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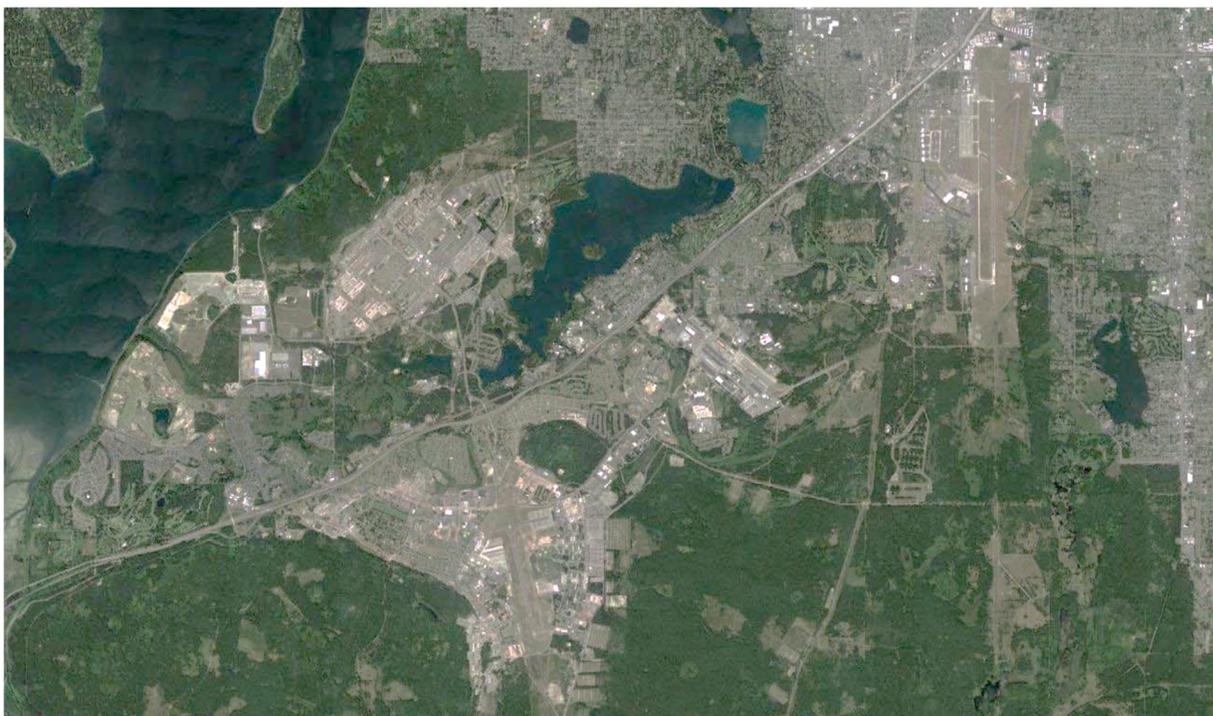
16 NOVEMBER 2017

## **2017 Air Sparge and Soil Vapor Extraction System**

Operations & Maintenance Manual  
Joint Base Lewis-McChord Area of Concern 9-2  
Lewis North Credit Union

**Joint Base Lewis-McChord**  
Pierce County, Washington

Joint Base Lewis-McChord Public Works – Environmental Division  
IMLM-PWE  
MS 17 Box 339500  
Joint Base Lewis-McChord, Washington 98433





REPLY TO  
ATTENTION OF

**DEPARTMENT OF THE ARMY**  
HEADQUARTERS, JOINT BASE LEWIS-MCCHORD  
1010 LIGGETT AVENUE, BOX 339500, MAIL STOP 14A  
JOINT BASE LEWIS-MCCHORD, WA 98433-9500

November 16, 2017

Public Works

Mr. Charles Hoffman  
Washington Department of Ecology  
Attention: Hazardous Waste & Toxics Reduction  
PO Box 47775  
Olympia, Washington 98504-7775

Dear Mr. Hoffman:

Enclosed for your review is one paper copy of the Final 2017 Air Sparge and Soil Vapor Extraction System, Operations and Maintenance Manual, Joint Base Lewis-McChord Area of Concern 9-2, Lewis North Credit Union. This final version incorporates revisions per your comments received on November 9, 2017.

If you have any questions or need clarification, please contact me at (253) 477-3742.

Sincerely,

GHEBRESLASSIE.ME  
SERET.C.1015675159

Digitally signed by  
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DN: cn=US, o=U.S. Government, ou=DoD, ou=PKI,  
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Date: 2017.11.16 15:56:27 -0800

Meseret C. Ghebreslassie  
Installation Restoration Program Manager  
Public Works Department

FINAL

2017 AIR SPARGE AND SOIL VAPOR EXTRACTION SYSTEM  
OPERATIONS & MAINTENANCE MANUAL

JOINT BASE LEWIS-MCCHORD AREA OF CONCERN 9-2  
LEWIS NORTH CREDIT UNION

CONTRACT NO. W912DW-11-D-1031, TASK ORDER 0001

NOVEMBER 16, 2017

JOINT BASE LEWIS-MCCHORD  
FORT LEWIS, WASHINGTON

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## ACRONYMS AND ABBREVIATIONS

AOC	Area of Concern
AS	air sparge
bgs	below ground surface
BTEX	benzene, toluene, ethylbenzene, and xylenes
CFR	Code of Federal Regulations
DQO	Data Quality Objectives
DTW	depth to water
Ecology	Washington State Department of Ecology
EPA	Environmental Protection Agency
FID	Flame Ionization Detector
FLAO	Fort Lewis Agreed Order
IA	Interim Action
IRP	Installation Restoration Program
JBLM	Joint Base Lewis-McChord
$\mu\text{g}/\text{m}^3$	micrograms per cubic meter
MTCA	Model Toxics Control Act
MW(s)	Monitoring Well(s)
NFA	No Further Action
PCS	petroleum contaminated soil
PID	photoionization detector
ppbv	parts per billion-volume
PSCAA	Puget Sound Clean Air Agency
psig	pounds per square inch gauge
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
SAP	Sampling and Analysis Plan
scfm	standard cubic feet per minute
Sealaska	Sealaska Environmental Services LLC
SSD	Sub-slab Depressurization
SSHP	Site Safety and Health Plan

## **ACRONYMS AND ABBREVIATIONS (continued)**

SVE	Soil Vapor Extraction
SVP	soil vapor probe
TPH-G	gasoline-range total petroleum hydrocarbons
USACE	United States Army Corps of Engineers
USAEC	US Army Environmental Command
UST	underground storage tank
VI	vapor intrusion
VOC	volatile organic compound
WAC	Washington Administrative Code
ZOI	zone of influence

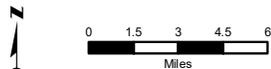
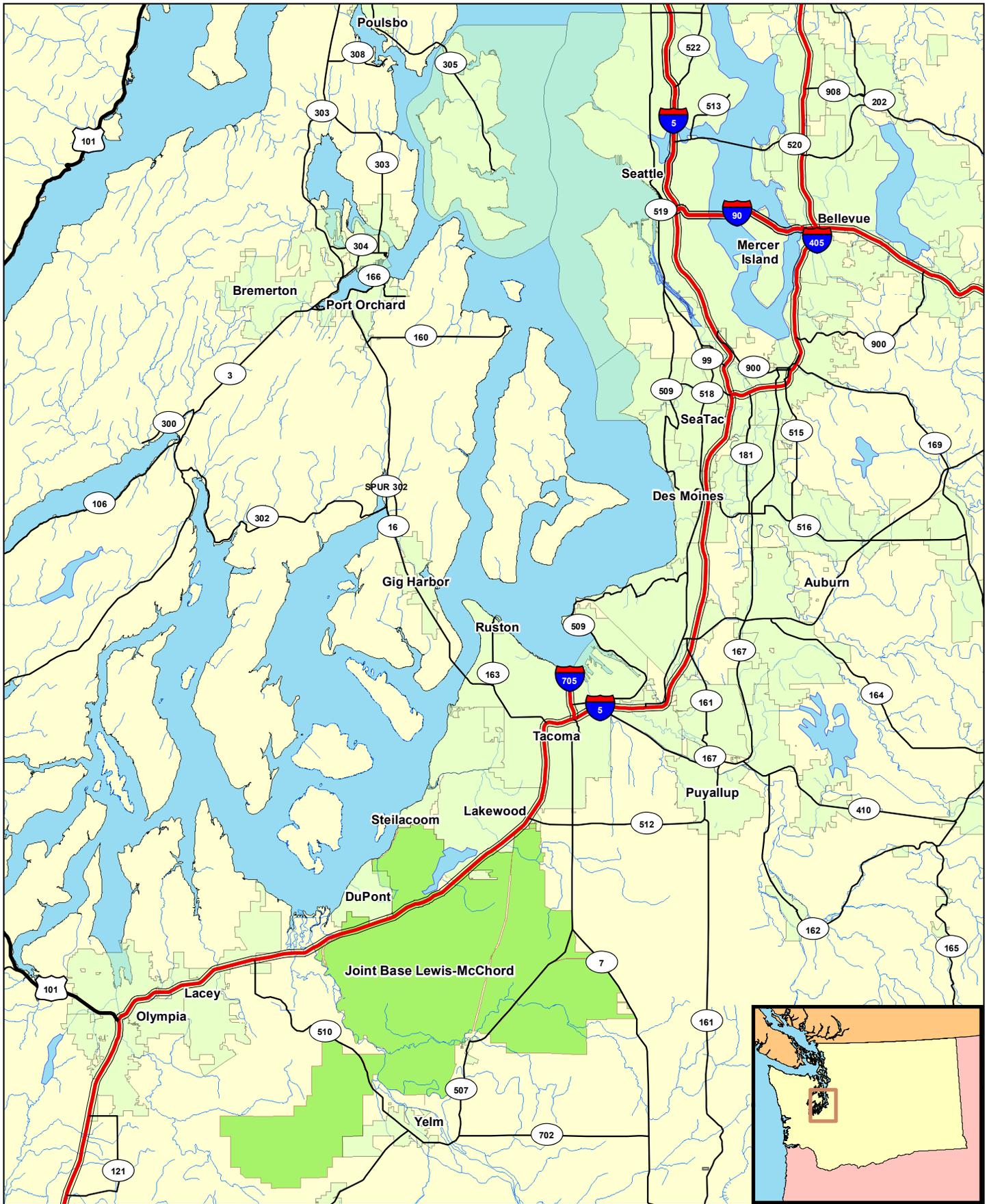
## 1 INTRODUCTION

This document outlines a plan for operation, monitoring, and maintenance of a sub-slab depressurization (SSD), air sparge (AS), and soil vapor extraction (SVE) system installed to remediate petroleum-impacted soil and groundwater at a former fueling station (Building A1033, i.e., site Area of Concern [AOC] 9-2) on Joint Base Lewis-McChord (JBLM) [Figure 1-1]. A brief review of site history is provided, followed by an outline of the operating strategy and plan for ongoing monitoring. Conditions for varying system operating conditions and criteria for system shutdown are provided.

Figure 1-2 is the site map for the new America's Credit Union (hereafter referred to as the Credit Union). The long axis of the Credit Union building (JBLM building number 11574) is oriented southwest to northeast. For ease of discussion, the 17<sup>th</sup> Street end of the building is referred to as "north."

Conditions at AOC 9-2, the site of a former vehicle fueling station, are described in the Fort Lewis Agreed Order Draft Feasibility Study for Seven Sites (Versar 2009a) and the Fort Lewis Agreed Order Remedial Investigation Report (Bussey 2008). A list of historical depth to water and field parameter measurements for eight monitoring wells (MW) at the site is provided in Appendix A, Table A-1. Historical groundwater analytical results for total petroleum hydrocarbons as gasoline (TPH-G) and benzene, toluene, ethylbenzene, and xylene (BTEX) concentrations detected in six groundwater monitoring wells at AOC 9-2 is provided in Appendix A, Table A-2. Both groundwater and soils are impacted by gasoline released from the former gas station. A combined AS and SVE system was installed to promote stripping of volatile organic hydrocarbons from the groundwater and the soils in the vadose zone at the site. The SVE system is configured to also function for SSD to protect building occupants. The goal of remediation by AS-SVE is to satisfy Washington State Department of Ecology (Ecology) Model Toxics Control Act (MTCA) Method A cleanup standards for groundwater.

A pilot test, conducted in early 2012, indicated that the existing AS/SVE/SSD system is capable of effecting site remediation. Performance monitoring will continue until results indicate that MTCA cleanup levels are achieved or until volatile organic compounds (VOC) concentrations reach asymptotic conditions and no further removal is possible. Confirmation sampling will verify that cleanup levels have been achieved. The Interim Action (IA) Work Plan (Versar 2013a) defined criteria for system shutdown, including extent of VOC removal as indicated by SVE exhaust and VOC concentrations in soil gas and groundwater.



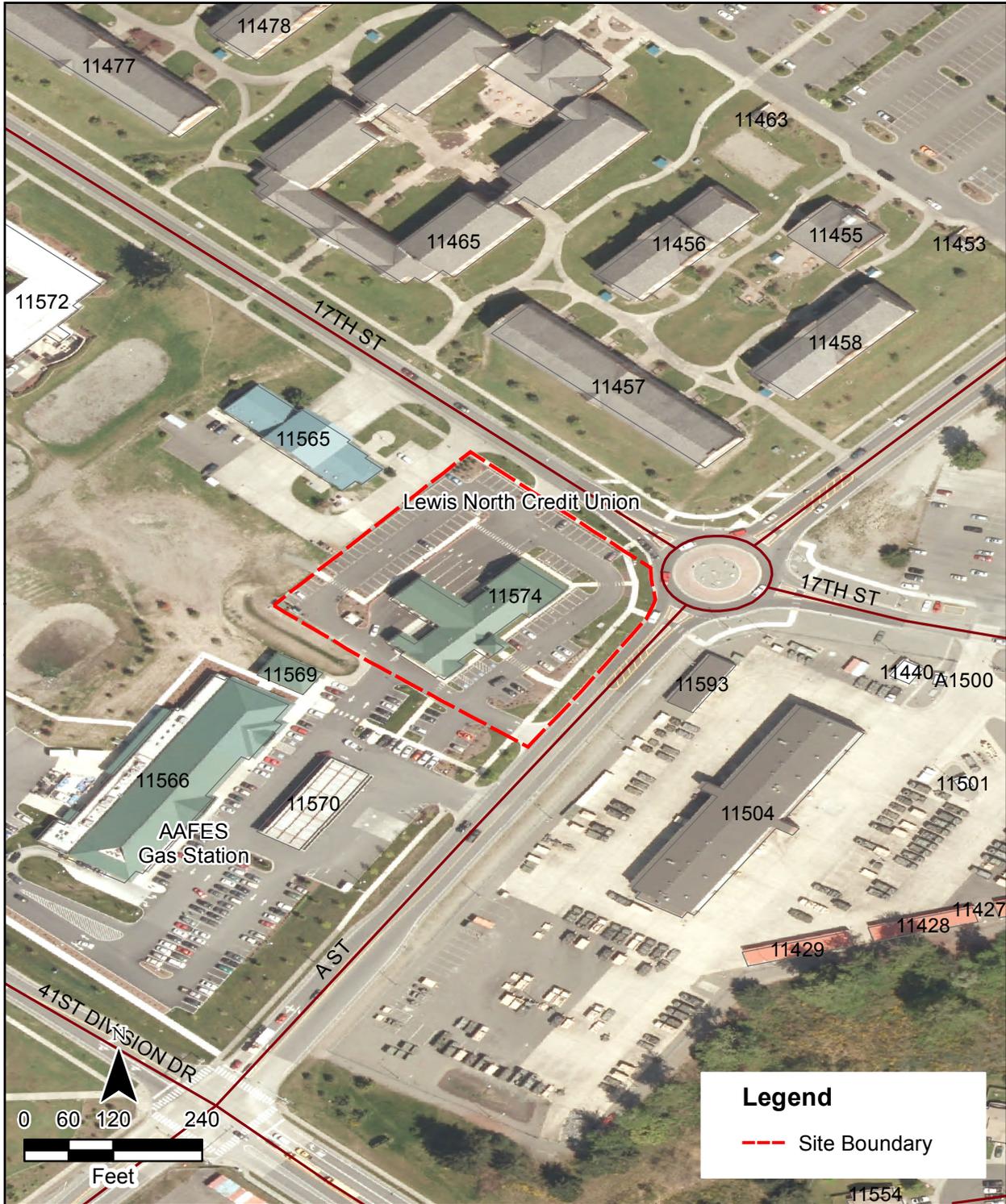
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 Coordinate System: UTM Zone 10  
 Horizontal Datum: WGS 84

City Limit  
 JBLM

**USACE SEALASKA**

**Figure 1**  
**Joint Base Lewis-McChord**  
**Location Map**

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**USACE**

**SEALASKA**

Figure 1-2  
 Location of Lewis  
 North Credit Union

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## 1.1 BACKGROUND

The former vehicle fueling station site is located on the southwest corner of the intersection of 17th Street and A Street on Lewis North (Figures 1-1 and 1-2). The station, constructed in 1967, consisted of a 10 feet x 15 feet office and a 30 feet x 60 feet metal canopy. Records indicate that two 4,000-gallon tanks were removed in 1990. Significant soil contamination was encountered during the removal of two additional 4,000-gallon gasoline underground storage tanks in 1994. As a result, 1,138 cubic yards of petroleum contaminated soil was removed at that time. Figure 1-3 illustrates the limits of the 1994 underground storage tank (UST) removal and excavation. The excavation was limited by groundwater and the foundation of the former Building A1033. A 1996 Site Assessment Report (USACE 1996) outlines events associated with the 1994 UST removal and subsequent investigations, including monitoring well installation.

In 1998 a 10,000-gallon gasoline tank, associated piping, and fuel dispenser were removed. No additional soil removal took place during the 1998 tank removal because no evidence of a release associated with this tank was discovered. The 1998 UST removal and details of associated site characterization are presented in the June 1999 Field Report for JBLM UST & Petroleum Contaminated Soil (PCS) Removal and Disposal (Garry Struthers & Associates 1999).

The building was demolished in 2002. Two additional USTs were discovered during the June 2009 excavation for construction of a Credit Union building. The USTs were located adjacent and north of the four USTs removed in 1990 and 1994. The tanks removed in 2009 were estimated to have a capacity of about 1,000 gallons each and appeared to have been closed-in-place with concrete fill. Figure 1-3 illustrates the location of the excavation limits associated with the 2009 UST removal. Six soil samples were collected from the floors and walls of the UST excavation. Laboratory results indicate that diesel is present in the soil at concentrations below MTCA Method A levels for unrestricted use.

Construction of a Credit Union building at AOC 9-2 was completed in early 2010. Because gasoline is present in groundwater underlying the site, it was elected to install a sub-slab depressurization SSD/SVE system during building construction in order to protect building occupants. Two AS wells were also installed during construction. A pilot test and vapor intrusion survey were conducted in early 2012 to evaluate the effectiveness of AS/SVE for site remediation and SSD for protection of building occupants (Versar 2012). The results of pilot testing and vapor intrusion monitoring (Versar 2013b) suggested that the existing system is sufficient to effect site remediation.

## 1.2 HYDROGEOLOGY

The unconfined upper Vashon Aquifer consists of glacial outwash deposits generally underlain by lower permeability Vashon Till deposits. Table A-1 lists depth to groundwater and results of field parameter measurements. Depth to groundwater is typically 20 to 30 feet below ground surface (bgs). The regional direction of groundwater flow in the Vashon Aquifer across the JBLM Cantonment Area is generally to the west toward Puget Sound. Groundwater typically flows west to southwest toward Puget Sound at AOC 9-2. Groundwater velocity in the region is roughly estimated to be about 1 foot per day. There are no known potential receptors currently located downgradient of AOC 9-2.

Detailed background information is included in the Fort Lewis Agreed Order (FLAO) Remedial Investigation Report (Bussey 2008). In summary, seven monitoring wells (designated as 95-A17-1, 95-A17-2, 95-A17-3a, 95-A17-4, 96-A17-5, 96-A17-6, and 07-A17-7) were installed prior to construction of the AS-SVE system. Those wells were sampled in groundwater monitoring events conducted from 1995 to present. One additional monitoring well (10-A17-8) was completed and developed on 08 October 2010.

## 1.3 OPERATIONS AND MONITORING -- PURPOSE AND SCOPE

Ongoing performance monitoring will evaluate the progress of the AS/SVE system in removing VOCs from soil and groundwater, and monitor the effectiveness of the SSD system in mitigating vapor intrusion (VI).

The objective of the AS/SVE system is to remediate groundwater to below MTCA Method A cleanup levels for groundwater (Washington Administrative Code [WAC] 173-340, Table 720-1), and to protect of building occupants from VOC intrusion by ensuring operation of the SVE blower to maintain the SSD system.

Ongoing operation and performance monitoring performed:

- Maintain sub-slab depressurization for protection of building occupants from VOC intrusion and removal of VOCs for site remediation.
- Maximize number of daily AS cycles.
- Monitor zones of influence (ZOI) of SVE and AS systems.
- Monitor VOC concentrations in SVE exhaust.
- Monitor the effectiveness of SSD and vapor mitigation system.

- Monitor and maintain operation and performance of the SVE and AS systems.
- Observe decreases in VOC concentrations in groundwater.

Weekly operations and monitoring activities include:

- Inspection of AS and SVE blowers for pressure, flow, temperature, and any possible mechanical anomalies.
- Measurement of SVE exhaust flow and VOC concentrations by photoionization detector (PID).
- Measurement of ambient air near SVE blower for VOC concentrations by PID.
- Drain SVE knockout drum as necessary.

The primary operations and monitoring activity to be performed on a quarterly schedule:

- Download data from continuous water level monitoring probes installed in five groundwater monitoring wells at AOC 9-2. The data will be downloaded and analyzed to assess groundwater mounding effect induced by regular operation of the AS blower.

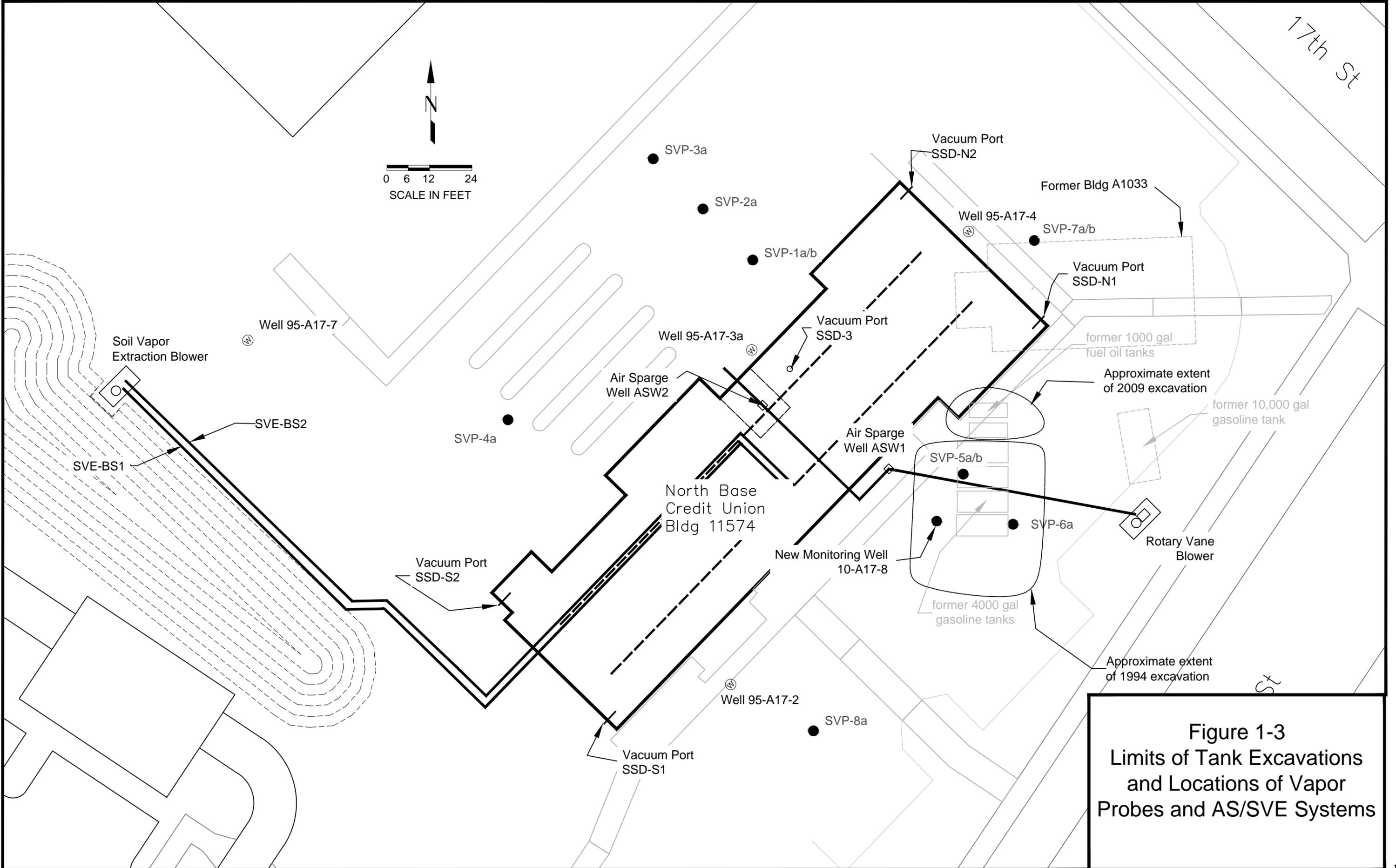
The primary operation and monitoring activities to be performed on a semi-annual schedule:

- Measure soil vapor probe pressures.
- Sample groundwater monitoring wells at AOC 9-2. Groundwater samples will be submitted to the laboratory for analysis for TPH-G and BTEX.

The primary operation and monitoring activity to be performed on an annual schedule:

- Collect indoor and ambient background air samples to assess the possibility of soil vapor intrusion into the Credit Union.

Confirmation sampling will be conducted once the results of performance monitoring indicate that MTCA groundwater cleanup standards have been met. Contingency technologies for expanding the existing system and/or stimulating in situ bioremediation may be recommended if monitoring indicates that AS/SVE operation has not removed VOCs to satisfy MTCA cleanup standards.



**Figure 1-3**  
**Limits of Tank Excavations**  
**and Locations of Vapor**  
**Probes and AS/SVE Systems**

## **2 SYSTEM DESCRIPTION**

The remedial system consists of an SVE system supplemented by an AS system. In addition, a vapor barrier underlies the building slab. The SVE blower maintains a negative pressure under the vapor barrier and beyond the building into the parking lot. The combination vapor barrier and SVE comprise the SSD system. The AS system consists of a blower supplying two AS wells installed to strip VOCs from groundwater for extraction by the SVE blower. Figure 2-1 shows the layout of the SVE system.

### **2.1 VAPOR BARRIER**

A polyolefin vapor barrier was installed under the entire slab during building construction. Figure 2-1, Detail 3 illustrates the building footing, vapor barrier (membrane), and underlying fill layer. Two layers of 15 mil (15/1000 of an inch) Stego Wrap, polyolefin vapor barrier were installed under the concrete floor of the building. All vapor barrier penetrations were sealed with tape. A concrete slab was poured over the vapor barrier. All slab penetrations and seams were sealed with self-leveling caulk. A series of smoke tests were performed before and after slab installation to ensure the integrity of the vapor barrier. The contractor sealed any leaks in seams and floor penetrations detected during each smoke testing event. Smoke testing and repair were repeated until no smoke leaks were observed. The combination of the sub-slab vapor barrier and sealed slab penetrations provides passive protection against fuel vapors entering the building. Vapor sampling ports penetrate the building footings at five points to allow for measurement of vacuum pressure and sub-slab air quality. Figure 2-1, Detail 3, illustrates the building footing, slab and sub-slab monitoring port.

### **2.2 SOIL VAPOR EXTRACTION/ SUB-SLAB DEPRESSURIZATION SYSTEM**

The SVE/SSD system is designed with a three-tiered system for protection of occupants of the Credit Union building:

- A vapor barrier under the building slab.
- A positive pressure maintained inside by the building HVAC system.
- A negative sub-slab pressure maintained by the SVE blower.

Gasoline vapors are drawn into 4-inch schedule 40, perforated PVC pipe installed in two sets of lateral trenches under the slab of the new building. Trenches are installed to a depth of about 7 feet below the concrete floor slab (Figure 2-1, Detail 2). The laterals are installed about 10 feet inside the edges of the building.

A manifold on the SVE blower suction line divides the vapor extraction laterals into north and south zones as shown in Figure 2-1. Extraction lines are equipped with pressure gauges and control valves at the suction side of the blower to allow for control of the vacuum pressure in each zone (Figure 2-2). Taps for flow elements are installed at each AS well head to measure flow (Figure 2-1, Detail 1).

The north zone is located nearest the source area and is expected to extract more VOCs. Although the lithology appears to be fairly uniform across the site, some variation in air extraction is expected between zones. Air flow and vacuum pressure can be measured for each SVE zone. Bulk soil gas VOC concentrations are measured at the SVE blower exhaust port.

The SVE system consists of a GAST R6P-350A blower housed in a small shack on a concrete pad located near the southwest corner of the site adjacent to the stormwater pond. The blower is equipped with a knock-out drum to collect condensed water vapors.

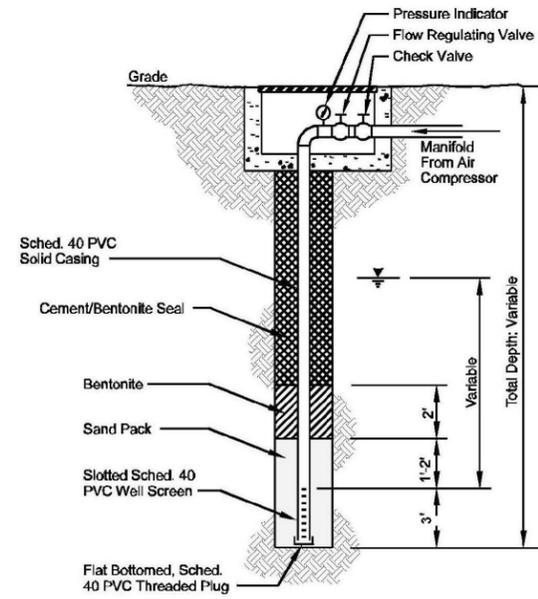
The SVE system maintains a negative pressure under the slab and vapor barrier. In addition, the building heating, ventilation, and air conditioning system is designed to maintain a positive pressure in the building interior. By maintaining this pressure differential over the slab and sub-slab system, soil vapors will be drawn into the underlying extraction laterals, and away from the membrane.

Approximately 95% of the building site is covered with either asphalt or concrete. The capped site minimizes infiltration of surface air, maximizing the effectiveness of the SVE system. In addition, planting areas along the building foundation are planted with grass rather than less dense shrubbery. These barriers provide an upper boundary for the SVE operation. Because most of the site is covered with asphalt or concrete, the ZOI is expected to extend under and beyond the footprint of the Credit Union and well beyond the area of contamination. This large ZOI is important, because soil vapor data indicate that VOCs are present west of the building.

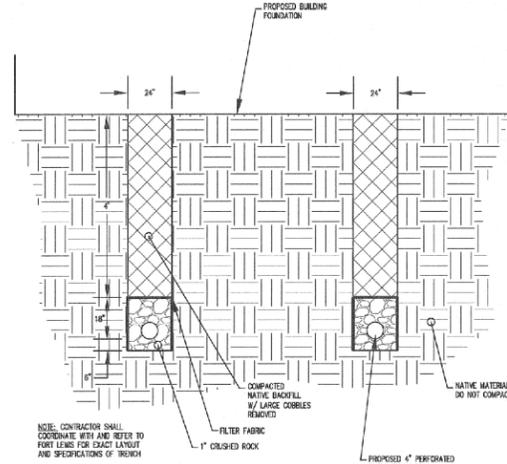
### **2.3 AIR SPARGE SYSTEM**

Figure 2-1 shows the site plan including the AS system layout. Figure 2-3 shows details of the AS blower arrangement. The AS system consists of a rotary vane blower, piping, and two vertical AS wells.

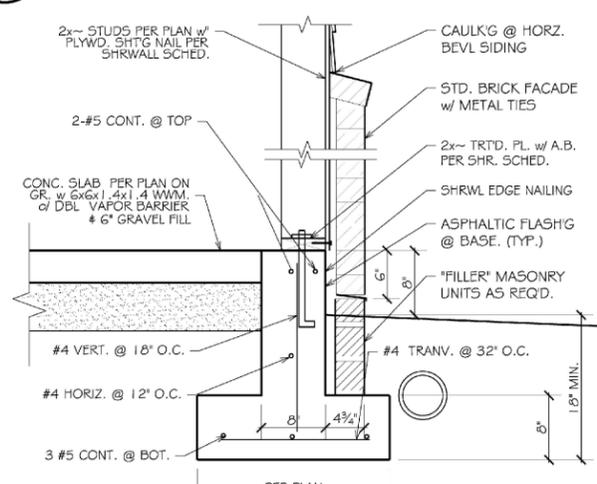
**Typical Vertical Air Sparging Well Construction**



**1 Air Sparge Well Construction**



**2 Vapor Extraction System Trench**

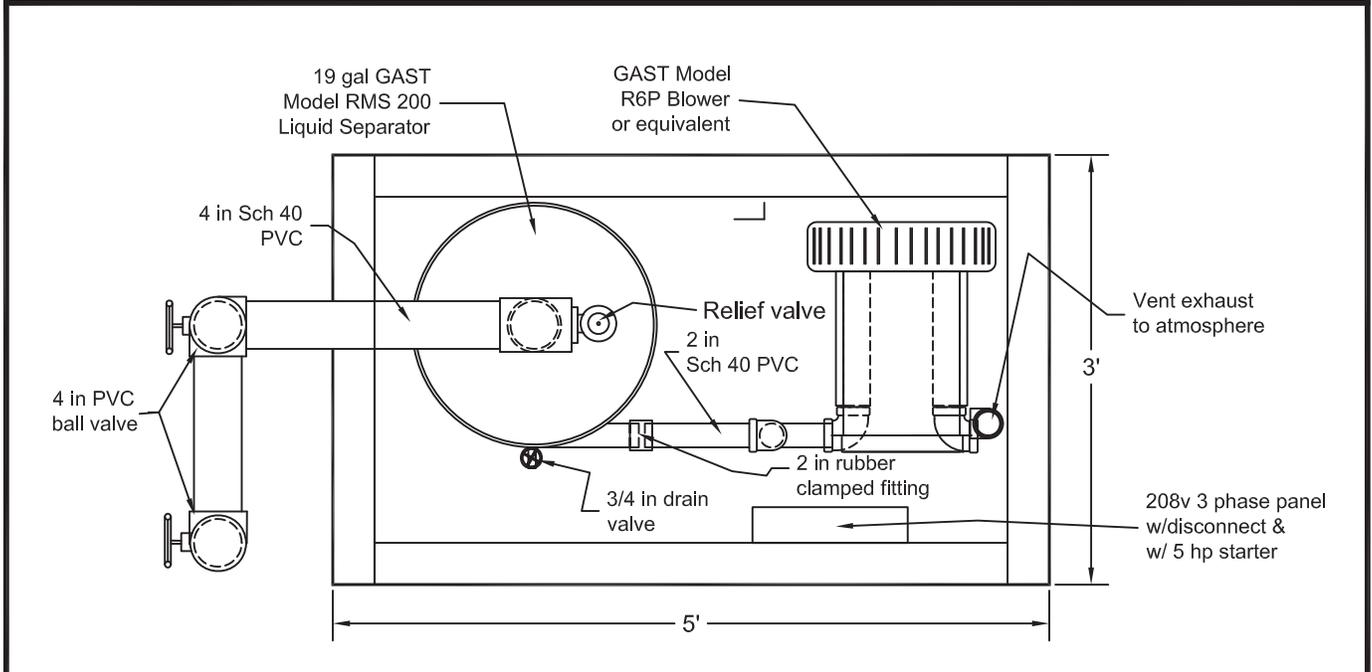
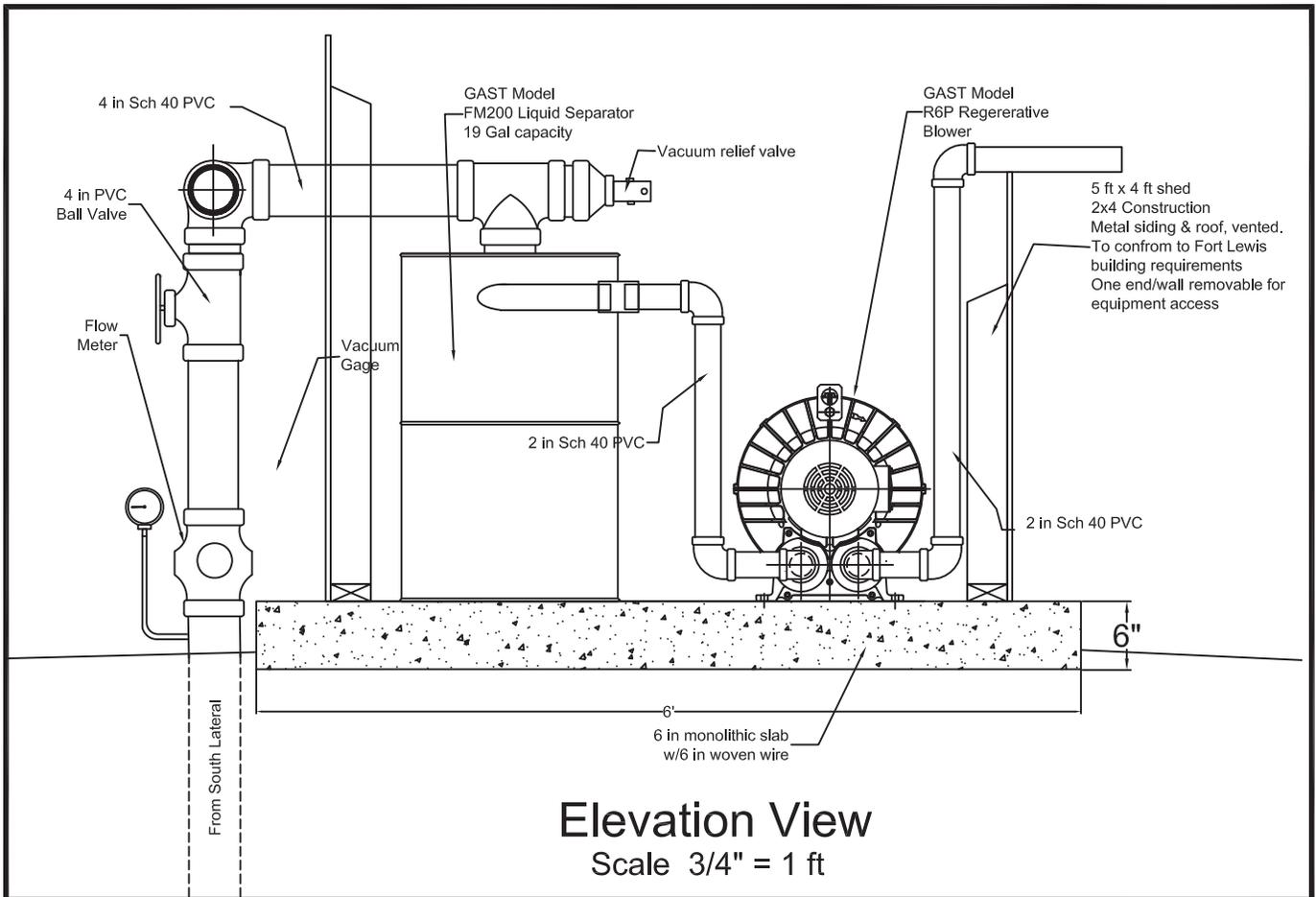


**3 Typical Footing**

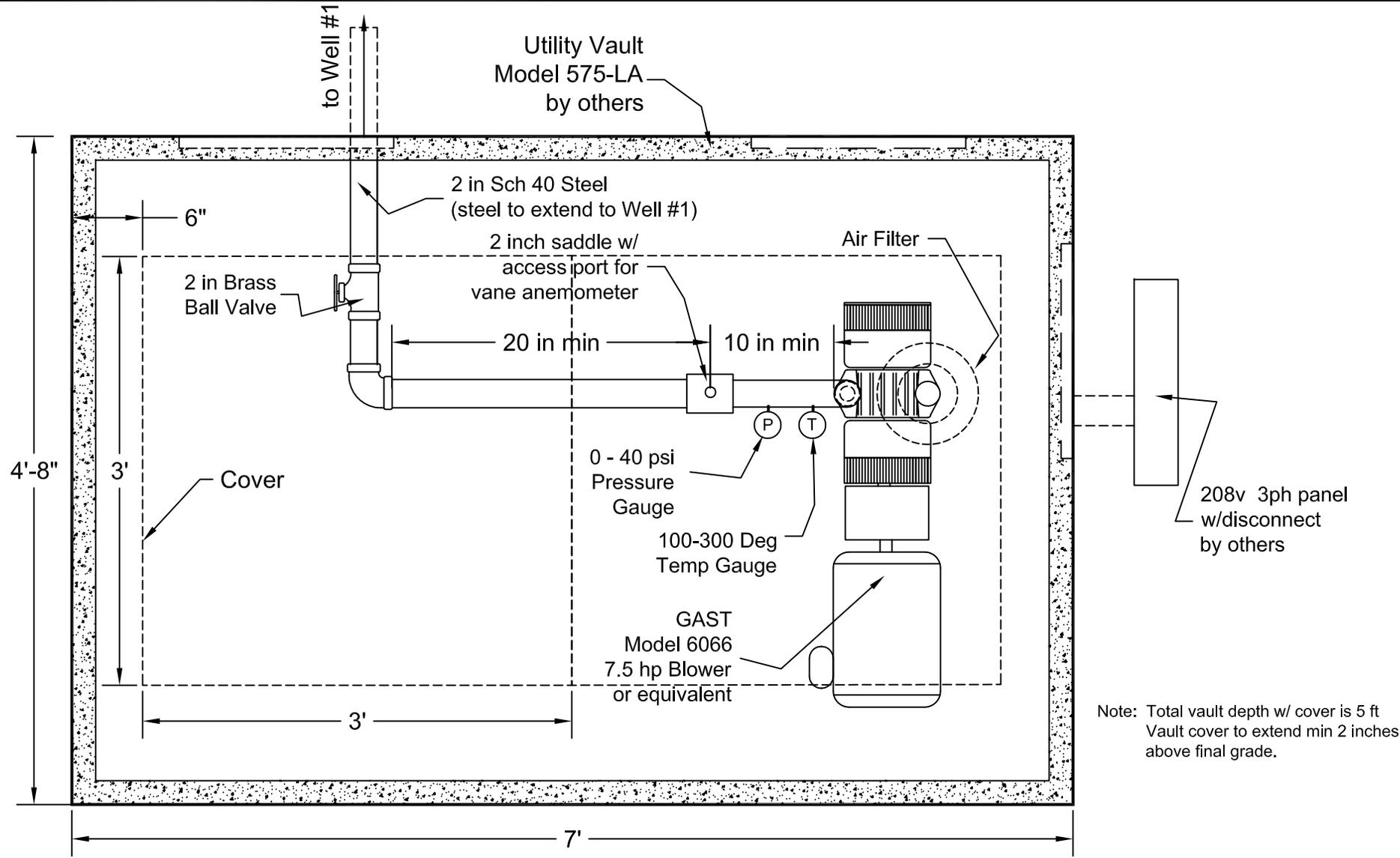


<p><b>Legend</b></p> <ul style="list-style-type: none"> <li>▲ Soil Vapor Probe</li> <li>■ Vacuum Port</li> <li>◇ Air Sparge Well</li> <li>● Monitoring Well</li> <li>● Monitoring Well w/Transducer</li> </ul>	<p>Map Data: Coordinate System: UTM, Zone 10 Horizontal Datum: WGS 84</p>	<p><b>USACE</b></p>	<p><b>SEALASKA</b></p>	<p>Figure 2-1 AOC 9-2 Air Sparge and Soil Vapor Extraction Layout</p>
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**Figure 2-2**  
**Soil Vapor Extraction Details**



**AIR SPARGE BLOWER DETAILS**  
Scale 1" = 1 ft

**Figure 2-3**  
Air Sparge System  
Details

The AS blower is a GAST Model 6066 compressor installed in a concrete vault located in the planting strip at the east edge of the property. The blower supplies air to the two AS wells. As discussed in the Draft Design Report (Versar 2009b), the AS compressor is sized to account for the piping and fitting head loss from the injection wells. The AS compressor discharges at over 15 pounds per square inch gauge (psig) at a minimum of 20 standard cubic feet per minute (scfm) per well.

A manifold connects the AS blower to two AS wells (Figure 1-3, ASW-1 and ASW-2). Flow control valves, flow measuring ports, and pressure gauges are installed at the head of each sparge well. Valves at the AS wells can be adjusted to balance flow and pressure to each well.

A manifold connects the air supply line to the tops of well AS-1 and well AS-2. Valves at the tops of the wells are used to control air flow. From well AS-2, the manifold extends to a stub-out at the east side of the building footings for connection to a potential third AS well. Pressure indicators, flow regulating valves, and check valves are installed on the air supply manifold in the vaults at the top of the AS wells.

## **2.4 SOIL VAPOR PROBES**

Eleven soil vapor probes (SVP) were installed in March 2010. SVPs were placed at 20-foot intervals extending perpendicular to the midpoint of the north lateral as shown in Figure 1-3. Two sets of two probes were installed at a distance of 20 feet from the northeast side of the building, near the source and plume area. One probe was installed at the approximate bottom depth of the extraction laterals (i.e., 7 feet). The other probe was installed at the calculated depth of influence of the extraction laterals (Versar 2009b). For example, 20 feet from the building, the upper probe was set at 7 feet. The lower probe was set at about 15 feet, the estimated maximum depth of influence at that point.

The probes were installed to depths within the calculated ZOI. The pairs of probes closest to the building were driven to 7 and 15 feet. The more distant probes were installed to 10 feet. The soil vapor probes were designated SVP-1a/b through SVP-8a. Table 2-1 identifies the probes, distances from the building, and depth. Figure 1-3 shows locations of permanent vapor monitoring and sub-slab pressure monitoring points, including:

- Three vapor monitoring locations at two depths (SVP-1a/b, SVP-5a/b, and SVP-7a/b);
- Five vapor monitoring locations at one depth (SVP-2a, SVP-3a, SVP-4a, SVP-6a, and SVP-8a);

- One mid-building, sub-slab monitoring point (SSD-3);
- Four corner, sub-slab monitoring points (SSD-S1, SSD-S2, SSD-N1, and SSD-N2);
- SVE blower suction lines from north and south zones (SVE-BS1 and SVE-BS2); and
- SVE blower exhaust (11574-SVE-BE-1).

As illustrated in Figure 2-4, the ZOI slopes up and away from the extraction laterals.

Soil vapor samples may be collected from the SVPs and analyzed for TPH-G and BTEX to evaluate the effect of the AS/SVE system. Soil gas pressures may also be measured at the SVPs to assess the extent of influence of the AS and SVE blowers.

**Table 2-1.** Soil Vapor Probe Locations and Depths

Probe Number	Affected by SVE Zone	Perpendicular to Building Wall	Approximate Distance from Wall (feet)	Vapor Probe Depth (feet)
SVP-1a	North	West	20	7
SVP-1b	North	West	20	15
SVP-2a	North	West	40	10
SVP-3a	North	West	60	7
SVP-4a	South	West	40	10
SVP-5a	North	East	20	7
SVP-5b	North	East	20	15
SVP-6a	North	East	40	10
SVP-7a	North	North	20	7
SVP-7b	North	North	20	15
SVP-8a	South	East	40	10

## 2.5 GROUNDWATER MONITORING WELLS

Eight groundwater monitoring wells are installed at AOC 9-2 (see Figure 1-3). Monitoring well construction details are provided in Table 2-2. A monitoring well (MW 10-A17-8) was installed within the excavation limits of the former USTs within the calculated ZOI of the eastern sparge well (AS-1).

**Table 2-2.** Monitoring Well Construction Details, Fort Lewis Agreed Order Site AOC 9-2

Location ID	Northing NAD 27	Easting NAD 27	TOC Elevation (ft AMSL)	Well Depth (ft bgs)	Screen Top (ft bgs)	Screen Bottom (ft bgs)	Completion Date
AOC 9-2 (Formerly Building A1033, Now Building 11574)							
95-A17-1	660636.2	1477935.7	236.9	42.5	27.1	42.1	18-Aug-95
95-A17-2	660603.4	1477725.7	235.9	42.2	27.0	42.0	17-Aug-95
95-A17-3a	660699.7	1477730.7	235.9	44.5	29.3	44.3	17-Aug-95
95-A17-4	660734.1	1477793.9	236.8	42.5	26.6	42.0	18-Aug-95
96-A17-5	660832.5	1477581.5	233.9	45.0	29.8	44.8	22-Jan-96
96-A17-6	660896.0	1477694.5	235.1	45.0	29.8	44.8	22-Jan-96
07-A17-7	660693	1477589	233.2	37	22	37	21-Jun-07
10-A17-8	660665	1477794	235.8	39	29	39	8-Oct-10

*Notes:*

AOC 9-2 monitoring wells were re-surveyed in December 2011.

TOC – Top of casing

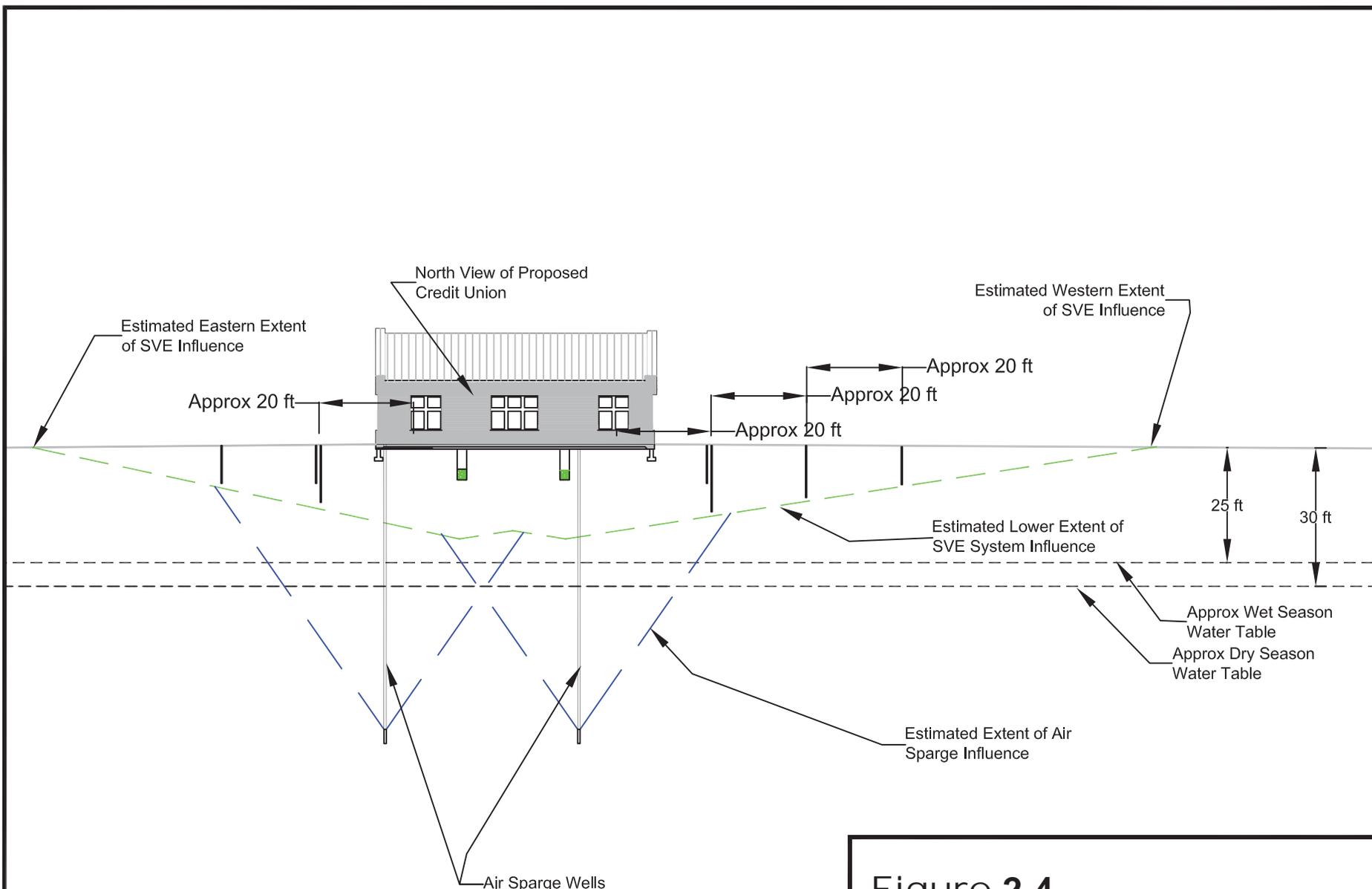
ft AMSL – Feet above mean sea level

ft bgs – Feet below ground surface

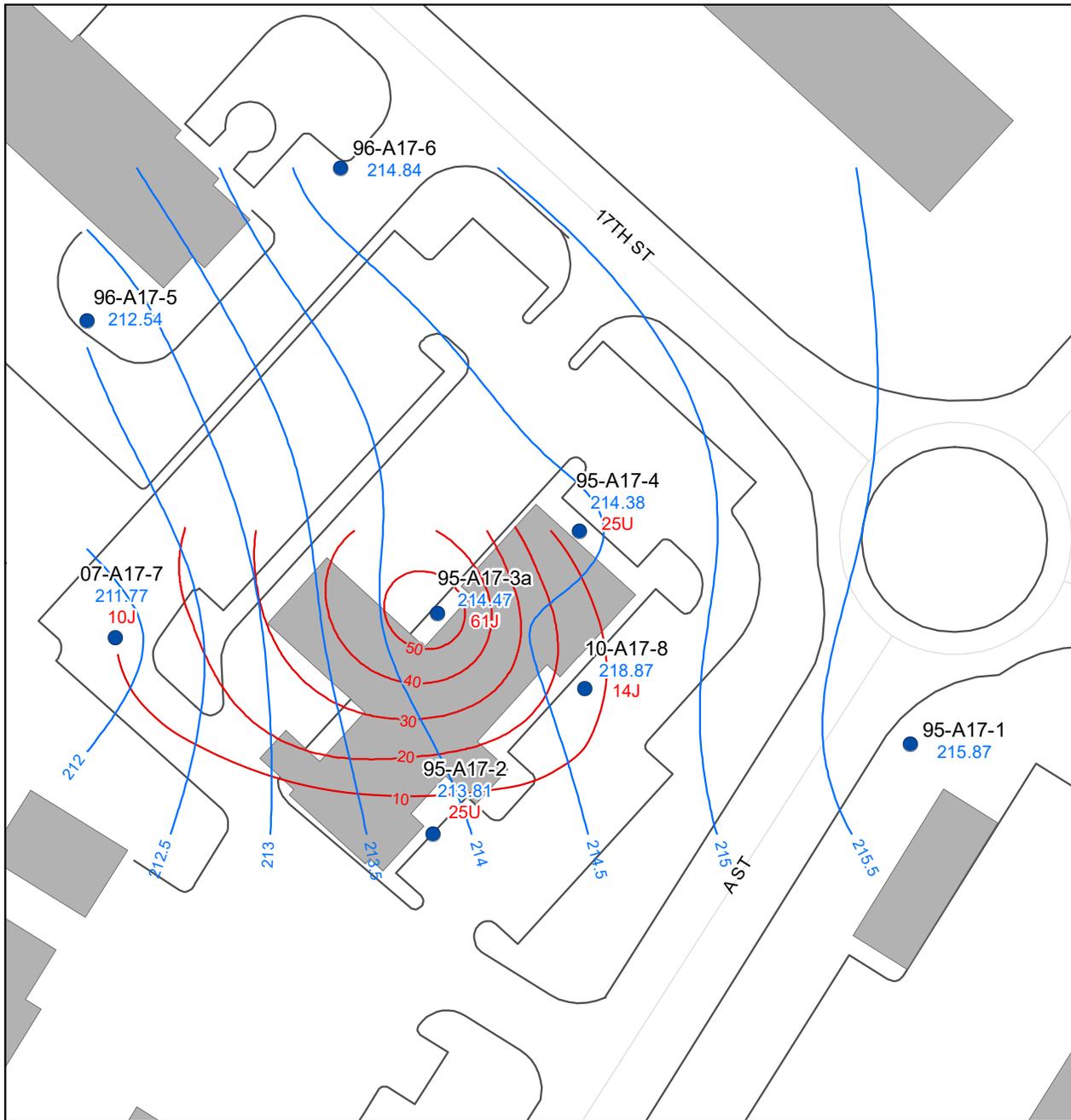
-- Not applicable, no data

Recent groundwater contour maps (Figures 2-5 and 2-6) indicate the highest concentrations of VOCs in the area of the suspected UST leakage, near the north end of the Credit Union building. The maps indicate a relatively flat groundwater gradient. Seasonal variations in the direction of groundwater were observed, with flow generally toward the south and southwest. Because the aerated, bubbly groundwater may distort water level readings and ability to collect samples, the AS compressor will be turned off a minimum of 48 hours before a groundwater monitoring event. Monitoring wells near the AS wells will experience a rise to mounded level and return to static level within about 90 minutes of a sparge event. Mounding effects are observed almost immediately at monitoring wells 95-A17-2, 95-A17-3a, and 95-A17-4. The mounding effect at monitoring wells may not be observed at monitoring wells at or beyond the site perimeter. When operating at a 30 minute AS cycle, mounding effects are negligible at perimeter wells MW 96-A17-5 and 07-A17-7. Results of groundwater monitoring should be correlated with data downloaded from the Leveloggers. Increases in VOC concentrations at groundwater monitoring wells, particularly those not near the AS wells, may suggest plume mobilization. In that case, changes in AS operation should be considered, as discussed in Section 4.1.4.

