, but no trend seems evident from the data.
- Reference bar 15351 exhibits a significant *increase* in horizontal distance of approximately 2 metres between the measurements on June 24 and July 20, 2010. This increased distance is maintained thereafter, apart from an inconsistent reading in August 2011. It is unlikely that the crest has moved away from this reference bar, and so it is more likely that the measurements after June 2010 were made along a different bearing than originally recommended. This discrepancy was also discussed in the 2010 monitoring data review (Golder 2011), and it was recommended that an additional measurement be taken along the correct azimuth. It appears that subsequent measurements were still made along an incorrect bearing, except for the measurement taken by YES on August 1, 2012. Based on the assumption that this measurement is correct, no loss of crest is evident at this location.

The minimum distance between the crest of the east wall to the FCDC is located behind the North Instability Zone. At this location, the crest of the pit wall consists of a steep overburden face, with approximately 5 to 6 metres of overburden soils capping the bedrock. In addition, seepage had been observed in 2009 to be emanating from the overburden/bedrock contact, causing erosion in the bedrock and debris to accumulate downslope.

The following conditions were observed in the 2005 and 2008 pit wall inspections, which were carried out after the 2003 remedial construction works of the FCDC.

- Within the North Instability Zone, the minimum distance measured between the crest of the wall and the FCDC was approximately 18.5 metres. To the north of this minimum distance location, a steep overburden scarp had also exhibited on-going recession due to ravelling. The distance from this steep overburden scarp crest to the FCDC was approximately 35 metres.
- Above the South Instability Zone, the minimum distance measured between the backscarp crest of the wall and the FCDC was approximately 93 metres.

The minimum distances indicated above have not changed in 2012 based on visual observations and measurements made from the topographical data provided by YG in 2012.

In general, the reference bar monitoring data, together with visual observations, indicate that localized areas continue to ravel and erode, but there do not appear to be indications of any significant crest regression since the bars were installed in 2008.

3.5.2.2 Monitoring Survey Prisms

The location of the monitoring survey prisms is shown in Figure 1. Displacement over time graphs and wander plots of the prism monitoring data are presented in Figures C-2 to C-10 in Appendix C.

Seven survey prisms were installed behind the crest of the east wall within the area of greater potential for ground deformation. In addition, two survey monitoring prisms were installed uphill of the FCDC. These latter prisms are located in an area that is not expected to exhibit deformation, and can be used as baseline monitors to determine the accuracy of the monitoring system. The periodic monitoring of all survey prisms is expected to provide indications of overall stability conditions.

Monitoring survey prisms were installed in August 2006, when initial readings were taken. Since the initial installation of survey prisms, no additional survey prisms have been installed. All existing monitoring prisms have been recently surveyed in October 2012.

The wander plots in Appendix C indicate a degree of accuracy varying between 20 and 40 millimetres in the east–west direction, and 30 to 50 millimetres in the north–south direction.

Table 3 presents a summary of cumulative coordinate changes based on the most recent monitoring data.

Table 3: Monitoring of Survey Prisms – August 2006 to October 2012 (Most Recent Survey)

Survey Prism	Initial Installation Coordinates			Cumulative Changes Between August 2006 and October 2012 (mm)		
	Northing	Easting	Elevation	Northing	Easting	Elevation
13872	6915376.00	584838.73	1289.09	-7.5	3.0	-31.8
13873	6915330.14	584922.20	1298.26	-10.1	4.0	-59.5
13874	6915302.30	584972.86	1297.44	-24.4	-19.7	-40.7
13875	6915262.94	585078.53	1303.92	-10.2	-61.2	-48.3
13876	6915108.37	585074.49	1281.13	-32.3	-3.3	-107.1
13877	6915066.79	585200.63	1300.46	19.4	-13.9	8.2
13878	6915002.33	585128.77	1280.65	33.5	-30.5	79.1
13879	6914854.63	585228.55	1275.00	-3.0	-19.5	-8.3
13880	6914786.53	585240.53	1269.17	46.9	-24.0	-6.5

Table 4 presents the resulting apparent vectors and cumulative displacements survey prisms for the interval between August 2006 and October 2012.

Table 4: Apparent Movement of Monitoring Survey Prisms –August 2006 to October 2012 (Most Recent Survey)

Survey Prism	Total Vector – Changes Between August 2006 and October 2012			Net Velocity (mm/day)
	Total Cumulative Displacement (mm)	Trend (Azimuth Degrees)	Plunge (Degrees) (1)	
13872	32.8	158.2	-75.7	< 1.0
13873	60.5	158.4	-79.7	< 1.0
13874	51.4	218.9	-52.4	< 1.0
13875	78.6	260.5	-37.9	< 1.0
13876	111.9	185.8	-73.1	< 1.0
13877	25.2	324.4	19.0	< 1.0
13878	91.2	317.7	60.2	< 1.0
13879	21.4	261.3	-22.8	< 1.0
13880	53.1	332.9	-7.0	< 1.0

Notes: Negative plunge = downward direction; Positive plunge = Upward direction.

Appendix C contains plots of displacement-over-time and wander plots for each survey prism (Figures C-2 to C-10). The wander plots indicate that, with the possible exception of prisms 13875 and 13876, none of the prisms are exhibiting displacements beyond the accuracy of the monitoring system. Because the survey prisms were installed behind the crest of the east wall, it is expected that any actual movement or deformation would trend predominantly southwest, out of the pit wall.

Prism 13876 exhibits a total cumulative displacement of about 112 millimetres. The last three readings on the wander plot indicate an average displacement towards 173° azimuth. Consequently, this prism is not likely exhibiting actual movement and the readings are within the accuracy of the monitoring system.

Prism 13875 exhibits a total cumulative displacement of about 79 millimetres. The plot of total vertical displacement in Figure C-5 exhibits a degree of variability, but it appears that about 50 to 70 millimetres of negative vertical displacement has occurred since September 2010. The plot of total horizontal displacement indicates approximately 30 millimetres of positive horizontal displacement over the same time period. The last three readings on the wander plot indicate an average displacement toward 260° azimuth, which is out of the slope. The total displacement over the last three readings is about 55 millimetres, which is just beyond the accuracy of the monitoring system. Because the direction of the last three readings is out of the slope, it may reflect actual movement. Therefore, the next reading of this prism should be plotted immediately and checked to confirm if the recent readings are apparent or indicate actual displacement in the slope.

No additional prisms are considered necessary in the Faro Pit. The visual inspection did not identify any new cracks or areas of concern. The monitoring data indicate that, aside from localized ravelling and displacement, no large-scale deformation is occurring. The reference bars and prisms should continue to be read at the current frequency. As indicated above, the reference bar measurements should be plotted immediately so that inconsistent readings can be checked and rectified, or in the case that actual regression is occurring, mitigative actions and safety precautions can be taken in a timely manner. In addition, the next reading of Prism 13875 should be plotted immediately to determine if actual movement is occurring in the vicinity of this prism.

The accuracy of the monitoring system appears to be on the order of +/- 30 to 50 millimetres. This range of accuracy is little larger than most mine pit slope surveying systems. Accuracies on the order of 25 to 30 millimetres can typically be achieved at active mines where surveys of fixed prisms are being carried out on a weekly or monthly basis. However, the degree of accuracy at Faro is considered to be appropriate for the large scale deformations that the monitoring of survey points are intended to detect.

According to information provided previously by YES (Golder 2007), the monitoring survey prisms have been surveyed from three “observation (control) points” at fixed locations on the west side of the pit. Distances across the pit from the location of the “control” stations to the monitoring survey prisms are on the order of 800 to 1,400 metres. The current monitoring procedure uses metal bars that are fixed on the ground to which removable survey prisms are attached every time a survey is carried out. The prisms are surveyed from three separate base stations, and the prism is rotated for each base stations. It might be possible to improve the survey accuracy and efficiency by permanently attaching the prisms to the metal bars, as is typically done in most open pit mines. It is expected that any variations resulting from the repetitive installation and removal of the prisms would be eliminated, and therefore, the survey accuracy could be improved. In addition, the use of permanent prism installations will reduce the exposure of personnel to the safety hazards related to working within the proximity of the crest of the existing slope. Recommendations on improving the surveying accuracy have previously been provided in Golder, 2011.

3.5.3 Summary of 2012 Faro Pit East Wall Slope Stability

The 2009, 2008 and 2005 assessments indicated that the North and South Instability Zones had not significantly changed since the 2002 inspection. Minimum crest distances to the FCDC measured at both North and South Instability Zones were on the same order as the 2002 inspection.

The 2012 assessment also indicates that the North and South Instability Zones have not significantly changed since the 2002 inspection. Minimum crest distances to the FCDC measured at both North and South Instability Zones were on the same order as the previous 2009 inspection.

Overall, the visual observations and the review of the monitoring data indicate that catastrophic failure of the bedrock and overburden slopes at the backscarps do not appear to be likely within the near future. Limited erosion and ravelling instability are expected to continue to develop slowly at the crest of the east wall due to sloughing or ravelling in the steep overburden face, and to seepage erosion of the underlying bedrock, which undercuts the overburden slope. Since this process appears to be more active in the North Instability Zone, this area is considered to remain the most critical to the stability of the FCDC over the long-term, while the South Instability Zone is not expected to undermine the FCDC for many years.

4.0 GRUM PIT SLOPE STABILITY INSPECTION

4.1 Grum Pit Description

The following is summarized from Deloitte and Touche Inc., 2002, and Golder, 2010.

The Grum deposit was discovered in 1973. Exploration programs were carried out from 1975 to 1977, and included an underground exploration program. The underground development consisted of a ramp from a portal at approximately the 1,265 metre elevation and two declines developed along the ore zone for approximately 700 metres.

The Grum deposit actually consists of two separate zones, named the Main Zone and the Champ Zone, which were to be mined in two or more phases. However, only the Main Zone was ultimately mined. Prior to mining, most of the surrounding area drained into Grum Creek, a secondary tributary that flowed into Vangorda Creek. The pit area did not exhibit a well-defined drainage system, and was described as generally wet. A small lake, the Doal Lake, was located within the Grum Pit area. The lake was drained prior to mining, and surface water was diverted around the Grum Pit via the Grum Interceptor Ditch.

Mining at the Grum Pit was carried out intermittently from 1990 to 1992 and consisted mostly of overburden and waste rock stripping. Only a limited quantity of ore was mined prior to a temporary mine shut down in 1993. Mining at the Grum Pit was reportedly resumed from late 1994 until another temporary mine shut down in late 1996. Mining activities were once again resumed in mid-1997 and ceased permanently in 1998, when the mine site fell under care and maintenance status. At that time the Phase 1 Pit was mostly completed and an access slot that was being excavated at the southeast end of the pit was also nearly completed. The ultimate Grum Pit design was never completed and the pit is currently inactive and inundated to approximately the 1,213 metre elevation.

The Grum Pit is oval in shape, with the long axis trending northwest–southeast, as shown in Figure 2. The pit is approximately 850 metres long and approximately 700 metres at its widest point. The east wall represents the main slope of the mined pit. The crest of the east wall is located at approximately the 1,300 metre elevation. The actual elevation of the pit floor at the time of shut down is unknown.

The Grum Pit has been excavated mainly in calcareous phyllite, with minor exposures of sulphides. The stability performance of the rock walls has reportedly been adequate. However, the east wall of the Grum Pit was excavated through a bedrock valley infilled with glacial till reaching thicknesses of 100 metres. Layers of sand and gravel were also encountered within the till (Golder 2010). This portion of the slope has been affected by slope instability in the overburden for many years. Apparently, the slope instability occurred during the temporary mine shut down from late 1996 to mid-1997, when mining, dewatering operations, and slope overburden slope depressurization were suspended. Water flow at the base of the till was reportedly considered to have caused the overburden instability (Deloitte & Touche 2002). Golder provided a review of the stability of the east wall in 2009 (Golder 2010). Recommendations for monitoring the instability zone were also provided.

Since the shutdown in 1998, an in-pit lake has formed in the Grum Pit. The water level in the pit has been continuously rising. The water level was reported to be at the 1,186 metre elevation in early 2004 and at the 1,205 metre elevation by mid-2009 (Golder 2010). As of September 2012, the water elevation was at approximately 1,212 metres elevation (masl, NAD 83). The pit overflow elevation is located on the south side of the pit, at approximately 1,230 metres elevation.

4.1.1 Grum Pit East Wall Engineering Geology

The following description of the Grum Pit engineering geology is based on a summary presented in the Golder 2010 report, which was based on a review of the available technical documentation at the time. Sources for the 2010 report are provided in the Reference section.

The overburden soil deposits in the Grum Pit area primarily consist of till deposits and glacio-fluvial silts, sands and gravel deposits. Overburden thicknesses greater than 100 meters were reported in the Grum Pit dewatering assessments. In the east portion of the pit the overburden soil deposit thickness extends to approximately 100 metres. A buried channel, or thalweg, that is interpreted to trend north/south exists in this area of the pit. The overburden deposit thickness decreases to less than 40 metres in the northeast and southeast area of the pit, and pinches out toward the west side of the pit.

The majority of the overburden sediments overlying the bedrock in the Grum Pit area are described as glacial till. However, a sand and gravel layer varying in thickness from 20 to 30 meters was reportedly encountered at depth along the alignment of the north/south trending buried channel. Further investigations carried out for the dewatering of the Grum Pit identified a second upper sand and gravel layer. These interpreted glacio-fluvial layers were also previously interpreted on geological cross-sections.

This thick overburden soil sequence was exposed in the pit slopes on the east wall of the Grum Pit. The large scale slope instability on the east wall developed within these sediments.

The bedrock geology of the Grum Pit consists of metamorphic rocks of the Mt. Mye and Vangorda Formations. The Grum deposit has been described as consisting of three to five highly folded layers of massive and disseminated sulphide mineralization within a 150 meter thick sequence of phyllites. The most important mineralized zone is associated with a basal carbonaceous member of the Vangorda Formation. Other thin low-grade zones were also described to exist within the Vangorda Formation, while more significant mineralized zones would also exist in the upper part of the Mt. Mye Formation.

Minor post-metamorphic dykes are also present in the Grum Pit.

The ore zones in the Grum deposit are described to exhibit complex superimposed poly-phase fold structures that plunge at a shallow inclination to the northwest. Schistocity or fissility, in the case of phyllites, represents the main pervasive rock fabric in the rock masses in the Grum Pit. The schistocity has been described as axial planar to a second phase of folding, and dips at shallow angles (10 to 30 degrees) generally to the southwest. The long axis of the deposit parallels the axial direction of the second phase folds, and plunges at 11 degrees toward 315˚ azimuth.

In terms of distinct geologic structures, several faults are reported to exist within the Grum deposit. The main structural features include the following.

- Faults that truncate the deposit on the northwest and southeast sides, and would not be exposed in the pit. The main off-set displacements within the deposit are associated to these moderately dipping (35 to 45 degree) structures. In the vicinity of these faults, the surrounding rocks vary from intact rock that is similar to the enclosing phyllites to approximately 3 to 10 meter thick zones of gouge and fractured rock.
- A steep, northwest dipping fault set that trends approximately 060˚ azimuth, and intersects the deposit with a down drop of approximately 60 meters to the northwest.

- Smaller faults mapped underground and later in the pit, trend on average 080˚ azimuth and are steeply-dipping.
- Joints mapped underground and on surface tend to strike 060˚ azimuth and dip sub-vertically.

The main drainage in the area of the Vangorda Plateau is the Vangorda Creek. The Grum Pit is located to the north of this creek, and most of the area in the vicinity of the pit prior to mining drained to the Grum Creek, a secondary tributary flowing into Vangorda Creek. Apparently, the pit area prior to mining was not intersected by well-defined drainage, but it was described to be generally wet, and a shallow lake, the Doal Lake, was located within the current pit area. As part of the mining development, surface water was subsequently diverted around the Grum Pit via the Grum Interceptor Ditch (Figure 2). Since mining operations ceased in 1998, water from groundwater flow, surface run-off and precipitation has accumulated in the pit, forming the existing pit lake. The current water level is at approximately the 1,213 meter elevation.

The stability conditions of the Grum Pit east wall are discussed in the following section.

4.2 Grum Pit East Wall Stability Conditions

The east wall of the Grum Pit has been affected by slope instability in the overburden materials that have been exposed at the top of the east wall. Based on available information, it is believed that the instability occurred within the overburden sediments. However, it is possible that the instability may have also involved the underlying bedrock. The instability zone is indicated in Figure 2.

Between the time of failure and the 2009 site visit, the limits of the instability zone expanded to the south and north, as well as extending to the east and to the upper portion of the pit wall (Golder 2010).

Based on topographic data and photographic records, the initial failure was reportedly about 300 metres long in a north/south direction. Previous field observations and a comparison of 1997 topography versus 2003 topography indicated that a portion of the failure debris at the crest of the slope was mined out, and that the slope behind the back-scarp was laid back (Golder 2010). The size of the failure zone has increased since 1997, and the failure is now approximately 350 metres long. The large-scale slope instability zone now extends almost the entire length of overburden soils exposed on the east wall of pit wall (Photograph D-1 in Appendix D).

The overburden deposits in the instability zone consist of glacial till and layers of sand and gravel that fill a north/south trending buried channel. These sediments were reported to be saturated, with confined aquifer conditions existing within the sand and gravel layers.

A summary of the previous Golder observations and recommendations for the Grum Pit is provided in the following section.

4.3 Summary of Previous Observations and Recommendations for the Grum Pit

The following is a summary of the observations and recommendations provided by Golder for the east wall of the Grum Pit, based on the 2009 site visit.

- As a result of the large-scale slope instability, an approximately 15 metre high, prominent back-scarp formed around the limits of the failure zone on the east wall. Tension cracks had developed behind the highest portion of the backscarp in the central portion of the instability zone, but the cracks extended only a few meters behind the crest of the scarp. No additional tension cracks were observed further away from the crest of the east wall.

- Based on the observations of the 2009 field inspection, it appeared that the slope instability was originally initiated in the central portion of the slide zone, predominantly as a rotational slide through the maximum overburden thickness exposed by the excavation of the pit wall. Subsequently, the initial slope failure progressed, with regressive failures expanding the limits of the instability zone to the south and north, and possibly into areas of shallower bedrock, as well as extending to the east and to the upper portion of the east wall.

  The obsequent scarps and graben features observed in the south and north-central portions of the failure zone indicated that failure had extended behind the original back-scarp.

  Based on a bathymetry survey, it appeared that a continuous failure slope is present between the pit floor and the top of the failure debris at the base of the back-scarp. It was unknown if the slope failure had developed only in the overburden soils, or alternatively, if it had also developed in the underlying rock slopes.

- A review of the 2005 photographs indicated that the failure zone had been active between 2005 and 2009. The extents of the instability zone had progressed since 2005 and expanded to the boundaries observed in 2009. The comparison between the 2003 and 2009 topographic surfaces also indicated ongoing ground deformation on the order of several meters over this interval.

- The risk of the instability progressing further to the east and south behind the crest of the wall was considered to present the following potential hazards and threats.

  - The continuing regression of the slope instability to the east and south, as has occurred since 2005, was considered to present a potential threat to the substation, power lines and water-treatment access road located along the crest of the pit wall. The substation was located within 50 metres of the crest of the 2009 back-scarp. The access road is located immediately behind the back-scarp along the southeast and south side of the failure zone. The power line is located along the south edge of the access road. The minimum distance of the Grum Creek diversion ditch to the crest of the east wall was estimated to be approximately 55 metres.

  - In the case of an overall slope failure of the back-scarp, it was considered possible that the failure debris would create additional load, *i.e.,* driving forces, on the existing failure mass on the lower slope. This additional load could disturb the marginal equilibrium of lower portion of the failure zone resulting in a possible rapid acceleration of ground movement into the pit.

- It appeared that the overburden slope instability on the east wall of the Grum Pit was exhibiting on-going deformation. Consequently, further settlement and movement of the failure mass was expected to continue into the pit, and to potentially displace and increase the water level in the pit. However, the slope instability on the east wall appeared to have reached an advanced stage in the failure process, with a shallower slope formed at the lower portion of the instability zone. Therefore, it was considered possible that the failure mass could be in a condition close to equilibrium, and that the on-going movement could likely continue to occur as slow creep deformation. In this case, a catastrophic movement of the existing failure mass into the pit, with an associated rapid displacement of water and increase of the lake elevation, was not considered likely to occur.

- The actual increase of the water level in the pit lake due to ground movement appeared to have been marginal during the interval of 2005 to 2009.
  - Therefore, it was considered that, provided that no significant changes in the stability of the east wall occurred, the increase in the water level of the pit lake due to ground movement could be expected to be marginal in comparison to the change of water elevation due from surface run-off and groundwater inflows.
  - Based on water and pit volume calculations at the time of the 2009 site visit, the expected time remaining until the pit overflows the outlet, at an elevation of approximately 1,230 metres, was estimated to be approximately 11 years and 3 months, assuming no further displacement of the existing failure mass above the outlet elevation. If the existing failure debris above the outlet elevation were to fail into the pit below the outlet elevation, the remaining time until the pit overflows would be approximately 10 years and one month. These calculations assumed that the pit would continue to fill with water at the same average rate it that had filled over the last five years prior to 2009.

- Ultimately, as the pit water level rises and approaches the elevation of the outlet on the south side of the pit, a pit wave from a rapid failure of the existing steep back-scarp could overtop the outlet and send a large volume of water downstream of the pit. Consequently, it was recommended that the stability of the back-scarp be assessed to:
  - determine the likelihood of failure of the back-scarp;
  - confirm the possible need to carry out an inundation study for the area downstream of the pit; and
  - confirm the possible need to develop long-term monitoring procedures and possible mitigation measures.

The back-scarp stability investigation was considered to require geotechnical field investigation, laboratory testing and slope stability analysis. It was recommended that a separate scope of work be prepared for these proposed investigations.

As an alternative, it was recommended that the back-scarp slope be mined back to an overall slope angle of approximately 2:1 horizontal to vertical, which was considered to likely provide a stable long-term slope. The estimated time for the pit to fill to the elevation of the south rim was estimated to be approximately 10 to 11 years. Re-sloping of the back-scarp was recommended within approximately one-half of this interval in order to ensure that the back-scarp was re-sloped and stabilized well before the rising water level could de-stabilize the back-scarp. Accordingly, it was recommended to complete this re-sloping within the next 5 to 6 years, or before 2015.

- In the short-term, a rapid failure of the back-scarp and the existing failure debris in the lower portion of the slope was not considered likely to result in a pit wave that would overtop the outlet on the south side of the pit. However, a pit wave from such a rapid failure was considered to present a significant hazard to any water pumping or treatment facilities located within the pit and to any personnel that would be temporarily working within the pit limits.
  - Consequently, a back-scarp stability monitoring program was recommended in order to:
    - determine the ground movement rates of the existing failure mass to the west of the back-scarp;
    - monitor the progression of the instability beyond the current back-scarp limits;
    - create a proper record of the existing and developing instability; and
    - provide advance warning of a possible failure of the steep back-scarp.

The recommended slope stability monitoring program is summarized in Table 5 below.

Table 5: Grum Pit 2010 Recommended Monitoring Program

Monitoring Procedure	Objective	Main Tasks	Frequency
Visual Inspections	■ Monitor stability of the crest of the back scarp. ■ Monitor progression of the instability zone. ■ Provide warning of failure in the area of the access road to the water treatment plant and power line/substation.	Monitoring based on routine walk over and visual inspection on the most critical areas at the crest of the east wall instability zone.	Every second week during spring, summer and fall, or prior to personnel entering the pit limits.
Extensometer and/or Pins	■ To provide short-term monitoring between prism surveys of the stability of the crest of the back-scarp in the event of new cracks developing behind the crest of the wall.	Extensometers and/or Pin readings.	If new cracks develop behind the back-scarp, monitor before personnel enters the pit limits.
Survey Slope Monitoring Prisms	■ Establish ground movement rates on the existing failure mass. ■ Quantify the progression of the slope instability process. ■ Monitor the stability of the crest of the back-scarp.	Topographic survey of fixed prisms.	Spring and fall of 2010. The frequency for future monitoring will be adjusted based on the review of 2010 data. If new cracks develop behind the back-scarp, monitor before personnel enters the pit limits.

Further details of the monitoring recommendations are provided in Golder, 2010. Ultimately, only monitoring pins were installed behind the crest of the east wall of the Grum Pit. Site staff also carry out daily driving visual inspections, and photograph the walls of the Grum Pit on a monthly basis. Monitoring prisms have not been installed on the failure debris within the pit or behind the steep backscarp on wall.

The monitoring pin data are reviewed in Section 4.4.2.

4.4 Grum Pit 2012 Slope Stability Review

On August 9, 2012, prior to the Golder 2012 site visit, YG reported to Golder that cracks had developed in the instability zone (Photographs D-2 and D-3).

During the 2012 site visit, the crest of the east wall and the Grum Pit instability zone were walked over and inspected for recent cracks and ponded water. The following areas were walked over and inspected:

- behind the crest of the east wall;
- behind the backscarp of the instability zone;
- the road behind the crest;
- accessible benches on the slope;
- the North and South Arrays of reference bars; and
- the Grum Pit Interceptor Ditch.

The following observations were made during the visual inspection:

- By the time of the site visit in September 2012, the cracks reported by YG in August had extended to the north, and a portion of the backscarp had slumped (Photographs D-4 and D-5).
- Erosion gullies and seepage were observed within the instability zone. Surface water and snowmelt are draining from the crest directly through the failure zone and into the pit (Photograph D-4).
- A crack that appeared to be recent was observed by Golder at the crest of the east wall, to the south of the South Array of monitoring pins, near the road (Photographs D-6 and D-7). The crack was approximately 3 metres long and 20 centimetres deep.
- A second crack that appeared to be recent was observed by Golder at the North Array. The crack intersected the second monitoring pin from the crest (Photographs D-8 and D-9) and was approximately 50 centimetres deep. The visible portion of the crack was approximately 3 metres long.
- An old crack was observed, located north of the South Array (Photograph D-10). The crack was 30 cm deep, about 4 metres long, shaped in a curve. No other recent cracks were observed in the vicinity of the South Array.
- Old slumping structures were observed at the edge of the crest near the South Array (Photograph D-11).

- No cracks were observed along the road behind the crest of the east wall.
- Several areas of ponded water were observed behind the crest, as shown on Photographs D-12 to D-15. Some were marked with GPS and are shown on Figure 3. Some of the ponds were located to the north of the instability zone.
- In addition, a significant pond of water was observed behind the crest, shown on Photograph D-16. This large pond was also marked with GPS and is indicated on Figure 3.
- Water from the slot cut on the south side of the pit has reportedly been seeping into the pit.
- Discussions with site personnel indicate that there may be a culvert under the road north of what is known as Boyd’s Pond, which may be diverting water to the crest of the east wall.
- The monitoring pins in the North and South Arrays appear to be in good condition (Photographs D-17 and D-18). These are discussed further in Section 4.4.2 of this report.
- The Grum Pit Interceptor Ditch appears to be in good condition (Photograph D-19). The ditch was transporting water and was not at full capacity.
- The north, south and west walls are exhibiting adequate stability. Based on the photographs and visual inspection, only localized raveling of the bedrock is occurring on these slopes, and the bench crests are mainly intact (Photograph D-20).

4.4.1 Photograph Comparison

Photographs taken of the Grum Pit instability zone during the site visit were compared to 2009 photographs to detect any changes in the location or shape of the failure debris, or the shape and size of the failure. The comparison photos are shown in Figure B-3 in Appendix B. The comparison indicates that there doesn’t appear to have been any significant movement on the south side of the instability zone, either in the backscarp or in the failure debris below the backscarp. However, there has been a recent slumping failure on the north side of the backscarp. Also, there appears to be fresh cracks that have developed in the failure debris immediately below the backscarp slump (Figure B-4).

The 2012 monitoring data review is discussed in the following section.

4.4.2 Review of 2012 Slope Monitoring Data

Prisms have not been installed on the Grum Pit east wall instability zone as per Golder’s 2010 recommendations. Rather, two arrays of monitoring pins were installed in June of 2010. The monitoring pins consist of discarded mill rods of approximately 3.5 metres in length. They were installed so that about one metre of the rod sticks out of the ground. In addition, TEES personnel indicated that they are walking the crest every few weeks and carrying out visual inspections for cracks or changes in the instability zone.

The monitoring pin installation details provided by Brodie Consulting (Brodie Consulting Ltd. 2010) indicate that three monitoring pins were installed in an array to the south of the transformer station. A fourth pin was installed in July 2010. To the north of the transformer station, an array of six pins was installed. The locations of the pins were marked with a hand-held GPS.

The installation coordinates and the initial distance measurement data are presented in Table 6, below. The approximate locations of the monitoring pins are shown in Figure 2.

Table 6: Location of 2010 Grum Pit Monitoring Pins

Monitoring Pin Number	Installation Coordinates (WGS 84)			Initial Distance Measurements (metres)	
	Northing	Easting	Elevation (m)	(June, 2010)	
GP-S1	N 62°15'59.8"	W 133°12'47.8"	1294	4.00	Distance from crest to Pin 1
GP-S2	N 62°15'59.9"	W 133°12'47.5"	1295	5.56	Distance between Pin 1 and Pin 2
GP-S3	N 62°16'00.1"	W 133°12'47.5"	1313	7.81	Distance between Pin 2 and Pin 3
GP-S4(1)	N 62°16'00.2"	W 133°12'46.1"	1308	15.63	Distance between Pin 3 and Pin 4
GP-N1	N 62°16'04.6"	W 133°12'52.0"	1305	4.00	Distance from crest to Pin 1
GP-N2	N 62°16'04.6"	W 133°12'51.7"	1304	5.38	Distance between Pin 1 and Pin 2
GP-N3	N 62°16'04.4"	W 133°12'52.5"	1312	5.23	Distance between Pin 2 and Pin 3
GP-N4	N 62°16'04.7"	W 133°12'51.0"	1303	6.13	Distance between Pin 3 and Pin 4
GP-N5	N 62°16'04.7"	W 133°12'50.9"	1305	6.26	Distance between Pin 4 and Pin 5
GP-N6	N 62°16'04.8"	W 133°12'50.1"	1308	5.74	Distance between Pin 5 and Pin 6

Notes:

1) Pin GP-S4 was installed in July 2010, and the first reading in July is reported.

After the installation of the monitoring pins in 2010 and the initial distance measurement, distance measurements have been subsequently carried out by the site staff. TEES staff on site carry out the measurements of the distance from the crest to the first pin and of the distance between each subsequent pin. Initially, measurements were taken about once a week, until October 2010 when the measurement frequency was changed to once a month.

The purpose of the monitoring pins is to provide short-term monitoring of the stability of the crest of the back-scarp in the event of new cracks developing behind the crest of the Grum Pit east wall. The procedure carried out in the Grum Pit is slightly different than the procedure used for the reference bars in the Faro Pit. In the Faro Pit, measurements are made from the crest to each reference bar along a pre-defined bearing to determine if regressive failure at the crest is occurring. A decrease in distance indicates a loss of crest.

In the Grum Pit, the distance from the crest to the first pin is measured. Then, the distance from the first pin to the second pin is measured, and so on along the array, as indicated in Table 6. The purpose of measuring from the crest to the first pin is to determine if any loss of crest is occurring. The purpose of measuring the distances between the remaining pins is to determine if any tension cracks located behind the crest are increasing in width. However, no cracks were observed behind the crest until September 2012, when a crack was observed in the vicinity of the north array.

A summary of the distance readings is presented in Table 7, below. Plots of the horizontal distance measurements by date are presented in Figure C-11 in Appendix C.

Table 7: Grum Pit Monitoring Pins – Summary of Horizontal Distance Measurements

Date	Monitoring Pin Number									
	GP-S1	GP-S2	GP-S3	GP-S4	GP-N1	GP-N2	GP-N3	GP-N4	GP-N5	GP-N6
	Horizontal Distance (metres)									
24-Jun-10	4.000	5.562	7.814	-	4.000	5.382	5.226	6.126	6.264	5.740
29-Jul-10	4.000	5.562	7.814	15.630	4.000	5.381	5.329	6.124	6.270	5.743
4-Aug-10	4.000	5.650	7.810	15.619	4.000	5.381	5.228	6.123	6.217	5.740
12-Aug-10	4.000	5.565	7.812	15.635	4.000	5.385	5.230	6.123	6.271	5.748
19-Aug-10	4.000	5.565	7.810	15.626	4.000	5.383	5.230	6.126	6.270	5.740
26-Aug-10	4.000	5.564	7.810	15.631	4.000	5.381	5.230	6.126	6.270	5.742
2-Sep-10	4.000	5.560	7.812	15.632	4.000	5.383	5.230	6.127	6.273	5.734
9-Sep-10	4.000	5.563	7.807	15.623	4.000	5.380	5.250	6.124	6.265	5.737
16-Sep-10	4.000	5.564	7.811	15.625	4.000	5.383	5.229	6.127	6.270	5.739
23-Sep-10	4.000	5.558	7.808	15.623	4.000	5.378	5.231	6.122	6.266	5.735
30-Sep-10	4.000	5.560	7.805	15.622	4.000	5.379	5.225	6.122	6.265	5.732
7-Oct-10	4.000	5.562	7.806	15.632	4.000	5.380	5.229	6.125	6.267	5.736
10-Nov-10	4.000	5.561	7.809	15.623	4.000	5.390	5.230	6.123	6.268	5.738
7-Dec-10	4.000	5.561	7.811	15.627	4.000	5.388	5.324	6.120	6.272	5.739
5-Jan-11	4.000	5.559	7.781	15.629	4.000	5.380	5.234	6.121	6.270	5.739
1-Feb-11	4.000	5.559	7.808	15.630	4.000	5.381	5.235	6.123	6.269	5.737
7-Mar-11	4.000	5.559	7.808	15.636	4.000	5.381	5.234	6.124	6.270	5.738
5-Apr-11	4.000	5.557	7.806	15.635	4.000	5.387	5.234	6.121	6.268	5.737
3-May-11	4.000	5.558	7.807	15.630	4.000	5.382	5.234	6.122	6.272	5.737
9-Jun-11	4.000	5.565	7.803	15.622	4.000	5.381	5.240	6.134	6.273	5.731
1-Jul-11	4.000	5.562	7.804	15.622	4.000	5.380	5.232	6.127	6.274	5.732
7-Aug-11	4.000	5.566	7.804	15.625	4.000	5.377	5.228	6.125	6.275	5.734
5-Sep-11	4.000	5.559	7.802	15.612	4.000	5.370	5.224	6.119	6.265	5.715
6-Oct-11	4.000	5.561	7.801	15.621	4.000	5.374	5.231	6.124	6.271	5.726

Date	Monitoring Pin Number									
	GP-S1	GP-S2	GP-S3	GP-S4	GP-N1	GP-N2	GP-N3	GP-N4	GP-N5	GP-N6
	Horizontal Distance (metres)									
3-Nov-11	4.000	5.560	7.811	15.627	4.000	5.372	5.235	6.124	6.273	5.731
6-Dec-11	4.000	5.560	7.803	15.620	4.000	5.376	5.235	6.117	6.271	5.726
5-Jan-12	4.000	5.566	7.803	15.626	4.000	5.374	5.234	6.112	6.273	5.726
5-Mar-12	4.000	5.556	7.804	15.631	4.000	5.390	5.239	6.117	6.272	5.734
9-Apr-12	4.000	5.557	7.802	15.634	4.000	5.384	5.245	6.129	6.274	5.730
28-May-12	4.000	5.562	7.800	15.632	4.000	5.372	5.236	6.125	6.275	5.725
20-Jun-12	4.000	5.565	7.798	15.618	4.000	5.367	5.232	6.118	6.278	5.722
25-Jul-12	4.000	5.568	7.805	15.629	4.000	5.381	5.246	6.128	6.284	5.741
28-Aug-12	4.000	5.571	7.804	15.645	4.000	5.382	5.254	6.129	6.281	5.733
18-Sep-12	4.000	5.563	7.799	15.624	4.000	-	-	6.120	6.276	5.722
24-Oct-12	4.000	5.576	7.809	15.641	4.000	-	-	6.126	6.281	5.734
25-Oct-12	-	-	-		4.000	-	-	6.101	6.279	5.726
21-Nov-12	4.000	5.574	7.808	15.632	4.000	-	-	6.100	6.279	5.726
Δ Between Last and Initial Measurement	0.000	0.012	-0.006	0.002	0.000	0.000	0.028	-0.026	0.015	-0.014

The last row in Table 7 shows the change between the last measurement and the initial measurement, between the pins. The values indicate that very little to no change is occurring and the differences appear to be within the margin of error of the measurement system. However, the measurements that are supposed to be from the crest to the first monitoring pin on both the South and North Arrays (GP-S1 and GP-N1) do not show any variation and are reported as 4.0 metres for every measurement. This discrepancy should be clarified with the personnel that are carrying out the measurements to ensure that the distance from the crest to the first pin is actually being measured and recorded. Some variability would be expected for these measurements, similar to the variation exhibited in the measurements for all the other pins.

