# Revision 2016-1
# Physical Monitoring Plan
# Minto Mine, YT

Prepared by:
Minto Explorations Ltd.
Minto Mine
December 2016

# Minto Mine Physical Monitoring Plan

**First Issue: June 2014**

**REVISION INFORMATION**

| Rev. Number | Issue Date | Description & Revisions Made |
|---|---|---|
| - | June, 2014 | First issue |
| 2015-1 | November, 2015 | Annual update of existing instrumentation and monitoring frequencies.<br><br>Instruments Added: A215, A216, A217, A218, A2RAMP01, A2RAMP02, A2RAMP03, A2RAMP04, DSSH-26, DSSH-27, M82, M83, M84, M85, M86, M87, SWD06<br><br>Instruments Removed: DSI-14, DSI-21, DSSH-21, DSSH-22, DSSH-23, DSSH-25, WSP2 |
| 2016-1 | December, 2016 | Annual update of existing instrumentation and monitoring frequencies.<br><br>Instruments Added: DSP-07, DSP-08, DSP-10, DSSH-28, DSSH-29, DSSH-30, DSSH-31, MV1, MV2, SWD-07, SWD-08, SWD-09<br><br>Instruments Replaced: DSSH-06, DSSH-10, DSSH-15, DSSH-18, DSSH-19, DSSH-20<br><br>Instruments to be installed in 2016: DSI-22, DSI-23, SWD-10, SWD-11<br><br>Instruments Removed: A2RAMP01, A2RAMP02, A2RAMP03, A2RAMP04, SWD-02, SWD-02A, SWD-04A, SWD-05A, DSP-09 |

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# 1 Introduction

The following document describes the instrumentation and monitoring program currently in place at Minto to monitor the stability of mining structures including waste rock, tailings, and water storage facilities. The program consists of two main components: instrumentation to measure ground conditions and deformation, and regular geotechnical inspections. The following sections summarize inspection and data collection frequencies, instrument installation details and locations, and data collection procedures.

Mining and monitoring activities at Minto included in this plan are licensed under the following:

- Type A Water Licence QZ14-031, August, 2015
- Type B Water Licence MS15-094, July 2016
- Quartz Mining Licence QML-0001, December, 2014

Existing mine structures at Minto are shown in Figure 1-1, and described in the following section.

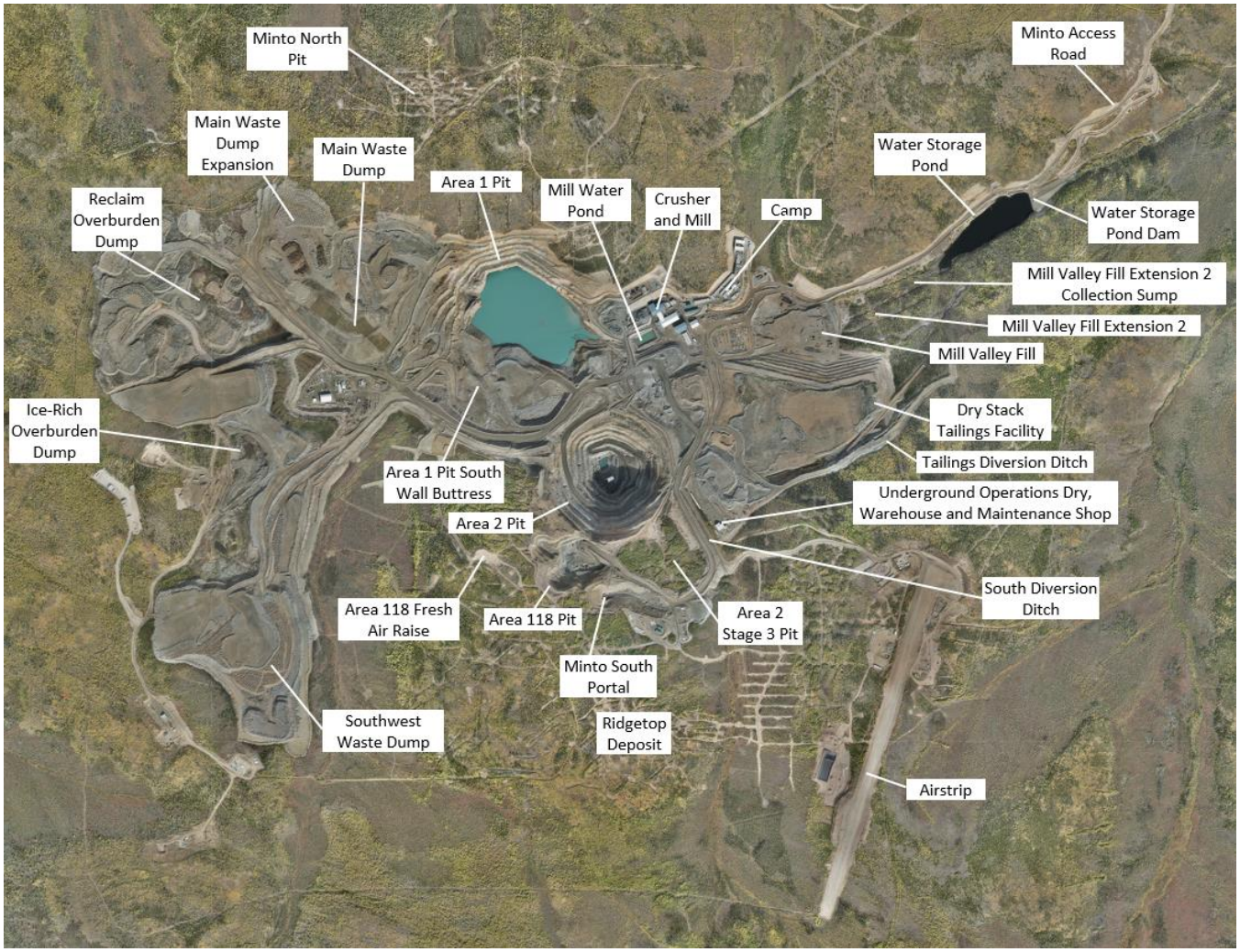


Figure 1-1: Minto site plan (October 2014)

# 2 Mine Structures

Mine structures currently being monitored at Minto as well as future structures included in the Phase V/VI plan are listed in Table 1.

**Table 1: Description of Mine Structures at Minto**

| Structure | Description | Instrumentation |
|---|---|---|
| Area 2 Pit and Area 2 Pit Tailings Management Facility (A2PTMF) | The Area 2 Pit was completed in 2015 to the extents licensed under Phase IV (Stages 1 and 2); the pit will be extended to the south as part of Phase V/VI (Stage 3), scheduled to commence in January, 2017.<br><br>Tailings deposition Area 2 Stage 2 pit (A2S2) began in March, 2015 and the pit is now maintained as a tailings management facility. | • Survey hubs<br>• GroundProbe radar (during A2S3 mining) |
| Area 2 Underground | The Area 2 underground began development in 2016 and is accessed by a portal and decline south of the Area 2 and Area 118 Pits. Production mining is currently taking place using a longhole stoping method and is expected to be completed in 2017. | None |
| Area 118 Pit | Mining of the Area 118 Pit was carried out in 2014. The pit is currently inactive and the access is barrricaded. As part of Area 2 Stage 3 pit mining, overburden will be dispatched to the Area 118 pit, scheduled to start in January, 2017. | • Survey hubs |
| Area 118 In-Pit Dump | The Area 118 In-Pit Dump is included in the Phase V/VI licence and has not commenced yet. The dump will fill in the Area 118 Pit. It is scheduled to commence in January, 2017 as part of A2S3 pit mining. | None |
| Area 118 Underground | The Area 118 underground began development in 2013 and was completed in 2016. It is accessed by a portal and decline south of the Area 2 and Area 118 Pits. Production mining took place using a longhole stoping method. | None |
| Big Creek Bridge | Bridge on the Minto access road crossing Big Creek, located at Km 19. Licenced under Type B water licence MS15-094. | None |
| Barge Landings | Barge landings on the Minto access road at the yukon river. Licensed under Type B water license MS15-094. | None |
| Camp | The camp consists of several connected bunkhouse buildings (Sherwood, Minto, Selkirk), a kitchen buidling, and several separate buildings including the gym and Site Services offices. | None |
| Dry Stack Tailings Storage Facility (DSTSF) | Construction of the DSTSF with filtered tailings placement was carried out from 2007 to November 2011. As part of progressive reclamation activities in 2012-2013, the DSTSF was covered with a layer of overburden approximately one to four meters thick. The DSTSF began showing deformation in 2009, interpreted as primarily horizontal sliding towards the north/northeast on an ice-rich layer in the underlying overburden, several meters above bedrock. The movement has continued since then but at a decreasing rate in response to construction of both the Mill Valley Fill waste rock buttress and the Mill Valley Fill Extension 2 waste rock buttress. | • Survey hubs<br>• Thermistors<br>• Inclinometers<br>• Piezometers |
| Ice Rich Overburden Dump (IROD) | Originally constructed as a free-standing rockfill structure to contain ice-rich overburden. The IROD is no longer active and is now entirely surrounded by the Southwest Waste Dump rockfill. | None |
| Main Pit (Area 1 Pit) and Main Pit Tailings Management Facility (MPTMF) | Mining in the Main Pit was completed in 2011. Instability in the south wall of the pit occurred in 2009 during mining of Stage 3 of the pit, and subsequently a larger failure occurred in 2011 after completion of Stage 5. Continued sloughing and creep movement of the south wall led to the design and | • Survey hubs<br>• Inclinometer |

| Structure | Description | Instrumentation |
|---|---|---|
| | construction of a waste rock buttress, known as the South Wall Buttress, completed in 2013.<br><br>Slurry tailings deposition into the pit began in 2012 and the pit is now maintained as a tailings management facility.<br><br>Dumping of NP:AP<3 waste rock (SAT), intended to be below the final water table at closure, continues into the pit, forming several benches of "in-pit dumps". Tension cracking on the west in-pit dump is monitored with a series of survey hubs installed in 2015 as recommended in previous inspection reports. | |
| Main Pit Dump | The Main Pit Dump is included in the Phase V/VI licence and has not commenced yet. The dump will be located on the southwest side of the Main Pit, partially on top of the South Wall Buttress. It is scheduled to commence in January, 2017 as part of A2S3 pit mining. | None |
| Main Waste Dump (MWD) | The Main Waste Dump stores waste rock released during the mining of the first three stages of the Main Pit. The dump is no longer active. | • Inclinometer |
| Main Waste Dump Expansion (MWDE) | This dump is an extension of the MWD that stores waste rock released from the Minto North Pit. The dump is no longer active. Reclamation re-sloping began in 2016. | • Inclinometer |
| Mill Site | The mill site consists of the mill building, crusher and crusher stockpile pad. | None |
| Mill Valley Fill Extension (MFVE) | A waste rock buttress to the north of the DSTSF, constructed from January 2012 to March 2013 to prevent or decrease movement of the DSTSF. | • Survey hubs |
| Mill Valley Fill Extension 2 (MVFE2) | An extension of the MVFE waste rock buttress to the northeast, constructed from November 2015 toAugust 2016 to further decrease movement of the DSTSF. | • Piezometers<br>• Survey hubs<br>• Inclinometers |
| Mill Valley Fill Extension 2 Collection Sump | A replacement sump for the Minto Creek Detention Structure (MCDS), constructed in 2016. It detains surface water considered impacted from upstream sub-catchment areas and directs it to the MPTMF or water treatment plant. | None |
| Minto Access Road | Road from the Yukon River barge crossing to the mine site. Licenced under Type B water licenceMS15-094. | None |
| Minto East, Copper Keel, Wildfire Underground | The Minto East, Copper Keel and Wildfire underground are in the phase V/VI mining plan and have not commenced yet. | N/A |
| Minto North Pit | Mining of the North Pit was completed in Septmember 2016. The pit is currently inactive and the access is barrricaded. | None |
| Ore Stockpiles | There are two primary ore stockpiles on site – North and South stockpile. These are located south of the crusher and east of the Area 2 pit. | None |