2-10



**Figure 2-4**  
Cross Section Showing Vapor Probes and Estimated Vertical and Horizontal ZOI for Air Sparge and SVE Systems



**Notes:**

Depth to water measurements collected April 18, 2016.

Groundwater samples collected April 18 and 19, 2016.

AS/SVE System was running during sampling (Mounding observed in well 10-A17-8, thus it was not used in contour creation)

TPH-G Cleanup level = 800 µg/L

**Legend**

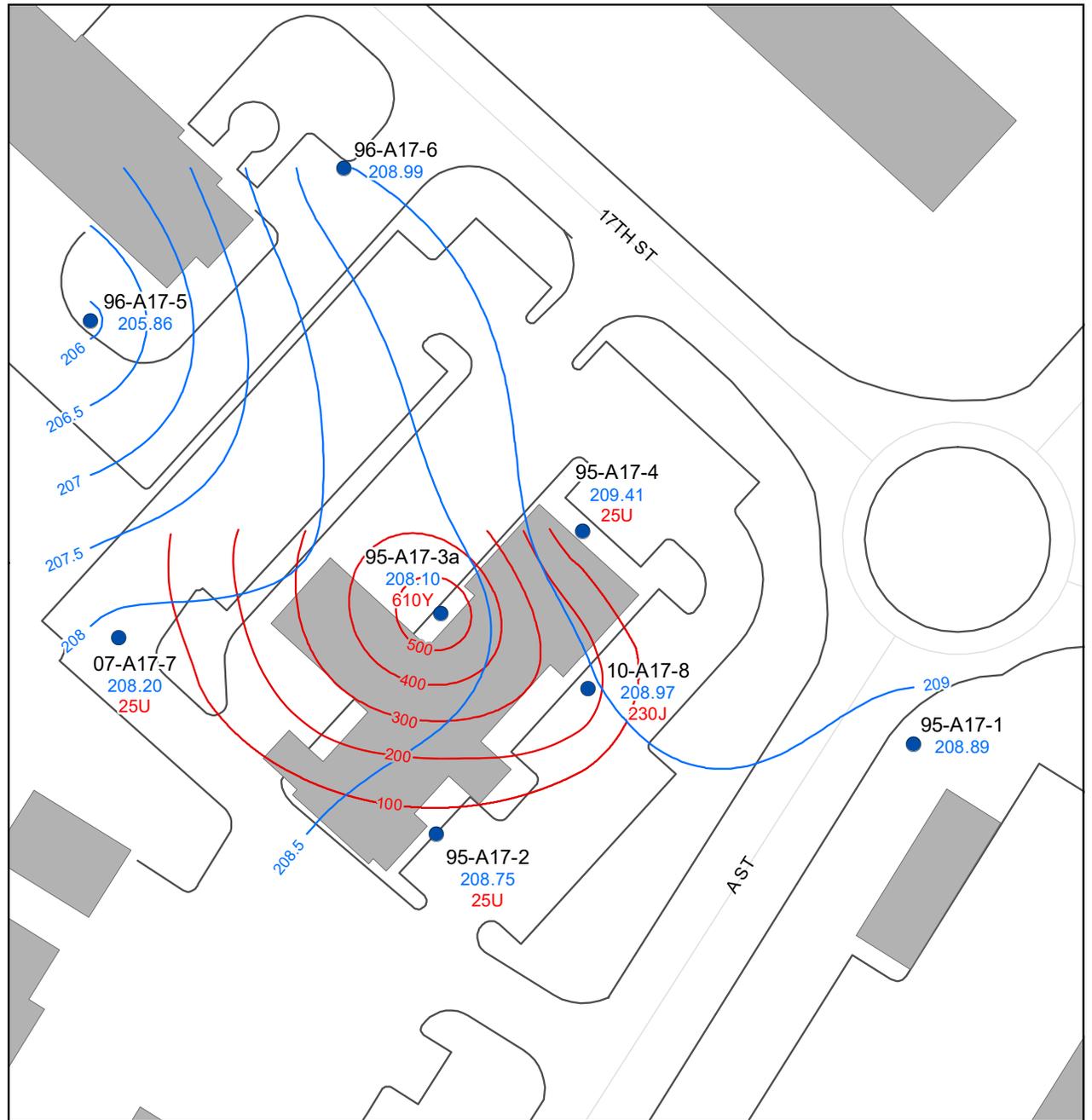
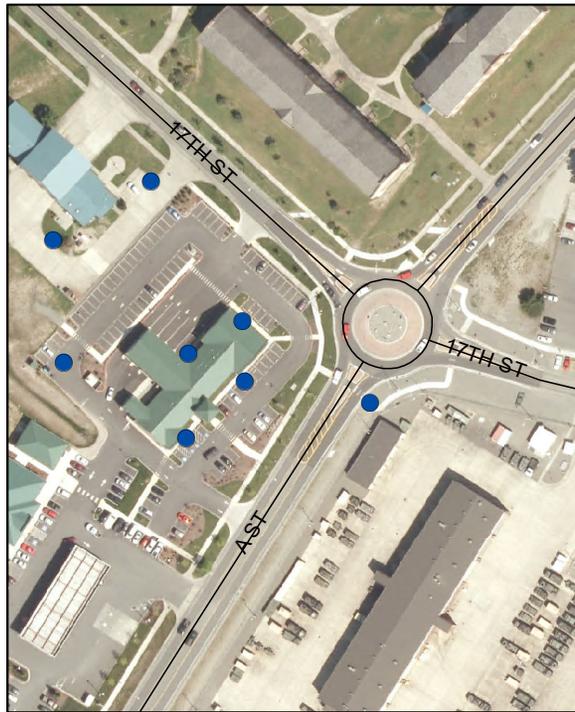
- Monitoring Well
- ~ Groundwater Elevation (fmsl)
- ~ TPH-G Concentration (µg/L)

		<p>Label ID</p> <p>07-A17-7 - Well ID</p> <p>211.77 - GW Elev.</p> <p>10J - TPH-G (µg/L)</p>
--	--	--

**USACE**



**Figure 2-5**  
AOC 9-2 Groundwater Elevation and  
TPH-G Concentration Contours April 2016



**Notes:**

Depth to water measurements collected August 18, 2016.

Groundwater samples collected August 29, 2016.

TPH-G Cleanup level = 800 µg/L

**Legend**

- Monitoring Well
- ~ Groundwater Elevation (fmsl)
- ~ TPH-G Concentraion (µg/L)

		<p>Label ID</p> <p>07-A17-7 - Well ID</p> <p>208.20 - GW Elev.</p> <p>25U - TPH-G (µg/L)</p>
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**USACE**



**Figure 2-6**  
**AOC 9-2 Groundwater Elevation and**  
**TPH-G Concentration Contours August 2016**

### **3 PROJECT ORGANIZATION AND RESPONSIBILITIES**

The project team consists of an Operation, Maintenance, and Reporting Team; project and program managers from the US Army Corps of Engineers (USACE) and US Army Environmental Command (USAEC); the JBLM Installation Restoration Program (IRP) Program Manager; and personnel from Sealaska Environmental Services LLC (Sealaska), Ecology, Credit Union, and the contracted laboratories. Table 3-1 shows anticipated roles and responsibilities for this project.

#### **3.1 PLANNING AND COORDINATION**

Before conducting each AS/SVE system vapor sampling event, Sealaska will ensure that applicable delivery orders with the contracted laboratory (currently Eurofins-Air Toxics, Ltd.) are established, and will notify the Credit Union point-of-contact of upcoming monitoring events.

**Table 3-1.** Project Team Roles and Responsibilities for Ongoing Performance Monitoring for AS/SVE and SSD Systems

<b>Project Role</b>	<b>Name, Company Phone Number, Email</b>	<b>Responsibilities</b>
USACE Project Manager	Ember Korver 206-764-3479 ember.e.korver@usace.army.mil	Project management
USACE Technical Lead	Jayson Osbourne 206-369-2615 jayson.b.osborne@usace.army.mil	Technical support, document review
JBLM IRP Program Manager	Meseret Ghebreslassie 253-477-3742 meseret.c.ghebreslassie.civ@mail.mil	Program management, Document review
Project Manager	Scott Elkind Sealaska 360-626-3991 scott.elkind@sealaska.com	Communication and coordination with project team, JBLM and USACE managers, and Ecology
System Operation & Maintenance Manager	Bob Thomas Sealaska 253-930-2768 bob.thomas@sealaska.com	Communication and coordination with project team. Preparation of planning documentation and reports
Field Professional	Tom Malamakal Sealaska 425-623-2951 tom.malamakal@sealaska.com	Coordination and completion of fieldwork. Preparation of planning documentation and reports.
Analytical Laboratory – air and soil vapor samples	Kelly Buettner Eurofins-Air Toxics, Ltd. 916-985-1000 kbuettner@airtoxics.com	Analysis of air samples
Regulatory Review	Charles Hoffman Ecology 360-407-6344 chof461@ecy.wa.gov	Review planning and reporting documents
Credit Union Branch Manager	Joy Benge 253-912-3242 jbenge@youracu.org	Current Branch Manager
Credit Union Facilities Engineer	Paul Winchell 253-912-3223 pwinchell@youracu.org	Facilities Engineer

## 4 OPERATION, MAINTENANCE AND MONITORING

### 4.1 SYSTEM OPERATION

The IA Work Plan (Versar 2013a) specifies the following operations based on the results of pilot testing:

- Adjust and balance pressure and flows to SVE zones and AS wells at settings defined in Pilot Test and Startup Report (Versar 2013b).
- Maintain continuous operation of the SVE blower until the site is remediated.
- Operate the AS blower in pulsed mode with an inter-sparge period of at least one hour.
  - Monitor wells downgradient of AS wells for mounding effect.
  - Increase AS frequency if no indication that selected AS cycle is increasing groundwater gradient or mobilizing gasoline plume.

Maintenance will focus on the following system elements:

- Maintain integrity of SVE suction lines and blower.
- Empty SVE knockout drum of water (check at least once weekly).
- Maintain integrity of AS blower lines and AS well heads and blower.
- Empty AS blower knockout bottle of water.

Information on monitoring equipment used at the site is provided in Appendix B.

The SVE blower knockout drum collects about one-half to a full drum of water per week during the rainy season. The water is collected by the extraction laterals under the building. The extraction laterals are greater than 15 feet above groundwater. The water in the knockout drum is presumed to be rain water that is drawn from the planting beds and under the building slab by the low suction from the SVE blower. Sampling and analysis of the water indicated non-detect for TPH-G and BTEX. However, the knockout water will be transported for treatment at one of the JBLM air stripper systems.

#### 4.1.1 System Startup and Shutdown

The AS and SVE blowers operate independently. In addition to removal of VOCs, the SVE blower is critical to maintenance of the SSD system for protection of building occupants. The SVE blower should only be turned-off for brief maintenance or after confirmation

sampling demonstrates that remedial action objectives have been met. Procedures for startup and shutdown of the AS and SVE blowers are outlined in the following sections.

#### **4.1.1.1 AS Blower Startup**

The AS blower is located in a subsurface concrete vault on the east side of the Credit Union building (see Figure 1-3). The AS blower should only be operated when the SVE blower is operating. The AS blower may be operated in automatic or manual modes. Below is the sequence for AS blower startup:

1. Perform safety checks before entering the blower vault:
  - a. Complete Confined Space Entry Checklist (Appendix C: Field Forms). The AS vault is a non-permit confined space provided that air monitoring is performed prior to entry and results indicate safe conditions.
  - b. Inspect AS blower vault. Survey air in vault with PID and 4-gas meter. Enter the vault only if VOCs are not present and oxygen, lower explosive limit, and other gases are at safe conditions as defined in the Site Safety and Health Plan (SSHP) included in the Project Management Plan (Sealaska 2016a).
  - c. Confirm if the AS blower is operating. Hearing protection is required in the vault and within 10 feet in area around vault lid when the AS blower is operating.
2. Verify that valve at blower discharge is 100% open. Check pressure gauge downstream of the blower discharge valve. The AS blower typically discharges at 14 to 16 psig. If the blower discharge pressure is higher than 18 psig, check positions of downstream AS valves. Discharge pressures over 20 psig probably indicate a downstream obstruction and need for investigation and repair.
3. Verify that valves at AS well heads are open to the desired position. AS well head valves have remained in full open position since system construction. However, changes in valve position may be performed to direct more sparged air to a particular well.
4. The motor starter panel powers the blower through a timer panel. Select “Auto” or “Hand” mode on the blower timer. The blower will operate with the motor starter panel “On” and the timer in “Hand” mode. Verify blower operation in “Hand” mode before relying on the timer. If necessary, reset blower timer to correct day and time. Program the blower timer for desired time, frequency and duration of air sparging. The existing blower timer allows for four on-off cycles per 24-hour period. After

- programming AS cycle time, enter “Run” or “Hand” for the desired operation.
5. Return during a scheduled sparge event to verify timer operation.
  6. Check blower discharge line and AS well head pressures during operation.
  7. During weekly inspections, check AS line and sparge well heads for signs of corrosion or air leaks.

#### **4.1.1.2 AS Blower Shutdown**

Follow safety procedures outlined in Section 4.1.1.1. The AS blower may be turned off at the timer by switching from “Run” to “Off.” The timer and blower may be completely disabled by switching off the motor starter panel in the AS blower vault.

In the event of an emergency, the AS compressor may be turned off at the motor starter panel. Complete power to the AS compressor can be disabled at the breaker in the electrical panel in the Credit Union mechanical room.

#### **4.1.1.3 SVE Blower Startup**

The SVE blower is located in the shed at the northwest corner of the Credit Union parking lot (see Figure 1-3). The SVE blower is not equipped with a timer because it must remain in continuous operation to remove subsurface VOCs and protect building occupants from possible intrusion of petroleum hydrocarbons.

Hearing protection is required in the SVE blower shed. Low concentration VOCs (generally less than 30 parts per billion-volume [ppbv]) are discharged from the SVE exhaust line. Operators should minimize exposure to VOC exhaust, for instance only a few seconds are required for flow and PID readings.

The SVE blower is started with the motor starter panel switch in the “On” position.

- **SVE Suction Line Valves:** Verify that the SVE suction line valves are sufficiently open to allow air flow. During blower operation, the SVE suction line valves are typically in the 75% open (south SVE zone) and 100% open (north SVE zone) as defined during the pilot test. With these valve settings, suction pressures typically range from about 3.0 in H<sub>2</sub>O vacuum to 10 in H<sub>2</sub>O vacuum.

#### **4.1.1.4 Ongoing Inspection**

Inspect SVE suction lines for air leaks (hissing), cracks or other damage. If gauges on suction lines indicate vacuum pressures significantly different than historical values (normally between 3 and 9 psig), investigate the following possible causes:

- Positions of SVE valves may have been changed;
- Gauge may have failed; or
- SVE line is damaged by possible blockage or leak.

#### **4.1.2 SVE Blower Shutdown**

The SVE blower should only be turned-off for brief maintenance or in the event that confirmation sampling indicates that remedial action objectives are satisfied. Turn off the SVE blower by lowering the motor starter panel switch to “Off.” If the SVE blower will be off for an extended period, verify that the knockout drum is emptied of water.

In the event of an emergency the SVE blower may be turned off at the motor starter panel. Complete power to the SVE blower shed can be disabled at the breaker in the electrical panel in the Credit Union mechanical room.

#### **4.1.3 Coordination of Air Sparge and Soil Vapor Extraction Systems**

The SVE blower will be operated at settings defined in the system pilot test (valve SVE-BS-1 at 75% open, and valve SVE-BS-2 at 100% open). Valves on the AS blower lines have been set to 100% open but may be adjusted to balance pressures at the heads of each AS well. The SVE blower will be operated continuously in order to extract VOCs and minimize the risk of vapor intrusion to the Credit Union building.

#### **4.1.4 Pulsed Operation of AS Blower**

Pulsing of the AS blower results in a rise and fall of groundwater levels within the treatment zone. Constant operation of the AS blower will mound groundwater, creating a steeper gradient with the possibility of further mobilizing the affected groundwater. Pulsed operation of the AS blower with a cycle time that ends shortly after reaching the peak mounded groundwater level will minimize the effect on local groundwater gradient. The pilot test determined that groundwater was lifted to maximum height within 60 minutes of startup of the AS blower. Groundwater returned to the pre-sparge depth within 35 minutes after the blower was turned off. The SVE system collects VOCs during operation of the AS blower and continues removal for several hours after start of the AS blower.

The optimum number of AS pulses was defined based on changes in water levels at the site. Groundwater level fluctuations are monitored to determine the mounding effect of air sparging. The earliest effects of mounding with air sparging are observed at wells MW 95-A17-3a and MW 10-A17-8, nearest the AS wells. Changes in depth to water (DTW) are continuously measured at monitoring wells: 95-A17-2, 95-A17-3a, 95-A17-4, 96-A17-5, and 07-A17-7. Those five monitoring wells are configured with Solinst Levellogger DTW probes (Appendix B) equipped with data loggers for continuous monitoring. Groundwater levels are also monitored by manual DTW probes during semi-annual monitoring events. A sparge duration and frequency of one hour per day, initiated in July 2014, resulted in a slight mounding effect at the most distant monitoring wells, 96-A17-5 and 07-A17-7. In October 2014, the sparge duration was decreased 30 minutes and the pulse frequency increased to four cycles per day. Negligible mounding effects at the distant monitoring wells were observed during four, 30 minute AS pulses per day. The existing timer on the AS blower allows for only four on-off cycles per day. The AS pulse regimen of four, 30 minute cycles remains in effect as of the date of this document.

The following actions will be implemented for operation and monitoring of the AS/SVE system:

- Operate the SVE blower continuously to maintain constant negative sub-slab pressure and extract VOCs removed by air sparging.
- Ensure that when the AS blower is operating, MW 10-A17-8 is capped to prevent vapors from venting directly to the atmosphere.
- Maintain the existing AS pulse regimen. Allow an inter-sparge period of at least 1 hour to allow groundwater levels to stabilize (i.e., 1-hour sparging followed by at least 1 hour without sparging). Increase AS pulse frequency to as many cycles per day as possible, if system remains effective as described below.

The following procedure is recommended if changes in AS pulse duration and frequency are desired:

- Use Levellogger data loggers to continuously monitor groundwater levels at monitoring wells: 95-A17-2, 95-A17-3a, 95-A17-4, 96-A17-5, and 07-A17-7 to assess the effect of AS pulsing. Allow at least 14 days of operation after each change in AS duration, frequency of operation, and/or AS well valve positions in order to observe possible cycles in AS mounding.

- Begin with valves at AS well heads open 100%. If no changes in groundwater levels are observed at MWs near the site perimeter (96-A17-5 or 07-A17-7), then increase pulse frequency. Increase pulse frequencies if no effect on perimeter monitoring wells is observed in Levellogger data. Maintain an inter-sparge period of at least two hours.
- If a rise in downgradient DTW is observed, reduce the duration of the sparge cycle. Allow operation at the reduced duration for at least 14 days. Retrieve Levelloggers and download water level data. Reduce the duration of the AS cycle. Again, retrieve water level data and determine if there is a downgradient mounding effect.
- If increases in DTW at site perimeter wells continue to be correlated to AS operation even with reduced sparge cycles, then close AS well head valves to 75% open. With each adjustment in sparge duration, valve position or sparge frequency, retrieve and analyze Levellogger data to assess the extent of downgradient groundwater mounding.
- If a rise in downgradient DTW is observed, reduce the duration of the AS cycle. Continue to reduce the duration of the AS cycle until no rise in groundwater at perimeter wells is observed. If a downgradient mounding effect cannot be eliminated with reduction in sparge duration, reduce the AS valve positions to 50% (Consult blower curve in Appendix D. Do not exceed maximum blower pressure.).

## 4.2 SYSTEM INSPECTION AND MAINTENANCE

Routine maintenance will be conducted on the AS/SVE system during weekly and monthly inspections. Table 4-1 outlines weekly, monthly, quarterly, semi-annual, and annual system inspection activities.

Blank log sheets for the AS/SVE system are included in Appendix C. Field personnel will begin each site visit by recording the date, time, and purpose of visit in the Daily Site Log stored in the SVE building. All observations, sampling, and maintenance will be recorded in inspection log sheets and stored in the project trailer. Log sheets and field notes will be scanned, uploaded, and stored in a project-specific folder on the Sealaska network.

System inspection and maintenance are performed to ensure integrity of the vapor mitigation system, pressurized AS system, and vacuum SVE system. Two blowers and associated equipment require routine inspection for mechanical integrity. The system has pressurized pipe and components on the AS side and components under low vacuum on the SVE side. Basic maintenance includes checking and sealing air leaks, and removing water from

monitoring ports and knockout containers. Monitoring is performed to ensure that negative pressure is maintained under the building to remove VOCs and protect building occupants. VOC concentrations are measured at the SVE blower exhaust and in ambient air in and around the building. Condition of SVE suction lines and AS pressure lines is routinely monitored. SVPs in the parking lot surrounding the Credit Union building allow for assessment of extent of influence of the AS/SVE system.

**Table 4-1.** Inspection, Monitoring, Maintenance Activities, and Frequencies for the AS/SVE/SSD System

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**Weekly Monitoring, Inspection, and Maintenance Activities**

Weekly monitoring, maintenance, and inspection tasks include:

SVE System:

- Note any unusual noises in blowers.
- Note any possible leakages from SVE vacuum pipe and fittings.
- Note any visual oil leaks around the blower.
- Check temperature of SVE blower suction and SVE exhaust lines.
- Measure pressure, vacuum, and air flow velocity on the SVE suction lines.
- Record SVE exhaust temperature for each blower.
- Compare SVE flow, vacuum, and temperature to historical readings. Note any significant differences and troubleshoot possible problem.
- Note any possible air leaks from AS blower pipe and fittings.
- Measure AS blower discharge temperature with infrared thermometer. Compare with temperature gauge.
- Compare AS pressures and temperatures to historical readings. Note any significant differences and troubleshoot possible problem.
- Check water level in knock out drum, record water level and drain if necessary.
- Record pressure readings at AS well heads. Remove standing water around each well head.
- Check temperature of AS blower discharge line.
- Check temperatures of AS well heads.
- Use PID to monitor SVE blower exhaust.
- Check condition of various safety signs and reattach or replace if necessary.

---

**Monthly Monitoring, Inspection, and Maintenance Activities**

Monthly monitoring, maintenance, and inspection includes all weekly tasks listed and:

- Sub-slab depressurization (SSD) Ports:
  - Clear water from SSD ports as necessary.
  - Measure vacuum pressures at five building foundation monitoring points (SSD) ports.
  - Measure suction pressures for each SSD extraction zone.
  - Compare SSD differential pressure to historical readings. Note any significant differences and troubleshoot possible problem.
  - Tighten fittings at AS well heads and AS injection lines if necessary.
  - Check blower shafts for alignment. Repair if necessary.
  - Check operating temperatures and pressures and compare to blower specifications.
  - Check condensate bottle and air filter on intake to AS compressor. Empty bottle and clean filter if necessary.
-

**Table 4-1.** Inspection, Monitoring, Maintenance Activities, and Frequencies for the AS/SVE/SSD System (continued)

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**Quarterly Monitoring, Inspection, and Maintenance Activities**

Quarterly monitoring, maintenance, and inspection includes all tasks listed above and:

- SVE exhaust – four Tedlar bag samples collected at equally-spaced intervals for 8 hours during maximum daily AS blower cycles.

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**Semi-Annual Monitoring, Inspection, and Maintenance Activities**

Semi-Annual monitoring, maintenance, and inspection includes all tasks listed above and:

- Vacuum pressures at parking lot soil vapor probes (with and without AS blower operating).
- Groundwater quality monitoring.
- Groundwater level measurements.

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**Annual Monitoring, Inspection, and Maintenance Activities**

Annual monitoring, maintenance, and inspection includes all tasks listed above and:

- Vapor Intrusion Monitoring (interior and ambient air samples by Summa canister).
  - SVP screening by PID or Flame Ionization Detector and samples by Tedlar bag.
- 

### 4.3 PERFORMANCE MONITORING

Performance monitoring will involve sampling to observe trends in groundwater and soil vapor conditions, SVE and SSD performance, measurement of blower ZOIs, and abilities of the blowers to strip and remove VOCs. Performance monitoring will focus on verification of:

- Negative sub-slab pressure maintained by the SVE system;
- Removal of VOCs to improve soil vapor quality;
- Balance of air flow between SVE zones; and
- Air flow to AS wells.

In addition, annual vapor intrusion monitoring will assess the effectiveness of the SVE and SSD systems in mitigating VI from the underlying gasoline plume (see Section 4.4).

Table 4-2 outlines the various media, monitoring parameters, and equipment to be employed in monitoring. Table 4-3 outlines parameters and frequency of ongoing performance monitoring for the AS/SVE/SSD systems.

Other documents related to performing sampling and monitoring at the North Fort Credit Union AS/SVE system include the project SSHP, Sampling and Analysis Plan (SAP) for VI Monitoring (Versar 2013a), and the SAP for groundwater monitoring (Versar 2014).

### 4.3.1 AS/SVE/SSD System

Monitoring of the AS/SVE/SSD system performance will focus on the mechanical systems, parking lot soil vapor probes and sub-slab soil gas pressures. The effectiveness of the SSD system in mitigating VI will be assessed by measuring the pressure differentials across the building floor slab. Negative pressure differentials are expected during SVE operation. Vacuum pressure will be measured at the five sub-slab monitoring ports to determine differential pressure between the sub-slab and building interior and sub-slab and ambient outside air. Sub-slab pressure differentials will be monitored weekly throughout the performance monitoring phase.

**Table 4-2. Media, Monitoring Parameters, and Equipment**

Medium	Monitoring Parameters	Equipment and/or Method	Monitoring Points
Groundwater	<ul style="list-style-type: none"> <li>DTW</li> <li>pH, specific conductivity, temperature, turbidity, DO</li> <li>TPH-G (NWTPH-Gx) and BTEX (EPA Method 8260C)</li> </ul>	<ul style="list-style-type: none"> <li>DTW probe</li> <li>Levellogger<sup>1/</sup></li> <li>Horiba U-22 or similar meter</li> <li>Bladder or submersible pump</li> <li>Disposable bailer</li> </ul>	<ul style="list-style-type: none"> <li>Monitoring wells: 95-A17-2, 95-A17-1; 95-A17-3a, 95-A17-4, 10-A17-8</li> </ul>
Soil Vapor Pressure	<ul style="list-style-type: none"> <li>Low vacuum and low positive pressure</li> </ul>	<ul style="list-style-type: none"> <li>Magnehelic differential pressure gauges (vacuum)<sup>1/</sup></li> </ul>	<ul style="list-style-type: none"> <li>Soil vapor probes: SVP-1a/b; SVP-2a; SVP-3a; SVP-4a; SVP-5a/b; SVP-6a; SVP-7a/b; SVP-8a</li> </ul>
Soil Vapor Chemistry	<ul style="list-style-type: none"> <li>TPH-G, BTEX using TO-15 GC/MS Full Scan</li> <li>Tedlar Bag Method</li> </ul>	<ul style="list-style-type: none"> <li>Peristaltic pump (Preferred)</li> <li>Vacuum pump (if peristaltic pump not available)</li> <li>Tedlar bags</li> <li>PID or FID for field screening<sup>1/</sup></li> </ul>	<ul style="list-style-type: none"> <li>Soil vapor probes and SVE exhaust</li> </ul>
Vapor Intrusion and Ambient Air Monitoring	<ul style="list-style-type: none"> <li>Summa Method TO-15 GC/MS Full Scan SIM for VOC and TPH-G</li> </ul>	<ul style="list-style-type: none"> <li>Summa canisters with flow regulators configured for an 8-hour sample</li> </ul>	<ul style="list-style-type: none"> <li>Building interior (lobby, conference room, and custodian's closet)</li> <li>Exterior: upwind and parking area near neighboring gas station</li> </ul>
Sub-slab Pressure	<ul style="list-style-type: none"> <li>Low vacuum and low positive pressure</li> </ul>	<ul style="list-style-type: none"> <li>Magnehelic vacuum gauges (Models: 2000-00N (0.05 to 0.2 inches water); 2000-00 (0 to 0.25 inches water); 2000-0 (0 to 0.5 inches water)<sup>1/</sup></li> </ul>	<ul style="list-style-type: none"> <li>Sub-slab ports: SSD-N1, SSD-N2; SSD-S1; SSD-S2; SSD-3</li> </ul>

**Table 4-2. Media, Monitoring Parameters, and Equipment (continued)**

<b>Medium</b>	<b>Monitoring Parameters</b>	<b>Equipment and/or Method</b>	<b>Monitoring Points</b>
Air Sparge Blower	<ul style="list-style-type: none"> <li>• Pressure</li> <li>• Temperature</li> <li>• Flow</li> </ul>	<ul style="list-style-type: none"> <li>• Positive pressure gauges</li> <li>• Temperature gauges</li> <li>• Infrared Temperature Gun<sup>1/</sup></li> <li>• Blower curve for flow</li> </ul>	<ul style="list-style-type: none"> <li>• Pressure gauges on blower discharge and sparge lines</li> <li>• Temperature gauge on blower discharge line</li> </ul>
Extracted Soil Vapor	<ul style="list-style-type: none"> <li>• Flow</li> <li>• Pressure</li> <li>• TPH-G, BTEX</li> <li>• Laboratory analyses</li> </ul>	<ul style="list-style-type: none"> <li>• Testo Compact Mini-Vane Anemometer</li> <li>• Vacuum gauge (Magnehelic brand)<sup>1/</sup></li> <li>• PID (RAE Systems Portable ppb VOC monitor) or FID<sup>1/</sup></li> </ul>	<ul style="list-style-type: none"> <li>• All monitoring at suction risers from north and south extraction lines to blower and blower exhaust</li> </ul>
Indoor Air	<ul style="list-style-type: none"> <li>• TPH-G, BTEX</li> <li>• Laboratory analyses</li> </ul>	<ul style="list-style-type: none"> <li>• Summa canisters, Method TO-15 for TPH-G and BTEX</li> <li>• PID or FID for field screening<sup>1/</sup></li> </ul>	<ul style="list-style-type: none"> <li>• Interior Rooms (lobby, custodian's closet, conference room)</li> </ul>
Ambient Air	<ul style="list-style-type: none"> <li>• TPH-G, BTEX</li> <li>• Laboratory analyses</li> </ul>	<ul style="list-style-type: none"> <li>• Summa canisters, Method TO-15 for TPH-G and BTEX</li> <li>• PID or FID for field screening<sup>1/</sup></li> </ul>	<ul style="list-style-type: none"> <li>• HVAC intake</li> <li>• West Edge of Property</li> <li>• Property Boundary at Gas Station</li> </ul>

*Notes:*

<sup>1/</sup> See Appendix B for monitoring equipment information.

FID – Flame Ionization Detector

ppb – parts per billion

EPA – Environmental Protection Agency

**Table 4-3. Parameters and Frequency of Monitoring for AS/SVE and SSD Systems**

<b>Operating Condition</b>	<b>Parameter and Location</b>	<b>Frequency of Monitoring</b>
Performance Monitoring	SVE blower suction pressures for each extraction zone	Weekly
	Groundwater Quality Monitoring (MW: 95-A17-2, 95-A17-3a, 95-A17-4, 07-A17-7, and 10-A17-8)	Semi-annually
	Groundwater Level Measurements	Concurrent with groundwater quality monitoring and data-logging DTW measurements
	Pressure differentials at building foundation monitoring points	Monthly
	Soil vapor monitoring at soil vapor probes	Annually
	Pressure differentials at soil vapor probes	Semi-annually
	Vapor intrusion and ambient air monitoring	Annually
Safety Monitoring To Verify Vapor Extraction/ Capture System Performance	SVE Exhaust <ul style="list-style-type: none"> <li>• Flow</li> <li>• Temperature</li> <li>• Pressure</li> <li>• VOCs by PID or FID</li> <li>• VOCs by Tedlar bag</li> </ul>	<ul style="list-style-type: none"> <li>• Weekly: Flow, temperature, pressure and PID/FID monitoring</li> <li>• Quarterly: Four Tedlar bag samples collected at equally spaced intervals for 8 hours during maximum daily AS blower cycles</li> </ul>
	PID or FID monitoring of ambient air near SVE blower building	Quarterly: PID/FID monitoring of ambient air around SVE blower building
	Indoor air quality monitoring with PID or FID	In the event of loss of SSD vacuum pressure
	Indoor air quality sampling with Summa canisters for laboratory characterization	In the event of loss of SSD vacuum pressure, elevated PID readings for interior air or other evidence of possible vapor intrusion into building

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**Table 4-3. Parameters and Frequency of Monitoring for AS/SVE and SSD Systems (continued)**

Operating Condition	Parameter and Location	Frequency of Monitoring
Confirmation Sampling (performed after satisfying Criteria for System Shutdown).	SVE Exhaust <ul style="list-style-type: none"> <li>Flow</li> <li>Temperature</li> <li>Pressure</li> <li>VOCs by PID or FID</li> </ul>	Restart blower and monitor weekly for one month after Shutdown Criteria are satisfied
	SVE Exhaust <ul style="list-style-type: none"> <li>Soil Vapor by Tedlar bag for TPH-G, BTEX</li> </ul>	<ul style="list-style-type: none"> <li>Fourth week of monitoring after Shutdown Criteria are satisfied</li> <li>Four Tedlar bags collected at two hour intervals for 8 hours at typical AS frequency or Summa canister, calibrated to draw a composite sample for 24 hours.</li> </ul>
	Soil Vapor Probes <ul style="list-style-type: none"> <li>Soil Vapor by Tedlar bag for TPH-G, BTEX</li> </ul>	<ul style="list-style-type: none"> <li>After monitoring by PID/FID indicates no VOCs</li> <li>One Tedlar bag sample from each SVP during maximum AS blower operation (11 total Tedlar bag samples)</li> </ul>
	Groundwater Quality Monitoring (MWs: 95-A17-2, 95-A17-3a, 95-A17-4, 07-A17-7, and 10-A17-8)	One time after Shutdown Criteria Satisfied
Post-Shutdown Monitoring	Groundwater Level Measurements	Concurrent with groundwater quality monitoring
	<ul style="list-style-type: none"> <li>Groundwater Quality Monitoring</li> <li>Groundwater Level Measurements</li> </ul>	Quarterly for five quarters. Discontinue if water quality remains below MTCA cleanup levels for five consecutive quarters

*Notes:*

- BTEX – Benzene, toluene, ethylbenzene and xylenes
- FID – Flame Ionization Detector
- PID – Photoionization Detector
- SSD – Sub-slab depressurization
- SVP – Soil vapor probe
- TO-15 – Laboratory analysis for gasoline and BTEX in air samples
- TPH-G – Gasoline-range total petroleum hydrocarbons

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### **4.3.2 Air Flow and Temperature at AS Wells and from SVE Zones**

Flow monitoring ports are installed in the supply lines to the AS wells and in the suction lines of the SVE blower. Saddle taps are installed for flow monitoring in order to minimize the flow distortion that may result from a tee or other pipe fitting. A portable vane anemometer will be used to measure flow and temperature of air flowing through each SVE suction line. The vane anemometer probe must be inserted through the pipe tap to position the propeller in the center of the pipe and in-line with the direction of air flow. Gauges installed on each SVE zone indicate suction pressures. Valves on each SVE line allow for flow adjustment.

Because the vane anemometer is not suited for the higher pressures of the AS lines, pressure and temperatures may be measured and used to estimate air flows using the AS blower curve. Gauges installed at the blower discharge and on each AS well head indicate air pressures. A portable infrared temperature gun will be used to read line temperatures. Valves on each AS well head allow for flow adjustment.

### **4.3.3 Vacuum Pressure Monitoring**

Magnehelic gauges, configured for differential pressure readings, will be connected to the various vacuum monitoring points. The gauges will be available to accommodate the range of vacuum pressures at the site. A pressure range from 0 to 10 inches of water may be observed in the extraction laterals. The smallest differential pressures will be observed at the outermost parking lot SVPs. A gauge with a range as low as 0.005 inches of water vacuum will be available for SVP readings. In the event that changes in operating conditions occur during SVP monitoring, the system will be allowed to reach steady state. Upon blower startup, steady state is recognized at vapor monitoring points by an immediate decrease from ambient pressure followed by stabilization at some negative pressure. Pressure readings will be monitored for each operating condition until the stable condition is achieved.

Vacuum pressures will be routinely measured at the SVE blower suction lines from north and south zones (SVE-BS1 and SVE-BS2);

Differential pressures will be routinely measured at the following monitoring points:

- One mid-slab, sub-slab monitoring point (SSD-3);
- Four corner, sub-slab monitoring points (SSD-S1, SSD-S2, SSD-N1, and SSD-N2);

- Three SVP monitoring locations at two depths (SVP-1a/b, SVP-5a/b, and SVP-7a/b); and
- Five SVP monitoring locations at one depth (SVP-2a, SVP-3a, SVP-4a, SVP-6a, and SVP-8a).

#### **4.3.3.1 Pressure at Soil Vapor Probes**

The pilot test demonstrated that the horizontal ZOI exerted by the SVE blower extends from the two extraction laterals under the building to the outermost SVPs. ZOI is defined by measurement of pressure differentials at SVPs.

Eleven soil vapor probes are installed at the site. Three locations consist of two probes, installed to different depths. The combination of radial and vertical probe placement will allow for three-dimensional assessment of SVE ZOI.

Figure 1-3 shows the locations of SVPs. Appendix B contains catalog cuts for the types of Magnehelic gauges that will be employed in monitoring pressures in sub-slab ports and soil vapor probes. Monitoring well MW 10-A17-8 will be plugged for the AS ZOI evaluation because that well may vent soil vapor during and shortly after operation of the AS blower.

A portable Magnehelic gauge, configured for differential pressure reading, will be connected to the SVPs to measure soil vapor pressure. Soil vapor pressures will be monitored to verify the extent of the estimated ZOI. Monuments and SVP valves will be purged of surface water as necessary. Teflon tubing will be used to connect a Magnehelic gauge to the SVP barb. The gauge will be positioned to zero inches of water and the valve reopened. Differential pressures for each SVP will be recorded in field logs. Soil vapor pressures will be plotted on a site map.

#### **4.3.3.2 Building and Sub-Slab Pressure Gradient**

Passive and active systems impede intrusion of soil vapors into the Credit Union building. The sub-slab vapor barrier is designed to prevent migration of soil gases into the building. Mechanical systems (blowers) will induce a pressure gradient to further protect against soil vapor intrusion. The HVAC system maintains a positive pressure in the Credit Union building. Suction from the SVE blower through the extraction laterals maintains a negative pressure under the building slab and parking lot. Building interior pressures will be slightly above atmospheric pressure. A differential pressure gauge will be used to measure the pressure gradient between the building interior and sub-slab. The interior to sub-slab pressure gradient will be measured at the interior monitoring point. Interior and sub-slab

pressures will be compared to atmospheric (barometric) pressure measurements. Differential pressure readings at exterior sub-slab monitoring points (SSD-3, SSD-S1, SSD-S2, SSD-N1, and SSD-N2) will measure the difference between atmospheric and sub-slab conditions. Sub-slab differential pressures on the order of 0.010 to 0.05 inch of water are expected.

#### **4.3.4 Soil Vapor Monitoring**

The effect of air sparging on soil vapor concentrations will be observed at the SVE exhaust and SVPs. Weekly monitoring of SVE exhaust will be conducted using a PID. Performance monitoring will also include semi-annual pressure monitoring of SVPs. Soil vapor samples will be collected annually from the eleven SVPs during normal operation of the AS and SVE systems.

##### **4.3.4.1 Vapor Monitoring -- SVE Exhaust**

Vapor samples will be collected to analyze long-term system performance and to verify the system is compliant with the Puget Sound Clean Air Agency's (PSCAA) total maximum allowable emission standard of 15 pounds of benzene per year and 50,000 pounds of total VOCs per year. During the pilot test, peak VOC concentrations were observed 12 to 14 hours after sparging. It is believed that peak VOC concentrations are now appearing much earlier after operation of the AS blower. Increased sparge frequency is likely to equalize SVE exhaust concentrations through the day. Bulk daily SVE exhaust concentrations will decrease with ongoing AS/SVE operation. Weekly monitoring of SVE exhaust is typically performed by PID. SVE blower exhaust will be monitored by PID. Procedures for SVE exhaust monitoring are outlined in Section 5.3.2. Table 4-3 outlines sampling parameters and frequencies. Sample times may be adjusted based on field observations and results of earlier sampling events as performance monitoring progresses.

##### **4.3.4.2 Vapor Monitoring – Soil Vapor Probes**

SVP pressures will be measured semi-annually. Differential pressure (between subsurface and ambient) will be measured by Magnehelic gauge at each SVP location.

Soil gas samples will be collected from the eleven SVPs during confirmation sampling. Procedures for sampling SVPs are outlined in Section 5.3.1.

#### **4.4 VAPOR INTRUSION MONITORING**

VI monitoring will be performed annually per the VI SAP (KTA 2011) and under similar conditions and locations as those employed in the 2012 and 2016 VI monitoring events (Versar 2013b, Sealaska 2016b). VI monitoring consists of employing Summa canisters (spherical stainless steel vessels under vacuum), at strategic locations inside and outside the Credit Union. The Credit Union point of contact, JBLM Fire Department, and JBLM Police will be notified prior to the VI monitoring event. All vapor intrusion monitoring will be performed with the AS blower operating at the optimum inter-sparg cycle frequency defined in an earlier phase. VI monitoring is outlined in Section 5.3.6.

## **5 SAMPLING AND ANALYSIS PLAN**

The SAP describes procedures for conducting AS/SVE system vapor sampling and other air sampling at the site. Groundwater monitoring is also conducted at the Credit Union. Protocols for completing groundwater monitoring are presented Fort Lewis Agreed Order Groundwater Monitoring Plan (Sealaska 2014). However, Section 5.2 includes a brief discussion of the groundwater sampling to be conducted at the site.

Vapor samples will be collected to analyze long-term system performance and to verify the system is compliant with the PSCAA total maximum allowable emission standard of 15 pounds of benzene per year.

Performance monitoring will be conducted according to the procedures outlined in Section 4.3 of this manual. Table 4-3 outlines parameters and frequency of ongoing performance monitoring for the AS/SVE/SSD systems.

### **5.1 PRIOR COORDINATION**

Before conducting each groundwater and AS/SVE system vapor sampling event, the Sealaska will ensure that applicable delivery orders with the contracted laboratory (Eurofins-Air Toxics) are established and will notify the Credit Union point of contact (current Branch Manager) about the events. JBLM IRP will also be notified prior to the start of any sampling event.

### **5.2 GROUNDWATER MONITORING**

Although not covered in this O&M manual, the following is a brief discussion of the groundwater sampling to be conducted at the site. Groundwater samples will be collected and analyzed for TPH-G and BTEX to monitor the effectiveness of the AS/SVE system at mitigating volatile constituents in the saturated zone. Monitoring well locations, and 2016 water table and TPH-G concentration contours are presented in Figures 2-5 and 2-6.

Because the aerated, bubbly groundwater may distort water level readings and ability to collect samples, the AS compressor will be turned off a minimum of 48 hours before a groundwater monitoring event.

During each event, an electronic water level indicator will be used to measure the static water level in all monitoring wells currently used in the groundwater monitoring program at AOC 9-2. All measurements will be recorded to the nearest 0.01-foot from the top of the PVC casing.

Five monitoring wells will be sampled (95-A17-2, 95-A17-3a, 95-A17-4, 07-A17-7, and 10-A17-8) and depth to water will be measured in three additional wells (95-A17-1, 96-A17-5, and 96-A17-6). A standard low-flow purging procedure will be to purge water prior to sampling. The pump intakes are positioned approximately 2 to 4 feet above the bottom of the monitoring well screen. A pump controller will be used to limit the purging flow rate to less than 1 liter per minute. During purging, relative water levels will be monitored with an electronic water level indicator and water quality parameters such as pH, specific conductivity, temperature, dissolved oxygen, and turbidity are measured with a pre-calibrated Horiba or similar meter to verify stabilization.

Groundwater samples will be collected immediately after the field measurements have stabilized without turning off the pumping system. In the event that drawdown is excessive or that water quality parameters do not stabilize, then the monitoring well will be purged until three well volumes have been removed or the pump is covered by less than 2 feet of water, whichever occurs first.

### **5.3 PERFORMANCE MONITORING**

The following sections provide the approach for completing performance monitoring of the AS/SVE system.

#### **5.3.1 Vapor Sampling – Soil Vapor Probes**

Performance monitoring will include semi-annual sampling of SVPs. One Tedlar bag sample will be collected at each SVP.

Differential pressure (between subsurface and ambient) will be measured by Magnehelic gauge at each SVP location. Soil vapor samples will be collected into 1-liter Tedlar bags by peristaltic pump or vacuum pump. A PID or Flame Ionization Detector (FID), if available, will be used to assess real-time concentrations of VOCs in soil vapor. PID/FID readings will be collected at the SVE blower exhaust and SVPs. The instrument will be calibrated with isobutylene prior to each field mobilization and every 8 hours during ongoing field work. Each SVP will be purged of soil gas until PID readings from the pump discharge stabilize. The hose on the Tedlar bags is equipped with tubing barbs with in-line valves that can be open and closed. Vapor sampling points are capped with a similar valve also equipped with a tubing barb. The suction side of the soil vapor pump will be attached by Teflon tubing to the valved fitting at the sampling location. The discharge side of the pump will be attached by Teflon tubing to the hose barb on the Tedlar bags. With the Teflon tubing attached to both the hose barb and sampling port the in-line valve will be opened to allow air from the

vapor sampling point to flow into the bag. The Tedlar bag will be filled, purged of one volume then refilled for the sample. After the Tedlar bag has a substantial amount of air in it the valve will be closed and the hose barb will be disconnected from the tubing. Care will be taken not to fill the Tedlar bag too full to minimize the possibility of tearing during transport to the lab. In order to obtain more representative soil vapor samples, approximately two volumes of Tedlar bags will be purged from soil vapor probes prior to collection of the sample for laboratory analysis. New tubing will be used for each sample point. Tedlar bag samples will be submitted to Eurofins-Air Toxics laboratory in Folsom, California for analysis for TPH-G and BTEX by Method TO-15.

### **5.3.2 Vapor Sampling – SVE Exhaust**

SVE blower exhaust will be monitored by PID after startup of the AS blower. Tedlar bag samples will also be collected from the SVE blower exhaust. The bag will be filled, purged and refilled under the pressure of the SVE exhaust. After daily operation of the AS blower is started, three SVE samples will be collected each quarter for eight quarters (2 years). Collection of SVE exhaust samples will begin at least 10 hours after startup of the AS blower. The current plan for quarterly SVE exhaust monitoring specifies collection of four Tedlar bag samples collected at equally-spaced intervals over 8 hours. Sample times may be adjusted based on field observations and results of earlier sampling events as quarterly performance monitoring progresses. The Pilot Test and subsequent monitoring indicated that VOC concentrations in SVE exhaust are evident within 1.5 to 2.5 hours after a sparge event.

### **5.3.3 Horizontal Zone of Influence**

The Pilot Test demonstrated that the horizontal ZOI exerted by the SVE blower extends from the two extraction laterals under the building to the outermost SVPs. ZOI is defined by measurement of pressure differentials at SVPs. A Magnehelic gauge, configured for differential pressure measurement, will be used at all SVPs. Bypassing well MW 10-A17-8 which will be plugged for the AS ZOI evaluation. Soil vapor pressures will be plotted on a site map.

### **5.3.4 Building and Sub-Slab Pressure Gradient**

Passive and active systems impede intrusion of soil vapors into the Credit Union building. The sub-slab vapor barrier is designed to prevent migration of soil gases into the building. Mechanical systems (blowers) induce a pressure gradient to further protect against soil vapor intrusion. The HVAC system maintains a positive pressure in the Credit Union Building. Suction from the SVE blower through the extraction laterals maintains a negative

pressure under the building slab and parking lot. Building interior pressures are slightly above atmospheric pressure. A differential pressure gauge is used to measure the pressure gradient between the building interior and sub-slab. The interior-to-sub-slab pressure gradient is measured at the interior monitoring point. Interior and sub-slab pressures are compared to atmospheric (barometric) pressure measurements. Differential pressure readings at exterior sub-slab monitoring points (SSD-3, SSD-S1, SSD-S2, SSD-N1, and SSD-N2) measure the difference between atmospheric and sub-slab conditions. Sub-slab differential pressures on the order of 0.02 to 0.05 inch of water are expected.

### **5.3.5 Air Flow to AS Wells and from SVE Zones**

Flow monitoring ports are installed in the supply lines to the air sparge wells and in the suction lines of the SVE blower. Saddle taps are installed for flow monitoring in order to minimize the flow distortion that may result from a tee or other pipe fitting. A portable vane anemometer will be used to measure flow and temperature of air flowing through each SVE suction line. The vane anemometer probe must be inserted through the pipe tap to position the propeller in the center of the pipe and in-line with the direction of air flow. Gauges installed on each SVE zone indicate suction pressures. Valves on each SVE line allow for flow adjustment.

Because the vane anemometer is not suited for the higher pressures of the AS lines, pressure and temperatures are measured and used to estimate air flows using the AS blower curve. Gauges installed at the blower discharge and on each AS well head indicate air pressures. A portable infrared temperature gun is used to read line temperatures. Valves on each AS well head allow for flow adjustment.

### **5.3.6 Vapor Intrusion and Ambient Air Monitoring**

VI monitoring will be performed annually according to a VI SAP (KTA 2011). The VI SAP was submitted for Ecology review in August 2011 and finalized in October 2011. The Credit Union point of contact, JBLM Fire Department, and JBLM Police will be notified prior to the VI monitoring event. All vapor intrusion monitoring will be performed with the AS blower operating at the inter-sparge cycle frequency defined in an earlier phase. Indoor and outdoor (ambient) air samples will be collected concurrently using evacuated 6-liter Summa canisters.

### **5.3.6.1 Ambient Air Sampling**

Per the VI SAP, indoor and outdoor (ambient) air samples will be collected concurrently using evacuated 6-liter Summa canisters. Canisters will be provided and certified clean by Eurofins-Air Toxics laboratory. One spare Summa canister and flow regulator will be ordered from the laboratory in the event that one canister fails. Canisters will be equipped with vacuum gauges and flow regulators set to collect 8-hour time-integrated samples. Unless otherwise noted, outdoor air samples will be collected at a minimum height of 6 feet.

Summa canisters for ambient air sampling will be located at:

- South edge of the Credit Union property, on the boundary of the parking lot at the adjacent fueling station and mini-mall. An 8-hour, time-integrated sample will be collected at this location.
- West edge of the Credit Union property, on the boundary of the parking lot at the adjacent Fire Station. This sampling location was defined as the upwind direction in the VI SAP (KTA 2011). An 8-hour time-integrated sample will be collected at this location.
- Air intake to HVAC system at the west side of the building. This canister will be placed at the elevation of the air intake on top of the cage that protects the building heat pumps. An 8-hour, time-integrated sample will be collected at this location at the height of the air intake.

### **5.3.6.2 Vapor Intrusion Monitoring**

In accordance with the VI SAP, indoor air samples will be collected by Summa canisters equipped with vacuum gauges and calibrated flow regulators and sampling canes specified to draw air from a height of 4 feet from the floor. Time-integrated samples will be collected for 8 hours from all indoor locations. Summa canisters for indoor air sampling will be located at:

- Credit Union lobby.
- Custodian's closet, located in the north wing of the building. The custodian's closet is the area with the most floor penetrations nearest to the source area. The door to the closet will be closed to allow for the most conservative (high concentration) vapor collection.
- Conference room. The conference room is the largest room in the Credit Union building. The southeast corner of the conference room overlies the former UST area.

A kitchen, two restrooms, custodian closet and storage room share the north wing of the building with the conference room. The door between the Credit Union lobby and conference facilities will remain closed and locked throughout VI monitoring per usual Credit Union policy. Credit Union personnel will unlock the door to allow sampling personnel access to the conference facility when necessary.

All functions in the building will be allowed to proceed as normal during VI monitoring. No modifications will be made to HVAC settings, door positions, use or activities of building personnel or customers. However, unlike the 2012 VI monitoring event, automatic metered room deodorizers will be deactivated at least 24 hours before and remain off through the duration of the sampling events.

Canister locations will be photographed, measured, and identified on building floor plans. After sample collection, Summa canisters will be secured in the Sealaska JBLM job trailer and shipped under proper chain of custody by overnight carrier to Eurofins-Air Toxics Laboratory in Folsom, California for analysis by Method TO-15 for TPH-G and BTEX.

Analyses of ambient air samples will be compared to indoor air samples to assess possible effects of background air on indoor air quality.

#### **5.3.6.3 Possible Interior Sources of Volatile Organic Compounds**

Vapor intrusion monitoring (Versar 2013b) indicated that the automatic, metered room deodorizer used in the Credit Union restrooms interferes with analyses for gasoline-range VOCs. Automatic room deodorizers will be turned off at least 24 hours before any vapor intrusion monitoring events. In addition, an inventory of possible addition VOC sources will be completed. Any potential VOC sources will be stage away from the Summa canister used for sampling or removed from the site prior to initiation of vapor intrusion monitoring.