A crack was observed by TEES staff in September 2012. The data spreadsheet provided by TEES indicated that the crack was observed across pin GP-N3. However, Golder did not observe any cracks across GP-N3. A crack was observed by Golder across GP-N2 (Photograph D-8). Furthermore, correspondence with TEES personnel indicated that they were not measuring GP-N1 or GP-N2 due to the safety concern of the crack. However, as shown above, a measurement is recorded for GP-N1, but not for GP-N2 or GP-N3. This also indicates that there is some discrepancy in terms of where the measurements are being made with respect to GP-N1, and whether the measurement recorded for GP-N2 is the distance from the crest to GP-N2 or from GP-N1 to GP-N2. It is recommended that YES and site staff review the measurement procedures to ensure that all personnel are following the same procedures. Furthermore, the discrepancies in the measurements should be clarified as soon as possible and the records should be updated accordingly.

With the understanding that the crack is actually located at GP-N2 and not GP-N3, then only the following measurements should be suspended for safety reasons:

- from the crest to GP-N1; and
- from GP-N1 to GP-N2.

The distance from GP-N2 to GP-N3 should continue to be recorded provided that field personnel stay on the east side of the crack and carry out a visual inspection to determine that no new cracks have formed behind the present crack. In addition, once the snow cover has melted, smaller pins should be installed on either side of the crack located at GP-N2, and this distance should be measured and recorded on a regular basis to determine if the crack is increasing in width.

Prior to carrying out the measurements, it is recommended to walk the area to the north and south of the both arrays to look for any new cracks. Stay to the east of any existing cracks and do not walk the area between the pit crest and existing or new cracks. Once the limit of new and existing cracks has been established, it is considered safe to read the pins located to the east of the cracks. This includes pins GP-N2 and GP-N3 in the north array, as pin GP-N2 is accessible without having to walk to the west of the crack at pin GP-N2.

Before entering the pit, the above monitoring procedures should also be carried out, and the monitoring data from the pins should be analyzed and interpreted to confirm that there has not been any movement between the pins. If new cracks are identified, or the monitoring data indicate that there is movement between the pins, personnel should not be allowed into the pit and a qualified slope stability professional should be consulted to assess the stability of the failure zone and backscarp, and to determine what, if any, remedial actions may be required.

4.4.3 Summary of 2012 Grum Pit East Wall Slope Stability

The 2012 visual assessment, photograph comparison and review of the monitoring data indicate that the south side of the Grum Pit instability zone has not changed significantly since the 2009 inspection. Until recently, instability has been limited to spalling and surface erosion of the back scarp. However, based on visual observations and photographic comparisons, there does appear to have been significant movement of the backscarp and possibly the failure debris on the north side of the instability zone. Because monitoring prisms have not been installed on the failure debris at the base of the backscarp, it is not possible to confirm if the old failure debris continues to move toward the pit.

Cracks have recently developed in the face and at the crest of the back scarp on the north side, and shallow-seated failure of the backscarp occurred at the face in August 2012. Furthermore, as discussed in the monitoring review, the crest appears to be exhibiting recession and cracking along the North Array.

Based on the visual inspection and monitoring data review, the following actions are recommended:

- Extensometers and/or displacement monitoring pins should be installed across new cracks that develop at the crest and behind the back-scarp. Before installing extensometers or additional monitoring pins, the recommended visual inspection for new cracks and a review of the monitoring data should be carried out. If new cracks are identified, stay to the east of the cracks, but it is acceptable to measure across the crack in this manner.

- It is recommended that extensometers and/or displacement pins be monitored on a monthly basis (as long as safe access allows), and weekly during the spring run-off. This recommended reading interval is subject to review depending on displacement rates, or every time prior to allowing personnel to enter the pit limits.

- The monitoring data for the crack displacements should be properly recorded on data log books, and the data should be plotted on displacement versus time graphs. The displacement plots should be placed in common areas to be available for review by the personnel that need to access the pit.

- Monitoring prisms should be installed on the failure debris below the back scarp, at the locations recommended in Golder's 2010 report (shown in Figure B-5, Appendix B). Visual observations indicate that there has been recent movement on the north side of the instability zone. It appears that the recent cracks behind the backscarp have developed in response to movement of the failure debris into the pit, probably as the result of rising water levels. However, as there is no monitoring of the existing failure debris, it is difficult to confirm this. Given that the stability of the backscarp is somewhat dependent on the stability of the failure debris, it is important to know if the failure debris is continuing to exhibit displacements.

  - These prisms can be surveyed on an annual or semi-annual basis (spring and late fall) by the same contractor that carries out the surveying of the prisms in the Faro Pit. The failure debris should be inspected by a geotechnical engineer to ensure it is safe to access the slope before installation. This can be done in conjunction with the 2013 site inspection.

- Several large areas of ponded water have been observed behind the crest of the east wall. In particular, the settling pond is located near the pit crest on the east side. It is possible that these ponds are providing groundwater inflow that is contributing to the seeps that are observed in the failure zone, and to the on-going instability within the failure zone. It is recommended that the topography behind the east wall be examined to determine if it is possible to divert ponded water away from the pit crest, or if the low spots can be filled in with fine-grained till to prevent the ponding of water.

The recent slumping on the north side of the instability zone and the recent cracks observed behind the crest of the east wall along the North Array do not appear to be a threat to the Interceptor Ditch at this time. However, it is appears that the slumping on the north side of the instability zone has developed in response to deeper-seated movement of the existing failure debris below the backscarp, probably in response to rising pit water levels. If deeper-seated movements of the failure debris continue to develop due to rising water levels, it is possible that larger scale failures of the backscarp could develop in the near term, which could become a threat to the facilities located behind the east wall. Therefore, it is important to know if movement is occurring within the failure debris between the base of the backscarp and the pit lake.

4.4.4 Grum Pit Overflow Elevation and Timeframe Update

In 2009, Golder estimated a maximum pit water level based on the bottom of the outlet, or slot cut, on the south side of the pit. Recent hydrogeologic investigations have determined that groundwater in the soils below the slot cut are mounding to an average elevation of 1,221.3 metres, and this assumed to be the new maximum pit water level, as the water is expected to flow out of the pit at this elevation. The current pit water level is approximately 1,214 metres, which is approximately 7.3 metres below the new maximum pit water level. Consequently, the pit water level could theoretically rise an additional approximate 7.3 metres in the next two years, based on the current fill rate. The effect that this additional increase in water level could have on the stability of the backscarp is unknown at this time as no stability investigations or analyses have been carried out on the backscarp. In order to develop a degree of confidence that the backscarp would remain stable under this increasing water level, it is recommended that the backscarp geotechnical investigations that were previously recommended in 2009 (Golder 2010) be carried out. Given the two-year timeframe, it is worth considering carrying out these investigations in summer of 2013 or, alternatively, consideration should be given to laying the slope back as previously recommended. The scope of these stability investigations is discussed further in Section 7.2.

5.0 VANGORDA PIT SLOPE STABILITY INSPECTION

5.1 Vangorda Pit Description

The Vangorda Pit is located approximately two kilometres southeast of the Grum Pit. Mining in the Vangorda Pit began in 1990 and was completed in 1996. Mining activities were suspended from 1993 to late 1994.

The Vangorda Pit is oval in shape, with the long axis trending northwest–southeast, as shown on Figure 4. The widest and deepest part of the pit is on the northwest side. The pit is approximately 1,115 metres long, approximately 350 metres across at its widest point, and has a maximum of depth of 150 metres. The southeast side of the pit is narrower and shallower, with a width of approximately 200 metres and a depth of approximately 50 metres (Deloitte & Touche Inc. 2002).

The Vangorda Creek initially flowed from northwest to southeast across the thickest part of the ore body. The creek was subsequently diverted around the north and northwest side of the pit in a flume that consists of a 2.4 metre diameter half-round culvert placed into an open channel lined with rip rap. This diversion is called the Vangorda Creek Diversion Channel (Figure 4). The bench on which the flume is located on the north and northwest side of the pit is called the upper bench.

Water enters the pit via three gullies. One gully is located on the southwest-facing wall, and two gullies are located in the northwest corner of the pit.

The 2002 Deloitte & Touche Inc. report indicates that the Vangorda Pit slopes experienced local instability, particularly in the northwest corner of the pit. This area is characterized by carbonaceous phyllites and is adjacent to several faults. The localized wall failures were reportedly related to a pit expansion that required the Vangorda Creek Diversion Channel to be moved soon after construction. The northeast walls and the slot area walls have historically exhibited adequate stability performance.

The Vangorda Pit is currently inactive and inundated to the 1,082 metre elevation (masl, NAD 83) as of September 2012. A pump barge pumps water to a water treatment plant. Recently, seepage was reported on the northwest pit wall, below the road bed and adjacent to the creek diversion. No monitoring instrumentation has been installed in the Vangorda Pit.

5.1.1 Vangorda Pit Engineering Geology

The following sections on the engineering geology of the Vangorda Pit are summarized from reports by Deloitte and Touche Inc. (2002), SRK (2003), and Curragh Resources (1987).

5.1.1.1 Overburden Soils

The overburden soil deposits and the surficial landforms of the Vangorda Plateau have been deposited and formed by the most recent of several glaciation events estimated to have occurred in the Yukon. In the area of the Vangorda Plateau, extensive overburden deposits have been observed, which include till deposits and glacio-fluvial outwash silt, sand and gravel deposits. Thick till blankets overlie the area surrounding the Grum and Vangorda Deposits. However, the glacial overburden cover in the area of the Vangorda Deposit is significantly less than in the Grum Deposit area (Curragh Resources 1987).

5.1.1.2 Bedrock Geology

The bedrock geology of the Vangorda Pit consists of metamorphic rocks of the Mt. Mye and Vangorda Formations, which are described in Section 2.0.

The Vangorda ore zone consists of one major sulphide horizon located approximately 50 to 120 metres beneath the basal carbonaceous member of the Vangorda Formation. The host rocks surrounding the deposit are dominantly non-calcareous phyllites and schists (SRK 2003). The Vangorda ore horizon has been folded into a sub-horizontal to slightly northwest plunging fold. The Vangorda Deposit is shallower than the Grum Deposit and, therefore, the degree of weathering of the deposit is greater (Curragh Resources 1987).

5.1.1.3 Structural Geology

The main geological and structural features related to the Vangorda Pit are summarized in the following paragraphs.

Regionally, the strata dip northeast and southwest (Deloitte & Touche Inc. 2002). The phyllites and schists reportedly exhibit penetrative foliation dipping about 20 degrees to the west. However, the foliation is not consistent, and varies locally between steeper and flatter dips due to different phases of folding (SRK 2003).

The rocks exposed in the pit wall are of variable strength. In the northwest wall, the rocks range from dark grey to black, low-strength, graphitic schists to light grey, strong, relatively massive and competent schists (SRK 2003), as shown in Photograph E-1 in Appendix E. The sulphide-bearing rock exposed in the pit is subject to oxidation and is observed to be highly oxidized in some walls. Iron staining is evident to some degree on all the pit walls.

Faulting within the pit is characterized by mainly west dipping, low-angle faults. A few high-angle, westerly dipping faults have also been observed. Three main faults have been identified as intersecting the Vangorda Pit, as follows (SRK 2003):

- The Cross Fault is a major, steeply dipping, east–west trending fault that has been reported to intersect the pit wall “approximately 400 metres south of the northwest wall of the pit” (SRK 2003). However, the actual location was not reported in the literature reviewed for this report. Historically, localized sloughing and raveling have been associated with the disturbed rocks within the Cross Fault zone.
- The Creek Fault is located in the northwest wall of the Vangorda Pit (Photograph E-1). The fault has essentially truncated the ore body, juxtaposing the black graphitic phyllite of the basal member of the Vangorda Formation against the ore body (Curragh Resources 1987). The Creek Fault was reported to be approximately 1 metre wide and infilled with fault gouge. SRK (2003) reports the fault orientation as 65 degrees dip toward 080° azimuth (i.e., dip and dip direction). This orientation is favourable with respect to the northwest wall, as the fault strikes into the wall.
- The Northwest Fault is also located in the northwest wall, adjacent to the Creek Fault (Photograph E-1). This zone is considerably weaker than the surrounding rock, which has resulting in on-going sloughing of the weak material in the fault zone. At the time of the site visit, this fault was not able to be observed with certainty and it appears that the material surrounding the fault has sloughed into angle of repose, and has covered the majority of the fault. SRK (2003) cites an orientation of 55-60 degrees dip toward 103° azimuth. This fault also strikes obliquely into the wall, and is not expected to affect overall stability. Raveling and sloughing along the fault has been on-going.

The joints and foliation were characterized by SRK in 2003, and the following sets were identified by measuring joint set orientations in the northwest wall. A stereographic projection of the SRK structural data has been reproduced in Figure 5.

- Set 1 dips to the south-southwest, and has an average dip of 75 degrees toward 218° azimuth.
- Set 2 dips to the west and northwest, and has an average dip of 86 degrees toward 291° azimuth.
- Set 3 is the foliation. It is variable in dip and dip direction, but the mean orientation is to the south, with an average dip of 16° toward 168° azimuth.

5.2 Vangorda Pit Slope Stability Conditions

5.2.1 Vangorda Pit Historical Slope Stability Performance

The relevant slope stability performance history of the Vangorda Pit has been summarized by Deloitte & Touche Inc. (2002) and SRK (2003). The main points are summarized below.

- The northwest side of pit has experienced instability due to the presence of weak carbonaceous phyllites and several faults that intersect this portion of the pit.
- The northeast wall has historically been more stable.
- Considerable sloughing and raveling, as well as some bench-scale instability, have been associated with the disturbed Cross Fault rock mass.
- Five slope monitoring prisms were installed in July 1992 between the 1,130 and 1,152 metre elevations on the north side of the pit. However, no pit monitoring has been undertaken since cessation of mining in 1998 and it is unknown if any of these prisms have survived.
- In October 1992, some leakage was observed from the Vangorda Creek Diversion and considerable seepage was observed along the northern and western sides of the pit bottom. Seepage was also observed from the crest of the wall above the flume down to the pit bottom in the area where the Northwest Fault intersects the wall.
- A bench-scale failure occurred on the southwest wall of the pit in October 1992, which was controlled by unfavourably-oriented, intersecting rock joints, and freeze-thaw action.
- During June 1999, a large rock fall occurred from the bench face overlooking the Vangorda Creek drainage flume. The rock fall damaged the flume. Seven sections of the flume were replaced, and remedial works were undertaken in 2001 to remove the remaining unstable rock from the bench face through controlled blasting.
- No large-scale instability has occurred in the Vangorda Pit to date. Instabilities have been at the bench scale and have involved movement along rock joints and raveling or sloughing of rock material.

5.2.2 2012 Structural Mapping

During the Golder 2012 site visit, structures were mapped in the Vangorda Pit where safe access allowed. A stereographic projection of the mapped joints is shown in Figure 6, and the mapping locations are shown on Figure 4. Photos of the mapping stations are shown in Figures E-2 to E-6 in Appendix E. The joints have been categorized by their persistence, or continuity, in the wall, because the more continuous features are of a greater concern for overall slope stability. On the stereographic projection, joints greater than 3 metres in length were grouped together, and joints with a continuity of 1 to 3 metres were grouped together. The average orientation of foliation observed in the south side of the pit has also been plotted on the stereographic projection. The foliation was estimated to dip approximately eight degrees toward the south. The mapping data indicate the following:

- The 2012 mapping data appear to coincide well with the SRK mapping data. Numerous features observed dipping to the southwest, west, northeast and east are at similar orientations to the features mapped by SRK and defined within Sets 1 and 2.
- The mean orientation of the foliation observed at the south end of the pit is very similar to the mean orientation of the foliation observed at the north end of the pit by SRK. Both indicate very shallow to flat-lying dips for the foliation.
- In addition to the expected structures, very few south dipping and southeast dipping structures were also identified in the 2012 mapping. These joints are discontinuous, i.e., they exhibit a continuity of less than 3 metres.
- The continuous structures observed in the pit dip steeply to the west and the northeast. These structures are near-vertical and as such are less likely to daylight in the slopes.
- Moderately dipping, discontinuous structures that dip to the east and west were also observed and mapped.
- The quality of the joints was also assessed. The majority of the joints were wavy (i.e., non-planar), and the surfaces were stained or slightly altered, and rough. Fewer structures were observed to be planar, and these exhibited surfaces that were also stained or slightly altered, and rough.

5.2.3 Current Vangorda Pit Slope Stability Conditions

During the 2012 site visit, portions of the crest on each side of the Vangorda Pit were walked over and inspected for new cracks and ponded water. The four pit walls were also visually inspected from the crest and from the bottom of the access road that leads into the pit. The following areas were walked over and inspected:

- portions of the pit crest perimeter;
- the roads behind the crest and the access road into the pit;
- sections of the Vangorda Creek Diversion Channel; and
- the walls were inspected from the bottom of the access road.

The following observations were made during the visual inspection.

- No recent cracks or ponded water were observed at the crest of the pit.
- No recent cracks were observed in, or near, the roads around the crest of the pit (Photograph E-7).
- No recent cracks were observed near the Vangorda Creek Diversion Channel. However, portions of the flume are in disrepair and are leaking, and water is flowing along the rip rap channel located beneath the flume (Photographs E-8 to E-10).
  - TEES personnel indicate that the flume and the road are visually inspected daily by vehicle and any standing water behind the crest is cleared out as needed.
  - During the site visit, it appeared that maintenance and repair of portions of the flume was underway.
- Very little seepage was observed in the northwest wall below the road bed and diversion channel.
- Water is flowing or being discharged into the pit in several locations, as follows:
  - In the centre of the northeast wall, some water flows into the pit from the original Vangorda Creek bed (Photograph E-11). However, the majority of the water is pumped from the creek to the diversion channel (Photographs E-12 and E-13). The pump is activated when a certain water level is reached.
  - Surface water run-off from the southwest access road and water pumped from the Little Creek Pond is flowing along gullies into the pit in the northwest corner of the pit (Photograph E-14).
  - Emergency water discharge from the booster pump is discharged into the Vangorda Pit at the location shown in Photograph E-15.

The following sections discuss the stability conditions of each wall.

5.2.3.1 Northwest Wall

The northwest wall is shown in Photograph E-1. This wall faces southeast. The stability performance of this wall has been essentially dependent on the rock quality exposed in the wall. Where the weak, graphitic schists and the Creek and Northwest Faults have been exposed in the wall (on the northwest side and in the upper benches above and below the road), the slope has exhibited a higher degree of raveling and erosion. The majority of the bench crests have been lost, and these portions of the wall have essentially developed into talus slopes.

Where slightly more competent rock is exposed on the northeast side and middle to lower benches, some bench crests are still visible. However, this rock is altered and not much stronger than the graphitic schists, and raveling is also occurring on this side of the wall. Therefore, the available catchment is limited (Photograph E-16).

The Creek Fault intersects the northwest wall of the pit (Photograph E-1) and strikes into the wall. This orientation is favourable with respect to the northwest wall, and is not expected to affect overall stability. The Northwest Fault also intersects the northwest wall, adjacent to the Creek Fault. Although this fault zone exhibits on-going raveling and sloughing, the fault strikes obliquely into the wall and is therefore not expected to affect overall stability. It was determined by SRK in 2003 that the potential for a wedge to form between the two faults was not kinematically possible. Based on the orientations reported for the faults, this conclusion is supported by Golder.

Although the orientation of the foliation observed by SRK (2003) in the northwest wall is unfavourable with respect to the wall, in that the foliation is dipping obliquely out of the wall, the reported dip of 16 degrees is sufficiently shallow that planar failure is not considered likely to occur. Furthermore, SRK reported that no signs of past plane or sliding failures along the foliation were observed during their inspection.

Several southwest-dipping structures were mapped during the 2012 site visit that exhibit dips of approximately 70 degrees. These structures were observed in the more competent rock on the south side of the pit. If present on the north side of the pit, they would be expected to daylight in the northeast corner of the pit. Limited access did not allow Golder to confirm if these structures are present on the wall. However, because of the steep dips and discontinuous nature of these structures, they are not expected to be a concern with respect to multi-bench or overall stability.

Faro site staff have reported seepage in the northwest wall. Very little seepage was observed during the site visit, most likely because of the drier time of year. The likely cause of seepage in the northwest wall is due to water leaking from the Vangorda Creek Diversion Channel into the wall (Photograph E-17).

No recent cracks were observed at the crest, or in the face, of the northwest wall. It is considered unlikely that large-scale failure will develop in this wall. However, raveling and erosion is likely to continue on the wall. As the weaker, graphitic schists in the northwest corner of the wall continue to erode, it is possible that, over the long term, this portion of the slope could become undercut, which could lead to a larger scale failure that could affect the road. Therefore, daily visual inspections should continue to be carried out to look for developing cracks, as well as undercut areas on the slope. Furthermore, the leakage from the flume should be remediated, by either lining the channel beneath the flume, or the flume itself, so that water will no longer infiltrate the wall behind the crest.

5.2.3.2 Northeast Wall

The northeast wall of the Vangorda Pit is shown in Photograph E-18. This wall faces southwest. The majority of the rock exposed in this wall is relatively competent and bench crests are still visible on the wall. The rock mass from the north side to just south of the Vangorda Creek bed is very blocky and exhibits irregular, angular blocks and a schistose fabric. South of the Vangorda Creek bed the rock appears more competent, even though it exhibits a high degree of oxidation and iron-staining. The rock here is locally massive and joint sets are more apparent. The benches have remained relatively intact with no major bench-scale or multi-bench scale instabilities apparent on the wall. Some of the bench faces on the south end of the wall have broken back to moderately and steeply dipping joints that dip to the west and southwest, resulting in a loss of catchment. The remaining joints strike into the wall and are therefore favourably oriented. However, raveling continues to occur on this wall, using up the remaining catchment. The main concern on this wall is rockfall. Therefore, if any work is to be carried out below the slope, by boat for example, a minimum distance of ten metres from the toe of the wall should be maintained.

The upper slopes of the northeast wall on the south side of the Vangorda Creek bed consist of till slopes that have been over-steepened from years of erosion and portions of the bench crests in the till have been lost completely (Photographs E-18 and E-19). The slope is not very high, there is no access to the bottom of the slope, and there are no facilities located immediately behind the crest of the slope. Therefore the ongoing erosion is not considered to be a concern.

5.2.3.3 Southeast Wall and Access Road Slopes

The southeast wall of the Vangorda Pit is shown in Photograph E-20. Only a small portion of the pit faces to the northwest, as this portion of the pit is not only narrower than the north side, but the access road has been excavated in this wall. Photograph E-21 shows the east slope of the access road. The lower benches have presumably been excavated in rock, and waste rock has been placed above the rock slopes, as shown in Photograph E-20.

In general, the rock on the south side of the pit, i.e., in the southeast wall and the access road slopes, exhibits variable strength and degrees of alteration, such that there are competent zones juxtaposed with very weak zones. In particular, this is evident in Photograph E-20, where blocks of competent rock are lying on top of altered and weak material on the east side of the access road. Although some of the blocks may have rolled from the waste rock slopes above, hard rock blocks are visible in the rock portion of the slope as well.

In the portion of the southeast wall that faces northwest, a block of competent rock is surrounded by zones of raveling in weaker rock (Photograph E-22). These zones are likely raveling along the northwesterly dipping structures observed in the pit. Likewise, the eastern slope of the access road is likely raveling along the westerly dipping structures observed in the pit (as shown in Photographs E-2 and E-3). The western slope of the access road appears to consist mainly of waste rock that has been placed at angle of repose (Photograph E-23).

Aside from the on-going raveling in weak rocks, the overall stability performance of these slopes is considered to be adequate. However, there are very few catch-benches on the southeast wall. The pit access road is located at on the southeast side of the pit. No berms have been placed on either side of the access road. Consequently, rock fall is the main concern along both sides of the access road, and the following remedial action items are recommended.

- A minimum approach distance of 10 metres should be observed when working near the area shown in Photograph E-22. This minimum distance should also be maintained when working beneath the other slopes as well. As the pit is flooded below the remaining walls, there is no access to these walls. The minimum approach distance is recommended in the event that any work is carried out from a boat, i.e. bathymetry surveys, water sampling, etc.

- There is no catch ditch or berm along the east side of the access road, and no berm along the west side to protect from rockfall. The water ditch along the west side of the road is partially infilled with rock fall debris, and is not providing protection in areas. The material that has accumulated at the toe of the slopes should be used to construct berms of approximately 1.5 metres in height, with a catch ditch between the berm and the toe of the slope, as indicated in Photograph E-24. The berm should continue along the entire western margin of the access road, including the portion located beneath the southwest wall as shown in Photograph E-26.

- There is no berm along the lower portion of the access road immediately above the pit lake. A vehicle descending down the ramp could enter the pit lake if the vehicle's brakes were to fail on the ramp or if slippery conditions were encountered on the ramp. A vehicle control berm should be placed along the margin of the pit lake, as indicated in Photograph E-25, except for the portion of the access road that may be required for accessing the pit for pumping or for launching boats.

5.2.3.4 Southwest Wall

The southwest wall of the Vangorda Pit is shown in Photograph E-25. This wall faces northeast. The upper portion appears to have been excavated in till and the lower benches in rock. However, it was not possible to determine the overburden/bedrock contact in the wall due to the amount of debris on the wall. A fault, possibly the Cross Fault, is apparent at the south end of the wall, and is indicated on Photograph E-25.

With the exception of the very southern portion of the wall, virtually no bench crests remain in this wall. The majority of the north and centre portions of the wall have raveled to angle of repose (Photographs E-26 and E-27), with some locally over-steepened portions. In the rock portion of the slope, it appears that raveling has occurred along moderate, northeast dipping structures. At the south end of the southwest wall, some bench crests are still visible, but excessive ravelling has occurred in the highly oxidized zones (Photograph E-28). No cracks were observed at the crest or in the face of this wall. No bulging was apparent at the toe of the unsloped portions of the slope. With the exception of on-going raveling, the slope appears to exhibit adequate stability performance. However, routine visual inspection is recommended for this wall to detect any tension cracks developing at the crest or the face. It is likely that over-steepened portions will continue to ravel and erode, and any activity below the wall should be done only after a visual inspection and with the assistance of a spotter.

There are essentially no catch-benches along the southwest wall, and rock fall hazards along the access ramp are the principal issue for the southwest wall. As discussed in the previous section, the ditch at the toe of the slope should be cleaned out and a berm should be placed along the edge of the access road.

It is understood by Golder that water is planned to be discharged from the location shown in Photograph E-28. As is apparent in the photograph, this area has already experienced a large degree of raveling and erosion, likely from previously discharging water at this location. This portion of the wall and the wall to the north essentially has no catchment remaining, so no activities that could further erode or undermine the wall should be undertaken. Water should not be discharged at any point along the southwest wall, and the current planned discharge location should be relocated to the northwest corner of the pit where water is currently being discharged. The area of discharge in the northwest corner of the pit has a slope that is lower and less steep, and, therefore, is less of a stability concern.

5.2.3.5 Vangorda Slope Monitoring Program

Site staff indicate that they currently carry out daily driving visual inspections of the Vangorda pit slopes and crests, and photograph the walls on a monthly basis. These visual inspections are intended to detect the development of cracking or changes in the slopes and crests, and are considered to be adequate at this time. The remediation of the leakage from the flume on the northwest wall will improve the seepage conditions in the wall, and consequently improve the stability condition of the wall. The main concern in the pit is due to rockfall hazards. Based on these considerations, no monitoring pins or prisms are required in the Vangorda Pit at this time.

5.2.4 Summary of 2012 Vangorda Pit Slope Stability

During the 2012 inspection, no recent cracks or ponded water were observed in the walls, crests, or roads.

However, portions of the flume are in disrepair and are leaking, and water is flowing along the rip rap channel located beneath the flume.

Very little seepage was observed in the northwest wall below the road bed and diversion channel. The stability performance of this wall is considered to be adequate. However, raveling and erosion is expected to continue. As the weaker schists in the northwest corner of the wall continue to erode, it is possible that, over the long term, this portion of the slope could become undercut, which could lead to a larger scale failure that could affect the road. Therefore, daily visual inspections should continue to be carried out to look for developing cracks, as well as undercut areas on the slope. Furthermore, the leakage from the flume should be remediated, by either lining the channel beneath the flume, or the flume itself, so that water will no longer infiltrate the wall behind the crest.

The northeast wall has been excavated in relatively competent rock, and bench crests are still visible on the wall. However, raveling continues to occur on this wall, using up the remaining catchment. The main concern on this wall is rockfall. Therefore, if any work is to be carried out below the slope, by boat for example, a minimum distance of ten metres from the toe of the wall should be maintained.

The upper slopes of the northeast wall on the south side of the Vangorda Creek bed consist of till slopes that have been over-steepened from years of erosion and portions of the bench crests in the till have been lost completely. However, the slope is not very high, there is no access to the bottom of the slope, and there are no facilities located immediately behind the crest of the slope. Therefore the ongoing erosion is not considered to be a concern.

In general, the rock on the south side of the pit, i.e., in the southeast wall and the access road slopes, exhibits variable strength and degrees of alteration, such that there are competent zones juxtaposed with very weak zones. The weak zones exhibit on-going raveling. Aside from the raveling in weak rocks, the overall stability performance of these slopes is considered to be adequate. However, there are very few catch-benches on the southeast wall. The pit access road is located at on the southeast side of the pit. No berms have been placed on either side of the access road. Consequently, rock fall is the main concern along both sides of the access road, and the following remedial action items are recommended.

- A minimum approach distance of 10 metres should be observed when working near the area shown in Photograph E-22. This minimum distance should also be maintained when working beneath the other slopes as well. As the pit is flooded below the remaining walls, there is no access to these walls. The minimum approach distance is recommended in the event that any work is carried out from a boat, i.e. bathymetry surveys, water sampling, etc.
- Berms should be constructed of approximately 1.5 metres in height, with a catch ditch between the berm and the toe of the slope along both sides of the access road, as indicated in Photograph E-24. The berm should continue along the entire western margin of the access road, including the portion located beneath the southwest wall, as shown in Photograph E-26.
- There is no berm along the lower portion of the access road immediately above the pit lake. A vehicle descending down the ramp could enter the pit lake if the vehicle’s brakes were to fail on the ramp or if slippery conditions were encountered on the ramp. A vehicle control berm should be placed along the margin of the pit lake as indicated in Photograph E-25, except for the portion of the access road that may be required for accessing the pit for pumping or for launching boats.

The upper portion of the southwest wall appears to have been excavated in till and the lower benches in rock. A fault, possibly the Cross Fault, is apparent at the south end of the wall.

The majority of the north and centre portions of the wall have raveled to angle of repose, with some locally over-steepened portions. At the south end of the southwest wall, some bench crests are still visible, but excessive ravelling has occurred in the highly oxidized zones. No cracks were observed at the crest or in the face of this wall. No bulging was apparent at the toe of the unsloped portions of the slope. With the exception of on-going raveling, the slope appears to exhibit adequate stability performance. However, routine visual inspection is recommended for this wall to detect any tension cracks developing at the crest or the face. It is likely that over-steepened portions will continue to ravel and erode, and any activity below the wall should be done only after a visual inspection and with the assistance of a spotter.

There are essentially no catch-benches along the southwest wall, and rock fall hazards along the access ramp are the principal issue for the southwest wall. As discussed in the previous section, the ditch at the toe of the slope should be cleaned out and a berm should be placed along the edge of the access road.

It is understood by Golder that water is occasionally discharged from the location shown in Photograph E-28. As is apparent in the photograph, this area has already experienced a large degree of raveling and erosion, likely from previously discharging water at this location. This portion of the wall and the wall to the north essentially has no catchment remaining, so no activities that could further erode or undermine the wall should be undertaken. Water should not be discharged at any point along the southwest wall, and the current emergency water discharge location should be relocated to the northwest corner of the pit where water is currently being discharged. The area of discharge in the northwest corner of the pit has a slope that is lower and less steep, and, therefore, is less of a stability concern.

6.0 RECOMMENDATIONS FOR FUTURE INSPECTIONS

The frequency of pit slope inspections at any given mine site will vary, as it typically depends on the stability issues and the degree of concern at the particular site. If there are stability concerns of little consequence, the frequency of inspections can generally be low, but if there are stability issues of a critical nature, inspections may be required several times a year.

Based on the 2012 stability assessment of the Faro Mine Complex, a full inspection of all three pits is recommended for 2013 for the following reasons:

- to follow up on the recommendations for a review by site personnel and YES of the monitoring procedures for the reference bars and monitoring pins in the Faro and Grum Pits, respectively;
- to follow up on the recommendations for rockfall control above the in-pit access road in the Vangorda Pit;
- to follow up on and assist with the placement of the recommended prisms in the Grum Pit; and
- to inspect the Grum Pit instability zone, which continues to exhibit on-going deformation.

It is recommended that the inspection be carried out sometime in the fall of next year (September-October 2013).

Once the 2013 inspection has been completed, a frequency for future inspections can be established.

The primary reason to inspect the Faro Pit is to be able to provide early warning of an overall failure along the east wall that could affect the FCDC. Provided that the on-site monitoring is being carried out effectively, and the results indicate no change in the slope stability performance, the inspection frequency of the Faro Pit could likely be reduced to once every two years.

Likewise, it is probable that once the rockfall controls are put in place in the Vangorda Pit, and provided that appropriate maintenance and visual inspections continue to be carried out and that no stability issues develop, the inspection frequency for the Vangorda Pit could be decreased to once every two to three years.

With respect to the Grum Pit, it is recommended to discuss the inspection frequency after the 2013 inspection, as it will depend on the performance of the instability zone over the next year. However, at this time it is anticipated that annual inspections will continue to be required.

7.0 SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

This report has presented the observations made by Golder during the site visit to the Faro Mine Complex from September 12 to 14, 2012, to carry out an assessment of the slope stability conditions in the Faro, Grum and Vangorda Pits. A review of the Faro and Grum Pit monitoring data was carried out as part of this review and has been discussed. A visual comparison between previous and more recent photos was carried out for the Faro North and South Instability Zones and for the Grum Pit east wall instability zone. The geologic structures and the pit slope stability performance in the Vangorda Pit have been described. Potential hazards in the Vangorda Pit have been identified and recommendations for mitigation have been provided.

The following is a summary of the conclusions and recommendations provided in this report. A table of recommendations and action items is provided at the end of this section.

7.1 Faro Pit

The 2012 assessment indicates that the North and South Instability Zones have not significantly changed since the 2002 inspection. Minimum crest distances to the FCDC measured at both North and South Instability Zones were on the same order as the previous 2009 inspection.

In general, the reference bar monitoring data, together with visual observations, indicate that localized areas continue to exhibit a small amount of raveling and erosion, but there do not appear to be indications of any significant crest regression or failure since the bars were installed in 2008.

However, the reference bar measurements in Table 2 indicate that the measurement procedure is not being carried out consistently between personnel. The horizontal distance plot indicates a degree of variability that is generally within the accuracy of the measurements, but there are a few measurements that are clearly inconsistent. It is likely that these inconsistent readings are due to different personnel taking measurements, where not all individuals are following the same measurement procedure and/or measuring along the correct bearing. Care should be taken to ensure that all personnel who are carrying out measurements, whether mine staff or consultants, are following the same measurement procedures to ensure that measurements are as accurate and error-free as possible. It is therefore recommended that YES and the site staff perform the measurements together at least once, to confirm that all personnel carrying out measurements are using the same reference points, bearings and procedure. Furthermore, a second “alignment” bar should be added a short distance from each original reference bar, aligned along the bearing at which the measurement from the first bar to the crest should be made. This would greatly improve the measurement accuracy for the reference bars in the Faro Pit. Finally, reference bar measurements should be plotted as soon as possible on a horizontal distance plot such as the one in Figure C-1 to quickly identify potentially inconsistent readings. If necessary, a second, confirmatory measurement should be taken and plotted in a timely manner.

No additional prisms or reference bars are considered necessary in the Faro Pit. The visual inspection did not identify any new cracks or areas of concern. However, the next reading of Prism 13875 should be plotted immediately to determine if actual movement is occurring in the vicinity of this prism.

The prisms should continue to be read at the current frequency, which is approximately once a year. The reference bars should also continue to be read at the current frequency, which is once in the spring (March-June) and once in the fall (September-December).