| Structure | Description | Instrumentation |
|---|---|---|
| Reclamation Overburden Dump (ROD) | Received the bulk of the overburden released as part of Phase IV and earlier mining of the Main Pit. The material in the ROD is available for use in reclamation of the mine at closure. | None |
| Ridgetop Pit (Ridgetop North Pit, Ridgetop South Pit) | The Ridgetop Pit (North and South) is included in the Phase V/VI licence and has not commenced yet. | • Thermistors |
| Ridgetop Waste Dump | The Ridgetop Waste Dump is included in the Phase V/VI licence and has not commenced yet. | N/A |
| South Diversion Ditch (SDD) | A diversion ditch located southeast of the Area 2 Pit to divert unimpacted surface water around the mine workings. | None |
| South Wall Buttress (SWB) | Waste rock buttress constructed against the Main Pit south wall from 2009-2011 as a result of instability in the south wall of the pit. | • Survey hubs |
| Southwest Waste Dump (SWD) | The Southwest Waste Dump (SWD) stores waste rock released during phase IV mining. Dumping at the SWD is now complete and reclamation re-sloping began in 2015. Re-sloping is expected to be completed in 2017. | • Survey hubs<br>• Inclinometers<br>• Thermistors<br>• Piezometers |
| Tailings Diversion Ditch (TDD) | A diversion ditch located south of the DSTSF to divert unimpacted water around the tailings facility. | None |
| Water Storage Pond Dam (WSP) | The Water Storage Pond and Dam are located east of the mine along Minto Creek. The dam was constructed in 2006 as a clay-core water retention dam for collecting precipitation and surface water runoff at the site. Maximum depth of water at the face of the dam is approximately 15 m. | • Survey hubs<br>• Thermistors<br>• Piezometers |

# 3 Design and Monitoring References

Table 2 lists the design reports for each structure and the monitoring/inspection guidance reports used to develop the inspection (Section 5) and instrumentation (Section 6) programs for each structure.

**Table 2: Design Documents and Monitoring/Inspection Guidance Documents**

| Structure | Design Reports | Monitoring/Inspection Guidance Reports |
|---|---|---|
| Area 2 Pit and Area 2 Pit Tailings Management Facility (A2PTMF) | *Prefeasibility Geotechnical Evaluation, Phase IV, Minto Mine.* SRK, December 2009.<br><br>*Review of Minto Area 2 West Wall Stability*. SRK, September 11, 2012.<br><br>*Review of Minto Area 2 West Wall Stability-April 2013*. SRK, April 18, 2013.<br><br>*Review of Minto Area 2 West Wall Stability-September 2013*. SRK, September 30, 2013.<br><br>*Main Dam – Area 2 Pit Stability Assessment.* SRK Consulting Project: 1CM002.003.0701, February, 2015. | *Operation, Maintenance, and Surveillance Manual - Area 2 Pit Tailings Management Facility* Revision 2015-2. Minto, December 2015.<br><br>*Minto Mine Operations Adaptive Management Plan* Revision 2016-01. Minto, May, 2016. |
| Area 2 Stage 3 Pit | *Pit Slope Stability Evaluation, Minto Mine, Area 2 Pit – Stage 3.* SRK Consulting Project: 219500.190, August 2015. | *Minto Mine Ground Control Plan – Open Pit Operations.* Minto, 2016. |
| Area 2 Underground | *Area 2 Mining Stability Assessment Summary*. Golder Associates, June, 2016.<br><br>*Area 2 Mining Stability Assessment Summary*. Golder Associates, December, 2016. | *Minto Mine Ground Control Plan – Underground Operations.* Minto, 2016. |
| Area 118 Pit | *Prefeasibility Geotechnical Evaluation, Phase IV, Minto Mine.* SRK, December 2009.<br><br>*Review of Final Area 118 Pit Design*. SRK Consulting, Project: 219500.070. January, 2015. | - |
| Area 118 In-Pit Dump | *Phase V/IV Ridgetop South and Area 118 Backfill Dumps Physical Stability Assessment.* SRK, October 2013. | - |
| Area 118 Underground | *Minto 118-Zone – FLAC3D Analysis of the Longhole Base Case Option.* Itasca, August 2014.<br><br>*Geotechnical Characterization of Existing and Proposed Longhole Open Stope Mining Areas.* Golder Associates File: 1528754-002-R-Rev0-3000. July 30, 2015.<br><br>*Longhole Open Stope Stability Addendum – Revised Mining Heights.* Golder Associates, File 1528754-006-TM-Rev0-3000, November 2015. | *Minto Mine Ground Control Plan – Underground Operations.* Minto, 2016.<br><br>*Ground Control Management Plan Review*. Golder Associates, File 1528754-007-TM-Rev0-1000. September 2015. |

| Structure | Design Reports | Monitoring/Inspection Guidance Reports |
|---|---|---|
| | *Area 118 Plunge Mining Stability Assessment Summary.* Golder Associates, File: 1528754-008-PP-Rev0-5000, December 2015 | |
| Big Creek Bridge | - | - |
| Camp | - | - |
| Dry Stack Tailings Storage Facility (DSTSF) | *Geotechnical Design Report, Dry Stack Tailings Storage Facility, Minto Mine, Yukon*. EBA File: 1200173. January 2007. | *Operation, Maintenance, and Surveillance Manual, Dry Stack Tailings Storage Facility, Minto Mine, YT.* Revision 2014-1 Minto, November 2014.<br><br>*Minto Mine Operations Adaptive Management Plan.* Revision 2016-01. Minto, May, 2016. |
| Ice Rich Overburden Dump (IROD) | *Geotechnical Design Ice-Rich Overburden Dump, Minto Mine, Minto, YT.* EBA file: 1200173. January 2006.<br><br>*Ice-Rich Overburden Dump Containment Berm Inspection Report, Minto Mine Site, Minto Yukon.* EBA File: 1200173.001. June 19, 2007. | *Geotechnical Design Ice-Rich Overburden Dump, Minto Mine, Minto, YT.* EBA file: 1200173. January 2006. EBA, 2007.<br><br>*Minto Mine Operations Adaptive Management Plan* Revision 2016-01. Minto, May, 2016.<br>. |
| Main Pit (Area 1 Pit) and Main Pit Tailings Management Facility (MPTMF) | *Pit Slope Evaluation for Area 1 Open Pit.* SRK Consulting, Project: 2CM022.03, July 2007.<br><br>*SAT Dump on Tailings.* SRK Consulting Project: 1CM002.043, March 2016. | *Operation, Maintenance, and Surveillance Manual - Main Pit Tailings Management Facility*. Revision 2015-2 Minto, December, 2015.<br><br>*Minto Mine Operations Adaptive Management Plan* Revision 2016-01. Minto, May, 2016. |
| Main Pit Dump | *Phase V/VI Main Pit Dump Physical Stability Assessment.* SRK Consulting Project: 1CM002.003.0701, November, 2013.<br><br>*Update to the Main Pit Dump Physical Stability Assessment.* SRK Consulting Project: 1CM002.003.0701. February, 2015. | - |
| Main Waste Dump (MWD) | *Geotechnical Evaluation Proposed Main Waste Dump Minto Mine, Minto, YT.* EBA. April, 1998. | *Geotechnical Evaluation Proposed Main Waste Dump Minto Mine, Minto, YT.* EBA. April, 1998.<br><br>*Minto Mine Operations Adaptive Management Plan* Revision 2016-01. Minto, May, 2016. |
| Main Waste Dump Expansion (MWDE) | *Minto Mine Phase V/VI Expansion Waste Rock and Overburden Management Plan.* Minto. June, 2014.<br><br>*Phase V/VI Main Waste Dump Expansion – Physical Stability Assessment.* SRK Consulting Project: 1CM002.012.012, November, 2013 | *Minto Mine Operations Adaptive Management Plan* Revision 2016-01. Minto, May, 2016. |
| Mill Site | - | - |

| Structure | Design Reports | Monitoring/Inspection Guidance Reports |
|---|---|---|
| Mill Valley Fill Extension (MFVE) | *Waste Rock and Overburden Management Plan, Phase IV Development, Minto Mine YT.* EBA File: W14101068.015. September 9, 2011.<br><br>*Upstream Water Management for the Mill Valley Fill Expansion and Dry Stack Tailings Storage Facility.* EBA File: W14101168.013. September 14, 2011. | *Minto Mine Operations Adaptive Management Plan* Revision 2016-01. Minto, May, 2016. |
| Mill Valley Fill Extension 2 (MVFE2) | *Minto Mine Phase V/VI Expansion Waste Rock and Overburden Management Plan.* Minto. June, 2014.<br><br>*Mill Valley Fill Extension Stage 2 Preliminary Design Report.* SRK Consulting Project: 1CM002.015. March, 2014<br><br>*Mill Valley Fill Extension Stage 2 Final Design Report.* SRK Consulting Project: 1CM002.040. September, 2015.<br><br>*Mill Valley Fill Extension Stage 2 Record of Construction.* Minto. November, 2016. | *Mill Valley Fill Extension Stage 2 – Expected Performance and Evaluation Criteria.* SRK Consulting Project: 1CM002.050, November, 2016.<br><br>*Minto Mine Operations Adaptive Management Plan* Revision 2016-01. Minto, May, 2016.<br>. |
| Mill Valley Fill Extension 2 Collection Sump | *Design for the MVFE Stage 2 Collection Sump.* SRK Consulting Project: 1CM002.020. June, 2015.<br><br>*Mill Valley Fill Extension Stage 2 Colleciton Sump Record of Construction*. Minto. April, 2016. | - |
| Minto Access Road | - | - |
| Minto East, Copper Keel, Wildfire Underground | *Wildfire Proposed Underground Mine Area – Geotechnical Characterization and Long Hole Open Stope Stability Assessment.* Golder Associates, September, 2016.<br><br>*Minto East – Revised Longhole Open Stope Stability.* Golder Associates, File: 1528754-009-TM-Rev0-6000, January, 2016.<br><br>*Geotechnical Characterization of Existing and Proposed Longhole Open Stope Mining Areas,* Golder Associates, Reference No. 1528754-002-R-Rev0-3000, July, 2015.<br><br>*Minto Mine Underground Reserve Update Geotechnical Input*, Golder Associates, Reference No. 1528754-003-R-Rev0-3000, July, 2015.<br><br>*Minto Phase VI Underground Geotech Evaluation*, SRK Consulting Project: 2UC031.005, February, 2012. | - |
| Minto North Pit | *Minto North South Wall Wedge Analysis.* SRK, August, 2016.<br><br>*Site Visist and Review of North Pit – South Wall.* BGC Engineering, July, 2016.<br><br>*Review of Minto North Wall Stability.* SRK, May, 2016. | *Minto Open Pit Ground Control Plan_Rev0.* Minto, 2016. |