#### **5.3.7 Weather Data**

Weather conditions will be recorded for the period around each monitoring event. Field readings will be collected for temperature, barometric pressure, and relative wind speed. Online weather data from sites such as the National Weather Service may also be consulted for real time and historical weather. A Solinst Barologger (see Appendix B) is installed at the SVE building to monitor site-specific barometric pressure. Barologger data can be uploaded to a laptop computer and correlated with Levelogger readings to follow trends in groundwater depth and correlate with pressure readings at SVE and SSD monitoring ports and SVPs. Official weather data may also be collected from the National Climatic Data Center (NCDC) for the dates and times of the special monitoring events.

## **5.4 INTERMITTENT AS OPERATION AND PERFORMANCE MONITORING**

The strategy for AS operation will be adjusted as remediation progresses and performance monitoring indicates a reduction in plume size and shape. Results of groundwater monitoring performed in 2016 and 2017 indicated TPH-G and BTEX constituents at concentrations below the MTCA Method A cleanup levels. However, presumption of site cleanup may be premature.

Air sparging strips volatiles from groundwater within the ZOI of the AS wells. When concentrations reach asymptotic levels, the effect may be a “donut hole” of clean groundwater around the AS wells with the possibility of a ring of petroleum hydrocarbons beyond the ZOI. Reducing the air sparge frequency or duration, or turning the AS system off for extended periods may allow the groundwater plume to “rebound” around the AS wells and allow for increased volatilization and removal of contaminants from groundwater.

Based on 2016 and 2017 groundwater monitoring results, intermittent operation of the AS system is recommended to allow for plume rebound and help increase the removal of volatiles. The SVE system operates continuously to maintain a vacuum under the building and remove VOCs from the underlying soil. Because this revised AS operation strategy is expected to increase concentrations in the SVE exhaust, monitoring of the SVE exhaust will be used to assess the effectiveness of intermittent AS operation. Groundwater monitoring results will also be used to evaluate the possibility of plume rebound into monitoring wells near the AS wells.

The following proposed strategy for intermittent operation of the AS system is recommended.

### **5.4.1 Operating Condition 1: AS Compressor Off for One Month**

- Turn off the AS compressor for one month, then turn the AS compressor back on for one month.
- Less than one week before AS compressor shutdown and immediately before AS compressor restart, perform special groundwater monitoring events to collect samples from MW 10-A17-8 and 95-A17-3a (the wells nearest the AS wells). Analyze for TPH-G. This data will be used to assess contaminant concentration rebound.
- During the “on” cycle, operate AS compressor with typical cycle of four, equally spaced, 30-minute sparge cycles per day.

- Analyze SVE exhaust by PID within 2.5 hours before AS shutdown and after AS restart. Continue to perform weekly monitoring of SVE exhaust by PID. The PID is most effective for field screening for lighter range petroleum hydrocarbons.
- After one month of restored AS operation, collect SVE exhaust samples by Tedlar bag or Summa canister over at least an 8 hour period.
- If laboratory results yield SVE exhaust concentrations above 10 ppbv, then repeat AS Operating Condition 1.
- Continue to perform special startup and shutdown related groundwater monitoring as described above.
- If TPH-G concentrations do not change between the pre-shutdown and pre-startup and/or the pre-startup concentrations are below MTCA Method A cleanup levels, proceed to Operating Condition 2.
- If SVE exhaust concentrations are not detected or remain stable (asymptotic) at low concentrations (below 10 ppbv) through a minimum 8-hour sampling event, proceed to Operating Condition 2.

#### **5.4.2 Operating Condition 2: AS Compressor Off for Two Months**

- Turn the AS compressor off for two months to allow longer time for plume rebound, then, turn the AS compressor back on for one month.
- Less than one week before AS compressor shutdown and immediately before AS compressor restart, perform special groundwater monitoring events to collect samples from MW 10-A17-8 and 95-A17-3a (the wells nearest the AS wells). Analyze for TPH-G.
- During the “on” cycle, operate AS compressor with typical cycle of four, equally spaced, 30-minute sparge cycles per day.
- After one month of restored AS operation, collect SVE exhaust samples by Tedlar bag or Summa canister over at least an 8 hour period.
- If laboratory results indicate VOC concentrations in SVE exhaust above 10 ppbv, then repeat AS Operating Condition 2.

- If SVE exhaust concentrations remain unchanged from the previous monitoring event, then conduct a special groundwater monitoring event. If TPH-G is detected in groundwater, then repeat Operating Condition 2.
- Proceed to confirmation sampling (see Section 8) after Operating Condition 2 indicates SVE exhaust concentrations below 10 ppbv and groundwater concentrations below MTCA Method A cleanup levels.

#### **5.4.3 Ongoing Through All AS Operating Conditions and Sampling Considerations**

- Weekly monitoring of SVE exhaust by PID within 1.5 to 2.5 hours of a sparge event. Recognize that the PID is only a screening tool.
- SVE exhaust monitoring by Tedlar bags (four samples spaced evenly over 8 hours) or Summa canister for a minimum of 8 hours at a minimum frequency of once per quarter.
- Semi-annual SVP monitoring.
- Annual VI monitoring.

Section 9 outlines criteria for cleanup and confirmation sampling prior to submittal of a report to Ecology to request No Further Action (NFA).

### **5.5 FIELD RECORDKEEPING**

Various forms are used to document inspections and monitoring completed at the site and to ensure proper health and safety protocols are followed. Blank field forms are included in Appendix C.

### **5.6 INVESTIGATION-DERIVED WASTE**

PPE and Teflon tubing used for vapor sampling will be disposed of in a Sealaska dumpster as part of the normal solid waste stream.

### **5.7 SAMPLE LABELING, HANDLING, AND SHIPMENT**

Sample labels for AS/SVE system vapor samples will indicate the site location (AOC 9-2), sampler's initials, parameters to be analyzed, time, date, and sample name. For example, a Summa canister sample collected from the Credit Union lobby on 2 February 2009 was labeled "AOC92120209Lobby." A sample collected from the SVE exhaust at 13:20 hours on 2 November 2011 was labeled "AOC9-2SVE111102-1320."

Sample packaging and shipping procedures are based on Environmental Protection Agency (EPA) specifications and United States Department of Transportation regulations as specified in 49 Code of Federal Regulations (CFR) 173.6 and 49 CFR 173.24. On the day of collection, all samples will be delivered by courier to the current laboratory under contract to JBLM. Samples will be identified as “Environmental Samples” and not as hazardous material. The following are general packaging procedures for Tedlar bag samples:

- Attach sample labels securely to each sample container.
- Use plastic bubble-wrap bags, sheets, or Styrofoam packing material to protect sample containers.
- Use insulated plastic or metal-clad plastic coolers as shipping containers.
- Place the original chain of custody form in the cooler in a sealed plastic bag.
- Place two signed custody seals over the lid of the cooler and cover with clear plastic tape.
- Cover and seal the cooler drain with plastic tape.
- Use strapping tape to shut the cooler.
- Attach the completed shipping label to the top of the cooler.

For Summa canisters, after sampling the canisters will be packaged in the boxes in which they were provided and returned to the laboratory.

## **5.8 CHAIN OF CUSTODY DOCUMENTATION**

Chain of custody procedures are employed to maintain and document sample possession. A sample is considered under a person's custody if it is in that person's physical possession, within visual sight of that person after taking physical possession, secured by that person so that the sample cannot be tampered with, or secured by that person in an area that is restricted to unauthorized personnel.

The originator (the sampler) will fill in all requested information on the custody record and will sign and date the record in the first “relinquished by” box. Original signed custody records listing the samples in the cooler will accompany all shipments of samples. (Note: it is possible that more than one custody form will be needed per cooler to list all the samples contained in the cooler.) The originator of the custody record will keep the bottom copy (usually pink).

## 6 QUALITY ASSURANCE PROJECT PLAN

The following Quality Assurance Project Plan (QAPP) is designed to show plans for compliance with Quality Assurance (QA)/Quality Control (QC) portions of a SAP per WAC 173-340-820. It should be noted that some elements of a typical QAPP are not repeated if included elsewhere in this Plan.

The purpose of QA/QC procedures for this site is to provide assurance that field and analytical procedures produce data of acceptable quality to evaluate long-term trends of contaminant concentrations at the site.

This section includes the QA/QC procedure for air-related sampling only. Groundwater sampling QA/QC procedures are provided in the Fort Lewis Agreed Order Groundwater Monitoring Plan (Sealaska 2014).

### 6.1 DATA QUALITY OBJECTIVES

Data Quality Objectives (DQOs) define the type, quantity, and quality of data that are needed to answer specific environmental questions, and support environmental decisions. DQOs are developed using a systematic planning process described in the Guidance for the Data Quality Objectives Process (EPA 2006). The DQOs consist of the following seven iterative steps:

1. State the problem.
2. Identify the goals of the study.
3. Identify information inputs.
4. Define the boundaries of the study.
5. Develop the analytic approach.
6. Specify performance or acceptance criteria.
7. Develop the plan for obtaining data.

#### **Step 1: State the problem.**

- Monitoring of the AS/SVE system is necessary to assess performance and ensure that SVE exhaust is not exceeding PSCAA emissions limits.
- There is a potential for contaminants in groundwater to volatilize to indoor or ambient air. Contaminants of concern include TPH-G and BTEX.

**Step 2: Identify the goals of the study.**

- Assess the presence, concentration, and potential migration of volatile compounds into indoor or ambient air.
- To confirm whether or not contaminants in indoor or ambient air are exceeding MTCA Method B Air Cleanup Levels for carcinogens and non-carcinogen compounds. Contaminants include benzene (0.32 micrograms per cubic meter [ $\mu\text{g}/\text{m}^3$ ]), toluene (2,300  $\mu\text{g}/\text{m}^3$ ), ethylbenzene (460  $\mu\text{g}/\text{m}^3$ ), and total xylenes (46  $\mu\text{g}/\text{m}^3$ ).
- To confirm SVE emissions are not exceeding PSCAA emissions limits of 15 pounds of benzene per year or 50,000 pounds of VOCs per year.

**Step 3: Identify information inputs.**

- Monitoring of system components will be completed as shown in Table 4-3.
- Vapor intrusion and ambient air monitoring results.
- SVE exhaust monitoring results.

**Step 4: Define the boundaries of the study.**

- The AOC 9-2 site, Credit Union Building, and area immediately adjacent (see Figure 1-2).
- Vapor intrusion and ambient air monitoring will be conducted annually.
- SVE exhaust monitoring will be completed quarterly.

**Step 5: Develop the analytic approach.**

- If petroleum hydrocarbon or BTEX concentrations are detected in indoor air, then the AS/SVE system operation will be evaluated to assess performance and adjusted as needed.

**Step 6: Specify performance or acceptance criteria.**

- To minimize sampling error, samples will be collected by Sealaska personnel who are trained in the collection air monitoring data and air samples.
- Air samples for laboratory testing will be analyzed by an accredited laboratory. The primary laboratory for this project is Eurofins-Air Toxics laboratory in Folsom, California.

**Step 7: Develop the plan for obtaining data.**

- Collection of air data and air samples will be completed as shown in Table 4-3.

## 6.2 FIELD QUALITY CONTROL SAMPLES

Duplicate air samples will be collected in the following frequency:

- Soil vapor duplicate samples will be collected at a frequency of one for every 10 primary samples. A second Tedlar bag (duplicate) will be filled with air from the SVE system immediately following the primary sample.

## 6.3 LABORATORY QUALITY CONTROL

The project laboratory will be responsible for conducting laboratory QC procedures and reporting laboratory QC results in accordance with laboratory standard operating procedures. The project laboratory will perform and report the following laboratory QC once per batch of BTEX samples for benzene and toluene: method blank, blank spike, matrix spike, and matrix spike duplicate. The laboratory will perform and report a method blank and blank spike for each batch of samples analyzed for TPH-G. The laboratory will perform and report results of surrogate recoveries for each sample analyzed for BTEX and TPH-G. The current project laboratory's control limits for acceptable surrogate recoveries are shown in Table 6-1.

**Table 6-1.** Surrogate Recovery Control Limits

Analytical Method	Surrogate Analyte	Acceptable Surrogate Recovery Range (%)
TO-15	1,2-Dichloroethane-d4	71 - 122
	4-Bromofluorobenzene	75 - 119
	Toluene-d8	90 - 108

## 6.4 QA/QC REVIEW AND VERIFICATION

Data quality will be reviewed and verified by Sealaska personnel to determine if the data are suitable for use. Project data as well as QA/QC data (i.e., field QC results, lab QC results, practical quantitation limits [PQLs], and holding times) will be evaluated in terms of precision, accuracy, representativeness, comparability, and completeness. Results of these evaluations will be summarized in the annual report. Corrective action for field or laboratory data will be evaluated on a case by case basis, and may include re-sampling. Other corrective actions for field or laboratory procedures will be taken as needed in consultation with Ecology.

## 7 CRITERIA FOR SYSTEM SHUTDOWN

### 7.1 CLEANUP CRITERIA

The objective of the AS/SVE system is to remediate groundwater to below MTCA Method A cleanup levels for groundwater (WAC 173-340, Table 720-1). However, some SVE systems AS/SVE systems often reach a point of mass transfer limitation after extended operation. Depending on the soil type, the rate of VOC diffusion through soil is exceeded by the extracted air flow rate and VOCs in SVE exhaust reach asymptotic concentrations. Soil gas monitoring will be performed to verify VOC removal from the vadose zone before the AS/SVE system is shutdown. Intermittent operation of the AS system, discussed in the IA Work Plan (Versar 2013a) will be performed in the event of asymptotic VOC concentrations from the SVE exhaust and/or groundwater concentrations below MTCA cleanup levels. Table 7-1 summarizes criteria to verify after completing Intermittent AS Operation Conditions 1 and 2 (Section 5.4) before proceeding to confirmation sampling. Contingent technologies may be implemented if intermittent AS operation is not effective in achieving a rebound in VOC removal. For instance, amendments may be added to groundwater to stimulate in situ bioremediation or chemical oxidation.

**Table 7-1.** Criteria to Be Considered Before Proceeding to Confirmation Sampling

<b>Soil Vapor Extraction Blower Exhaust</b>
No SVE exhaust rebound is observed in exhaust concentrations following restart of the AS compressor after a two month shutdown (Intermittent AS Operating Condition 2).
<b>Soil Gas Analysis</b>
Soil gas constituents collected from SVPs remain at asymptotic conditions (below 10 ppbv) during monitoring associated with Intermittent AS Operating Condition 2.
<b>Groundwater Monitoring</b>
Groundwater monitoring parameters (TPH-G and BTEX) are present at concentrations below MTCA Method A cleanup levels for groundwater for two consecutive sampling events.
<i>Notes:</i> AS – air sparge BTEX – Benzene, toluene, ethylbenzene and xylenes analyzed using EPA Method TO-15. MTCA – Washington Department of Ecology Model Toxics Control Act. ppbv – parts per billion-volume SVE – soil vapor extraction. SVP – soil vapor probe TPH-G – Gasoline-range total petroleum hydrocarbons analyzed using TO-15 for air and soil vapor samples.

If the AS operation strategy does not result in significant increases in groundwater and soil vapor concentrations, inspection and sampling will shift from the current performance monitoring to confirmation sampling as described in the Interim Action Workplan (Versar 2013b), approved by Ecology in July 2013. According to the Workplan, confirmation sampling involves one round of groundwater, SVE exhaust, SVPs, and VI monitoring. If confirmation sampling reveals concentrations below cleanup levels, the system will be turned off and post-shutdown monitoring, involving five quarters of groundwater monitoring, will be implemented.

## 8 CONFIRMATION SAMPLING

Confirmation sampling will assess VOC concentrations in soil vapor at each SVE zone. Sampling will be completed at monitoring wells 95-A17-2, 95-A17-3a, 95-A17-4, 07-A17-7, and 10-A17-8 (see Table 4-3).

The north extraction zone is located near the source area and exhibited the highest VOC concentrations when isolated to the SVE blower. During confirmation sampling each extraction zone will be isolated and operated independently in order to define the VOC concentrations from each zone. Photoionization detector readings will be used for real time monitoring of VOC concentrations from each extraction zone. The AS blower will be operated at the typical sparge frequency defined in earlier phases (four, equally-spaced 30-minute cycles per day). VOC concentrations in the SVE exhaust will be confirmed by collection of three Tedlar bag samples from each SVE zone. SVE zones will be operated in isolation for sample collection. Groundwater levels and quality at the five monitoring wells on the site will be monitored quarterly for eight quarters, then semi-annually or until Ecology agrees on NFA. The IA Work Plan (Versar 2013a) specified grab sampling using Tedlar bags to identify possible spikes in VOC concentrations associated with AS cycling. As the system approaches remediation and with four, equally-spaced sparge events per day, soil vapor concentrations tend to equalize. This updated plan recommends the optional use of Summa canisters. Summa canisters allow for composite sampling for up to 24 hours and may provide a better representation of bulk soil gas concentrations.

After SVE exhaust sampling indicates an absence of VOCs, the 11 SVPs will be sampled to evaluate soil gas concentrations under the site. Table 4-3 includes the confirmation sampling parameters and frequencies.

## 9 PROJECT REPORTING

The following section provide information on project reporting required for AOC 9-2.

### 9.1 ANNUAL PERFORMANCE MONITORING REPORTS

Annual Performance Monitoring Reports for AOC 9-2 will be prepared until the cleanup criteria are satisfied. Annual Performance Monitoring Reports will include the following:

- Investigation chronology;
- Discussion of AS/SVE system maintenance activities;
- A site map for each site showing relevant surface features, sampling locations, groundwater elevations obtained during the groundwater monitoring events, and VOC concentrations detected during the groundwater monitoring events;
- Discussion of sampling methodology including any deviations from this plan;
- Results of air monitoring;
- Comparison of laboratory results with cleanup standards;
- Summary of differential pressures at SSD ports and SVPs;
- Trends in VOCs at SVE exhaust;
- Trends in VOCs at groundwater monitoring wells;
- Comparisons of DTW variations at groundwater monitoring wells;
- Notes on any changes in system operation;
- Descriptions of anomalies in system performance;
- AS and SVE ZOIs and comparison to results of pilot test and other monitoring events;
- Copies of original field forms;
- Laboratory certificates of analysis with chain of custody records;
- An evaluation of the data, discussion of the influence and effectiveness of the AS/SVE components and system;
- Recommendations for modifying AS pulse frequency and duration; and
- Recommendations for modifying SVE valve settings.

A Results section will present the findings of groundwater monitoring and system-wide performance monitoring. The Results section will identify the optimum AS/SVE operating conditions as developed in the pilot test. The report will address the effectiveness of the SSD system at maintaining negative sub-slab pressures. The reports will conclude with recommendations for modification or expansion in design of the final system for remediation of the AOC 9-2 site.

A draft copy of each Performance Monitoring Report will be submitted to Ecology for review.

## **9.2 ANNUAL JBLM GROUNDWATER MONITORING REPORTS**

Results of groundwater monitoring will be submitted in the Annual FLAO Groundwater Monitoring Report. The Annual FLAO Monitoring Report, submitted to Ecology, includes results for AOC 9-2 and three other FLAO sites.

## **9.3 CONFIRMATION SAMPLING REPORTS**

Once the site cleanup criteria and the criteria for system shutdown have been achieved, a Confirmation Sampling Report will be submitted. This report will include a request for NFA at the site. A draft version of the Confirmation Sampling Report will be submitted to Ecology for review. Ecology comments will be addressed and a final report will be submitted.

## 10 REFERENCES

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- Versar. 2014. Fort Lewis Agreed Order Groundwater Sampling and Analysis Plan – 2012; Building 4131 Former UST Site (AOC 8-2), Building A0111 Former UST Site (AOC 8-4), Building A1033 Former UST Site (AOC 9-2), Gray Army Fuel Facility (AOC 10-8). February.

**APPENDIX A**  
**HISTORICAL GROUNDWATER MONITORING DATA**

**Table A-1. AOC 9-2 Depth to Water and Groundwater Parameter Measurements**

Well ID TOC Elevation	Date	DTW (ft btoc)	GWLELV (ft AMSL)	pH	Cond. ( $\mu$ S/cm)	DO (ppm)	ORP (mv)	Temp °C	
95-A17-1 236.9	1-Aug-95	30.49	204.77	-	-	-	-	-	
	1-Feb-96	24.21	211.05	-	-	-	-	-	
	1-Sep-96	28.2	207.06	-	-	-	-	-	
	1-Mar-97	22.8	212.46	-	-	-	-	-	
	1-Aug-97	26.4	208.86	-	-	-	-	-	
	1-Mar-98	24.06	211.2	-	-	-	-	-	
	1-Sep-98	29.2	206.06	-	-	-	-	-	
	1-Mar-99	21.1	214.16	-	-	-	-	-	
	1-Aug-99	27.01	208.25	-	-	-	-	-	
	1-Mar-00	23.93	211.33	-	-	-	-	-	
	1-Sep-00	28.99	206.27	-	-	-	-	-	
	1-Mar-01	29.51	205.75	-	-	-	-	-	
	1-Aug-02	29.6	205.66	-	-	-	-	-	
	28-Oct-03	30.11	205.15	-	-	-	-	-	
	20-Oct-04	30.94	204.32	-	-	-	-	-	
	9-Nov-05	30.51	204.75	-	-	-	-	-	
	14-Jun-07	26.33	208.93	-	-	-	-	-	
	21-Mar-08	26.33	208.93	-	-	-	-	-	
	8-Aug-08	29.78	205.48	-	-	-	-	-	
	9-Mar-09	27.57	207.69	-	-	-	-	-	
	25-Aug-09	29.87	207.03	-	-	-	-	-	
	22-Feb-10	26.1	210.8	-	-	-	-	-	
	24-Aug-10	28.6	208.3	-	-	-	-	-	
	24-Feb-11	25.1	211.8	-	-	-	-	-	
	9-Sep-11				Could Not Locate				
	14-Mar-12	25.5	211.4	-	-	-	-	-	
	16-Aug-12	27.9	209	-	-	-	-	-	
	21-Feb-13	24.28	212.62	-	-	-	-	-	
	13-Aug-13	28.8	208.1	-	-	-	-	-	
	10-Mar-14	23.6	213.3	-	-	-	-	-	
22-Sep-14	28.67	208.23	-	-	-	-	-		
21-Apr-15	25.37	211.53	-	-	-	-	-		
1-Sep-15	29.43	207.47	-	-	-	-	-		
18-Apr-16	21.03	215.87	-	-	-	-	-		
18-Aug-16	28.01	208.89	-	-	-	-	-		
95-A17-2 235.9	1-Aug-95	30.2	204.59	-	-	-	-	-	
	1-Feb-96	24.24	210.55	-	-	-	-	-	
	1-Sep-96	27.71	207.08	-	-	-	-	-	
	1-Mar-97	22.34	212.45	-	-	-	-	-	
	1-Aug-97	26.08	208.71	-	-	-	-	-	
	1-Mar-98	23.82	210.97	-	-	-	-	-	
	1-Sep-98	28.7	206.09	-	-	-	-	-	
	1-Mar-99	20.6	214.19	-	-	-	-	-	
	1-Aug-99	26.55	208.24	-	-	-	-	-	
	1-Mar-00	23.49	211.30	-	-	-	-	-	
	1-Sep-00	28.51	206.28	-	-	-	-	-	
1-Mar-01	29.09	205.70	-	-	-	-	-		
1-Aug-02	28.92	205.87	-	-	-	-	-		

**Table A-1. AOC 9-2 Depth to Water and Groundwater Parameter Measurements (continued)**

Well ID TOC Elevation	Date	DTW (ft btoc)	GWLELV (ft AMSL)	pH	Cond. (µS/cm)	DO (ppm)	ORP (mv)	Temp °C
95-A17-2 Cont.	28-Oct-03	29.65	205.14	-	-	-	-	-
	28-Apr-04	27.97	206.82	-	-	-	-	-
	20-Oct-04	30.47	204.32	-	-	-	-	-
	9-Nov-05	30	204.79	-	-	-	-	-
	31-Oct-06	30.38	204.41	6.89	0.155	-	-	13.30
	14-Jun-07	26.03	208.76	6.90	0.153	-	-	13.30
	21-Nov-07	28.82	205.97	6.06	0.107	-	-	13.30
	21-Mar-08	26.02	208.77	7.32	0.139	-	-	12.43
	8-Aug-08	29.37	205.42	7.19	0.114	1.45	195.33	12.57
	9-Mar-09	27.21	207.58	7.24	0.124	0.62	148.75	13.33
	25-Aug-09	29.49	206.41	6.66	0.106	0.76	252.00	13.10
	22-Feb-10	25.5	210.40	- <sup>1/</sup>	-	-	-	-
	24-Aug-10	27.82	208.08	- <sup>1/</sup>	-	-	-	-
	24-Feb-11	24.4	211.50	5.48 <sup>1/</sup>	0.126	3.06	-	12.80
	9-Sep-11	27.25	208.65	6.27	0.111	3.60	230.00	16.00
	14-Mar-12	24.73	211.17	-	-	5.96	26.00	11.20
	16-Aug-12	27.03	208.87	-	-	-	-	-
	21-Feb-13	25.37	210.53	7.45	-	5.07	23.00	13.20
	13-Aug-13	28.4	207.50	6.60	0.176	0.47	24.00	13.60
	10-Mar-14	Low Water Level, Unable to Collect Sample						
22-Sep-14	27.7	208.20	6.50	0.147	5.90	173.00	17.20	
23-Apr-15	24.56	211.34	6.26	0.191	8.30	206	14.71	
1-Sep-15	28.38	207.52	6.49	0.196	9.40	125	16.83	
18-Apr-16	22.09	213.81	6.44	0.173	5.83	170	18.73	
18-Aug-16	27.15	208.75	6.82	0.161	7.03	168	17.34	
95-A17-3a 235.9	1-Aug-95	30.41	204.81	-	-	-	-	-
	1-Feb-96	24.65	210.57	-	-	-	-	-
	1-Sep-96	28.06	207.16	-	-	-	-	-
	1-Mar-97	22.31	212.91	-	-	-	-	-
	1-Aug-97	26.1	209.12	-	-	-	-	-
	1-Mar-98	23.51	211.71	-	-	-	-	-
	1-Sep-98	28.7	206.52	-	-	-	-	-
	1-Mar-99	20	215.22	-	-	-	-	-
	1-Aug-99	26.44	208.78	-	-	-	-	-
	1-Mar-00	23.16	212.06	-	-	-	-	-
	1-Sep-00	28.54	206.68	-	-	-	-	-
	1-Mar-01	29.51	205.71	-	-	-	-	-
	1-Aug-02	29.14	206.08	-	-	-	-	-
	30-Jun-03	28.94	206.28	-	-	-	-	-
	28-Oct-03	29.85	205.37	-	-	-	-	-
	28-Apr-04	28.06	207.16	-	-	-	-	-
	20-Oct-04	30.88	204.34	-	-	-	-	-
	24-May-05	28.75	206.47	-	-	-	-	-
	9-Nov-05	30.32	204.90	-	-	-	-	-
	14-Jun-06	26.99	208.23	-	-	-	-	-
31-Oct-06	30.86	204.36	6.49	0.253	-	-	12.60	
14-Jun-07	26.09	209.13	6.51	0.252	-	-	12.60	
21-Nov-07	29.21	206.01	6.05	0.205	-	-	13.00	

**Table A-1. AOC 9-2 Depth to Water and Groundwater Parameter Measurements (continued)**

Well ID TOC Elevation	Date	DTW (ft btoc)	GWELEV (ft AMSL)	pH	Cond. ( $\mu$ S/cm)	DO (ppm)	ORP (mv)	Temp °C
95-A17-3a Cont.	21-Mar-08	26	209.22	7.35	0.237	0.70	-	12.37
	8-Aug-08	29.42	205.80	7.16	0.214	0.97	-25.75	12.28
	9-Mar-09	27.07	208.15	7.04	0.227	0.71	-177.00	12.88
	25-Aug-09	29.46	206.44	6.03	0.199	0.77	233.00	13.10
	22-Feb-10	25.6	210.30	6.52	0.205	0.47	-196.00	12.80
	23-Aug-10	29.1	206.80	4.80	0.200	1.17	-125.00	13.10
	24-Feb-11	24.55	211.35	5.86	0.191	0.73	-	13.00
	9-Sep-11	27.62	208.28	6.07	0.177	4.87	-98.00	14.40
	14-Mar-12	24.85	211.05	-	-	-	-	-
	16-Aug-12	27.47	208.43	-	-	-	-	-
	21-Feb-13	25.66	210.24	-	-	-	-	-
	13-Aug-13	27.85	208.05	-	-	-	-	-
	14-Mar-14	22.9	213.00	6.36	0.223	7.70	26.00	13.60
	23-Sep-14	28.07	207.83	6.30	0.147	2.90	42.00	14.70
	22-Apr-15	24.96	210.94	6.5	0.329	5.20	0	14.5
	2-Sep-15	28.96	206.94	6.57	0.403	0.0	-56	15.50
	18-Apr-16	21.43	214.47	6.32	0.212	3.38	-79	16.6
18-Aug-16	27.8	208.10	6.55	0.230	0.99	63	16.7	
95-A17-4 236.8	1-Aug-95	29.91	205.24	-	-	-	-	-
	1-Feb-96	23.65	211.50	-	-	-	-	-
	1-Sep-96	27.56	207.59	-	-	-	-	-
	1-Mar-97	21.75	213.40	-	-	-	-	-
	1-Aug-97	25.85	209.30	-	-	-	-	-
	1-Mar-98	23.35	211.80	-	-	-	-	-
	1-Sep-98	28.7	206.45	-	-	-	-	-
	1-Mar-99	19.7	215.45	-	-	-	-	-
	1-Aug-99	26.33	208.82	-	-	-	-	-
	1-Mar-00	22.93	212.22	-	-	-	-	-
	1-Sep-00	28.1	207.05	-	-	-	-	-
	1-Mar-01	29.05	206.10	-	-	-	-	-
	1-Aug-02	29.04	206.11	-	-	-	-	-
	28-Oct-03	29.51	205.64	-	-	-	-	-
	20-Oct-04	30.5	204.65	-	-	-	-	-
	9-Nov-05	29.8	205.35	-	-	-	-	-
	14-Jun-07	25.72	209.43	-	-	-	-	-
	21-Mar-08	25.77	209.38	6.15	0.13	-	-	14.37
	8-Aug-08	29.31	205.84	7.15	0.14	6.81	130.00	12.00
	9-Mar-09	26.91	208.24	7.12	0.14	7.03	228.25	13.83
	25-Aug-09	29.32	207.48	-	-	-	-	-
	21-Feb-10	25.38	211.42	5.95	0.14	4.97	285.00	13.30
	24-Aug-10	27.95	208.85	-	-	-	-	-
24-Feb-11	24.37	212.43	6.01	0.14	6.91	-	13.30	
9-Sep-11	27.45	209.35	6.09	0.13	5.90	353.00	14.30	
14-Mar-12	24.89	211.91	-	-	6.36	26.00	11.20	
16-Aug-12	27.29	209.51	-	-	-	-	-	
21-Feb-13	25.49	211.31	6.69	-	6.47	-146.00	13.50	
13-Aug-13	27.85	208.95	-	-	-	-	-	
14-Mar-14	22.5	214.30	6.26	0.18	8.55	32.00	13.50	

**Table A-1. AOC 9-2 Depth to Water and Groundwater Parameter Measurements (continued)**

Well ID TOC Elevation	Date	DTW (ft btoc)	GWELEV (ft AMSL)	pH	Cond. (µS/cm)	DO (ppm)	ORP (mv)	Temp °C
96-A17-5 233.9	23-Sep-14	27.99	208.81	-	-	-	-	-
	22-Apr-15	24.76	212.04	6.31	0.18	9.4	206	14.4
	1-Sep-15	28.82	207.98	-	-	-	-	-
	18-Apr-16	22.42	214.38	6.46	0.16	5.39	191	18.11
	18-Aug-16	27.39	209.41	-	-	-	-	-
	1-Feb-96	22.44	211.14	-	-	-	-	-
	1-Sep-96	26.2	207.38	-	-	-	-	-
	1-Mar-97	20.75	212.83	-	-	-	-	-
	1-Aug-97	24.6	208.98	-	-	-	-	-
	1-Mar-98	22.25	211.33	-	-	-	-	-
	1-Sep-98	27.3	206.28	-	-	-	-	-
	1-Mar-99	18.9	214.68	-	-	-	-	-
	1-Aug-99	25.05	208.53	-	-	-	-	-
	1-Mar-00	21.92	211.66	-	-	-	-	-
	1-Sep-00	27.07	206.51	-	-	-	-	-
	1-Mar-01	27.76	205.82	-	-	-	-	-
	1-Aug-02	27.68	205.90	-	-	-	-	-
	28-Oct-03	28.3	205.28	-	-	-	-	-
	9-Nov-05	28.47	205.11	-	-	-	-	-
	14-Jun-07	24.47	209.11	-	-	-	-	-
	21-Mar-08	24.48	209.10	-	-	-	-	-
	8-Aug-08	27.93	205.65	-	-	-	-	-
	9-Mar-09	25.71	207.87	-	-	-	-	-
	25-Aug-09	28.03	205.87	-	-	-	-	-
	21-Feb-10	24.29	209.61	-	-	-	-	-
	24-Aug-10	26.66	207.24	-	-	-	-	-
	24-Feb-11	23.26	210.64	-	-	-	-	-
	9-Sep-11	26.15	207.75	-	-	-	-	-
	14-Mar-12	25.7	208.20	-	-	-	-	-
	16-Aug-12	26.01	207.89	-	-	-	-	-
21-Feb-13	24.28	209.62	-	-	-	-	-	
13-Aug-13	26.93	206.97	-	-	-	-	-	
10-Mar-14	21.85	212.05	-	-	-	-	-	
23-Sep-14	26.66	207.24	-	-	-	-	-	
21-Apr-15	23.57	210.33	-	-	-	-	-	
1-Sep-15	27.51	206.39	-	-	-	-	-	
18-Apr-16	21.36	212.54	-	-	-	-	-	
18-Aug-16	28.04	205.86	-	-	-	-	-	
96-A17-6 235.1	1-Feb-96	22.95	209.66	-	-	-	-	-
	1-Mar-01	28.18	204.43	-	-	-	-	-
	28-Oct-03	27.25	205.36	-	-	-	-	-
	9-Nov-05	27.41	205.20	-	-	-	-	-
	14-Jun-07	23.41	209.20	-	-	-	-	-
	21-Mar-08	23.43	209.18	-	-	-	-	-
	8-Aug-08	26.91	205.70	-	-	-	-	-
	9-Mar-09	24.62	207.99	-	-	-	-	-
	25-Aug-09	26.98	208.12	-	-	-	-	-
	21-Feb-10	23.2	211.90	-	-	-	-	-

**Table A-1. AOC 9-2 Depth to Water and Groundwater Parameter Measurements (continued)**

Well ID TOC Elevation	Date	DTW (ft btoc)	GWLELV (ft AMSL)	pH	Cond. ( $\mu$ S/cm)	DO (ppm)	ORP (mv)	Temp °C
96-A17-6 Cont.	24-Aug-10	25.5	209.60	-	-	-	-	-
	25-Feb-11	22.14	212.96	-	-	-	-	-
	9-Sep-11	25.11	209.99	-	-	-	-	-
	14-Mar-12	22.56	212.54	-	-	-	-	-
	16-Aug-12	24.93	210.17	-	-	-	-	-
	21-Feb-13	23.2	211.90	-	-	-	-	-
	13-Aug-13	25.85	209.25	-	-	-	-	-
	10-Mar-14	20.6	214.50	-	-	-	-	-
	23-Sep-14	26.59	208.51	-	-	-	-	-
	21-Apr-15	22.48	212.62	-	-	-	-	-
	1-Sep-15	28.5	206.60	-	-	-	-	-
	18-Apr-16	20.26	214.84	-	-	-	-	-
	18-Aug-16	26.11	208.99	-	-	-	-	-
	07-A17-7 233.2	16-Nov-07	27.85	206.20	7.27	0.170	-	-
26-Mar-08		24.88	209.17	7.18	0.138	0.79	38.33	12.67
26-Aug-08		28.33	205.72	7.25	0.161	0.35	-158.25	12.85
3-Mar-09		26.09	207.96	-	-	-	-	-
25-Aug-09		28.46	204.74	6.70	0.132	0.23	172	13.20
21-Feb-10		24.30	208.90	5.82	0.067	0.24	131	11.9
24-Aug-10		26.71	206.49	5.64	0.132	0.37	76	14.1
24-Feb-11		23.20	210.00	5.24	0.038	5.66	-	10.6
9-Sep-11		26.20	207.00	6.05	0.125	1.82	243	16.5
14-Mar-12		23.63	209.57	-	-	6.8	26	9.5
16-Aug-12		26.02	207.18	7.34	-	1.06	28	18.6
21-Feb-13		24.28	208.92	7.48	-	2.49	22	9.9
13-Aug-13		27.00	206.20	5.97	0.099	0.59	57	13.3
14-Mar-14		21.45	211.75	5.97	0.059	6.3	46	11.6
23-Sep-14		26.74	206.46	6.2	0.101	2	2	14
22-Apr-15		23.60	209.60	6.17	0.130	4.9	28	12.8
2-Sep-15		27.46	205.74	6.55	0.180	0.0	49	14.85
18-Apr-16	21.43	211.77	6.8	0.149	0.47	-84	13.36	
18-Aug-16	25.00	208.20	5.75	0.123	0.67	16	13.8	

**Table A-1. AOC 9-2 Depth to Water and Groundwater Parameter Measurements (continued)**

Well ID TOC Elevation	Date	DTW (ft btoc)	GWELEV (ft AMSL)	pH	Cond. ( $\mu$ S/cm)	DO (ppm)	ORP (mv)	Temp °C
10-A17-8	29-Nov-10	26.87	208.93	-	-	-	-	-
235.8	25-Feb-11	24.30	211.50	-	-	-	-	-
	9-Sep-11	26.68	209.12	5.82	0.208	1.99	230	16
	18-Nov-11	29.00	206.80	-	-	-	-	-
	14-Mar-12	24.81	210.99	-	-	-	-	-
	16-Aug-12	27.18	208.62	-	-	-	-	-
	21-Feb-13	25.53	210.27	-	-	-	-	-
	13-Aug-13	28.02	207.78	6.6	0.176	0.48	24	13.6
	10-Mar-14	22.85	212.95	6.01	-	2	47	14.7
	22-Sep-14	27.13	208.67	6.4	0.159	4.4	-21	18.9
Duplicate	22-Sep-14	27.13	208.67	6.4	0.159	4.4	-21	18.9
	22-Apr-15	24.72	211.08	6.43	0.297	4.53	-11	17.3
Duplicate	22-Apr-15	24.72	211.08	6.43	0.297	4.53	-11	17.3
	1-Sep-15	28.39	207.41	6.31	0.371	3.40	-35	19.54
Duplicate	1-Sep-15	28.39	207.41	6.31	0.371	3.40	-35	19.54
	18-Apr-16	16.93	218.87	7.18	0.153	8.53	156	19.21
Duplicate	18-Aug-16	26.83	208.97	7.56	0.194	6.07	146	19.92

*Notes:*

<sup>1/</sup> Pump is broken and caught in well. Well casing is possibly bent. Sample collected using a disposable bailer.  
 New TOC elevations surveyed on 11 June 2010 were used beginning with August 2009 data.

- TOC – Top of casing
- DTW (ft btoc) – Depth to water (feet below top of casing). Static DTW collected prior to purging beginning in 2015
- GWELEV (ft AMSL) – Groundwater elevation (feet above mean sea level)
- Cond. ( $\mu$ S/cm) – Conductivity (microsiemens per centimeter)
- DO (ppm) – Dissolved oxygen (parts per million)
- ORP (mv) – Oxygen / reduction potential (millivolts)
- Temp. (°C) – Temperature (degrees Celsius)
- No data, not applicable

**Table A-2. Results of Groundwater Sampling for TPH-G and BTEX Concentrations**

Well ID	Date	TPH-G (µg/L)	Benzene (µg/L)	Toluene (µg/L)	Ethyl benzene (µg/L)	Total Xylenes (µg/L)	
95-A17-1	28-Oct-03	100U	0.5U	0.5U	0.5U	1U	
	20-Oct-04	100U	1U	1U	1U	3U	
	9-Nov-05	100U	1U	1U	1U	3U	
95-A17-2	28-Oct-03	4,700	1.6	2.9	102	184	
	28-Apr-04	200U	1	1U	1	3U	
	20-Oct-04	760	1	1U	18	2	
	9-Nov-05	1,900	1U	2	54	67	
	31-Oct-06	100U	1U	1U	1U	3U	
	14-Jun-07	500U	1U	1U	1U	3U	
	7-Nov-07	3,000	1U	1	12	12	
	8-Mar-08	500U	1U	1U	1U	3U	
	26-Aug-08	500U	1U	1U	1U	3U	
	9-Mar-09	500U	1U	1U	1U	3U	
	25-Aug-09	500U	1U	1U	1U	3U	
	26-Mar-10	50U	1U	1U	1U	3U	
	24-Aug-10	No Sample Collected					
	24-Feb-11	50U	1U	1U	1U	3U	
	9-Sep-11	50U	1U	1U	1U	3U	
	14-Mar-12	50U	1U	1U	1U	2U	
	16-Aug-12	50U	1U	1U	1U	2U	
	21-Feb-13	250U	0.20U	0.20U	0.20U	0.40U	
	13-Aug-13	No Sample Collected					
	10-Mar-14	No Sample Collected					
	22-Sep-14	250U	0.5U	0.080J	0.5U	0.5U	
	23-Apr-15	25U	0.1U	0.1U	0.1U	0.2U	
	1-Sep-15	48J	0.1U	0.08J	0.07J	0.37J	
19-Apr-16	25U	0.1U	0.1U	0.1U	0.4U		
29-Aug-16	25U	0.1U	0.1U	0.1U	0.2U		
95-A17-3a	30-Jun-03	32,000	690	1,200	1,100	4,800	
	28-Oct-03	10,400	200	270	270	1,200	
	28-Apr-04	23,000	600	800	780	3,500	
	20-Oct-04	8,200	160	100	310	740	
	24-May-05	25,000	630	650	810	3,400	
	9-Nov-05	6,000	220	170	280	940	
	14-Jun-06	29,000	490	500	840	4,000	
	31-Oct-06	26,000	590	380	840	3,000	
	14-Jun-07	30,000	310	360	610	2,700	
	7-Nov-07	30,000	360	270	730	2,700	
	8-Mar-08	35,000	410	400	870	3,600	
	26-Aug-08	17,700	175	162	517	1,819	
	9-Mar-09	31,200	399	335	772	2,762	
	25-Aug-09	27,300	209	245	629	2,370	
	22-Feb-10	25,000	320	390	990	3,650	
	24-Aug-10 <sup>1/</sup>	1,300	73	12	42	24	
	24-Feb-11	27,000	270	350	1,100	3,970	
9-Sep-11	13,000	140	110	480	1,620		
14-Mar-12	8,700	91	170	350	330		

**Table A-2. Results of Groundwater Sampling for TPH-G and BTEX Concentrations**  
 (continued)

Well ID	Date	TPH-G (µg/L)	Benzene (µg/L)	Toluene (µg/L)	Ethyl benzene (µg/L)	Total Xylenes (µg/L)
95-A17-3a Cont.	16-Aug-12	16,000	110	240	610	2,440
	21-Feb-13	20,000	75	190	480	1,880
	13-Aug-13 <sup>2/</sup>	21,000	92	460	460	2,100
	14-Mar-14	15,000	36	100	230	1,210
	23-Sep-14	1,400	3.7	15	16	216
	22-Apr-15	1,500	21	25	33	166
	2-Sep-15	3,400	28	34	120	242
	19-Apr-16	61J	0.1U	0.1U	0.1U	0.4U
	29-Aug-16	610	1.9	6.9	13	66
	95-A17-4	28-Oct-03	100U	0.5U	0.5U	0.5U
20-Oct-04		100U	1U	1U	1U	3U
9-Nov-05		100U	1U	1U	1U	3U
14-Jun-07		500U	1U	1U	1U	3U
8-Mar-08		500U	1U	1U	1U	3U
26-Aug-08		300	1U	1U	1U	3U
9-Mar-09		500U	1U	1U	1U	3U
21-Feb-10		50U	1U	1U	1U	3U
9-Sep-11		50U	1U	1U	1U	3U
14-Mar-12		50U	1U	1U	1U	2U
21-Feb-13		250U	0.20U	0.20U	0.20U	0.40U
14-Mar-14		250U	0.20U	0.20U	0.20U	0.40U
22-Apr-15		25U	0.1U	0.1U	0.1U	0.2U
19-Apr-16		25U	0.34	0.48	0.22	6.5
96-A17-5	28-Oct-03	100U	0.5U	0.5U	0.5U	1U
	9-Nov-05	100U	1U	1U	1U	3U
07-A17-7	7-Nov-07	3,400	130	6.8	130	31
	8-Mar-08	2,100	47	3.8	120	8.3
	26-Aug-08	1,990	132	5.7	199	4.6
	25-Aug-09	2,500U	79.1	5U	94.1	15U
Duplicate	25-Aug-09	2,500U	79.5	5U	95	15U
	21-Feb-10	50U	2.5	1U	1U	3U
	24-Aug-10 <sup>1/</sup>	18,000	210	220	690	2,500
	24-Feb-11	50U	1U	1U	1U	3U
	9-Sep-11	1,600	44	15	79	46
	14-Mar-12	50U	1U	1U	1U	2U
	16-Aug-12	150	4.7	3.9	1U	3U
	21-Feb-13	250U	0.20U	1.6	0.20U	0.40U
	13-Aug-13	250U	0.6	0.85	0.2U	0.4U
	Duplicate	13-Aug-13	250U	0.57	0.63	0.25
14-Mar-14		250U	0.20U	0.25	0.20U	0.4U
23-Sep-14		250U	0.5U	0.5U	0.5U	0.5U
22-Apr-15		25U	0.1U	0.1U	0.1U	0.2U
2-Sep-15		19J	0.1U	0.1U	0.05J	0.2U
19-Apr-16		10J	0.08	0.08	0.1U	0.4U
29-Aug-16		25U	0.1U	0.1U	0.1U	0.34J

**Table A-2.** Results of Groundwater Sampling for TPH-G and BTEX Concentrations  
 (continued)

Well ID	Date	TPH-G (µg/L)	Benzene (µg/L)	Toluene (µg/L)	Ethyl benzene (µg/L)	Total Xylenes (µg/L)
10-A17-8	29-Nov-10	71,000	2,100	8,400	1,900	9,600
	25-Feb-11	22,000	720	1,000	<b>490</b>	2,220
Duplicate	25-Feb-11	21,000	730	1,100	<b>490</b>	2,210
	9-Sep-11	26,000	330	300	740	4,200
	18-Nov-11	74,000	900	6,200	2,200	11,500
	14-Mar-12	19,000	710	1,300	<b>490</b>	2,000
	22-May-12	13,000	630	<b>830</b>	<b>350</b>	2,050
	16-Aug-12	59,000	1,500	3,400	1,600	8,800
	21-Feb-13	34,000	1,100	2,000	<b>640</b>	3,700
	13-Aug-13	70,000	770	3,600	1,700	8,900
	10-Mar-14	9,500	160	<b>330</b>	<b>160</b>	1,030
	22-Sep-14	3,500	46	<b>90</b>	<b>61</b>	<b>410</b>
Duplicate	22-Sep-14	3,700	50	<b>110</b>	<b>65</b>	<b>440</b>
	22-Apr-15	4,800	470	<b>260</b>	<b>100</b>	<b>810</b>
Duplicate	22-Apr-15	5,000	380	<b>210</b>	<b>89</b>	<b>670</b>
	1-Sep-15	25,000	170	<b>800</b>	740	3,750
Duplicate	1-Sep-15	24,000	180	<b>870</b>	770	3,920
	18-Apr-16	14J	0.14	0.57	0.07	1.6
Duplicate	18-Apr-16	15J	0.14J	<b>0.52</b>	0.08J	<b>1.48</b>
	29-Aug-16	230J	<b>3</b>	<b>3.8</b>	<b>5.2</b>	<b>26</b>
Duplicate	29-Aug-16	230J	<b>3.1</b>	<b>3.9</b>	<b>5.4</b>	<b>27</b>
<b>MTCA Cleanup Level</b>		<b>800</b>	<b>5</b>	<b>1,000</b>	<b>700</b>	<b>1,000</b>

Notes:

<sup>1/</sup> It is suspected that these samples' labels were switched.

<sup>2/</sup> Sample was labelled as 95-A17-2 by mistake.

TPH-G – Gasoline Range Total Petroleum Hydrocarbons

µg/L – Micrograms per liter

**BOLD** – Analyte detected above practical quantification limit

**BOLD** – Analyte detected above MTCA Method A cleanup level

U – Analyte not detected above result reporting limit

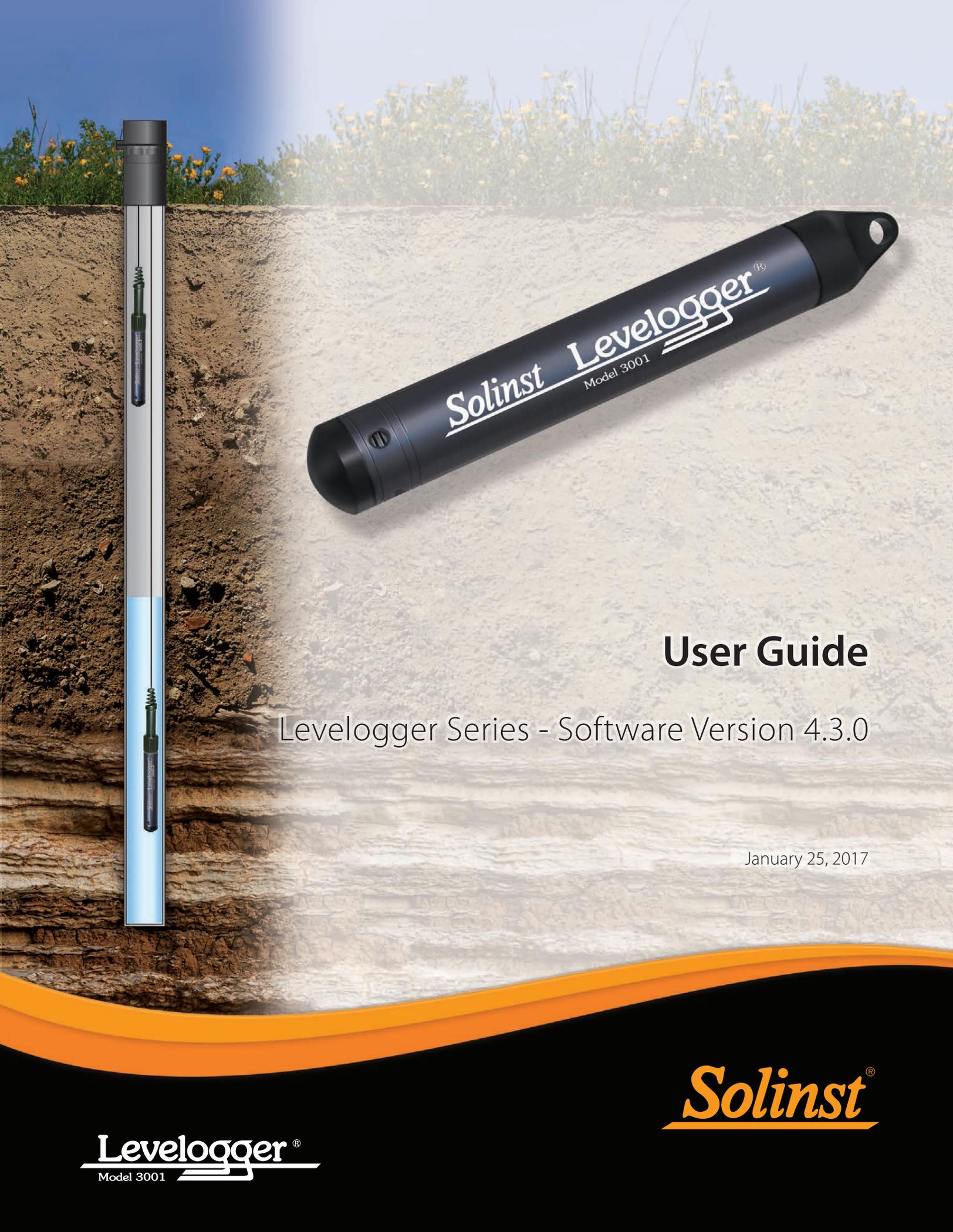
-- No data, not applicable

## **APPENDIX B**

### **INFORMATION FOR MONITORING EQUIPMENT**

Contents:

- Solinst Levellogger
- Solinst Barologger
- RAE Systems Photoionization Detector
- Magnehelic Gauges
- Infrared Temperature Gun



# User Guide

Levelogger Series - Software Version 4.3.0

January 25, 2017

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## NOTE

This version of software is not compatible with older models of the Levellogger (Made before Dec. 2005). To program and use the old versions, Levellogger 3.1.1 Software and User Guides can still be accessed at: [www.solinst.com/downloads/](http://www.solinst.com/downloads/) For Software version 2.0.3, contact Solinst.

## NOTE

Let Solinst keep you up-to-date with each new software and firmware release. Register your software at: [www.solinst.com/Registration/](http://www.solinst.com/Registration/) to receive these updates automatically.

## NOTE

To use the new compression algorithm, which enables up to 120,000 data points, the Levellogger Edge or Barologger Edge must be in linear sampling mode and slate memory mode.

## 1 Introduction

This User Guide focuses on the current Levellogger Series, which includes:

- **Levellogger Edge**
- **Barologger Edge**
- Levellogger Junior Edge
- LTC Levellogger Edge
- Rainlogger Edge

Software Version 4.3.0 is also compatible with Levellogger Gold, Barologger Gold, Levellogger Junior, LTC Levellogger Junior and Rainlogger dataloggers. For details on setting up Gold Series dataloggers, see Section 5.9. Software Version 4.3.0 is compatible with the AquaVent and Leveloader Gold, which have separate User Guides.

This Windows based software provides many convenient features. You can view and program datalogger settings, begin logging sessions, monitor real-time readings, download data, manage data files, perform data compensations, and save and export data files. Depending on the type of datalogger, there will be differences in programming options. See below for a summary of the differences:

Datalogger Programming Options			
Datalogger Type	Sampling Options	Memory Capacity	Battery Life
<b>Levellogger Edge (Barologger Edge)</b> 	Linear (0.125 second to 99 hours), Compressed Linear, Event Based, Schedule, Repeat Schedule, Real Time View, Future Start/Stop	40,000 sets of readings or up to 120,000 Compressed. Slate or Continuous Mode (see note)	10 years based on 1 reading per minute
Levellogger Junior Edge 	Linear (0.5 second to 99 hours), Real Time View, Future Start	40,000 sets of readings in Slate Mode	5 years based on 1 reading per minute
LTC Levellogger Edge 	Linear (2 seconds to 99 hours), Event Based, Schedule, Repeat Schedule, Real Time View, Future Start/Stop	27,000 sets of readings in Slate Mode or Continuous Mode.	8 years based on 1 reading every 5 minute
Rainlogger Edge & Rainlogger 	Event Based (records tips from tipping-bucket rain gauge), Real Time View , Future Start	Up to 60,000 tip time logs in Slate Mode	10 years based on 2 parameters logged every 10 minutes
Levellogger Gold 	Linear (0.5 second to 99 hours), Event Based, Schedule, Real Time View, Future Start/Stop	40,000 sets of readings, Slate or Continuous Mode	10 years based on 1 reading per minute
Barologger Gold 	Linear (0.5 second to 99 hours), Event Based, Schedule, Real Time View, Future Start/Stop	40,000 sets of readings, Slate or Continuous Mode	10 years based on 1 reading per minute
Levellogger Junior 	Linear (0.5 second to 99 hours), Real Time View, Future Start	32,000 sets of readings in Slate Mode	5 years based on 1 reading per minute
LTC Levellogger Junior 	Linear (5 seconds to 99 hours), Real Time View, Future Start	16,000 sets of readings in Slate Mode	5 years based on 1 reading every 5 minutes



## ! NOTE

Solinst recommends using the most recent firmware, Version 3.003 and up, when using a Levellogger Edge with Software Version 4.3.0.