Overall, the visual observations and the review of the monitoring data indicate that catastrophic failure of the bedrock and overburden slopes at the backscarps on the northeast wall do not appear to be likely within the near future. Limited erosion and ravelling instability are expected to continue to develop slowly at the crest of the east wall due to sloughing or ravelling in the steep overburden face, and to seepage erosion of the underlying bedrock, which undercuts the overburden slope. Since this process appears to be more active in the North Instability Zone, this area is considered to remain the most critical to the stability of the FCDC over the long-term, while the South Instability Zone is not expected to undermine the FCDC for many years.

7.2 Grum Pit

The 2012 visual assessment, photograph comparison and review of the monitoring data indicate that the south side of the Grum Pit instability zone has not changed significantly since the 2009 inspection. However, based on visual observations and photographic comparisons, there does appear to have been significant movement of the backscarp and possibly the failure debris on the north side of the instability zone.

The recent slumping on the north side of the instability zone and the recent cracks observed behind the crest of the east wall along the North Array do not appear to be a threat to the Interceptor Ditch at this time. However, it is appears that the slumping on the north side of the instability zone has developed in response to deeper-seated movement of the existing failure debris below the backscarp, probably in response to rising pit water levels. If deeper-seated movements of the failure debris continue to develop due to rising water levels, it is possible that larger scale failures of the backscarp could develop in the near term, which could become a threat to the facilities located behind the east wall. Therefore, it is important to know if movement is occurring within the failure debris between the base of the backscarp and the pit lake. However, this cannot be confirmed without monitoring prisms. In addition, no stability investigations or analyses have been carried out on the failure zone and backscarp to determine if the rising water levels will have a negative impact on the stability of these zones.

Based on the above considerations, the following actions are recommended:

- Extensometers and/or displacement monitoring pins should be installed across new cracks that develop at the crest and behind the back-scarp. These should be monitored on a monthly basis, and weekly during the spring run-off. This recommended reading interval subject to review depending on displacement rates, or every time prior to allowing personnel to enter the pit limits.
  - Before installing extensometers or additional monitoring pins, the recommended visual inspection for new cracks and a review of the monitoring data should be carried out. If new cracks are identified, stay to the east of the cracks, but it is acceptable to measure across the crack in this manner.
- The monitoring data for the crack displacements should be properly recorded on data log books, and the data should be plotted on displacement versus time graphs. The displacement plots should be placed in common areas to be available for review by the personnel that need to access the pit.
- Monitoring prisms should be installed on the failure debris below the back scarp, at the locations recommended in Golder's 2010 report (See Figure B-5). Given that the stability of the backscarp is somewhat dependent on the stability of the failure debris, it is important to know if the failure debris is continuing to exhibit displacements.

- These prisms can be surveyed on an annual or semi-annual basis (spring and late fall) by the same contractor that carries out the surveying of the prisms in the Faro Pit. The failure debris should be inspected by a geotechnical engineer to ensure it is safe to access the slope before installation. This can be done in conjunction with the 2013 site inspection.

- Several large areas of ponded water have been observed behind the crest of the east wall. It is possible that these ponds are providing groundwater inflow that is contributing to the seeps that are observed in the failure zone, and to the on-going instability within the failure zone. It is recommended that the topography behind the east wall be examined to determine if it is possible to divert ponded water away from the pit crest, or if the low spots can be filled in with fine-grained till to prevent the ponding of water.

- Based on the pit water level data, the Grum Pit water level could theoretically rise an additional approximate 7.3 metres in the next two years, based on the current fill rate. The effect that this additional increase in water level could have on the stability of the failure zone and backscarp is unknown at this time as no stability investigations or analyses have been carried out on the failure zone and backscarp. In order to develop a degree of confidence that these zones would remain stable under this increasing water level, and given the two-year timeframe, it is worth considering carrying out the geotechnical investigations that were previously recommended in 2009 (Golder 2010). As a preliminary step, an office-based back-analysis of the instability zone could be carried out and, based on the results, and if required, field investigations could take place in the summer of 2013. A more detailed scope of the stability assessment of the failure zone and backscarp with respect to rising water levels can be provided upon request. Alternatively, consideration should be given to laying the slope back as previously recommended.

7.3 Vangorda Pit

During the 2012 inspection, no recent cracks or ponded water were observed in the walls, crests, or roads.

However, portions of the flume are in disrepair and are leaking, and water is flowing along the rip rap channel located beneath the flume.

Very little seepage was observed in the northwest wall below the road bed and diversion channel. The stability performance of this wall is considered to be adequate. However, raveling and erosion is expected to continue. As the weaker schists in the northwest corner of the wall continue to erode, it is possible that, over the long term, this portion of the slope could become undercut, which could lead to a larger scale failure that could affect the road. Therefore, visual inspections should continue to be carried out to look for developing cracks, as well as undercut areas on the slope. Furthermore, the leakage from the flume should be remediated, by either lining the channel beneath the flume, or the flume itself, so that water will no longer infiltrate the wall behind the crest.

The northeast wall has been excavated in relatively competent rock, and bench crests are still visible on the wall. However, raveling continues to occur on this wall, using up the remaining catchment. The main concern on this wall is rockfall. Therefore, if any work is to be carried out below the slope, by boat for example, a minimum distance of ten metres from the toe of the wall should be maintained.

The upper slopes of the northeast wall on the south side of the Vangorda Creek bed consist of till slopes that have been over-steepened from years of erosion and portions of the bench crests in the till have been lost completely. However, the slope is not very high, there is no access to the bottom of the slope, and there are no facilities located immediately behind the crest of the slope. Therefore the ongoing erosion is not considered to be a concern.

In general, the rock on the south side of the pit, i.e., in the southeast wall and the access road slopes, exhibits variable strength and degrees of alteration, such that there are competent zones juxtaposed with very weak zones. The weak zones exhibit on-going raveling. Aside from the raveling in weak rocks, the overall stability performance of these slopes is considered to be adequate. However, there are very few catch-benches on the southeast wall. The pit access road is located at on the southeast side of the pit. No berms have been placed on either side of the access road. Consequently, rock fall is the main concern along both sides of the access road, and the following remedial action items are recommended.

- A minimum approach distance of 10 metres should be observed when working near the area shown in Photograph E-22. This minimum distance should also be maintained when working beneath the other slopes as well. As the pit is flooded below the remaining walls, there is no access to these walls. The minimum approach distance is recommended in the event that any work is carried out from a boat, i.e. bathymetry surveys, water sampling, etc.
- Berms should be constructed of approximately 1.5 metres in height, with a catch ditch between the berm and the toe of the slope along both sides of the access road, as indicated in Photograph E-24. The berm should continue along the entire western margin of the access road, including the portion located beneath the southwest wall, as shown in Photograph E-26.
- There is no berm along the lower portion of the access road immediately above the pit lake. A vehicle descending down the ramp could enter the pit lake if the vehicle's brakes were to fail on the ramp or if slippery conditions were encountered on the ramp. A vehicle control berm should be placed along the margin of the pit lake as indicated in Photograph E-25, except for the portion of the access road that may be required for accessing the pit for pumping or for launching boats.

The upper portion of the southwest wall appears to have been excavated in till and the lower benches in rock. A fault, possibly the Cross Fault, is apparent at the south end of the wall.

The majority of the north and centre portions of the wall have raveled to angle of repose, with some locally over-steepened portions. At the south end of the southwest wall, some bench crests are still visible, but excessive ravelling has occurred in the highly oxidized zones. No cracks were observed at the crest or in the face of this wall. No bulging was apparent at the toe of the unsloped portions of the slope. With the exception of on-going raveling, the slope appears to exhibit adequate stability performance. However, routine visual inspection is recommended for this wall to detect any tension cracks developing at the crest or the face. It is likely that over-steepened portions will continue to ravel and erode, and any activity below the wall should be done only after a visual inspection and with the assistance of a spotter.

There are essentially no catch-benches along the southwest wall, and rock fall hazards along the access ramp are the principal issue for the southwest wall. As discussed in the previous section, the ditch at the toe of the slope should be cleaned out and a berm should be placed along the edge of the access road.

Emergency water discharge pipelines are located on the southwest wall as shown in Photograph E-28. Water is periodically discharged from the booster pump into the Vangorda Pit at this location. As is apparent in the photograph, this area has already experienced a large degree of raveling and erosion, likely from previously discharging water at this location. This portion of the wall and the wall to the north essentially has no catchment remaining, so no activities that could further erode or undermine the wall should be undertaken. Water should not be discharged at any point along the southwest wall, and the current emergency water discharge location should be relocated to the northwest corner of the pit where water is currently being discharged. The area of discharge in the northwest corner of the pit has a slope that is lower and less steep, and is, therefore, less of a stability concern.

Currently, site staff carry out daily driving visual inspections of the Vangorda pit slopes and crests, and photograph the walls monthly. These visual inspections are intended to detect the development of cracking or changes in the slopes and crests, and are considered to be adequate at this time. The remediation of the leakage from the flume on the northwest wall will improve the seepage conditions in the wall, and consequently improve the stability condition of the wall. The main concern in the pit is due to rockfall hazards. Based on these considerations, no monitoring pins or prisms are required in the Vangorda Pit at this time.

7.4 Recommendations and Action Items

The following table summarizes the recommendations and action items that have been provided in this report

Table 8: Summary of Recommendations and Action Items from 2012 Site Inspection

Pit	Recommendation	Frequency
All Pits	Migrate all site data to NAD 83 to avoid issues with overlaying data onto current site plans. Historic prism, reference bar, and monitoring pin coordinates and data should be converted to NAD 83, and future prism or monitoring point surveys should be recorded in NAD 83.	N/A
Faro	YES and TEES to review measurement procedure for reference bars to ensure all personnel are following the same procedure.	Once a year, or as needed if personnel change.
	Update sheet with coordinates of reference bars 15717, 15737, and 15742.	N/A
	Add a second "alignment" reference bar near the original reference bar, such that the two bars are along the correct bearing for the distance measurement, to improve accuracy and ensure the correct measurement procedure.	N/A
	Plot reference bar measurements right away to check for inconsistent readings. If measurement appears to be inconsistent, measure again to check, and check that measurement procedure is being followed correctly.	Every time measurements are taken.
	Plot the location of Prism 13875 and other prisms right away to check if actual movement is occurring.	Each time prisms are surveyed.
	Continue to survey prisms.	Once per year.
	Continue to measure distance from crest to reference bars.	Once in the spring and once in the fall.
	Continue visual inspections, particularly of the north and south instabilities in the east wall. Look for seepage, slumping, and cracks in the slope face or behind the crest.	Daily.
	Inspection by a geotechnical engineer should be carried out in 2013 to follow up on these recommendations. Frequency of inspections can then be decreased to once every two years, provided stability conditions do not change.	As indicated.
Grum	YES and TEES to review measurement procedure for monitoring pins to ensure all personnel are following the same procedure.	Once a year, or as needed if personnel change.
	Update monitoring pin spreadsheet and comments with correct names of monitoring pins and measurements. Clarify measurement of the first pin in each array and the crest (currently being input as 4.0 every time in the spreadsheet).	N/A
	Install extensometers or monitoring pins across new cracks. Record data in logbooks and plot on displacement graphs. Carry out visual inspection and review monitoring data before accessing area. Stay to the east of any cracks.	Monitor once per month and weekly during fall and spring seasons. Review monitoring data before entering the pit.
	Install monitoring prisms on east wall instability zone. See Grum Pit section in this report and Golder 2010 report for details. Failure debris should be inspected by a geotechnical engineer to ensure it is safe to access the slope before installation. Can be done in conjunction with 2013 site inspection.	Contractor to survey at the same time that Faro prisms are surveyed. If displacements are evident then frequency should be increased after review by a geotechnical engineer.
	Attempt to divert ponded water behind crest to the ditch. Alternatively, fill in depressions with fine-grained till to inhibit ponding and seepage.	N/A
	Continue visual inspections, particularly of the instability in the east wall. Look for seepage, slumping, and cracks in the slope face or behind the crest. Stay to the east of any cracks.	Daily and before entering the pit.
	Carry out office-based back-analysis of existing failure zone and backscarp to determine if slope will remain stable as water levels rise.	Spring of 2013.
	Inspection by a geotechnical engineer should be carried out in 2013 to follow up on these recommendations. Re-evaluate frequency after 2013 inspection.	As indicated.

Pit	Recommendation	Frequency
Vangorda	Fix leaks in flume of the Vangorda Creek Diversion Channel, particularly where flume is located behind the crest of the northwest wall, to reduce seepage.	Ongoing.
	Continue visual inspections, particularly of the northwest wall. Look for undercut portions of the slope that could slump, and cracks in the slope face or behind the crest.	Daily.
	Maintain a distance of 10 metres if working below the walls where a rockfall berm cannot be placed.	Ongoing.
	Construct rockfall berms on either side of the access road. Berms should be approximately 1.5 metres high, with a catch ditch between the berm and the toe of the slope. The berm should include the portion below the southeast wall shown in Photograph E-26. Clean the ditch below this portion of the wall.	N/A
	Construct a vehicle control berm at the bottom of the ramp, above the pit lake as indicated in Photograph E-25.	N/A
	Avoid discharging water from the southwest corner of the pit, as indicated in Photograph E-28.	N/A
	No prisms or monitoring pins are considered necessary at this time.	N/A
	Inspection by a geotechnical engineer should be carried out in 2013 to follow up on these recommendations. Frequency of inspections can then be decreased to once every 2-3 years, provided stability conditions and hazards do not change.	As indicated.

8.0 CLOSURE

We trust this report satisfies your current requirements. If you have any questions or require further assistance, please do not hesitate to contact us.

GOLDER ASSOCIATES LTD.

Jennifer J. Ramesch, M.Sc.
Geotechcnial Specialist, Mining Division

A. V. Chance, P.Eng.
Principal, Mining Division

February 7/2013

JJR/AVC/md/np

o:\final\2012\1426\12-1426-0031\1214260031-001-r-rev0-6000\1214260031-001-r-rev0-6000 faro mine complex annual pit slope stability inspection 2012 07feb_13 docx

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Golder Associates Ltd. 2002. *Faro Creek Diversion Channel Short-term Stability Review, Faro YT.* December 16, 2002.

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GRUM PIT REFERENCES (GOLDER 2010)

1) Golder Associates Ltd. – Proposal for "Geotechnical Slope Stability Assessment of the East Wall of the Grum Pit, Faro Mine, Yukon". July 15, 2009.

2) Robertson GeoConsultants Inc. – Report "Integrated Comprehensive Abandonment Plan (ICAP)". November, 1996.

3) Gartner Lee Ltd. – Report "Anvil Range Mine Complex - 2002 Baseline Environmental Information". May, 2002.

4) Anvil Range Mining Corporation – Drawing "Current Status Map – Grum Wall Failure Area – Sept 11, 97", paper copy provided by Piteau Associates.

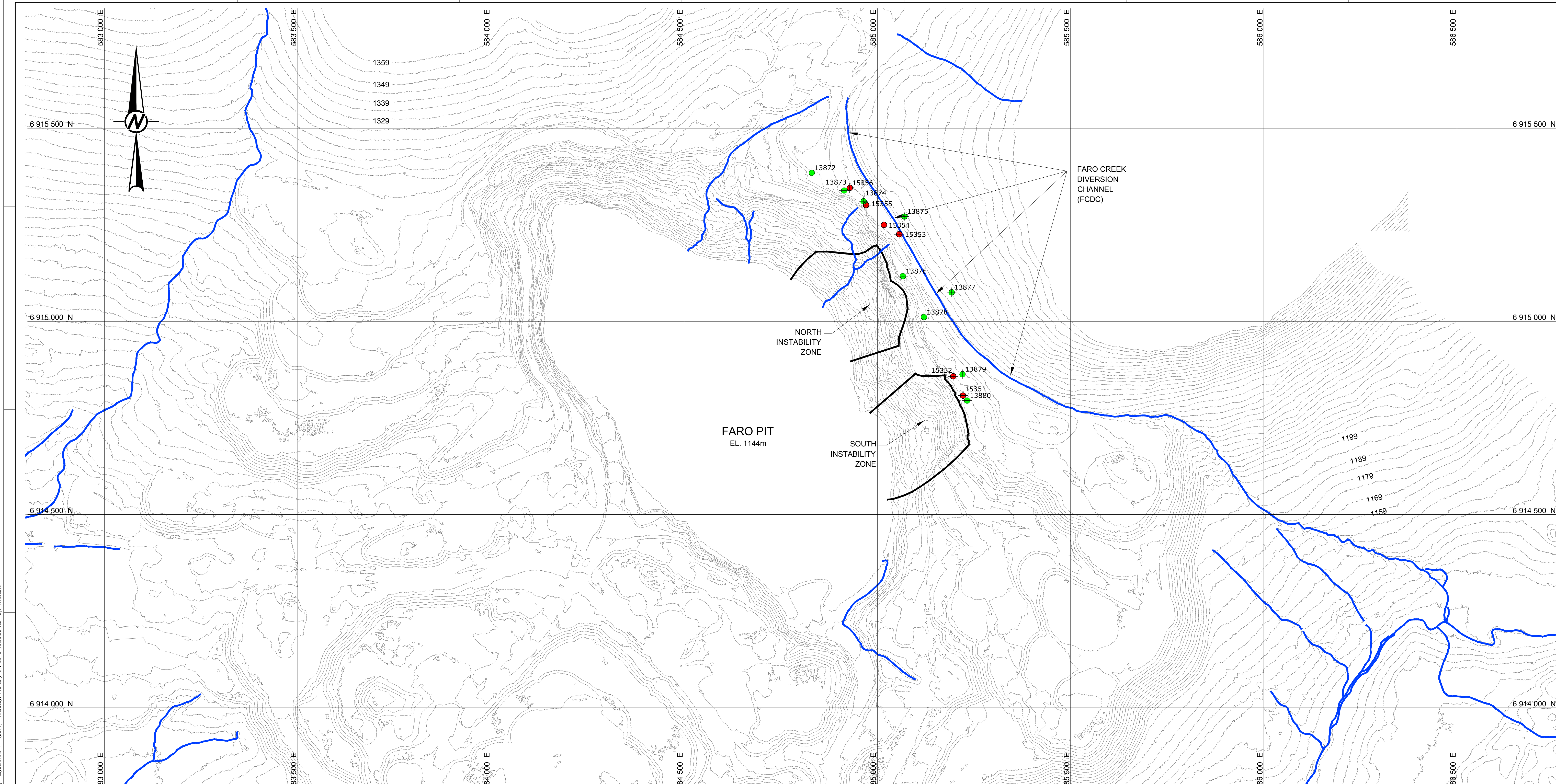
5) SRK Consulting Ltd. – Electronic mail communication dated August 8, 2009.

6) Brodie Consulting Ltd. - Memorandum "Grum Pit – NE Pit Wall Stability, Faro Pit East Wall Stability". March, 2009.

7) Anvil Range Mining Corporation – Drawing of the Grum Deposit Topography and Overburden/Bedrock Contour Plan. Paper copy provided by Piteau Associates. December, 1990.

8) Piteau Associates - Report "Grum Pit. Review and Analysis of Hydrogeological Data and Design of Phase 1 Dewatering System". January, 1991.

9) Piteau Associates - Technical Memorandum "Current Groundwater Conditions in the Southeast Walls of the Grum Pit". June, 1995.



LEGEND

15351	MONITORING PRISM
13877	REFERENCE BAR
	CREEK

NOTES
1. CONTOUR INTERVAL: 5m

REFERENCES
1. CONTOUR DATA PROVIDED BY GOVERNMENT OF YUKON ON SEPTEMBER 21, 2012.
2. COORDINATE SYSTEM IS UTM NAD27.

0 200 400 600 m
SCALE IN METRES

REV	DATE	DESCRIPTION	DRW	DES	CHK	RVW
0	06FEB2013	ISSUED WITH DOC. 001	TK	MP	JJR	AVC

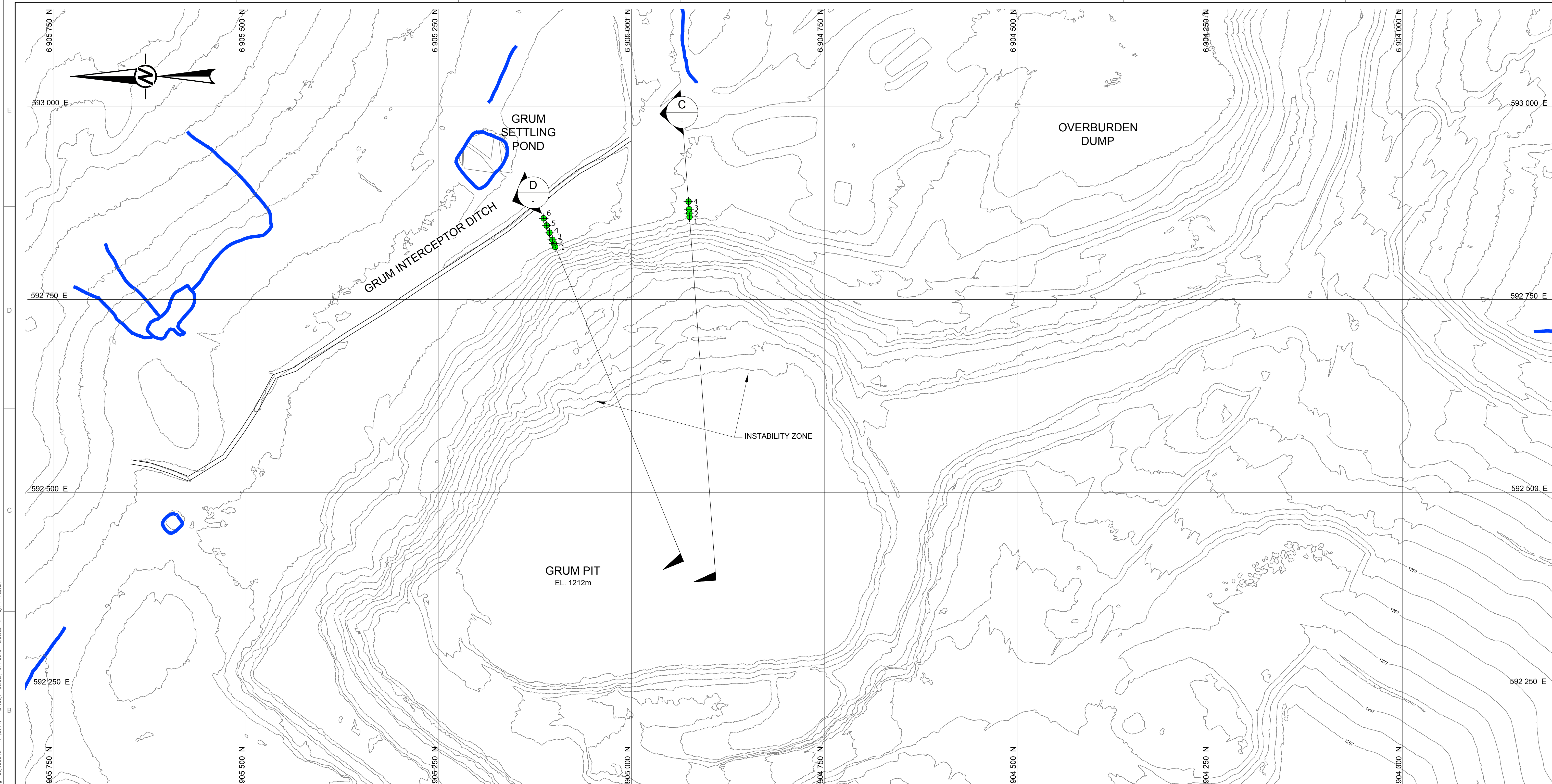
CLIENT
GOVERNMENT OF YUKON
FARO, YT

CONSULTANT
Golder Associates

PROJECT 12-1426-0031\5000
FARO MINE COMPLEX STABILITY INSPECTION

TITLE
FARO PIT 2012 STATUS AND MONITORING POINT LOCATIONS

DRAWING No. FIGURE 1
SHEET No. 1 OF 6



LEGEND

- MONITORING PIN
- CREEK/POND
- CROSS-SECTIONS FROM GOLDER 2010 GRUM PIT REPORT

NOTES

1. CONTOUR INTERVAL: 5m

REFERENCES

1. CONTOUR DATA PROVIDED BY GOVERNMENT OF YUKON ON SEPTEMBER 21, 2012.
2. COORDINATE SYSTEM IS UTM NAD27.

0 100 200 300 m

SCALE IN METRES

REV	DATE	DESCRIPTION	DRW	DES	CHK	RVW
0	06FEB2013	ISSUED WITH DOC. 001	TK	MP	JJR	AVC

CLIENT

GOVERNMENT OF YUKON
FARO, YT

CONSULTANT

Golder Associates

PROJECT 12-1426-0031\5000

FARO MINE COMPLEX STABILITY INSPECTION

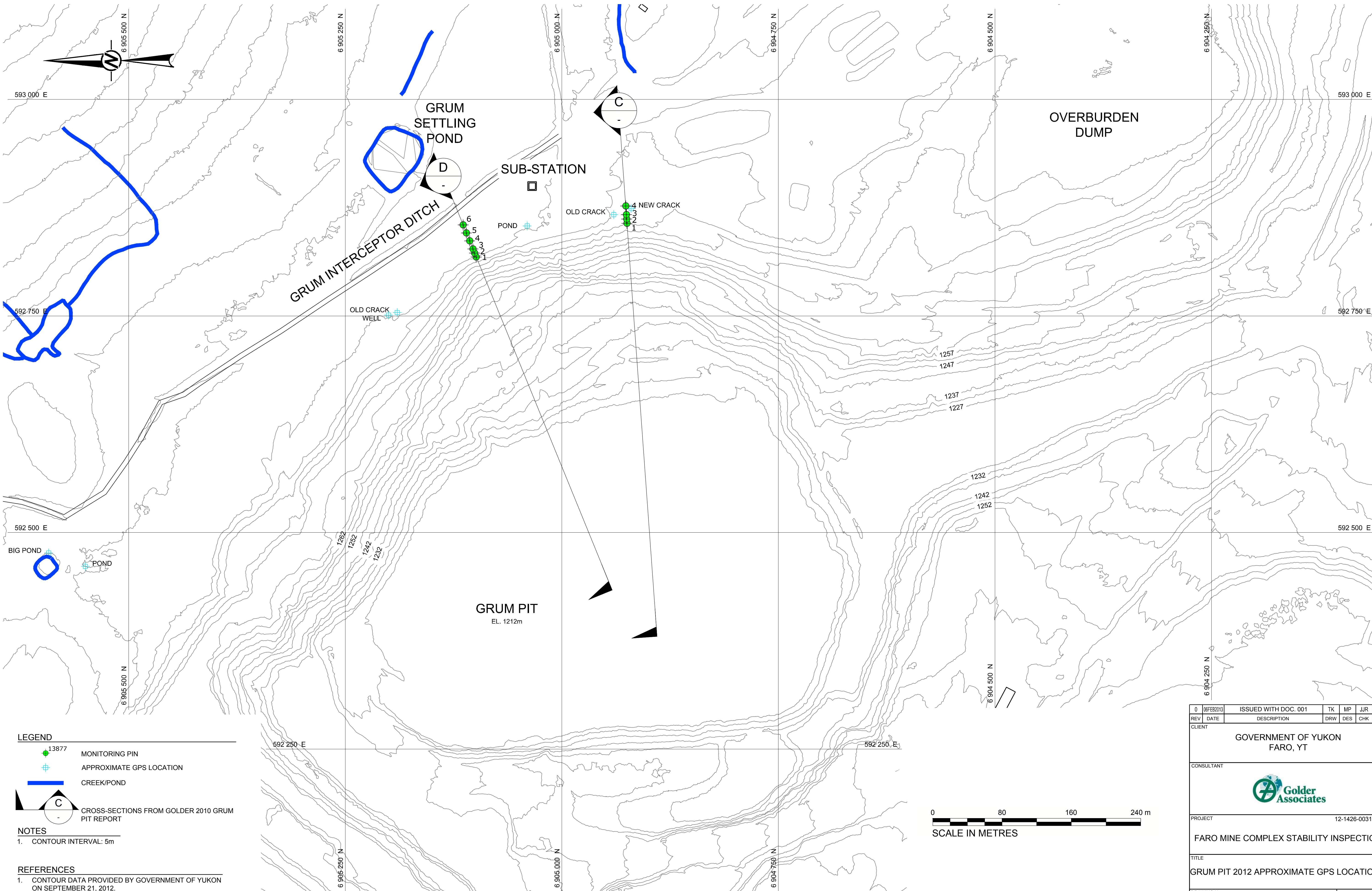
TITLE

GRUM PIT 2012 STATUS AND MONITORING POINT LOCATIONS

DRAWING No. FIGURE 2

SHEET No. 2 OF 6

SHEET SIZE ANSI D



LEGEND

13877 MONITORING PIN

APPROXIMATE GPS LOCATION

CREEK/POND

C CROSS-SECTIONS FROM GOLDER 2010 GRUM PIT REPORT

NOTES

1. CONTOUR INTERVAL: 5m

REFERENCES

1. CONTOUR DATA PROVIDED BY GOVERNMENT OF YUKON ON SEPTEMBER 21, 2012.
2. COORDINATE SYSTEM IS UTM NAD27.

REV	DATE	DESCRIPTION	DRW	DES	CHK	RVW
0	06FEB2013	ISSUED WITH DOC. 001	TK	MP	JJR	AVC

CLIENT

GOVERNMENT OF YUKON
FARO, YT

CONSULTANT

Golder Associates

PROJECT 12-1426-0031\5000

FARO MINE COMPLEX STABILITY INSPECTION

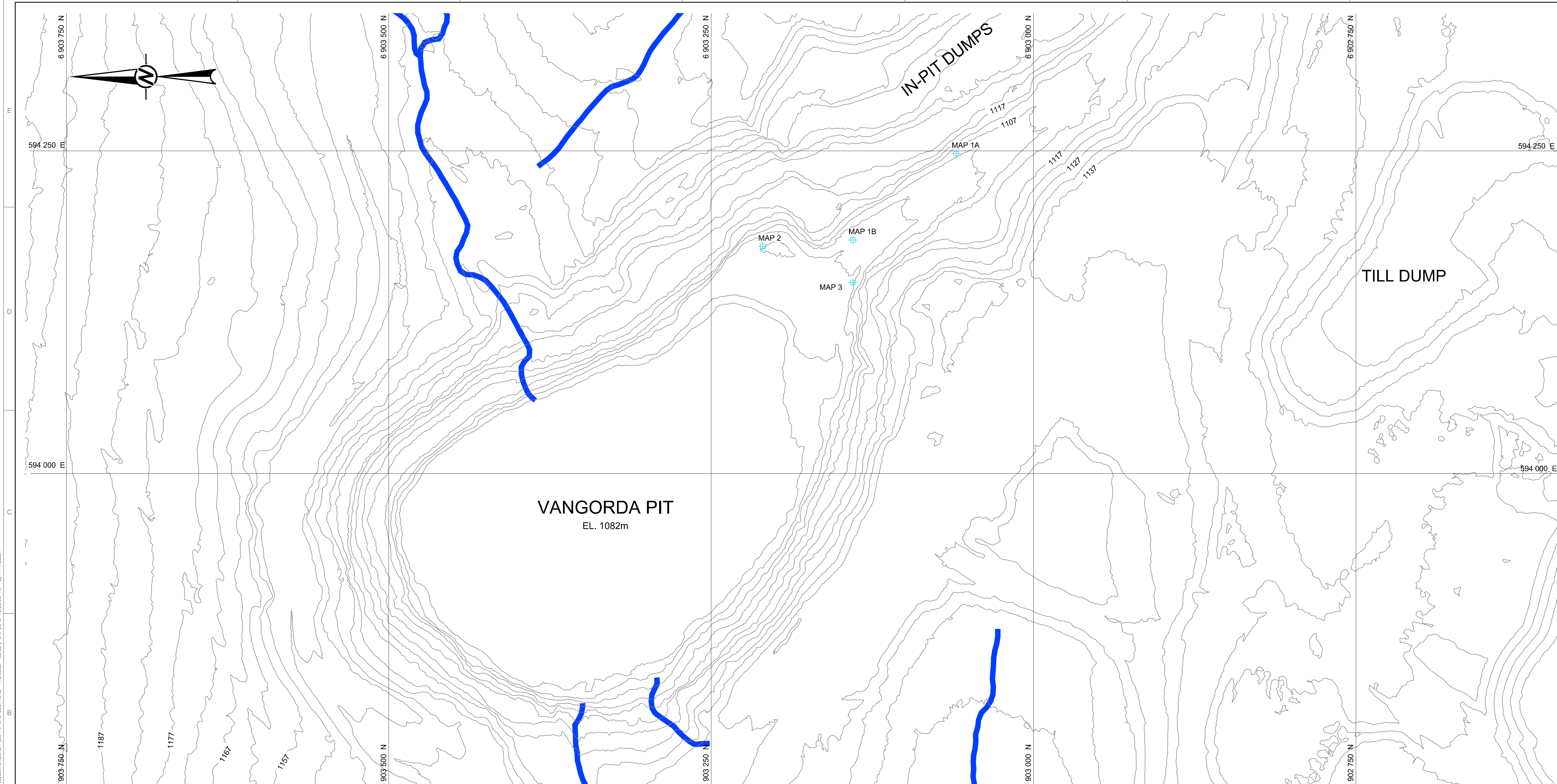
TITLE

GRUM PIT 2012 APPROXIMATE GPS LOCATIONS

DRAWING No. FIGURE 3

SHEET No. 3 OF 6

SHEET SIZE ANSI D



LEGEND

- APPROXIMATE GPS LOCATION
- CREEK

NOTES

1. CONTOUR INTERVAL: 5m

REFERENCE

1. CONTOUR DATA PROVIDED BY GOVERNMENT OF YUKON ON SEPTEMBER 21, 2012.
2. COORDINATE SYSTEM IS UTM NAD27.

0 60 120 180 m
SCALE IN METRES

REV	DATE	DESCRIPTION	DRW	DES	CHK	RVW
0	06FEB2013	ISSUED WITH DOC. 001	TK	MP	JJR	AVC

CLIENT
GOVERNMENT OF YUKON
FARO, YT

CONSULTANT
Golder Associates

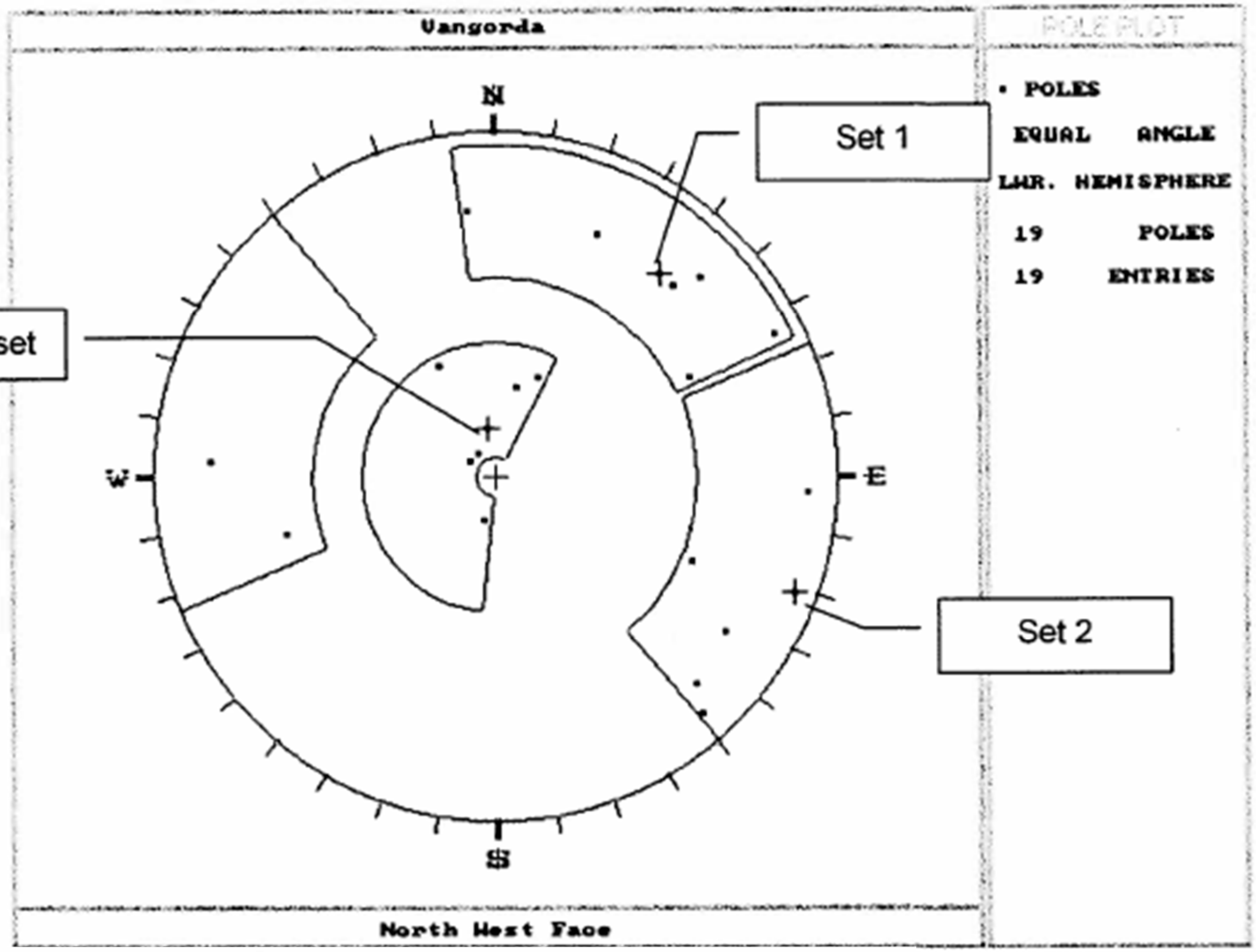
PROJECT 12-1426-0031\5000
FARO MINE COMPLEX STABILITY INSPECTION

TITLE
VANGORDA PIT 2012 STATUS AND APPROXIMATE GPS LOCATIONS

DRAWING No. FIGURE 4
SHEET No. 4 OF 6

SHEET SIZE ANSI D 25 mm 0

Drawing File: N:\Bur-Graphics\Projects\2012\1426\12-1426-0031\5000\Figures\12-1426-0031_06.dwg Layout:VONGORDA (2011) GPS LOCATIONS Thursday, February 07, 2013 10:33:05 AM By: TYKlassen



SRK Consulting
Engineers and Scientists

PROJECT NO.	DATE	REVISION
1CD003.15	April 2003	B

FIGURE 3
Vangorda pit lower hemisphere plot of poles to joint sets (each point represents the average orientation of a group of joints)

REFERENCE: SRK Consulting. 2003. *Engineering Analysis of Vangorda Pit Wall Stability.* Prepared for Deloitte & Touche Inc., April 2003.