| Structure | Design Reports | Monitoring/Inspection Guidance Reports |
|---|---|---|
| | *Minto Phase VI Preliminary Feasibility Study Technical Report.* SRK, January 2012. | |
| Ore Stockpiles | - | - |
| Reclamation Overburden Dump (ROD) | *Geotechnical Design Proposed Reclamation Overburden Dump, Minto Mine, Yukon.* EBA File: W14101068.004. February 2008.<br><br>*Reclamation Overburden Dump Expansion Geotechnical Design Report.* EBA File: W14101068.0040. June 29, 2010. | *Reclamation Overburden Dump Expansion Geotechnical Design Report.* EBA File: W14101068.0040. June 29, 2010.<br><br>*Minto Mine Operations Adaptive Management Plan* Revision 2016-01. Minto, May, 2016. |
| Ridgetop Pit (Ridgetop North Pit, Ridgetop South Pit) | *Pre-Feasibility Geotechnical Evaluation Phase IV Minto Mine,* SRK Consulting Project: 2CM022.006, December, 2009.<br><br>*Ridgetop North Pit TMF Stability Assessment,* SRK Consulting Project: 1CM002.003.710, February, 2015. | - |
| Ridgetop Waste Dump | *Phase V/VI Ridgetop Waste Dump Physical Stability Assessment.* SRK Consulting Project: 1CM002.012.0.12, November, 2013. | - |
| South Diversion Ditch (SDD) | *Phase 1 – Preliminary Engineering, Stormwater Diversion Ditches Minto Mine, YT,* EBA File: W14101068.013 | - |
| South Wall Buttress | *Area 1 South Wall Buttress Design Report, Minto Mine, Yukon.* EBA File: W141010668.012, July 2011. | - |
| Southwest Waste Dump (SWD) | *Geotechnical Design Proposed Southwest Waste Dump, Minto Mine, Yukon.* EBA File: W14101068.005. September 2008. | *Geotechnical Design Proposed Southwest Waste Dump, Minto Mine, Yukon.* EBA File: W14101068.005. September 2008.<br><br>*Minto Mine Operations Adaptive Management Plan* Revision 2016-01. Minto, May, 2016. |
| Tailings Diverion Ditch (TDD) | *Preliminary Design of the Tailings Diversion Ditch Upgrade,* SRK Consulting Project: 1CM002.012.006, November, 2013. | - |
| Water Storage Pond Dam (WSP) | *Geotechnical Design Tailings/Water Dam, Minto Project, Yukon.* EBA File: 0201-95-11509. Dec. 1995.<br><br>*As-built Construction Report, Water Retention Dam, Minto Mine, Minto, YT.* EBA File: 1200173.001. April 2008. | *Operation, Maintenance and Surveillance Manual, Water Retention Dam, Minto Mine, Minto, YT.* EBA File: W14103414-01. August 2014. |

# 4 Roles and Responsbilities

Table 3 lists the roles and responsibilites for physical monitoring on the site.

**Table 3: Roles and Responsibilities**

| Role | Responsibilities |
|---|---|
| Mine Technician Assistants | • Collect instrumentation data at specified frequencies<br>• Input data into monitoring spreadsheets/databases<br>• Internal reporting of monitoring data<br>• Maintain equipment |
| Geotechnical Engineers | • QA/QC of data collection<br>• Ensure compliance with license requirements<br>• Monthly and annual Water Licence reporting<br>• Visual inspections at specified frequencies<br>• Communicate with consultants as required<br>• Review and update Physical Monitoring Plan |
| Environmental Officers | • Compile monthly and annual Water Licence reports<br>• Visual inspections of water diversion/collection structures |
| Chief Engineer | • Review monthly and annual Water Licence reports<br>• Ensure compliance with licence requirements |

# 5 Inspections

Table 4 lists the regular, required inspections.

**Table 4: Inspections**

| Structure | Frequency | Description |
|---|---|---|
| Area 2 Pit and Area 2 Pit Tailings Management Facility (A2PTMF) | Quarterly | Visual inspection by Geotechnical Engineer and review of monitoring data as per OMS Manual. |
| Area 2 Stage 3 Pit | Weekly (during active mining) | Weekly visual inspection by Geotechnical Engineer/EIT during active pit mining. Documented in weekly wall inspection report and two-week operating plan documents. |
| Area 2 Underground | Quarterly | Visual inspection by Geotechnical Engineer as per Underground Ground Control Plan. |
| Area 118 Pit | Semi-Annually – May/June post thaw, and September pre freeze-up | Included in site-wide geotechnical inspection - Inspection and data review by Professional Engineer as per QZ14-031 (Clause 100) and QML-0001 (Clause 13.2). Q2 inspection must be completed by an independent engineer by June 30 each year. |
| Area 118 In-Pit Dump | Minimum every 4 hours during active dumping | Visual inspection by the supervisor or other competent person (typically the Pelly Shifter or Minto Operations Supervisor) as per O.I.C. 2006/178 Clause 15.44. |
| Area 118 Underground | N/A | No longer accessible. |
| Big Creek Bridge | Annually | Visual inspection by a Professional Engineer as per MS15-094. |
| Camp | Semi-Annually – May/June post thaw, and September pre freeze-up | Included in site-wide geotechnical inspection - Inspection and data review by Professional Engineer as per QZ14-031 (Clause 100) and QML-0001 (Clause 13.2). Q2 inspection must be completed by an independent engineer by June 30 each year. |
| Dry Stack Tailings Storage Facility (DSTSF) | Monthly | Visual inspection by Geotechnical Engineer and review of monitoring data as per OMS Manual. |
| Ice Rich Overburden Dump (IROD) | Semi-Annually – May/June post thaw, and September pre freeze-up | Included in site-wide geotechnical inspection - Inspection and data review by Professional Engineer as per QZ14-031 (Clause 100) and QML-0001 (Clause 13.2). Q2 inspection must be completed by an independent engineer by June 30 each year. |
| Main Pit (Area 1 Pit) and Main Pit Tailings Management Facility (MPTMF) | Quarterly | Visual inspection by Geotechnical Engineer and review of monitoring data as per OMS Manual. |

| Structure | Frequency | Description |
|---|---|---|
| Main Pit Dump | Minimum every 4 hours during active dumping | Visual inspection by the supervisor or other competent person (typically the Pelly Shifter or Minto Operations Supervisor) as per O.I.C. 2006/178 Clause 15.44. |
| Main Waste Dump (MWD) | Semi-Annually – May/June post thaw, and September pre freeze-up | Included in site-wide geotechnical inspection - Inspection and data review by Professional Engineer as per QZ14-031 (Clause 100) and QML-0001 (Clause 13.2). Q2 inspection must be completed by an independent engineer by June 30 each year. |
| Main Waste Dump Expansion (MWDE) | Semi-Annually – May/June post thaw, and September pre freeze-up | Included in site-wide geotechnical inspection - Inspection and data review by Professional Engineer as per QZ14-031 (Clause 100) and QML-0001 (Clause 13.2). Q2 inspection must be completed by an independent engineer by June 30 each year. |
| Mill Site | Semi-Annually – May/June post thaw, and September pre freeze-up | Included in site-wide geotechnical inspection - Inspection and data review by Professional Engineer as per QZ14-031 (Clause 100) and QML-0001 (Clause 13.2). Q2 inspection must be completed by an independent engineer by June 30 each year. |
| Mill Valley Fill Extension (MFVE) | Monthly | Visual inspection by Geotechnical Engineer and review of monitoring data as part of DSTSF monthly inspection. |
| Mill Valley Fill Extension 2 (MVFE2) | Monthly | Visual inspection by Geotechnical Engineer and review of monitoring data as part of DSTSF monthly inspection. |
| Mill Valley Fill Extension 2 Collection Sump | Monthly | Visual inspection by Geotechnical Engineer and review of monitoring data as part of DSTSF monthly inspection. |
| Minto Access Road | Annually | Visual inspection by a Professional Engineer as per MS15-094. |
| Minto East, Copper Keel, Wildfire Underground | N/A | N/A – structure does not exist yet. |
| Minto North Pit | Semi-Annually – May/June post thaw, and September pre freeze-up | Included in site-wide geotechnical inspection - Inspection and data review by Professional Engineer as per QZ14-031 (Clause 100) and QML-0001 (Clause 13.2). Q2 inspection must be completed by an independent engineer by June 30 each year. |
| Ore Stockpiles | Semi-Annually – May/June post thaw, and September pre freeze-up | Included in site-wide geotechnical inspection - Inspection and data review by Professional Engineer as per QZ14-031 (Clause 100) and QML-0001 (Clause 13.2). Q2 inspection must be completed by an independent engineer by June 30 each year. |
| Reclamation Overburden Dump (ROD) | Semi-Annually – May/June post thaw, and September pre freeze-up | Included in site-wide geotechnical inspection - Inspection and data review by Professional Engineer as per QZ14-031 (Clause 100) and QML-0001 (Clause 13.2). Q2 inspection must be completed by an independent engineer by June 30 each year. |

| Structure | Frequency | Description |
|---|---|---|
| Ridgetop Pit (Ridgetop North Pit, Ridgetop South Pit) | N/A | N/A – structure does not exist yet. |
| Ridgetop Waste Dump | N/A | N/A – structure does not exist yet. |
| South Diversion Ditch (SDD) | Semi-Annually – May/June post thaw, and September pre freeze-up | Included in site-wide geotechnical inspection - Inspection and data review by Professional Engineer as per QZ14-031 (Clause 100) and QML-0001 (Clause 13.2). Q2 inspection must be completed by an independent engineer by June 30 each year. |
| South Wall Buttress (SWB) | Quarterly | Visual inspection by Geotechnical Engineer and review of monitoring data as part of the MPTMF quarterly inspection. |
| Southwest Waste Dump (SWD) | Semi-Annually – May/June post thaw, and September pre freeze-up | Included in site-wide geotechnical inspection - Inspection and data review by Professional Engineer as per QZ14-031 (Clause 100) and QML-0001 (Clause 13.2). Q2 inspection must be completed by an independent engineer by June 30 each year. |
| Tailings Diversion Ditch (TDD) | Semi-Annually – May/June post thaw, and September pre freeze-up | Included in site-wide geotechnical inspection - Inspection and data review by Professional Engineer as per QZ14-031 (Clause 100) and QML-0001 (Clause 13.2). Q2 inspection must be completed by an independent engineer by June 30 each year. |
| Water Storage Pond Dam (WSP) | Monthly | Visual inspection by Geotechnical Engineer as per OMS Manual. |

# 6 Instrumentation

A map of site wide active instrumentation is shown in Appendix A. Installation information and data collection schedules are contained in the following sections.