## ! NOTE

The Model number refers to the depth of submergence below water level that the pressure sensor can withstand. i.e.: The Levellogger Edge, which is available in M5, M10, M20, M30, M100, and M200 ranges has actual water level ranges of 5 m (16.40 ft), 10 m (32.80 ft), 20 m (65.60 ft), 30 m (98.40 ft), 100 m (328.0 ft), and 200 m (656.2 ft), respectively.

## 1.1 Levellogger Series

### 1.1.1 Levellogger Edge

The Levellogger Edge is an absolute (non-vented) datalogger, which measures groundwater and surface water levels and temperature. Water levels are displayed as temperature compensated pressure readings, and can be barometrically compensated with the aid of a Barologger Edge.

Levellogger Edge Technical Specifications	
<b>Level Sensor:</b>	Piezoresistive Silicon with Hastelloy Sensor
Ranges:	15, 10, 20, 30, 100, 200 m
Accuracy	± 0.05% FS
Normalization:	Automatic Temperature Compensation
Temp. Comp. Range:	0°C to 50°C
<b>Temperature Sensor:</b>	Platinum Resistance Temperature Detector (RTD)
Temp. Sensor Accuracy:	± 0.05°C
Temp. Sensor Resolution:	0.003°C
<b>Battery Life:</b>	10 years (based on 1 reading/minute)
<b>Clock Accuracy:</b>	± 1 minute/year (-20°C to 80°C)
<b>Operating Temperature:</b>	-20°C to 80°C
<b>Maximum # Readings:</b>	40,000 (up to 120,000 using data compression)
<b>Memory:</b>	FRAM, Continuous or Slate mode
<b>Communication Speed:</b>	9600 bps, 38,400 bps with USB optical reader
<b>Com Interface:</b>	Optical Infra-red: USB, RS-232, SDI-12
<b>Size:</b>	7/8" x 6.25" (22 mm x 159 mm)
<b>Weight:</b>	129 grams (4.5 oz.)
<b>Corrosion Resistance:</b>	Titanium based PVD coated body and superior corrosion resistant Hastelloy sensor
<b>Other Wetted Materials:</b>	Delrin®, Viton®, 316L Stainless Steel
<b>Sampling Modes:</b>	Linear, Event & User-Selectable Schedule with Repeat Mode, Future Start, Future Stop, Real Time View
<b>Measurement Rates:</b>	0.125 second to 99 hours
<b>Barometric Compensation:</b>	High accuracy, air-only, Barologger Edge

LT Edge Models	Full Scale	Accuracy
M5	5 m (16.4 ft.)	± 0.05% FS
M10	10 m (32.8 ft.)	± 0.05% FS
M20	20 m (65.6 ft.)	± 0.05% FS
M30	30 m (98.4 ft.)	± 0.05% FS
M100	100 m (328.1 ft.)	± 0.05% FS
M200	200 m (656.2 ft.)	± 0.05% FS



### ! NOTE

Solinst recommends using the most recent firmware, Version 3.003 and up, when using a Barologger Edge with Software Version 4.3.0.

## 1.1.2 Barologger Edge

The Barologger Edge uses algorithms based on air pressure only. It measures and logs changes in atmospheric pressure, which are then used to compensate water level readings recorded by a Levellogger Edge, Levellogger Junior Edge, or LTC Levellogger Edge.

Barologger Edge Technical Specifications	
<b>Level Sensor:</b>	Piezoresistive Silicon with Hastelloy Sensor
Accuracy	± 0.05 kPa
Normalization:	Automatic Temperature Compensation
Temp. Comp. Range:	-10°C to 50°C
<b>Temperature Sensor:</b>	Platinum Resistance Temperature Detector (RTD)
Temp. Sensor Accuracy:	± 0.05°C
Temp. Sensor Resolution:	0.003°C
<b>Battery Life:</b>	10 years (based on 1 reading/minute)
<b>Clock Accuracy:</b>	±1 minute/year (-20°C to 80°C)
<b>Operating Temperature:</b>	-20°C to 80°C
<b>Maximum # Readings:</b>	40,000 (120,000 using data compression)
<b>Memory:</b>	FRAM, Continuous or Slate mode
<b>Communication Speed:</b>	9600 bps, 38,400 bps with USB optical reader
<b>Com Interface:</b>	Optical Infra-red: USB, RS-232, SDI-12
<b>Size:</b>	7/8" x 6.25" (22 mm x 159 mm)
<b>Weight:</b>	129 grams (4.5 oz.)
<b>Corrosion Resistance:</b>	Titanium based PVD coated body and superior corrosion resistant Hastelloy sensor
<b>Other Wetted Materials:</b>	Delrin®, Viton®, 316L Stainless Steel
<b>Sampling Modes:</b>	Linear, Event & User-Selectable Schedule with Repeat Mode, Future Start, Future Stop, Real Time View
<b>Measurement Rates:</b>	0.125 second to 99 hours

LT Edge Models	Full Scale (FS)	Accuracy
Barologger	Air Only	±0.05 kPa



### 1.1.3 Levellogger Junior Edge

The Levellogger Junior Edge provides an inexpensive alternative for measuring groundwater and surface water levels and temperature.

#### Levellogger Junior Edge Technical Specifications

<b>Level Sensor:</b>	Piezoresistive Silicon with Hastelloy Sensor
Ranges:	5, 10 m
Accuracy	± 0.1% FS
Normalization:	Automatic Temperature Compensation
Temp Comp. Range:	0°C to 40°C
<b>Temperature Sensor:</b>	Platinum Resistance Temperature Detector (RTD)
Accuracy:	± 0.1°C
Resolution:	0.1°C
<b>Battery life:</b>	5 years (based on 1 reading/minute)
<b>Clock Accuracy:</b>	± 1 minute / year (-20°C to 80°C)
<b>Operating Temperature:</b>	-20°C to 80°C
<b>Memory:</b>	FRAM, Slate Mode
<b>Maximum # Readings</b>	40,000 (no data compression)
<b>Com Interface:</b>	Optical Infra-red: USB, RS-232, SDI-12
<b>Communication Speed:</b>	9600 bps
<b>Size:</b>	7/8" x 5.6" (22 mm x 142 mm)
<b>Weight:</b>	4.2 oz (119 grams)
<b>Wetted Materials:</b>	Delrin®, Viton®, 316L Stainless Steel, Hastelloy
<b>Sampling Mode:</b>	Linear, Future Start, Real Time View
<b>Measurement Rates:</b>	0.5 seconds to 99 hours
<b>Barometric Compensation:</b>	High accuracy, air-only, Barologger Edge

#### ! NOTE

Solinst recommends using the most recent firmware, Version 3.003 and up, when using a Levellogger Junior Edge with Software Version 4.3.0.

#### ! NOTE

The Levellogger Junior Edge looks very similar to the previous Levellogger Junior. To determine the difference, look at the serial number on the body of the Levellogger. If the fourth number in the serial number is 1, it is a Levellogger Junior. If the fourth number is a 2, it is a Levellogger Junior Edge.

LT Models	Full Scale (FS)	Accuracy
M5	5 m (16.4 ft.)	± 0.1% FS
M10	10 m (32.8 ft.)	± 0.1% FS



## NOTE

Solinst recommends using the most recent firmware, Version 1.000, when using a LTC Levellogger Edge with Software Version 4.3.0.

### 1.1.4 LTC Levellogger Edge

The LTC Levellogger Edge provides an accurate and convenient method to measure level, temperature and conductivity all in one probe.

LTC Levellogger Edge Technical Specifications	
<b>Level Sensor:</b>	Piezoresistive Silicon with Hastelloy Sensor
Ranges:	15, 10, 20, 30, 100, and 200 m
Accuracy	± 0.05% FS
Normalization:	Automatic Temperature Compensation
Temp Comp. Range:	0°C to 50°C
<b>Temperature Sensor:</b>	Platinum Resistance Temperature Detector (RTD)
Accuracy:	± 0.05°C
Resolution:	0.003°C
<b>Conductivity Sensor:</b>	4-Electrode Platinum
Full Range:	0 to 100,000 µS/cm
Calibrated Range:	50 to 80,000 µS/cm
Accuracy:	±1% > 30,000 µS/cm; ±2% 500 - 30,000 µS/cm; ±30 µS < 500 µS/cm
Resolution:	± 0.1 µS/cm
Normalization:	Specific Conductance normalized to 25°C for full range
User Calibration Points:	1413, 5000, 12,880, 80,000 µS
<b>Battery Life:</b>	8 years (based on 1 reading every 5 minutes)
<b>Clock Accuracy:</b>	± 1 minute / year
<b>Operating Temperature:</b>	-20°C to 80°C
<b>Memory:</b>	FRAM, Continuous or Slate Mode
<b>Maximum Readings:</b>	27,000
<b>Communication Speed:</b>	9600 bps, 38,400 bps with USB optical reader
<b>Com Interface:</b>	Optical Infrared: USB, RS-232, SDI-12
<b>Size:</b>	7/8" x 7.5" (22 mm x 190 mm)
<b>Weight:</b>	200 g (7.05 oz.)
<b>Corrosion Resistance:</b>	Titanium ceramic PVD coated body and superior corrosion resistant Hastelloy pressure sensor
<b>Other Wetted Materials:</b>	Hastelloy, Delrin®, Viton®, Platinum
<b>Sampling Mode:</b>	Linear, Event & User-Selectable Schedule with Repeat Mode, Future Start, Future Stop, Real Time View
<b>Measurement Rates:</b>	2 seconds to 99 hours
<b>Barometric Compensation:</b>	High accuracy, air-only, Barologger

LTC Edge Models	Full Scale	Accuracy
M5 C80	5 m (16.4 ft.)	± 0.05% FS
M10 C80	10 m (32.8 ft.)	± 0.05% FS
M20 C80	20 m (65.6 ft.)	± 0.05% FS
M30 C80	30 m (98.4 ft.)	± 0.05% FS
M100 C80	100 m (328.1 ft.)	± 0.05% FS
M200 C80	200 m (656.2 ft.)	± 0.05% FS



### 1.1.5 Rainlogger Edge

The Rainlogger Edge is designed for use with most standard tipping-bucket rain gauges with a normally-open style reed switch output. It records each tip time from the tipping-bucket, and outputs the amount of rainfall per programmed time period (based on rainfall calibration constant).

Rainlogger Edge Technical Specifications	
Battery Life:	10 years (logging 2 parameters/10 minutes)
Clock Accuracy:	± 1 minute/year
Operating Temperature:	-20°C to 80°C
Maximum # Readings:	Up to 60,000 tip times
Memory:	FRAM, Slate mode only
Communication:	Optical infra-red: USB, RS-232, SDI-12
Measurement:	Records each tip by the tipping-bucket rain gauge and outputs the amount of rainfall
Sampling Mode:	Event Based, Future Start, Real Time View
Size:	7/8" x 5.5" (22 mm x 140 mm)
Weight:	1.6 oz (44 grams)
Materials:	ABS, Delrin®, Viton®

#### ! NOTE

Solinst recommends using the most recent firmware, Version 3.001, when using a Rainlogger Edge with Software Version 4.3.0.



### 1.1.6 Leveloader Gold

The Leveloader Gold is a data transfer device for use with all versions of Leveloggers. It can be used to download, store, and transfer data from Levellogger to PC, as well as, save settings files for transfer to a Levellogger. Also allows real time viewing of Levellogger readings. The Leveloader is used with Levellogger Software, see separate Leveloader Gold User Guide.

#### ! NOTE

Solinst recommends using the most recent firmware, Version 2.002, when using a Leveloader Gold with Software Version 4.3.0.



### NOTE

To use the Levellogger Gold with Software Version 4.3.0, ensure you are using version 2.007 firmware.

Contact Solinst if you need to upgrade your firmware from version 1.016 or lower.

## 1.1.7 Levellogger Gold

The Levellogger Gold is an absolute (non-vented) datalogger, which measures groundwater and surface water levels and temperature. Water levels are displayed as temperature compensated pressure readings, and can be barometrically compensated with the aid of a Barologger.

Levellogger Gold Technical Specifications	
<b>Level Sensor:</b>	Piezoresistive Silicon in 316L Stainless Steel
Ranges:	15, 30, 65, 100, 300 ft. (5, 10, 20, 30, 100 m)
Accuracy	0.05% FS
Normalization:	Automatic Temperature Compensation
Temp. Comp. Range:	10°C to 40°C
<b>Temperature Sensor:</b>	Platinum Resistance Temperature Detector (RTD)
Temp. Sensor Accuracy:	± 0.05°C
Temp. Sensor Resolution:	0.003°C
<b>Battery Life:</b>	10 Years - based on one reading/min
<b>Clock Accuracy:</b>	± 1 minute/year
<b>Operating Temperature:</b>	-20°C to 80°C
<b>Maximum # Readings:</b>	40,000 of level and temperature
<b>Memory:</b>	EEPROM Slate, Continuous, and redundant backup of last 1200 readings
<b>Communication:</b>	Optical Infra-red: USB, RS-232, SDI-12
<b>Communication Speed:</b>	9600 bps
<b>Size:</b>	7/8" x 6" (22 mm x 154 mm)
<b>Weight:</b>	6.3 oz (179 grams)
<b>Corrosion Resistance:</b>	Zirconium Nitride (ZrN) Coating
<b>Other Wetted Materials:</b>	316L Stainless Steel, Delrin®, Viton®
<b>Sampling Modes:</b>	Linear, Event & User-Selectable with 30 separate line items, Future Start, Future Stop, Real Time View
<b>Measurement Rates:</b>	0.5 sec to 99 hrs
<b>Barometric Compensation:</b>	High accuracy, air-only, Barologger Gold

LT Models	Full Scale (FS)	Accuracy
F15, M5	16.4 ft., 5 m	± 0.010 ft., 0.3 cm
F30, M10	32.8 ft., 10 m	± 0.016 ft., 0.5 cm
F65, M20	65.6 ft., 20 m	± 0.032 ft., 1 cm
F100, M30	98.4 ft., 30 m	± 0.064 ft., 1.5 cm
F300, M100	328.1 ft., 100 m	± 0.164 ft., 5 cm



**NOTE**

To use the Barologger Gold with Software Version 4.3.0, ensure you are using version 2.007 firmware.

### 1.1.8 Barologger Gold

The Barologger Gold uses algorithms based on air pressure only. It measures and logs changes in atmospheric pressure, which are then used to compensate water level readings recorded by a Levellogger.

Barologger Gold Technical Specifications	
<b>Level Sensor:</b>	Piezoresistive Silicon in 316L Stainless Steel
Accuracy	0.05% FS
Normalization:	Automatic Temperature Compensation
Temp. Comp. Range:	0°C to 40°C
<b>Temperature Sensor:</b>	Platinum Resistance Temperature Detector (RTD)
Temp. Sensor Accuracy:	± 0.05°C
Temp. Sensor Resolution:	0.003°C
<b>Battery Life:</b>	10 Years - based on one reading/min
<b>Clock Accuracy:</b>	± 1 minute/year
<b>Operating Temperature:</b>	-20°C to 80°C
<b>Maximum # Readings:</b>	40,000 of pressure and temperature
<b>Memory:</b>	EEPROM Slate, Continuous, and redundant backup of last 1200 readings
<b>Communication:</b>	Optical Infra-red: USB, RS-232, SDI-12
<b>Communication Speed:</b>	9600 bps
<b>Size:</b>	7/8" x 6" (22 mm x 154 mm)
<b>Weight:</b>	6.3 oz (179 grams)
<b>Corrosion Resistance:</b>	Zirconium Nitride (ZrN) Coating
<b>Other Wetted Materials:</b>	316L Stainless Steel, Delrin®, Viton®
<b>Sampling Modes:</b>	Linear, Event & User-Selectable with 30 separate line items, Future Start, Future Stop, Real Time View
<b>Measurement Rates:</b>	0.5 sec to 99 hrs

LT Models	Full Scale (FS)	Accuracy
Barologger	Air Only	± 0.003 ft., 0.1 cm



**! NOTE**

To use the Levellogger Junior with Software Version 4.3.0, ensure you are using version 2.007 firmware.

**! NOTE**

The Levellogger Junior looks very similar to the newer Levellogger Junior Edge. To determine the difference, look at the serial number on the body of the Levellogger. If the fourth number in the serial number is 1, it is a Levellogger Junior. If the fourth number is a 2, it is a Levellogger Junior Edge.

### 1.1.9 Levellogger Junior

The Levellogger Junior functions like the Levellogger Gold; provides an inexpensive alternative for measuring groundwater and surface water levels and temperature.

Levellogger Junior Technical Specifications	
<b>Level Sensor:</b>	Piezoresistive Silicon in 316L Stainless Steel
Ranges:	15, 30 ft. (5, 10 m)
Accuracy	± 0.1% FS
Normalization:	Automatic Temperature Compensation
Temp Comp. Range:	10°C to 40°C
<b>Temperature Sensor:</b>	Platinum Resistance Temperature Detector (RTD)
Accuracy:	± 0.1°C
Resolution:	0.1°C
<b>Battery life:</b>	5 years (based on 1 reading/minute)
<b>Clock Accuracy:</b>	± 1 minute / year
<b>Operating Temperature:</b>	-20°C to 80°C
<b>Memory:</b>	Non-volatile EEPROM, FRAM back-up, Slate mode only
<b>Maximum # Readings</b>	32,000 (no data compression)
<b>Com Interface:</b>	Optical Infra-red: USB, RS-232, SDI-12
<b>Communication Speed:</b>	9600 bps
<b>Size:</b>	7/8" x 5.5" (22 mm x 140 mm)
<b>Weight:</b>	154 g (5.4 oz)
<b>Wetted Materials:</b>	Delrin®, Viton®, 316L Stainless Steel
<b>Sampling Mode:</b>	Linear, Future Start, Real Time View
<b>Measurement Rates:</b>	0.5 seconds to 99 hours
<b>Altitude Input:</b>	-980 to 16,400 ft. (-300 to 5,000 m)
<b>Barometric Compensation:</b>	High accuracy, air-only, Barologger Gold

LT Models	Full Scale (FS)	Accuracy
F15, M5	16.4 ft., 5 m	± 0.020 ft., 0.6 cm
F30, M10	32.8 ft., 10 m	± 0.032 ft., 1.0 cm



### NOTE

Solinst recommends using the most recent firmware, Version 2.005, when using a LTC Levellogger Junior with Software Version 4.3.0.

## 1.1.10 LTC Levellogger Junior

The LTC Levellogger Junior provides an inexpensive and convenient method to measure level, temperature and conductivity all in one probe.

### LTC Levellogger Junior Technical Specifications

<b>Level Sensor:</b>	Piezoresistive Silicon with Hastelloy Sensor
Ranges:	30, 100 ft. (10, 30 m)
Accuracy	± 0.1% FS
Normalization:	Automatic Temperature Compensation
Temp Comp. Range:	10°C to 40°C
<b>Temperature Sensor:</b>	Platinum Resistance Temperature Detector (RTD)
Accuracy:	± 0.1°C
Resolution:	0.1°C
<b>Conductivity Sensor:</b>	4-Electrode Platinum
Full Range:	0 to 80,000 µS/cm
Calibrated Range:	500 to 50,000 µS/cm
Accuracy:	± 2% of reading or 20 µS/cm
Resolution:	1 µS
Normalization:	Specific Conductance normalized to 25°C for full range
User Calibration Points:	1413, 5000, 12,880 µS
<b>Battery Life:</b>	5 years (based on 1 reading/ 5 minutes)
<b>Clock Accuracy:</b>	± 1 minute / year
<b>Operating Temperature:</b>	-20°C to 80°C
<b>Memory:</b>	Non-volatile EEPROM, FRAM back-up, Slate mode only
<b>Maximum Readings:</b>	16,000
<b>Communication Speed:</b>	9600 bps
<b>Com Interface:</b>	Optical Infrared: USB, RS-232, SDI-12
<b>Size:</b>	7/8" x 7.5" (22 mm x 190 mm)
<b>Weight:</b>	200 g (7.05 oz.)
<b>Wetted Materials:</b>	Hastelloy, Delrin®, Viton®, 316L Stainless Steel, Platinum
<b>Sampling Mode:</b>	Linear, Future Start, Real Time View
<b>Measurement Rates:</b>	5 seconds to 99 hours
<b>Altitude Input:</b>	-980 to 16,400 ft. (-300 to 5,000 m)
<b>Barometric Compensation:</b>	High accuracy, air-only, Barologger

LTC Models	Full Scale (FS)	Accuracy
F30, M10 C50	32.8 ft., 10 m	± 0.032 ft., 1.0 cm
F100, M30 C50	98.4 ft., 30 m	± 0.098 ft., 3 cm



**NOTE**

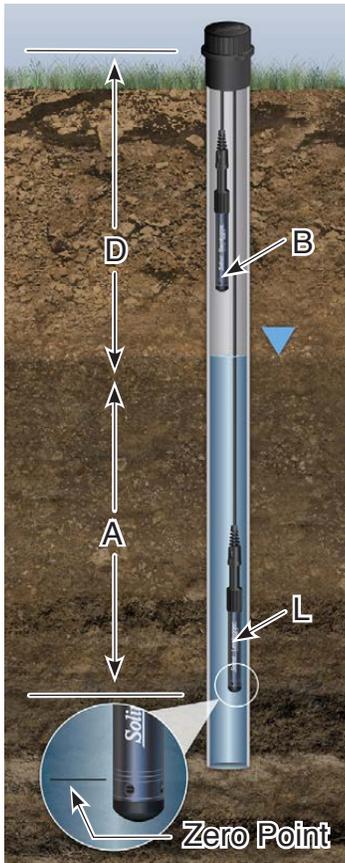
Solinst recommends using the most recent firmware, Version 2.000, when using a Rainlogger with Software Version 4.3.0.

If using a firmware version prior to version 2.000, the Rainlogger will function differently (See previous Levelogger User Guide).

### 1.1.11 Rainlogger

The Rainlogger is designed for use with most standard tipping-bucket rain gauges with a reed switch output. It records each tip time from the tipping-bucket, and outputs the amount of rainfall per programmed time period (based on rainfall calibration constant).

Rainlogger Technical Specifications	
Battery Life:	10 years (logging 2 parameters/10 minutes)
Clock Accuracy:	± 1 minute/year
Operating Temperature:	-20°C to 80°C
Maximum # Readings:	Up to 60,000 tip times
Memory:	Non-volatile EEPROM, Slate mode only
Communication:	Optical infra-red: USB, RS-232, SDI-12
Measurement:	Records each tip by the tipping-bucket rain gauge and outputs the amount of rainfall
Sampling Mode:	Event Based, Future Start, Real Time View
Size:	7/8" x 7" (22 mm x 175 mm)
Weight:	4.8 oz (135 grams)
Materials:	316L Stainless Steel, Delrin®, Viton®



$$A = L - B$$

Figure 1-1

Levellogger Measurement Fundamentals

### ! NOTE

Levelloggers measure the pressure of air plus water column above their sensor (zero point). To adjust the level readings after data collection, for example to water level depths below top of casing (**D**), refer to the Advanced options within the software Data Wizard.

### ! NOTE

The Levellogger Gold, Levellogger Junior and LTC Levellogger Junior models convert pressure readings to the water level equivalent above the datalogger's pressure zero point of 950 cm (31.17 ft). The Levellogger Edge, Levellogger Junior Edge and LTC Levellogger Edge have no zero point offset. As such, water level data will appear different, although measuring the same amount of pressure. Barometric Compensation using the Data Wizard, automatically considers this zero point offset difference when compensating a mix of Models.

## 1.2 Measurement Parameters

### 1.2.1 Level

All Levelloggers measure total (absolute) pressure. When submerged, the Levellogger is recording the combination of barometric pressure and water pressure. The actual pressure of just water (**A**) above the sensor is obtained by subtracting barometric pressure (**B**) from the total pressure (**L**) (see Figure 1-1).

The best method to compensate for barometric pressure is to employ a Barologger above the water level, to obtain records of barometric pressure. The Levellogger Software includes a Data Wizard, which guides you through the automated process of barometric compensation. Manual methods can be employed to determine the absolute water level using barometric records collected on-site or available from a local weather station (i.e. airport). Water level readings from Levelloggers are automatically temperature-compensated.

**A** = Actual water column height

**B** = Barometric pressure

**L** = Levellogger total pressure readings

**D** = Depth to water level, below reference datum

**Note:** the Levellogger Gold, Levellogger Junior and LTC Levellogger Junior models convert pressure readings to the water level equivalent above the datalogger's pressure zero point of 950 cm (31.17 ft). The Levellogger Edge, Levellogger Junior Edge and LTC Levellogger Edge have no zero point offset. As such, water level data will appear different, although measuring the same amount of pressure (i.e. Levellogger Edge data will appear to be reading 950 cm (31.17 ft) higher than a Levellogger Gold. Barometric Compensation using the Data Wizard, automatically considers this zero point offset difference when compensating a mix of Models.

#### 1.2.1.1 Pressure Calibration

The Levellogger Edge is calibrated against a range of set reference points to an accuracy of 3 decimal places. During the calibration procedure, the Levellogger is fully submerged in a highly accurate water bath. The bath is allowed to stabilize. The pressure is then calibrated to six separate pressure points covering the entire range of pressure to check for any non-linearity. The process is repeated again at two different temperatures to check for temperature effects. Once done, the Levellogger is approved after all specifications for accuracy, precision, stability and hysteresis have been met. The Levellogger should be calibrated for the life-time of the instrument, as long as it is used within its specified range.

#### 1.2.2 Barometric Pressure

The Barologger is designed for use in air only. It has a specific range and firmware algorithms based on air pressure rather than water pressure. This makes the Barologger less accurate if used in water, but more accurate if used as intended in air. Using a Barologger is the most accurate and convenient method of obtaining atmospheric pressure and air temperature measurements, which are then synchronized to the Levellogger. The Data Wizard in the Levellogger Software simplifies the adjustment of the level measurements for barometric pressure changes, by using the synchronized data from all Levelloggers on site and the site Barologger.

## 1.2.3 Temperature

Levelloggers record temperature compensated water levels. Groundwater and surface water temperature measurements are particularly important in situations where temperatures may fluctuate significantly, and when temperature is used in determining liquid level, viscosity and hydraulic conductivity. Temperature monitoring is vital in the calculation of certain temperature dependent contaminant reaction rates. A Platinum Resistance Temperature Detector is used to accurately compensate for temperature changes within the range of 0 to +50°C for the Levellogger Edge and LTC Levellogger Edge, -10°C to +50°C for the Barologger Edge, and 0 to +40°C for the Levellogger Junior Edge. The Levellogger will record temperature in its thermal range of -20 to +80°C, but outside the range, compensation will be less accurate.

## 1.2.4 Conductivity

The LTC Levellogger Edge and Junior models provide the added feature of electrical conductivity measurement; they measure the actual conductivity at the current temperature. Conductivity measurement is particularly useful in monitoring saltwater intrusion, surface water infiltration and mixing, as well as the monitoring of certain pollutants and contaminant parameters. Conductivity is measured via a platinum 4-electrode sensor, which produces highly stable and consistent readings. Conductivity calibration is performed by using a liquid solution, with a known conductivity value, and the Calibration Wizard in the Levellogger Windows Software. The Data Wizard allows you to convert conductivity readings to Specific Conductance (at 25°C), or Salinity expressed in Practical Salinity Units (PSU). A Practical Salinity Unit (PSU) is a dimensionless descriptor for the Practical Salinity Scale (PSS). The PSS defines salinity as the ratio of a water sample's conductivity to that of a standard KCL solution. The Data Wizard uses the equation given in the UNESCO Technical Paper "Algorithms for computation of fundamental properties of seawater", to convert Conductivity readings to Salinity. For more information, see: Fofonoff, N. P. and R.C. Millard, Jr. Algorithms for computation of fundamental properties of seawater, UNESCO, Tech. Pap. Mar. Sci.,44.

### 1.2.4.1 Calibration of the Conductivity Sensor

The conductivity sensor of an LTC Levellogger is a highly sensitive device requiring regular calibration by the user. The conductivity calibration frequency is dependent on the water quality of the Levellogger's monitoring environment. To determine whether an LTC Levellogger should be re-calibrated, test the unit in a solution with a known electrical conductivity value at a reference temperature. In Real Time View, observe current readings by using the Read Now function. If this reading varies from the known Specific Conductance of the solution by greater than the stated accuracy of the conductivity measurement, the unit should be re-calibrated using the Conductivity Calibration Wizard procedure outlined in Section 6. As a minimum, calibrate your LTC Levellogger at least twice a year. Ensure that a conductivity calibration is performed when the LTC Levellogger is being set up for its initial use and after long periods of dry storage.

## 1.2.5 Total Rainfall

Solinst Rainloggers are designed to record the number of tips of an external tipping-bucket rain gauge, and output the amount of rainfall per tip.

### ! NOTE

For every degree change in temperature, there is approximately a 2% change in conductivity. To convert raw conductivity measurements to Specific Conductance measurements, you can use the following equation:

$$\text{Specific Conductance} = \text{Conductivity} / (1 + 0.02 * (\text{temp}(C) - 25))$$

You can also perform this calculation automatically using the Data Wizard.

**NOTE**

For software installation instructions, see Section 3.

**1.3 Software Communication**

Levellogger Software is Windows based, and is therefore used with a desktop or laptop PC. Dataloggers connect to a laptop or desktop PC with an Optical Reader cable. The Optical Reader cable uses an infrared data reader/port connected to the datalogger and a USB or RS-232 (Serial) Com Port to transfer information between the datalogger and computer.

If you are programming dataloggers in the office, or have deployed your datalogger using a wireline or cord, an Optical Reader is most commonly used for communication with a PC (see Figure 1-2).

If a datalogger is deployed in the field using a Direct Read Cable, a PC Interface Cable is used for communication with the PC, without removing it from the well (see Figure 1-3).



Figure 1-2 Levellogger Connected to a PC Using an Optical Reader

**NOTE**

Always plug in the USB device before starting the Software.

When you plug in a USB device for the first time, you will need to install the USB Driver on the PC. (See Section 4.1.3).



Figure 1-3  
Levellogger and Direct Read Cable Connected to PC Using a PC Interface Cable

**! NOTE**

It is always recommended to use the most recent version of software and firmware.

**! NOTE**

For more information, visit [www.solinst.com](http://www.solinst.com) to view the 3001 Levellogger Series: Hardware Compatibility, which is located on the Downloads page.

### 1.3.1 Backwards Compatibility

The Levellogger Edge is not backwards compatible with previous versions of Levellogger Software. Only Levellogger Software Version 4 and up can be used to program the Levellogger Edge and Barologger Edge. The Levellogger Junior Edge is only compatible with Levellogger Software Version 4.0.2 and up. The Rainlogger Edge is only compatible with Software Version 4.1 and up. The LTC Levellogger Edge is only compatible with 4.3.0 and up.

The Levellogger Junior, LTC Levellogger Junior, Rainlogger, and Leveloader are compatible with Levellogger Software Version 4.3.0. If used with previous software versions, they will not have some of the features gained with the release of Version 4.3.0 Software. The Levellogger Gold and Barologger Gold are also compatible with Version 4.3.0 Software, and previous versions.

To use your Levelloggers with Version 4.3.0 Software, ensure your firmware is upgraded to the following versions:

Datalogger	Firmware Version
Levellogger Edge	3.003
Barologger Edge	3.003
Levellogger Junior Edge	3.003
LTC Levellogger Edge	1.000
Rainlogger Edge	3.001
Leveloader Gold	2.002
Levellogger Gold	2.007
Barologger Gold	2.007
Levellogger Junior	2.007
LTC Levellogger Junior	2.005
Rainlogger	2.000

For more information on previous software and firmware versions, visit [www.solinst.com](http://www.solinst.com) to view **3001 Levellogger Series: Hardware Compatibility**, located on the Downloads page.

## 2 System Requirements

The minimal hardware and software requirements for software installation and operation are:

Hardware	Software
Memory: 32 MB or more	OS: Windows 7, 8 or 10
Display: VGA: 800 x 600 pixels, 256 colour	
Ports: USB or RS-232 Serial Port	

Communication Port Setting for Levellogger Communications:

Bits per second	9600
Data bits	8
Stop bits	1
Flow control	None

## 3 Software Installation

### Web Download

Download the newest version of Levellogger Software by visiting [www.solinst.com/downloads/](http://www.solinst.com/downloads/)

### CD Installation

- 1) Insert the software CD provided.
- 2) If the installer does not automatically start, to activate the software install click on the 'setup.exe' file located on the software CD.
- 3) The Software Installation Wizard will guide you through the remaining installation process. Figure 3-1 shows the Levellogger Installation Wizard.
- 4) Restart the computer after installation is completed. Default Directory is C:\Program Files\Solinst\Levellogger4\_3

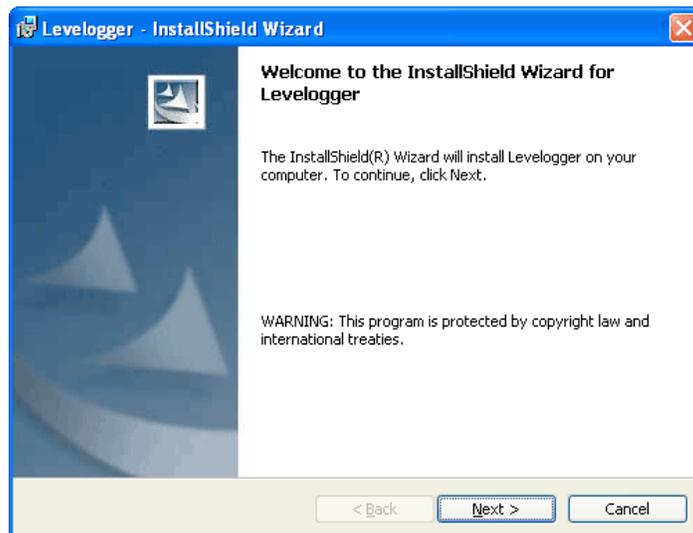


Figure 3-1 Software Installation Wizard

## 4 Startup, Configurations and Settings

### 4.1 Startup

If using a USB port, plug in the USB cable before starting the Levellogger Software. If plugging in the USB device for the first time, the driver for the device will have to be installed, see Section 4.1.3 for USB driver installation instructions.

To start the Levellogger Software, click  , or click the Start button and select:

Programs > Solinst > Levellogger 4 > Levellogger 4.3.0

Once the program is started, you can set up the parameters for the Software.

#### 4.1.1 Software/Firmware Update Checks

Each time the software is opened, it automatically checks for software updates. If there is an update, "[Software Update Available](#)" will appear in the top right of the menu bar. When you click the message, it will open a web page where you can download the software update.

The Software also checks for firmware updates once you have retrieved settings from a connected Levellogger (see Section 5). "[Firmware Update Available](#)" will appear in the top right menu bar. Clicking the message will open a web page where you can download the firmware update. See Section 12 for firmware update instructions.

#### 4.1.2 Communicating with a USB Port

USB port communication requires the installation of USB driver software and the setting up of a virtual com port. The user will either:

- 1) Connect a Levellogger Optical Reader or PC Interface Cable to the USB port
- 2) Use a USB to RS-232 Adapter

If 1, during the installation of Levellogger Software, the **Virtual Com Port Driver** will be installed automatically. The Levellogger Software Installation Wizard also copies a folder to the Levellogger folder containing all the Solinst USB drivers. When you plug in the Solinst USB device, check the com port designation after installing the device (see Section 4.2.1).

If 2, Solinst strongly recommends the use of either Keyspan™ or IO Gear™ USB to RS-232 Serial Adapters. These adapters have a sufficiently large buffer to accommodate the size of data bundle and bit transfer rate of the Levellogger. Follow the manufacturer's USB Driver and Com port setup installations found on the CD accompanying the adapter.

If you have installed another brand-name adapter, but cannot communicate with the Levellogger, in most cases the problem is that the adapter does not have a large enough internal memory buffer. The minimum buffer size should be 96 bytes.

#### ! NOTE

Your PC must have an internet connection to check for software and firmware updates.

You can also check for updates using the Help menu.

#### ! NOTES

To check the Com port assigned to a USB device after installation, open the Device Manager. Expand "Ports (COM & LPT)" to show the Com Port that has been assigned. To change the assigned Port, see Section 4.2.1.

You may have to restart your computer after adding a new USB device, before that port will be detected by the Levellogger Software

## ! NOTE

Do not install generic drivers that Windows will locate. Generic drivers are completely incompatible with Solinst USB devices.

## ! NOTE

USB driver installation should be automatic when connecting a PC Interface Cable or Optical Reader.

## ! NOTE

The 'Found New Hardware Wizard' may start automatically, beginning at step 3 below.

## ! NOTE

If the USB driver does not install the first time, repeat the steps a second time. It often takes more than once to install the driver for Windows 7 systems.

## ! NOTE

If you are unsure which is the correct device in the list, with the screen visible, safely remove the device and then reconnect it. The list should automatically refresh accordingly.

### 4.1.3 Installing USB Drivers for Levellogger 4 Software

Levellogger Software Version 4.3.0, for use with Solinst USB Optical Reader, PC Interface Cable and Levellogger, comes equipped with USB drivers for: Windows 7 and 10.

Windows 8 can also be used, see Section 4.1.3.2 for instructions to enable Windows 8 USB installation.

#### 4.1.3.1 USB Installation for Windows 7

Plug the USB Device into the PC. The system will automatically detect the connected unit. Windows 7 should automatically install the driver for the device.

If no driver is automatically found, and the 'Found New Hardware Wizard' fails to start, the following steps should be taken:

- 1) Press the Windows start button to bring up the start menu, select 'Control Panel', then 'Hardware and Sound', then 'Device Manager'.
- 2) Under 'Other Devices' there will be a Solinst device shown with a yellow warning symbol. Right click on this device, and select 'Update Driver Software'.

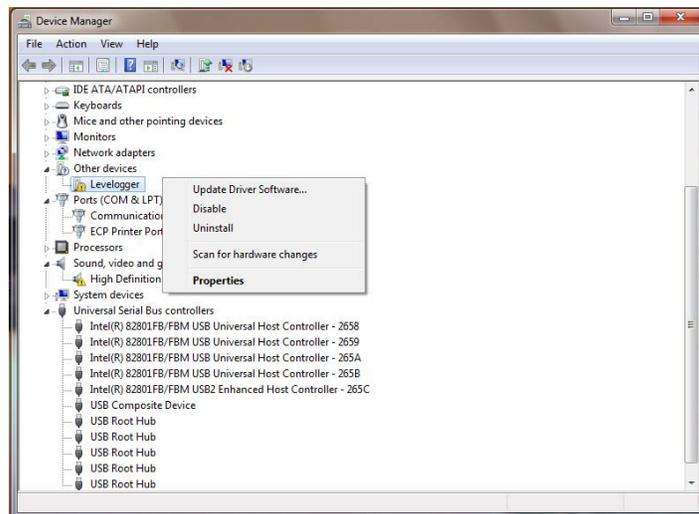


Figure 4-1 Windows 7 Device Manager

- 3) Select 'Browse my computer for driver software'.

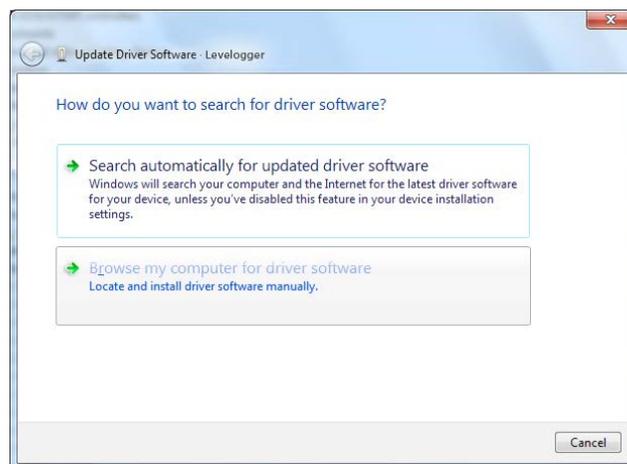


Figure 4-2 Update Driver Software

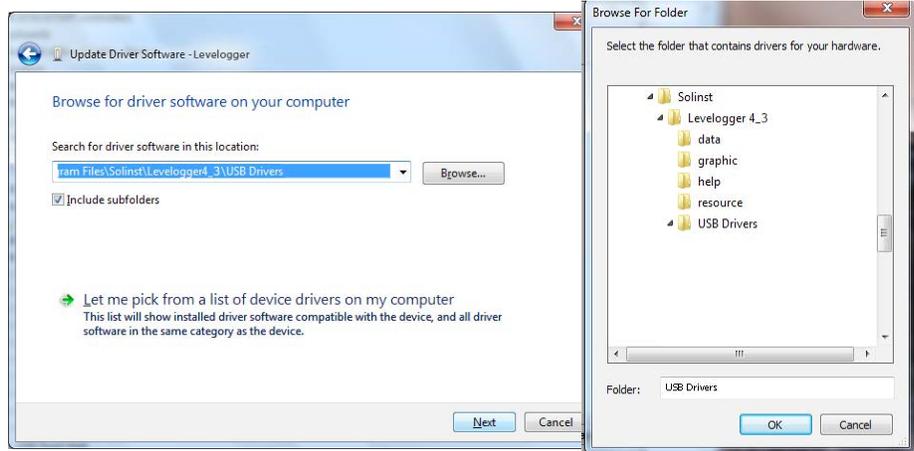


Figure 4-3 Browse for Driver Software

**! NOTE**

Make sure you only select the USB Drivers folder when browsing for the driver location. Do not choose a sub file from the folder.

- 4) Click the Browse button and point the navigation window to the provided USB drivers located within the Levelogger4\_3 folder. Default destination is:  
 C:\Program Files\Solinst\Levelogger4\_3\USB Drivers  
 Select the actual USB Drivers folder, not a sub file from the folder.
- 5) Select Next. A window may appear stating 'Windows can't verify the publisher of this driver software', select 'Install this driver software anyway'.

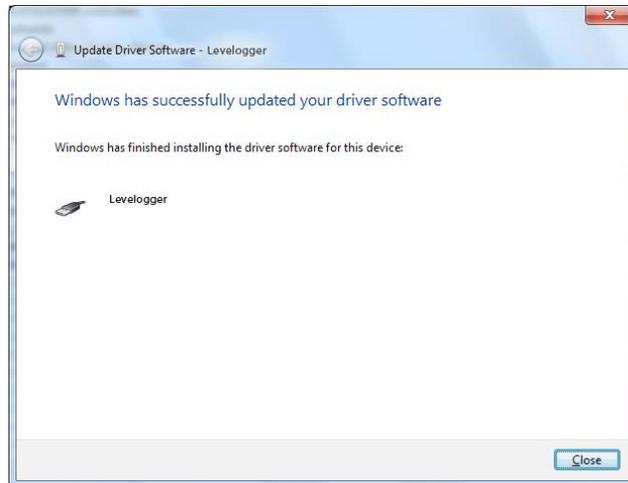


Figure 4-4 Update Complete

- 6) Windows will confirm when the installation is complete. Press Close to close the window, then go back to the 'Device Manager'.

**NOTE**

If you are unsure which is the correct device in the list, with the screen visible, safely remove the device and then reconnect it. The list should automatically refresh accordingly.

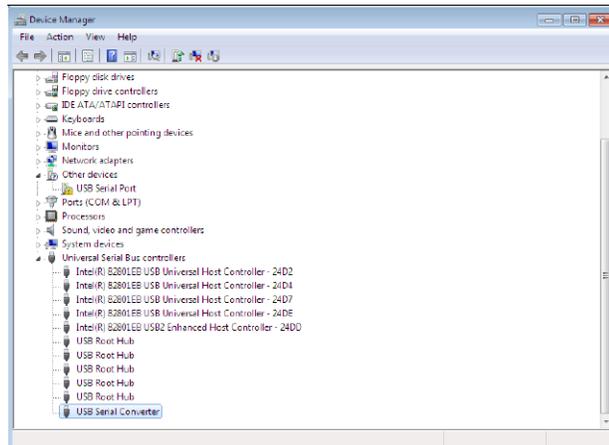


Figure 4-5 Update Serial Port

- 7) You may have to repeat steps 2-6 to update the USB Serial Port. This would be shown under 'Other Devices' with a yellow warning symbol.
- 8) Once installation is complete, a window will confirm the COM port assigned to the device.

## 4.1.3.2 Enabling USB Installation for Windows 8

- 1) Press Win + C on your keyboard to bring up the Charms Bar. Click on “Settings”.
- 2) Click on “Change PC settings” to open the Modern Control Panel.

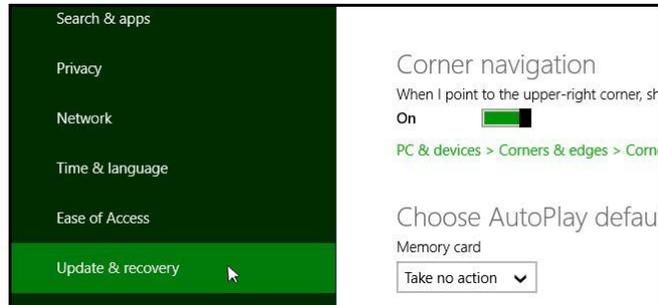


Figure 4-6 Windows 8 Control Panel

- 3) In the Control Panel, switch over to the “Update & recovery” section.
- 4) Click on the “Recovery” option.



Figure 4-7 Restart Windows 8 PC

- 5) In the Advanced startup section, click the “Restart now” button. This will restart your PC.

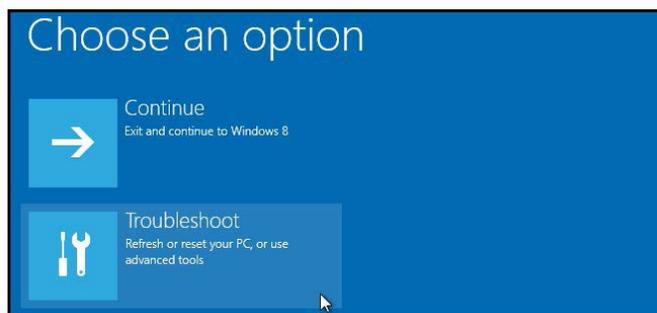


Figure 4-8 Troubleshoot Windows 8 PC

- 6) Once your PC has rebooted, select the “Troubleshoot” option.
- 7) Select “Advanced options”.
- 8) Select “Startup Settings”.
- 9) Select “Restart” to reboot your PC once more. This will allow modification to the boot time configuration settings.

## Startup Settings

Press a number to choose from the options below:

Use number keys or functions keys F1-F9.

- 1) Enable debugging
- 2) Enable boot logging
- 3) Enable low-resolution video
- 4) Enable Safe Mode
- 5) Enable Safe Mode with Networking
- 6) Enable Safe Mode with Command Prompt
- 7) Disable driver signature enforcement
- 8) Disable early launch anti-malware protection
- 9) Disable automatic restart after failure

Press F10 for more options

Press Enter to return to your operating system

Figure 4-9 Windows 8 Startup Settings

- 10) A list of settings that can be changed will be shown. The setting you are looking for is "Disable driver signature enforcement". To choose this setting, press the F7 key.
- 11) After the PC automatically restarts, you will be able to install the USB drivers, as described in Section 4.1.3.1.

## NOTE

USB driver installation should be automatic when connecting a PC Interface Cable.

## NOTE

The 'Found New Hardware Wizard' may start automatically, beginning at step 5.

## NOTE

If you know that you need to **Disable Driver Signature Enforcement** before installing drivers on your PC, then proceed to the instructions in section 4.1.3.4.

## NOTE

If you are unsure which is the **correct device in the list**, with the screen visible, safely remove the device and then reconnect it. The list should automatically refresh accordingly.

### 4.1.3.3 USB Installation for Windows 10

Plug the USB device into the PC. The system will automatically detect the connected unit. Windows 10 should automatically install the driver for the device.

If no driver is automatically found, and the 'Found New Hardware Wizard' fails to start, the following steps should be taken:

1. Open the Windows Start Menu and click on "Settings". Click on "Devices".
2. In Devices, click on "Connected Devices". You should see your connected Solinst USB device listed under Other Devices. It should indicate that the device's setup is incomplete.

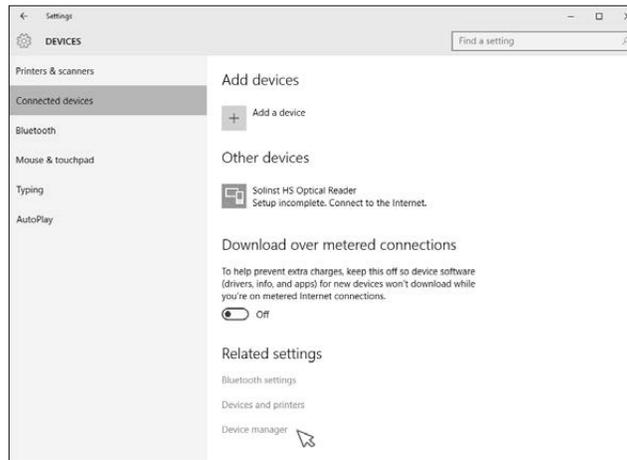


Figure 4-10 Windows 10 Connected Devices

3. Under Related settings, click on "Device Manager".

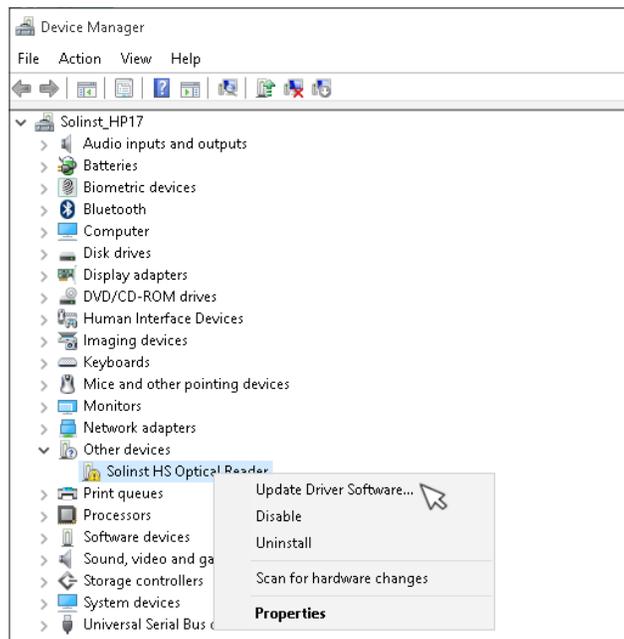


Figure 4-11 Windows 10 Device Manager

4. Under Other devices, there will be a Solinst device shown with a yellow warning symbol. Right click on this device, and select "Update Driver Software...".

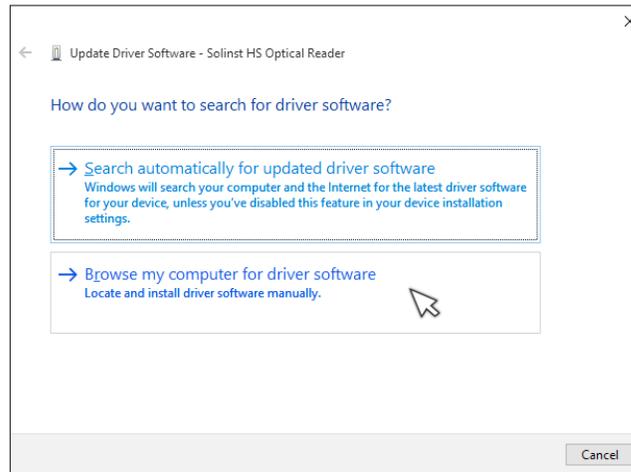


Figure 4-12 Update Driver Software

## NOTE

Make sure you only select the USB Drivers folder when browsing for the driver location. Do not choose a sub file from the folder.

5. Select “Browse my computer for driver software”.
6. Click the Browse button and point the navigation window to the provided USB drivers located within the Levellogger4\_3 folder. Default destination is:  
 C:\Program Files\Solinst\Levellogger4\_3\USB Drivers  
 Select the actual USB Drivers folder, not a sub file from the folder.

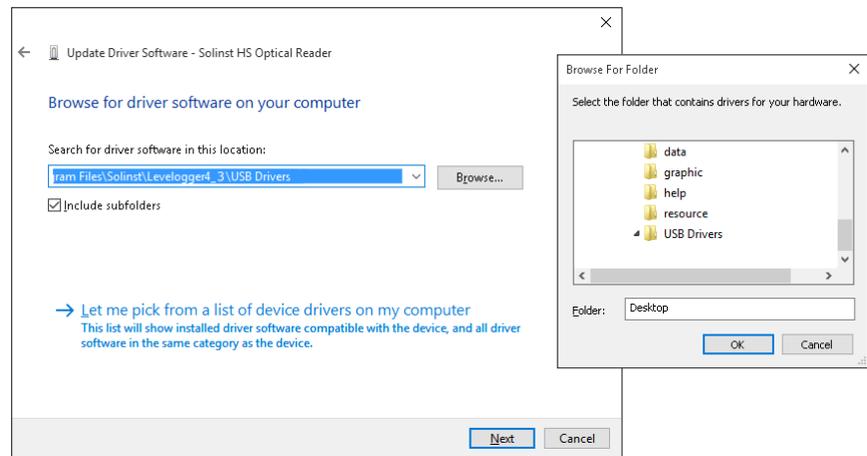


Figure 4-13 Browse for Driver Software

7. Select Next. A Window may appear stating “Windows can’t verify the publisher of this driver software”, select “Install this driver software anyway”.

If you encounter the following error: “Windows encountered a problem installing the driver software for your device. Windows found driver software for your device but encountered an error...” Then please proceed with the instructions to **Disable Driver Signature Enforcement** in Section 4.1.3.4.