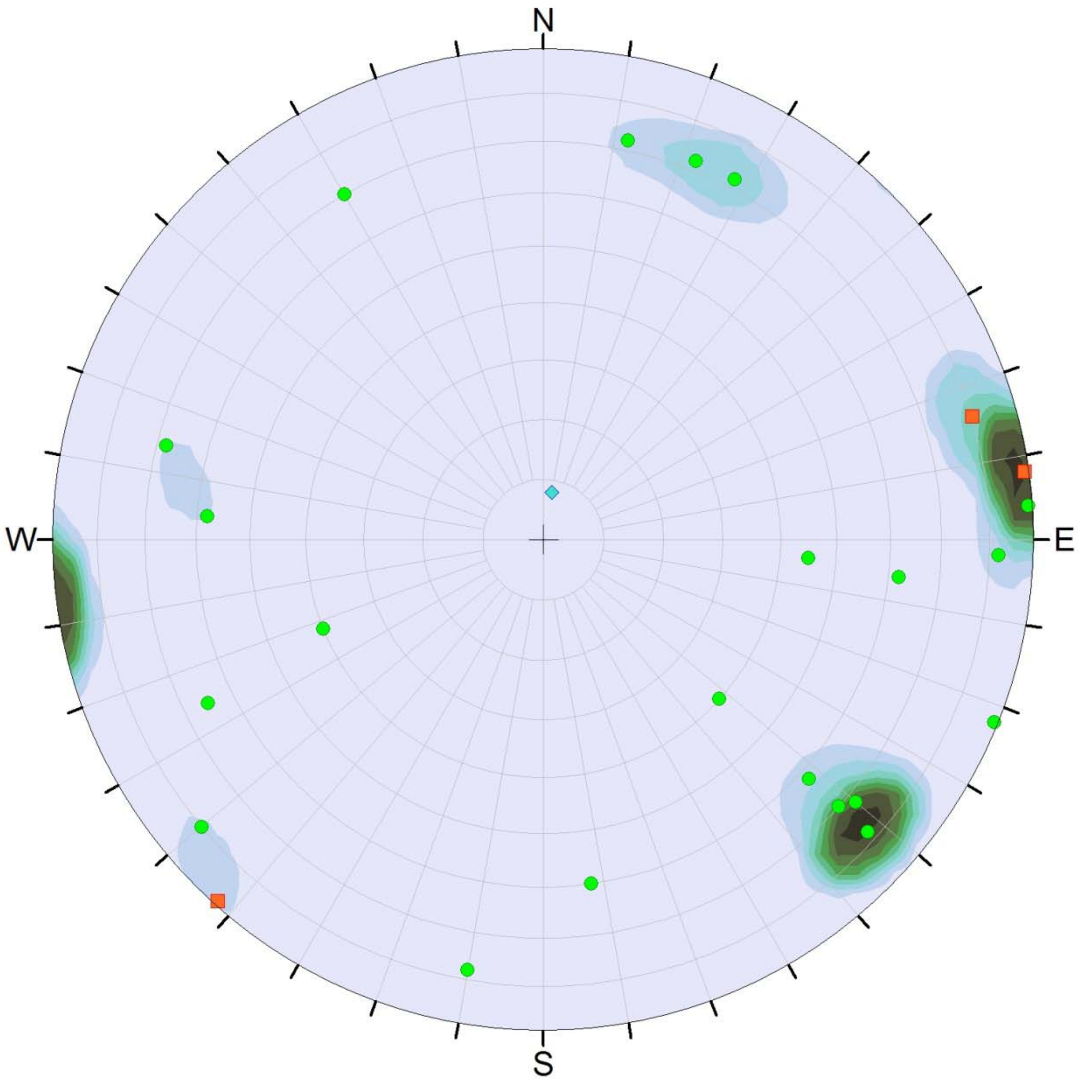
PROJECT
GOVERNMENT OF YUKON
FARO MINE COMPLEX STABILITY INSPECTION
FARO, YT

TITLE
VANGORDA PIT
STRUCTURAL MAPPING DATA

Golder Associates

PROJECT No. 12-1426-0031			PHASE No. 6000
DESIGN	JJR	11JAN13	SCALE NTS REV. 0
CADD	DRH	11JAN13	FIGURE 5
CHECK	JJR	6FEB13	
REVIEW	AVC	6FEB13	

FILE: O:\Active_2012\1426\12-1426-0031 Faro Mine - Yukon\07 Deliverables\Figures and Appendices\Rev. 0\Figures\Figures 5-6_Vangorda Structural Mapping Data_Rev 0.pptm January 29, 2013



PERSISTENCE

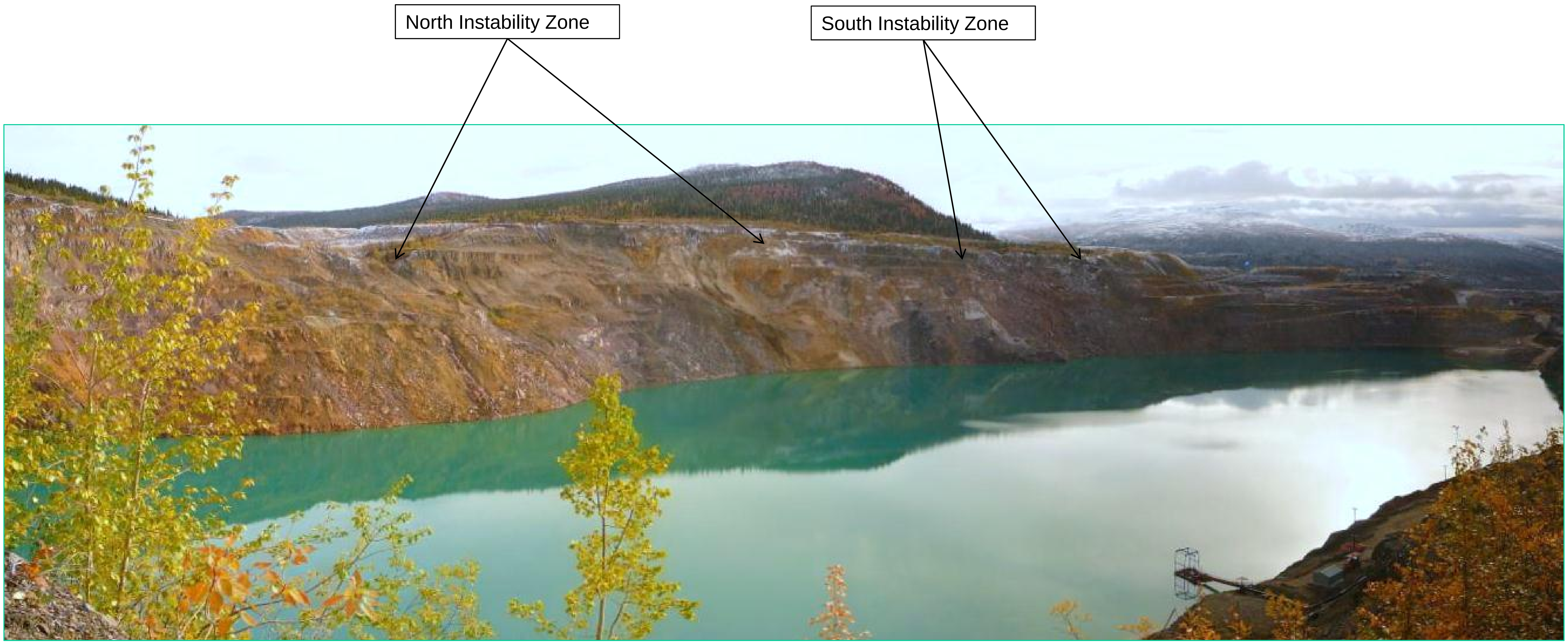
- 1-3 m [28]
- > 3 m [11]
- Foliation [1]

Equal Area
Lower Hemisphere
40 Poles
25 Entries

PROJECT	GOVERNMENT OF YUKON FARO MINE COMPLEX STABILITY INSPECTION FARO, YT				
TITLE	VANGORDA PIT 2012 STRUCTURAL MAPPING DATA				
Golder Associates	PROJECT No. 12-1426-0031			PHASE No. 6000	
	DESIGN	JJR	11JAN13	SCALE NTS	REV. 0
	CADD	DRH	11JAN13	FIGURE 6	
	CHECK	JJR	6FEB13		
	REVIEW	AVC	6FEB13		

APPENDIX A

Photographs - Faro Pit



Photograph A-1
Faro Pit east wall. View looking east-southeast.

Photograph A-2
Faro Pit east wall. View looking north-northeast.

Photograph A-3
Faro Pit – North Instability Zone. Old crack to the north of the instability zone.

Photograph A-4
Faro Pit – North Instability Zone. View looking southwest behind backscarp.

Photograph A-5

Faro Pit – South Instability Zone. View looking northwest behind backscarp.

Golder Associates

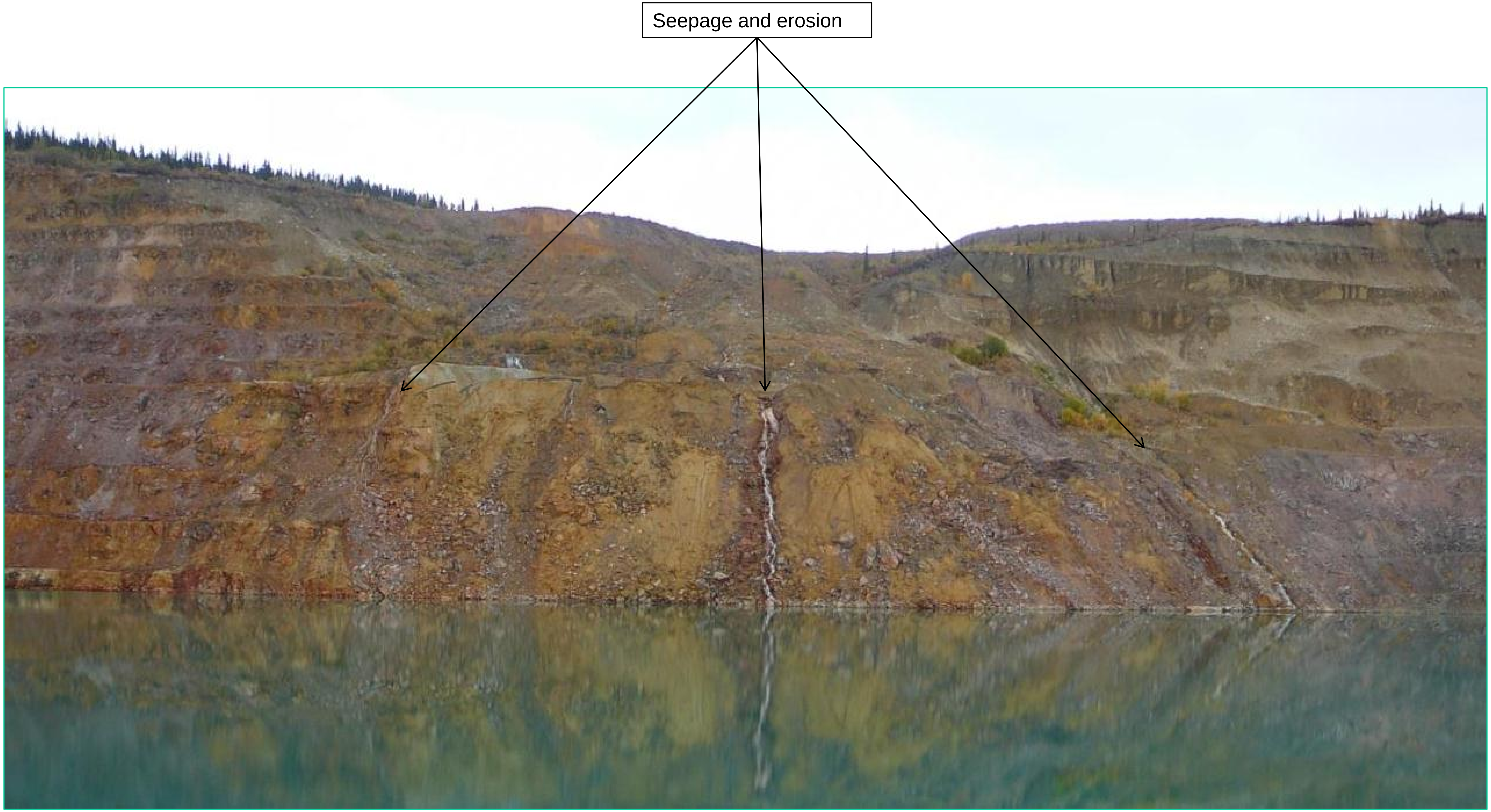
Photograph A-6
Faro Pit – North Instability Zone.
Area of ponded water behind crest of east wall.

Photograph A-7
Faro Pit – North Instability Zone.
Pond of water to the north of the North Instability Zone. This water drains into a creek, which drains into the pit to the north of the North Instability Zone.

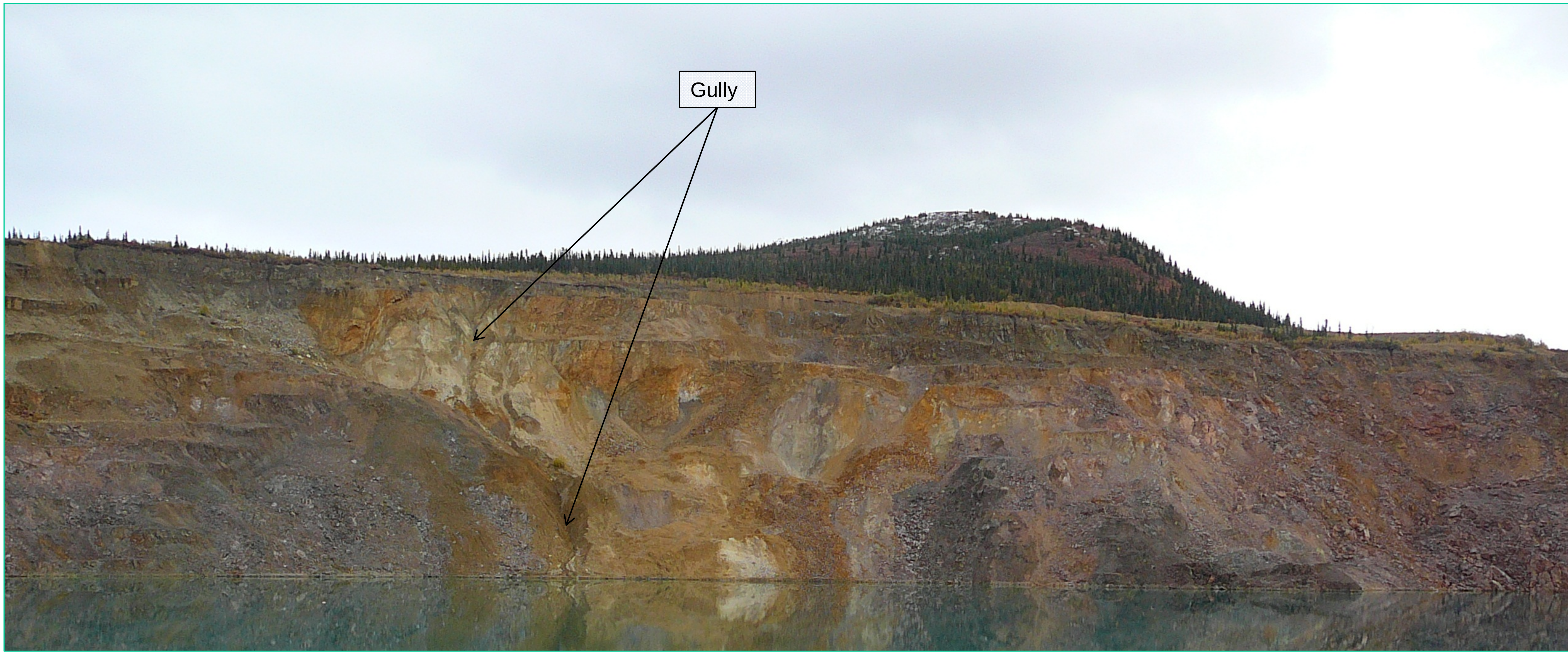
Photograph A-8
Faro Creek Diversion Channel. View looking northwest.

Photograph A-9
Faro Creek Diversion Channel. View looking southeast.

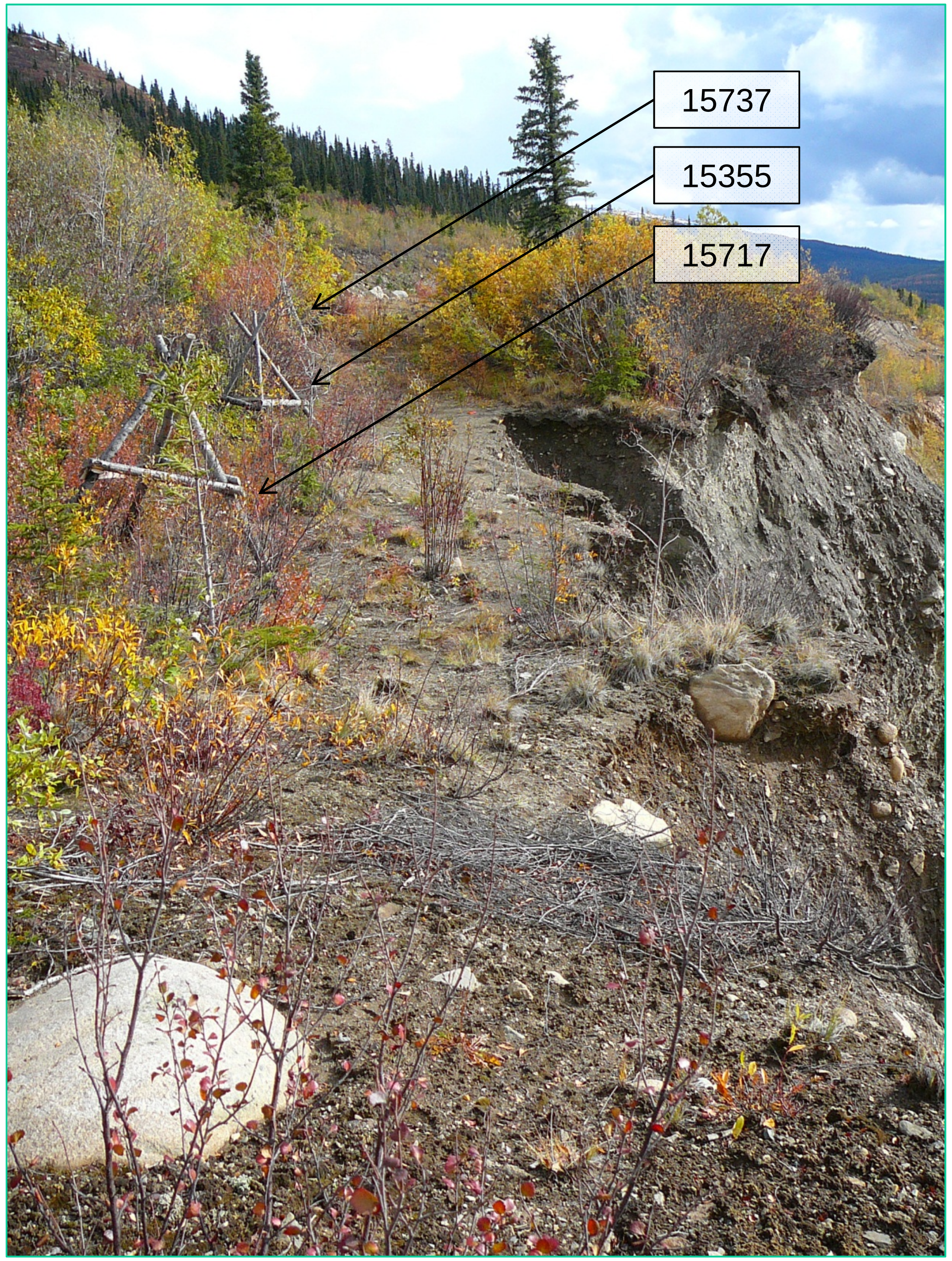
Golder Associates



Photograph A-10
Faro Pit east wall, north of North Instability Zone. View looking east.

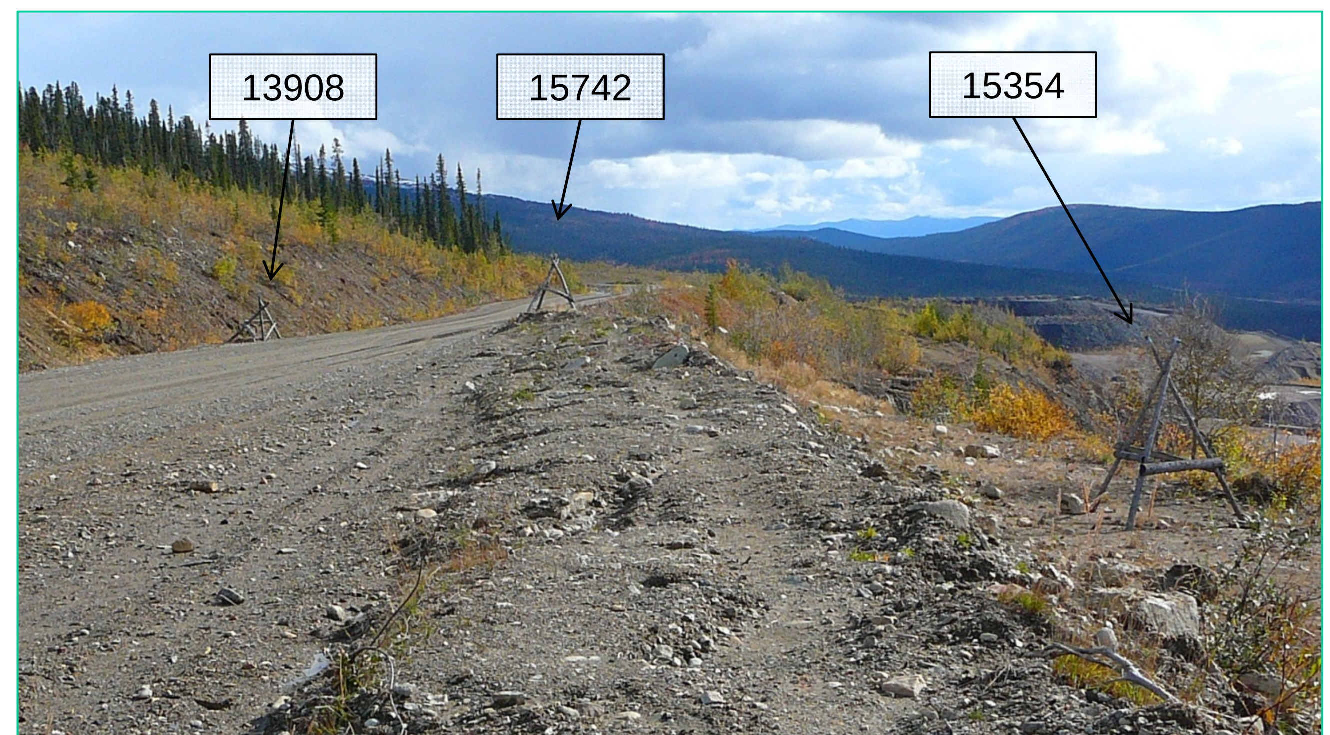


Photograph A-11
Faro Pit east wall, North Instability Zone. View looking east.



Photograph A-12
Faro Pit Reference Bars 15737, 15717, and 15355

Photograph A-13
Faro Pit Prism 13874



Photograph A-14
Faro Pit Reference Bars 15354 and 15742, and Control Point 13908

Golder Associates

O:\Active_2012\1426\12-1426-0031 Faro Mine - Yukon\07 Deliverables\Figures and Appendices

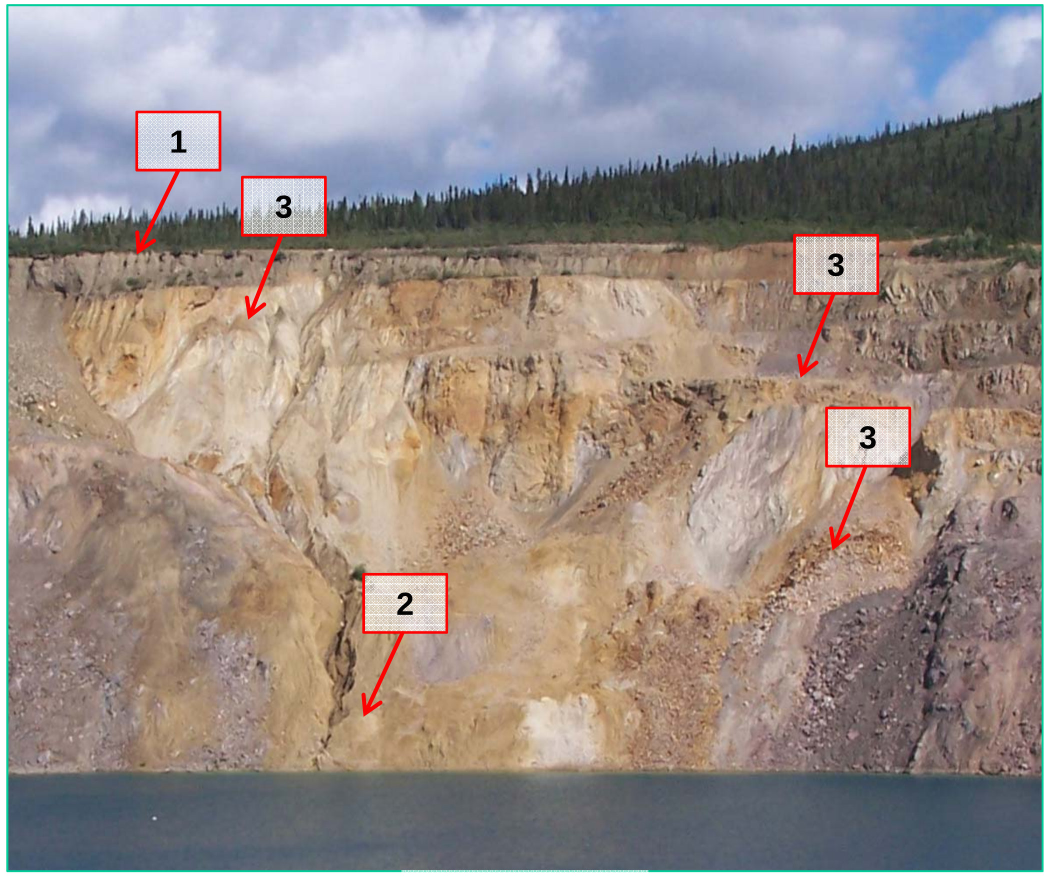
Photograph A-15
Faro Pit – North wall.

Photograph A-16
Faro Pit – West wall.

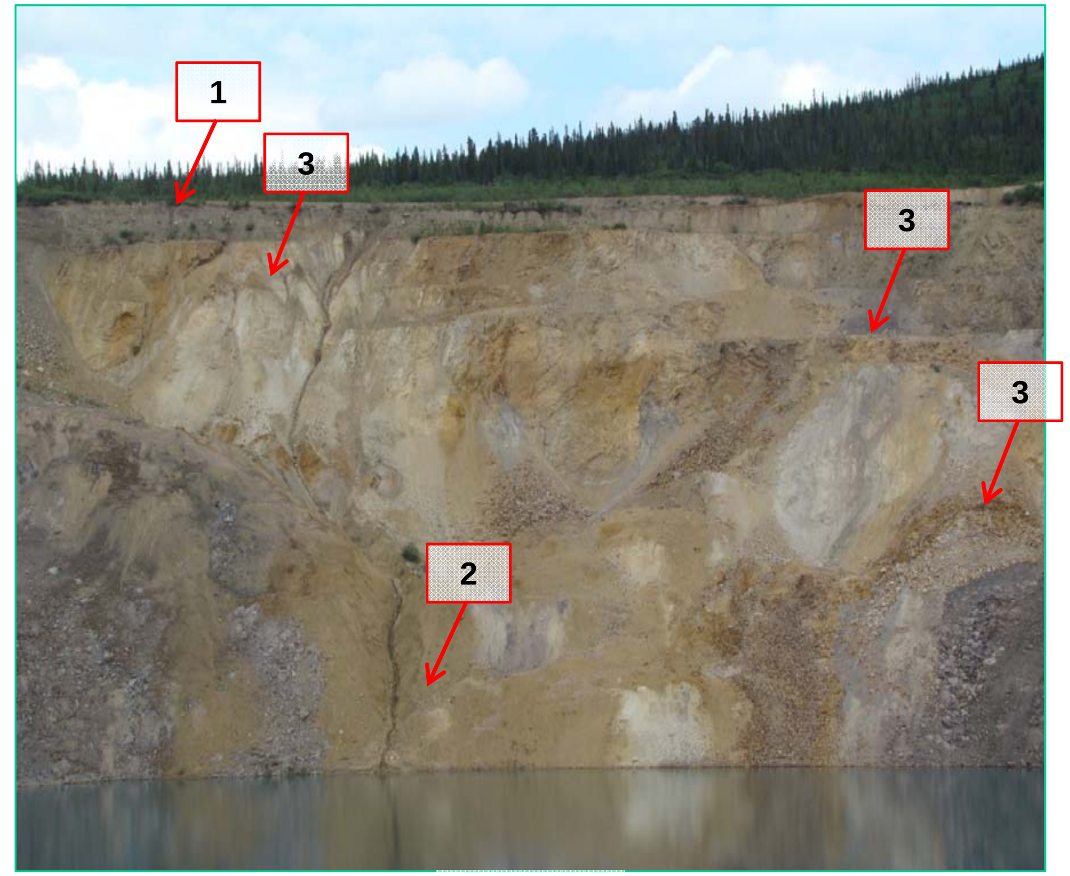
Photograph A-17
Faro Pit – South wall.

APPENDIX B

Photograph Comparison



August 2006



July 2008

Figure B-1: Faro Pit East Wall – North Instability Photo Comparison

1. The crest and backscarp do not exhibit signs of significant erosion or regression.

2. Erosion gully does not appear to have changed significantly. Appears to have widened slightly overall between 2010 and 2012.

3. Failure debris does not appear to exhibit significant displacements from year to year.

July 2010

September 2012

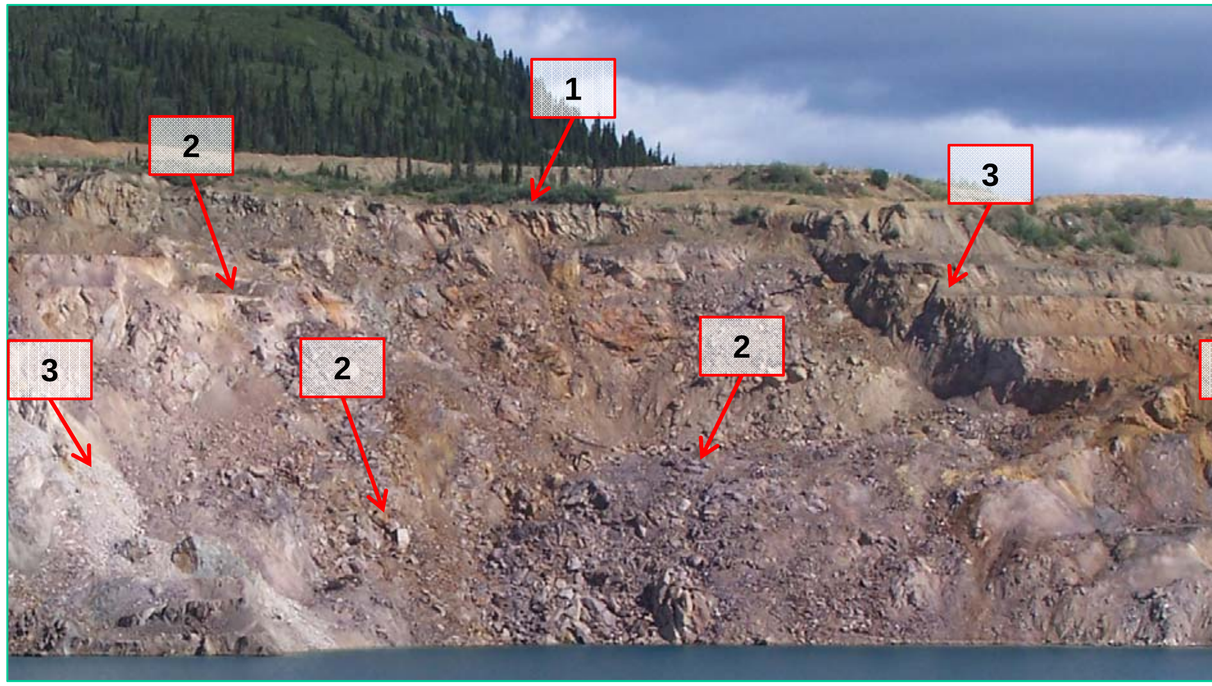
Golder Associates

Figure B-2: Faro Pit East Wall – South Instability Photo Comparison

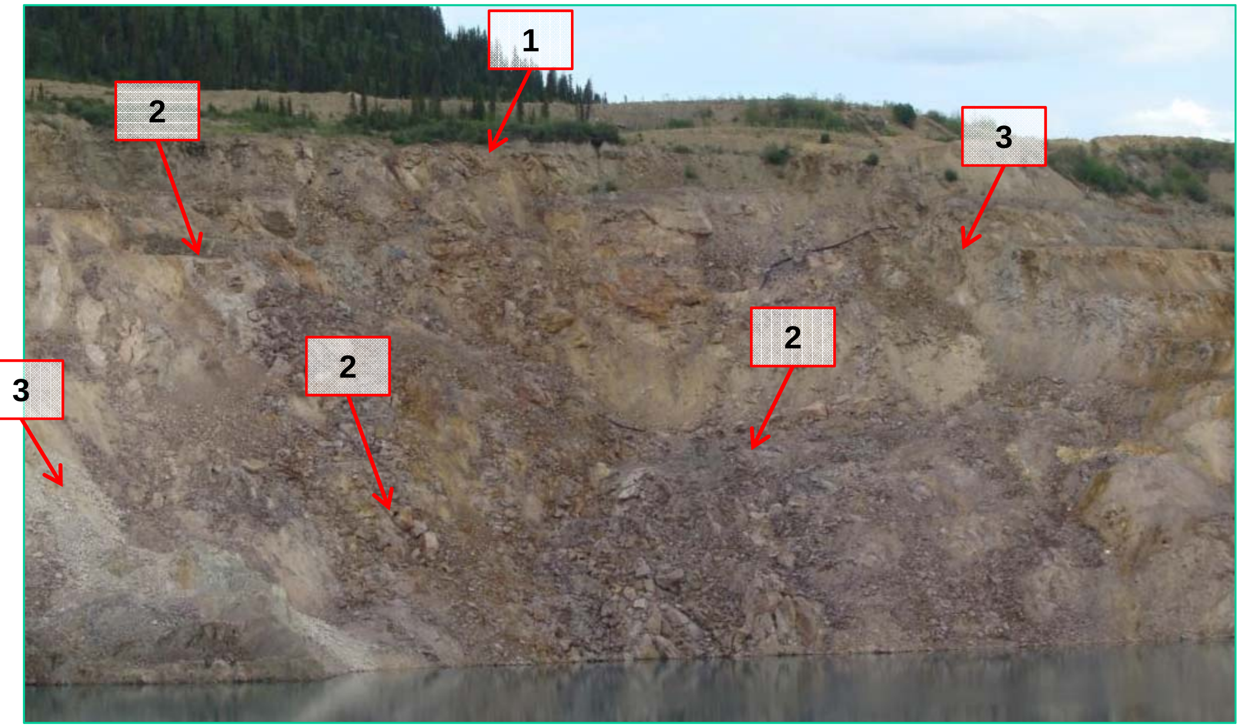
1. The crest and backscarp do not exhibit signs of significant erosion or regression.