## Inclinometers

Inclinometers are used to measure lateral, differential ground movement in a borehole. Inclinometer stations consist of grouted, slotted PVC pipe into which the inclinometer probe is lowered and deflection is measured at 0.5m intervals. The current probe used on site is an RST digital MEMS inclinometer system.

**Table 5: Inclinometers**

| Area | ID | Northing (m) | Easting (m) | Elevation (m) | A0 Azimuth | Hole Depth (m) | Date Installed | Reading Frequency |
|---|---|---|---|---|---|---|---|---|
| Area 2 Pit | A2I-1 | 6944164.73 | 385298.95 | 822.46 | 302 | 55.5 | 2013-04-26 | Quarterly |
| Dry Stack Tailings Storage Facility and Mill Valley Fill Extension 2 | DSI-22 | - | - | - | - | - | To be installed in Q4 2016 | Bi-weekly |
| Dry Stack Tailings Storage Facility and Mill Valley Fill Extension 2 | DSI-23 | - | - | - | - | - | To be installed in Q4 2016 | Bi-weekly |
| Dry Stack Tailings Storage Facility and Mill Valley Fill Extension 2 | DSI-24 | - | - | - | - | - | To be installed in Q4 2016 | Bi-weekly |
| Main Pit (Area 1 Pit) and Main Pit Tailings Management Facility (MPTMF) | MDI -2 | 6945013.08 | 384217.20 | 858.67 | 93 | 50.5 | 2010-02-10 | Quarterly |
| Southwest Waste Dump | SDI-3 | 6944591.11 | 383966.00 | 847.42 | 90 | 46.5 | 2010-02-11 | Quarterly |

## Survey Hubs

Survey hubs are used to monitor surface movement of structures and are comprised of steel posts cemented into waste rock or bedrock and equipped with a threaded base to which a high precision RTK-corrected GPS instrument is attached. The GPS currently used on site is a Trimble R8.

**Table 6: Survey Hubs**

| Area | ID | Northing (m) | Easting (m) | Elevation (m) | Date Installed | Frequency |
|---|---|---|---|---|---|---|
| Area 2 Pit | A210 | 6944268.42 | 384934.69 | 861.28 | 2011-07-01 | Monthly |
| Area 2 Pit | A215 | 6944649.45 | 385155.49 | 808.72 | 2015-09-17 | Monthly |
| Area 2 Pit | A216 | 6944749.21 | 385046.39 | 805.78 | 2015-09-17 | Monthly |
| Area 2 Pit | A217 | 6944756.78 | 384852.52 | 806.68 | 2015-09-17 | Monthly |
| Area 2 Pit | A218 | 6944707.23 | 384783.21 | 806.83 | 2015-09-17 | Monthly |
| Dry Stack Tailings Storage Facility | ASH05 | 6944280.52 | 385830.65 | 850.16 | 2011-03-07 | Monthly |
| Dry Stack Tailings Storage Facility | ASH06 | 6944331.73 | 385623.79 | 824.17 | 2011-03-07 | Monthly |
| Dry Stack Tailings Storage Facility | DSSH-24 | 6944757.90 | 385712.10 | 792.07 | 2014-02-28 | Weekly |
| Dry Stack Tailings Storage Facility | DSSH-26 | 6944601.28 | 385490.96 | 796.35 | 2015-07-28 | Weekly |
| Dry Stack Tailings Storage Facility | DSSH-27 | 6944755.11 | 385894.59 | 792.70 | 2015-07-28 | Weekly |
| Dry Stack Tailings Storage Facility | DSSH-06 | 6944971.372 | 385553.396 | 783.866 | 2016-08-21 | Weekly |
| Dry Stack Tailings Storage Facility | DSSH-10 | 6944992.584 | 385806.037 | 769.004 | 2016-08-21 | Weekly |
| Dry Stack Tailings Storage Facility | DSSH-12 | 6944947.303 | 385707.165 | 778.364 | 2016-08-16 | Weekly |
| Dry Stack Tailings Storage Facility | DSSH-14 | 6944920.27 | 385606.55 | 782.88 | 2012-04-21 | Weekly |
| Dry Stack Tailings Storage Facility | DSSH-15 | 6944944.092 | 385490.104 | 784.82 | 2016-08-16 | Weekly |
| Dry Stack Tailings Storage Facility | DSSH-17 | 6944980.74 | 385896.26 | 772.07 | 2012-04-21 | Weekly |
| Dry Stack Tailings Storage Facility | DSSH-18 | 6945070.727 | 385513.039 | 782.379 | 2016-08-16 | Weekly |
| Dry Stack Tailings Storage Facility | DSSH-19 | 6945109.679 | 385575.406 | 781.303 | 2016-08-16 | Weekly |
| Dry Stack Tailings Storage Facility | DSSH-20 | 6945072.083 | 385754.334 | 775.779 | 2016-08-21 | Weekly |
| Dry Stack Tailings Storage Facility | DSSH-28 | 6945045.688 | 385931.012 | 767.752 | 2016-08-21 | Weekly |
| Dry Stack Tailings Storage Facility | DSSH-29 | 6945162.176 | 385833.535 | 766.045 | 2016-08-21 | Weekly |
| Dry Stack Tailings Storage Facility | DSSH-30 | 6944883.247 | 385890.044 | 789.008 | 2016-08-21 | Weekly |
| Dry Stack Tailings Storage Facility | DSSH-31 | 6945030.732 | 386040.736 | 776.254 | 2016-11-01 | Weekly |
| Dry Stack Tailings Storage Facility | MV1 | 6945249.731 | 386021.140 | 727.554 | 2016-04-04 | Weekly |
| Dry Stack Tailings Storage Facility | MV2 | 6945216.537 | 385979.321 | 740.349 | 2016-04-04 | Weekly |
| South Wall Buttress | M73 | 6944723.57 | 384312.30 | 840.77 | 2011-05-23 | Monthly |

| Area | ID | Northing (m) | Easting (m) | Elevation (m) | Date Installed | Frequency |
|---|---|---|---|---|---|---|
| South Wall Buttress | M75 | 6944639.43 | 384475.64 | 837.55 | 2011-05-23 | Monthly |
| South Wall Buttress | M76 | 6944623.10 | 384560.12 | 835.27 | 2011-05-23 | Monthly |
| South Wall Buttress | M79 | 6944846.97 | 384208.90 | 847.66 | 2011-09-04 | Monthly |
| South Wall Buttress | M80 | 6944931.70 | 384256.33 | 842.06 | 2011-09-04 | Monthly |
| Main Pit | M81 | 6944971.63 | 384890.13 | 806.83 | 2012-05-08 | Monthly |
| South Wall Buttress | M82 | 6944844.39 | 384433.50 | 820.17 | 2015-05-23 | Bi-weekly |
| South Wall Buttress | M83 | 6944947.98 | 384475.79 | 809.06 | 2015-01-08 | Bi-weekly |
| South Wall Buttress | M84 | 6945021.46 | 384445.11 | 807.37 | 2015-01-08 | Bi-weekly |
| South Wall Buttress | M85 | 6944846.60 | 384315.66 | 826.08 | 2015-07-27 | Monthly |
| South Wall Buttress | M86 | 6944668.03 | 384400.26 | 837.96 | 2015-07-27 | Monthly |
| South Wall Buttress | M87 | 6944894.30 | 384383.86 | 821.67 | 2015-09-19 | Bi-weekly |
| Southwest Waste Dump | SWD01 | 6944760.85 | 384077.86 | 859.07 | 2011-03-07 | Monthly |
| Southwest Waste Dump | SWD05A | 6943939.94 | 383837.70 | 869.16 | 2011-03-07 | Monthly |
| Southwest Waste Dump | SWD06 | 6944762.06 | 384189.37 | 836.42 | 2015-07-27 | Monthly |
| Southwest Waste Dump | SWD07 | 6944743.49 | 384111.649 | 840.00 | 2016-11-21 | Monthly |
| Southwest Waste Dump | SWD08 | 6944560.14 | 383883.182 | 867.25 | 2016-11-21 | Monthly |
| Southwest Waste Dump | SWD09 | 6944163.106 | 383790.749 | 861.532 | 2016-11-21 | Monthly |
| Southwest Waste Dump | SWD10 | -To be installed Q1, 2017 as a replacement for SWD-05A | | | | Monthly |
| Southwest Waste Dump | SWD11 | To be installed Q1, 2017 as a replacement for SWD-03A | | | | Monthly |
| Water Storage Pond Dam | WSP1 | 6945613.04 | 386480.98 | 723.31 | 2011-06-09 | Monthly |
| Water Storage Pond Dam | WSP3 | 6945551.85 | 386548.62 | 719.73 | 2011-06-09 | Monthly |
| Water Storage Pond Dam | WSP4 | 6945531.56 | 386555.22 | 719.93 | 2011-06-09 | Monthly |
| Water Storage Pond Dam | WSP5 | 6945504.74 | 386560.23 | 721.02 | 2011-06-09 | Monthly |

## Thermistors

Thermistor strings are used to measure ground temperature profiles in boreholes, and in particular permafrost conditions at Minto. Thermistor strings consist of multiple temperature sensor nodes distributed along a single multi-conductor cable, installed within or attached to the outside of grouted PVC pipe. EBA and RST thermistor strings have been installed on site. EBA thermistors are read using a basic ohmmeter and RST thermistors are read using a RST TH2016B readout unit.