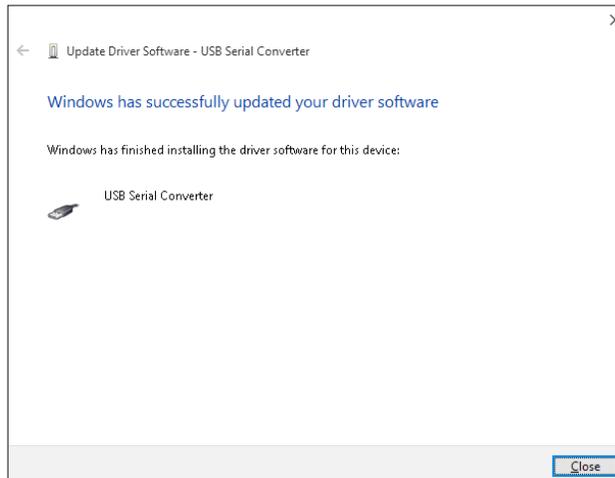


Figure 4-14 Update Complete

8. Windows will confirm when the installation is complete. Press Close, then go back to the Device Manager.

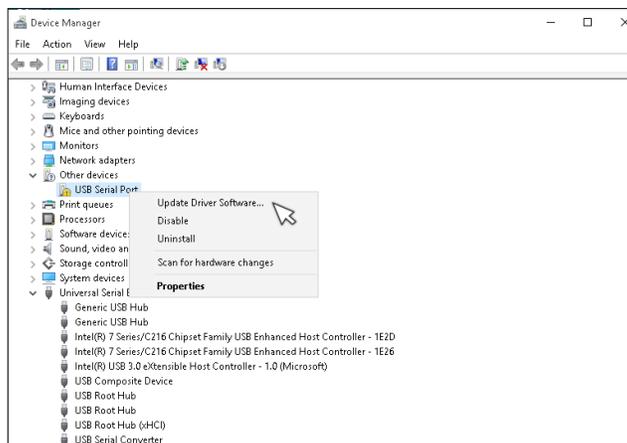


Figure 4-15 Update USB Serial Port

9. Follow Steps 4-8 to update the USB Serial Port, shown under Other devices with a yellow warning symbol.

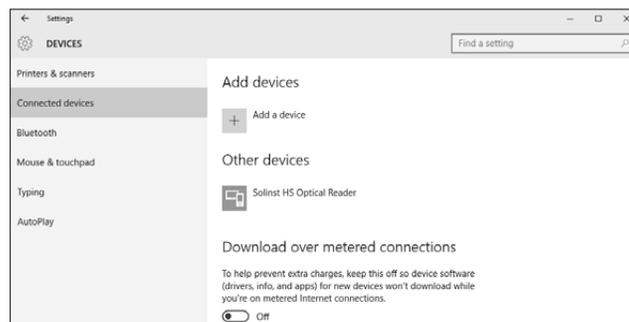


Figure 4-16 Installed Solinst USB Device

10. Once the installation is complete, this will be shown in the Devices > Connected devices Window. See Figure 4-16.

## 4.1.3.4 Disable Driver Signature Enforcement for Windows 10

1. Open the Windows Start Menu and click on “Settings”.
2. In Settings, click on “Update & security”.

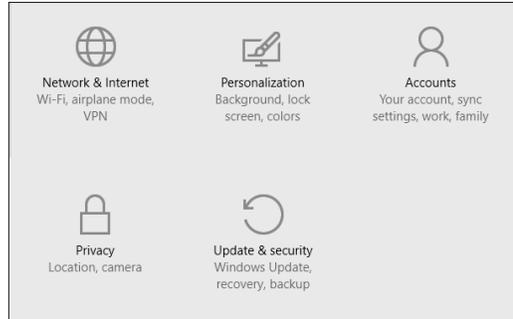


Figure 4-17 Windows 10 Settings

3. Then click on the Recovery option on the left hand side.
4. Once selected, you will see an Advanced startup section appear on the right hand side. Click on the “Restart now” button.

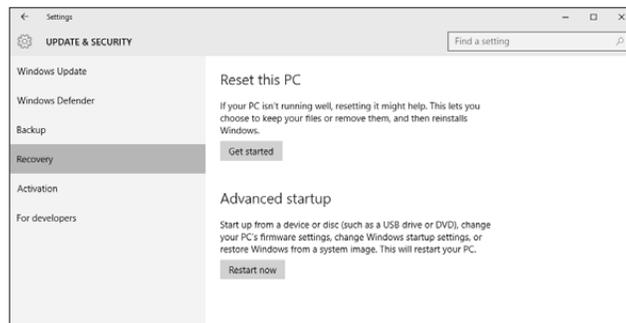


Figure 4-18 Windows 10 Advanced Startup

5. Once your Computer has rebooted, choose the “Troubleshoot” option.

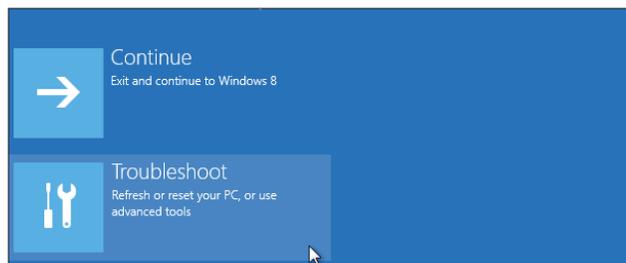


Figure 4-19 Windows 10 Troubleshoot

6. Select “Advanced options”.
7. Select “Startup Settings”.

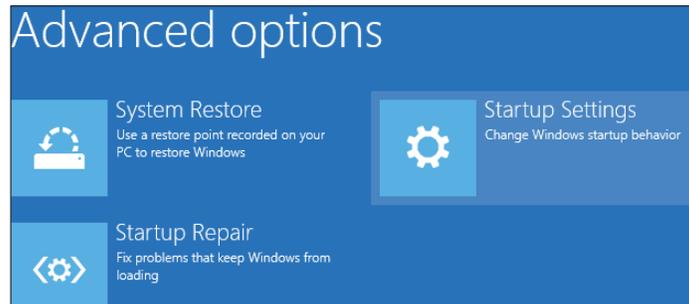


Figure 4-20 Windows 10 Advanced Options

8. Select “Restart” to reboot your PC once more. This will allow modification to the boot time configuration settings.
9. A list of settings that can be changed will be shown. The setting you are looking for is “Disable driver signature enforcement”. To choose this setting, press the F7 key.

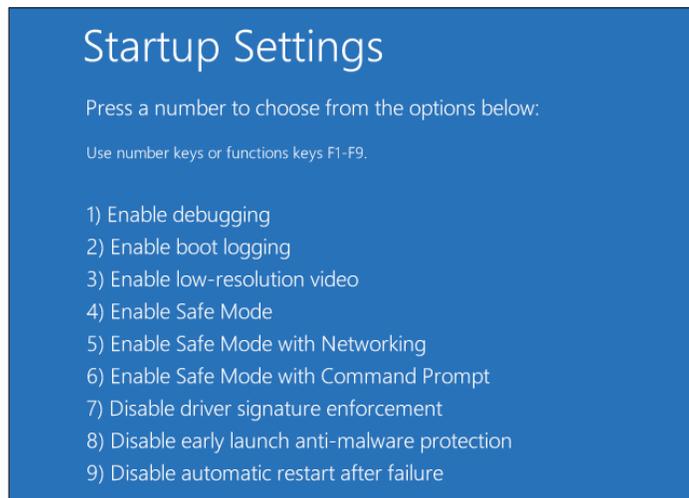


Figure 4-21 Windows 10 Startup Settings

10. After the PC automatically restarts, you will be able to install the USB drivers, as described in Section 4.1.3.3.

## NOTES

To check the Com port assigned to a USB device after installation, open the Device Manager. Expand 'Ports (COM & LPT)' to show the Com Port that has been assigned.

You may have to restart your computer after adding a new USB device, before that port will be detected by the Levellogger Software

## 4.2 Configuration and Settings

### 4.2.1 Com Port Designation Set Up

After installing a USB device, should the Com Port number assigned to the device conflict with your existing devices, it is possible to change the Com Port designation number:

- 1) Click Start > Settings > Control Panel
- 2) Click Systems to open the System Properties
- 3) Click the Hardware tab and click 'Device Manager'
- 4) Double Click the Ports Icon and select the 'USB Serial Port'
- 5) Right click and select Properties
- 6) Click the 'Port Settings' tab and click 'Advanced'
- 7) Select the Com Port Number and click 'OK'

**Note:** the path to the 'Port Settings' tab may be different for each Windows operating system. The above is just a guideline.

### 4.2.2 Data Directory

The program will save data downloaded to the following default directory: <C:\Program Files\Solinst\Levellogger4\_3\Data> unless otherwise specified in the Default Directory field of the Application Settings window (Figure 4-22).

Click the Configuration menu at the top of the program window, select Application Settings and input or navigate to a different folder destination. After completing the Application Settings, click the OK button to confirm and save the settings.

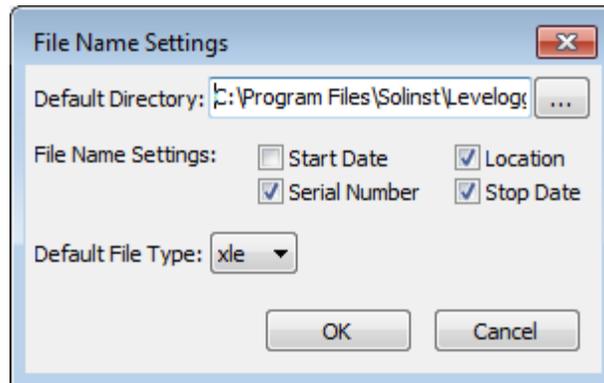


Figure 4-22 Application Setting Window

### 4.2.3 File Name Settings

From the Application Settings window in the Configuration menu, you can set what information will be included in your default file names of downloaded data (see Figure 4-22). You can include Start Date, Stop Date, Serial Number, and Location. Check-off the information you would like included.

After completing the Application Settings, click the OK button to confirm and save the settings.

#### 4.2.4 Default File Type

From the Application Settings window in the Configuration menu, you can set what default file type you would like to use for downloaded, saved and exported data files. You can select between either \*.xle (default) or \*.lev file types (see Figure 4-22). For more information about the two file types, see Section 7.1.1.

After completing the Application Settings, click the OK button to confirm and save the settings.

## NOTE

Depending on your Levellogger type, there will be different programming options. See Table 1-1 for the major differences. See Section 5.9 for programming the Levellogger Gold, Barologger Gold, and Levellogger Junior.

## NOTE

Click on icons to get an explanation of that software feature.

## NOTE

When first setting up a Barologger and Levellogger(s) that will be used for the same project, it is suggested to set them at the same sampling interval, and to use the Future Start and Stop options where possible. When the data sets have the same time stamps, and start and stop times, barometric compensation of the data will be most accurate. It is also useful to synchronize the clocks of the dataloggers. See Section 5.4.

## NOTE

The Levellogger Edge, which is available in M5, M10, M20, M30, M100, and M200 ranges has actual water level ranges of 5 m (16.40 ft), 10 m (32.80 ft), 20 m (65.60 ft), 30 m (98.40 ft), 100 m (328.0 ft), and 200 m (656.2 ft), respectively.

## 5 Levellogger Edge Series Setup

After you start the Levellogger Software, the main Levellogger Software window will appear, with the Datalogger Settings tab open.

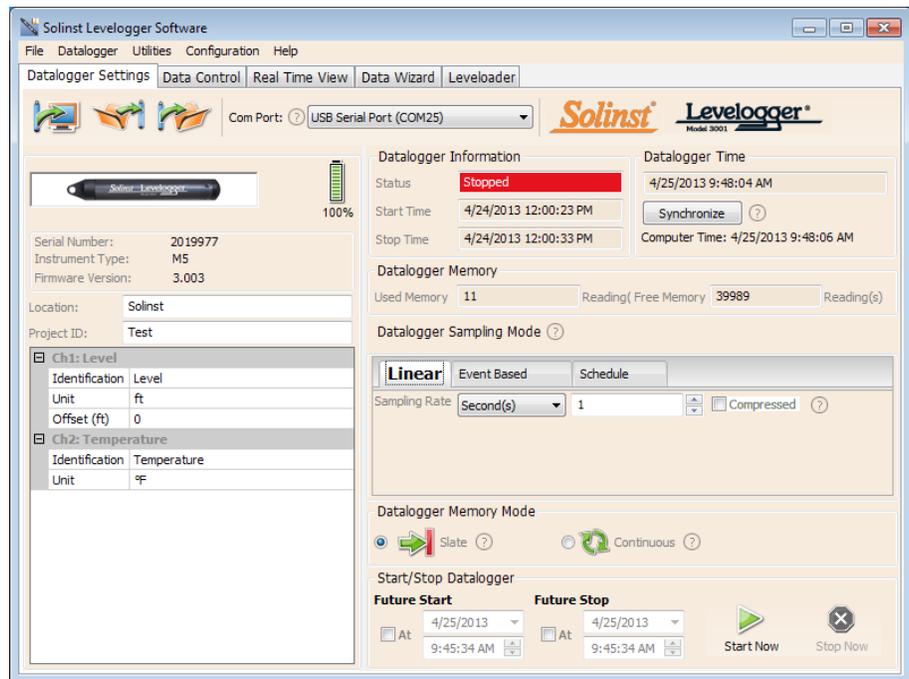


Figure 5-1 Datalogger Settings Tab

Select the appropriate COM or USB Port for the connected communications device from the centre drop-down menu.

Click to retrieve the current settings from the connected datalogger.

### 5.1 Datalogger Settings

After you have retrieved the settings of the connected datalogger, the Datalogger Settings tab will identify the Instrument Type, Serial Number, Firmware Version, Project ID, Location, and the Channel Settings.

- **Instrument Type:** will display the model of the attached datalogger, i.e.: M30, Barologger, Rainlogger.
- **Serial Number:** the unique serial number of the attached datalogger will be displayed.
- **Firmware Version:** shows the firmware version of the attached datalogger.
- **Project ID:** input your own identification system. The Project ID is limited to 32 characters.
- **Location:** input specific site / location information. The location is limited to 32 characters.

## NOTE

Readings can be converted to other units using the Data Wizard.

Readings can be corrected or offset with respect to a specific reference elevation or datum for a much wider spectrum of numeric offsets as part of the Data Wizard.

## NOTE

If you set your Levellogger to record in pressure units (kPa, bar, psi), you can not change the offset or enter an elevation value (in the Data Wizard). Only raw pressure readings will be provided.

## NOTE

There is no Offset input option for the Barologger Edge.

## NOTE

Levellogger and Barologger Edge data can be adjusted for altitude and density post data collection using the Data Wizard.

## NOTE

The LTC Levellogger Junior only measures in °C

### 5.1.1 Setting Up Channel Information

In the lower left portion of the Datalogger Settings tab is the area for setting channel parameters (level, temperature, conductivity, rainfall). The software will detect the available channels when the datalogger settings are retrieved.

#### 5.1.1.1 Level Channel (Ch1)

- **Identification** describes the measurement parameter of the channel and has already been configured as 'LEVEL'. The channel can be re-named to suit each project. The channel monitors water column equivalent pressure. The Identification field will be the channel heading, data column heading and graph line name when viewing the data. Identification is limited to 32 characters.
- **Unit** refers to the channel's unit of measurement. There are six options when using a Levellogger: m (default), cm, ft, kPa, bar, and psi. When using a Barologger Edge, the options are kPa (default), mbar, and psi.
- **Offset** refers to an adjustment, such as the distance between the tip of the Levellogger and the monitoring well cap or static water level. It is recommended that the value of 0.00 be used, as this keeps all subsequent readings relative to the tip of the Levellogger. The reference range is -1000 to 16,400 ft or -300 m to 5000 m.

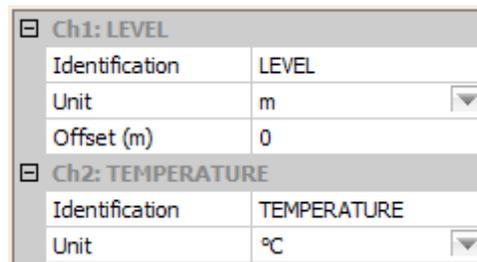


Figure 5-2 Levellogger Edge Channel Setup

The LTC Levellogger Junior also has inputs for:

- **Altitude** in feet or meters above sea level, at which the logger is actually deployed, is input in the altitude field. You can enter an elevation between -1000 ft below sea level and 16,400 ft (or -300 m and 5000 m) above sea level. The readings will then be automatically compensated for elevation.
- **Density** is used to adjust the range of the Levellogger based on the sample fluid density. The range for the density adjustment is from 0.9 kg/L to 1.1 kg/L.

#### 5.1.1.2 Temperature Channel (Ch2)

- **Identification** describes the measurement parameter of the channel and has already been configured as 'TEMPERATURE'. The channel can be re-named to suit each project. The Identification field will be the channel heading, data column heading and graph line name when viewing the data. Identification is limited to 32 characters.
- **Unit** refers to the channel's unit of measurement. For the Levellogger and Barologger, the temperature channel can be set to °C (default) or °F.

## NOTE

For every degree change in temperature, there is approximately a 2% change in conductivity. To convert raw conductivity measurements to Specific Conductance measurements, you can use the following equation:

$$\text{Specific Conductance} = \text{Conductivity} / (1 + 0.02 * (\text{temp}(C) - 25))$$

You can also perform this calculation automatically using the Data Wizard.

You can also convert Conductivity readings to Salinity (expressed in Practical Salinity Units (PSU)) using the Data Wizard.

### 5.1.1.3 Conductivity Channel (Ch3)

- **Identification** describes the measurement parameter of the channel and has already been configured as 'CONDUCTIVITY'. The channel can be re-named to suit each project. The Identification field will be the channel heading, data column heading and graph line name when viewing the data. Identification is limited to 32 characters.
- **Unit** refers to the channel's unit of measurement. There are two units of measure available for the user to select: mS/cm or  $\mu\text{S/cm}$ .

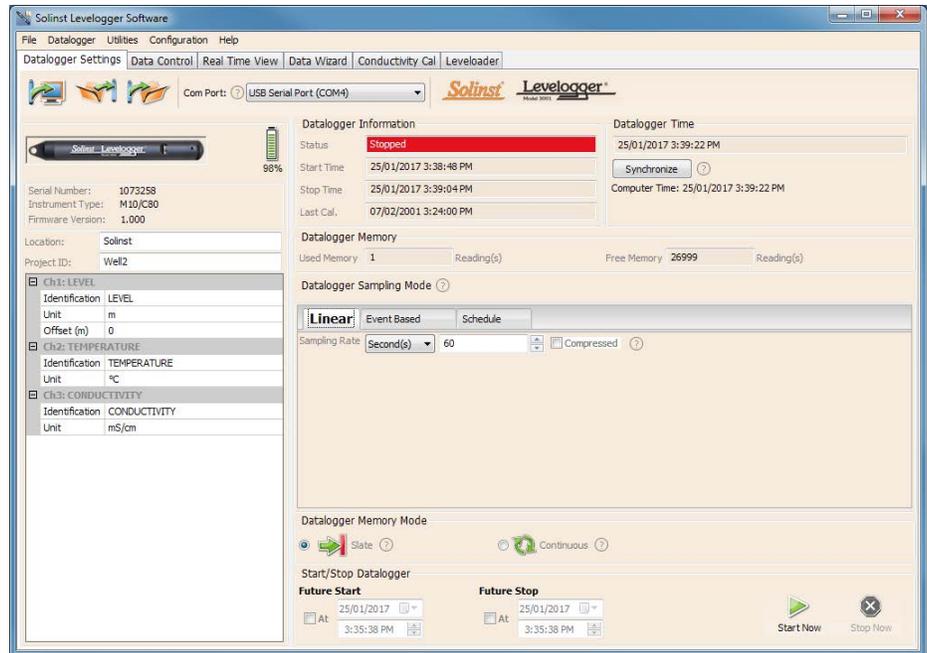


Figure 5-3 Conductivity Channel Setup

## 5.1.1.4 Rainloggers

There is one channel of measurement for the Rainlogger Edge and Rainlogger. The **RainFall** Channel records each tip time by the connected tipping-bucket and outputs the amount of rainfall per tip (input Rainfall Cal Constant).

- **Identification** describes the measurement parameter of the channel and has already been configured as 'RainFall'. The channel can be re-named to suit each project. The Identification field will be the channel heading, data column heading and graph line name when viewing the data. Identification is limited to 32 characters.
- **Units** refers to the channel's unit of measurement. There are two units of measure available for the user to select: mm or in.
- **The Rainfall Cal Constant** field allows you to enter the calibration factor for the tipping-bucket you will be using. The calibration factor is the amount of rainfall depth (mm, in) per tip. The calibration factor should be indicated on a label on the tipping-bucket device or in the manufacturer's documentation. Input the calibration factor in mm or inches.

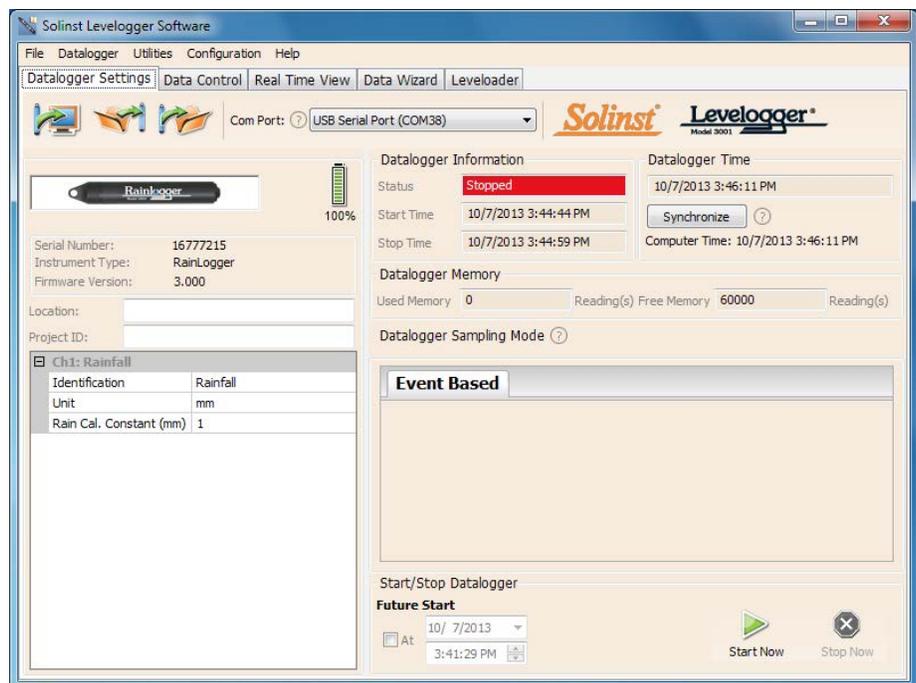


Figure 5-4 Rainlogger Channel Setup

## 5.2 Datalogger Information

The Datalogger Information section shows the Status of the attached datalogger (i.e.: Started, Stopped, Future Start) and the Start Time and Stop Time of the datalogger. When a Future Start and/or Stop time is set (see Section 5.8), the Start Time and Stop Time fields will fill in. The fields will update each time the datalogger is stopped and started.

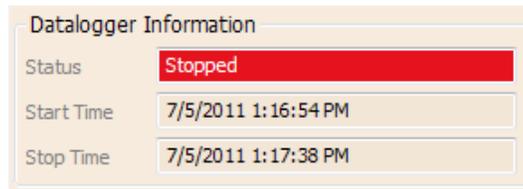


Figure 5-5 Datalogger Information

## 5.3 Datalogger Memory

The Datalogger Memory section shows the amount of memory used, and the amount of memory remaining (number of readings).



Figure 5-6 Datalogger Memory Remaining

If the Data Compression option is selected (see Section 5.5), the amount of free memory shown is approximated as a visual status bar.

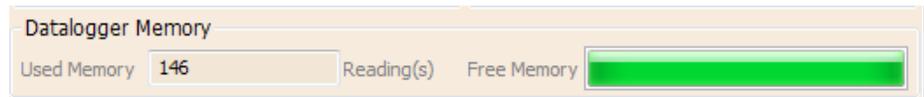


Figure 5-7 Datalogger Compressed Memory

## 5.4 Datalogger Time

The Datalogger Time section provides the controls for setting the datalogger clock. If you want to synchronize the datalogger's clock to the computer clock, click Synchronize to set the time in the datalogger.

If you start the datalogger without synchronizing the clock and the time difference between the datalogger and the PC is more than 3 seconds, the software will give you a message asking 'Do you want to synchronize the logger time to system time?'. Click Yes to synchronize the clock.

It can be very useful to synchronize the clocks of all the Leveloggers and Barologgers when it comes to Barometric Compensation.

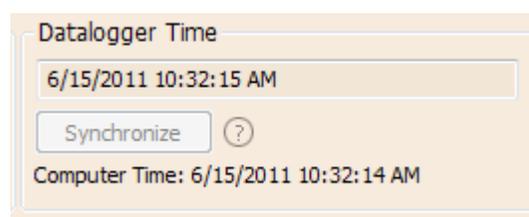


Figure 5-8 Datalogger Time

### ! NOTE

It is very useful to synchronize the clocks of all the Leveloggers and Barologgers for use on the same project.

### ! NOTE

To synchronize to a different time/ time zone you first must adjust the computer time using the Windows Operating System Date and Time Settings menu. Then re-start the Solinst Levelogger Software and synchronize your Dataloggers to the new time.

## ! NOTES

The battery life of the Levellogger Edge is 10 Years, based on 1 reading per minute. More rapid readings will reduce the battery life. For example, if a Levellogger Edge is setup in Continuous Mode at a sampling rate of 1 second, the battery will be depleted in approximately 4 months.

If a Levellogger Junior Edge is used at a sampling rate of 5 seconds, the battery will be depleted in approximately 2.5 months.

## ! NOTE

The Levellogger Junior Edge and LTC Levellogger Junior record using Linear sampling mode only.

The Levellogger Junior Edge has a sample rate of 0.5 seconds to 99 hours. The LTC Levellogger Junior has a sample rate of 5 seconds to 99 hours.

## ! NOTES

In Event Based sampling mode, the Levellogger Edge has a total memory of 25,000 sets of readings and the LTC Levellogger Edge has a total memory of 18,650 sets of readings.

In Event Based sampling mode, battery consumption is mainly a function of sampling rate. Therefore, with a smaller sampling interval, battery power will be used up quickly whether readings are stored or not.

## ! NOTE

Rainloggers record in Event Based mode only. They record the tip times of a connected tipping-bucket.

## 5.5 Datalogger Sampling Mode

The Datalogger Sampling Mode section allows you to choose the sampling measurement type. Options for the Levellogger Edge, Barologger Edge and LTC Levellogger Edge are Linear, Event Based and Schedule.

**Linear** refers to a set time interval between collection of readings. Sample Rate can be any number from 0.125 seconds to 99 hours for the Levellogger Edge and 2 seconds to 99 hours for the LTC Levellogger Edge.

There is a data compression option available for the Levellogger Edge. This increases the memory capacity of the Levellogger Edge from 40,000 readings to up to a maximum of 120,000. Check the Data Compression box to allow data compression.

**Data Compression** works by only saving data changes in memory. For example, if you have linear sampling set to record each second, and your water level varies a little for 60 seconds, the memory will only record incremental values for the 60 seconds. When your data is exported, it will display all 60 intervals with the corresponding level data.



Figure 5-9 Linear Sampling Setup

**Event Based** sample collection is the most memory efficient means of data collection. In Event mode, the Levellogger will be activated at every defined 'Sample Rate' to check if readings have changed by the selected 'Change' from the last recorded reading.

For the Levellogger Edge, 'LEVEL' or 'TEMPERATURE' is the selected parameter where change is monitored. You can also select 'CONDUCTIVITY' for the LTC Levellogger Edge. The Levellogger will record a new reading only if the specified change in the parameter has occurred, at the specific point in time, as defined by the 'Sample Rate'.

A default reading will also be stored in the datalogger memory, every 24 hours from the last recording, if no 'Change' occurs.



Figure 5-10 Event Based Sampling Setup

## NOTE

A schedule can be saved and applied to other Levelloggers, or a Levelloader, by saving the Levellogger Settings file (see Section 5.7).

**Schedule Sampling** allows you to select a logarithmic style sampling schedule adapted to the needs of each application.

Schedule Sampling is set by using the plus and minus buttons to add or subtract line items in the Schedule window. The maximum number of line items in a schedule is 30, each with its own sampling interval of seconds, minutes or hours and duration of seconds, minutes, hours, days or weeks. A 'Pause' interval can also be selected, which stops the Levellogger from recording for the specified duration.

Running totals of the number of readings still available, from the total possible 40,000 (27,000 readings for the LTC Levellogger Edge), and the run time to date are shown. If the number of readings selected exceeds the Levelloggers memory capacity an error message appears.

By checking Repeat, the Levellogger will continue to run through the schedule until its memory is full, or it is stopped.

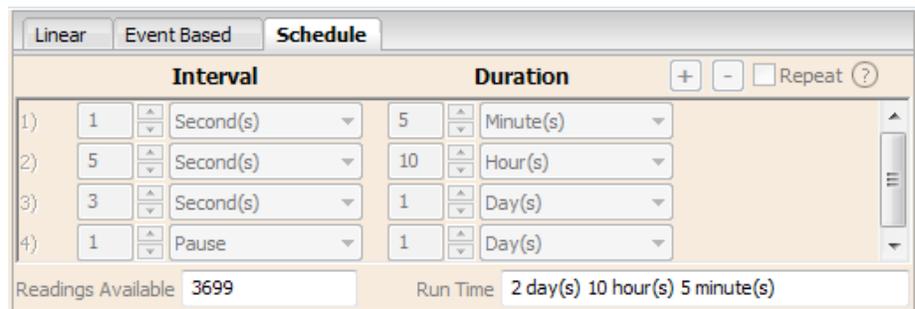


Figure 5-11 Schedule Sampling Setup

## NOTE

Datalogger Memory Mode is only available for the Levellogger Edge and LTC Levellogger Edge using Linear Mode.

Levellogger Junior Edge and LTC Levellogger Junior operate in Slate logging mode only.

## 5.6 Datalogger Memory Mode

Datalogger Memory Mode selection will only appear when **Linear** sampling mode is selected. When using a Levellogger in Linear Mode, there is a choice of **Continuous** Logging (wrap around) or **Slate** Logging .

Compressed Linear, Event Based and Schedule sampling modes can only use the Slate Mode option.

In Continuous Logging, the new log is started at the end of any previous log and continues logging, eventually recording over the first logged data. As one of the download options is to 'Append Data', Continuous Logging can be a preferred choice when logging long-term (see Section 7.1.2).

In Slate Logging, the new log is also started at the end of any previous log, but will stop recording after 40,000 readings (or up to 120,000 readings), so that the beginning of the current log will not be written over.



Figure 5-12 Datalogger Memory Mode

## NOTE

The Levellogger Junior Edge has memory for 40,000 readings, the LTC Levellogger Edge has memory for 27,000 readings, and the LTC Levellogger Junior has memory for 16,000 readings in Slate Mode.

## ! NOTE

Settings files created in Levellogger Software Version 3 or earlier (.lls or .sci files) can not be opened by Software Version 4. These settings files will need to be re-created and saved in Levellogger Software Version 4.

## ! NOTE

Remember to download any data on the datalogger before starting a new session. When starting a new logging session, any data from previous recording sessions will be erased.

## ! NOTES

If a setting has been changed, it will be highlighted in yellow as a reminder before the datalogger is started.

If a setting has been entered incorrectly, it will be highlighted in red.

Changed settings are applied to the datalogger automatically when the Start icon is selected.

## ! NOTE

Retrieve the Levellogger settings in order to refresh the status (i.e. when the status changes from Future Start to Started).

## 5.7 Saving and Retrieving Levellogger Settings Files

To store settings as defaults, click . It will store the settings of the Levellogger into an \*.dtf file as a series of defaults. The \*.dtf file will save the Project ID, Location, Sample Mode, Sample Rate, Channel ID, Unit, and Offset.

To retrieve settings from defaults, click from a selected \*.dtf file. This is particularly useful if programming several Levelloggers with similar identical settings. Keep in mind that Project ID and Location identification information will be identical and should be distinguished from logger to logger or monitoring point to point.

## 5.8 Starting and Stopping the Datalogger

### Starting the Datalogger

There are two ways to start logging: **Start Now** or by programming a **Future Start** time.

**To start logging immediately**, do not fill in a Future Start time and click, . It should say Start Now below the icon to indicate an immediate start. Any changed settings will automatically be applied to the datalogger, and it will start logging. Datalogger Status will change from Stopped to Started.

After the datalogger is started, and begins collecting readings, the Start icon will be greyed out, and only the Stop icon and Future Stop settings will be active.

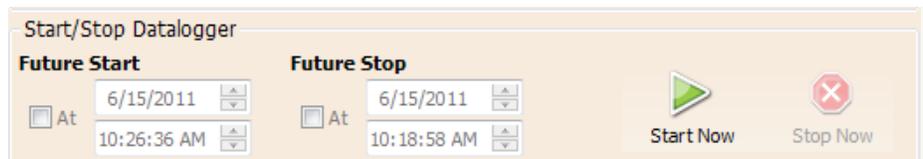


Figure 5-13 Starting the Datalogger Immediately

Check **Future Start 'At'** to set logging to start at a later date and/or time. This Start mode is referred to as Future Start in the Status field. Click to apply the Future Start time and any changes to the datalogger settings.

When the Future Start time is reached, the datalogger will start logging and the Status will change from Future Start to Started.

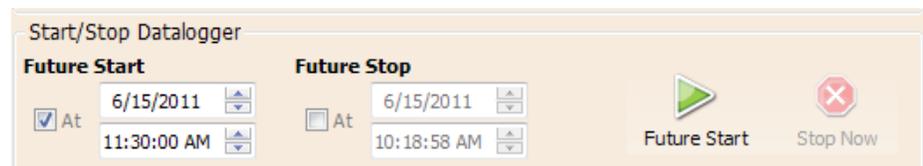


Figure 5-14 Future Start Setting

## Stopping the Datalogger

There are two ways to stop logging: Stop Now or at a programmed Future Stop time for the Levellogger Edge and Barologger Edge.

To stop the datalogger immediately when it is logging, click  , (it should say Stop Now below the icon).

The Levellogger can be stopped at any time before it reaches the maximum reading capacity. **Starting again begins a new recording session and clears previously stored data readings.**

### NOTE

You can not set a Future Stop time for the Levellogger Junior Edge, LTC Levellogger Junior, or Rainlogger.

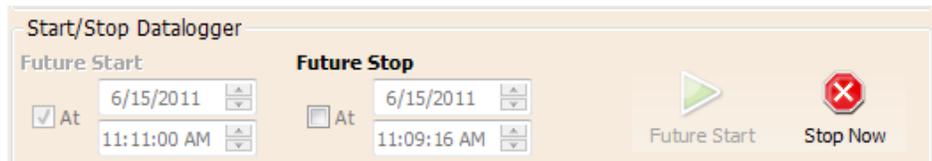


Figure 5-15 Stopping the Datalogger Immediately

To program a **Future Stop** time for your datalogger, check Future Stop 'At' and fill in the desired stop time. The Future Stop time will be applied to the datalogger once  is selected for an immediate or future start.

You can also program a Future Stop time after you have started the datalogger, by checking Future Stop 'At' and filling in the desired stop time. Select  to apply the Future Stop time (it should say Future Stop below the icon). The Stop Time should be shown in the Datalogger Status section.

### NOTE

If you have set a Future Stop time, but wish to stop the datalogger immediately, uncheck the Future Stop 'At' box, and the Stop icon should say Stop Now. Click the icon to stop logging.

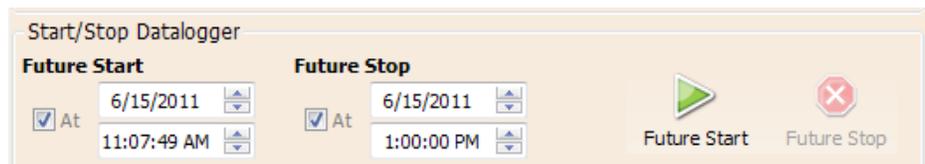


Figure 5-16 Future Stop Setting

It is critical to note that when Levelloggers log data in Slate mode, it means they will record data until stopped or their memory is full. When the memory fills, the datalogger will stop recording. For this reason, it is important to determine, based on your start time and sampling rate, the date and time at which the memory will be full and the datalogger will stop recording. Levellogger Edge units record in Slate mode if Event, Schedule, or Compressed logging, but in standard Linear mode they can be set to Slate or to Continuous logging.

## 5.9 Levellogger Gold Series Setup

This section briefly describes the Levellogger Gold, Barologger Gold and Levellogger Junior setup.

### NOTE

Click on icons to get an explanation of that software feature.

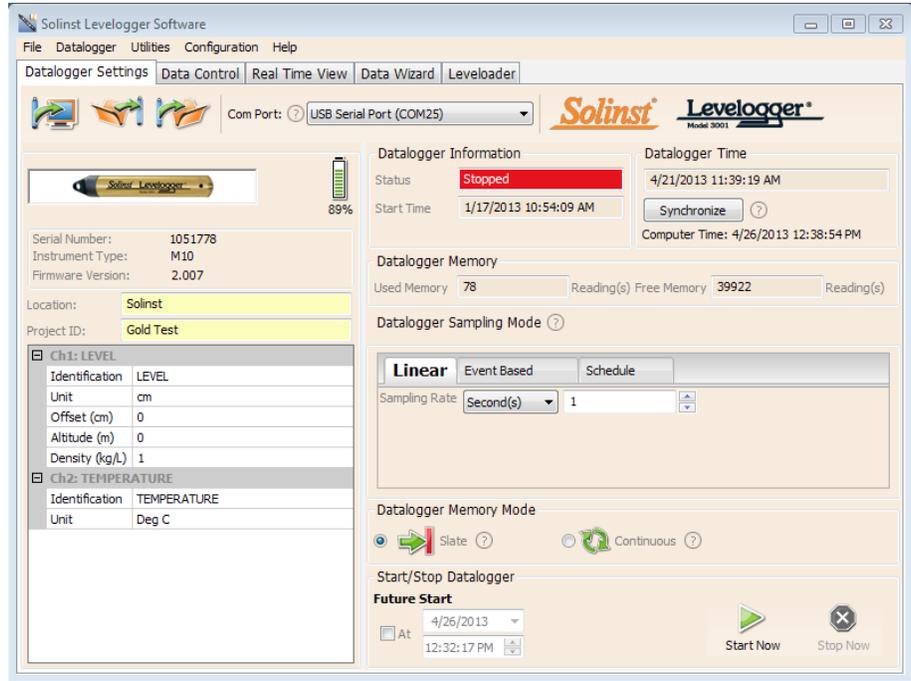


Figure 5-17 Levellogger Gold Settings

Select the appropriate COM or USB Port for the connected communications device from the centre drop-down menu.

Click to retrieve the current settings from the connected datalogger.

### Channel Information

#### Level Channel (Ch1)

- **Identification** describes the measurement parameter of the channel and has already been configured as 'LEVEL'. The channel can be renamed to suit each project. The channel monitors water column equivalent pressure. The Identification field will be the channel heading, data column heading and graph line name when viewing the data. The Identification is limited to 32 characters.
- **Units** refers to the channel's units of measurement. There are three units of measure available for the user to select: cm, m or ft. When the user changes the unit, the value of the range and altitude will change according to the Unit Conversion formula. Note that when a metric unit is used, the unit of altitude is meters. When feet are the level channel units, feet are the units of altitude.

- **Offset** refers to an offset correction, such as the distance between the tip of the Levellogger and the monitoring well cap or static water level. It is recommended that the value of 0.00 be used for offset as this keeps all subsequent readings relative to the tip of the Levellogger. The offset range for Levellogger Gold and Barologger Gold units is -1000 to 16400 ft or -300 m to 5000 m.
- **Altitude** in feet or meters above sea level, at which the logger is actually deployed, is input in the altitude field. Water column equivalent pressure decreases with altitude at a rate of approximately 1.2:1000 in the lower atmosphere below 5000 m. You can compensate for this by entering an elevation between -1000 ft below sea level and 16,400 ft (or -300 m and 5000 m) above sea level. The readings will then be automatically compensated for elevation.
- **Density Adjustment** is used to adjust the range of the Levellogger based on the sample fluid density. The range for the density adjustment is from 0.9 kg/L to 1.1 kg/L.

## Temperature Channel (Ch2)

- **Identification** describes the measurement parameter of the channel and has already been configured as 'TEMPERATURE'. The channel can be re-named to suit each project. The Identification field will be the channel heading, data column heading and graph line name when viewing the data. Identification is limited to 32 characters.
- **Unit** refers to the channel's unit of measurement. The Levellogger Gold and Barologger Gold measure in °C only.

## Sample and Memory Modes

**Sample Mode**, allows you to choose the sampling measurement type. Options are Linear, Event Based and Schedule.

- **Linear** refers to a set time interval between collection of readings. Sample Rate can be any number from 0.5 seconds to 99 hours. The Levellogger Gold and Barologger Gold can store 40,000 readings of level and temperature.
- **Event Based** sample collection is the most memory efficient means of data collection. In Event mode, the Levellogger will activate every sampling interval defined and check if readings have changed by the selected threshold (Change) from the last recorded reading. For the Levellogger Gold, 'LEVEL' or 'TEMPERATURE' is the selected parameter where change is monitored. The Levellogger will record a new reading only if the specified change in the parameter has occurred.
- **Schedule Sampling** allows you to select a logarithmic style sampling schedule adapted to the needs of each application. Schedule Sampling is set by using the plus and minus buttons to add or subtract line items in the Schedule window. The maximum number of line items in a schedule is 30, each with its own sampling interval of seconds, minutes or hours and duration of seconds, minutes, hours, days or weeks.

### ! NOTE

The Levellogger Junior records using Linear sampling mode only.

### ! NOTE

In Event Based sampling mode, the Levellogger Gold has a total memory of 25,000 readings of level and temperature

### ! NOTE

An important reminder for Event Based sampling is that, although actual memory usage in stable water level conditions may be relatively small, battery power consumption is partially a function of the sample reading rate. Therefore, a small sample reading interval will consume battery power at a higher rate whether readings are stored or not.

**NOTE**

The Levellogger Junior records in Slate Mode only. It has memory for 32,000 readings.

**Memory Mode** selection will be grayed-out if not in Linear Mode sampling. When using a Levellogger Gold in Linear Mode, there is a choice of **Continuous** logging (wrap around) or **Slate** logging. In Continuous logging the new log is started at the end of any previous log and continues logging, eventually recording over the first logged data. As one of the download options is to 'Append Data', Continuous logging can be a preferred choice when logging long-term. In Slate logging the new log is also started at the end of any previous log, but will stop recording after 40,000 readings, so that the beginning of the current log will not be written over.

### Starting and Stopping the Levellogger

There are two ways to start logging: **Start Now** or by programming a **Future Start** time.

**To start logging immediately**, do not fill in a Future Start time and click, . It should say Start Now below the icon to indicate an immediate start. Any changed settings will automatically be applied to the datalogger, and it will start logging. Datalogger Status will change from Stopped to Started.

After the datalogger is started, and begins collecting readings, the Start icon will be greyed out, and only the Stop icon and Future Stop settings will be active.

Check **Future Start 'At'** to set logging to start at a later date and/or time. This Start mode is referred to as Future Start in the Status field. Click  to apply the Future Start time and any changes to the datalogger settings.

When the Future Start time is reached, the datalogger will start logging and the Status will change from Future Start to Started.

**To stop the datalogger immediately** when it is logging, click , (it should say Stop Now below the icon).

The Levellogger can be stopped at any time before it reaches the maximum reading capacity. **Starting again begins a new recording session and clears previously stored data readings.**

It is critical to note that when Levelloggers log data in Slate mode, it means they will record data until stopped or their memory is full. When the memory fills, the datalogger will stop recording. For this reason, it is important to determine, based on your start time and sampling rate, the date and time at which the memory will be full and the datalogger will stop recording. Levellogger Gold units record in Slate mode if using Event, or Schedule sampling mode, but in standard Linear mode they can be set to Slate or to Continuous logging.



Figure 6-1  
LTC Levellogger Edge and Junior

**NOTE**

If you know the approximate conductivity range of the water that you will be measuring, best accuracy when calibrating your unit is to select two calibration points - one above, and one below that range. If you are measuring in water less than 1,413  $\mu\text{S}/\text{cm}$  or above 12,880  $\mu\text{S}/\text{cm}$  or 80,000  $\mu\text{S}/\text{cm}$ , use just one calibration solution.

## 6 Conductivity Calibration

The LTC Levellogger Edge and LTC Levellogger Junior conductivity sensors must be calibrated for reliable conductivity measurements. Calibrate for conductivity at the start of each new monitoring project or at a minimum each new monitoring season (twice a year).

Calibrating the LTC Levellogger directly after the monitoring project or season will provide information on the degree of conductivity deviation during the project or season. If necessary, readings can be corrected for any conductivity deviation in a spreadsheet program after the data has been exported.

The process of conductivity calibration is performed automatically by use of the Calibration Wizard. You place the LTC Levellogger in a specified calibration solution and follow the steps provided by the wizard. Conductivity calibration solutions are available from Solinst or any laboratory supply outlet.

The LTC Levellogger Edge has an 100,000  $\mu\text{S}/\text{cm}$  conductivity range and a calibrated range from 50 to 80,000  $\mu\text{S}/\text{cm}$ . It can be calibrated to 4 calibration standard points:

- 1,413  $\mu\text{S}/\text{cm}$
- 5,000  $\mu\text{S}/\text{cm}$
- 12,880  $\mu\text{S}/\text{cm}$
- 80,000  $\mu\text{S}/\text{cm}$

The LTC Levellogger Junior has an 80,000  $\mu\text{S}/\text{cm}$  conductivity range and a calibrated range from 500 to 50,000  $\mu\text{S}/\text{cm}$ . It can be calibrated to 3 calibration standard points:

- 1,413  $\mu\text{S}/\text{cm}$
- 5,000  $\mu\text{S}/\text{cm}$
- 12,880  $\mu\text{S}/\text{cm}$

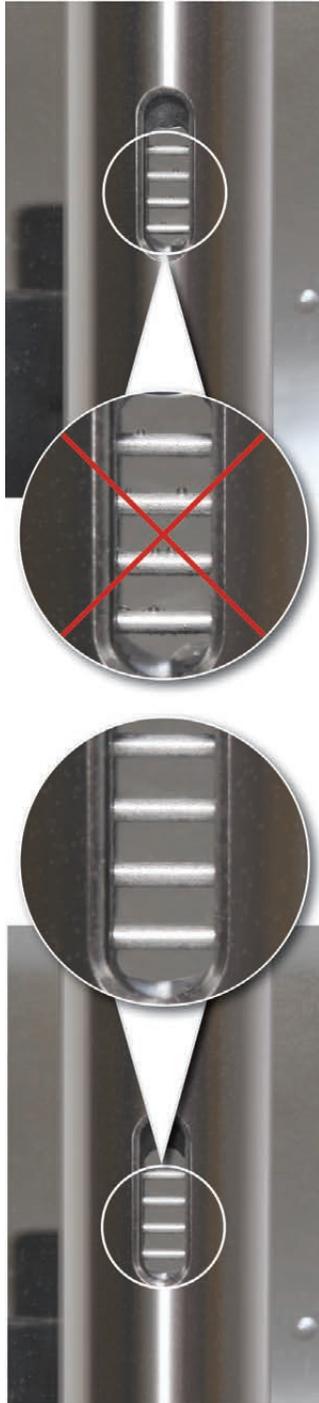
If you know the approximate conductivity range of the water that you will be measuring, best accuracy when calibrating your unit is to select two calibration points - one above, and one below that range. If you are measuring in water less than 1,413  $\mu\text{S}/\text{cm}$  or above 12,880  $\mu\text{S}/\text{cm}$  or 80,000  $\mu\text{S}/\text{cm}$ , use just one calibration solution.

The solution(s) must be between 10°C and 30°C during actual calibration. Temperature should remain stable during the 10 - 20 seconds it takes to perform each calibration.

For best accuracy, it is recommended you use calibration solutions that have a temperature error of  $\pm 2\%$  or better. You should also keep the solution as close to the stated temperature on the bottle as possible (i.e. 25°C). The closer you get to the temperature extremes of 10°C and 30°C, the less accurate your calibrations may be.

## NOTE

Ensure that the calibration solution covers the entire sensor cell and the logger is agitated to release entrapped air bubbles.

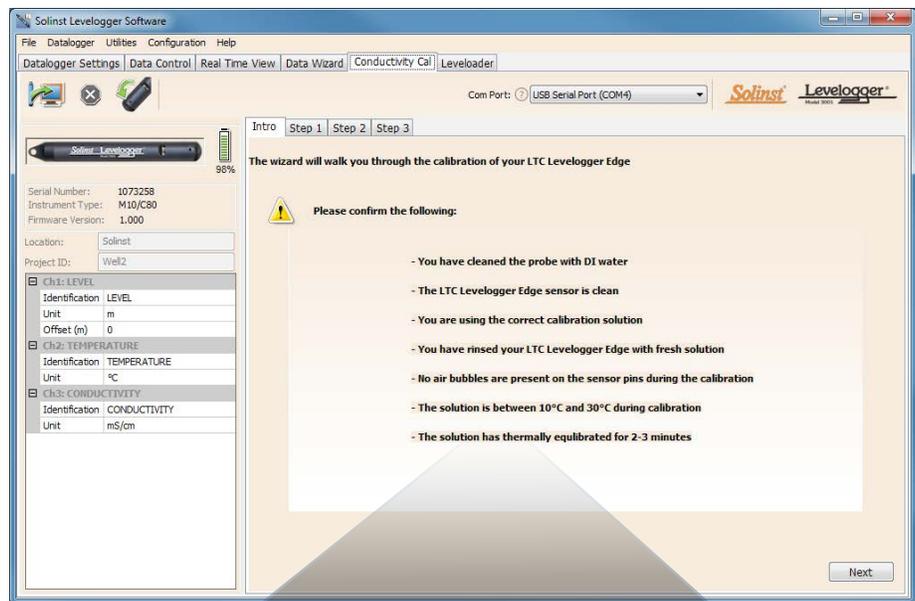


Retrieve the settings from the attached LTC Levelogger by clicking

Stop the LTC Levelogger by clicking

Start the Calibration Wizard by clicking the Conductivity Cal tab. The wizard will guide you through the calibration process. You can exit the wizard after any step to cancel the calibration session.

**Introduction:** The LTC Levelogger must be connected to the computer with an Optical Reader during the entire calibration process and **must be in the stopped mode**. Ensure you use fresh calibration solution and allow thermal equilibration of the solution during the process. Also ensure no air bubbles are present on the sensor and that the pins are clean. See Section 10.2 for recommended methods to clean the sensor pins. See Section 10.1.5.3 for protection against biofouling conditions.



- You have cleaned the probe with DI water
- The LTC Levelogger Edge sensor is clean
- You are using the correct calibration solution
- You have rinsed your LTC Levelogger Edge with fresh solution
- No air bubbles are present on the sensor pins during the calibration
- The solution is between 10°C and 30°C during calibration
- The solution has thermally equilibrated for 2-3 minutes

Figure 6-2 LTC Levelogger Calibration Wizard Introduction

- 1) **Setting the Temperature Coefficient:** The default setting for the Temperature Coefficient is 2.00. If the conductivity solution you are using to calibrate the LTC Levelogger states a different temperature coefficient on the label, please input that number into the Temperature Coefficient field.

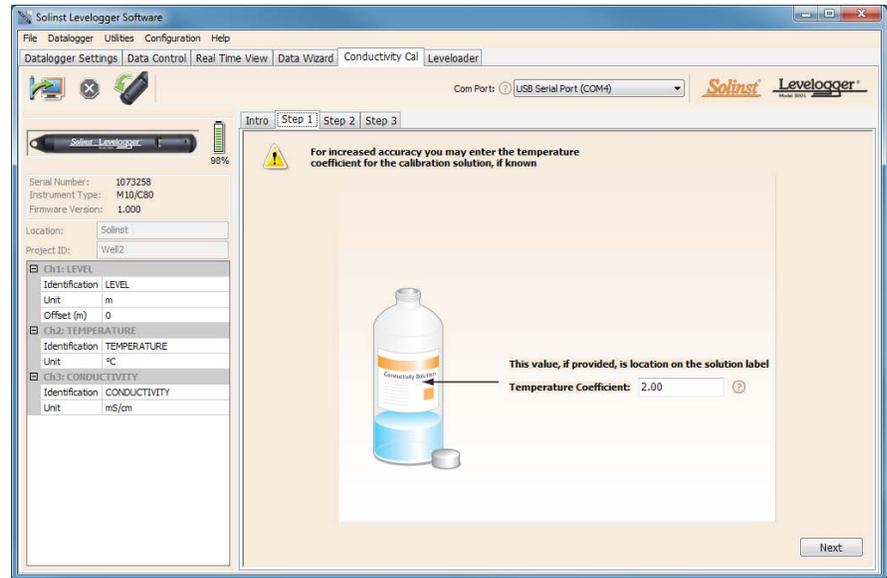


Figure 6-3 LTC Levelogger Calibration Wizard Step 1

- 2) **Setup:** The Levelogger Software requires the user to choose the calibration solutions. You can choose up to four (three for the LTC Levelogger Junior) solutions for a multipoint calibration of the LTC Levelogger. Ensure the solutions are ready in the calibration beaker or container. Start the calibration by selecting Next.

## NOTE

To obtain the highest accuracy, choose the calibration solution(s) closest to your expected conductivity.

Use a two point calibration for waters between 1,413  $\mu\text{S}/\text{cm}$  and 12,880  $\mu\text{S}/\text{cm}$ .

Use a one point 1,413  $\mu\text{S}/\text{cm}$  calibration for waters less than 1,413  $\mu\text{S}/\text{cm}$ .

Use a one point 12,880  $\mu\text{S}/\text{cm}$  / 80,000  $\mu\text{S}/\text{cm}$  calibration for waters greater than 12,880  $\mu\text{S}/\text{cm}$  / 80,000  $\mu\text{S}/\text{cm}$ .

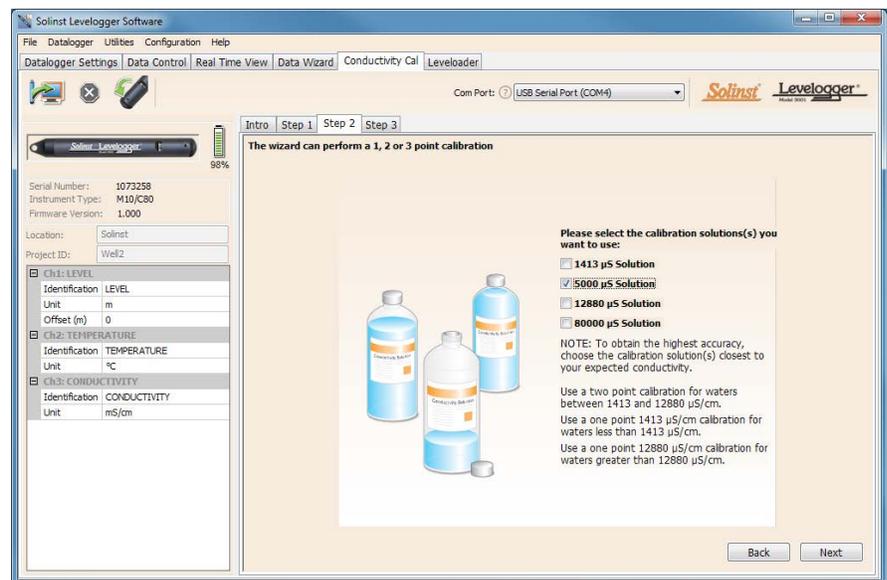


Figure 6-4 LTC Levelogger Calibration Wizard Step 2

- 3) **LTC Levelogger Rinsing Process:** Use DI water to rinse the LTC Levelogger first and then rinse the LTC Levelogger with the displayed calibration solution. Use fresh solution for calibration, and immerse the LTC Levelogger. Lightly tap the Levelogger to remove any bubbles from the sensor. Allow 2-3 minutes to stabilize, then select next to calibrate.

### NOTE

Always remember to use fresh solution, remove all bubbles from the sensor pins, and allow for thermal equilibration of the sensor before proceeding.

### NOTE

Once the calibration is complete for the first solution of a multipoint calibration, the Calibration Wizard will then go back to the beginning of Step 3 to start the rinsing process for the next solution selected.