2. Failure debris does not appear to exhibit significant displacements from year to year.

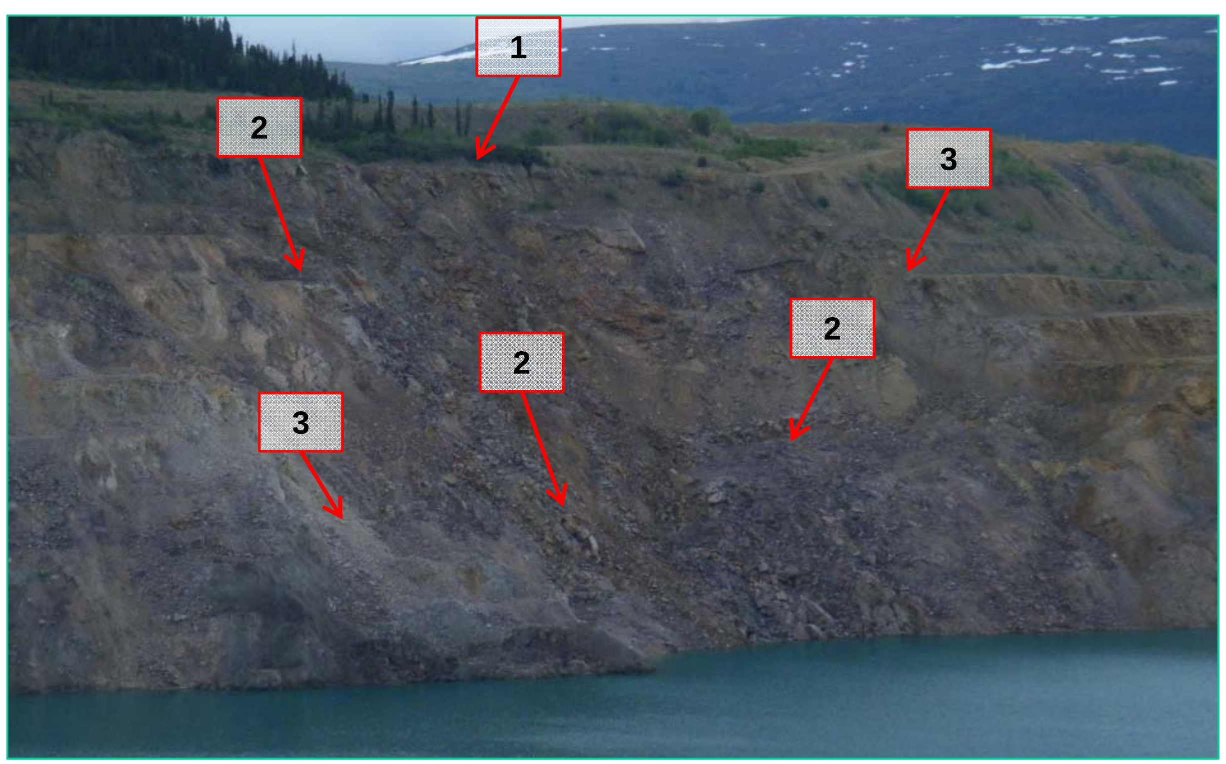
3. The boundaries do not appear to have changed significantly.



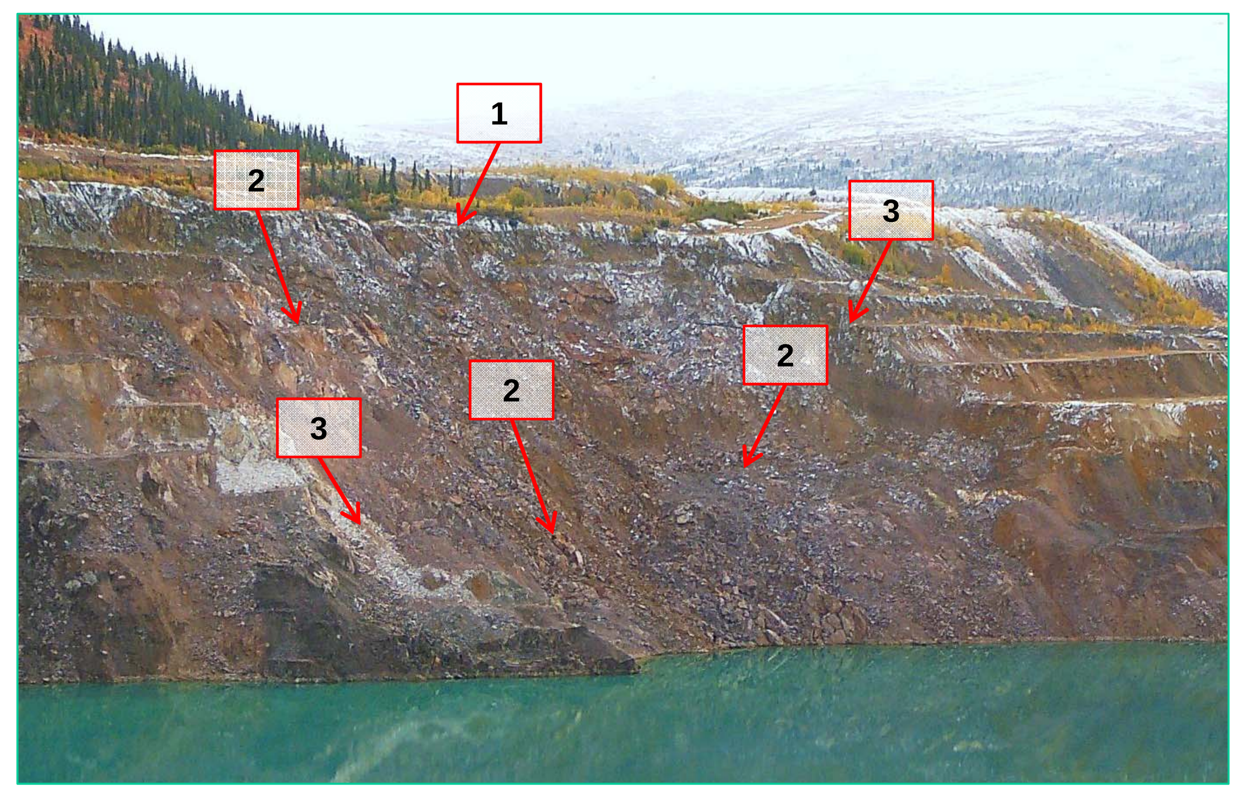
August 2006



July 2008

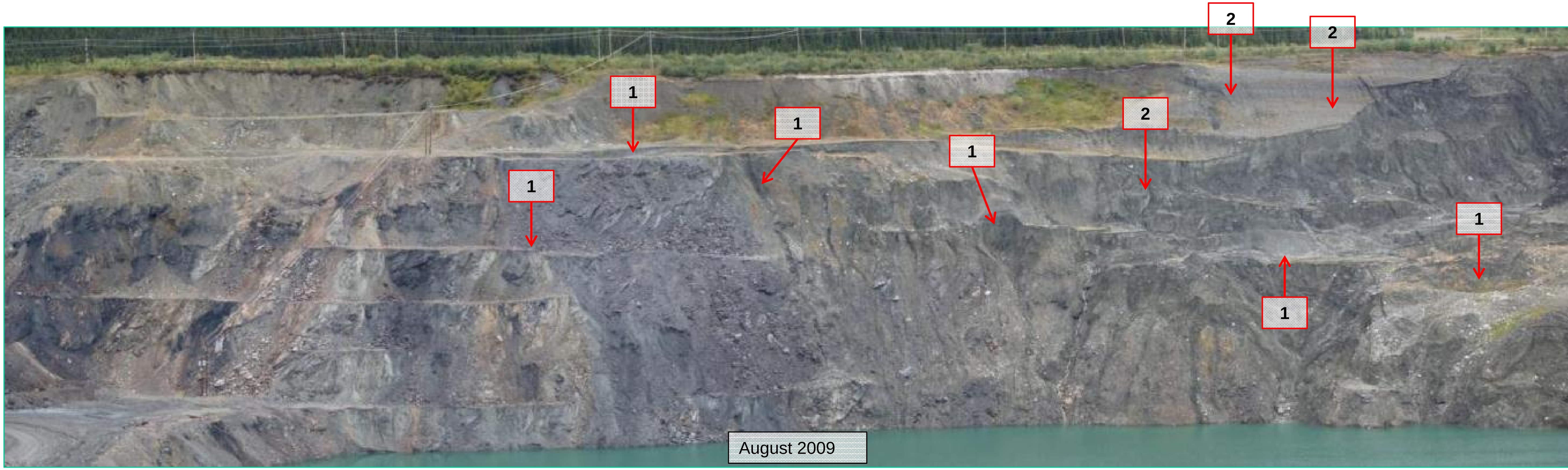


July 2010



September 2012

Golder Associates



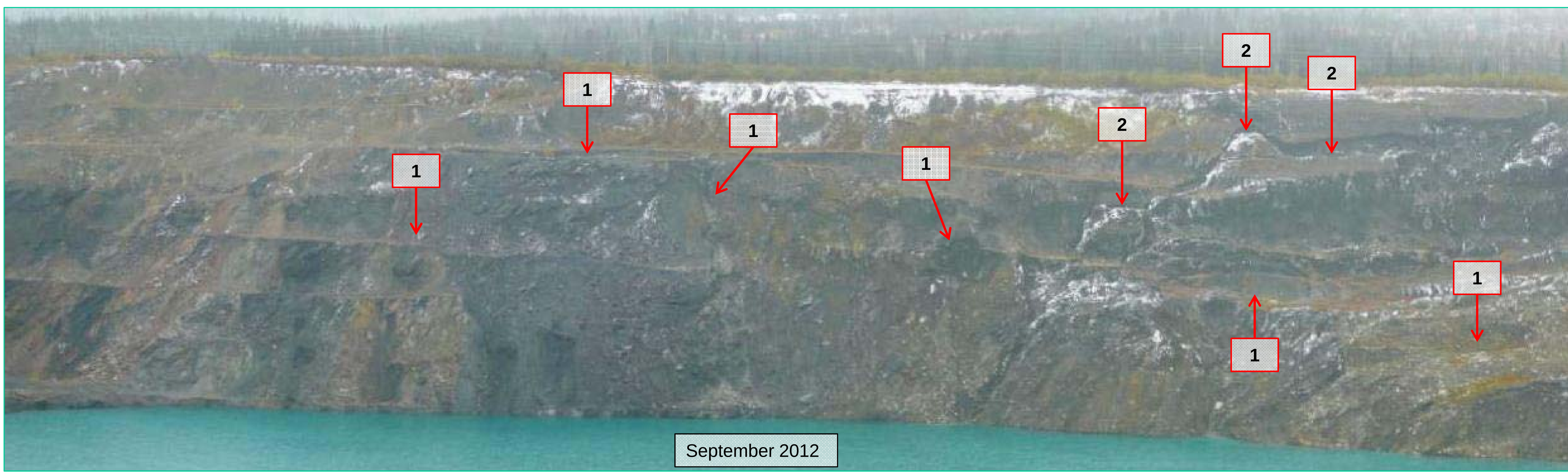
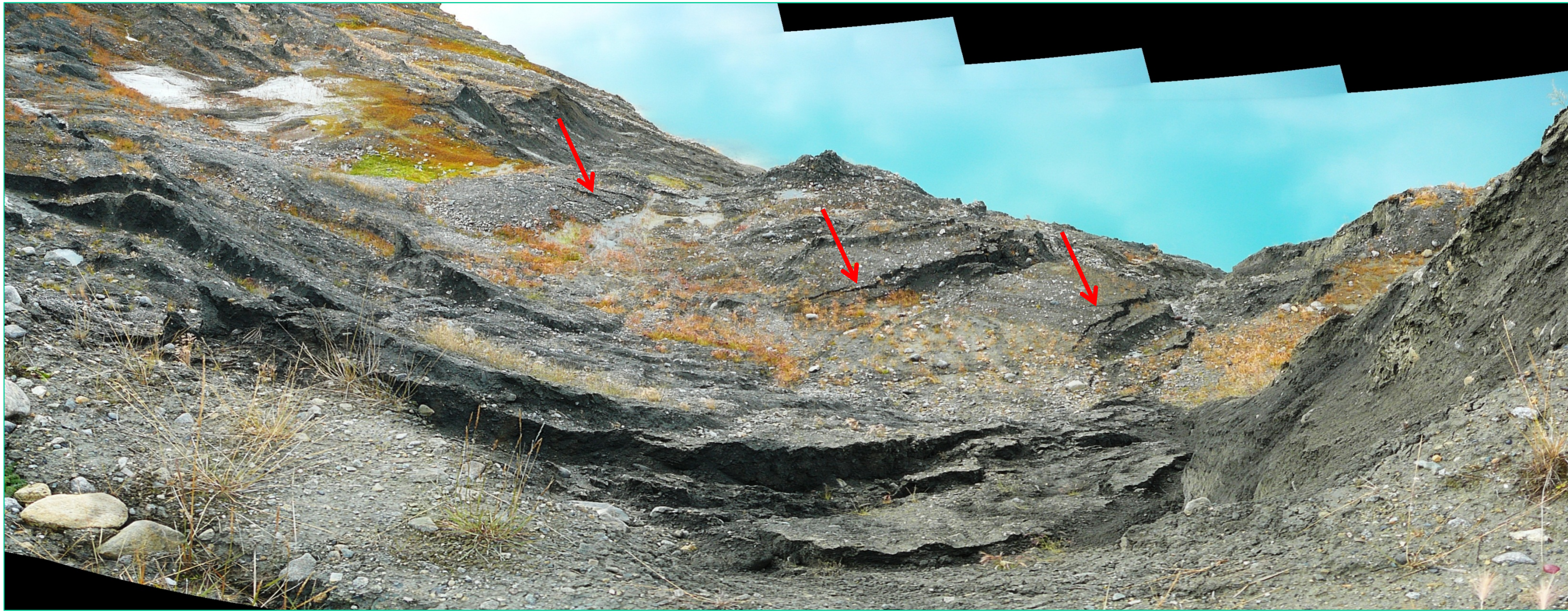


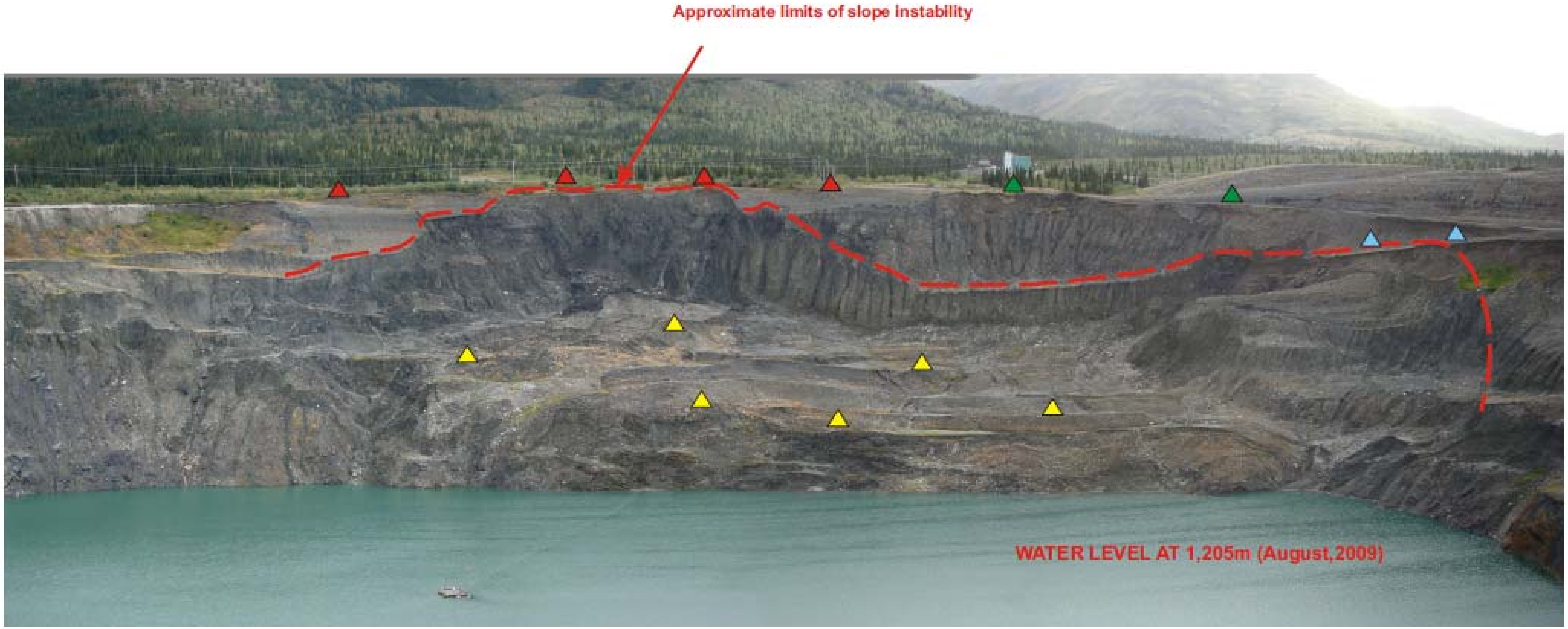
Figure B-3: Grum Pit East Wall –Photo Comparison
1. Areas where no significant change is apparent.
2. Recent movement on north side backscarp.



September 2012

Figure B-4: Grum Pit East Wall – Instability Zone
Photograph looking down slope toward pit lake.
Fresh cracks in failure debris below backscarp indicated by red arrows.

Golder Associates



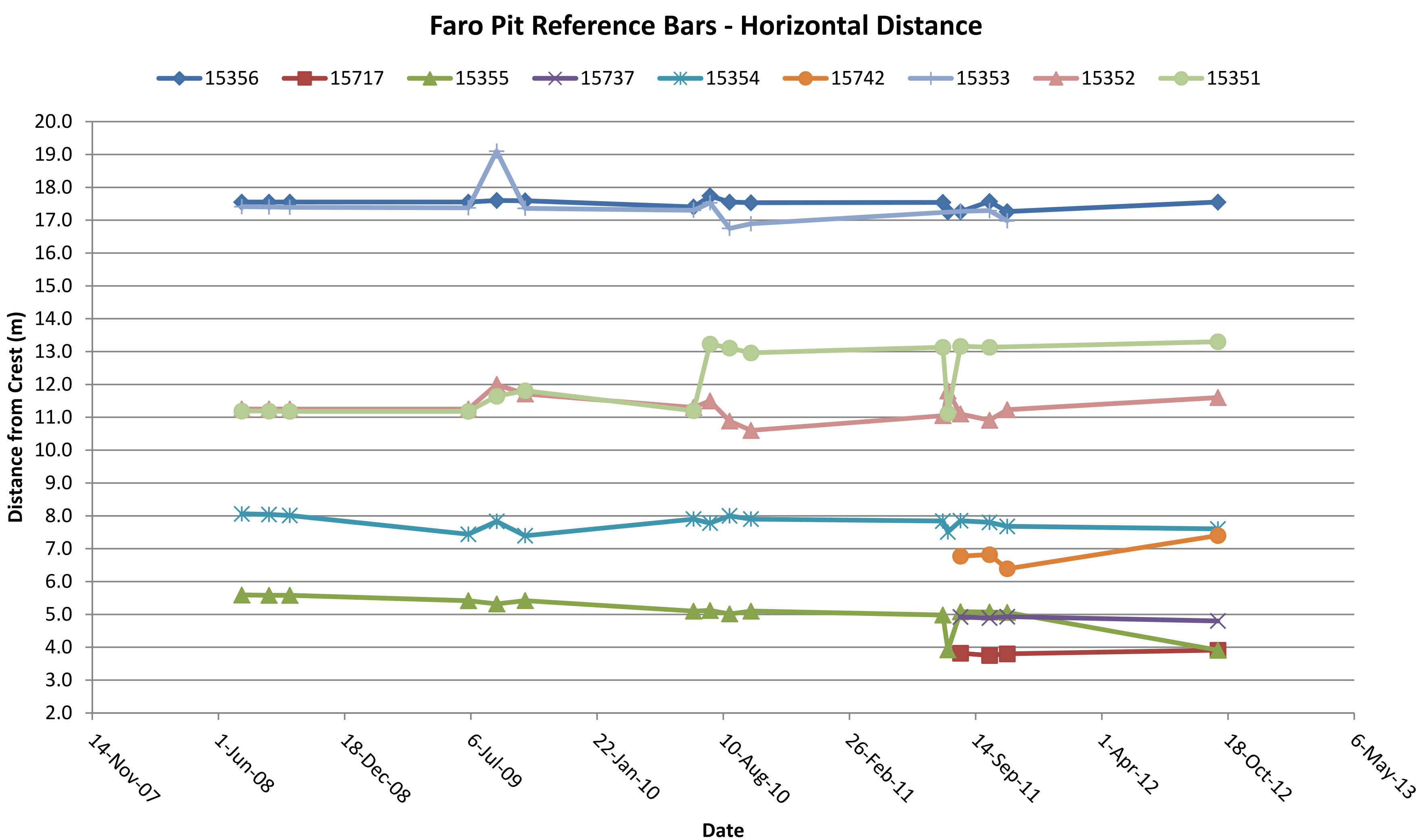
LEGEND

- Red triangle: Prisms behind the crest of the East wall
- Green triangle: Prisms along the access road behind the crest of the wall
- Yellow triangle: Prisms within the Failure Zone
- Blue triangle: Prisms on the ramp behind the crest of the slope

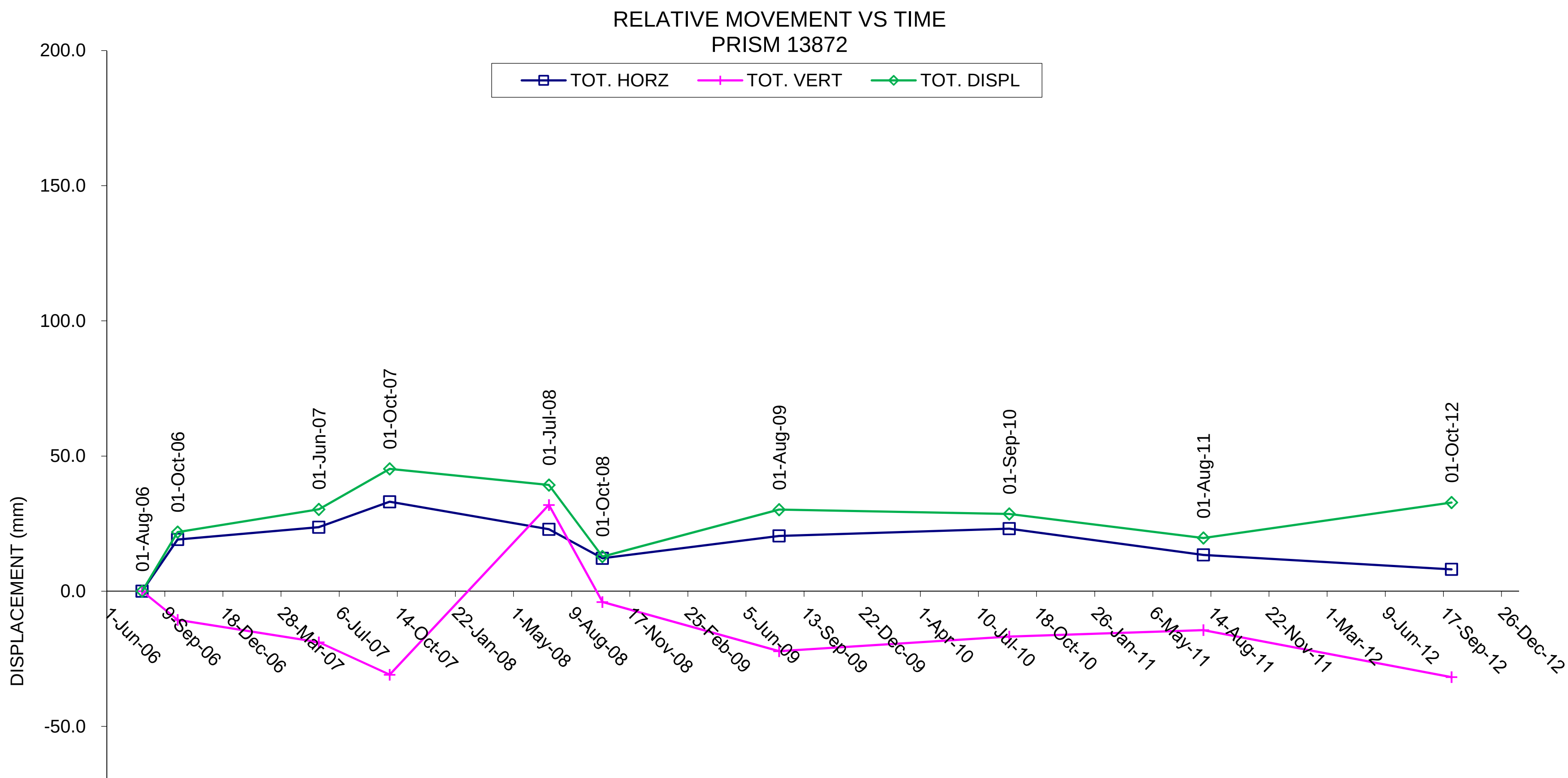
Figure B-5: Grum Pit East Wall – Recommended Prism Locations
Reproduced from Golder Associates Ltd. 2010. *Phase 1A Geotechnical Slope Stability Assessment of the East Wall of the Grum Pit, Faro Mine, Yukon.* March 23, 2010.

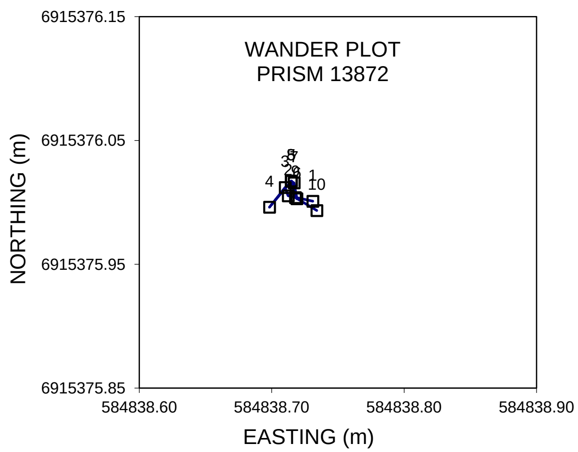
APPENDIX C

Monitoring Data

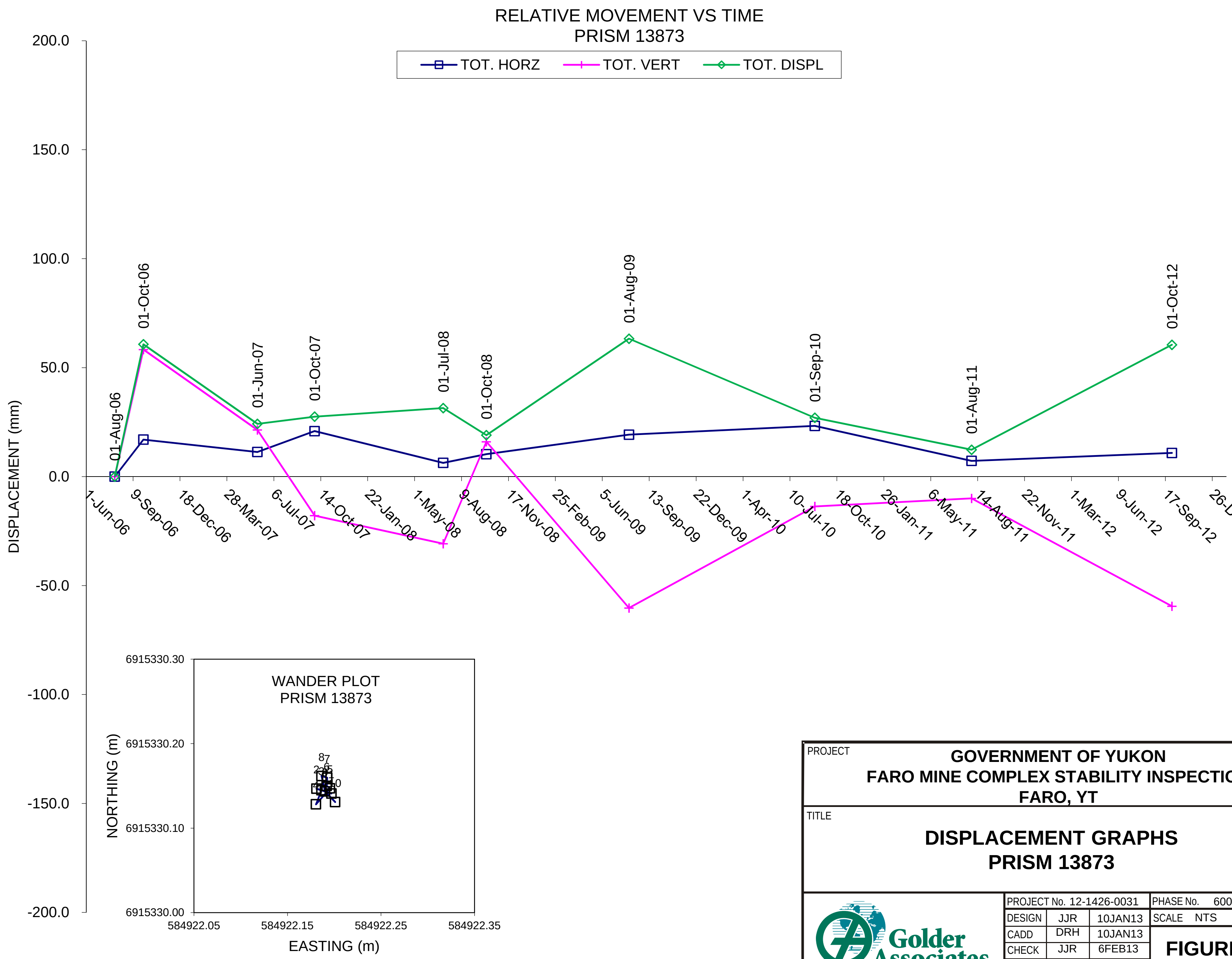


PROJECT	GOVERNMENT OF YUKON FARO MINE COMPLEX STABILITY INSPECTION FARO, YT			
TITLE	HORIZONTAL DISTANCE FARO PIT REFERENCE BARS			
Golder Associates	PROJECT No. 12-1426-0031			PHASE No. 6000
	DESIGN	JJR	10JAN13	SCALE NTS REV. 0
	CADD	DRH	10JAN13	FIGURE C-1
	CHECK	JJR	6FEB13	
	REVIEW	AVC	6FEB13	





PROJECT	GOVERNMENT OF YUKON FARO MINE COMPLEX STABILITY INSPECTION FARO, YT			
TITLE	DISPLACEMENT GRAPHS PRISM 13872			
Golder Associates	PROJECT No. 12-1426-0031		PHASE No. 6000	
	DESIGN	JJR	10JAN13	SCALE NTS	REV. 0
	CADD	DRH	10JAN13	FIGURE C-2
	CHECK	JJR	6FEB13	
	REVIEW	AVC	6FEB13	



PROJECT

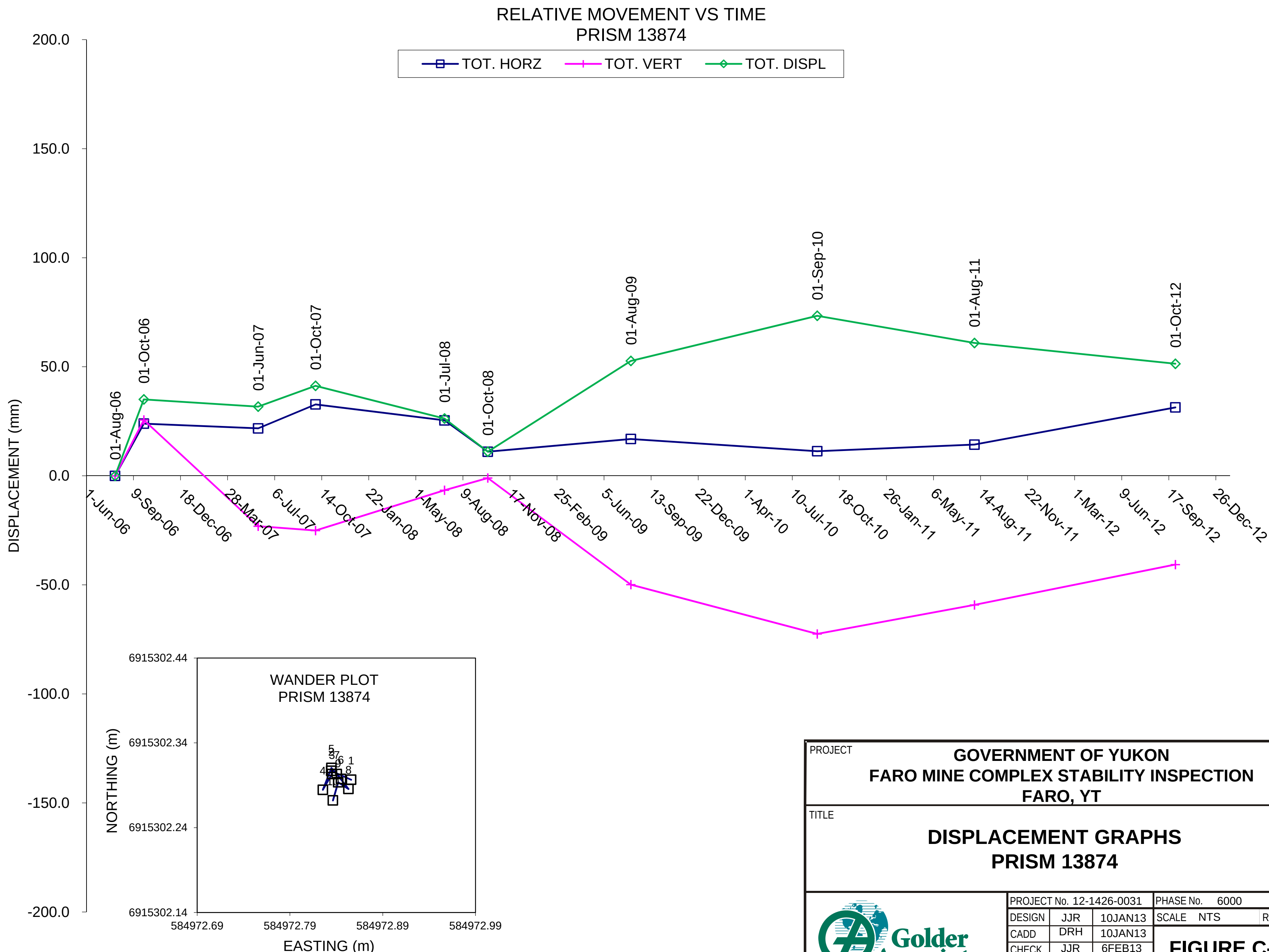
GOVERNMENT OF YUKON
FARO MINE COMPLEX STABILITY INSPECTION
FARO, YT

TITLE

DISPLACEMENT GRAPHS
PRISM 13873

Golder Associates

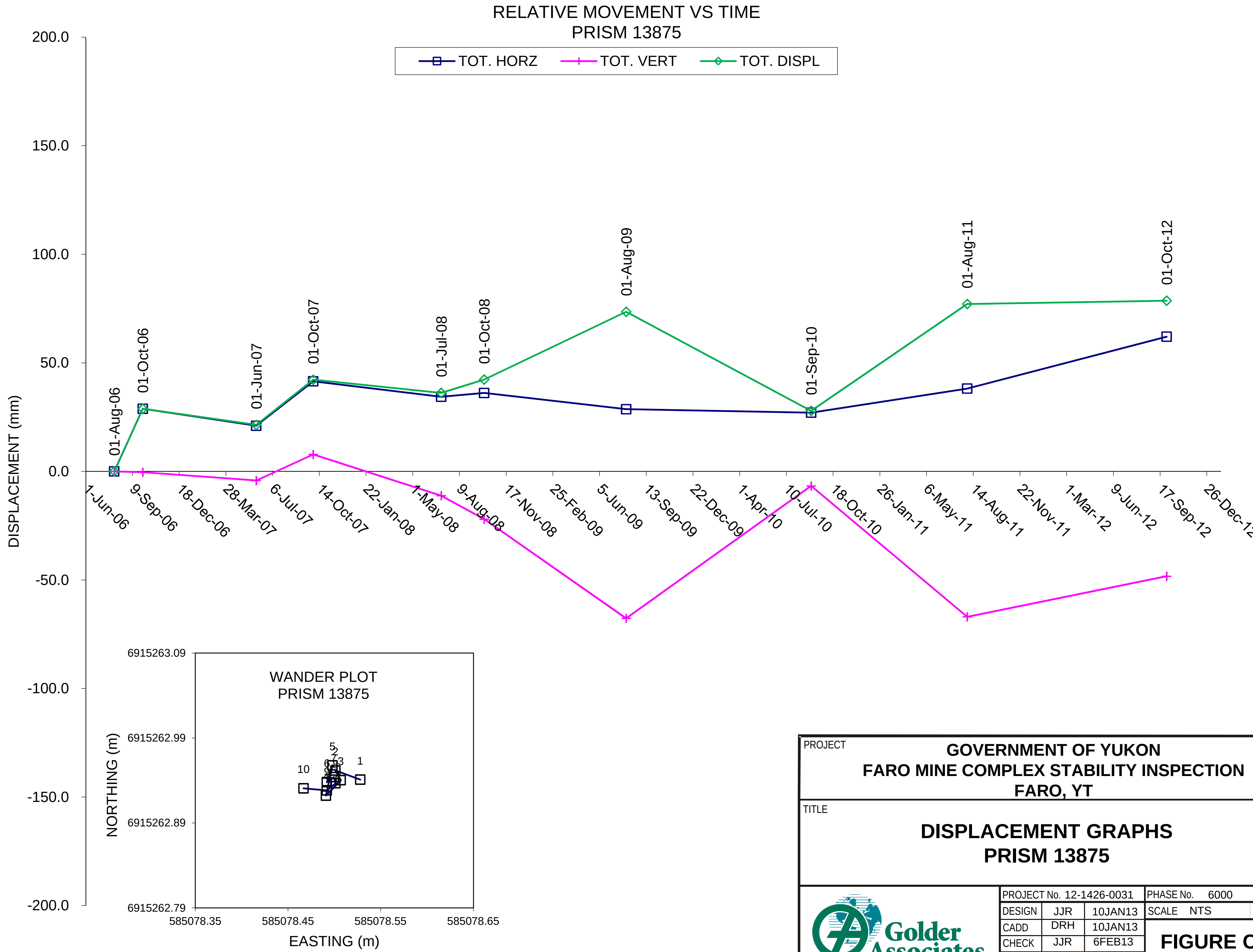
PROJECT No. 12-1426-0031			PHASE No. 6000	
DESIGN	JJR	10JAN13	SCALE NTS	REV. 0
CADD	DRH	10JAN13	**FIGURE C-3**	
CHECK	JJR	6FEB13		
REVIEW	AVC	6FEB13		