**Table 7: Thermistors**

| Area | ID | Northing (m) | Easting (m) | Elevation (m) | Thermistor String No. | Nodes | Hole Depth (m) | Date Installed | Reading Frequency |
|---|---|---|---|---|---|---|---|---|---|
| Area 2 Pit | A2T-1 | 6944162.01 | 385305.61 | 822.39 | 3491 | 16 | 63.4 | 2013-04-21 | Quarterly |
| Dry Stack Tailings Storage Facility | DST-10 | 6944584.06 | 385489.49 | 797.13 | 3492 | 16 | 63.4 | 2013-04-17 | Quarterly |
| Dry Stack Tailings Storage Facility | DST-11 | 6944899.64 | 385538.89 | 787.66 | 3494 | 16 | 86.9 | 2013-04-05 | Quarterly |
| Dry Stack Tailings Storage Facility | DST-13 | 6945014.60 | 386271.29 | 777.01 | 3495 | 16 | 101.5 | 2013-04-02 | Quarterly |
| Dry Stack Tailings Storage Facility | DST-14 | 6944769.09 | 385713.42 | 791.47 | 3497 | 16 | 66.5 | 2013-04-12 | Quarterly |
| Dry Stack Tailings Storage Facility | DST-15 | 6945033.78 | 385958.17 | 764.51 | 3493 | 16 | 64.0 | 2013-03-25 | Quarterly |
| Water Storage Pond | WDT-1 | 6945523.08 | 386550.83 | 720.03 | 2072 | 16 | 42.49 | 2007-11-16 | Monthly |
| Water Storage Pond | WDT-2 | 6945532.89 | 386574.77 | 713.66 | 2073 | 6 | 44.50 | 2007-11-07 | Monthly |
| Water Storage Pond | WDT-3 | 6945544.10 | 386544.43 | 719.78 | 2074 | 16 | 49.42 | 2007-11-11 | Monthly |
| Water Storage Pond | WDT-4 | 6945534.98 | 386547.90 | 719.85 | 2075 | 16 | 49.42 | 2007-11-10 | Monthly |
| Water Storage Pond | WDT-5 | 6945504.57 | 386557.50 | 721.03 | 2076 | 16 | 35.13 | 2007-11-13 | Monthly |
| Water Storage Pond | WDT-6 | 6945505.55 | 386556.32 | 721.03 | 2077 | 16 | 33.72 | 2007-11-13 | Monthly |
| Water Storage Pond | WDT-7 | 6945504.65 | 386556.39 | 721.08 | 2078 | 16 | 33.92 | 2007-11-13 | Monthly |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Water Storage Pond | WDT-8 | 6945532.89 | 386574.77 | 713.66 | 2079 | 16 | 34.14 | 2007-11-07 | Monthly |
| Southwest Waste Dump | SDT-1 | 6944766.71 | 384779.13 | 836.36 | 2220 | 16 | 59.1 | 2010-02-04 | Quarterly |
| Southwest Waste Dump | SDT-2 | 6944595.06 | 383971.30 | 847.11 | 2221 | 16 | 14.6 | 2010-01-31 | Quarterly |
| Southwest Waste Dump | SDT-3 | 6944333.87 | 383824.67 | 860.17 | 2222 | 16 | 15.8 | 2010-01-28 | Quarterly |
| Southwest Waste Dump | SDT-4 | 6944163.62 | 383783.54 | 860.99 | 2223 | 16 | 13.1 | 2010-01-30 | Quarterly |

## Vibrating Wire Piezometers

Vibrating wire piezometer strings are used to measure piezometric pressure profiles in boreholes. They consist of multiple vibrating wire sensors installed on PVC pipe in grouted boreholes. RST vibrating wire piezometers are installed on site and data is collected with an RST VW2106 readout unit.

**Table 8: Vibrating Wire Piezometers**

| Area | ID | Northing (m) | Easting (m) | Elevation (m) | Sensor | No. | Sensor Elevation (m) | Date Installed | Reading Frequency |
|---|---|---|---|---|---|---|---|---|---|
| Dry Stack Tailings Storage Facility | DSP-5 | 6944769 | 385713 | 791.47 | DSP-5A | VW24851 | 765.47 | 2013-04-16 | Monthly |
| | | | | | DSP-5B | VW24853 | 761.47 | | |
| Dry Stack Tailings Storage Facility | DSP-6 | 6944900 | 385539 | 787.66 | DSP-6A | VW24850 | 769.56 | 2013-04-05 | Monthly |
| | | | | | DSP-6B | VW24852 | 765.56 | | |
| Dry Stack Tailings Storage Facility | DSP-7 | 6944990 | 385390 | 780.404 | DSP-7-1 | VW34657 | 771.404 | 2015-12-09 | Bi-weekly |
| | | | | | DSP-7-2 | VW34658 | 763.404 | 2015-12-09 | Bi-weekly |
| | | | | | DSP-7-3 | VW34659 | 756.404 | 2015-12-09 | Bi-weekly |
| | | | | | DSP-7-4 | VW34660 | 753.404 | 2015-12-09 | Bi-weekly |
| | | | | | DSP-7-5 | VW34661 | 751.404 | 2015-12-09 | Bi-weekly |
| | | | | | DSP-7-6 | VW34662 | 747.404 | 2015-12-09 | Bi-weekly |
| Dry Stack Tailings Storage Facility | DSP-8 | 6945058 | 385872 | 755.548 | DSP-8-1 | VW34663 | 750.548 | 2015-12-10 | Bi-weekly |
| | | | | | DSP-8-2 | VW34664 | 745.548 | 2015-12-10 | Bi-weekly |
| | | | | | DSP-8-3 | VW34665 | 740.548 | 2015-12-10 | Bi-weekly |
| | | | | | DSP-8-4 | VW34666 | 735.458 | 2015-12-10 | Bi-weekly |
| | | | | | DSP-8-5 | VW34667 | 730.458 | 2015-12-10 | Bi-weekly |
| | | | | | DSP-8-6 | VW34668 | 720.458 | 2015-12-10 | Bi-weekly |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Dry Stack Tailings Storage Facility | DSP-10 | 6945223 | 385944 | 724.509 | DSP-10 | VW34617 | 717.209 | 2015-11-27 | Weekly |
| Southwest Waste Dump | SDP-2 | 6944595.06 | 383971.30 | 843.41 | SDP-2A | VW12912 | 843.414 | 2010-01-31 | Monthly |
| | | | | | SDP-2B | VW12911 | 842.714 | | |
| Southwest Waste Dump | SDP-3 | 6944333.87 | 383824.67 | 854.27 | SDP-3A | VW12906 | 854.266 | 2010-01-28 | Monthly |
| | | | | | SDP-3B | VW12907 | 853.566 | | |
| Southwest Waste Dump | SDP-4 | 6944163.62 | 383783.54 | 858.49 | SDP-4A | VW12908 | 858.494 | 2010-01-30 | Monthly |
| | | | | | SDP-4B | VW12909 | 857.794 | | |
| Water Storage Pond | WDP-2 | 6945632 | 386545 | 701.67 | WDP-2 | VW7212 | 701.67 | 2007-11-04 | Monthly |
| Water Storage Pond | WDP-3A | 6945618 | 386498 | 712.62 | WDP-3A | VW7557 | 712.62 | 2007-11-28 | Monthly |
| Water Storage Pond | WDP-3 | 6945609 | 386500 | 712.60 | WDP-3 | VW7202 | 712.60 | 2007-11-12 | Monthly |
| Water Storage Pond | WDP-4 | 6945609 | 386500 | 702.60 | WD -4 | VW7210 | 702.60 | 2007-11-14 | Monthly |
| Water Storage Pond | WDP-5 | 6945605 | 386526 | 712.35 | WDP-5 | VW7204 | 712.35 | 2007-11-20 | Monthly |
| Water Storage Pond | WDP-6 | 6945605 | 386526 | 701.50 | WDP-6 | VW7214 | 701.50 | 2007-11-20 | Monthly |
| Water Storage Pond | WDP-7 | 6945605 | 386526 | 689.20 | WDP-7 | VW7208 | 689.20 | 2007-11-20 | Monthly |
| Water Storage Pond | WDP-8 | 6945554 | 386542 | 693.10 | WDP-8 | VW7200 | 693.10 | 2007-11-18 | Monthly |
| Water Storage Pond | WDP-9 | 6945554 | 386542 | 687.93 | WDP-9 | VW7206 | 687.93 | 2007-11-18 | Monthly |
| Water Storage Pond | WDP-10 | 6945554 | 386542 | 676.17 | WDP-10 | VW7211 | 676.17 | 2007-11-18 | Monthly |
| Water Storage Pond | WDP-11 | 6945523 | 386551 | 712.96 | WDP-11 | VW7201 | 712.96 | 2007-11-16 | Monthly |
| Water Storage Pond | WDP-12 | 6945523 | 386551 | 694.64 | WDP-12 | VW7209 | 694.64 | 2007-11-16 | Monthly |
| Water Storage Pond | WDP-13 | 6945533 | 386578 | 684.55 | WDP-13 | VW7205 | 684.55 | 2007-11-07 | Monthly |

# 7 Instrumentation Procedures and Documentation

Data collection manuals for all monitoring devices are included in Appendix B.

After collection, data is input into a series of spreadsheets and databases used for storing, tracking and interpreting instrumentation data. Instructions for data input are contained in the instrumentation manuals in Appendix B.

# 8 Quality Assurance/Quality Control

Planned job obsrevations (PJO's) are routinely performed and documented on Mine Technician Assistants to verify data collection is consistent with the designed procedures.

Data collection equipment is returned to the manufacturers as per their recommended calibration schedules, typically annually.

All data is reviewed and summarized by the Geotechnical Engineer monthly as part of the Water Licence reporting.