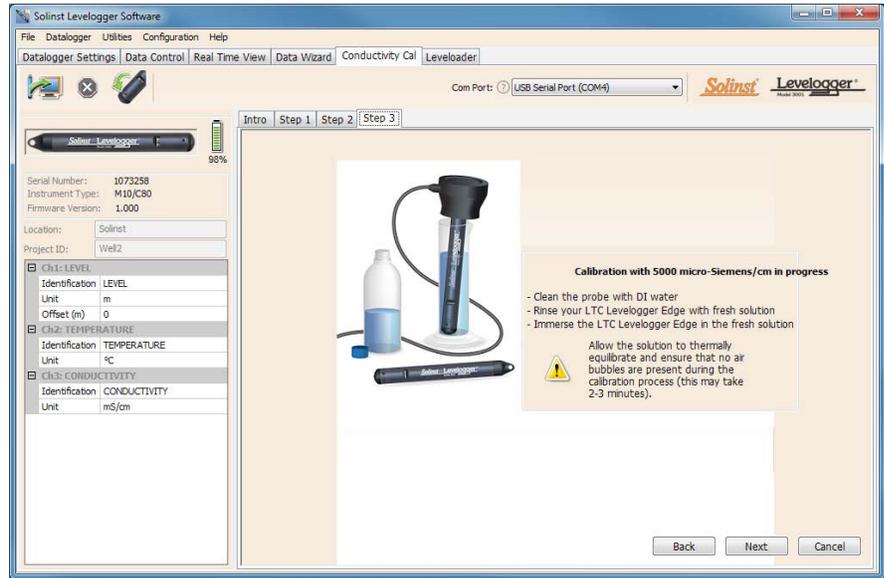


Figure 6-5 LTC Levelogger Calibration Wizard Step 3 (example of window calibrating with 5,000  $\mu\text{S}/\text{cm}$  solution)

**Calibration:** Since most standard calibration solutions state conductivity at a standard temperature of 25°C, the LTC Levelogger an account for temperature differences between 10 to 30°C when you calibrate the unit. The LTC Levelogger will compare the current temperature and conductivity readings against the temperature corrected standard solution.

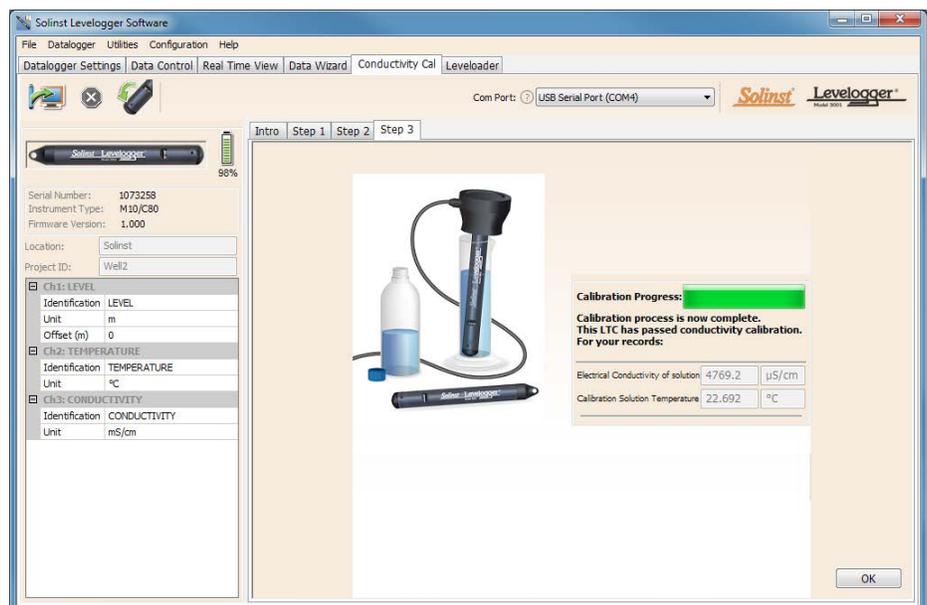


Figure 6-6 LTC Levelogger Calibration Successful

When a single-point calibration is successful, the process is complete. Once the calibration is complete for the first solution of a multipoint calibration, a message will appear stating that the calibration was successful. When you select 'Okay', the Calibration Wizard will go back to the beginning of Step 3 to start the rinsing process for the next solution selected. The calibration process will proceed automatically until completed for all solutions.

If a failure occurs at any point during calibration, a message will appear asking you to clean and check your probe, then start the calibration process over for that current solution by selecting 'Yes' (Figure 6-7). If performing a multipoint calibration, any previous successful calibration points will remain.

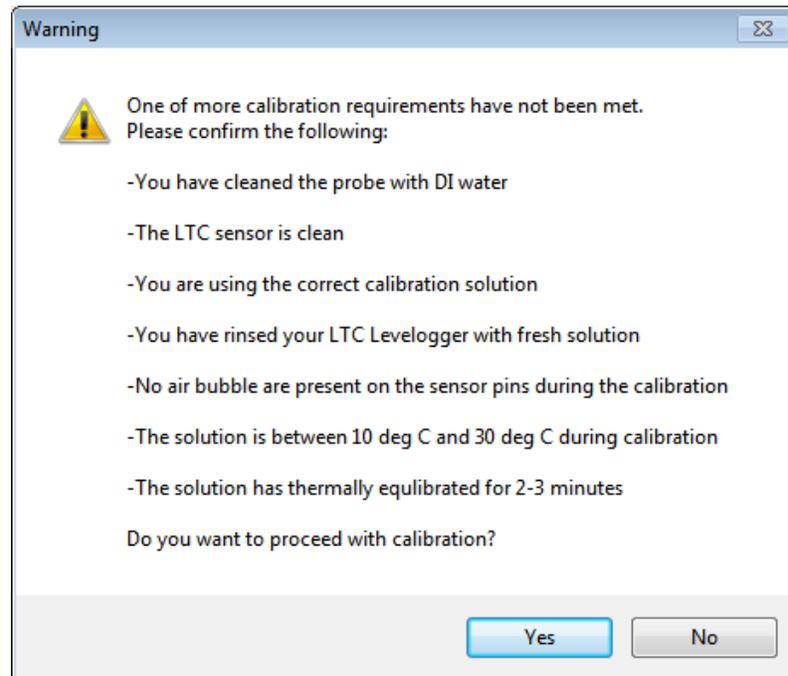


Figure 6-7 LTC Levellogger Calibration Warning 1

If a second failure occurs during calibration, a warning message will appear indicating that your probe may still be dirty, or damaged. This may occur if your LTC Levellogger conductivity sensor has been affected by dirt, mineral build-up, etc., so it no longer responds like it did when it was first factory calibrated. This step allows your sensor to be calibrated within a wider range of the standard solution value.

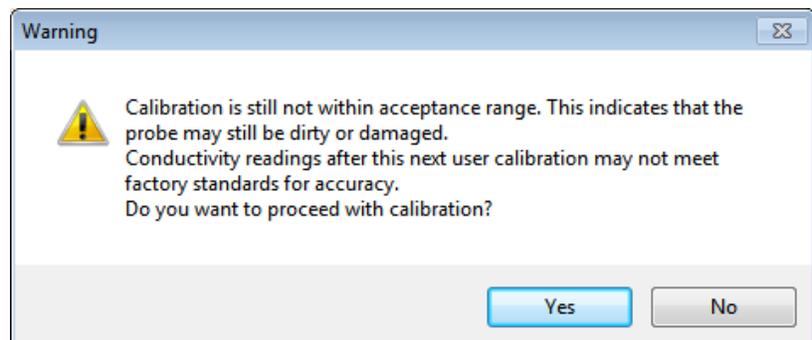


Figure 6-8 LTC Levellogger Calibration Warning 2

If you select 'Yes' to accept the larger tolerance, the calibration process will start over for that current solution (Figure 6-8). If performing a multipoint calibration, any previous successful calibration points will still remain. If you select 'No', the LTC Levellogger will default back to the last pre-calibrated state. You can retry the calibration using the normal tolerance range.

If a third calibration error occurs, or the results of the calibration are outside the error tolerance range, a warning message will appear asking you to contact Solinst for more options (Figure 6-9).

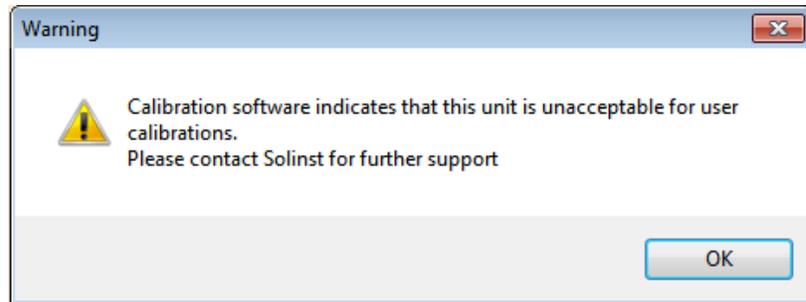


Figure 6-9 LTC Levellogger Calibration Warning 3

### 6.1 Restore Factory LTC Levellogger Calibration

An LTC Levellogger can be set back to original factory calibration settings for conductivity at any time, using this function. If you suspect that user calibrations are not working properly, you can restore the LTC Levellogger to its original factory settings and then perform a "first-time" conductivity user calibration to maximize accuracy.

To execute this function, simply click the Restore Factory LTC Calibration button,



with the LTC Levellogger connected to the PC.

## 7 Data Control (Downloading and Viewing Data)

Click the Data Control tab on the Main window. From the Data Control tab you can download data from a Levellogger, display data in tabular or graphic format, and save and export data files.

### NOTE

When you click on a data point in the graph, the corresponding data point will be highlighted in the table. You can also highlight a section of data in the graph.

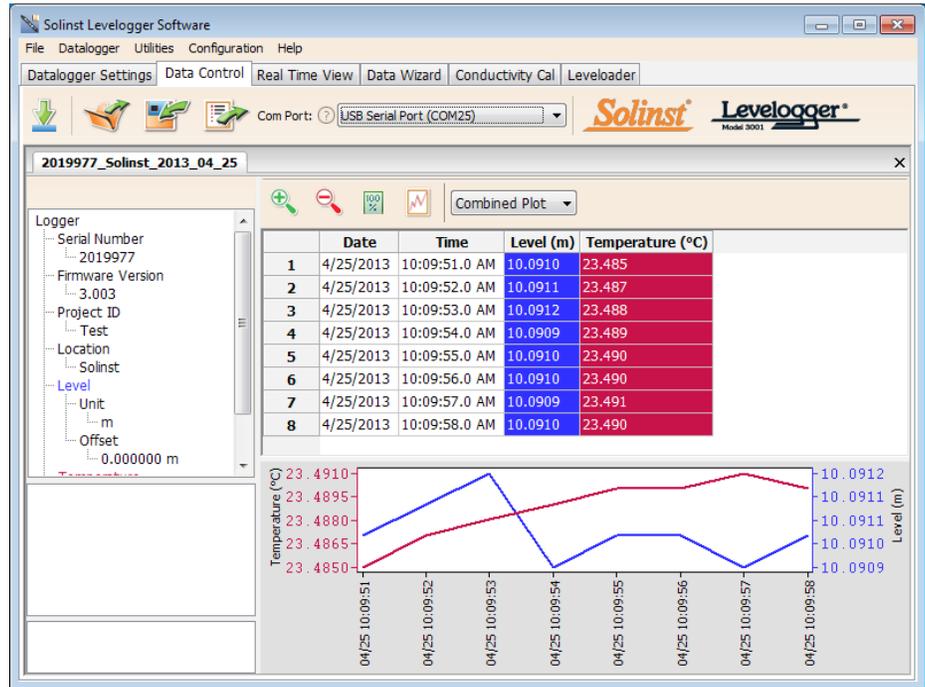


Figure 7-1 Data Control Tab

Click to open a \*.xle or \*.lev file. Multiple files can be opened at the same time and are available for viewing by clicking the File Name Tab on top of the data table.

All the Levellogger settings and the channel information effective during data collection are shown on the top left of the window.

The bottom left sections of the window are used to display information after a data compensation has been performed. The middle section displays information from a Barologger, if a barometric compensation is performed, and the bottom section includes information from other conversions, such as offsets or conductivity conversions (see Section 8).

## NOTE

As there is only one channel of data for Rainloggers, there are no graphing options.

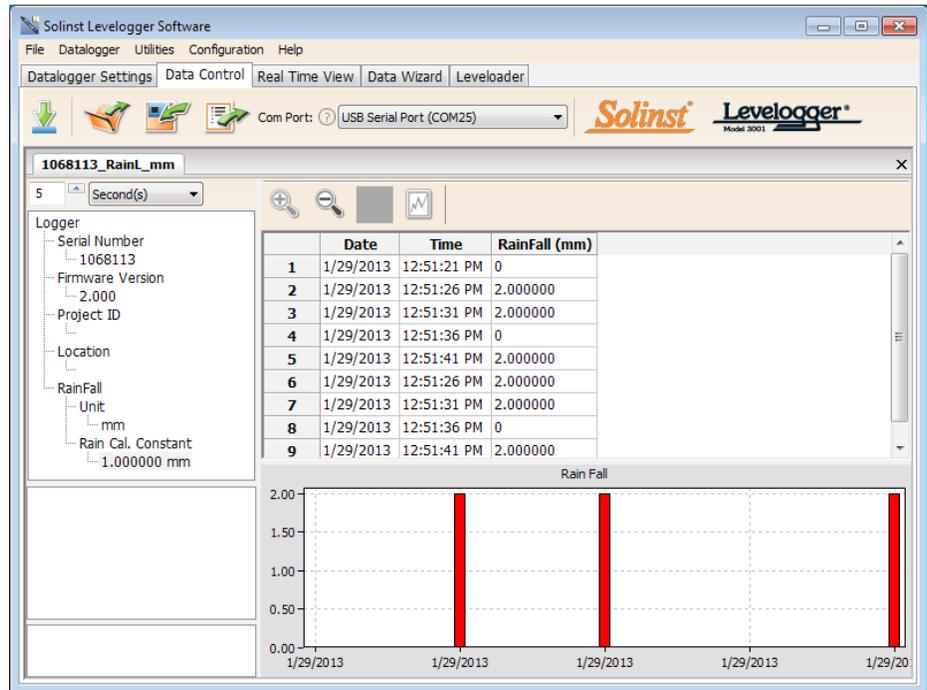


Figure 7-2 Rainlogger Data

When you view data downloaded from a Rainlogger, the RainFall data will be shown in a table and in a bar graph. A drop-down menu appears that allows you to select the time interval at which you would like the data shown, from 1 to 99 seconds, minutes, hours, days, or weeks (this acts like a zoom function). Figure 7-2 shows the data every 5 seconds from the start date and time.

## 7.1 Downloading Options and Saving Data Files

### 7.1.1 Default File Format

## NOTE

The default file type is \*.xle, unless changed in the Application Settings (see Section 4.2.4).

The default file type for Levelogger Software Version 4 and up is \*.xle, unless changed to \*.lev in the Application Settings (see Section 4.2.4). Previous Levelogger Software used \*.lev files as the default. The \*.xle file type is a \*.xml format, which allows for enhanced functionality. The \*.xle files can be exported as \*.xml files, which can be integrated into external database programs.

The \*.lev files of previous Levelogger downloads are compatible with Levelogger Software Version 4 and up, however, \*.xle files are not compatible with previous software versions. To ensure compatibility, all Levelogger Software versions allow data to be exported as \*.csv files for use in external spreadsheet programs. See Section 7.3 for Export options.

## NOTE

Before downloading data you must select the COM Port that the datalogger is connected to and retrieve the settings from the attached datalogger by clicking  in Datalogger Settings tab.

### 7.1.2 Downloading Data

Click  from the Data Control tab to download data from a connected datalogger. There are four options for downloading data. They are: **All Data**, **Append Download**, **Partial Download** and **Recover Previous Log**.

If you select **All Data**, the program will download all the data from the current logging session of a datalogger into a \*.xle file.

The default directory for saved data is in the 'Data' folder:  
<C:\Program\Files\Solinst\Levelogger4\_3\Data>.

If you select **Append Download**, the program will append the data in an opened \*.xle file from the datalogger. The opened \*.xle file and the attached datalogger should have the same serial number and start time, otherwise an error will occur.

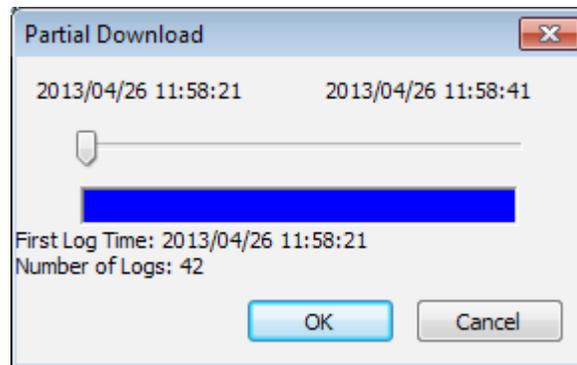


Figure 7-3 Partial Download Window

If you select **Partial Download**, a Partial Download Selection Window will open. The window shows the time stamp of the first and last reading in the logging session. Use the slider to select the time interval you would like data from. Once you click OK, all the data within that time will be downloaded to a \*.xle file.

If you select **Recover Previous Log**, the software will try to recover the data from the previous log session and download the data to a \*.xle file.

Once the data is downloaded from a Levelogger, it is automatically saved in a temporary file.

### 7.1.3 Saving Data

Click to save the data in a specific \*.xle file.

The default directory for saved data is in the 'Data' folder:  
<C:\Program\Files\Solinst\Levellogger4\_3\Data>.

However, the default directory for saved files can be changed by clicking the Configuration menu at the top of the program window, selecting 'Application Settings' and inputting or navigating to a different folder destination. If an error is experienced in saving your first data file such as depicted in Figure 7-4, you may not have file writing privileges to the default directory. In this case, create and set as the default file save folder, a new Levellogger data folder within the My Documents folder and attempt the file save procedure again.

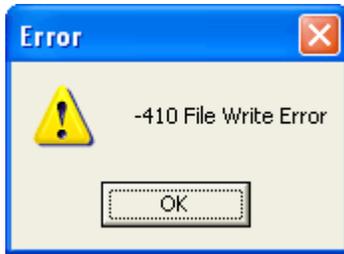


Figure 7-4 File Write Error Message

#### NOTE

As there is only one channel of data for Rainloggers, there are no graphing options.

#### NOTE

Right click, and drag the mouse to scan the data graph.

## 7.2 Graph Manipulation and Zoom Function

To perform the Zoom In function on the graph, click .

To perform a Zoom Out function on the graph click . Click to undo all the zoom functions.

The Zoom functions can also be used for data selections in the graph.

Click to open the Graph Option Dialog. The Graph Dialog is shown in Figure 7-5.

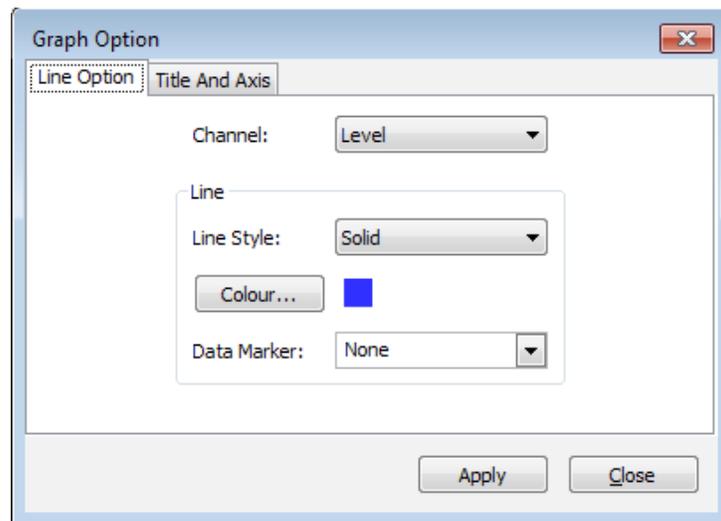


Figure 7-5 Line Option Window

The Line Option is used to adjust the style and colour of the line in the graph for each channel. The user can also select the shape of the data marker or remove the data marker.

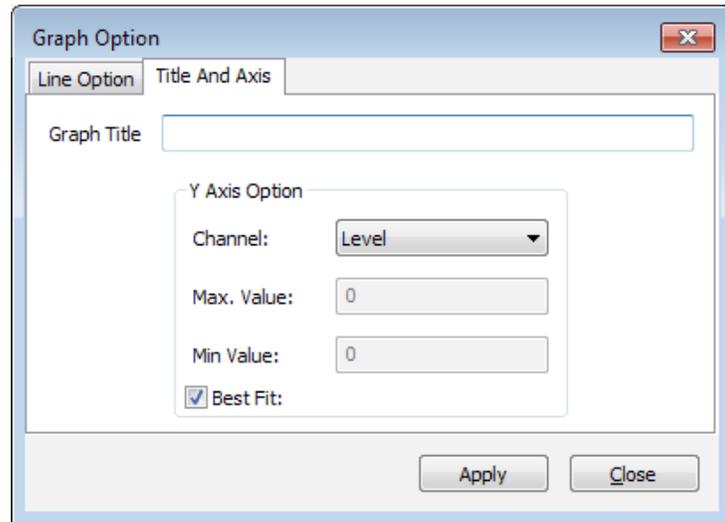


Figure 7-6 Title and Axis Option Window

The Title and Axis Option is used to enter the title of the graph and change the Y axis label or user selected scale. Check the Best Fit box to enable the software to determine the best fit scale. If the Best Fit box is not checked, the user has to enter a maximum and minimum value of the selected channel. The X axis is logging time.

There is the option to show Combined Plot graphs or Separated Plot graphs of the data. Choosing a Combined Plot will show the data from each of the channels in one graph. The Separated Plot option will show a separate graph for each data channel.

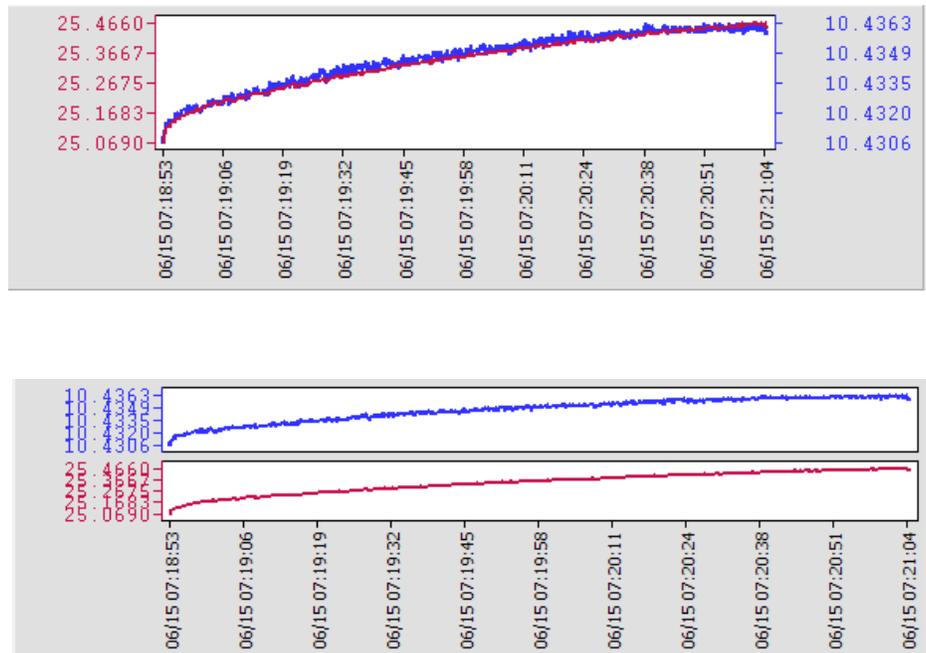


Figure 7-7 Combined and Separated Plot Graphs

There is also the option to view more than one graph at a time. Click and drag a File Name Tab and drop it when you see a shaded area on the window to open a separate graph of that data file. You can view any number of graphs at one time by re-sizing your window as required.

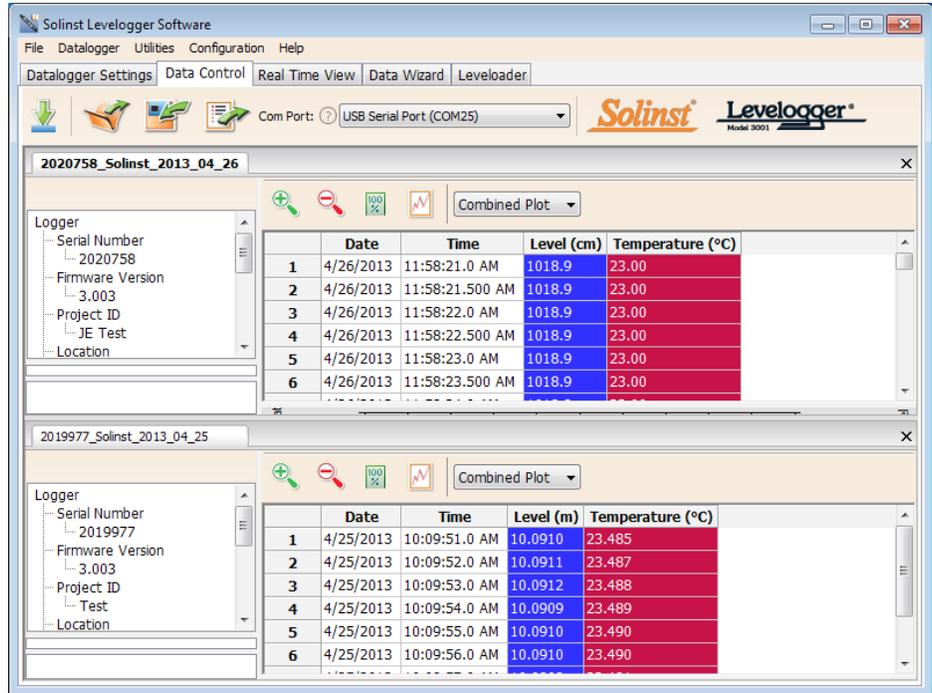


Figure 7-8 Viewing Two Graphs

### 7.3 File Export and Print Function

Data can be exported in \*.csv (comma separated value) file format or \*.xml (extensible markup language) file format by clicking File > Export > Data or 

The \*.csv and \*.xml file formats are supported and can be imported by most spreadsheet and database programs.

Also, the data graph can be exported to a \*.bmp file or a \*.png file by clicking File > Export > Graph.

The Datalogger Settings, data table and data graph can be printed. Click File > Print Preview, to open the Print Preview window. Figure 7-9 shows the print preview of the Datalogger Settings. The Datalogger Settings are always on the first page of the document. The data graph is on the second page of the document and the rest of the document is the data table.

Click Print..., to open the print dialog. You can choose to print the entire document or just a selection. You can also click File > Print, to open the print dialog.

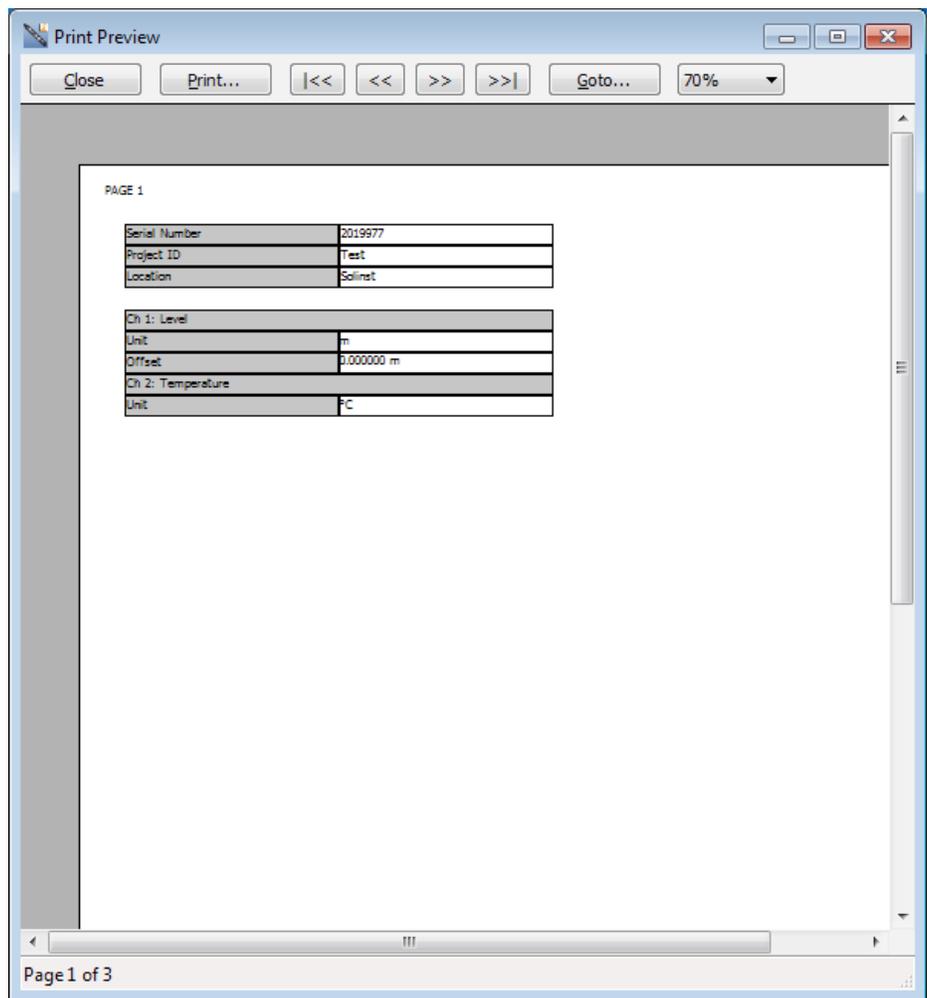


Figure 7-9 Print Preview Window

## 8 Data Compensation

Data Compensations, such as Barometric Compensation, Manual Data Adjustments and Parameter Adjustments can be performed automatically using the Levelogger Software Data Wizard, or manually, by exporting data to an external spreadsheet program.

### 8.1 Data Wizard

Open the Data Wizard tab. The first step is to select your Data Compensation Path. The choices for Leveloggers are **Basic** or **Advanced**.

Choosing **Basic** allows you to do a simple Barometric Compensation of Levelogger data only.

The **Advanced** option allows you to perform Barometric Compensation, Manual Data Adjustments and Parameter Adjustments, including adjustments to Rainlogger data.

#### NOTE

Multiple datalogger files can be compensated at once.

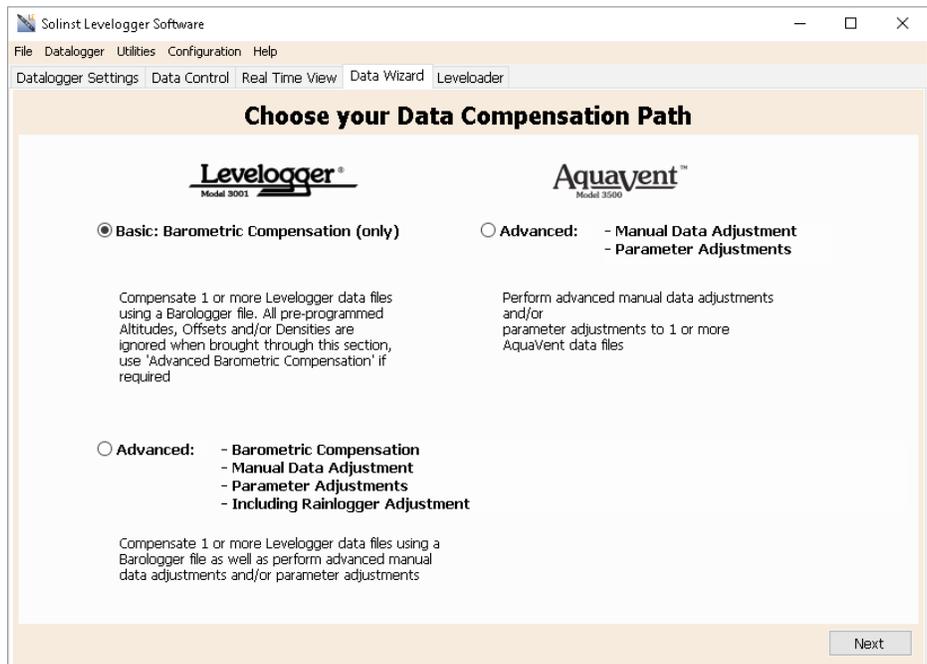


Figure 8-1 Data Wizard

## ! NOTE

Advanced compensation provides the option of performing one, two, or all three data compensation types, in any combination.

## ! NOTE

Manual Data Adjustment, and Parameter Adjustments are useful for correcting Levellogger data files to make data consistent across a project.

## ! NOTE

Parameter Adjustments is the only option for compensating Rainlogger data.

## ! NOTE

If you set your Levellogger to record in pressure units (kPa, bar, psi), you can not change the offset or enter an elevation value (in the Data Wizard). Only raw pressure readings will be provided.

## ! NOTE

Additional Adjustments appear when ">>" is selected. These are application specific, for advanced users.

**Barometric Compensation** simply subtracts the barometric reading from the corresponding Levellogger reading(s), to give true water level measurements.

**Manual Data Adjustment** allows you to enter a manual water level measurement or reference point as a field zero, which all Levellogger water level readings can then be adjusted to. There is the option to convert readings to Depth to Water Level measurements (e.g. from the top of a well casing to water level), or Elevation of Water Level measurements (e.g. above sea level).

**Parameter Adjustments** allow you to change Levellogger, Barologger or Rainlogger data to different units of measurements, add an offset, correct data for elevation differences, convert conductivity to Salinity or Specific Conductance, adjust density, or adjust barometric efficiency. Only the options available for your opened datalogger file types will be active (e.g. Conductivity Conversion is only available for LTC Levellogger Edge and LTC Levellogger Junior data files).

### Standard Adjustments:

- **Unit** conversion allows you to convert level readings in a Levellogger file to different units (m, cm, ft, kPa, bar or psi), a Barologger file to kPa, mbar, or psi, temperature readings to °C or °F, conductivity readings to µS/cm or mS/cm, or rainfall values to mm or inches.
- **Offset** allows you to enter any value, positive or negative, which will be added to each reading in the selected Levellogger file to be offset by that amount. It is recommended to stay with the default zero value, unless a known offset has been determined (e.g. to correct for pressure sensor drift. See Solinst Technical Bulletin: Understanding Pressure Sensor Drift).
- **Elevation** is used to correct for altitude differences between Levellogger or Barologger locations. Water column equivalent pressure decreases with altitude at a ratio of approximately 1.21/1000 in the lower atmosphere below 5000 m. You can compensate for this by entering an elevation between -1000 ft below sea level and 16,400 ft (or -300 m and 5000 m) above sea level.
- **Conductivity Conversion** allows you to convert raw Conductivity readings from an LTC Levellogger Edge or Junior, to Specific Conductivity (conductivity that is temperature compensated to the standard of 25°C). The Temperature Coefficient default for Specific Conductivity is 2.00. The Temperature Coefficient should not be adjusted, unless you know the value specific to the solution you are measuring. You can also convert Conductivity readings to Salinity expressed in Practical Salinity Units (PSU) (See Section 1.2.4).
- **Rainfall Cal. Constant** allows you to enter a different rainfall calibration constant for a Rainlogger Edge or Rainlogger data file (amount of rainfall per tip of the tipping-bucket rain gauge).

### Additional Adjustments:

- **Density Adjustment** corrects the range of the level channel in the Levellogger data file based on a user input adjustment of fluid density. The range of the density adjustment is from 0.9 kg/L to 1.1 kg/L.
- **Barometric Efficiency** adjustment is used to proportionally adjust Barologger data in relation to a particular Levellogger. Barometric efficiency is often expressed as a percentage or proportion. The input field is proportional and has a default value of 1.00. For more information about Barometric Efficiency, see Section 10.1.3.1. The barometric efficiency can be set from 0.01 to 3.00.

## NOTE

One Barologger can be used to compensate all Levelloggers in a 20 mile (30 km) radius and/or with every 1000 ft. (300 m) change in elevation.

### 8.1.1 Basic Compensation

When you choose **Basic** compensation, the next step is to select the Barologger file you want to use for compensation, then select the Levellogger file(s) you want to compensate. You can only select one Barologger file to compensate multiple Levellogger files.

**For best accuracy, the Levellogger file(s) and Barologger file should have the same start time and logging interval.** (The Future Start option in the Datalogger Settings tab is a convenient way to start all of your loggers at the same time.) If there is an inconsistency of the time stamp between the Barometric file and the Levellogger file(s), a linear approximation on the barometric data will be performed.

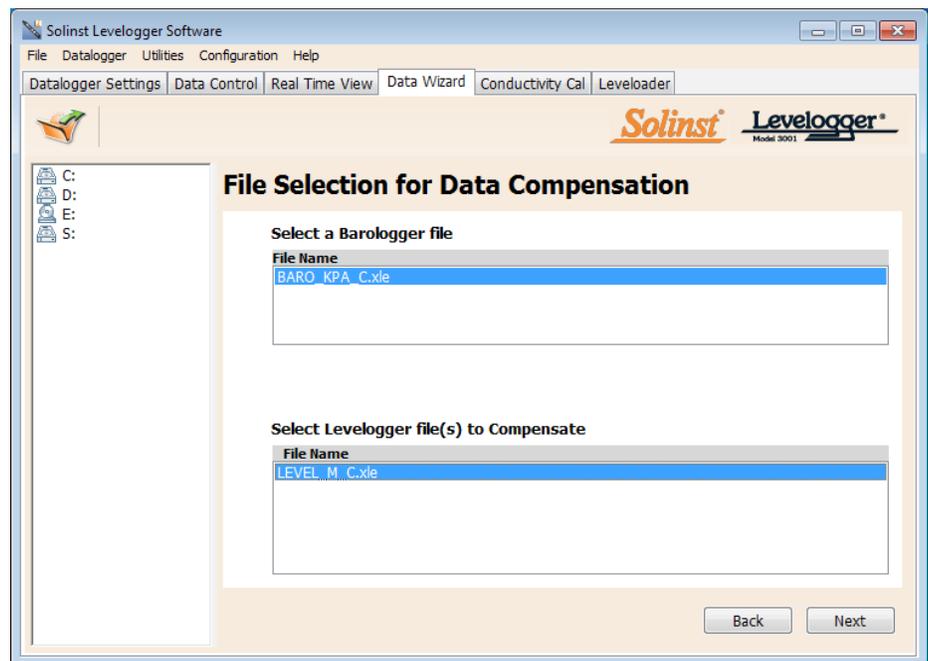


Figure 8-2 Selecting Files for Barometric Compensation

## NOTE

Both a Barologger file and a Levellogger file must be selected to complete a Barometric Compensation.

## NOTE

All data files are saved to the default location: <C:\Program Files\Solinst\Levellogger4\_3\Data>. However, the default directory for saved files can be changed by clicking the Configuration menu at the top of the program window, selecting 'Application Settings' and inputting or navigating to a different folder destination.

Any files you have open in the Data Control tab will be listed.

Use the directory on the left of the window or click to open any other Levellogger data files you would like to compensate. Ensure the files you want to compensate are highlighted in the list. **Both the Barologger file and Levellogger file(s) must be highlighted.** Do this by clicking the file name. To de-select a file, click it again. Multiple Levellogger files can be selected at once.

Select Next to complete the compensation.

The compensated data will automatically be saved in a new \*.xle file. The default file name will be the <original Levellogger file name> with the word <compensated> added to the file name prefix. Alternatively, the user can rename the compensated file by saving it in the Data Control tab. Do not change or delete the file extension. All data files are saved to the default location: <C:\Program Files\Solinst\Levellogger4\_3\Data>.

The next window will show the results of the compensation. If the compensation was unsuccessful, there will be an explanation in the Reason column (e.g. time stamp of Levellogger and Barologger files were not close enough to perform an accurate compensation). You can still view the compensated file in the Data Control tab by clicking 'Open' in the Action column. If the compensation is successful, select 'Open' to view the compensated file in the Data Control tab.

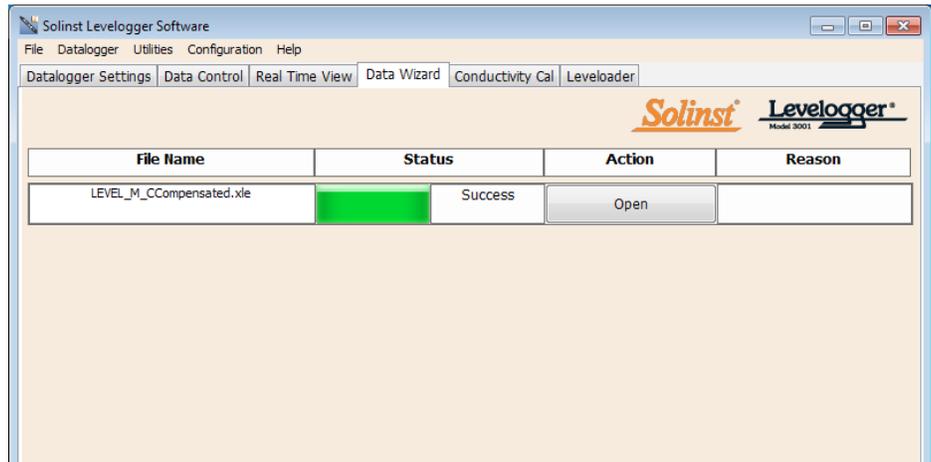


Figure 8-3 Barometric Compensation Results

From the Data Control tab, you can view the data, save the compensated file with a new filename and/or export the data (see Section 7).

All the original Levellogger settings and the channel information effective during data collection are shown on the top left of the window. The bottom left sections of the window are used to display the compensation information. The middle section displays information from the Barologger.

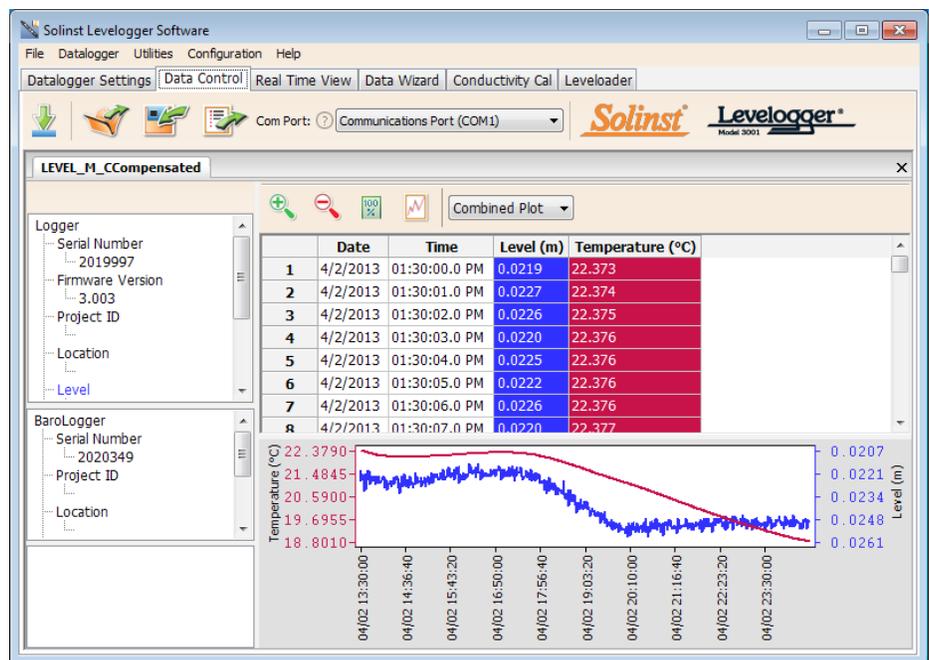


Figure 8-4 Viewing Compensated Files in the Data Control Tab

## 8.1.2 Advanced Compensation

When you select **Advanced** compensation, the Data Compensation Options window will open.

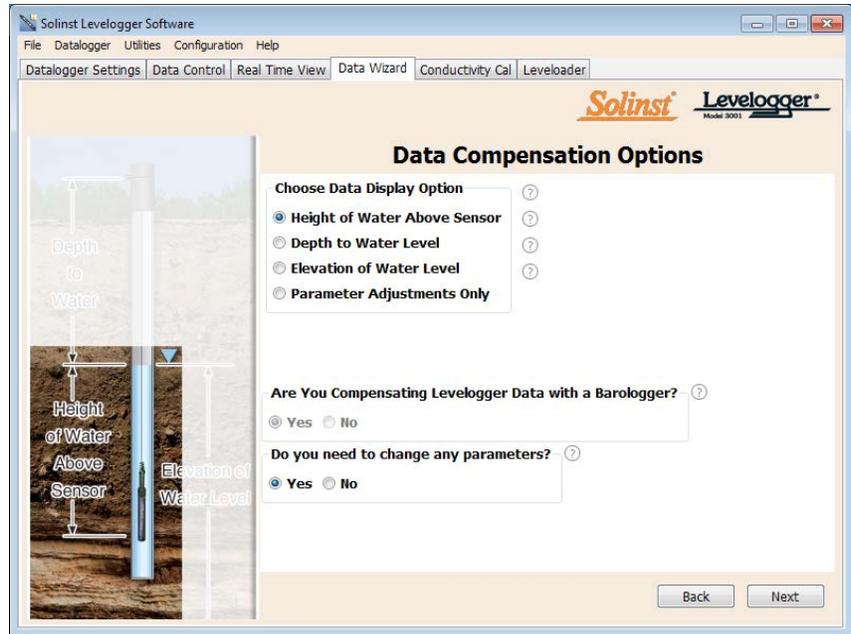


Figure 8-5 Advanced Data Compensation Options

First, you will select how you want your data displayed (Manual Data Adjustment):

- **Height of Water Above Sensor** is the default display option. Select this option to perform a Barometric Compensation and/or Parameter Adjustments to one or more data files, while keeping the sensor diaphragm (zero point) as the reference point.
- **Depth to Water Level** adjusts water level data to represent depth to water level readings (from the top of a well casing or other reference point) by entering a field zero, such as a manual depth to water level measurement. Adjustments can be made to one or more data files.
- **Elevation of Water Level** adjusts water level data to represent elevation of water level readings (above sea level or other reference point) by entering a measuring point elevation, and a field zero, such as a staff gauge measurement from that point. Adjustments can be made to one or more data files.
- **Parameter Adjustments Only** allows you to adjust one or more data files to different units, elevation, etc., while keeping the sensor diaphragm (zero point) as the reference point for Levelloggers. It also allows you to change Rainlogger data file parameters.

### NOTE

Parameter Adjustments Only, is the only option for compensating Rainlogger data.

Next, you will select Yes or No to **Barometrically Compensating** the data (will not be active if you selected Parameter Adjustments Only).

Next, you will select Yes or No to performing any **Parameter Adjustments** on the data files (will not be active if you selected Parameter Adjustments Only).

Click Next, after you have selected all of your Data Compensation options.

## NOTE

See Section 8.1.1 for more information on selecting files for Barometric compensation.

In the next window, you will choose the Levellogger file(s), Rainlogger file(s), and Barologger file(s) you would like to use in the compensation. Any files you have open in the Data Control tab will be listed.

Use the directory on the left of the window or click to open any other data files you would like to compensate. Ensure the files you want to compensate are highlighted in the list. **If doing a Barometric Compensation, ensure the Barologger file is highlighted.** Do this by clicking the file name. To de-select a file, click again. Select Next to continue.

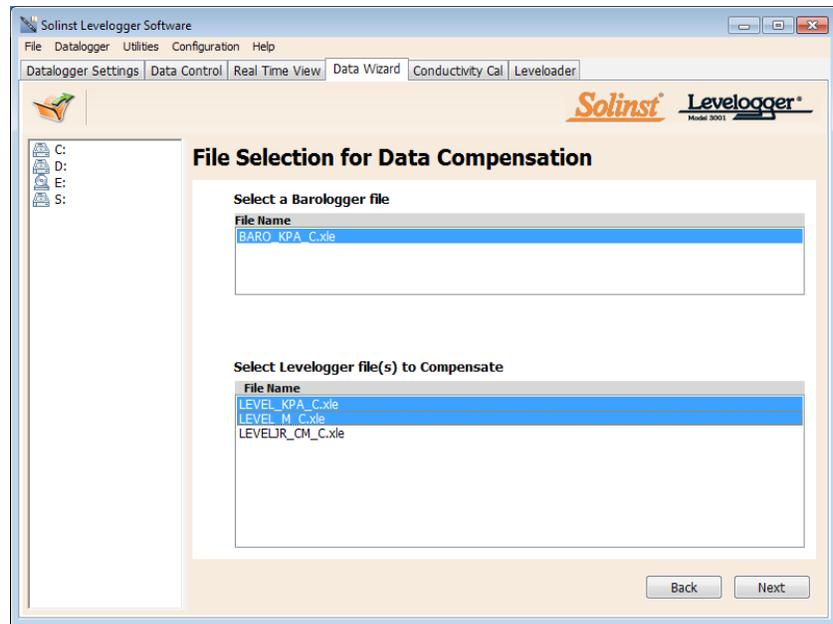


Figure 8-6 Selecting Files for Compensation

## NOTE

When adjusting Units for Levellogger files or Rainlogger files, If you select apply to all, the same unit change will be applied to all of the files being compensated at that time.

If you have selected yes to **Parameter Adjustments**, or selected the **Parameter Adjustments Only** option, in the next window you will enter these. You can expand the window by clicking “>>” to show additional adjustment options. If you did not select to change any parameters, this window will not be shown.

## NOTE

To show Additional Parameters that can be adjusted, click on the “>>” icon.

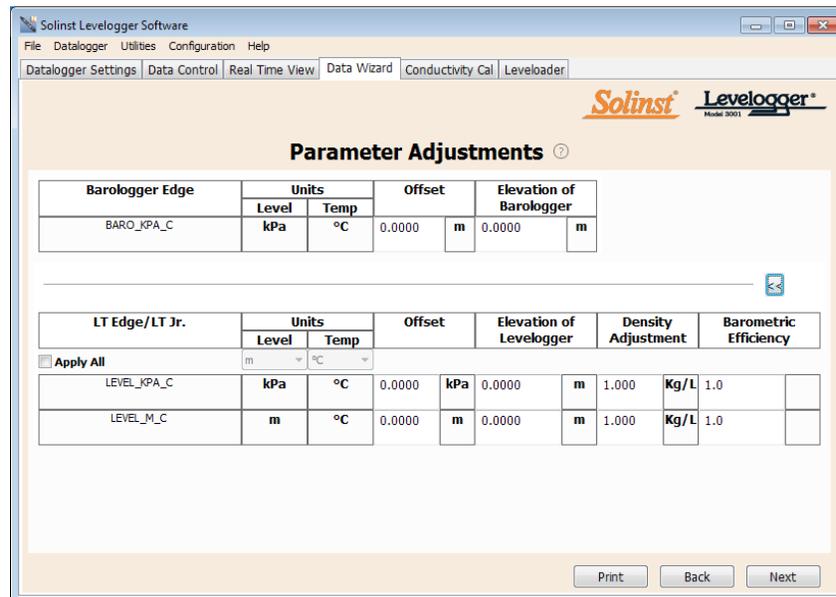


Figure 8-7 Parameter Adjustments

## NOTE

The date and time of measurement of the Field Zero must be recorded to complete the adjustment. The Field Zero must replace an actual reading the Levelogger file. I.e. take a manual measurement immediately after starting the Levelogger, and note that time.

Next, for each selected Levelogger file, you will enter the Field Zero(s) you would like to use to manually adjust your Levelogger data. (If you have selected **Height of Water Above the Sensor or Parameter Adjustments Only**, this window will not be shown.)

For **Depth to Water Level** adjustments, enter a **Field Zero (A)**. If the static water level is below your Field Zero measurement, the Field Zero is input as a positive value (e.g. a manual water level meter measurement taken from the top of a well casing. See Example 8.1). If the static water level is above your Field Zero, the Field Zero is input as a negative value (such as in an artesian condition).

The Time the Field Zero measurement was taken must replace an actual reading in the Levelogger file. This is selected from the drop-down menu showing all time stamps in the Levelogger file. Click 'Add' to apply the adjustment. If you need to change a Field Zero, click 'Update' after any edits.

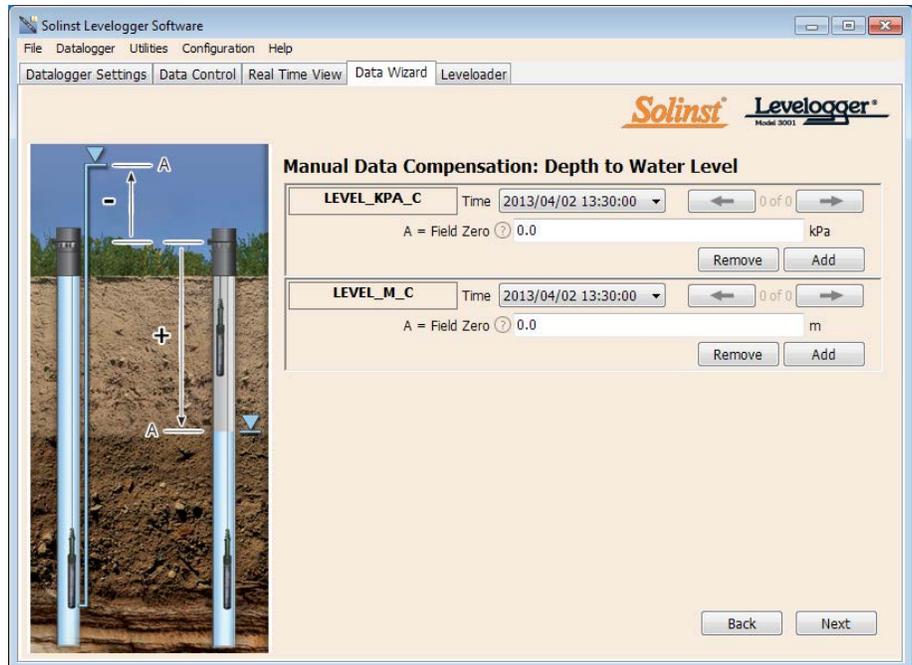
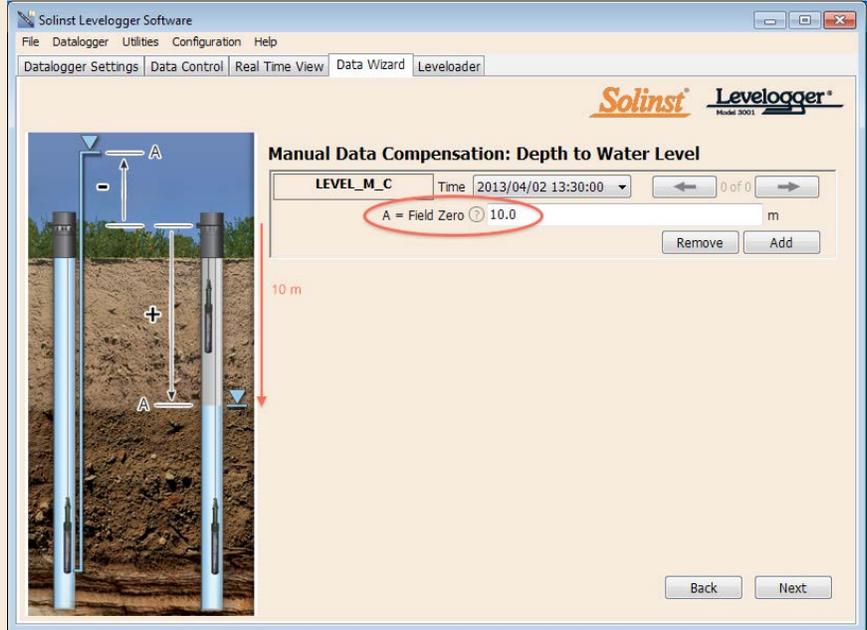


Figure 8-8 Manual Data Adjustment - Depth to Water Level



### Example 8.1 Depth to Water Level Adjustment

When using a manual depth to water measurement taken from the top of a well casing as a Field Zero, enter it as a positive value (e.g. 10 m).

In your adjusted data file, your readings will increase in value as the water level decreases. This is because the depth to static water level from the top of the well casing is increasing. The adjusted readings will decrease in value as the static water level rises.