PROJECT	**GOVERNMENT OF YUKON** **FARO MINE COMPLEX STABILITY INSPECTION** **FARO, YT**
TITLE	**DISPLACEMENT GRAPHS** **PRISM 13874**

Golder Associates

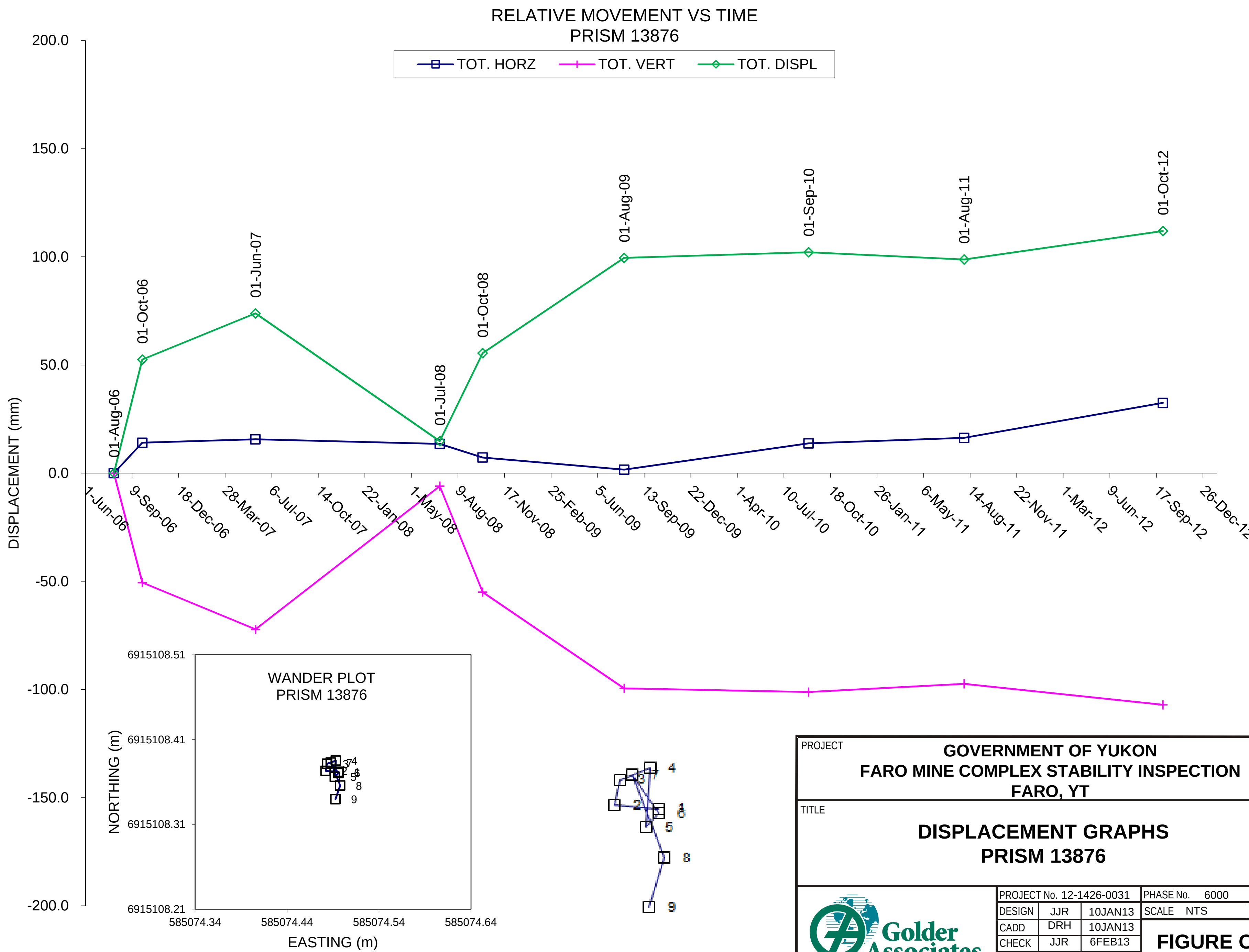
PROJECT No. 12-1426-0031			PHASE No. 6000	
DESIGN	JJR	10JAN13	SCALE NTS	REV. 0
CADD	DRH	10JAN13	**FIGURE C-4**	
CHECK	JJR	6FEB13		
REVIEW	AVC	6FEB13		



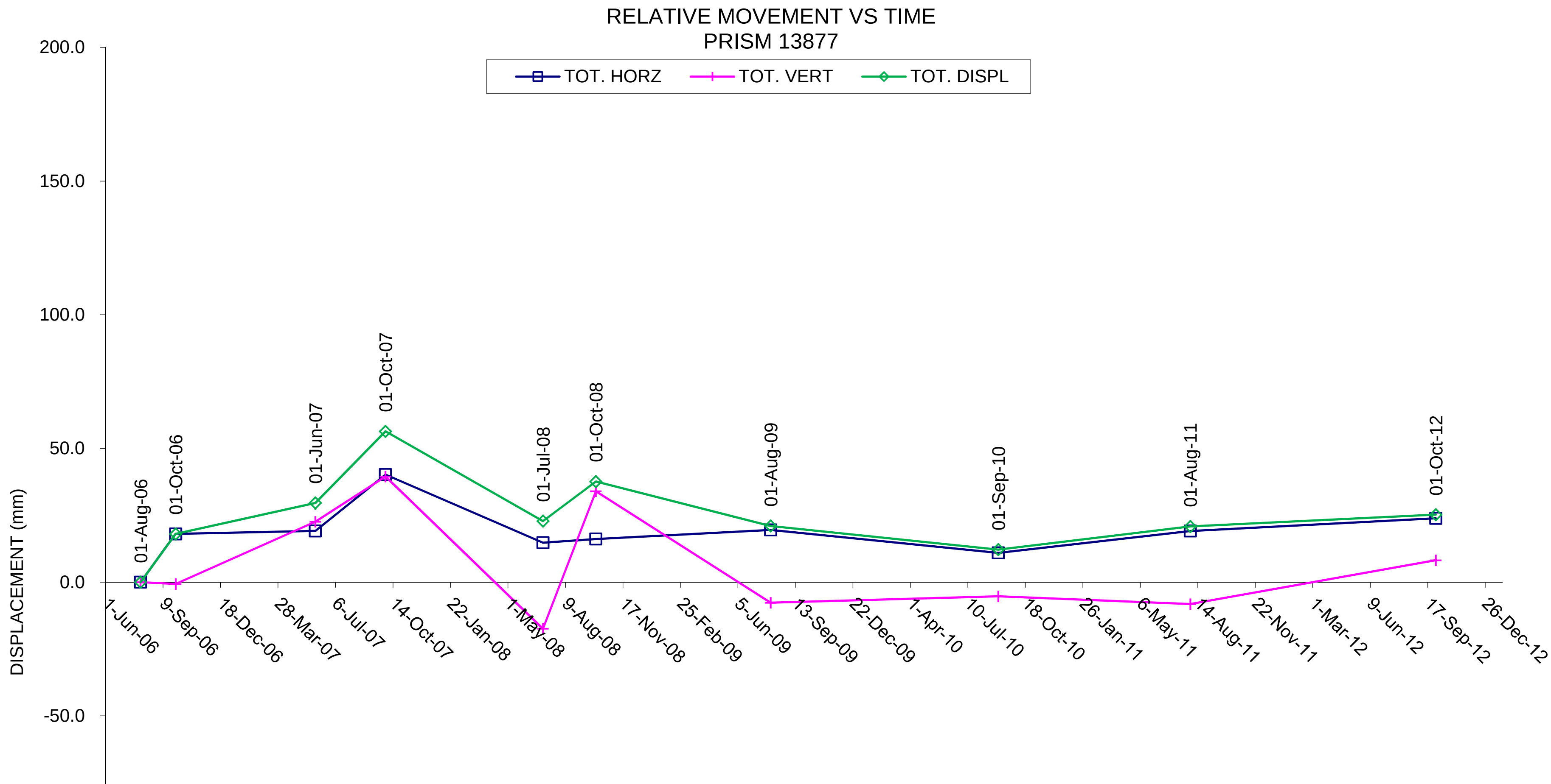
PROJECT	**GOVERNMENT OF YUKON FARO MINE COMPLEX STABILITY INSPECTION FARO, YT**
TITLE	**DISPLACEMENT GRAPHS PRISM 13875**

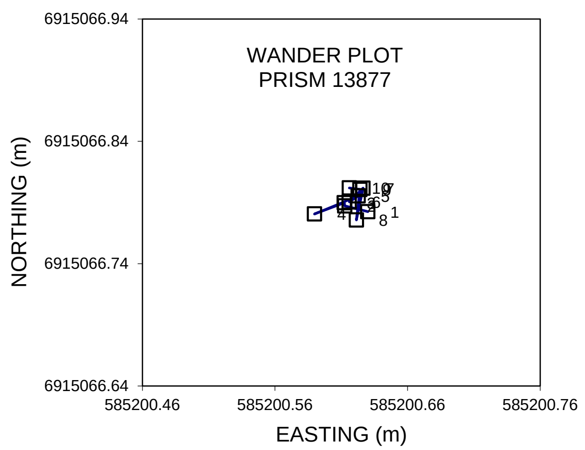
Golder Associates

PROJECT No. 12-1426-0031			PHASE No. 6000	
DESIGN	JJR	10JAN13	SCALE NTS	REV. 0
CADD	DRH	10JAN13	**FIGURE C-5**	
CHECK	JJR	6FEB13		
REVIEW	AVC	6FEB13		



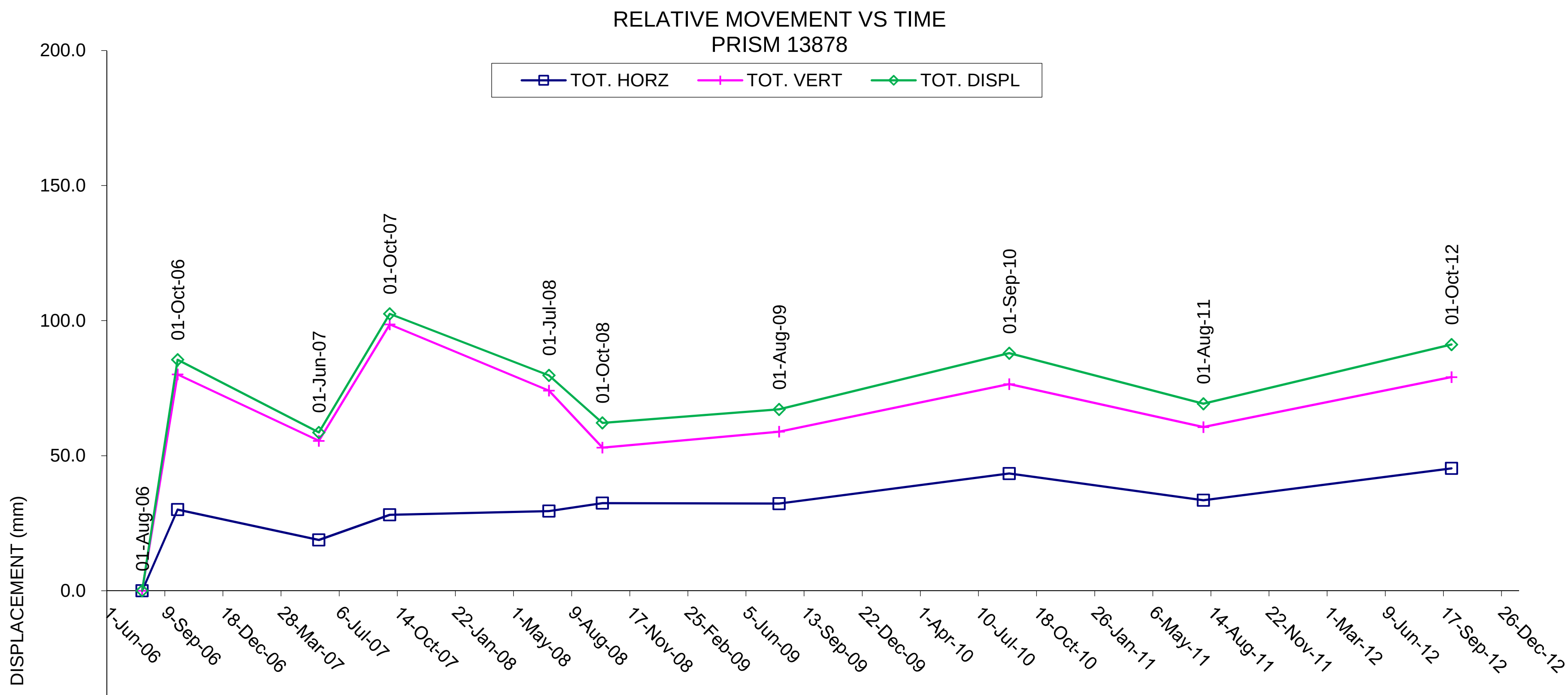
PROJECT	GOVERNMENT OF YUKON FARO MINE COMPLEX STABILITY INSPECTION FARO, YT			
TITLE	DISPLACEMENT GRAPHS PRISM 13876			
Golder Associates	PROJECT No. 12-1426-0031			PHASE No. 6000
	DESIGN	JJR	10JAN13	SCALE NTS REV. 0
	CADD	DRH	10JAN13	FIGURE C-6
	CHECK	JJR	6FEB13	
	REVIEW	AVC	6FEB13	

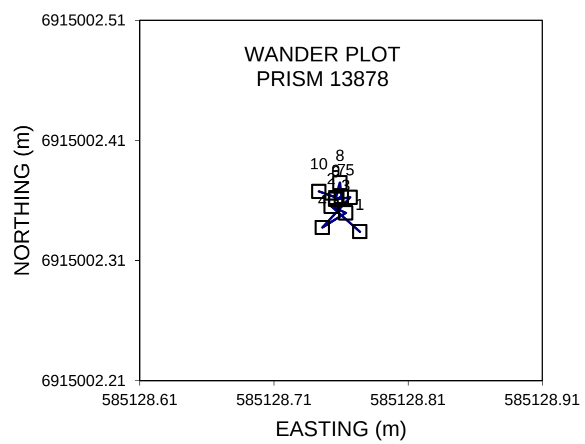




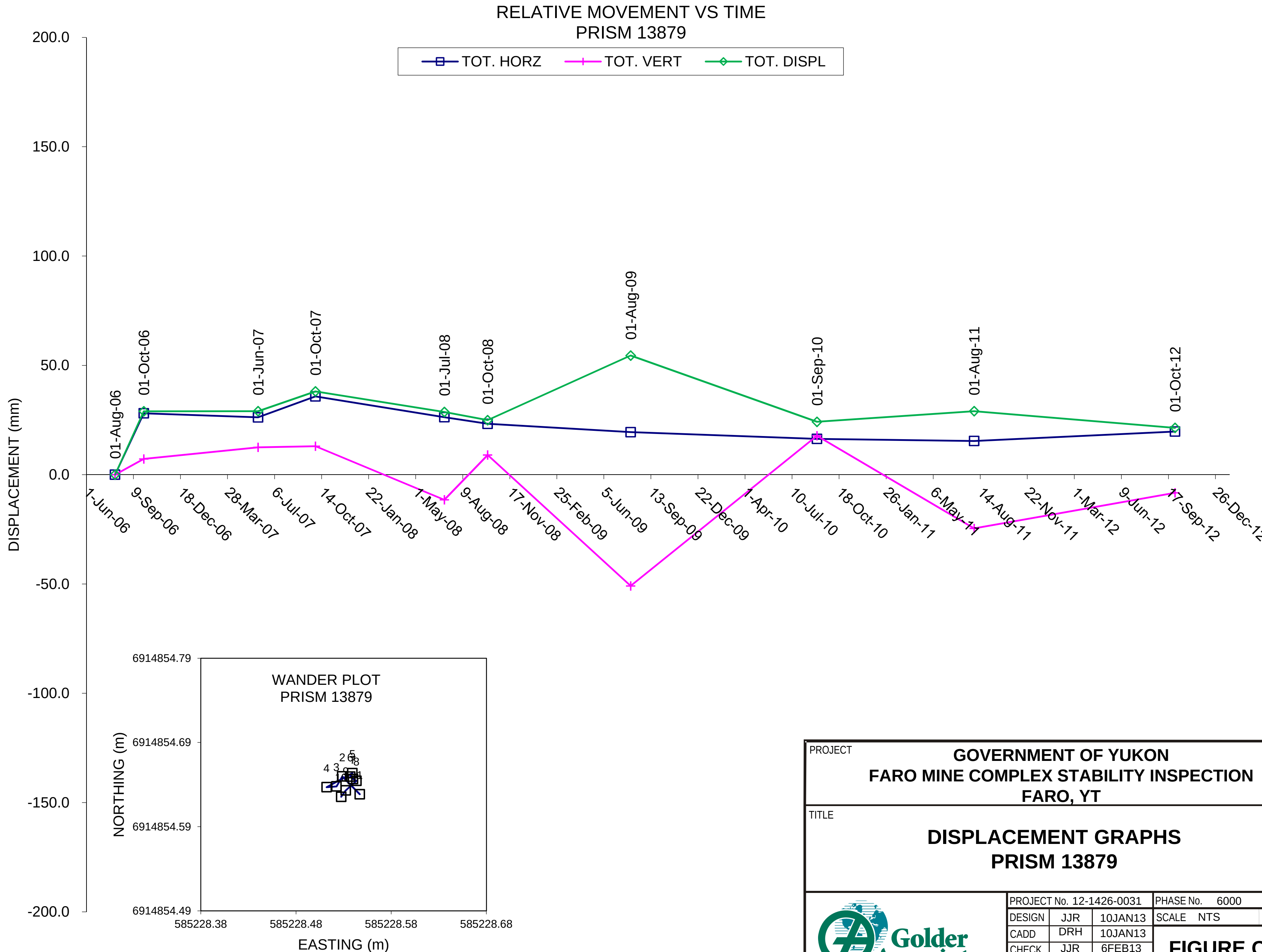
PROJECT	GOVERNMENT OF YUKON FARO MINE COMPLEX STABILITY INSPECTION FARO, YT		
TITLE	**DISPLACEMENT GRAPHS PRISM 13877**		
PROJECT No. 12-1426-0031		PHASE No. 6000	
DESIGN	JJR	10JAN13	SCALE NTS REV. 0
CADD	DRH	10JAN13	**FIGURE C-7**
CHECK	JJR	6FEB13	
REVIEW	AVC	6FEB13	

Golder Associates





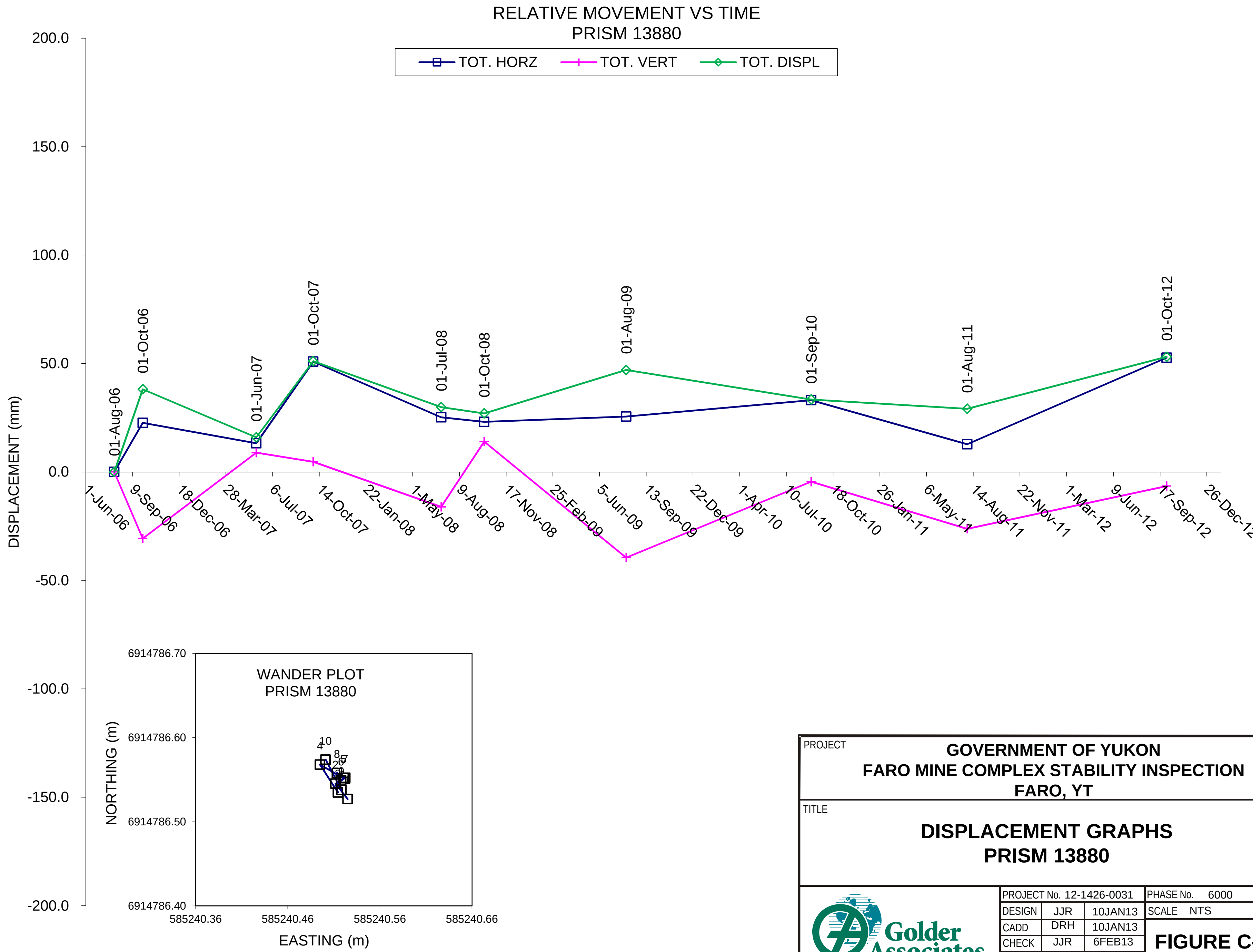
PROJECT	GOVERNMENT OF YUKON FARO MINE COMPLEX STABILITY INSPECTION FARO, YT				
TITLE	DISPLACEMENT GRAPHS PRISM 13878				
Golder Associates	PROJECT No. 12-1426-0031			PHASE No. 6000	
	DESIGN	JJR	10JAN13	SCALE NTS	REV. 0
	CADD	DRH	10JAN13	FIGURE C-8	
	CHECK	JJR	6FEB13		
	REVIEW	AVC	6FEB13		



PROJECT	GOVERNMENT OF YUKON FARO MINE COMPLEX STABILITY INSPECTION FARO, YT
TITLE	**DISPLACEMENT GRAPHS** **PRISM 13879**

Golder Associates

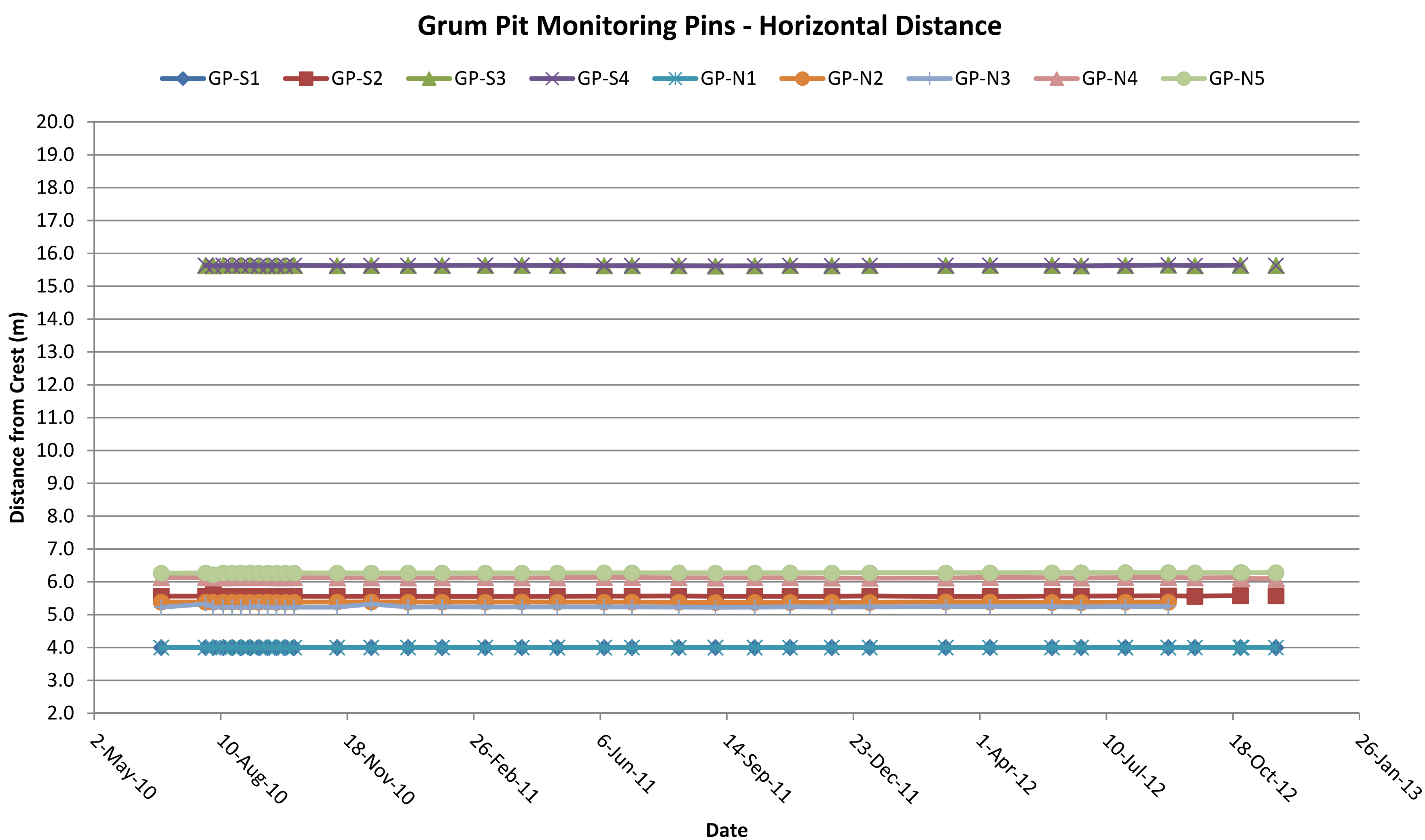
PROJECT No. 12-1426-0031			PHASE No. 6000	
DESIGN	JJR	10JAN13	SCALE NTS	REV. 0
CADD	DRH	10JAN13	**FIGURE C-9**	
CHECK	JJR	6FEB13		
REVIEW	AVC	6FEB13		



PROJECT	
GOVERNMENT OF YUKON FARO MINE COMPLEX STABILITY INSPECTION FARO, YT	
TITLE	
DISPLACEMENT GRAPHS PRISM 13880	

Golder Associates

PROJECT No. 12-1426-0031			PHASE No. 6000	
DESIGN	JJR	10JAN13	SCALE NTS	REV. 0
CADD	DRH	10JAN13	FIGURE C-10	
CHECK	JJR	6FEB13		
REVIEW	AVC	6FEB13		



PROJECT

GOVERNMENT OF YUKON
FARO MINE COMPLEX STABILITY INSPECTION
FARO, YT

TITLE

HORIZONTAL DISTANCE
GRUM PIT MONITORING PINS

Golder Associates

PROJECT No. 12-1426-0031			PHASE No. 6000	
DESIGN	JJR	10JAN13	SCALE NTS	REV. 0
CADD	DRH	10JAN13	**FIGURE C-11**	
CHECK	JJR	6FEB13		
REVIEW	AVC	6FEB13		

APPENDIX D

Photographs - Grum Pit

Photograph D-1
Grum Pit east wall and instability zone. View looking east.

Photograph D-2
Grum Pit Instability Zone – new cracks reported in August 2012 indicated by red arrows. View looking east.

Photograph D-3
Grum Pit Instability Zone – new cracks reported in August 2012.
View looking north.

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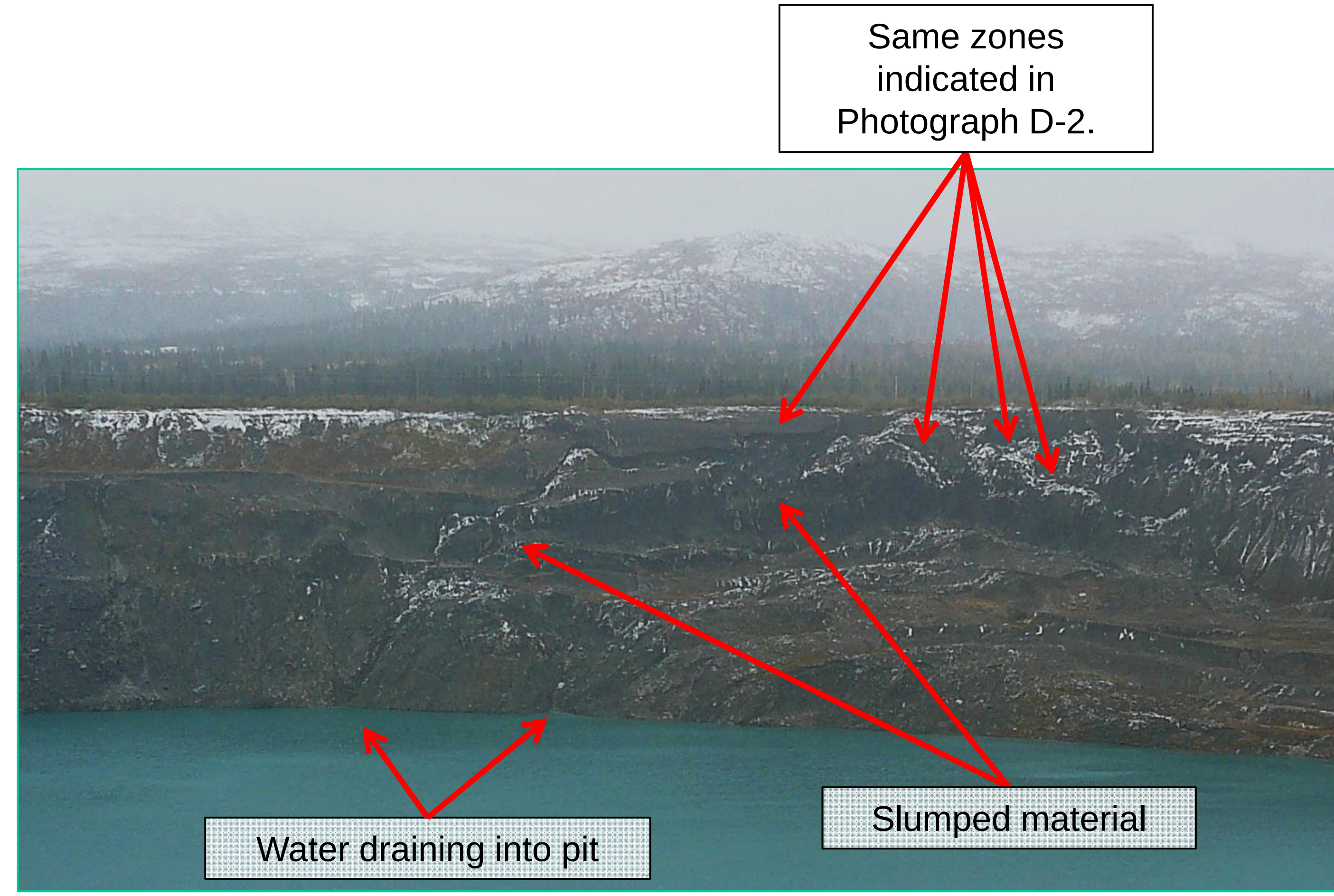
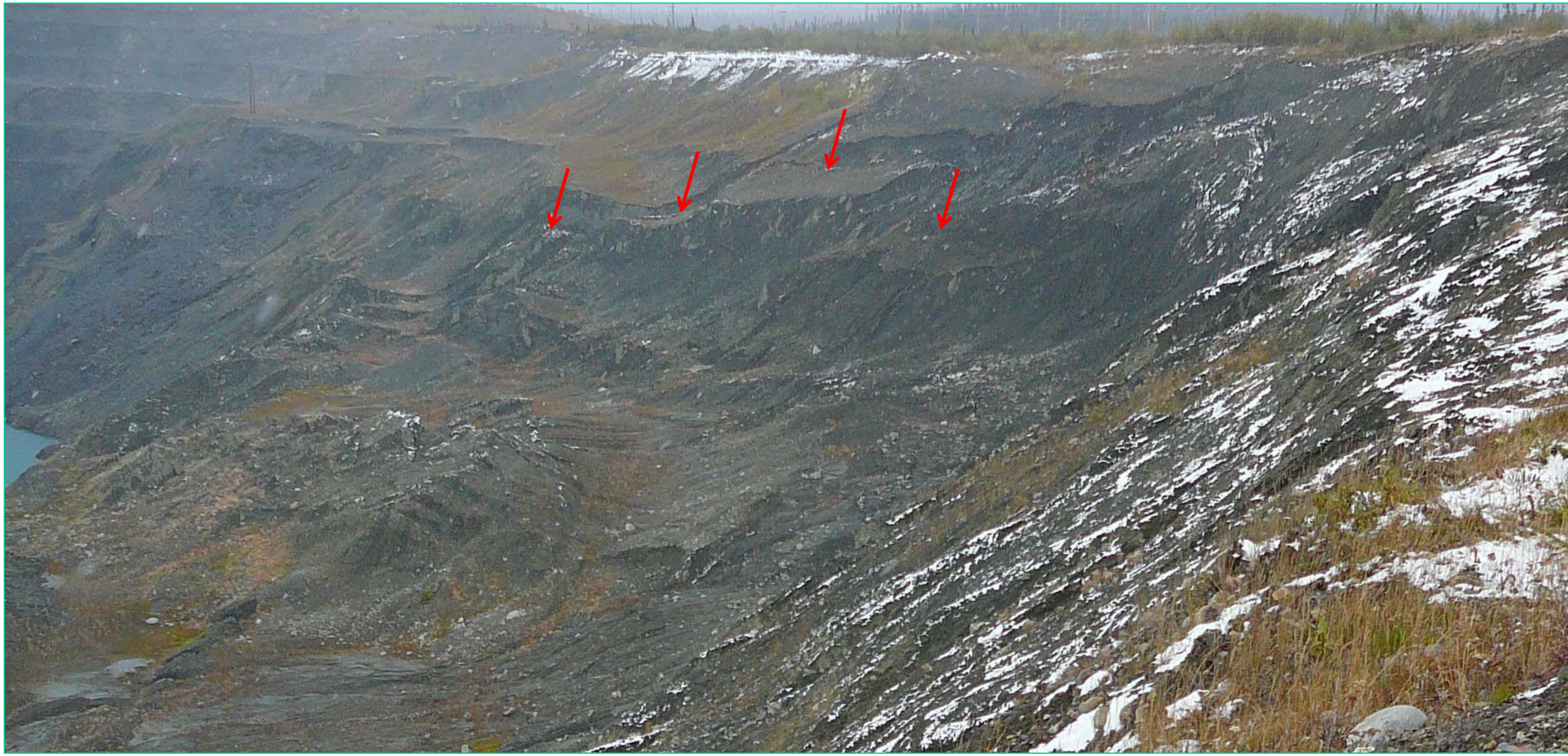
Photograph D-2 for comparison with Photograph D-4.