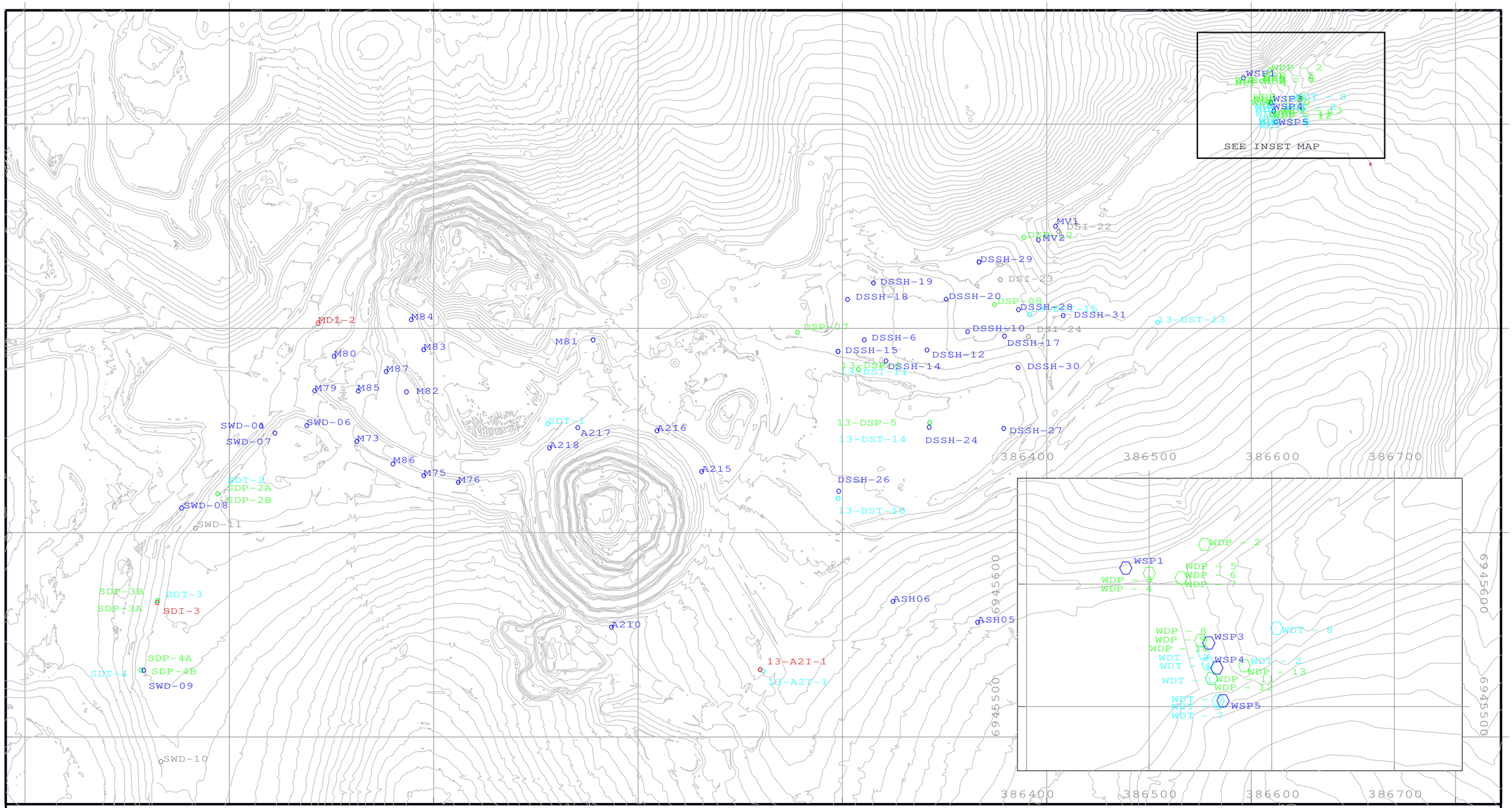
# 9 Reporting

Regular processing and review of monitoring data is completed and presented in the following documents.

**Table 9: Reporting**

| Report | Frequency | Submission |
|---|---|---|
| Pit Wall Inspection Reports | Weekly | Submitted internally each week |
| Minto Mine Type A Water Licence QZ14-031 Monthly Report (Clause 4.4) | Monthly | Submitted to Yukon Water Board maximum 30 days following each month |
| DSTSF Inspection Reports | Monthly | Filed internally within one week of the inspection |
| Water Storage Pond Dam Inspection Reports | Monthly | Filed internally within one week of the inspection |
| Area 2 and Main Pit Tailings Storage Facility Inspection Reports | Quarterly | Filed internally within one month of the inspection |
| Semi-Annual Site-wide Geotechnical Inspection Report | After spring melt (May/June) and before freeze-up (September) | Submitted to Yukon Water Board within 60 days of inspection. |
| Minto Mine Type A Water Licence QZ14-031 Annual Report (Clause 4.5) | Annually | Submitted to Yukon Water Board by March 31 each year |
| Minto Mine Type B Water Licence MS15-094 Annual Inspection Report (Clause 34) | Annually | Submitted to Yukon Water Board with the Annual Report |

# Appendix A: Instrumentation Map




| | | | | |
|---|---|---|---|---|
| DESIGNED BY: HF | DATE PLOTTED: 20-Dec-2016 | Monitoring Instrumentation 2016 | LEGEND | capstone MINTO MINE |
| CHECKED BY: | SCALE: | Comments: | SURVEY HUBS, THERMISTORS, PIEZOMETERS, INCLINOMETERS | |

# Appendix B: Data Collection and Input Manuals

## Inclinometer Measurements

Please refer to RST MEMS Digital Inclinometer System Instruction Manual for complete instruction.

System Overview:


**Figure 1 – System Overview**

1. Soft Shell Case
2. Digital Inclinometer Probe (w/ protective end cap)
3. Reel Battery Charger
4. 70mm/2.75" OD Cable Grip
5. 85mm/3.34" OD Cable Grip
6. Ultra-Rugged Field PC
7. 12V DC car adapter for Reel Battery Charger or Ultra-Rugged Field PC
8. Spare Reel Battery
9. Silicone Lubricant (for use on connectors)
10. USB Cable for Ultra-Rugged Field PC
11. AC Adapter (110-240V) for Reel Battery Charger
12. AC Adapter (110-240V) for Ultra-Rugged Field PC
13. Cable Reel with Wireless Communication System and protective end cap
14. Reel Carrying Case

1. Make sure the battery for the reel and the Field PC are charged.
2. Lift up protective box with two hands and put it on side as a work bench.

3. Remove cap from inclinometer casing and look for $A_0$ marking (black mark).

4. Remove excess water inside the probe and the cable connector.
   Probe is very sensitive and susceptible to vibration. **DO NOT BANG THE PROBE**. Use a paper towel to wipe it.

5. Apply silicon lubricant to probe and cable connector when needed.

6. Connect the inclinometer cable to the probe by aligning the keyways and threading the connector onto the probe. Turn the threaded ring, but not the cable.

7. Turn on the power of the reel. A green light indicates that the power is on. This energizes the accelerometers and makes them less susceptible to shock.

8. Check the depth of the hole. Turn on Field PC and select the hole you are going to measure.

9. Always start with **UPPER** Wheel in the $A_0$ direction.


10. Lower the probe gently and carefully. When it gets close to the bottom lower it very gently to avoid bouncing the probe off the bottom of the hole. The cable has aluminum sleeve marks which are spaced at 0.5m and it has a red measure mark with label every 5m.

11. Lower the probe gently to ensure the bottom of the hole is encountered. (Slightly passed the designated depth). Double check your correct depth by pulling out reel to the next 5m mark and counting back each 0.5m for each increment.

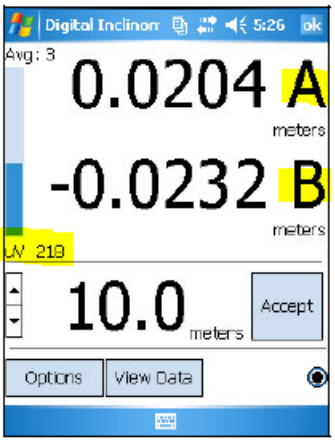
12. Place the cable grip on top of the casing and hang the cable by the aluminum crimps.

13. Connect the Field PC to the reel. Use the pen attached to the field PC and press "*Connections".*

14. Once connected, hit "*Readings*".



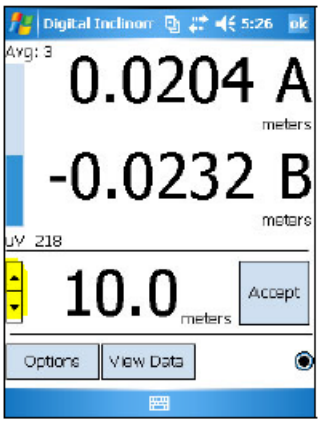
15. At each depth allow the A and B readings as well as the noise level become stabilized before you accept the readings. Ideally noise level should be at or below 30 µV.




16. Wear gloves as the Envirobind inside the inclinometer casing can be sticky and irritable. Pull up gently to the next marker and let the aluminum crimp to sit on the metal grip. Wait for the readings and noise level to stabilize and then hit *"Accept"*.


17. If you accidentally pull the probe too far (more than an inch), lower the probe back down to the previous bead then pull up to the bead you want to measure. This will ensure that the readings remain consistent.

18. At each 5m mark, check that you are at the right location. If you miss or overpass a reading, go back to the previous 5m depth. For examples, if something goes wrong at 41.5m, go back to 45m and drop the cable to 45.5m. Then gently pull up to 45m and hit *"Accept"* again. There are arrow keys on the Field PC which allow you to adjust your depth.




19. Once the last reading (0.5m) is taken, gently take out the probe and turn it 180° so that the **Lower** wheel is now in the $A_0$ direction.

20. Go back gently to the bottom of hole and take the second set of readings.

21. During the measurement of the second set of readings, checksum data will appear in a smaller font below the current readings. Checksum should be reasonably small and consistent. Ideally it should be somewhere between -0.0035m to +0.0045m.

22. If the checksum is large ( > 0.01m) and inconsistent, check the following:
    - Is the probe at the right depth?
    - Is the probe in the correct direction?
    - Lower the probe to the previous depth and retake the reading again.

    It is possible that checksum is high due to differential pressure in the ground. In that case continue measurement and keep monitoring checksum.

23. Once readings are completed, take out the probe and wipe away the Envirobind gently. Put the caps back onto the probe and connector.

# Data Input

Note: Windows Mobile Device Center must be installed on the computer in order to collect the readout unit to the computer.


1. Connect the USB cable from the readout unit to the computer and turn the power on.
2. Open DMM for Windows


3. *File – Open – Project Database*
   The database for all inclinometer data is stored here:
   X:\Mine Technical\03 - Monitoring\! Inclinometers\Master Database

4. *File – Import – Import RPP file*
   Navigate to the mobile device and select the .rpp file for the appropriate monitoring station and date. The data will then import and save in the database automatically.

## Thermistor Readings

Two different types of thermistors are currently installed on site – RST and EBA thermistors.

### To read RST thermistors:

1. Connect adapter cord to the TH2016B Readout Box.
2. Record the resistivity (Ohms) for each thermistor node on paper or store the data in the readout box with the following steps:
    a. Scroll with the Up/Down arrows to the ***Memory*** screen and press enter (arrow key)


    b. Scroll with the Up/Down arrows to the ***Store Data*** screen and press enter


    c. Scroll with the Up/Down arrows to the station being monitored and press enter to store the reading


    d. The data is now stored and the readbox can be turned off by pressing the escape button (ESC) three times to get back to the main menu and scrolling to Power Off.

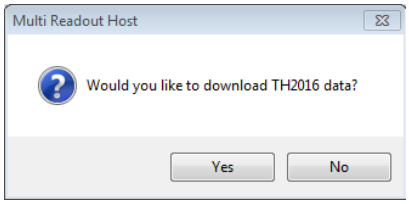

## To read EBA thermistors:

1. Connect the EBA 16 Point Ground Temperature Dial into the thermistor cable.
2. Connect the multi-meter to the EBA 16 Point Ground Temperature Dial.
3. Record on paper the resistance in Ohm's (Ω) for each point.