Original Levelogger Data (barometrically compensated height of water above sensor)	8.75 m	8.50 m	8.75 m	9.0 m	9.25 m
Adjusted Levelogger Data (depth to water)	(A) 10.0 m	10.25 m	10.0 m	9.75 m	9.50 m

For **Elevation of Water Level** adjustments, enter a **Measuring Point Elevation (A)** and a **Field Zero (B)** from that Measuring Point.

If the static water level is below your Measuring Point, the Field Zero is input as a positive value (e.g. if you are using a manual depth to water measurement as a Field Zero, from the top of a well casing as the Measuring Point).

If the static water level is above your Measuring Point, the Field Zero is input as a negative value (such as an artesian condition). The Measuring Point elevation may also be entered as a negative value.

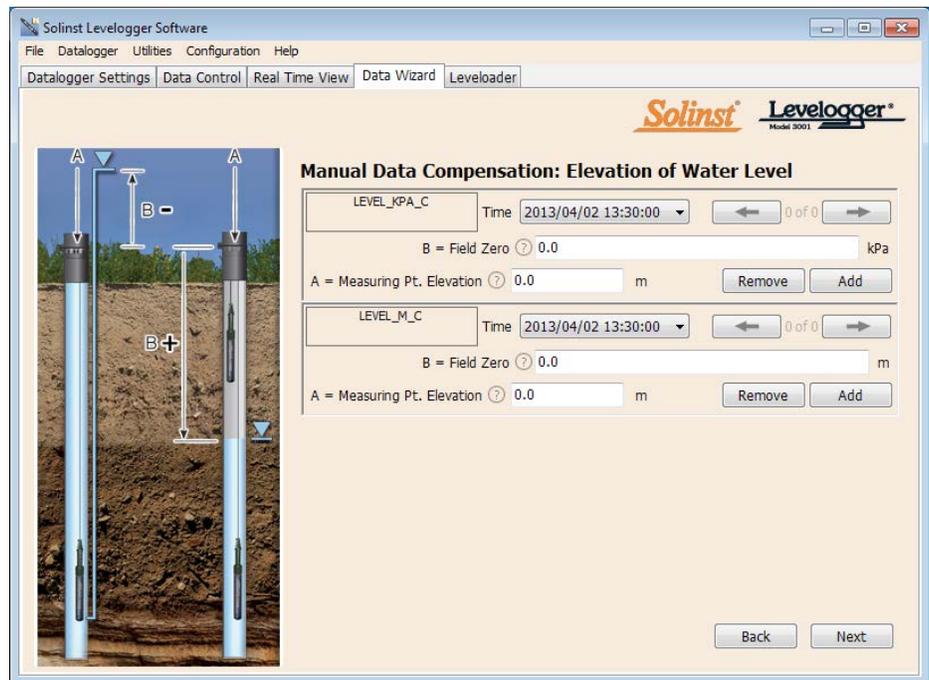


Figure 8-9 Manual Data Adjustment - Elevation of Water Level

## NOTE

The date and time of measurement of the Field Zero must be recorded to complete the adjustment. The Field Zero must replace an actual reading the Levelogger file. I.e. take a manual measurement immediately after starting the Levelogger, and note that time.

The Time the Field Zero measurement was taken, must replace an actual reading in the Levelogger file, and is selected from the drop-down menu showing all time stamps in the Levelogger file. Click 'Add' to apply the adjustment. If you need to change a Field Zero, click 'Update' after any edits.

You can make multiple adjustments to one data file by selecting 'Add' again to enter another Field Zero. All readings after this Time, will be adjusted to this second measurement. You can add as many adjustments to one Levelogger data file as you would like (as long as it doesn't exceed the total number of readings in that file).

Select Next to complete the compensation.

## NOTE

All data files are saved to the default location: <C:\Program Files\Solinst\Levellogger4\_3\Data>. However, the default directory for saved files can be changed by clicking the Configuration menu at the top of the program window, selecting 'Application Settings' and inputting or navigating to a different folder destination.

The compensated data will automatically be saved in a new \*.xle file. The default file name will be the <original Levellogger file name> with the word <compensated> added to the file name prefix. Alternatively, the user can rename the compensated file by saving it in the Data Control tab. Do not change or delete the file extension. All data files are saved to the default location: <C:\Program Files\Solinst\Levellogger4\_3\Data>.

The next window will show the results of the compensation. If the compensation was unsuccessful, there will be an explanation in the Reason column (e.g. time stamp of Levellogger and Barologger files were not close enough to perform an accurate compensation). You can still view the compensated file in the Data Control tab, by clicking 'Open' in the Action column. If the compensation is successful, select 'Open', to view the compensated data file in the Data Control tab.

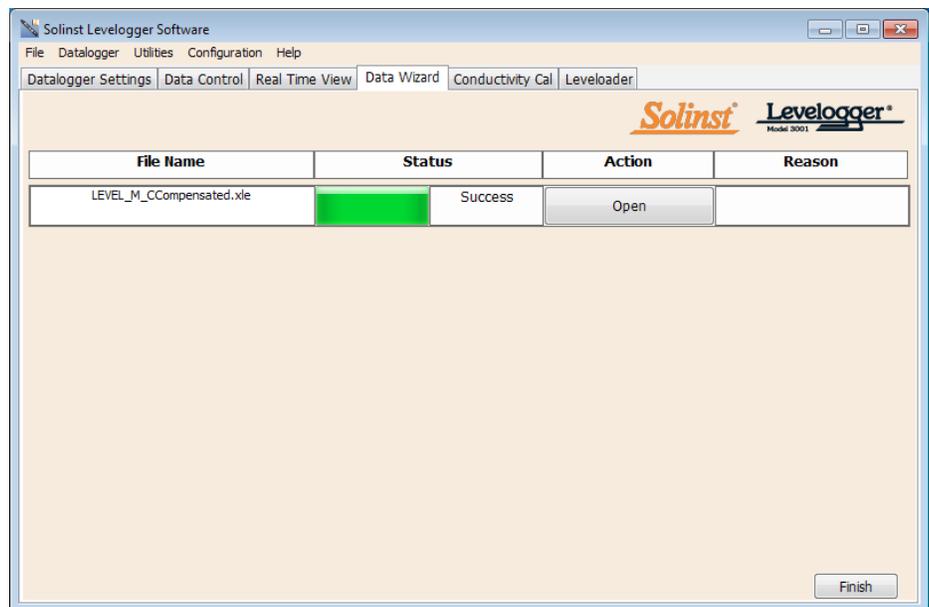


Figure 8-10 Advanced Data Compensation Results

From the Data Control tab, you can view the data, save the compensated file with a new filename and/or export the data (see Section 7).

All the original Levellogger settings and the channel information effective during data collection are shown on the top left of the window. The bottom left sections of the window are used to display the compensation information. The middle section displays information from the Barologger, and the bottom section includes information about manual data and parameter adjustments.

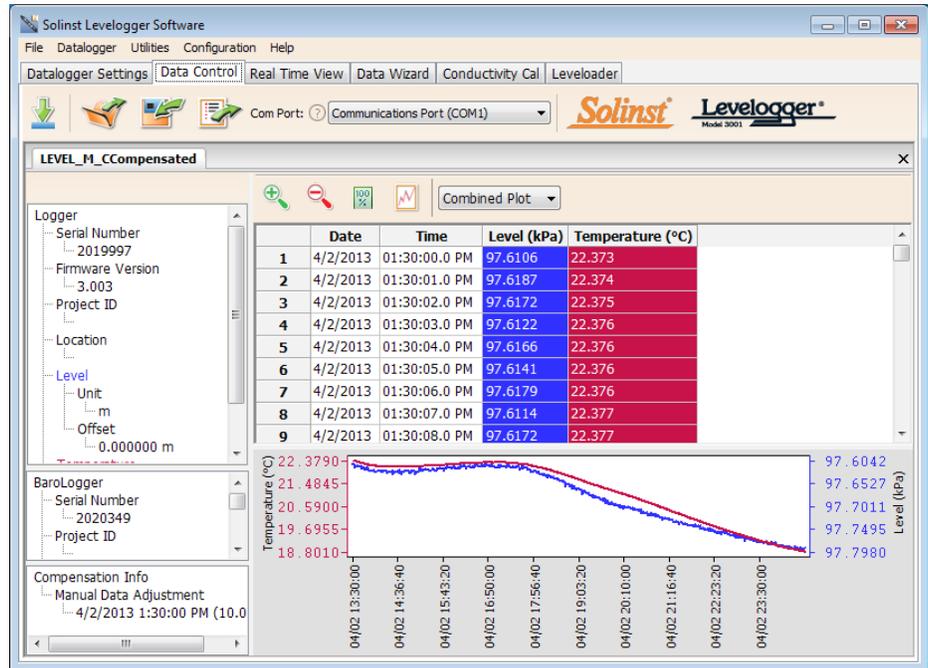


Figure 8-11 Viewing Compensated Files in the Data Control Tab

## NOTE

When analyzing barometric data it is important to keep in mind that storm events commonly reduce total atmospheric pressure by about 1.7% from pre-existing high pressure conditions. 1.7% converts to approximately 0.6 ft or 0.2 m of water level equivalent barometric fluctuation.

## NOTE

For Manual Barometric Compensation instructions for the Levellogger Gold and Levellogger Junior, visit: [www.solinst.com](http://www.solinst.com) and see the Levellogger Software Version 3.4.1 User Guide in the Downloads Section.

Or view "Automatic or Manual Barometric Compensation of Your Levellogger Data" in the Technical Bulletin Section at: <http://www.solinst.com/Prod/3001/Datalogger-Technical-Bulletins.html>

## NOTE

You can also convert the Levellogger Edge data units to match the Barometric units using the Data Wizard.

## NOTE

It is important to remember that weather station barometric data will often contain an offset or normalization (i.e. normalization to sea level). Manual data conversion and barometric compensation should account for any variation of the normalization or offset used between the barometric data sourced and Solinst Levelloggers.

## 8.2 Manual Barometric Compensation

This section describes how to perform manual barometric compensation on Levellogger Edge, Levellogger Junior Edge, and LTC Levellogger Edge data files when a Barologger was not dedicated as a barometric recorder.

For short term tests during which the barometric pressure varies insignificantly, the collection of continuous barometric data may be unnecessary. In this event, take a reading from an open air exposed Levellogger prior to running the short term test and record this level. This level represents the barometric pressure. Similarly, at the end of your test, take another barometric reading and record this measurement. After the submerged Levellogger data has been exported to a spreadsheet program, compensate your submerged Levellogger data files for barometric pressure. If no appreciable change in barometric reading occurred, you may write in the first cell of a new column, a simple calculation that subtracts your barometric reading from the submerged data file, then copy and paste this calculation to all the cells in that new column. The new column will represent the barometrically compensated liquid level.

Barometric data can be collected on site using a recording barometer or from a local weather station. To accomplish an accurate manual barometric compensation, the atmospheric pressure station should not be greater than 20 miles (30 km) away and within an elevation change of 1000 ft (300 m). In addition, the date and time of the barometric data should cover the range of data collected by the Levellogger. If setting up the barometer, set the recording interval to that of the Levellogger sampling interval or some multiple of the Levellogger interval. To compensate submerged Levellogger data using barometric data collected from an on site barometric datalogger or a nearby weather station, these steps must be taken:

- 1) Export both the Levellogger data file and the barometric file to a spreadsheet.
- 2) In the spreadsheet, ensure both files are using the same units. If your Levellogger data was recorded in m, cm, or ft, convert the barometric data column from its barometric measurement units (typically atm, mm Hg, psi, mbar or kPa) to feet or meters of water column equivalent using the conversion factors in Table 8-1. (There is also the option to initially set up your Levellogger to record in psi, kPa, or bar. This makes compensation using other atmospheric pressure devices easier.)

**Table 8-1**

Common barometric units to water column equivalent conversions		
Barometric unit	Water column equivalent (ft)	Water column equivalent (m)
1 psi	2.307	0.703
1 kPa	0.335	0.102
1 mbar	0.033	0.0102

Table 8-1 Common Barometric Units to Water column Equivalent Conversions

- 3) Once the units for each column are the same, subtract the barometric column from the Levellogger data to get the true net water level recorded by the Levellogger Edge.

## NOTE

Datalogger settings can not be changed in the Real Time tab. Changes must be made in the Datalogger Settings tab. The changes are applied when the Real Time readings are started.



## NOTE

You can also view Real Time readings from a Rainlogger Edge or Rainlogger using firmware version 2.000 or higher.

## 9 Real Time View

Click the Real Time View tab from the main software window (Figure 9-1). The purpose of this tab is to provide on-screen measurement as data is being recorded by the connected datalogger. The data is displayed in tabular and graphical format. All the channel information and Levellogger settings are displayed on the left of the window.

First, select a non-logged view rate   . This rate can be set independently of the logging period of the Levellogger and does not interfere with any logging taking place in the Levellogger itself.

Checking, **Enable Manual Data Adjustment**, allows you to enter a datum/ field zero (e.g. depth to water level) to which the change in Real Time View level measurements are then adjusted against. This is only available when you are taking readings in m, cm, or ft.

Real Time View readings can be displayed as a graph or in tabular format. The same graphing options as the Data Control tab are available for Real Time View readings. Real Time View readings are being recorded within the Levellogger Software and prior to closing the window, they can be saved by exporting the data into a \*.csv file, by choosing the file export option .

To start the current readings, click  . Immediately the readings will be displayed.

To take a reading at any specific time, click the  button and that reading will be added to the displayed data. To turn the Real Time View monitoring off, decide if you want to save the data as described above, and simply click .

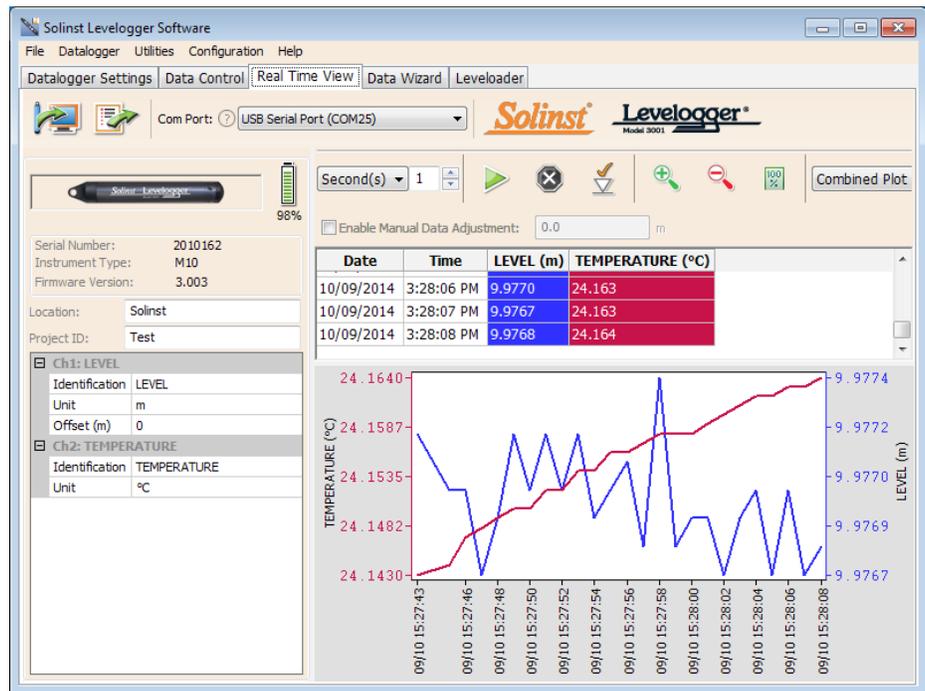


Figure 9-1 Real Time View Window

## 10 Installation and Maintenance of Levelloggers

### 10.1 Installation

Many options exist for installation of the Levellogger, but essentially these installation methods can be classified into two broad categories: free suspended or fixed installations.

- 1) In free suspended installations, the Levellogger is hung via suspension wire or Direct Read Cable from a well cap, or some fixed tie-off location, at the well head.
- 2) In fixed installations the Levellogger is fixed in place by a compression fitting, a clamping mechanism or simple metal straps.

It is recommended that the Levellogger be installed in a vertical orientation. However, inclined or horizontal installation is acceptable. The level sensor in the Levellogger is indicated by the machined line about the body of the logger just above the pressure access holes. The pressure transducer is oriented in a plane normal to the long axis of the body and detects pressure directed along the plane of the long axis (Figure 10-1). In vertical orientations, the sensor detects pressure above the pressure transducer line, whereas in non-vertical orientations, the pressure zero point is proportional to the angle of inclination.

Care should be taken to avoid dropping the Levellogger against a hard surface. Levelloggers should always be installed with the installation cap on (if not using a Direct Read Cable), whether it is being suspended by it or not. This prevents unnecessary battery drainage and protects the optical eyes.

Make sure you properly estimate the maximum and minimum expected water levels during the monitoring period. You need to install your Levellogger so it remains submerged at all times, and ensure that its maximum submergence depth throughout the monitoring period remains within its specified range. The pressure transducer can be damaged if the datalogger is over-pressurized by submergence greater than its level range. The Levellogger Edge, Levellogger Junior Edge, and LTC Levellogger Edge are warranted to pressures up to 200% of their full scale level range (150% for the Levellogger Gold, Levellogger Junior and LTC Levellogger Junior Models), however accuracy can not be guaranteed beyond its full scale.

Other important considerations when installing the Levellogger in pressurized or intermittently pressurized locations such as pressure vessels, pressurized pipes, pulse flow conditions, drop structures or near hydraulics works, is to keep in mind the potential effect of water or steam hammer and hydraulic jump. Water hammer is caused by an abrupt alteration of flow direction resulting in pressure surges. Steam hammer occurs when steam enters a cold pipe partially filled with water. The hammer effect has the potential to significantly increase hydraulic pressure possibly exposing the pressure sensor to pressures beyond its maximum rating. Hydraulic jump is a phenomenon that occurs when water is 'lifted' or 'ramped' by velocity or flow obstructions. Hydraulic jump causes turbulence and creates non-representative head conditions in the water column. Care should be taken to avoid logger installation at points susceptible to hydraulic jump.

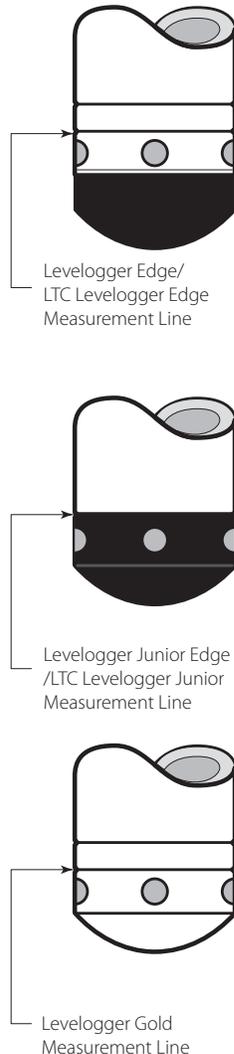


Figure 10-1



Figure 10-2  
Solinst 2" Locking Well Cap  
for Wireline or Kevlar Cord

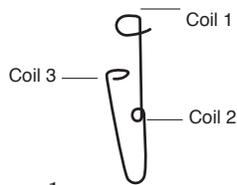


Diagram 1

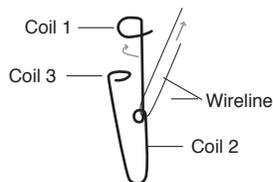


Diagram 2

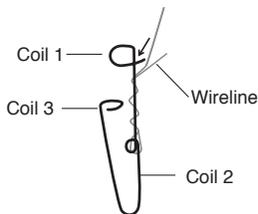


Diagram 3

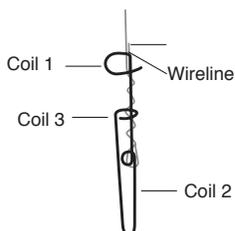


Diagram 4

Figure 10-3 Wireline Hook Installation

## 10.1.1 Free Suspended Installations

### 10.1.1.1 Suspension Wire/Cord Installation

When installing on a suspension wire or cord, the Levelogger is pre-programmed and started using the software. It is then deployed with the suspension wire or cord connected to the installation cap of the Levelogger to the underside of a well cap. The data is retrieved manually, by withdrawing the Levelogger, removing the installation cap and attaching an Optical Reader (or Direct Read to Optical Adaptor) directly to the datalogger. Data is downloaded to a desktop or laptop PC, or by using a DataGrabber, Levelogger App & Interface, or Leveloader (see separate instructions). This type of installation is applicable to both submerged and barometric record applications.

Solinst supplies stainless steel suspension wire assemblies including SS stranded wire and hooks available in a variety of lengths from 50 ft (15 m) to 500 ft (150 m), and Kevlar cord assemblies to 500 ft (150 m). Solinst also supplies the Model 3001 2" Well Cap Assembly from which the Levelogger can be suspended. An Adaptor for 4" wells also available (see Section 10.1.1.3).

Follow these steps to install the Levelogger using **stainless steel wire and hooks**:

- 1) Loop the cable through the coil 2 of the hook assembly, then wind the looped strands several times around the hook shaft and pass through coil 1.
- 2) Pass coil 3 through the Well Cap eyelet or Levelogger/Barologger eyelet and snap coil 3 to the hook shaft.
- 3) If the Well Cap is not used then some secure tie-off point should be used or installed.
- 4) If installing a Barologger, ensure the suspension level is above the highest expected water level.
- 5) When retrieving data and/or reprogramming the Levelogger, extract it from the monitoring location, un-thread the installation cap, interrogate and re-suspend the unit rechecking the security of the wireline clamps each time.



Figure 10-4 Kevlar Cord

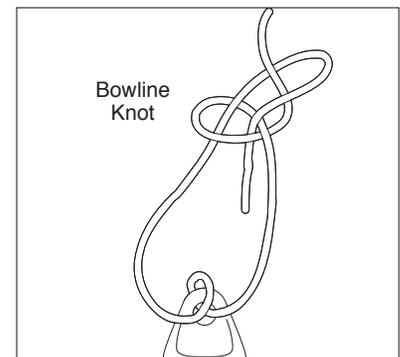


Figure 10-5 Bowline Knot Used to Connect  
Kevlar Cord to the Levelogger

It is recommended that the **Kevlar cord** be connected to the Levelogger and well cap using a bowline knot (see Figure 10-5). The Kevlar cord is comprised of multiple Kevlar strands braided with black polyester, and has break strength of 150 lbs. Kevlar is very suitable for underwater applications in freshwater and marine environments, as the material resists rusting.



Single Well Cap Option



Dual Well Cap Option

Figure 10-6  
Solinst 2" Locking Well Caps for  
Direct Read Cable Installation



Figure 10-7  
Solinst Direct Read Cable

## 10.1.1.2 Direct Read Cable Assembly Installation

When installing using a Direct Read Cable Assembly, the Levellogger can be deployed before it is programmed and started with the software. The Levellogger is installed using a Direct Read Cable to a Direct Read Wellhead, where a PC Interface Cable is connected allowing the Levellogger to communicate with a desktop or laptop PC. Alternatively, you can connect a Levellogger App Interface, DataGrabber, or Leveloader for communication (see separate instructions).

The Direct Read Cable system is composed of the ordered length of Direct Read Cable, the Model 3001 Well Cap Assembly (see Section 10.1.1.3) and the PC Interface Cable. The Direct Read cable threads to the Levellogger, while the socket at the opposite end of the Direct Read Cable fits into the specially designed Well Cap insert. The PC Interface Cable connects to the Direct Read socket at surface and to either a USB or RS-232 port on the PC. While use of the Model 3001 Well Cap is recommended and convenient, it is optional as long as a satisfactorily secure alternative tie-off point is found for the Direct Read Cable. Follow these steps to install a Direct Read Cable Assembly to the Levellogger:

- 1) Remove the installation cap from the Levellogger, align and connect the optical socket (two glass 'eyes' using the alignment pin) of the Direct Read cable to the Levellogger by threading the coupling onto the Levellogger tightly.
- 2) The Levellogger and optical socket will fit through the hole in the Well Cap insert.
- 3) Remove the protective cap from the non-optical socket at the wellhead end of the Direct Read Cable, seat the socket in the Well Cap Insert and align and thread it to the round socket of the PC Interface Cable.
- 4) Connect the USB or RS-232 socket of the PC Interface Cable to the USB or RS-232 Com Port on your PC.
- 5) The two plugged holes in the Well Cap can be opened to provide an access port for a Barologger, as well as a water level meter probe.

When removing a Direct Read Cable from a Levellogger, ensure you only twist the coupling. To avoid possible damage, do not twist the strain relief on the Direct Read Cable.



Figure 10-8 Proper way to remove a Direct Read Cable from a Levellogger

### 10.1.1.3 Model 3001 Well Cap Assembly

The Model 3001 Well Cap Assembly is designed to fit 2" wells, and provides options for installing Levelloggers with wireline, Kevlar cord, or using a Direct Read Cable.

The well cap base provides a tight friction fit onto the well casing. The cap is secured to the base with a twist lock. For further security, a 3/8" (9.5 mm) shackle diameter lock can be used. The Well Cap is vented to allow for the equalization of barometric pressure in the well. Users can choose to permanently secure the PVC Well Cap to the well casing, using three screw points on the inner shoulder of the Well Cap Base.

For wireline or Kevlar cord suspension, simply use the suspension hook on the underside of the insert to secure the Levellogger to the Well Cap (see Section 10.1.1.1). To install using a Direct Read Cable, lower the Levellogger with the Direct Read Cable through one opening in the insert (see Section 10.1.1.2).

#### NOTE

The insert has openings to hold two Direct Read Cables in the same well. If only one Direct Read Cable is used, the other hole (0.89" ID) provides access for Solinst Water Level Meters.



Figure 10-9 Model 3001 Well Cap Assembly (#110099).  
If installing Levelloggers in a 4" well, a reducer adaptor is available. (#110235)

#### NOTE

There are three holes in the top of the Support Hanger Bracket that can be used to secure it in the well cap base with screws.

A Support Hanger Bracket is available for use with the Well Cap Assembly. When installed, it provides an option for supporting and organizing down well cables or cords, or for coiling extra Direct Read Cable if the full length is not required. It is inserted through the top of the well cap base and hangs from the shoulder.



Figure 10-10 Support Hanger Bracket (#112764)



Figure 10-11  
Artesian Well Fitting Assembly

### **NOTE**

The Artesian Well Fitting Assembly is not recommended for pressures in excess of 30 psi (66 ft (20 m) of water column).

## 10.1.2 Fixed Installations

### 10.1.2.1 Flowing Artesian Monitoring

Monitoring of flowing artesian conditions using Levelloggers can be quite straight forward. Continuous artesian conditions infer that the piezometric surface never drops below the level of the ground surface, or particularly the top of casing elevation, and the casing is sealed with a wellhead. In this case, where freezing is not a concern, the Levellogger need only be installed on the wellhead itself by means of an Artesian Well Fitting Assembly, as illustrated in Figure 10-11. This same fitting allows the use of a Direct Read Cable to install the Levellogger at depth in a well, for cases when the piezometric surface falls below top of casing. See separate installation instructions.

When conducting artesian monitoring with Levelloggers, a number of issues should be considered. First, ensure that the maximum hydraulic pressure the datalogger will encounter at its installation point, will not exceed the specified range of the datalogger. Second, artesian conditions do not preclude the necessity for barometric compensation of Levellogger data. Artesian conditions are caused by aquacludes forming confined aquifers. Confined aquifers, while not acted on by barometric pressure to the same extent as unconfined aquifers, are typically subject to barometric pressure at some barometric efficiency (See Section 10.1.3.1). Finally, bear in mind that the total pressure and subsequent water column equivalent depth measured by the Levellogger after barometric compensation may not represent the actual water level within the artesian well. Sealed intermittent artesian wells can be pressurized when artesian, but can also be de-pressurized when non artesian. The Levellogger's reading after barometric compensation represent the height of the piezometric surface.

### 10.1.2.2 Vacuum Monitoring

Vacuum monitoring is usually conducted by first installing pressure transducers such as the Levellogger in monitoring wells and then shutting-in or sealing those wells to the atmosphere with pressure sealed wellheads. Air is pumped out from an extraction well amongst the cluster or matrix of monitoring wells, theoretically dropping air pressure in the vicinity of the extraction well. For short-term tests in which data is not required during the extraction event, the Levelloggers can be programmed and simply suspended from hooks or eyelets on the underside of the sealed wellheads, the test run and the data collected at the end of the test by extraction and downloading of the loggers. However, if ongoing data from the Levelloggers is required during the extraction event, the loggers must be installed in a manner similar to the artesian monitoring scenarios described previously in this section. Levelloggers or Barologgers can be used to monitor the drop in pressure.



Figure 10-12 Levellogger and Barologger in Well

### NOTE

The Barologger Edge should not be used to monitor water, as the internal mathematics for temperature compensation are based on air rather than water.

## 10.1.3 Barologger Installation

The Barologger is a Levellogger with a small range adequate to monitor the fluctuations that occur in barometric pressure. The Barologger's readings are used to barometrically compensate Levellogger readings. As a rule of thumb, a Barologger can be used to compensate all the Levelloggers in a 20 mile (30 km) radius and/or with every 1000 ft. (300 m) change in elevation.

To monitor barometric pressure correctly, the Barologger should never be submerged. In well installations, it is recommended that the Barologger be suspended in one of the monitored wells above the high water point (the well must be vented). For best reading accuracy, the Barologger should be installed in a similar thermal environment to that of the Levellogger. In groundwater wells, the Barologger should be suspended beyond the frost line and deep enough to avoid large temperature fluctuations. In surface water applications, the Barologger is best deployed in a dry well – a well embedded in the bottom of the water body, but sealed at the base from water entry and vented to the atmosphere. If a dry well cannot be installed, the Barologger can be installed on a float in the stilling well. Further information on the Barologger and barometric pressure can be found in Section 8.2.

### 10.1.3.1 Barometric Efficiency

The influence of barometric pressure on a groundwater surface can follow three scenarios. In confined aquifers with capillary or vadose head space, increased atmospheric pressure can tighten the pore spaces in the overlying soil and produce a capillary effect as the water level rises in response to having nowhere else to go but up. Second, some deeper aquifer systems can be quite barometrically isolated from the relatively small change in level that barometric influences can produce. The third scenario occurs in an unconfined aquifer, with high barometric efficiency, in which a barometric pressure change results in an equivalent or highly proportional drop or rise in groundwater pressure. In essence, depending on the aquifer type and depth, increased barometric pressure can result in either increased, static or decreased water levels. Barometric efficiency, the relationship of a barometric change on groundwater pressure, in confined aquifers generally ranges from 20 to 75%, whereas in unconfined aquifers the efficiency can range from 80 - 100%.

A second important element of Barometric efficiency is time lag – the time differential between a unit change in barometric at the surface to the time of transmission of that change to the aquifer. Calculating general barometric efficiency should not be done on a single barometric event, but rather on a statistically significant number of events. As a result, it may take a month or more of submerged Levellogger and Barologger data to determine barometric efficiency and time lag. As Barometric pressure fluctuates over time in excess of 60 cm water column equivalent pressure and as barometric efficiency can be such an important factor in accurately monitoring groundwater levels, it is vital that barometric compensation of the Levellogger data be performed.

The absolute pressure method used in the Levellogger and Barologger provide the user with the data necessary to determine barometric efficiency and time lag. If a barometric efficiency value has been determined from the Levellogger and Barologger data, that value can be applied to Barologger data in the Data Wizard.

Wells puncturing an aquifer have a negligible to non-existent effect on directly transmitting barometric changes to the larger aquifer. Barometric pressure is transmitted through overlying layers. To obtain the best and most accurate long term water level readings from Levelloggers, the user must first understand how the Levellogger calculates a depth of water above the transducer and second whether barometric efficiency should be considered in barometric compensation.

## 10.1.4 Rainlogger Installation

Solinst Rainloggers (Figure 10-13) are designed to log the tip times of an external tipping-bucket rain gauge, and output the amount of rainfall per tip.

The Rainlogger Edge housing is made of ABS, while the Rainlogger housing is made of stainless steel. Direct exposure to rainfall should be avoided, and Rainloggers should not be submerged. The Rainlogger Edge ABS housing provides extra electrostatic discharge (ESD) protection.

The rain gauge connected to the Rainlogger is supplied by the customer and is a normally-open style reed-switch type gauge most commonly known as a tipping-bucket rain gauge. The Rainlogger rain gauge connector (Figure 10-14) connects to the 2 m (6.5 ft.) cable supplied with the Rainlogger. The Rainlogger Edge and Rainlogger are supplied with different connector cables, which can not be interchanged. The connector cables have two wires, which are connected to the tipping-bucket by splicing to the tipping-bucket cable. As the tipping-bucket is just an electrical switch, for most models, the wires can be connected to either cable wire. Refer to the manufacturer's operating instructions. Longer, exposed cables should be protected from rodents and vandalism by cable armoring or installation within electrical conduit.



Figure 10-13 Solinst Rainloggers



Rain Gauge Connector

Figure 10-14  
The Tipping-bucket Rain Gauge Connector of the Rainlogger Edge

### ! NOTE

The Rainlogger Edge and Rainlogger are supplied with different connector cables, which can not be interchanged.



Figure 10-15 Rainlogger Edge Connected to Tipping-bucket

## 10.1.5 Installation in Extreme Environments

### 10.1.5.1 Freezing or High Temperature Conditions

Levellogger installation at submerged depths that may be at risk of freezing during the monitoring session is not recommended without taking adequate precautions to avoid transducer damage. When water freezes it expands approximately 9% by volume. A 9% expansion can equate to extreme pressure as demonstrated in Example 10.1. Therefore, solid freezing has the potential to damage the pressure transducer, which is rated to withstand up to 200% (150% for the Levellogger Gold and Junior Models) of its depth fluctuation range. Pressures beyond this threshold may damage the transducer. As such, care should be taken when choosing the appropriate pressure transducer range for your application.

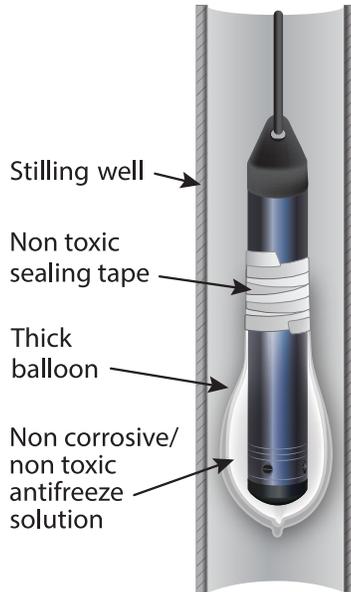


Figure 10-16  
Installation in Freezing Liquid

### Example 10.1 Solid Freezing Effects

The pressure exerted by the physical expansion or ice crystallization process on a retaining or enclosing contact surface is related to the temperature gradient over which the process occurs, i.e. the speed at which freezing occurs. For example, liquid freezing at  $-22^{\circ}\text{C}$ , can create expansion pressures of  $22\text{ kg/cm}^2$  or  $313\text{ psi}$  or the equivalent of  $721\text{ ft}$  or  $220\text{ m}$  water column depth.

With precautions, the Levellogger can be used in freezing liquid environments. If monitoring shallow water bodies or groundwater zones susceptible to freezing, the easiest way to avoid transducer damage is to lower the transducer to a point in the water column below the frost line or ice formation depth. In water bodies such as shallow streams, wetlands or ponds where freezing may penetrate to the bottom, install the Levellogger in a vented stilling well imbedded into the bottom of the water body beyond the frost line.

In cases where the above noted precautions cannot be taken and the Levellogger must be installed in the freezing zone, it is recommended that the logger be placed inside two elongated silicon, rubber or latex balloons, the balloons can be filled with a non-toxic, non-corrosive anti-freeze solution and sealed (Figure 10-16). Place the balloons in a section of perforated, 1.25" (30 mm) ID pipe and install the logger in the monitored water. The antifreeze solution will protect the Levellogger from ice expansion at the pressure transducer, yet transmit any pressure fluctuations that occur. However, it should be noted that even if these precautions are taken, there is still the risk that placing a Levellogger in a situation where the water may freeze solid can permanently damage the sensor (see Example 10.1).

Please note that a similar installation protection can be used when the Levellogger is monitoring liquids which are incompatible with its wetted materials.

The operating temperature range for Levelloggers is  $-20^{\circ}$  to  $80^{\circ}\text{C}$  ( $-4^{\circ}$  to  $180^{\circ}\text{F}$ ). At the opposite end of the thermal scale, exposing the Levellogger to temperatures beyond  $80^{\circ}\text{C}$  may damage the thermistor and otherwise affect the Levellogger.

### NOTE

Although precautions can be taken, placing a Levellogger in a situation where the water may freeze solid can permanently damage the sensor.

### 10.1.5.2 Marine or Brackish Installations

When installing the Levellogger in salt or brackish water or in a liquid having a specific gravity (density) different than fresh water, the density difference is compensated for by inputting the density of the monitored fluid in the Datalogger Settings window for the LTC Levellogger Junior and the Levellogger Gold Series (see Section 5.1). Also, see Section 8 for details in compensating the Levellogger Edge, Levellogger Junior Edge, and LTC Levellogger Edge for fluid density differences.

The Levellogger Edge and LTC Levellogger Edge can be used for monitoring in salt or brackish water. However, long term use of the stainless steel body Levellogger Junior Edge, LTC Levellogger Junior, Levellogger Junior and first generation LTC and LT Levelloggers in salt or brackish water is not recommended, as the salt or other pollutants may cause pitting which can lead to perforation of the Levellogger's casing. To minimize this effect, regularly lift the Levellogger from the liquid; within seconds a thin protective layer will be formed by oxidation. Again, this precaution applies to the Levellogger Junior Edge, LTC Levellogger Junior, Levellogger Junior, and first generation LTC and LT Levelloggers.

If using these dataloggers in a continuous salt/brackish monitoring scenario, the stainless steel body of the datalogger can be protected in a manner similar to the freezing protection method described in Section 10.1.5.1. The Levellogger can be placed in balloons and the balloons filled with non-corrosive/ non-toxic fluid. As pressure changes, the fluid encasing the loggers will transmit the pressure differential to the datalogger's pressure transducer. Care must be taken in the selection of the balloon material or filling fluid such that the balloon material prevents diffusion of salts across the concentration gradient or that the filling fluid is comprised of polymeric molecules too large to diffuse out of the balloon material.

### 10.1.5.3 Biofouling Conditions

Biofouling is the unwanted buildup of microorganisms, plants, algae, or organisms such as barnacles and muscles on a wetted surface. When a Levellogger is deployed for an extended period of time, especially in a saltwater environment, there is the risk of biofouling. Biofouling on the pressure sensor and conductivity cell can compromise the accuracy of the measurements.

A Solinst Biofoul Screen can be used to protect the Levellogger from biofouling. The copper-coiled Delrin screen naturally reduces biofouling, and lengthens the time a Levellogger can be deployed before maintenance is required. The Biofoul Screen simply slips onto the sensor end of the Levellogger where it is held in place with its compression fitting. It adds about 3/4" (19 mm) to the length of the Levellogger. It allows water to freely enter the conductivity cell, as well as the pressure transducer inlets. It is replaced as required.



Figure 10-17 Biofoul Screen Dimensions



Figure 10-18 Solinst Biofoul Screen for the Levellogger

## ! NOTE

It is important to ensure the installation cap or a Direct Read Cable is attached to the Levellogger during storage to prevent unnecessary battery drain and to protect the optical eyes.

## ! NOTE

To clean the optical infrared eyes on a Levellogger, use a clean, soft cloth or cotton swab to gently wipe away any debris and dry the eyes. Avoid soap or cleaners, as it may leave a residue. Compressed air may also be used to clear away any debris.

## ! NOTE

The Levellogger installation cap should be left on when you are soaking a Levellogger.

## 10.2 Levellogger Maintenance

Levellogger maintenance consists of cleaning the outside casing, the circulation holes and the optical infrared eyes. The required frequency of cleaning is dependent on several aspects of the monitored water quality. In freshwater with good to excellent water quality, the Levellogger cleaning requirements will be very minimal; amounting to a seasonal or even annual maintenance inspection.

In most cases cleaning can be accomplished by rinsing the Levellogger and using mild, non-residual, non-abrasive household cleaners using a very soft-plastic, bristled, pipe-cleaner type brush. Do not insert any object through the circulation holes at the sensor end of the Levellogger.

In some cases simple cleaners are insufficient to properly clean the Levellogger. Several commonly occurring water conditions require specific maintenance methods, these include hard water, high suspended solids loading, biological or chemical fouling and salt or brackish water conditions.

**Hard water** monitoring can result in the precipitation of calcium and magnesium deposits on the pressure transducer as well as other components of the Levellogger. These deposits can be safely dissolved using a diluted solution (typically  $\leq 10\%$  strength) of acetic or phosphoric acid. Commercially available products for dissolving hard water scaling are also available and can be used if designed for household use. Some industrial strength hard water scaling removers are much higher strength and are not recommended for cleaning the Levellogger.

**High suspended solids** load may block the circulation ports or clog the internal pressure cell of the Levellogger. The potential clogging effect of solids deposition can be minimized by placing the Levellogger in zones of flow. To remove solids build up, rinse the Levellogger under a low flow of tap water until particles have been washed away.

**Bacteriological or chemical fouling** can be an important consideration in many ground and surface water monitoring projects. Sessile bacteria will often utilize installed instrumentation as an attachment substrate. Chemical deposit can be the result of electrical charge differential between the instrumentation of the monitored liquid or the result of biological or algal activity. Both forms of fouling can result in difficult to remove deposits on the Levellogger transducer, the conductivity wires and the Levellogger casing. To remove fouling use a diluted ( $\leq 10\%$ ) solution of sulfuric acid. Persistent material may require soaking for several hours.

**Cleaning LTC Levellogger sensor pins** is recommended before calibrating the unit prior to starting a project. The pins of the LTC Levellogger sensor are platinum-coated, therefore they should not be roughly cleaned or touched with any metal. They can be cleaned with a soft bristle brush, Q-tip, or cloth. Almost any acid solution can be selected to clean the sensor, provided it is highly diluted (generally less than 10% acid). The "soaking" time should be monitored and kept to a minimum.

## 11 Diagnostics Utility

The Levellogger Diagnostics Utility can be used for troubleshooting Levelloggers and obtaining information about that Levellogger that can assist the Solinst Technical Support representative to identify and fix any problems you may encounter with your Levellogger. The Diagnostics Utility can be launched from the Utilities menu at the top of the software. The utility can be used to run a self-test, do a Memory Dump and create and email reports.

### 11.1 Run Diagnostics

The Run Diagnostics function reads the following information from the Levellogger:

- 1) Serial Number
- 2) Model Number
- 3) Firmware Version
- 4) Battery Voltage
- 5) Charge Level
- 6) Current Level Reading
- 7) Current Temperature Reading
- 8) Max/Min Pressure Reading
- 9) Max/Min Temperature Reading
- 10) Max/Min Conductivity Reading
- 11) Total Number of Logs

This information can be used to identify firmware, battery and/or temperature/pressure/conductivity sensor problems. This function also performs a series of self-tests on the Levellogger to check for problems with the battery, memory, pressure/temperature/conductivity sensors. If an LTC Levellogger fails the Conductivity Sensor Test, this could mean that you have not calibrated your LTC in a while (~1 year). It is recommended that you perform a conductivity calibration, then 'Run Diagnostics' again. If any of these tests fail then a report should be created and emailed to Solinst Technical Support. To execute this function simply click the 'Run Diagnostics' button.

#### NOTE

If an LTC Levellogger fails the Conductivity Sensor Test, this could mean that you have not calibrated your LTC in a while (~1 year). It is recommended that you perform a conductivity calibration, then 'Run Diagnostics' again.

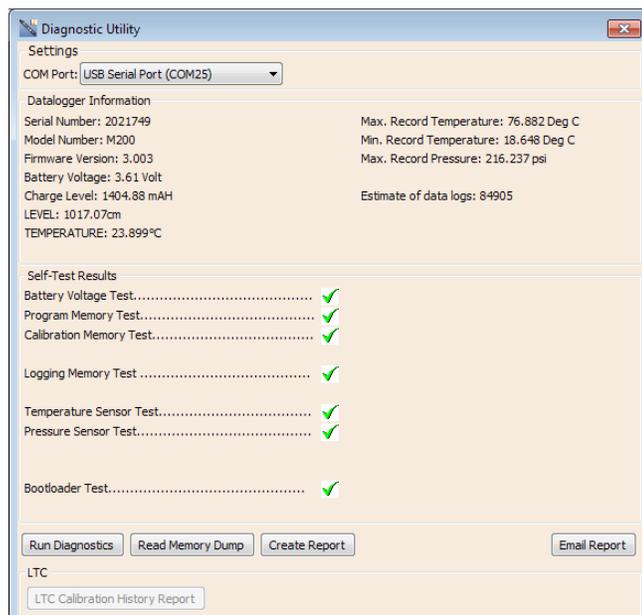


Figure 11-1 Run Diagnostics

## NOTE

It is recommended that, before attempting to use this function, you use the 'Create Report' function to send a report to the Solinst Technical Support.

### 11.2 Read Memory Dump

This function creates a complete dump of the Levellogger's memory, which can then be sent to Solinst Technical Support for analyzing.

To execute this function simply click the Read Memory Dump button. Performing a memory dump will create a \*.xle file of the data to save.

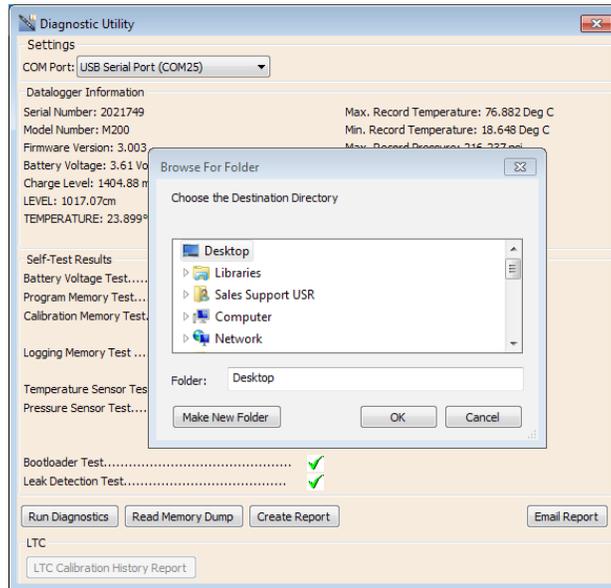


Figure 11-2 Read Memory Dump

### 11.3 Create Report

This function simply creates a text file containing the information obtained from the Run Diagnostics function. When you click the Create Report button, a window will pop up asking you to fill out your company information. Simply fill this out and the resulting report can be saved or sent to Solinst Technical Support for troubleshooting. If creating a report for an LTC Levellogger, the LTC Calibration History Report will be included.

## NOTE

The 'Email Report' option automatically creates a report and attaches it to an email to send to Solinst - all in one step.

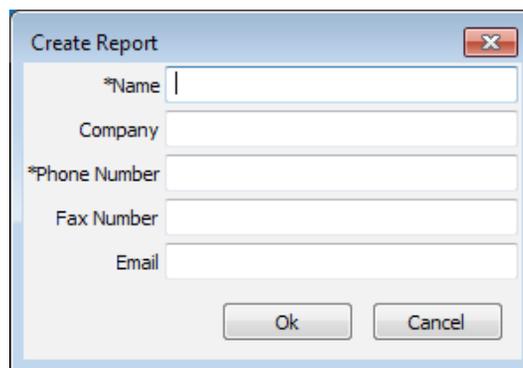


Figure 11-3 Customer Info Input Window

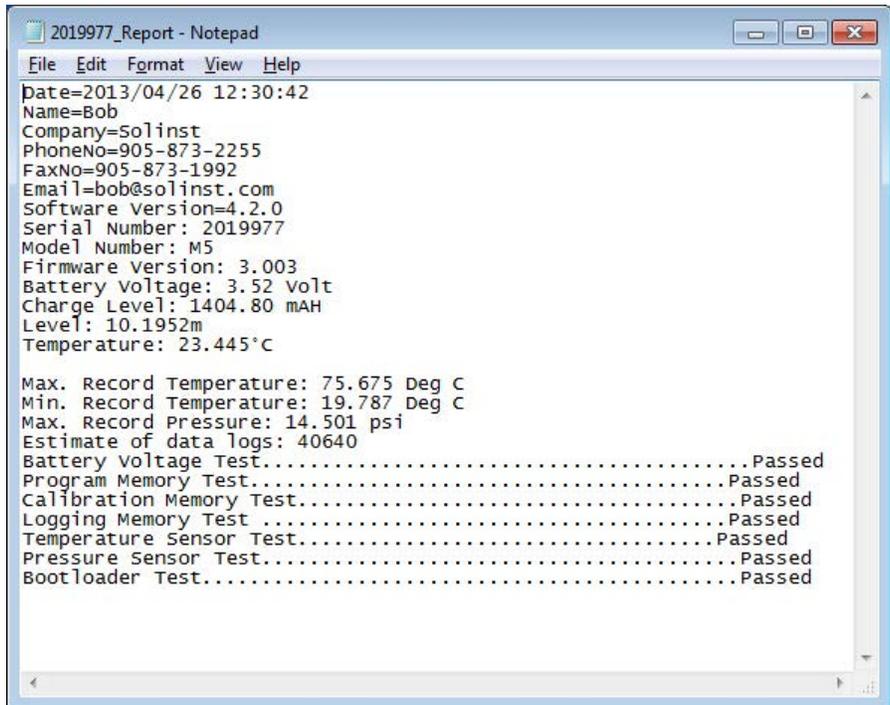


Figure 11-4 Report Example

### 11.4 Email Report

Clicking Email Report will guide you through the process of creating a Diagnostics Report, and it will automatically attach the report to an email to send to Solinst Technical Staff for troubleshooting. If you are emailing a report for an LTC Levellogger, the LTC Calibration History Report will be included.

## 11.5 LTC Calibration History Report

This function creates a report of all previous user calibrations performed on the LTC Levelogger. Use it to send a history report to Solinst for analysis if the LTC Levelogger readings are irregular and/or the unit does not maintain its calibration. To execute this function simply click the LTC Calibration History Report button. This creates a text file that can be sent to Solinst Technical Support.

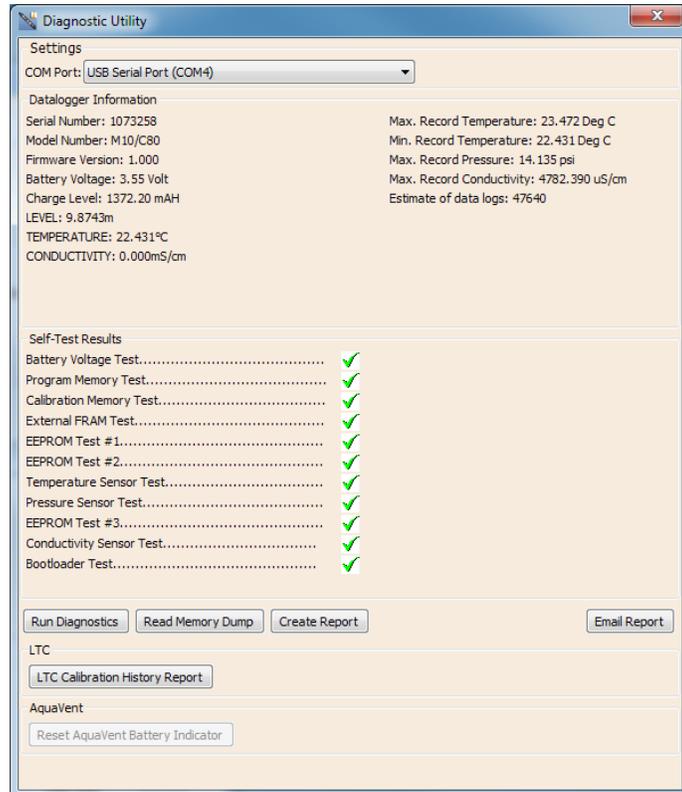


Figure 11-5 LTC Calibration History Report

## 11.6 Software/Firmware Updates

Each time the Diagnostic Utility is opened, it automatically checks for software updates. If there is an update, "[Software Update Available](#)" will appear in the top right of the window. When you click the message, a web page will open, allowing you to download the software update.

The Utility also checks for firmware updates. "[Firmware Update Available](#)" will appear in the top right of the window. Clicking the message will open a web page where you can download the firmware update. See Section 12 for firmware update instructions.

### NOTE

Your Computer must have an Internet connection to check for software and firmware updates.

You can also check for updates using the Help menu.

## NOTE

To check for firmware updates using Levellogger Software, retrieve settings from the connected datalogger (see Section 5). "Firmware Update Available" will appear in the top right menu bar if there is an update available. Clicking the message will open a web page where you can download the firmware update. You can also use the Software's Help menu.

## NOTE

It is important that the communication between the PC and the Levellogger is not interrupted during a firmware/calibration upload so please make sure to close any other running programs, including screen savers, and do not disconnect the Levellogger before the upload is finished.

## NOTE

Solinst recommends using an Optical Reader to connect your Levellogger to the PC during a firmware upgrade to avoid any interruptions during the extended communication period.

## 12 Firmware Upgrade Utility

The Firmware Upgrade Utility is used to upload new firmware files to a Levellogger. The zipped firmware file can be obtained from: <http://www.solinst.com/downloads/>

Make sure to unzip the firmware file after you have downloaded it, so you can access the \*.ssf file.

To upload new firmware to a Levellogger, follow these steps:

- 1) Open the Solinst Firmware Upgrade Utility from the Utilities menu in the main Levellogger Software. Pick the Com Port to which the Levellogger is connected and make sure the Baud Rate is set to 9600.
- 2) Click the 'Open' button , which should open a file dialog asking for the firmware file (\*.ssf) to upload. Navigate to the directory where the firmware file was saved on your PC, then click on the file and click 'Open'.
- 3) Check the 'Firmware File Information' box to make sure that the opened file is the right one.
- 4) Click the 'Upload Firmware' button , to start the firmware upload process.
- 5) If a communication error occurs and is indicated in the Levellogger Information Window (Figure 12-1) either before the 'Verified Program Checksum' message or after the 'Program Information Section', then restart the upgrade process.
- 6) If, however, a communication error occurs between the 'Verified Program Checksum' and the 'Program Information Section' messages, then please contact Solinst. You will need to give the Levellogger Serial Number and explain the exact positioning of the error message.

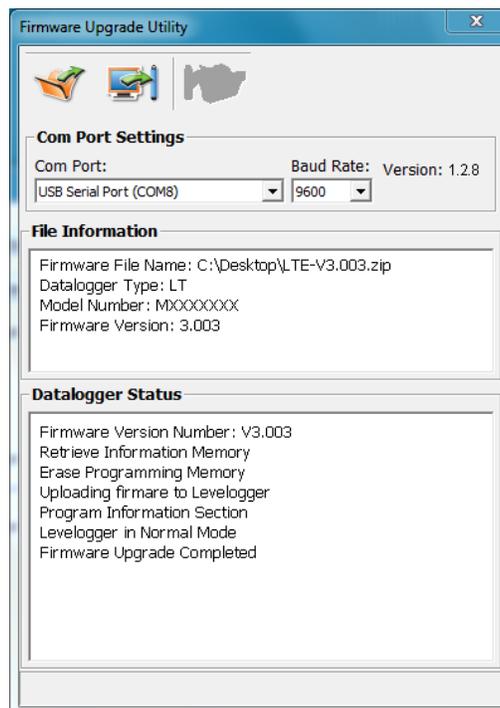


Figure 12-1  
Firmware Upgrade Utility Window

## **13 Trouble Shooting**

### **13.1 Problems During Installation of Levellogger Software**

#### **'Class not Registered' or 'DLL not found' or 'Access violation'**

- 1) You may not have Administrator Rights to install the software in the Windows 7/8/10 environment.
  - Ask your System Administrator for assistance.
- 2) Some files got corrupted during installation of the Levellogger software. Use 'Add/Remove Programs' to uninstall then re-install Levellogger software.