Photograph D-4
Grum Pit Instability Zone. Cracks had extended to the north by the September 2012 site visit and a portion of the backscarp had slumped. View looking east.



Photograph D-5

Grum Pit east wall and instability zone. Side view of recent instability. View looking north.

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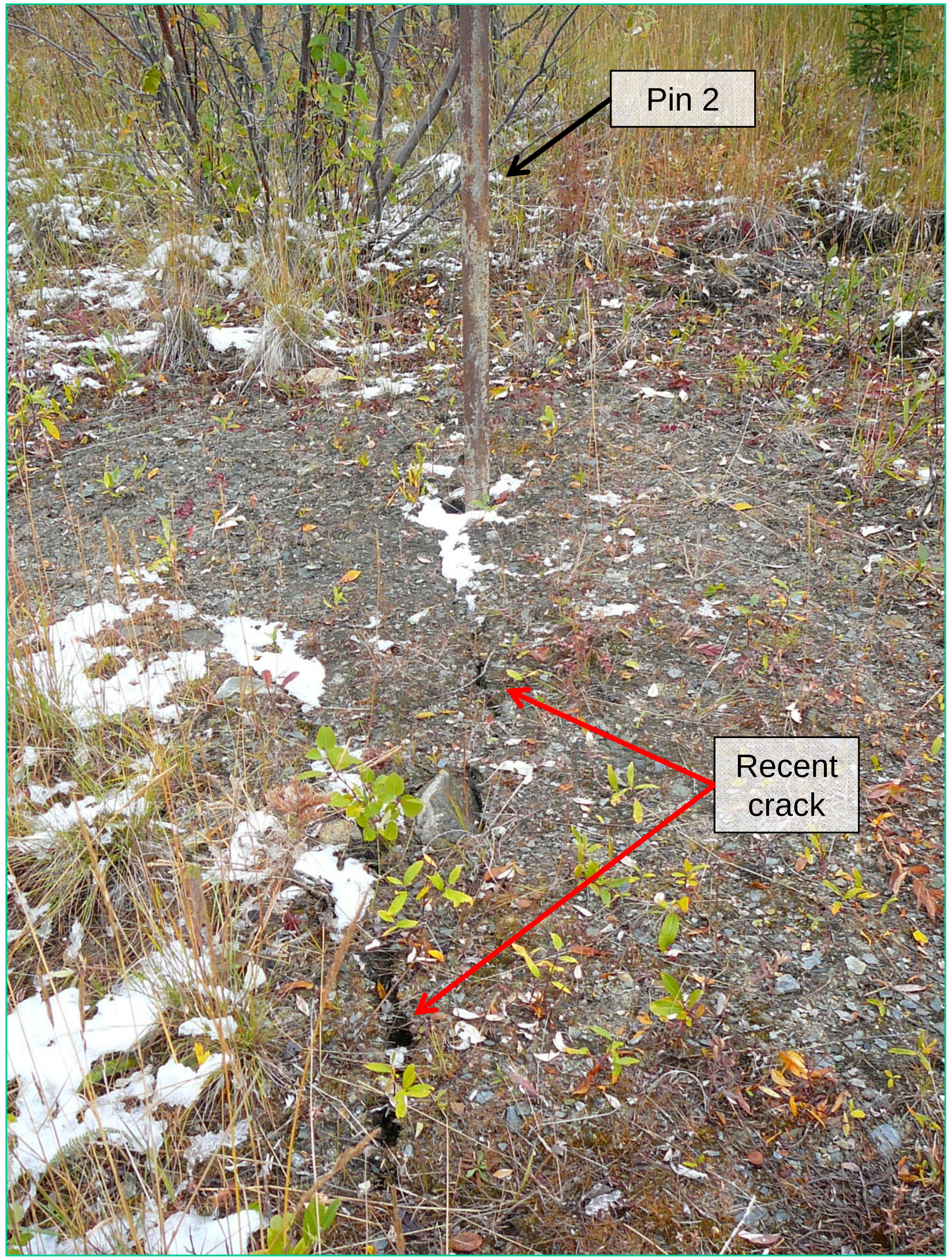
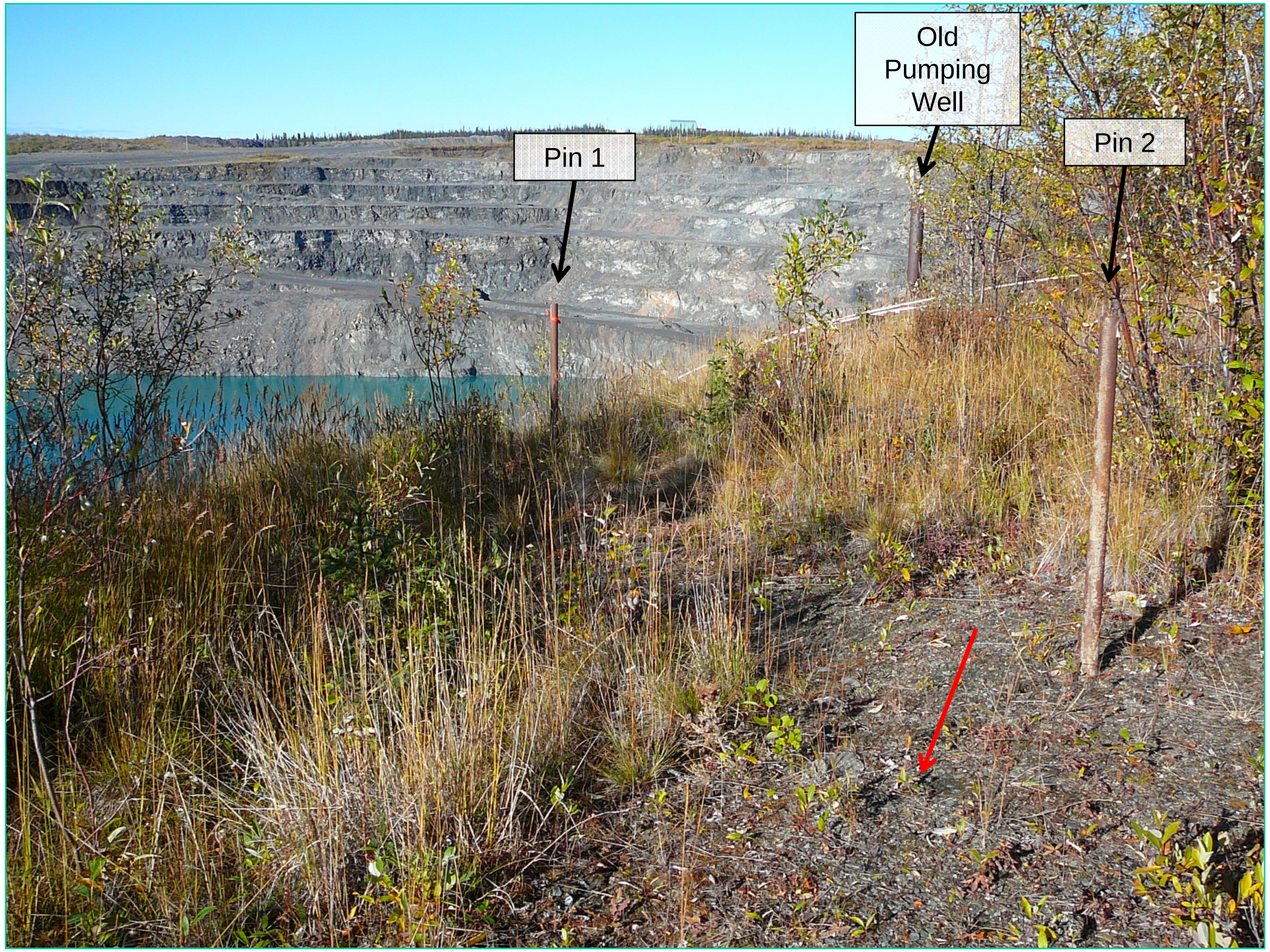
Photograph D-6
Grum Pit recent crack, located to the south of the South Array, near road. View looking southwest.

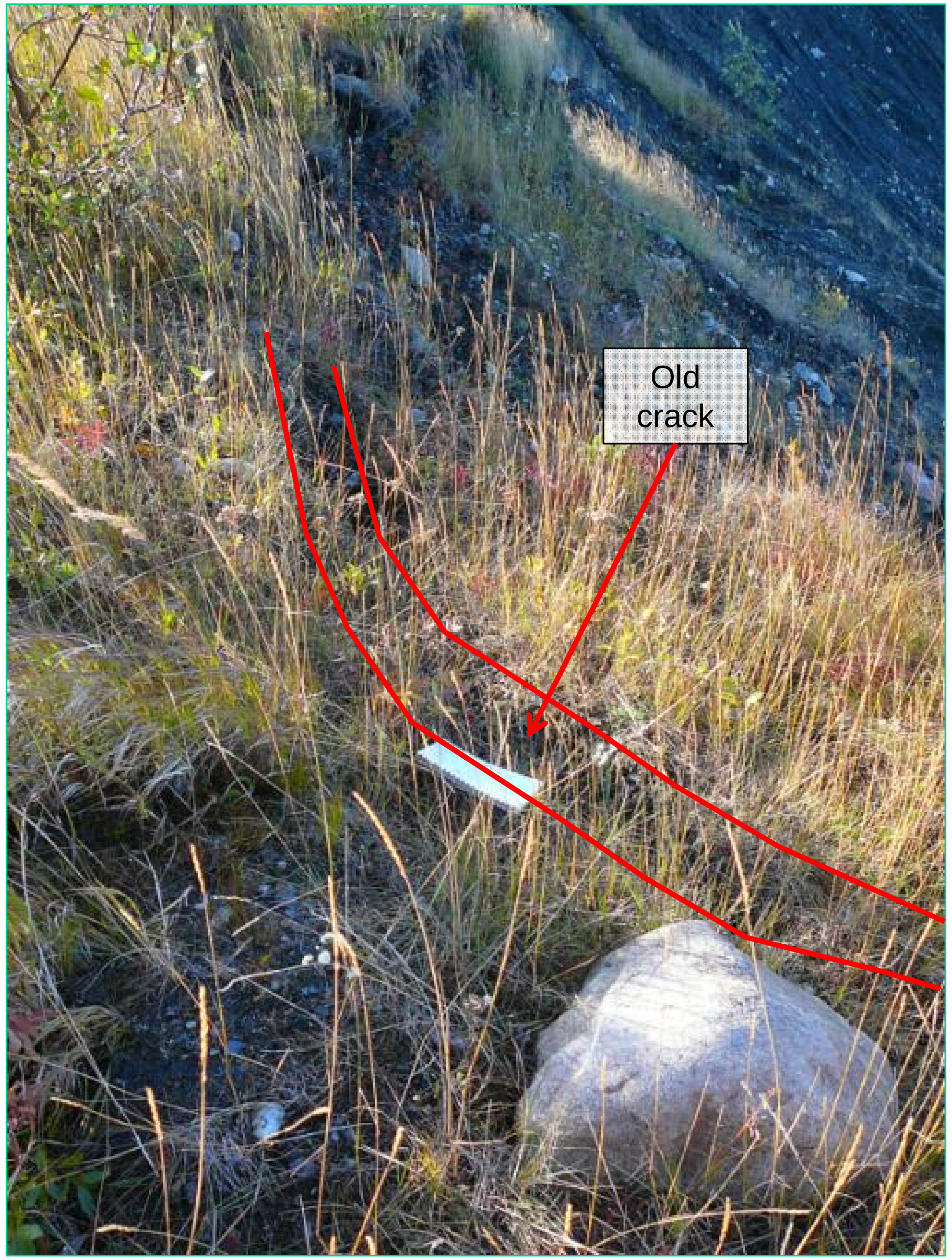
Photograph D-7
Grum Pit recent crack, located to the south of the South Array, near road. Approximate location indicated by red arrow. View looking northeast.



Photograph D-8
Grum Pit recent crack, located across the second pin from the crest in the North Array. View looking northwest.



Photograph D-9
Grum Pit recent crack, located across the second pin from the crest in the North Array. Approximate location indicated by red arrow. View looking west.



Photograph D-10
Grum Pit old crack, located at crest of east wall, south of the South Array. View looking south.

Photograph D-11
Grum Pit old slumping structures near South Array. View looking north.

Photograph D-12
Grum Pit - small pond of water near crest, between North and South Arrays. View looking south.

Photograph D-13
Grum Pit – areas of ponded water behind crest, in vegetated area. View looking west.

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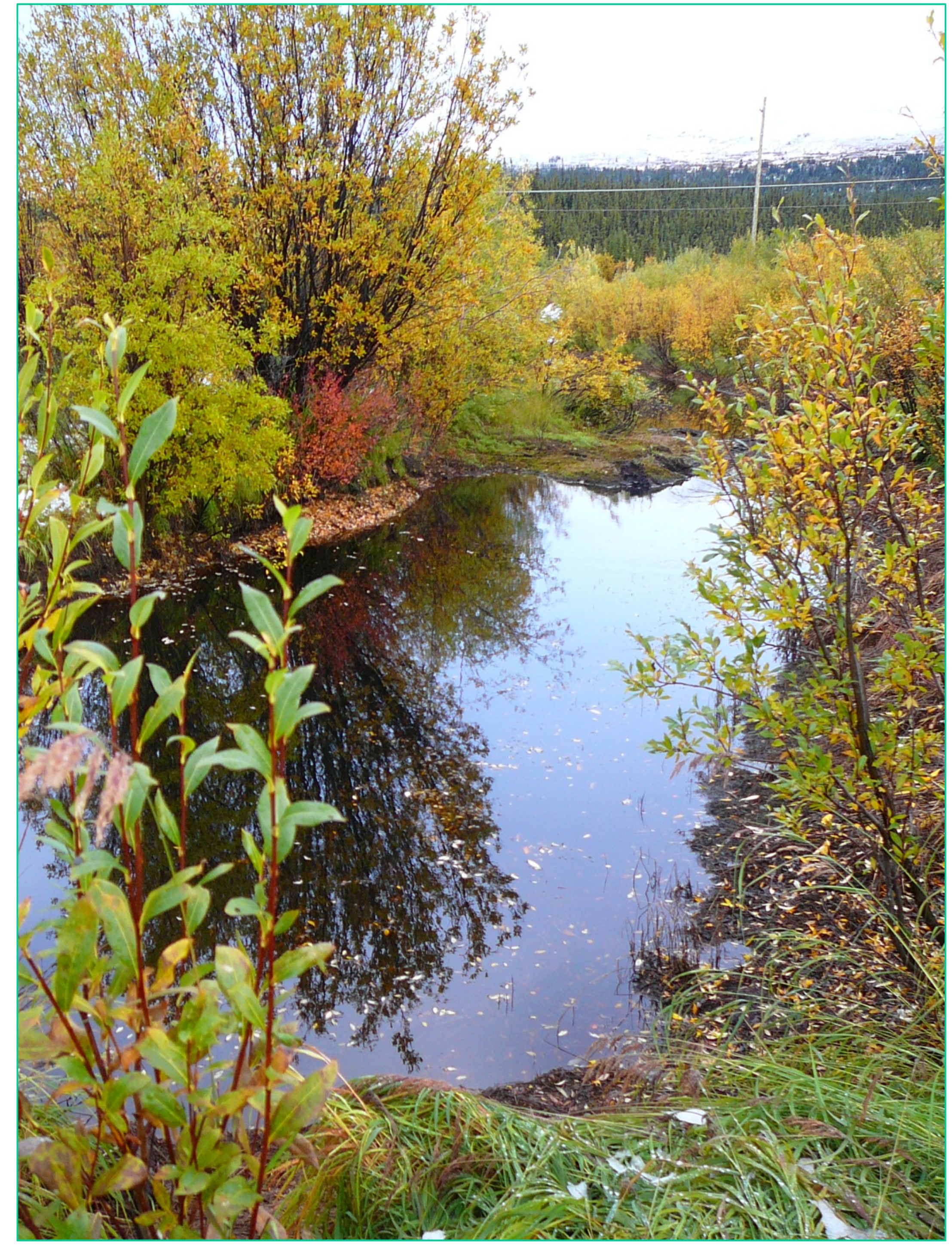
Photograph D-14
Grum Pit - ponded water behind crest, in vegetated area. View looking east.

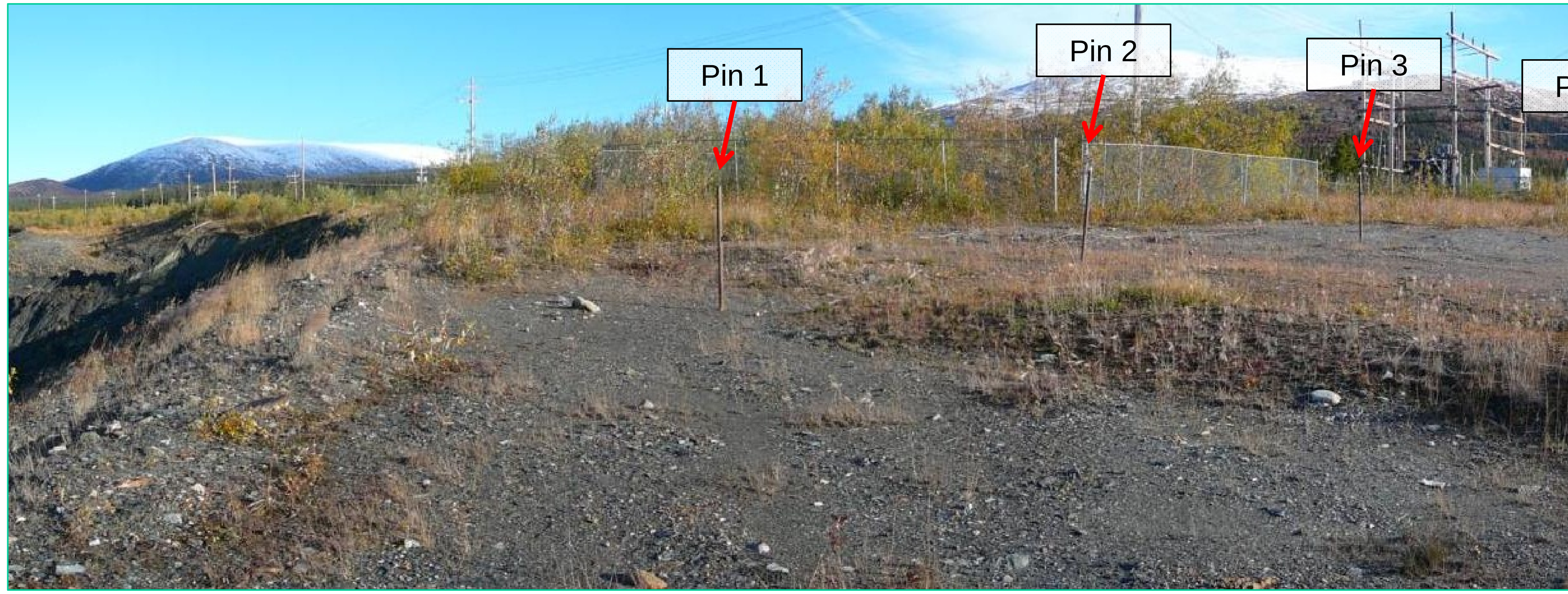


Photograph D-15
Grum Pit - ponded water behind crest, in vegetated area. View looking east.

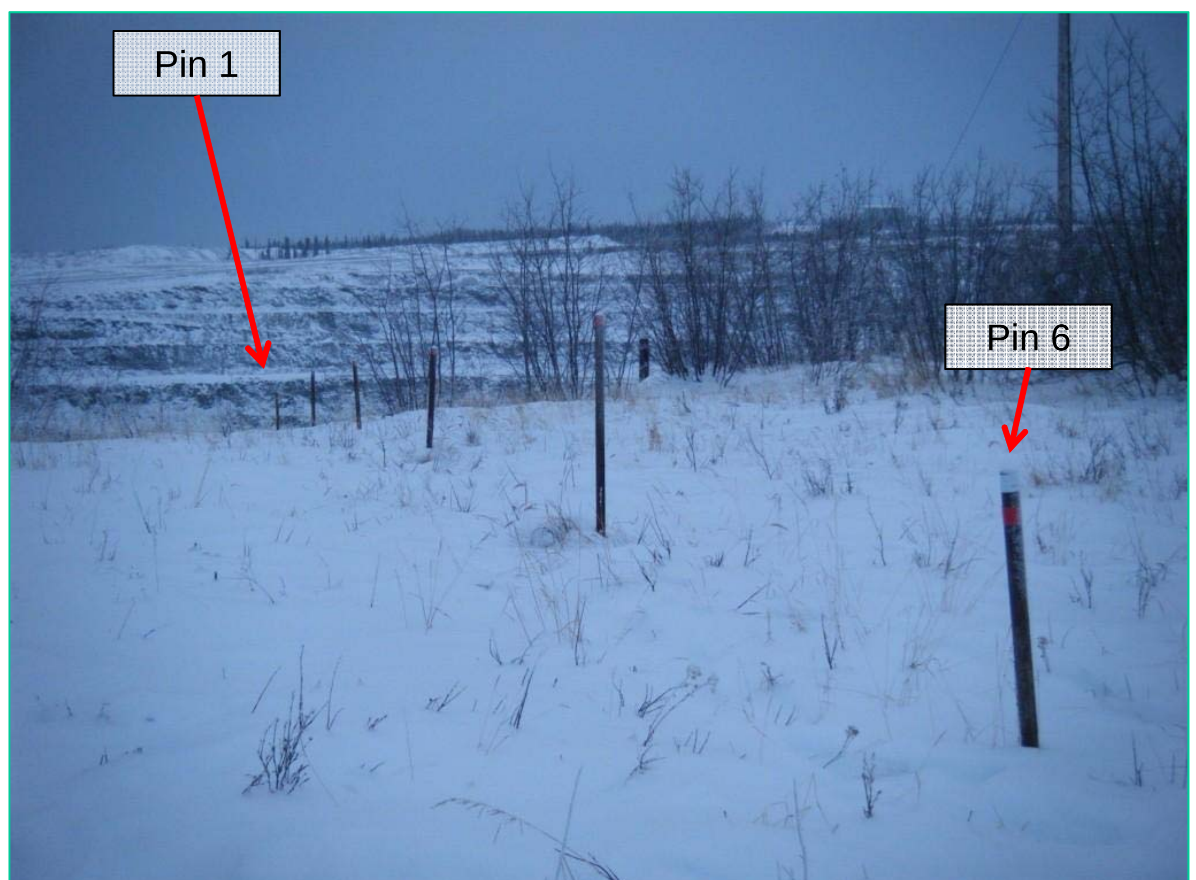
Photos taken September 12-14, 2012.

Photograph D-16
Grum Pit – large pond behind crest. View looking southeast.

Photograph D-17
Grum Pit – South Array of Monitoring Pins (1 to 4)



Photograph D-18
Grum Pit – North Array of Monitoring Pins (1 to 6)
(Photo provided by TEES, December 19, 2012.)

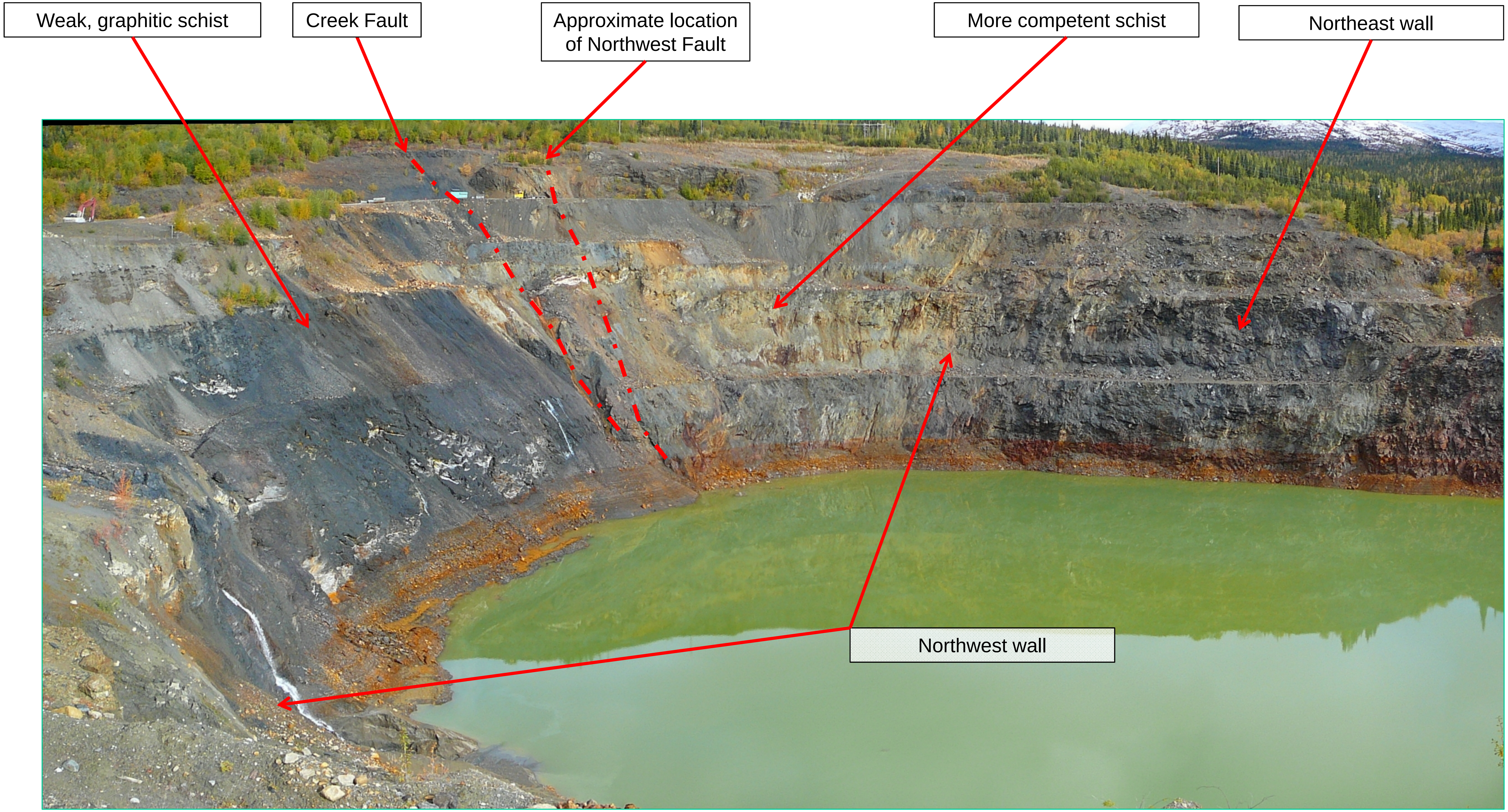


Photograph D-19
Grum Pit Interceptor Ditch. View looking southeast.

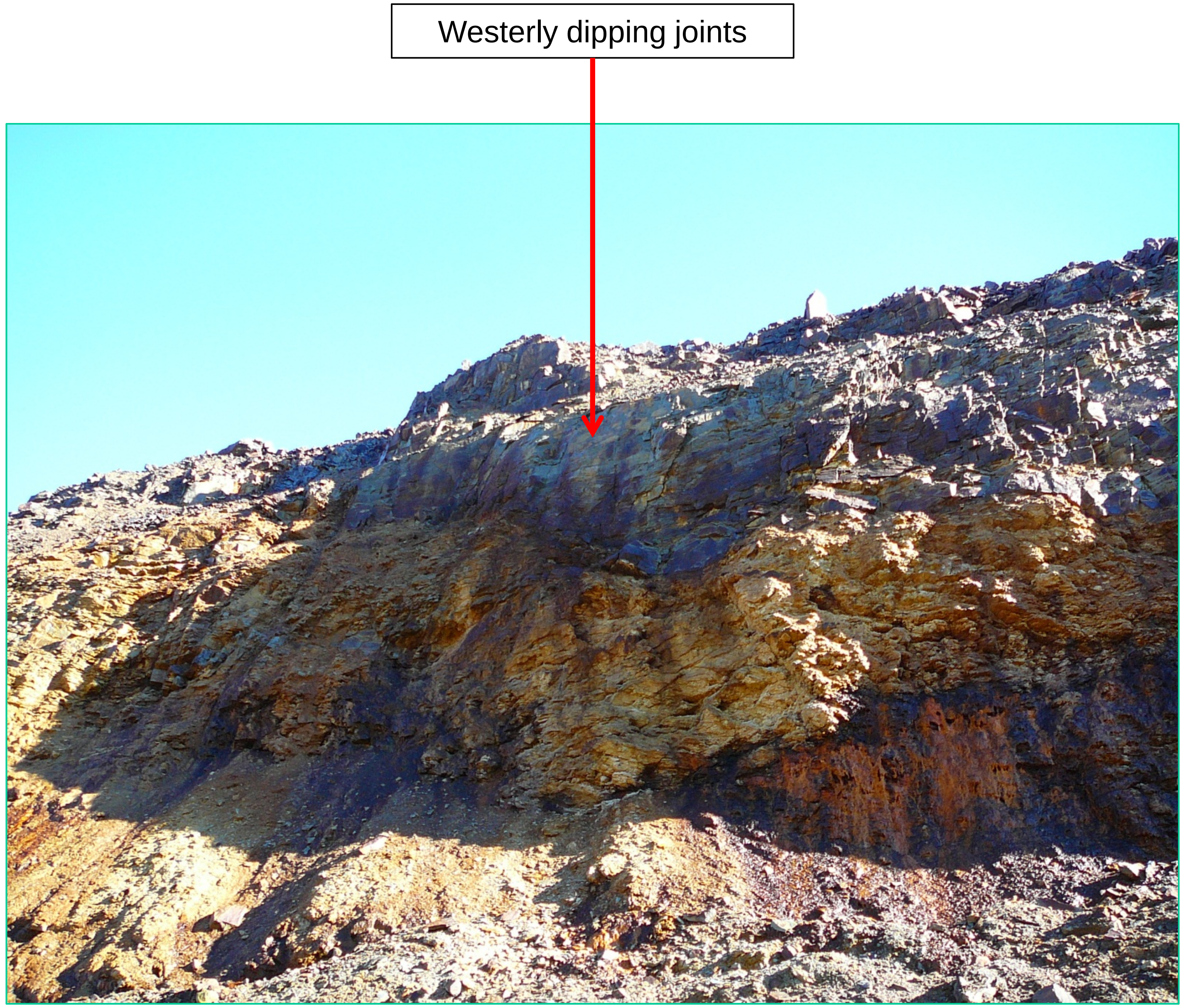
Photograph D-20
Grum Pit south, west and north walls. View looking southwest.

APPENDIX E

Photographs - Vangorda Pit



Photograph E-1
Vangorda Pit north wall. View looking north-northwest.



Photograph E-2
Vangorda Pit – Mapping Station 1.
View looking northeast from access road.

Photograph E-3
Vangorda Pit – Mapping Station 1, further down access road toward pit.
View looking northeast.

Photograph E-4
Vangorda Pit – Mapping Station 2. View looking north.

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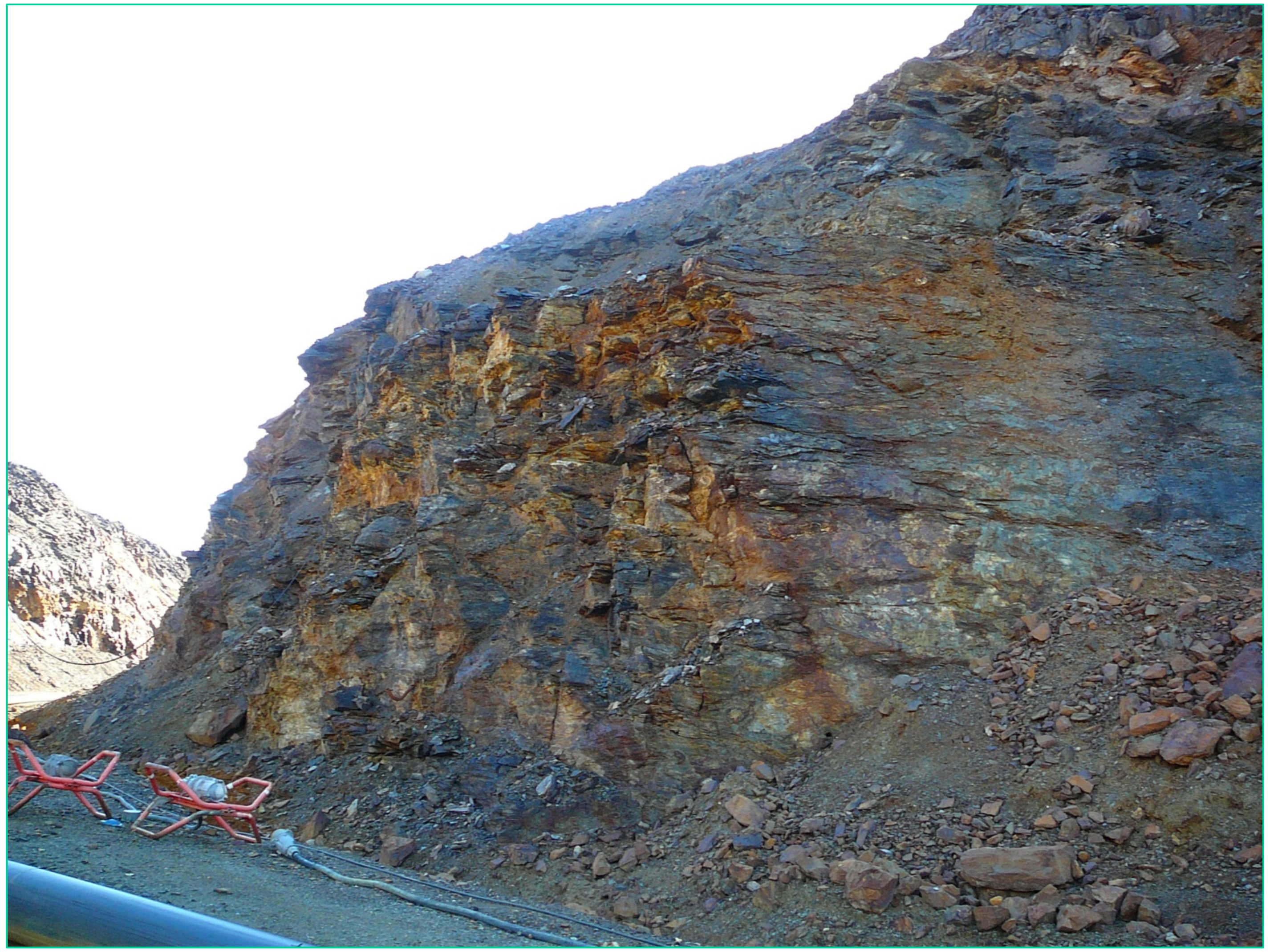

Photograph E-5
Vangorda Pit – Mapping Station 3. View looking south.