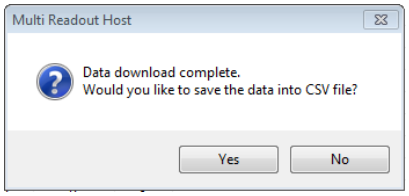
# Data Downloading

1. Connect USB cord from computer to the readout box.
2. Open the software Multi Readout Host.

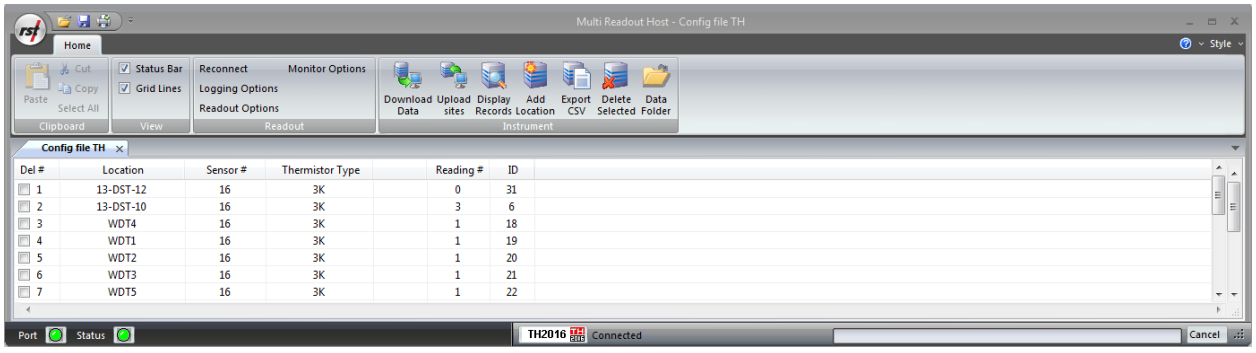

3. Turn on the power on the readout box.
4. The software will recognize the readout unit and prompt to download data. Choose “Yes” to download the data from the readout unit.




5. Once data is downloaded you will have the option to save all data as .csv file. Choose “Yes” and the data will be stored in My Documents in a folder named “TH2016data”.




6. The software can be used to setup new locations or view data but no further steps are required.

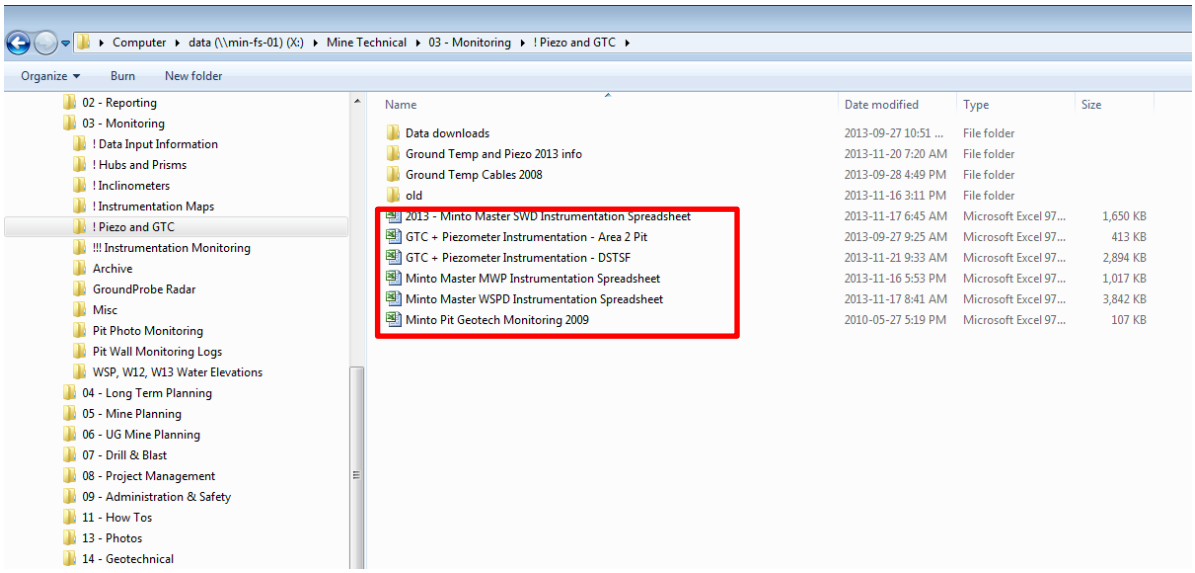


# Data Input

Spreadsheets for piezometer data input and tracking are stored here:

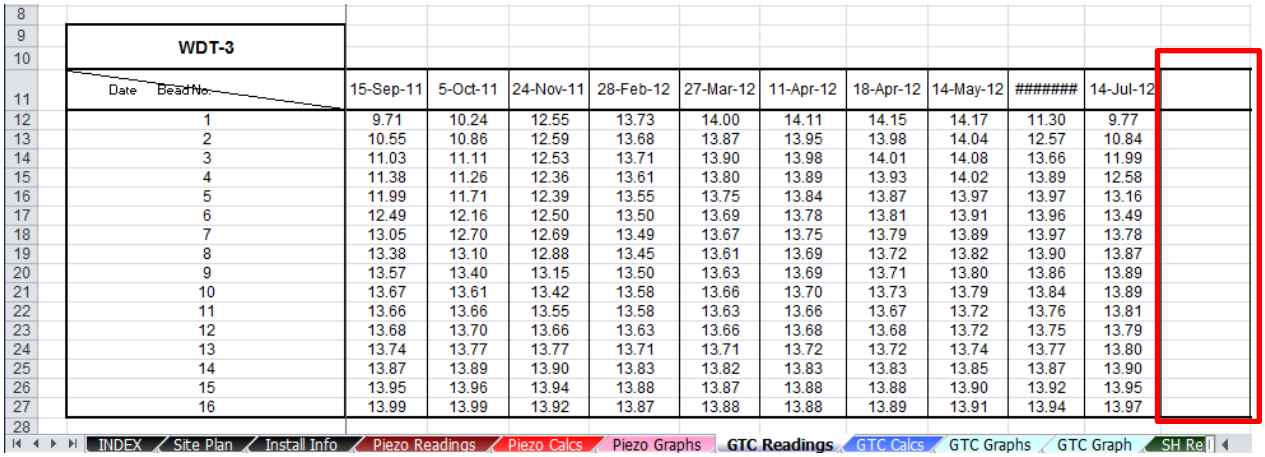
X:\Mine Technical\03 - Monitoring\! Piezo and GTC

1. Open the spreadsheet for the area monitored




2. Open the tab “GTC Readings”

3. In a new column enter the date and copy the resistivity data (Ohms) from the paper records, or from the .csv file saved in either “TH2016data” or “VW2016data” saved in My Documents.



| WDT-3 | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Date / Bead No. | 15-Sep-11 | 5-Oct-11 | 24-Nov-11 | 28-Feb-12 | 27-Mar-12 | 11-Apr-12 | 18-Apr-12 | 14-May-12 | ######## | 14-Jul-12 | |
| 1 | 9.71 | 10.24 | 12.55 | 13.73 | 14.00 | 14.11 | 14.15 | 14.17 | 11.30 | 9.77 | |
| 2 | 10.55 | 10.86 | 12.59 | 13.68 | 13.87 | 13.95 | 13.98 | 14.04 | 12.57 | 10.84 | |
| 3 | 11.03 | 11.11 | 12.53 | 13.71 | 13.90 | 13.98 | 14.01 | 14.08 | 13.66 | 11.99 | |
| 4 | 11.38 | 11.26 | 12.36 | 13.61 | 13.80 | 13.89 | 13.93 | 14.02 | 13.89 | 12.58 | |
| 5 | 11.99 | 11.71 | 12.39 | 13.55 | 13.75 | 13.84 | 13.87 | 13.97 | 13.97 | 13.16 | |
| 6 | 12.49 | 12.16 | 12.50 | 13.50 | 13.69 | 13.78 | 13.81 | 13.91 | 13.96 | 13.49 | |
| 7 | 13.05 | 12.70 | 12.69 | 13.49 | 13.67 | 13.75 | 13.79 | 13.89 | 13.97 | 13.78 | |
| 8 | 13.38 | 13.10 | 12.88 | 13.45 | 13.61 | 13.69 | 13.72 | 13.82 | 13.90 | 13.87 | |
| 9 | 13.57 | 13.40 | 13.15 | 13.50 | 13.63 | 13.69 | 13.71 | 13.80 | 13.86 | 13.89 | |
| 10 | 13.67 | 13.61 | 13.42 | 13.58 | 13.66 | 13.70 | 13.73 | 13.79 | 13.84 | 13.89 | |
| 11 | 13.66 | 13.66 | 13.55 | 13.58 | 13.63 | 13.66 | 13.67 | 13.72 | 13.76 | 13.81 | |
| 12 | 13.68 | 13.70 | 13.66 | 13.63 | 13.66 | 13.68 | 13.68 | 13.72 | 13.75 | 13.79 | |
| 13 | 13.74 | 13.77 | 13.77 | 13.71 | 13.71 | 13.72 | 13.72 | 13.74 | 13.77 | 13.80 | |
| 14 | 13.87 | 13.89 | 13.90 | 13.83 | 13.82 | 13.83 | 13.83 | 13.85 | 13.87 | 13.90 | |
| 15 | 13.95 | 13.96 | 13.94 | 13.88 | 13.87 | 13.88 | 13.88 | 13.90 | 13.92 | 13.95 | |
| 16 | 13.99 | 13.99 | 13.92 | 13.87 | 13.88 | 13.88 | 13.89 | 13.91 | 13.94 | 13.97 | |

INDEX | Site Plan | Install Info | Piezo Readings | Piezo Calcs | Piezo Graphs | **GTC Readings** | GTC Calcs | GTC Graphs | GTC Graph | SH Re

## Vibrating Wire Piezometer Readings

1. Connect adapter cord to the VW2106 Readout Box.
2. Connect the coloured wires to the correct wire clips on the extension cable. Make sure the wires do not touch each other.
3. Record the **DATE** and **TIME** as barometric pressure will be needed to calibrate the water level.
4. Record the measurement (between 7000B to 9000B) and the temperature (°C) for each piezometer. The piezometer ID should be labeled on the wire (eg. P5a and P5b).


5. Alternatively the data can be stored in the readout box:

    a. Scroll with the Up/Down arrows to the ***Memory*** screen and press enter (arrow key)


    b. Scroll with the Up/Down arrows to the ***Store Data*** screen and press enter

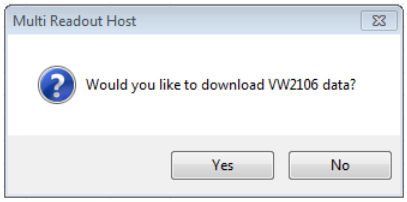

c. Scroll with the Up/Down arrows to the station being monitored and press enter to store the reading


d. The data is now stored and the readout box can be turned off by pressing the escape button (ESC) three times to get back to the main menu and scrolling to Power Off.