### **13.2 Error During Software Uninstall Process**

The 'Add/Remove Program' cannot locate the Levellogger <setup.exe> file of the software or the link between the software and the 'Add/Remove Program' is damaged.

The record in the Registry Table must be removed:

- 1) Ask your System Administrator to remove this.
- 2) Refer to the following link from Microsoft Website for instructions:  
<http://support.microsoft.com/default.aspx?scid=kb;en-us;247501>

### **13.3 Problems During Installation of RS-232 to USB Converter**

#### **Unable to install the RS-232/USB converter from Keyspan or IO Gear**

- 1) After plugging in the RS-232/USB Converter, a Hardware Installation Wizard will open. Follow the instruction from the Wizard and make sure to select the RS-232/USB Converter Driver from the Keyspan or IO Gear Installation CD.
- 2) If the Hardware Installation Wizard does not open after plugging in the RS-232/USB Converter, follow the steps below to open the Hardware Installation Wizard:
  - a. Select Control Panels
  - b. Double click on System
  - c. Select the Device Manager Tab
  - d. Double click on Other devices
  - e. Right click on USB Serial Converter
  - f. Select Update Driver...

### **13.4 Data Has Been Erased Accidentally**

If Levellogger has been restarted and old data has not been saved, go to Download Options and choose Data Recovery. It downloads the immediately previous log.

#### **! NOTE**

Solinst recommends Keyspan or IO Gear. For problems with converters from other manufacturers, please contact the manufacturer.

### 13.5 Error Messages During Use of Software

#### **'Communication Time Out' or 'Communication Error' or 'The Command that is sent to the Levellogger Edge is not defined'**

- 1) Try communicating with another Levellogger, Optical Reader or Direct Read Cable. The communication cable, Optical Reader or Levellogger may be damaged.
- 2) Clean the optical 'eyes' on the Levellogger and the cable, with a soft cloth.
- 3) Check that the communication cable is connected to the same Com Port that is chosen in the upper middle of the Main Window of the Levellogger software.
- 4) Check the Com port settings. They should be as follows:
  - Bits per second: 9600
  - Data bits: 8
  - Parity: None
  - Stop bits: 1
  - Flow control: None  
(This may have been set to Xon/Xoff – change it to None, Select [OK] and back out of this pathway.)

The route to view your Com port settings is as follows:

- a. Select Control Panels
  - b. Double click on System
  - c. Select the Device Manager Tab
  - d. Double click on Ports
  - e. Double click on Communications Port(s)
  - f. Choose the Port Settings Tab
- 5) Try using a different computer, to see if this is the cause of the problem.
  - 6) If using a laptop (especially in conjunction with a Direct Read Cable) your Com Port may not be powered adequately to receive/transmit data. Try using a desktop computer to test this, or contact Solinst to obtain a PC Interface Booster Cable.
  - 7) If problem persists, contact Solinst.

#### **'Port Cannot Open'**

- 1) If using a USB device, ensure you plugged it in before starting the Levellogger Software.
- 2) Ensure the correct Com Port is selected in the upper middle of the Main Window of the Levellogger software.
- 3) If the correct Com Port is not available, a USB Driver installation or update may be required.
- 4) Check if some other software is using the same Com Port in the background. Shut that software down or choose another Com Port if available. Such background software may be anti-virus software or PDA software.

- 5) Make sure your Com Port has been enabled:
  - a. Select Control Panel
  - b. Double click on System
  - c. Select the Device Manager Tab
  - d. Double click on Ports
  - e. Double click on Communications Port(s)
  - f. Choose General
  - g. Uncheck 'Disable in this hardware profile box'
- 6) If you are using a virtual Com Port, like a USB optical reader or USB/RS-232 converter, refer to the 'Problems During Installation of RS-232 to USB Converter' section to make sure they are installed properly.

**'File Create Error' and 'File Write Error'**

- 1) If you do not have file-writing privileges to the Levellogger default data folder, change the folder as follows: in the Levellogger software, click 'Configuration' then 'Application Settings'. Under 'Default Directory', enter a new destination folder, to which you have file writing privileges, e.g. 'My Documents'. Follow the same procedure if you have the same problem when you export the data file in csv format.
- 2) Ask your System Administrator for assistance.

**'File Open Error' and 'File Read Error'**

- 1) Shut down or disable any other software that is active and using the same file.
- 2) In Notepad or Wordpad, open the <\*.xle> or <\*.lls> file to check for corruptions in the file. How are the Levellogger files ended?
- 3) If problems persist contact Solinst for assistance.

**'Time Span Error, some data cannot be compensated'**

- 1) Find another barometric data file that has the same time stamp as the Levellogger.
- 2) Perform the compensation (a simple subtraction) in a spreadsheet program for any missing time stamps.

**'A different type of Levellogger is detected'**

Try clicking the Retrieve Settings icon again, or replace the Levellogger currently in the Optical Reader with the one that was previously being worked on, and complete the operation.

**'The selected file is not a barometer'**

Select a Barologger for the compensation process.

**'Data Corrupted'**

Contact Solinst for assistance. Use Levellogger Diagnostic Utility to do a memory dump and sent the dump file to Solinst for further analysis.

**'Internal Error'**

Contact Solinst for assistance.

**'Fail to append data - A different Levellogger has been detected!' or 'Fail to append data - A different start time has been detected!' or 'Fail to append data - New data is not available in the Levellogger!'**

The Levellogger software can only append data to a file that has the same serial number and start time as the connected Levellogger. Find the correct file, or use 'All Data' to download the complete file.

**'Only Levellogger Gold/Edge supports this function'**

The 'Append Data', 'Partial Download' and 'Data Recovery' functions are only supported by the Levellogger Gold/Edge loggers, not previous version Levelloggers.

**'Schedule cannot be empty'**

When using the 'Schedule' sampling option in a Levellogger Gold/Edge, the schedule must contain at least one item.

**'Readings in schedule exceed the maximum'**

The number of readings in a schedule should not result in more than 40,000 individual readings.



[www.solinst.com](http://www.solinst.com)

*High Quality Groundwater and Surface Water Monitoring Instrumentation*

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[instruments@solinst.com](mailto:instruments@solinst.com)

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## RAE Systems, Inc. Portable ppb VOC Monitor



ppbRAE

[Buy This Product](#)



### Hand-held PID Monitor Capable of Detecting VOCs in the Parts-Per-Billion (ppb) Range

The most sensitive handheld VOC monitor in the world with true parts per billion (ppb) detection of extremely low level, low vapor pressure and highly toxic Volatile Organic Compounds (VOCs) such as nerve agent, pesticide residues and low level permeation breakthrough detection.

#### Benefits

- ➔ New patented planar, dual channel PID detector
- ➔ New super bright UV lamp
- ➔ Increased sensitivity down to 1 ppb
- ➔ Reduced humidity interference
- ➔ Improved linearity
- ➔ Easily accessible lamp and sensor
- ➔ Strong, built-in sample draw pump with pump stall feature
- ➔ Prevents liquid flow into the monitor
- ➔ Snap-in, field replaceable NMH rechargeable battery 10 hours of continuous monitoring
- ➔ Smart battery charging
- ➔ Alkaline battery holder supplied
- ➔ Automotive charger available
- ➔ Large keys operable with 3 layers of gloves
- ➔ Large easy to read back light display
- ➔ Alarm activated
- ➔ LCD backlight is low light or manually activated
- ➔ Preset alarm thresholds for STEL, TWA, low and high level peak values
- ➔ Audio buzzer and flashing LED display will be activated when the limits are exceeded
- ➔ 15,000 point data logging storage capacity for data download to PC
- ➔ Rubber protective boot
- ➔ 102 built-in correction factors from a RAE list of 250+ chemicals
- ➔ User selectable hygiene and survey modes
- ➔ Protected from portable radios

#### Applications:

- ➔ Weapons of Mass Destruction – chemical warfare agents, rocket propellants
- ➔ Breath sampling
- ➔ Personal monitoring of very toxic compounds -TDI, Methyl isocyanate, Vinylcyclohexene, Hydrazines

- ➔ Personal monitoring of low volatile toxic compounds, for example
- ➔ Heat exchange fluids
- ➔ Pesticides and pesticide residues
- ➔ Hypo-allergenic studies in chemical clean rooms
- ➔ Laboratory fume hood breakthrough
- ➔ Personal protective equipment (PPE)-Breakthrough, Decision making
- ➔ Environmental Survey instrument
- ➔ Leak detection, Residue studies
- ➔ Drug detection

**Model PGM-7240 Monitor**

ppb RAE unit with 10.6 eV PID detector  
Nickel metal hydride batteries  
Alkaline battery holder  
Rubber Boot  
Inlet probe and water trap filter  
Operation and maintenance manual  
Soft carry case  
Pro-RAE Suite software (datalogging version)

**Model PGM 7240 KIT**

**Items included with Monitor Plus:**

Calibration Gas  
Calibration Regulator with flow controller  
Porous metal filter & O-ring kit  
Gas outlet port and tubing  
Tool kit  
Hard transport case

**Accessories**

Automotive charging adapter  
9.8 eV lamps  
Collapsible remote sampling probe  
Vibration alarm



**Series 2000  
Magnehelic® Differential  
Pressure Gage**

*Indicate Positive, Negative or Differential,  
Accurate within 2%*

Range - Inches of Water

	<b>Model Number</b>	<b>Description</b>	<b>Price</b>
	2000-00N	Differential pressure gage, range .05-0-.2" w.c., minor divisions .005, calibrated for vertical scale position.	\$77.45
	2000-00	Differential pressure gage, range 0-0.25" w.c., minor divisions .005, calibrated for vertical scale position.	\$73.00
	2000-0	Differential pressure gage, range 0-0.50" w.c., minor divisions .01, calibrated for vertical scale position.	\$63.50
	2001	Differential pressure gage, range 0-1.0" w.c., minor divisions .02.	\$63.50
	2002	Differential pressure gage, range 0-2.0" w.c., minor divisions .05.	\$63.50

**EMISSIONIVITY**

The IR1000 is set to an emissivity of 0.95. This applies to most applications and will provide a reliable accurate measure of the surface temperature.

Shiny bright surfaces (i.e. chrome, new copper, white boards) have a much lower emissivity, and will not read accurately. A common solution to measuring on these types of surfaces is to first apply a small piece of masking tape. The tape has an emissivity much closer to 0.95, and will quickly take on the temperature of the surface to which it is applied.

**BATTERY REPLACEMENT**

1. **Open** the battery compartment by pulling the compartment lid at the indentations, away from the trigger (see *Thermometer Attributes* section).
2. **Remove** and recycle exhausted batteries.
3. **Replace** 2 x AAA alkaline batteries observing the polarity indicated on the inside markings.
4. **Return** compartment lid and make sure it locks into place.

**ACCURACY**

Ambient Temperature	Target Temperature	Accuracy
77°F	59~95°F(15~35°C)	±1.8°F(1.0°C)
68~79°F (20~26°C)	32~1000°F (0~538°C)	±2% of reading or 4°F(2°C) whichever is greater
68~79°F (20~26°C)	-58~32°F (-50~0°C)	±(4°F+0.1 degree/degree) ±(2°C+0.05 degree/degree)

**WARRANTY**

This product is warranted to be free from defects in materials and workmanship for a period of two years from the date of purchase. During this warranty period, Klein Tools has the option to repair or replace or refund the purchase price of any unit which fails to conform to this warranty under normal use and service. This warranty does not cover damage which occurs in shipment or failure which results from alteration, tampering, accident, misuse, abuse, neglect, or improper maintenance. Batteries and damage resulting from failed batteries are not covered by warranty. A purchase receipt or other proof of original purchase date will be required before warranty repairs will be rendered.

Any implied warranties, including but not limited to implied warranties of merchantability and fitness for a particular purpose, are limited to the express warranty. Klein Tools shall not be liable for loss of use of the instrument or other incidental or consequential damages, expenses, or economic loss, or for any claim or claims for such damage, expenses or economic loss.

Some states or countries laws vary, so the above limitations or exclusions may not apply to you. This warranty gives you specific legal rights, and you may also have other rights which vary from state to state. If your Klein product requires repair or for information on how to exercise your rights under the terms of this warranty, please contact Klein Tools at 1-877-775-5346.

**CLEANING**

Clean the instrument by using a damp cloth. Do not use abrasive cleaners or solvents.

Take care to keep the sensor lens clean at all times. Clean the lens using a soft cloth or cotton swab with water or rubbing alcohol only, and allow the lens to dry before use.

**STORAGE**

Remove the batteries when instrument is not in use for a prolonged period of time. Do not expose to high temperatures or humidity. After a period of storage in extreme conditions exceeding the limits mentioned in the Specifications section, allow the instrument to return to normal operating conditions before using it.

**DISPOSAL / RECYCLE**



**Caution:** This symbol indicates that equipment and its accessories shall be subject to a separate collection and correct disposal.

**CUSTOMER SERVICE**

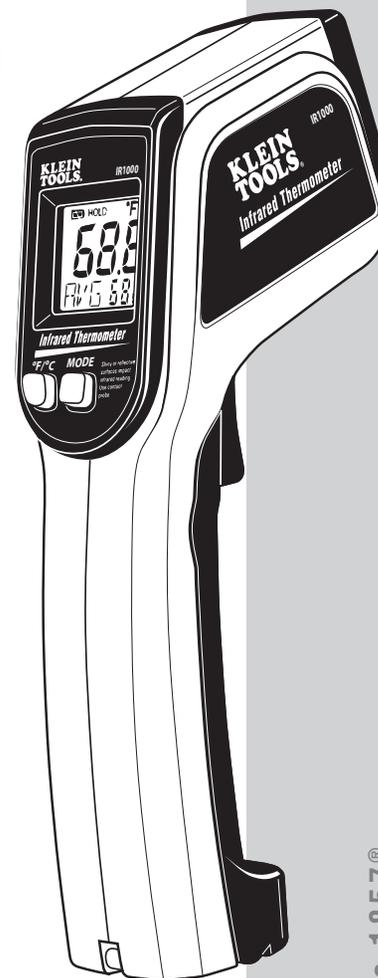
**KLEIN TOOLS, INC.**  
 450 Bond Street  
 Lincolnshire, IL 60069  
 1-877-775-5346  
 www.kleintools.com

# Instruction Manual

## IR1000

**ENGLISH**

- -58° TO 1000°F MEASUREMENT RANGE
- 12:1 SPOT RATIO
- LASER TARGETING
- MAX/MIN/AVG/DIFF
- BACKLIT DISPLAY
- AUTO SHUT OFF
- °F/°C BUTTON



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# IR1000 Instruction Manual

## GENERAL SPECIFICATIONS

The Klein Tools IR1000 is a professional series infrared thermometer. It features a wide measurement range, a tight distance-to-spot ratio, and several calculation modes to assist you in making the best possible measurements.

- **Operating Altitude:** 2000 meters
- **Relative Humidity:** 75% max
- **Operating Temperature:** 32~122°F (0~50°C)
- **Storage Temperature:** -4~140°F (-20~60°C)
- **Accuracy Temperature:** 22.8°C ± 1.7°C (73°F ± 3°F)
- **Emissivity:** 0.95 fixed
- **Optical Resolution (Distance: Spot):** 12:1
- **Dimensions:** 3.25 x 7 x 1.74"
- **Weight:** 3.9 oz.
- **Battery Type:** 2 x AAA alkaline batteries
- **Battery Life:** 14.5 hours
- **Display Resolution:** 0.1°
- **Display Hold:** Auto
- **Calibration:** Accurate for one year
- **Laser:** FDA and IEC Class II
- **Certifications:** CE and RoHS

## ⚠ WARNINGS

To ensure safe operation and service of the tester, follow these instructions. Failure to observe these warnings can result in severe injury or death.

- Do not direct laser beam into eyes, as this can cause permanent eye damage.
- Do not use instrument if the case is damaged in any way.
- Replace the batteries as soon as low battery indicator appears.
- Have the instrument serviced immediately if it is acting abnormally.
- Be cautious of readings of reflective materials as they may be indicated by the instrument as cooler than they actually are (see *Emissivity* section).
- Avoid using the instrument around strong electromagnetic fields.

## SAFE PRACTICES

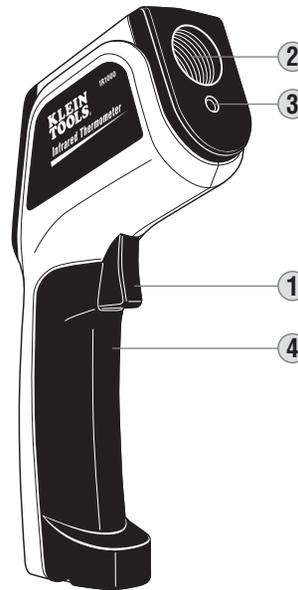
This instrument is designed for professionals who know the hazards associated with their trade. While this instrument offers no foreseeable dangers beyond its laser sight, the equipment you are servicing, as well as the environment you're working in, can be hazardous. These are a few common safety practices for those working around temperature critical environments:

- Follow the manufacturer's maintenance procedures when servicing equipment.
- Before using this instrument to determine if an area is safe to touch or enter, verify your readings are reasonably accurate by comparison with known measurements.
- Properly maintain your infrared thermometer and calibrate it regularly.

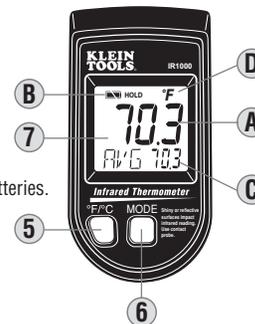
## SYMBOLS

- Laser
- Warning or Caution
- Follow safe disposal procedures
- Dangerous levels
- Battery

## THERMOMETER ATTRIBUTES



1. **Trigger:**  
Initiates measurement.
2. **IR Sensor:**  
Collects temperature data.
3. **Laser Pointer:**  
Assists in aiming the sensor.
4. **Battery Compartment:**  
Pops forward to store 2 x AAA batteries.
5. **°F/°C Button:**  
Changes the measurement scale.
6. **Mode Button:**  
Changes the calculation mode.
7. **LCD Screen:**  
Displays measurement and additional information.



- A. Most recent measurement.
- B. Low battery indicator.  
 Battery OK  
 Battery Low  
 Battery Exhausted
- C. Calculation display.
- D. Temperature scale (°F/°C)

## OPERATING INSTRUCTIONS

### Temperature Measurement

To take measurements with your IR1000, aim the instrument at the object to be measured and pull the trigger. The unit has an auto off after releasing the trigger of 15 seconds.

### Min/Max/Avg/Differential

Press the MODE button to select minimum, maximum, average or differential. Press the trigger and scan the area being measured.

- **Min:** Displays the lowest temperature measured while scanning.
- **Max:** Displays the highest temperature measured while scanning.
- **Avg:** Displays an average of the temperature as you are scanning.
- **Diff:** Displays the difference between the highest and lowest temperatures measured while scanning.

### Selecting Temperature Scale

Press the °F/°C button to alternate between Fahrenheit and Celsius. You can select either scale during or after measurement, when viewing any of the held values.

### Auto Hold

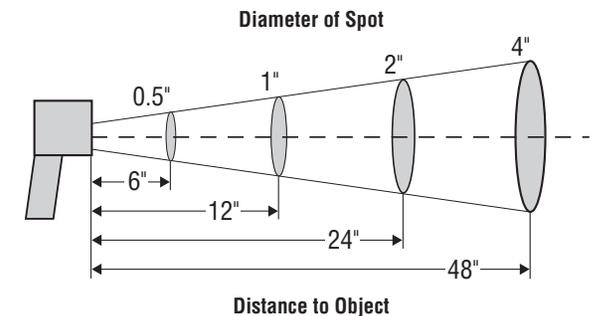
The IR1000 will hold the last temperature measured for 15 seconds after the trigger is released. To recall this value press the MODE key to activate the display to show the held temperature.

## DISTANCE TO SPOT RATIO

The distance-to-spot ratio is a representation of how focused the IR sensor is on the measurement area. The closer you are to the surface you are measuring, the smaller the area of measurement is.

The IR1000 has a 12:1 distance-to-spot ratio. This means that if you are 12 feet away from an air vent, the vent should be 1 foot or less in diameter in order to resolve the most accurate measurement.

Below is an illustration of other example measurements.



EMISIVIDAD

El IR1000 está ajustado a una emisividad de 0,95. Esto se aplica a la mayoría de aplicaciones y proporcionará una medida precisa y confiable de la temperatura en la superficie.

Las superficies brillantes y resplandecientes (es decir, cromo, cobre nuevo, tablas blancas) tienen una emisividad mucho más baja y no darán lecturas precisas. Una solución común para medir estos tipos de superficies es aplicar primero un pequeño pedazo de cinta de enmascarar. La cinta tiene una emisividad mucho más cercana a 0,95 y alcanzará rápidamente la temperatura de la superficie sobre la que esté aplicada.

REEMPLAZO DE LAS PILAS

1. **Abra** el compartimiento de las pilas jalando la tapa del compartimiento en las indentaciones, alejándola del gatillo (vea la sección "Atributos del termómetro").
2. **Retire** y recicle las pilas agotadas.
3. **Reemplácelas** con 2 pilas alcalinas AAA, observando la polaridad indicada en las marcas interiores.
4. **Reponga** la tapa del compartimiento y asegúrese de que quede bloqueada en su sitio.

PRECISIÓN

Temperatura Ambiente	Temperatura del Objeto	Precisión
77 °F	59~95 °F (15~35 °C)	±1,8 °F (1,0 °C)
68~79 °F (20~26 °C)	32~1000 °F (0~538 °C)	±2% de la lectura ó 4 °F (2 °C), lo que sea mayor
68~79 °F (20~26 °C)	-58~32 °F (-50~0 °C)	±(4 °F + 0,1 grados/grados) ±(2 °C + 0,05 grados/grados)

GARANTÍA

Se garantiza que este producto estará libre de defectos de materiales y fabricación durante un período de dos años a partir de la fecha de compra. Durante este período de garantía, Klein Tools tiene la opción de reparar, reemplazar o reembolsar el precio de compra de cualquier unidad que no cumpla con esta garantía bajo uso y servicio normales. Esta garantía no cubre los daños que ocurran en el envío o las fallas que ocurran debido a alteración, manipulación indebida, accidente, uso incorrecto, abuso, negligencia o mantenimiento inapropiado. Las pilas y los daños que ocurran por causa de pilas que fallen no están cubiertos por esta garantía. Se requerirá un recibo de compra u otro comprobante de la fecha de compra original antes de que se realicen las reparaciones bajo garantía.

Todas las garantías implícitas, incluyendo pero sin estar limitadas a las garantías implícitas de comerciabilidad e idoneidad para un propósito específico, están limitadas a la garantía expresa. Klein Tools no será responsable por la pérdida de uso del instrumento u otros daños incidentales o emergentes, gastos o pérdida económica, ni por cualquier reclamo o reclamos por dichos daños, gastos o pérdida económica.

Las leyes de algunos estados o países varían, por lo que es posible que las limitaciones o exclusiones que anteceden no tengan aplicación en el caso de usted. Esta garantía le confiere a usted derechos legales específicos y es posible que usted tenga también otros derechos que varían de un estado a otro. Si su producto Klein requiere reparación, o para obtener información sobre cómo ejercer sus derechos bajo los términos de esta garantía, sírvase contactar a Klein Tools llamando al 1-877-775-5346.

LIMPIEZA

Limpe el instrumento utilizando un paño húmedo. No utilice limpiadores abrasivos ni solventes.

Tenga cuidado de mantener limpio el lente del sensor en todo momento. Limpie el lente utilizando un paño suave o una bolita de algodón con agua o alcohol desinfectante solamente, y deje que el lente se seque antes de utilizarlo.

ALMACENAMIENTO

Retire las pilas cuando el instrumento no se vaya a usar durante un período prolongado. No lo exponga a altas temperaturas o humedad. Después de un período de almacenamiento en condiciones extremas que excedan los límites mencionados en la sección Especificaciones, deje que el instrumento regrese a las condiciones de funcionamiento normales antes de utilizarlo.

ELIMINACIÓN / RECICLAJE



**Precaución:** Este símbolo indica que el equipo y sus accesorios estarán sujetos a recogida y desecho correcto por separado.

SERVICIO AL CLIENTE

KLEIN TOOLS, INC.  
450 Bond Street  
Lincolnshire, IL 60069  
1-877-775-5346  
www.kleintools.com

# Manual de Instrucciones

## IR1000

ESPAÑOL

- INTERVALO DE MEDICIÓN DE -58° A 1000 °F
- RELACIÓN DE PUNTO 12:1
- ENFOQUE CON LÁSER
- MAX / MIN / PROM (AVG) / DIF
- PANTALLA CON LUZ DE FONDO
- AUTOAPAGADO
- BOTÓN DE °F / °C



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# IR1000

## Manual de Instrucciones

### ESPECIFICACIONES GENERALES

El IR1000 de Klein Tools es un termómetro infrarrojo de serie profesional. Cuenta con un amplio intervalo de medición, una relación de distancia a punto muy ajustada y varios modos de cálculo para ayudarle a realizar las mejores mediciones posibles.

- **Altitud de funcionamiento:** 2000 metros
- **Humedad relativa:** 75% máx
- **Temperatura de funcionamiento:** 32~122 °F (0~50 °C)
- **Temperatura de almacenamiento:** -4~140 °F (-20~60 °C)
- **Temperatura de precisión:** 22,8 °C ± 1,7 °C (73 °F ± 3 °F)
- **Emisividad:** 0,95 fija
- **Resolución óptica (Distancia: Punto):** 12:1
- **Dimensiones:** 3,25 x 7 x 1,74 pulgadas
- **Peso:** 3,9 onzas
- **Tipo de pilas:** 2 pilas alcalinas AAA
- **Vida útil de las pilas:** 14,5 horas
- **Resolución de la pantalla:** 0,1°
- **Retención de la pantalla:** Automática
- **Calibración:** Precisa durante un año
- **Láser:** FDA e IEC Clase II
- **Certificaciones:** CE e RoHS

### ADVERTENCIAS

Para asegurar un funcionamiento y un servicio seguros del probador, siga estas instrucciones. Si no se hace caso de estas advertencias, el resultado puede ser lesiones graves o la muerte.

- No dirija el rayo láser hacia los ojos, ya que esto puede causar daños oculares permanentes.
- No utilice el instrumento si la carcasa está dañada de alguna manera.
- Reemplace las pilas en cuanto aparezca el indicador de pila baja.
- Haga que le den servicio de mantenimiento al instrumento si se está comportando de manera anormal.
- Tenga cuidado con las lecturas de materiales reflectantes, ya que es posible que el instrumento las indique como más frías de lo que realmente son (vea *Emisividad*).
- Evite utilizar el instrumento cerca de campos electromagnéticos fuertes.

### PRÁCTICAS SEGURAS

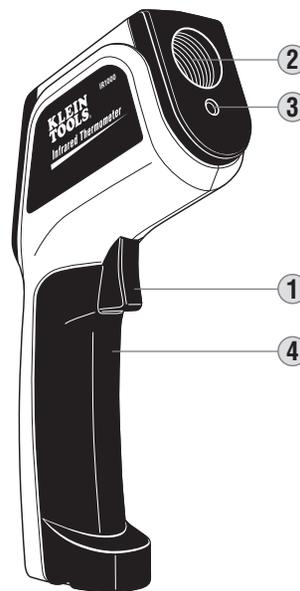
Este instrumento está diseñado por profesionales que conocen los peligros asociados con su actividad. Aunque este instrumento no ofrece peligros previsible más allá de su mira láser, el equipo al que usted esté haciendo servicio de mantenimiento, así como el entorno en el que esté trabajando, pueden ser peligrosos. Éstas son unas pocas prácticas de seguridad comunes para las personas que trabajan cerca de entornos de temperatura críticos:

- Siga los procedimientos de mantenimiento del fabricante cuando haga servicio de mantenimiento de equipos.
- Antes de utilizar este instrumento para determinar si es seguro tocar un área o entrar en ella, verifique que sus lecturas son razonablemente precisas en comparación con mediciones conocidas.
- Mantenga apropiadamente su termómetro infrarrojo y calíbrelo regularmente.

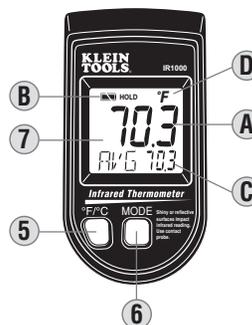
### SÍMBOLOS

- Láser
- Advertencia o precaución
- Siga los procedimientos de eliminación segura
- Niveles peligrosos
- Pila

### ATRIBUTOS DEL TERMÓMETRO



- Gatillo:** Inicia la medición.
- Sensor IR:** Recoge datos de temperatura.
- Indicador láser:** Ayuda a apuntar el sensor.
- Compartimiento de las pilas:** Salta hacia delante para almacenar 2 pilas AAA.
- Botón de °F/°C:** Cambia la escala de medición.
- Botó de modo:** Cambia el modo de cálculo.
- Pantalla LCD:** Muestra la medición e información adicional.
  - A. Medición más reciente.
  - B. Indicador de pila baja.
    - Pila OK
    - Pila baja
    - Pila agotada
  - C. Pantalla de cálculo.
  - D. Escala de temperatura (°F/°C)



### INSTRUCCIONES DE UTILIZACIÓN

#### Medición de temperatura

Para tomar medidas con su IR1000, apunte el instrumento hacia el objeto que vaya a medir y jale el gatillo. La unidad tiene una función de apagado automático después de soltar el gatillo de 15 segundos.

#### Min / Max / Prom (Avg) / Diferencial

Presione el botón de MODO para seleccionar mínimo, máximo, promedio o diferencial. Presione el gatillo y escanee el área que esté midiendo.

- **Min:** Muestra la temperatura más baja medida mientras se está escaneando.
- **Max:** Muestra la temperatura más alta medida mientras se está escaneando.
- **Prom (Avg):** Muestra un promedio de la temperatura mientras usted está escaneando.
- **Dif:** Muestra la diferencia entre las temperaturas más alta y más baja medidas mientras se está escaneando.

#### Selección de la escala de temperatura

Presione el botón de °F/°C para alternar entre grados Fahrenheit y centígrados.

Puede seleccionar cualquiera de las dos escalas durante o después de la medición, cuando esté viendo cualquiera de los valores retenidos.

#### Retención automática

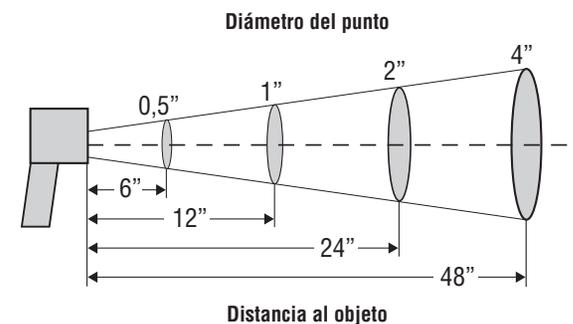
El IR1000 retendrá la última temperatura medida durante 15 segundos después de soltar el gatillo. Para recuperar este valor, presione la tecla de MODO para activar la pantalla y mostrar la temperatura retenida.

### RELACIÓN DE DISTANCIA A PUNTO

La relación de distancia a punto es una representación de qué tan enfocado está el sensor IR en el área de medición. Cuanto más cerca esté usted de la superficie que esté midiendo, más pequeña será el área de medición.

El IR1000 tiene una relación de distancia a punto de 12:1. Esto significa que si usted está a 12 pies de un respiradero de aire, dicho respiradero debe tener 1 pie o menos de diámetro para resolver la medición más precisa.

A continuación se muestra una ilustración de otras medidas de ejemplo.



## ÉMISSIVITÉ

L'instrument IR1000 est réglé sur une émissivité de 0,95. Ceci s'applique à la plupart des applications et fournira une mesure fiable et précise de la température à la surface.

Les surfaces brillantes et réfléchissantes (p. ex., le chrome, le cuivre nouveau, les panneaux blancs) ont une émissivité beaucoup plus faible et ne permettent pas une lecture précise. Une solution couramment utilisée pour effectuer des mesures sur ces types de surfaces consiste à appliquer d'abord.

## REPLACEMENT DES PILES

1. **Ouvrez** le compartiment des piles en tirant sur le couvercle de ce compartiment au niveau des indentations dans le sens opposé à la gâchette (voir la section *Attributs du thermomètre*).
2. **Retirez** et recyclez les piles complètement déchargées.
3. **Remplacez** 2 piles alcalines AAA en tenant compte de la polarité indiquée par les repères à l'intérieur du compartiment.
4. **Remettez en place** le couvercle du compartiment et assurez-vous qu'il est solidement en place.

## PRÉCISION

Température Ambiante	Température de la cible	Précision
77 °F	59-95 °F (15-35 °C)	±1,8 °F (1,0 °C)
68-79 °F (20-26 °C)	32-1000 °F (0-538 °C)	±2 % de la lecture ou 4 °F(2 °C) selon la plus élevée de ces valeurs
68-79 °F (20-26 °C)	-58-32 °F (-50-0°C)	±(4 °F+0,1 degré/degré) ±(2 °C+0,05 degré/degré)

## GARANTIE

Ce produit est garanti sans défauts de matériau ou de fabrication pendant une période de deux ans à compter de la date de l'achat. Pendant cette période de garantie, à son choix, Klein réparera ou remplacera tout produit qui ne serait pas conforme à cette garantie dans des conditions normales d'utilisation et de service, ou en remboursera le prix d'achat. Cette garantie ne couvre pas les dommages qui surviennent pendant l'expédition ou les défaillances qui résultent d'une altération, d'une falsification, d'un accident, d'une utilisation non conforme ou abusive, de négligence ou d'une maintenance incorrecte. Les piles et les dommages résultant de piles défectueuses ne sont pas couverts par la garantie. Un reçu d'achat ou un autre justificatif indiquant la date de l'achat initial sera exigé avant que des réparations ne soient effectuées dans le cadre de la garantie.

Toutes garanties implicites, y compris, entre autres, les garanties implicites de qualité marchande et d'adéquation à un but particulier, sont limitées à la garantie expresse. Klein Tools n'assumera aucune responsabilité au titre de la perte d'utilisation de l'instrument ou pour d'autres dommages, frais ou pertes économiques secondaires ou accessoires, ou en cas de réclamation ou de réclamations pour de tels dommages, frais ou pertes économiques.

Étant donné que les lois de certains États, de certaines provinces ou de certains pays varient, les limitations ou exclusions ci-dessus ne s'appliquent peut-être pas à vous. Cette garantie vous confère des droits particuliers, et vous pouvez aussi avoir d'autres droits qui varient selon l'État ou la province où vous résidez. Si votre produit Klein nécessite des réparations ou pour connaître la façon de faire valoir vos droits en vertu des termes de la présente garantie, veuillez contacter Klein Tools au 1-877-775-5346.

## NETTOYAGE

Nettoyez l'instrument en utilisant un chiffon humide. N'utilisez pas de produits de nettoyage abrasifs ou de solvants.

Prenez soin de toujours garder la lentille du capteur propre. Nettoyez la lentille en utilisant un chiffon doux ou un coton-tige avec de l'eau ou de l'alcool à friction seulement, et laissez la lentille sécher avant de l'utiliser.

## RANGEMENT

Retirez les piles lorsque l'instrument ne va pas être utilisé pendant une période prolongée. N'exposez pas à une température ou une humidité élevée. À la suite d'une période de rangement dans des conditions extrêmes dépassant les limites mentionnées dans la section consacrée aux spécifications, laissez l'instrument retourner dans des conditions de mesure normales avant de vous en servir à nouveau.

## MISE AU REBUT/RECYCLAGE



**Mise en garde:** Ce symbole indique que l'équipement et ses accessoires doivent faire l'objet d'une élimination distincte et d'une mise au rebut conforme aux règlements.

## SERVICE À LA CLIENTÈLE

KLEIN TOOLS, INC.  
450 Bond Street  
Lincolnshire, IL 60069  
1-877-775-5346  
www.kleintools.com

# Mode d'Emploi

## IR1000

## FRANÇAIS

- **PLAGE DE MESURE :**  
DE -58 ° À  
1 000 °F
- **RAPPORT OPTIQUE 12 :1**
- **CIBLAGE LASER**
- **MAX / MIN / MOYENNE / DIFFÉRENCE**
- **RÉTROÉCLAIRAGE**
- **EXTINCTION AUTOMATIQUE**
- **BOUTON °F / °C**



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# IR1000

## Mode d'Emploi

### SPÉCIFICATIONS GÉNÉRALES

L'instrument Klein Tools IR 1000 est un thermomètre à infrarouges de la série professionnelle. Il a une plage de mesure étendue, un excellent rapport de distance au point et plusieurs modes de calcul pour vous aider à prendre les meilleures mesures possibles.

- **Altitude de fonctionnement** : 2 000 mètres
- **Humidité relative** : 75 % max.
- **Température de fonctionnement** : 32-122 °F (0-50 °C)
- **Température de stockage** : -4~140 °F (-20~60 °C)
- **Précision de la température** : 22,8 °C ± 1,7 °C (73 °F ± 3 °F)
- **Émissivité** : 0,95, fixe
- **Résolution optique (distance au point)** : 12 :1
- **Dimensions** : 3,25 x 7 x 1,74 po
- **Poids** : 3,9 oz
- **Type de piles** : 2 piles alcalines AAA
- **Durée de vie des piles** : 14,5 heures
- **Résolution à l'affichage** : 0,1°
- **Maintien de l'affichage** : Auto
- **Calibrage** : Précision garantie pendant un an
- **Laser** : FDA et IEC Classe II
- **Certifications**: CE et RoHS

### ⚠ AVERTISSEMENTS

Pour assurer un fonctionnement sans danger et correct de l'instrument de mesure, suivez ces instructions. Le non-respect de ces avertissements pourrait entraîner des blessures graves ou même la mort.

- Ne dirigez pas le rayon laser directement dans les yeux car ceci pourrait causer une lésion permanente aux yeux.
- Ne vous servez pas de cet instrument si son étui est endommagé de quelque façon que ce soit.
- Remplacez les piles dès que l'indicateur de décharge des piles s'allume.
- Faites inspecter l'instrument immédiatement par un spécialiste si son fonctionnement vous semble anormal.
- Faites particulièrement attention lorsque vous faites des lectures de la température de matériaux réfléchissants car ils risquent d'être indiqués par l'instrument comme étant moins chauds qu'ils ne le sont réellement (voir *Émissivité*).
- Évitez d'utiliser l'instrument à proximité de puissants champs électromagnétiques.

### PRATIQUES DE SÉCURITÉ

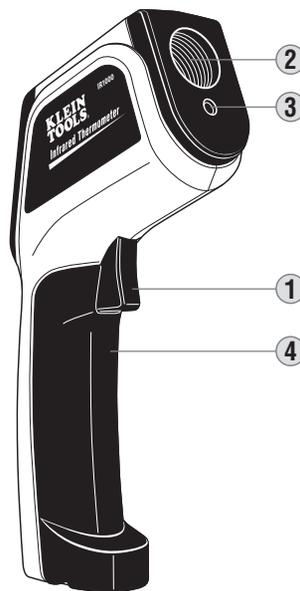
Cet instrument est conçu à l'intention de professionnels qui connaissent les risques de leur métier. Bien que cet instrument ne présente aucun danger prévisible en dehors du rayon laser, les équipements sur lesquels vous travaillez, ainsi que l'environnement dans lequel vous travaillez, peuvent être dangereux. Voici quelques pratiques de sécurité ordinaires pour les personnes qui travaillent dans des environnements où la température peut présenter des dangers.

- Suivez les procédures de maintenance du fabricant lorsque vous effectuez des opérations d'entretien.
- Avant de vous servir de cet instrument pour déterminer si une surface est à une température adéquate pour la toucher ou si vous pouvez entrer quelque part, assurez-vous que vos lectures sont raisonnablement comparables aux mesures connues par ailleurs.
- Entretenez correctement votre thermomètre infrarouge et calibrez-le à intervalles périodiques.

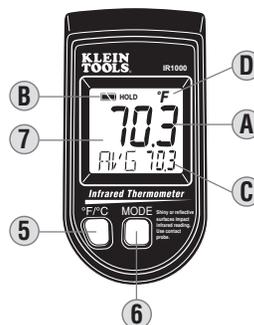
### SYMBOLES

- Laser
- Avertissement ou Mise en garde
- Suivez des procédures d'élimination sans danger.
- Niveaux dangereux
- Piles

### ATTRIBUTS DU THERMOMÈTRE



- Gâchette** : Déclenche la mesure.
- Capteur IR** : Recueille les données sur la température.
- Pointeur laser** : Aide à pointer le capteur.
- Compartment des piles** : S'ouvre d'un seul coup vers l'avant; rangement de 2 piles AAA.
- Bouton °F / °C** : Change l'échelle de mesure.
- Bouton de mode** : Change le mode de calcul.
- Écran ACL** : Affiche la mesure ainsi que d'autres informations.



- Mesure la plus récente.
- Indicateur de décharge des piles.
  - Piles OK
  - Piles partiellement déchargées
  - Piles totalement déchargées
- Affichage des calculs.
- Échelle des températures (°F/°C)

### INSTRUCTIONS POUR LE FONCTIONNEMENT

#### Mesure de la température

Pour faire des mesures avec votre instrument IR1000, pointez l'instrument sur l'objet à mesurer et tirez sur la gâchette. L'instrument est doté d'un mécanisme d'extinction automatique qui se déclenche 15 secondes après que vous ayez tiré sur la gâchette.

#### Min /Max /Moyenne /Différence

Appuyez sur le bouton MODE pour sélectionner minimum, maximum, moyenne ou différentiel. Appuyez sur la gâchette et balayez la surface à mesurer.

- **Min**: Affiche la mesure de température la plus basse lue pendant le balayage.
- **Max**: Affiche la mesure de température la plus élevée lue pendant le balayage.
- **Avg (Moyenne)** : Affiche une moyenne des températures lues pendant le balayage.
- **Diff** : Affiche la différence entre les températures les plus élevées et les plus basses lues pendant le balayage.

#### Sélection de l'échelle de température

Appuyez sur le bouton °F/°C pour alterner entre les degrés Fahrenheit et les degrés Celsius. Vous pouvez sélectionner n'importe laquelle de ces échelles pendant ou après la mesure lorsque vous regardez n'importe quelle valeur mise en mémoire.

#### Maintien automatique de l'affichage

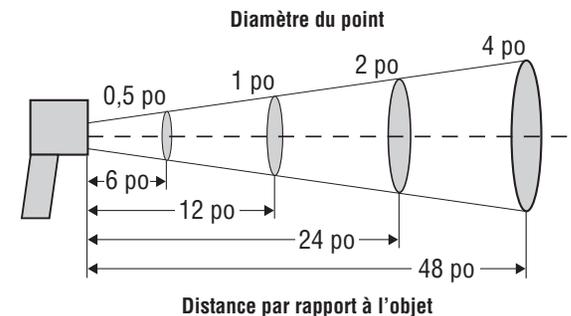
L'instrument IR1000 maintiendra la dernière température mesurée affichée pendant 15 secondes après que vous aurez relâché la gâchette. Pour rappeler cette valeur, appuyez sur la touche MODE afin d'activer l'écran d'affichage pour montre la température ainsi mise en mémoire.

### RAPPORT DE DISTANCE AU POINT

Le rapport de distance au point est une représentation de la façon dont le capteur IR est pointé sur la zone à mesurer. Plus vous êtes près de la surface que vous mesurez, plus la surface de mesure est petite.

L'instrument IR1000 a un rapport de distance au point de 12 :1. Cela signifie que si vous êtes à 12 pieds (4 m) d'une grille d'aération, la grille doit avoir un diamètre d'un pied (30 cm) ou moins pour que vous puissiez obtenir la mesure la plus précise.

Voici ci-dessous une illustration d'autres mesures à titre d'exemple.



**APPENDIX C**  
**FIELD FORMS FOR AS/SVE/SSD MONITORING**

# Air Sparge Blower, Air Sparge Wells, Extraction Laterals, Extraction Blower, Subslab Depressurization

<b>Technician:</b>					<b>Day/Date:</b>		
<b>Weather Condition:</b> (temp, barometer, wind, etc)							
Monitoring Point	Time	Valves (% Open)	Flow (m/s)	Temp. (°C/ °F) <sup>b</sup>	Pressure (in H <sub>2</sub> O +/-) <sup>c</sup> (psig) <sup>c</sup>	Comments	
<b>Air Sparge Blower</b>		<b>Time On:</b> _____			<b>Time Off:</b> _____		
AS Blower Vault							
<b>Air Sparge Wells</b>							
11574-ASW-1							
11574-ASW-2							
<b>Extraction Blower Suction</b>							
11574-SVE-BS-1							
11574-SVE-BS-2							
<b>Extraction Blower Exhaust (11574-SVE-BE-1)</b>		Always 100%			<b>VOCs by PID</b> (ppbv/ppmv) <sup>d</sup>		
<b>Sub-slab Probe Pressures</b>		<b>SSD-S1 (SE)</b> (in W.C.)	<b>SSD-S2 (SW)</b> (in W.C.)	<b>SSD-N1 (NE)</b> (in W.C.)	<b>SSD-N2 (NW)</b> (in W.C.)	<b>SSD-3 (inside)</b> (in W.C.)	
<b>Comments</b> (e.g. Duration of KO drum draining, Valve Position Changes, Samples, etc.)							
					<b>Signature:</b>		

Notes:

a: Identify phase of testing, AS and SVE valve positions, etc.;

c: Identify negative or positive pressure. (in H<sub>2</sub>O for SVE blower, psig for sparge blower).

b: Identify temperature units.

d: Identify units of measurement.

## Soil Vapor Migration and Subslab Depressurization Monitoring

<b>Project Phase/ Operating Condition<sup>a</sup>:</b>							
<b>Technician:</b>							
<b>Weather Conditions:</b> (wind, barometer, temp, etc. Data source)							
Monitoring Point <sup>b</sup>	Date	Time	Port Pressure (in H <sub>2</sub> O +/-)	Pressure Differential (in H <sub>2</sub> O)	VOC by PID (ppb/ppm)	Lab Sample (Summa/Tedlar) Sample ID	Comments
<b>Parking Lot Soil Vapor Probes</b>							
11574-SVP--1a							
11574-SVP--1b							
11574-SVP--2a							
11574-SVP--3a							
11574-SVP--4a							
11574-SVP--5a							
11574-SVP--5b							
11574-SVP--6a							
11574-SVP--7a							
11574-SVP--7b							
<b>Building Subslab Monitoring Port</b>							
11574-SSD-N1							
11574-SSD-N2							
11574-SSD-S1							
11574-SSD-S2							
11574-SSD-3							

Notes:

a: Identify blower and compressor status, AS and SVE valve positions, etc.

b: Soil Vapor Probe “a” installed at shallow depth. Soil Vapor Probe “b” installed at greater depth. Depths calculated based on calculated cone of expansion of extraction system. Depths decrease with distance from building.

# SUMMA CANISTER SAMPLING

**Day/Date:** \_\_\_\_\_

**Project Phase and Operating Condition:** AS blower on/off; SVE blower on/off; SVE valve positions (% open): \_\_\_\_\_

**Technician:** \_\_\_\_\_

**Weather Conditions:** (wind, barometer, temp, etc. Data source) \_\_\_\_\_

Time	Summa Canister Number	Sampling Cane Number	Canister Sampling Location	Initial Canister Vacuum (in Hg)	Final Canister Vacuum (in Hg)	Comments



# SEALASKA ENVIRONMENTAL SERVICES, LLC, (SES)

## CONFINED SPACE ENTRY PRE-ENTRY BRIEFING CHECKLIST

**Project Name:** \_\_\_\_\_ **Project Location:** \_\_\_\_\_

**Date:** \_\_\_\_\_ **Time:** \_\_\_\_\_

**Completed By:** \_\_\_\_\_

**Attendee(s):** \_\_\_\_\_

\_\_\_\_\_

- Hazard Communication (including the signs, symptoms, and modalities of chemical overexposure).
- Physical hazards present.
- All hazard controls.
- Acceptable entry conditions.
- Emergency procedures.
- Rescue procedures.
- Duties of entrants and attendants during routine and emergency operations.
- Frequency and Types of Monitoring.
- Communications system backup to be used.
- Review of work to be accomplished during entry.
- Decontamination procedures (if necessary).
- PPE disposal
- Potential emergencies that may occur outside the confined space.

**SEALASKA ENVIRONMENTAL SERVICES, LLC (SES)  
 CONFINED SPACE ENTRY PERMIT**

**PERMIT VALID FOR ONE SHIFT ONLY. ALL PERMIT COPIES REMAIN AT SITE UNTIL JOB COMPLETED. A PERMIT IS TO BE POSTED FOR ALL CONFINED SPACE ENTRIES REGARDLESS OF THE TYPE OF SPACE ENTERED. HOWEVER, ONLY SECTIONS OF THE PERMIT APPLICABLE TO THE SPECIFIC TYPE OF CONFINED SPACE (PERMIT vs NON-PERMIT) NEED BE COMPLETED.**

DATE: \_\_\_\_\_ SITE LOCATION/DESCRIPTION: \_\_\_\_\_

PURPOSE OF ENTRY: \_\_\_\_\_

SUPERVISOR(S) IN CHARGE OF CREWS/TYPE OF CREW/PHONE #: \_\_\_\_\_

COMMUNICATION PROCEDURES: \_\_\_\_\_

RESCUE PROCEDURES AND PHONE NUMBERS: \_\_\_\_\_

Name of Emergency Service (ES)	Phone# of ES	Date/Time ES contacted	ES Available ? Y or N	Date/Time ES Response Made		Comments/Problems with Service
				Before Confined Space	After Confined Space	

REQUIREMENTS COMPLETED	DATE	TIME	REQUIREMENTS COMPLETED	DATE	TIME
Breathing Apparatus	_____	_____	Line(s) Broken-Cappe Blank	_____	_____
Emergency Escape/Fall Retrieval Equipment	_____	_____	Protective Clothing	_____	_____
Fire Extinguishers	_____	_____	Purge-Flush and Vent	_____	_____
Full Body Harness w/ "D" Ring	_____	_____	Respiratory Protection	_____	_____
Lifelines	_____	_____	Secure Area (Post and Flag)	_____	_____
Lighting (Explosive Proof)	_____	_____	Standby Safety Personnel	_____	_____
			Ventilation	_____	_____

Note: For items that do not apply, enter N/A in the blank. See page 2 to add any special requirements..

**RECORD MONITORING RESULTS EVERY 1/4 HOUR**

<u>TEST(S) TO BE TAKEN</u>	Permissible Entry Level	Time(s)	_____	_____	_____	_____	_____	_____	_____
PERCENT OF OXYGEN	19.5% to 22.0%	_____	_____	_____	_____	_____	_____	_____	_____
LOWER FLAMMABLE LIMIT	Under 10 %	_____	_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____	_____	_____	_____

Note: Initial air monitoring is mandatory for all confined spaces.

REMARKS: \_\_\_\_\_



**APPENDIX D**  
**AIR SPARGE BLOWER CURVE**

### Vacuum Pump



### Mode 6066 Series

25 inHg max. vacuum  
55 CFM open flow  
15 psi max. pressure

### Product Features

- Oilless operation
- Rugged construction/low maintenance
- Essentially pulse-free service

### Includes

- Filter AD560
- Muffer AD560B
- Coupling AE544B-1 (.88" x 1.13") – Vacuum pump
- Coupling AE765 (.88" x 1.13") – Compressor
- Check valve AH326B

### Recommended Accessories

- Vacuum relief valve AE961
- Pressure relief valve AA307
- Vacuum gauge AA640
- Pressure gauge AA644B
- Coupling guard AH380B-1
- Base AB322E
- Repair kit K503

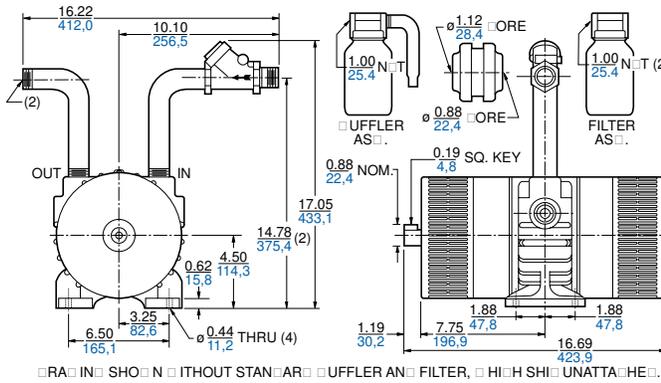
→ **Compressor**



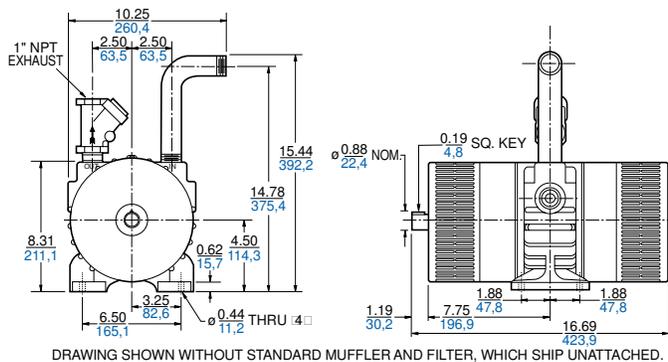
### Product Dimensions (inches, mm)

Dimensions are for reference only

#### Vacuum Pump



#### Compressor

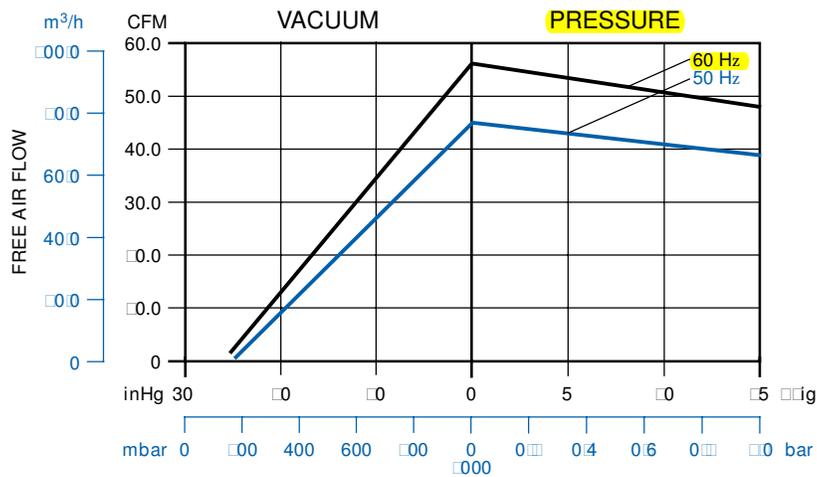


Product Specifications Note: "P" models are pressure, "V" models are vacuum.

Model Number	Motor	Base	Coupling Guard	RPM		HP	kW	Net Weight	
				60 Hz	50 Hz			lbs	kg
6066-P102	—	—	—	1725	—	5	3,73	88	39,6
6066-P106A-T339	230/460-60-3	•	•	1725	—	5	3,73	203	91,4
6066-P108-SD400-1*	415-50-3	•	•	—	1425	5	3,73	203	91,4
6066-V103	—	—	—	1725	—	5	3,73	92	41,4
6066-V105A	—	•	•	1725	—	5	3,73	114	51,3
6066-V107A-T339	230/460-60-3	•	•	1725	—	5	3,73	183	82,4
6066-V109-BC630-1*	415-50-3	•	•	—	1425	3	2,2	172	77,4

\* Available only in Europe.

### Product Performance



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