Photograph E-6
Vangorda Pit – Mapping Station 3. Close up view of foliation.

Photograph E-7
Vangorda Pit – access road on southwest side of pit. View looking northwest.

Photograph E-8
Vangorda Pit – Vangorda Creek Diversion Channel. Sections are in disrepair, allowing leaks. View looking north.

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Photograph E-9
Vangorda Pit – Water leaking beneath flume.

Photograph E-10
Vangorda Pit – Water flowing in channel beneath flume indicated by red arrows.

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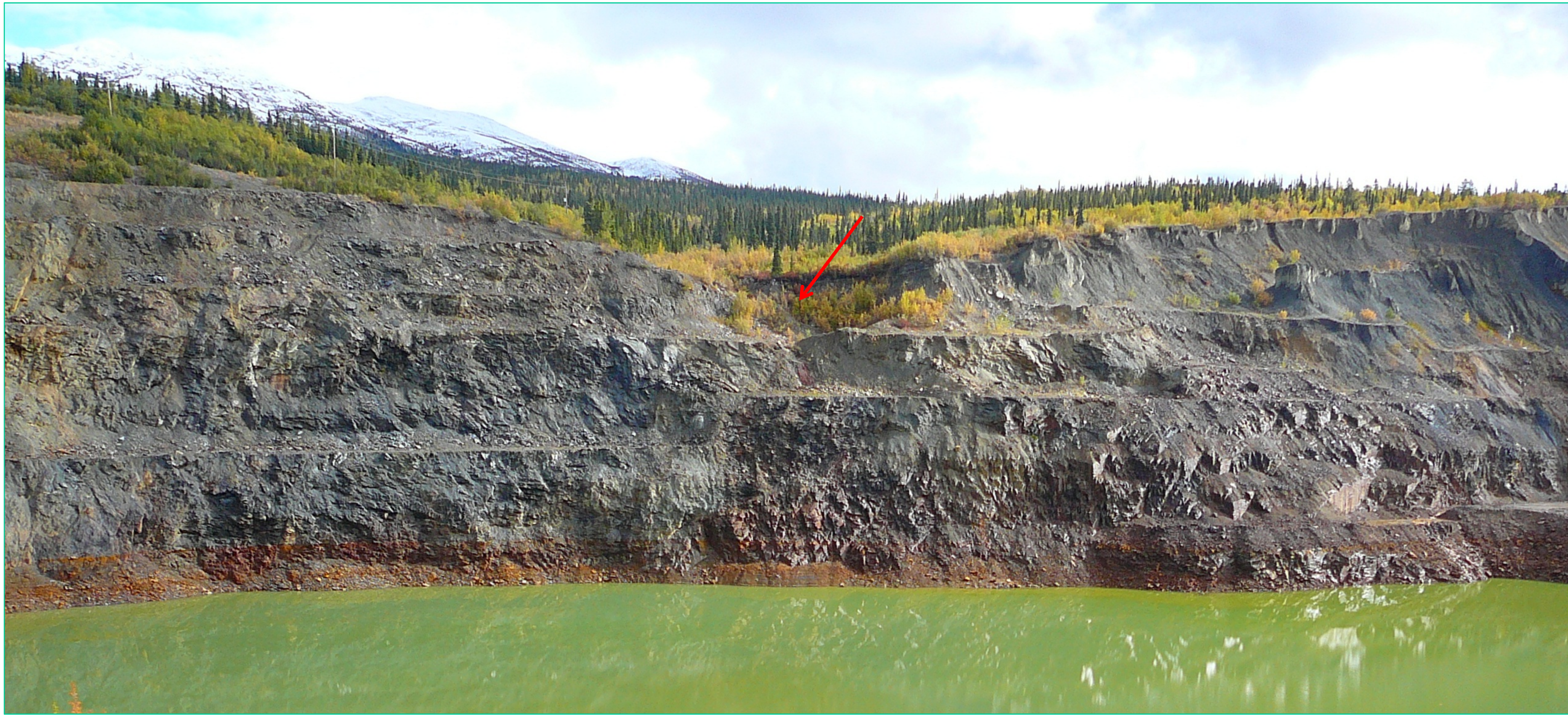

Photograph E-11
Vangorda Pit – Location of original Vangorda Creek channel. Some water enters the pit from this location.
View looking northeast.

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Photograph E-12
Vangorda Pit – original Vangorda Creek channel, behind east wall of pit. Pump is activated at a certain water elevation, and water is pumped across the road to the flume. View looking west.

Photograph E-13
Vangorda Pit – location of Vangorda Creek discharge into flume. View looking west.

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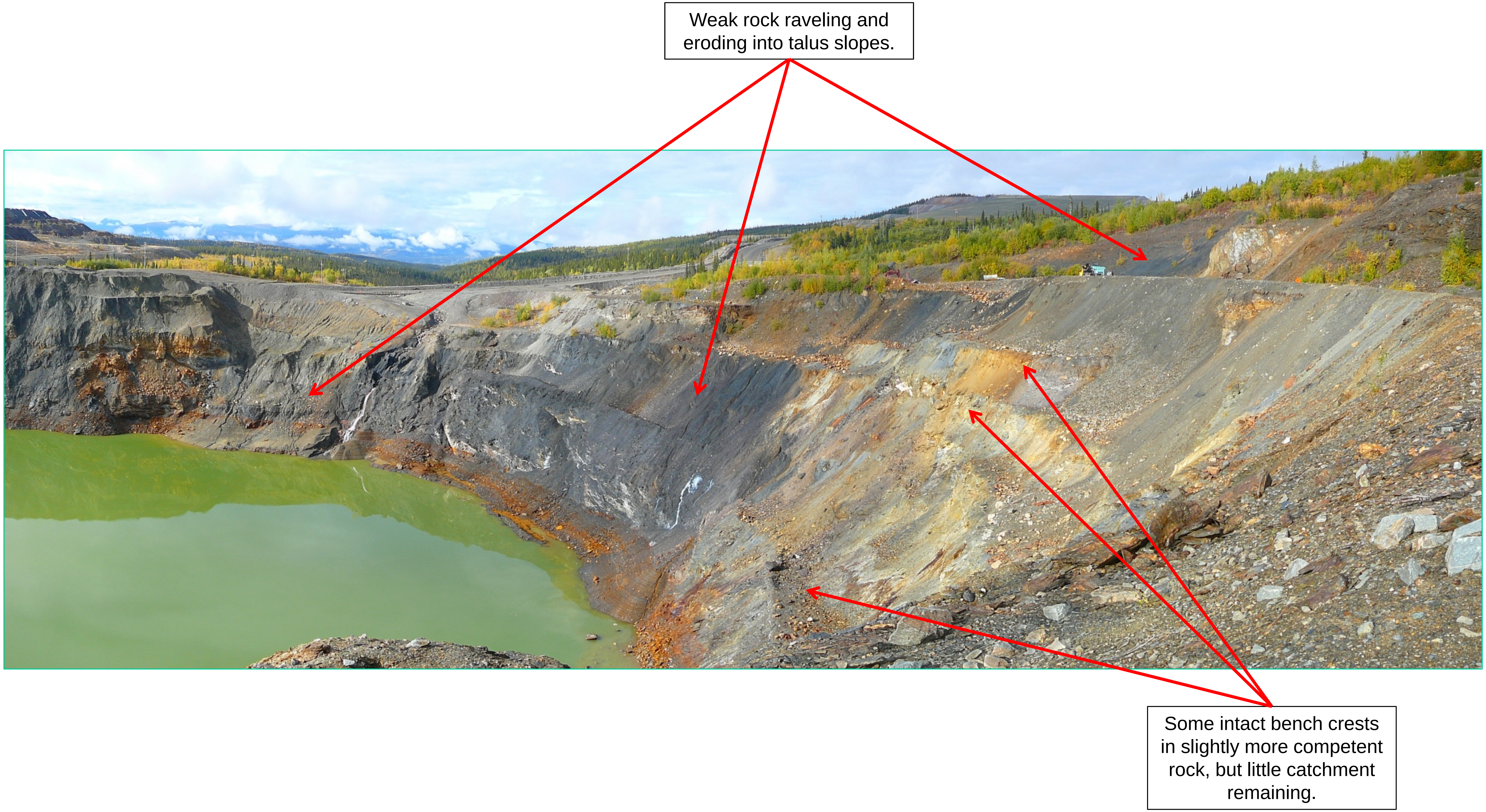
Photograph E-14
Vangorda Pit – Water flowing into pit in northwest corner.

Photograph E-15
Vangorda Pit – Emergency discharge pipelines from the booster pump.



Photograph E-16
Vangorda Pit northwest wall. View looking west.

Photograph E-17
Vangorda Pit northwest wall. View looking northwest.

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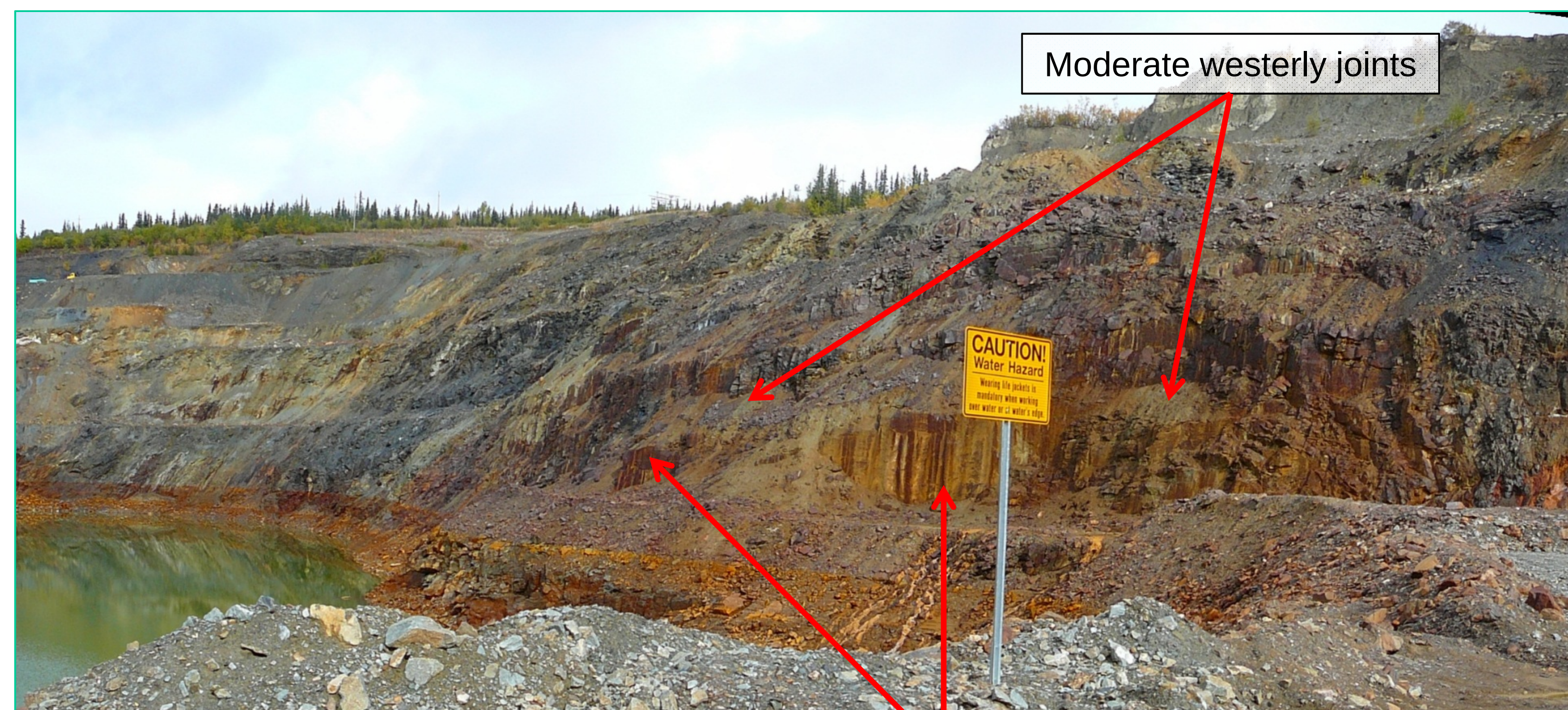
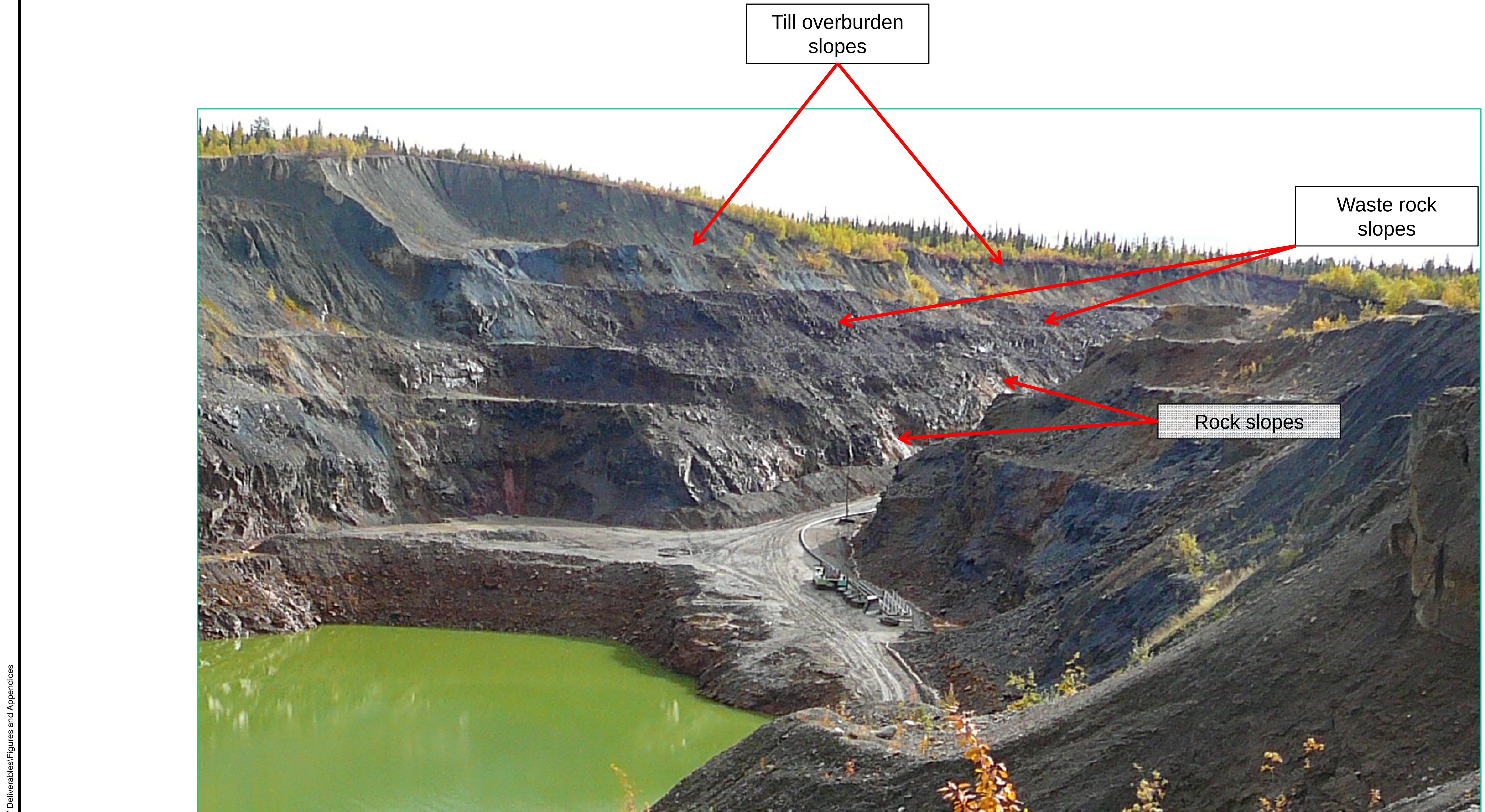
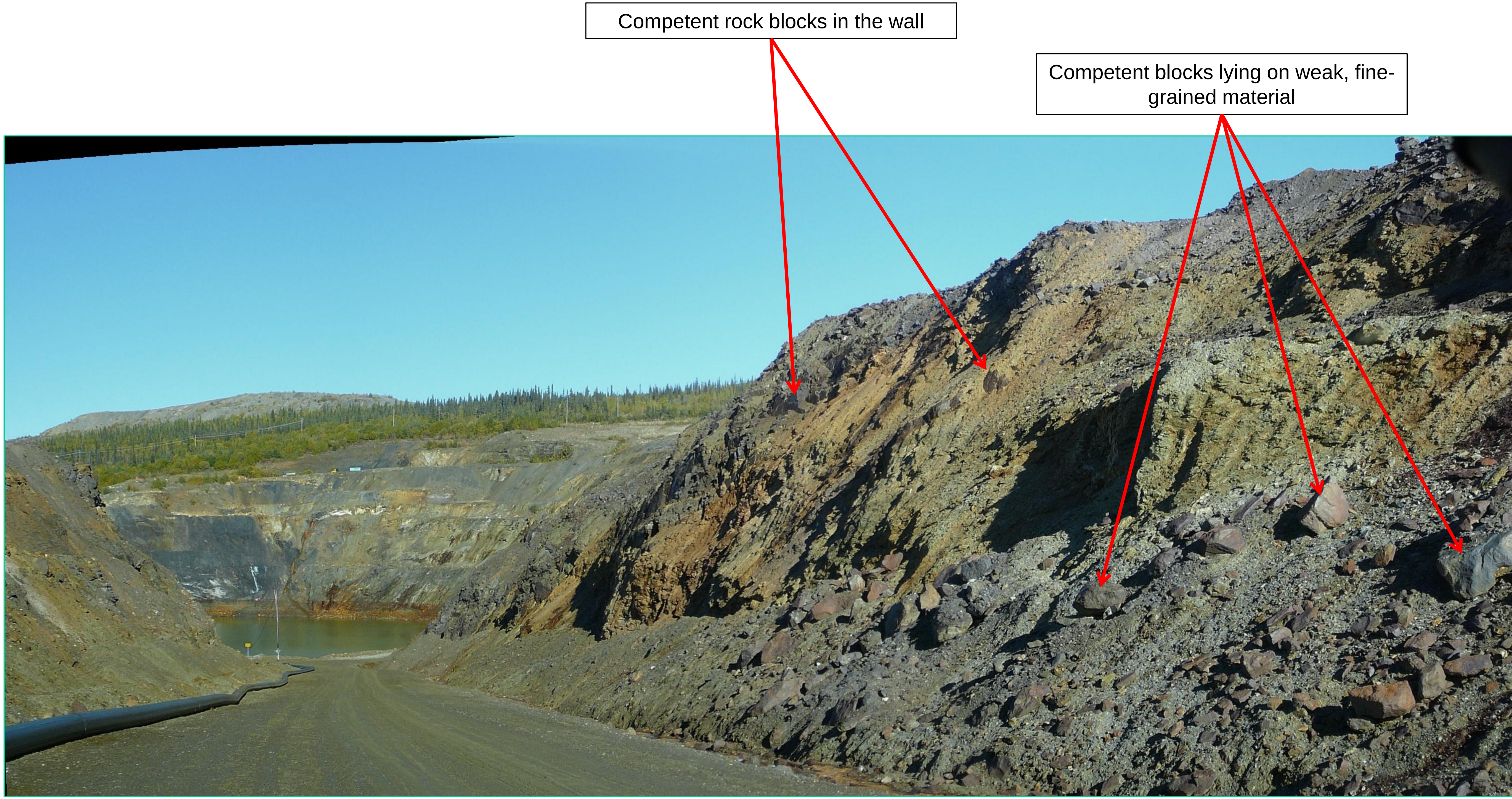
Photograph E-18
Vangorda Pit northeast wall. View looking northeast.



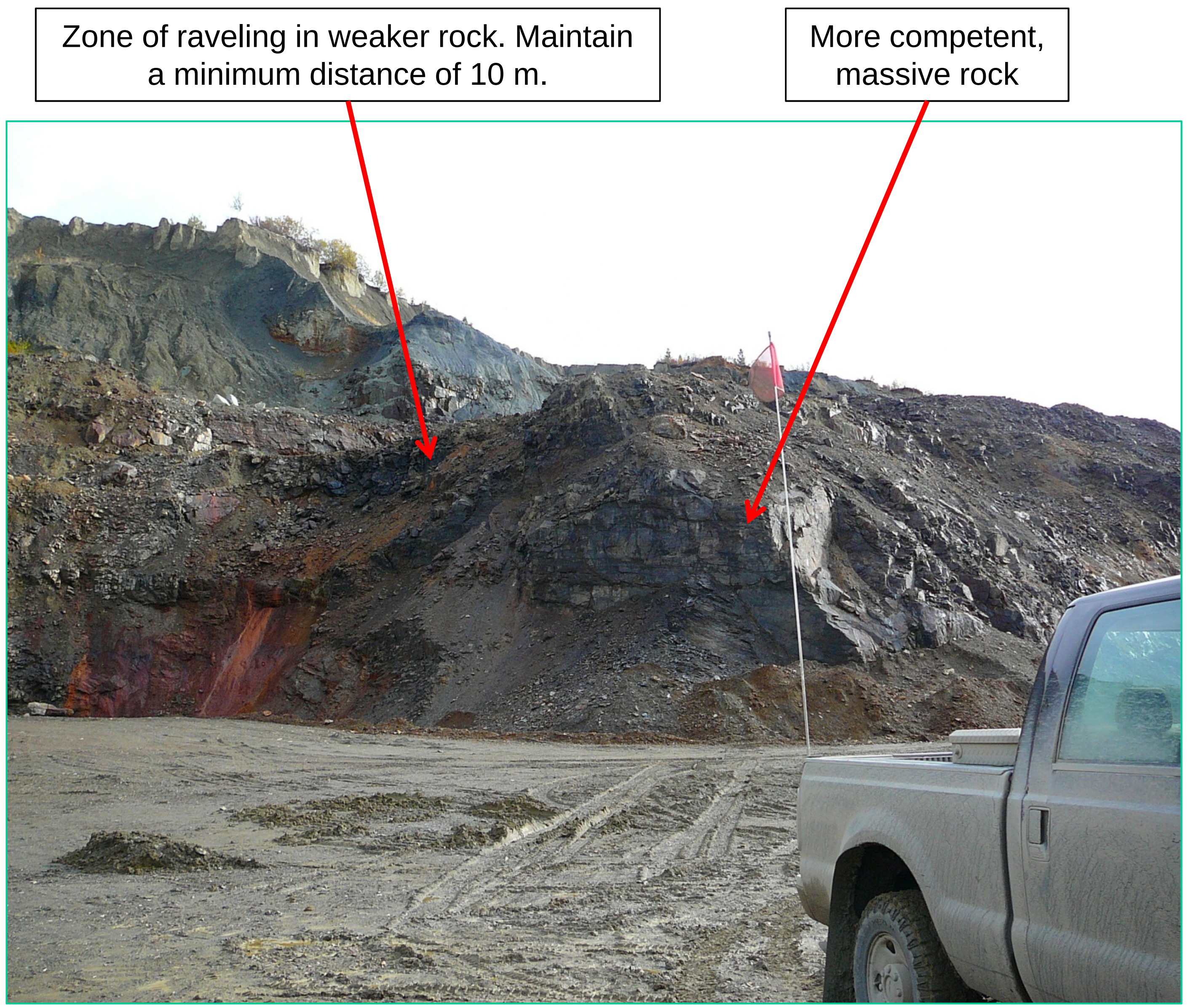
Photograph E-19
Vangorda Pit northeast wall.
View looking north-northeast.



Photograph E-20
Vangorda Pit southeast wall. View looking east-southeast.



Photograph E-21
Vangorda Pit access road, east slope. View looking northwest.



Photograph E-22
Vangorda Pit southeast wall. View looking west.

Photograph E-23
Vangorda Pit – West slope of access road. View looking south.

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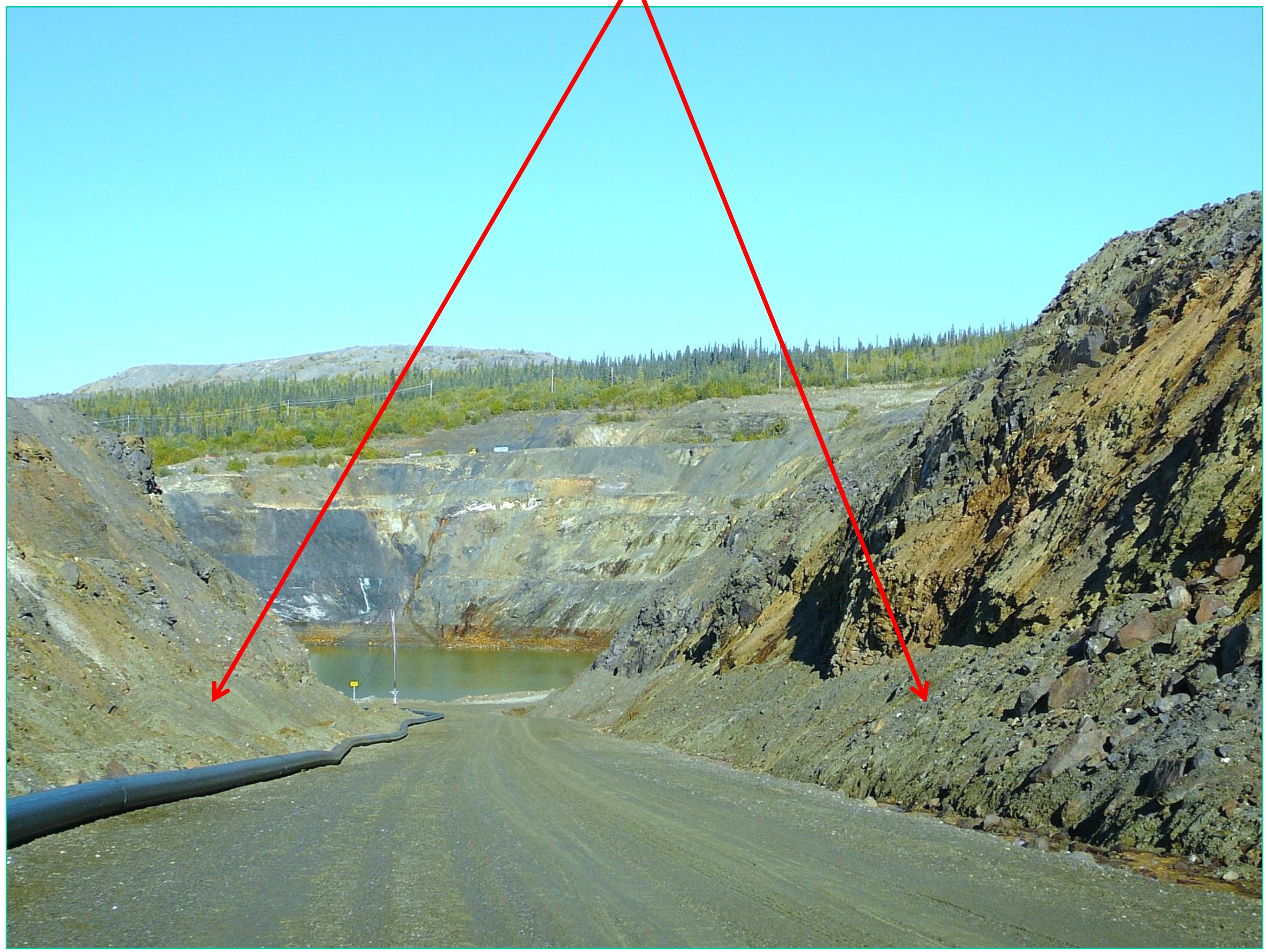
Doze this material into a berm, with a catch ditch between the berm and the slope.
Do not undercut the toe of the slope.



Photograph E-24
Vangorda Pit access road. View looking northwest.

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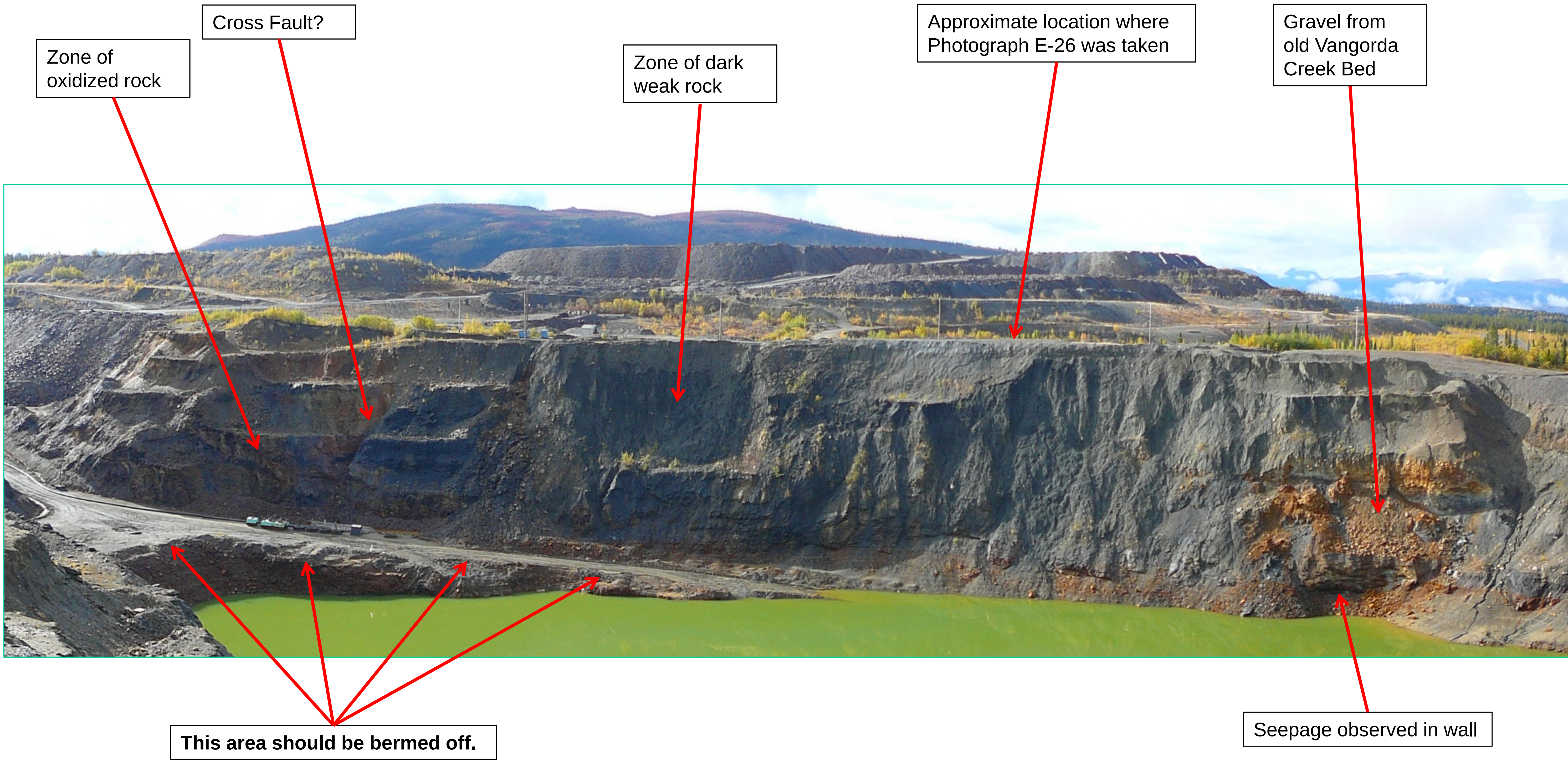

Photograph E-25
Vangorda Pit access road, west slope. View looking northwest.

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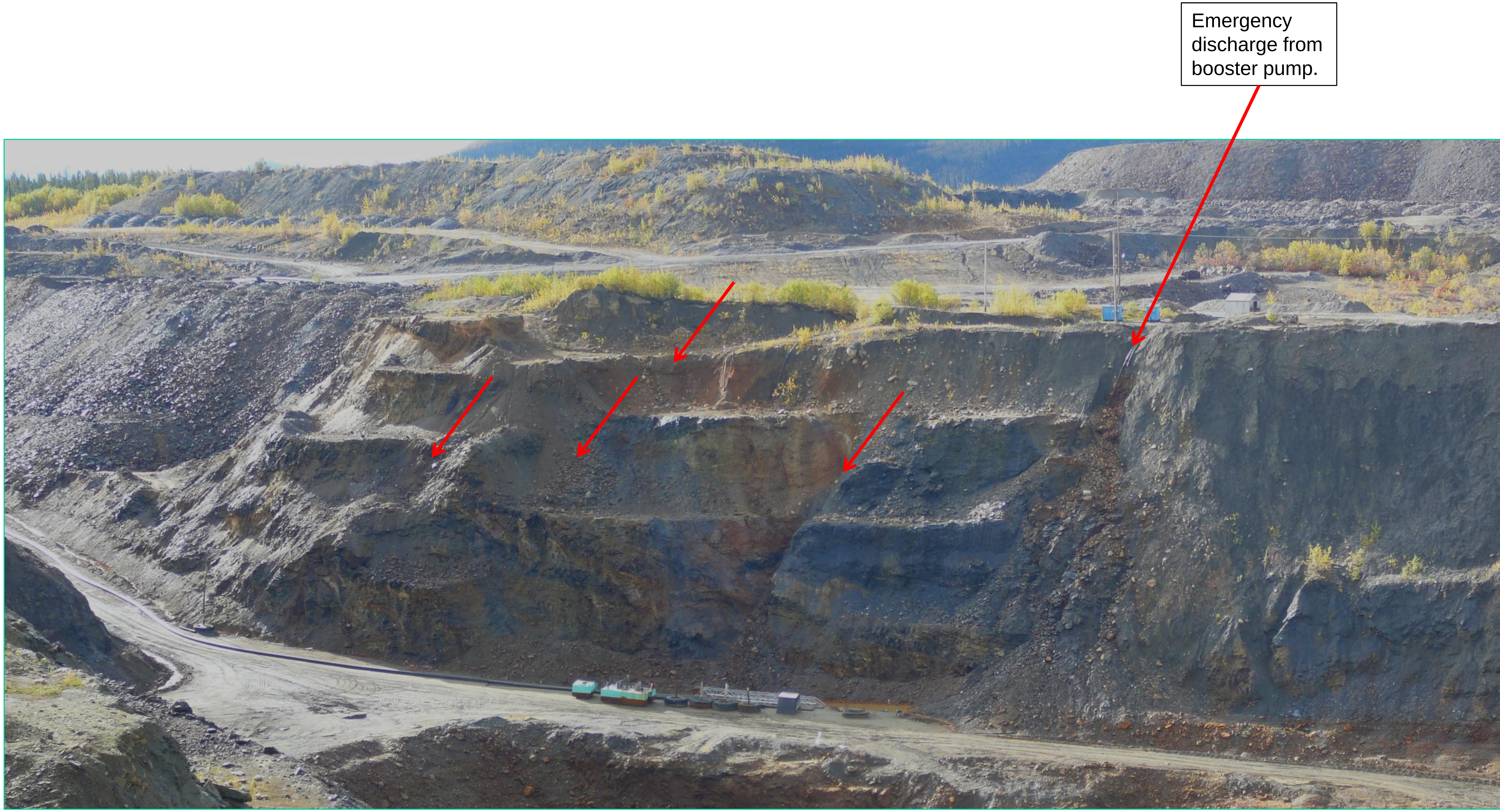
Use material at toe to make a berm. Leave a catch ditch between the berm and the slope. Do not undercut toe of slope.

Photograph E-26
Vangorda Pit west wall. View looking southeast.

Photograph E-27
Vangorda Pit west wall. View looking northwest.



Photograph E-28
Vangorda Pit – South side of southwest wall. Raveling in oxidized rock indicated by red arrows.
View looking south.

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Asia	+ 86 21 6258 5522
Australasia	+ 61 3 8862 3500
Europe	+ 356 21 42 30 20
North America	+ 1 800 275 3281
South America	+ 55 21 3095 9500

solutions@golder.com
www.golder.com

Golder Associates Ltd.
500 - 4260 Still Creek Drive
Burnaby, British Columbia, V5C 6C6
Canada
T: +1 (604) 296 4200

Golder Associates