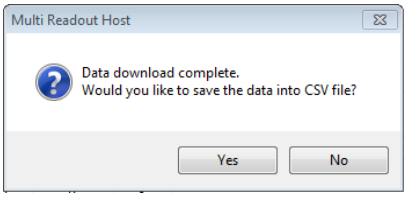
# Data Downloading

7. Connect USB cord from computer to the readout box.
8. Open the software Multi Readout Host.

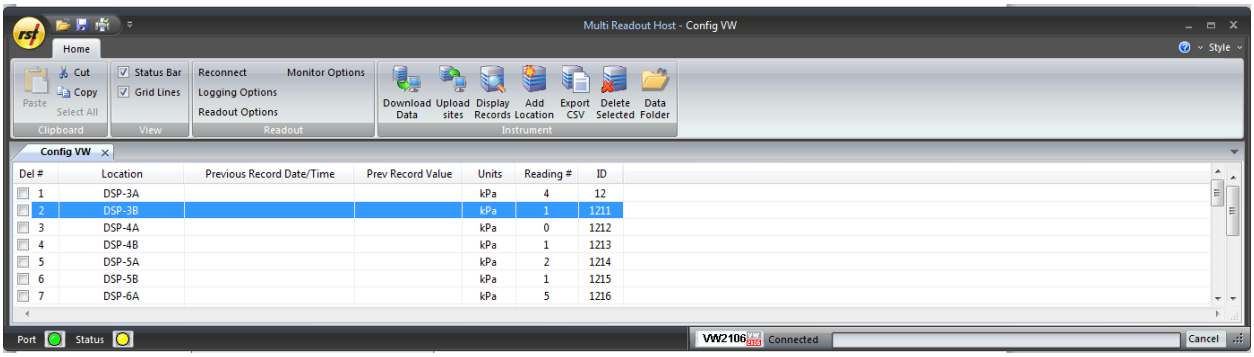

9. Turn on the power on the readout box.
10. The software will recognize the readout unit and prompt to download data. Choose “Yes” to download the data from the readout unit.




11. Once data is downloaded you will have the option to save all data as .csv file. Choose “Yes” and the data will be stored in My Documents in a folder named “VW2016data”.




12. The software can be used to setup new locations or view data but no further steps are required.

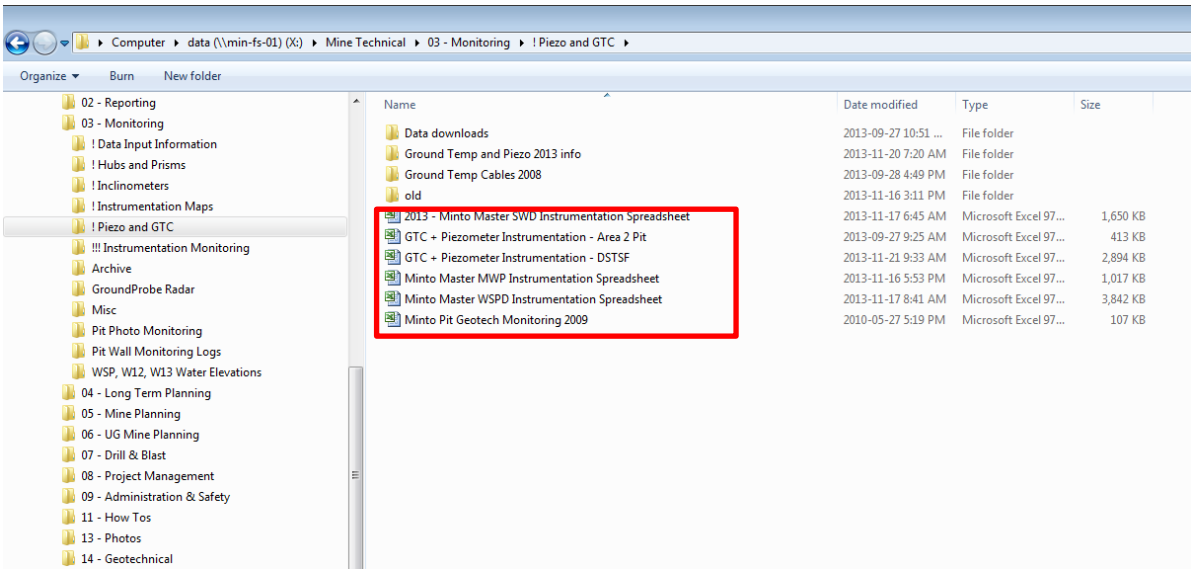


# Data Input

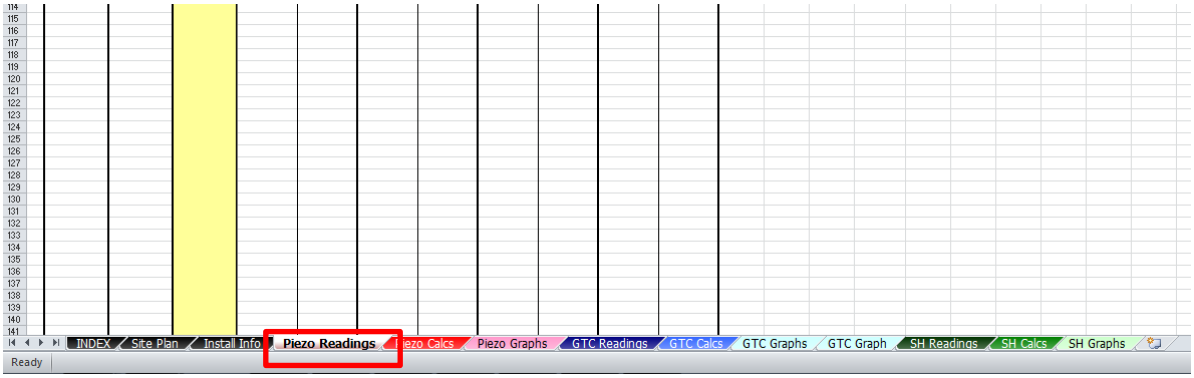
Spreadsheets for piezometer data input and tracking are stored here:

X:\Mine Technical\03 - Monitoring\! Piezo and GTC

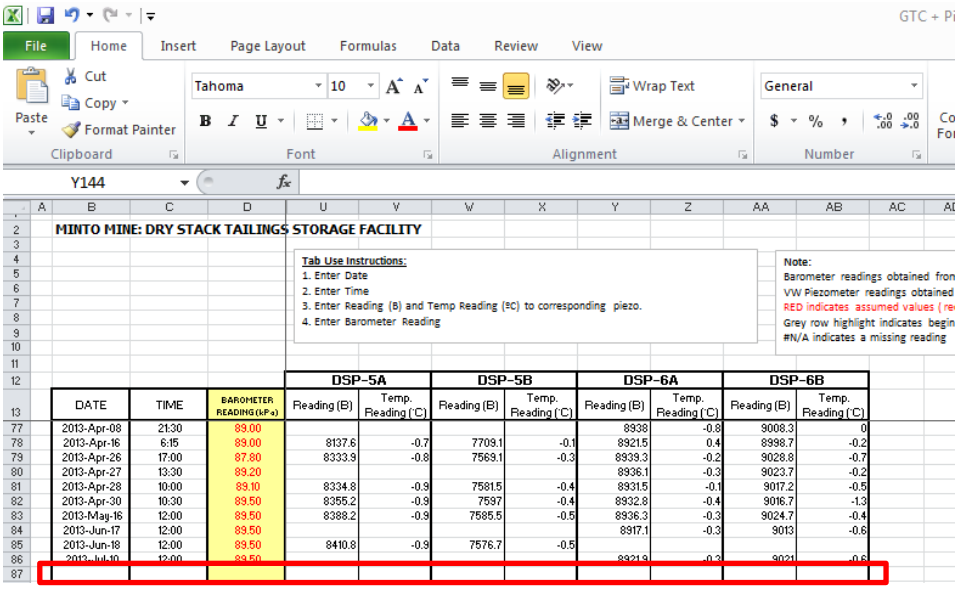
4. Open the spreadsheet for the area monitored




5. Open the tab “Piezo Readings”



6. In a new row, input the date, time, barometric pressure, B-unit and temperature readings for each instrument.



MINTO MINE: DRY STACK TAILINGS STORAGE FACILITY

Tab Use Instructions:
1. Enter Date
2. Enter Time
3. Enter Reading (B) and Temp Reading (ºC) to corresponding piezo.
4. Enter Barometer Reading

Note:
Barometer readings obtained from
VW Piezometer readings obtained
RED indicates assumed values ( re
Grey row highlight indicates begin
#N/A indicates a missing reading

| | DSP-5A | | DSP-5B | | DSP-6A | | DSP-6B | |
|---|---|---|---|---|---|---|---|---|
| DATE | TIME | BAROMETER READING (kPa) | Reading (B) | Temp. Reading (˚C) | Reading (B) | Temp. Reading (˚C) | Reading (B) | Temp. Reading (˚C) | Reading (B) | Temp. Reading (˚C) |
| 2013-Apr-08 | 21:30 | 89.00 | | | | | 8938 | -0.8 | 9008.3 | 0 |
| 2013-Apr-16 | 6:15 | 89.00 | 8137.6 | -0.7 | 7709.1 | -0.1 | 8921.5 | 0.4 | 8998.7 | -0.2 |
| 2013-Apr-26 | 17:00 | 87.80 | 8333.9 | -0.8 | 7569.1 | -0.3 | 8939.3 | -0.2 | 9028.8 | -0.7 |
| 2013-Apr-27 | 13:30 | 89.20 | | | | | 8936.1 | -0.3 | 9023.7 | -0.2 |
| 2013-Apr-28 | 10:00 | 89.10 | 8334.8 | -0.9 | 7581.5 | -0.4 | 8931.5 | -0.1 | 9017.2 | -0.5 |
| 2013-Apr-30 | 10:30 | 89.50 | 8355.2 | -0.9 | 7597 | -0.4 | 8932.8 | -0.4 | 9016.7 | -1.3 |
| 2013-May-16 | 12:00 | 89.50 | 8388.2 | -0.9 | 7585.5 | -0.5 | 8936.3 | -0.3 | 9024.7 | -0.4 |
| 2013-Jun-17 | 12:00 | 89.50 | | | | | 8917.1 | -0.3 | 9013 | -0.6 |
| 2013-Jun-18 | 12:00 | 89.50 | 8410.8 | -0.9 | 7576.7 | -0.5 | | | | |
| 2013-Jul-10 | 12:00 | 89.50 | | | | | 8921.9 | -0.3 | 9021 | -0.6 |

Barometric pressure can be obtained from the site's weather monitoring stations. Data is stored here:

X:\Environmental\Environmental Monitoring Program\1_MASTER LOGS\Meteorology Station Data\Met Station 1 and 2 Data Summary.xlsx