

STANDARD OPERATING PROCEDURE FOR PRESSURE TRANSDUCER INSTALLATION AND MAINTENANCE

State of Utah
Department of Environmental Quality
Division of Water Quality



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Utah Division of Water Quality (DWQ) Standard Operating Procedures (SOPs) are adapted from published methods, or developed by in-house technical experts. This document is intended primarily for internal DWQ use. This SOP should not replace any official published methods.

Any reference within this document to specific equipment, manufacturers, or supplies is only for descriptive purposes and does not constitute an endorsement of a particular product or service by the author or by DWQ. Additionally, any distribution of this SOP does not constitute an endorsement of a particular procedure or method.

Although DWQ will follow this SOP in most instances, there may be instances in which DWQ will use an alternative methodology, procedure, or process.¹

¹ *Disclaimer language above adapted from Washington State Department of Ecology SOPs.*

REVISION PAGE

Date	Revision #	Summary of Changes	Sections	Other Comments
5/1/14	0	not applicable	not applicable	New SOP. Began document control/revision tracking.

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1.0 SCOPE AND APPLICABILITY

This document presents the Utah Division of Water Quality's (DWQ) Standard Operating Procedure (SOP) for the installation and maintenance of pressure transducers in Utah's natural (rivers, streams, lakes) or engineered (ditches, canals, reservoirs) surface water bodies. This SOP applies to any DWQ monitor or non-DWQ cooperator installing or maintaining pressure transducers. This SOP also outlines the responsibilities of DWQ monitors to perform inspections of pressure transducers and associated equipment while collecting water samples or performing flow measurements at a site where a pressure transducer has been installed.

Level TROLL 300 pressure transducers are a low-cost and robust method of determining near-continuous flow in streams that are not gaged by another agency (such as the U.S. Geological Survey or a utility). The pressure transducer consists of an "absolute" or "uncompensated" pressure sensor which measures absolute pressure and is not vented to allow for compensation for atmospheric pressure. Therefore, atmospheric pressure is subtracted from the absolute measurement to determine the pressure from water. The pressure transducer will log the depth of water at set time intervals. Recorded values are stored in the sensor itself and are periodically retrieved by field personnel. By combining these logs of depths with a number of discharge measurements taken at the site, a rating curve can be developed, correlating the depth of water with the measured discharge. Once this correlation has been established, discharge may be inferred from water depth alone.

Flow data is used by DWQ scientists and engineers for a variety of purposes including but not limited to:

- understanding the effect of hydrologic condition on aquatic life uses
- determining pollutant loading and inputs into receiving waterbodies
- setting permit requirements for discharge of treated wastewater
- understanding groundwater/surface water interactions
- characterizing current water quality conditions and detecting long-term changes

The information discussed in this SOP is not a substitute for equipment user manuals or other technical documentation. Consult the appropriate manual for a complete guide to the proper use, calibration, maintenance, deployment, and troubleshooting of pressure transducer equipment/software. This SOP is to be used as a reference but the complete user manual should always accompany the field personnel.

2.0 SUMMARY OF METHOD

The transducers are programmed to log the depth of water every 15 minutes. The installation site will be scoped for feasible placement of the transducer inside of a PVC pipe with the bottom of the pipe as close as possible to the low-water level of the stream and the top of the pipe as high as feasible above the current water level and the expected high water level. The PVC pipe will act as a stilling well to even out the wave action of the flowing water, and to prevent damage to the transducer by natural causes or intentional damage. The pipe will be attached at the site using one of a number of methods to safeguard against high flows and vandalism.

3.0 DEFINITIONS

Discharge:	A term used in this SOP interchangeably with “flow”. This is the volume of water flowing per unit of time. A flow or discharge measurement is a manual measurement of stream flow performed by a DWQ monitor/cooperator.
Gaging station:	This is a site where flow is being measured continuously and automatically using devices such as, but not limited to, pressure transducers.
Pressure transducer:	A device that measures pressure
PVC:	Polyvinyl chloride
Reference level:	The fixed elevation or height under the water at which the pressure transducer is installed
Stage:	The height of the surface of the water in relation to the reference level
Stilling well:	A cylinder installed near a body of water used to hold and protect hydrological sensors. The stilling well allows water to move in and out freely to interact with sensors but dampens wave and current action so as to provide a representative water level and to reduce noise in water level data.

4.0 HEALTH AND SAFETY WARNINGS

In most cases, installation of pressure transducers will take place on stream banks. Most sites for installation of pressure transducers are near bridges fortified with rip-rap, which can be unstable, slippery, and sharp. Stream banks, where transducers are often installed are steep, slippery, and covered in cobble. Power tools, including hammer drills and sawzalls, can be hazardous if used improperly. Working near water in waders

poses a drowning hazard, and working near water in the winter poses a hypothermia hazard.

5.0 CAUTIONS

Since the pressure transducer relates recorded depth of the transducer to recorded flow at the site, it is imperative that the transducer remain at the reference level, or height under water, for the duration of measurements. The transducer will need to be removed from the PVC pipe to download data and to clean out any debris or sediment, and care should be exercised to return the transducer to the same level from which it was retrieved.

Flow measurements (see DWQ's SOP for Stream Flow Measurements) should be conducted by monitoring staff as accurately as possible as a limited number of flow measurements will be used to interpolate a range of discharge from the depths recorded by the transducer.

6.0 INTERFERENCES

The PVC pipe must be anchored firmly enough to prevent movement, which would change the reference depth of the transducer.

7.0 PERSONNEL QUALIFICATIONS/RESPONSIBILITIES

A senior Utah DWQ monitoring staff member will be the primary responsible party for installation of pressure transducers and development/maintenance of rating curves. This monitor will also be responsible for training new field staff.

Personnel installing pressure transducers and taking flow measurements should be knowledgeable of the relation between stream depth, or stage, and stream flow. Programming the transducers requires knowledge of computers and deployment software. Installation of the stilling wells and transducers is physically demanding and requires the use of a T-post driver, 3 pound hammer, hammer drill, and cable cutters.

Monitors that may be performing inspections of installed pressure transducers are required to read this SOP annually and acknowledge they have done so via a signature page (see **Appendix 1**) that will be kept on-file at DWQ along with the official hard copy of this SOP. Before new personnel can install pressure transducers or perform gage maintenance they must be trained by an experienced DWQ monitor. The signature page will be signed by both trainee and trainer to confirm that training was successfully completed and that the new monitor is competent in carrying out this SOP.

8.0 EQUIPMENT AND SUPPLIES

- Copy of this SOP
- Field Form (**Appendix 2**)

- In-Situ Inc. Level TROLL 300 logging pressure transducer or equivalent.
- Win-Situ 5 logger software
- In-Situ Inc. RS232 TROLL Com Direct Connect communication cable
- Laptop or desktop computer to communicate with the Level TROLL 300
- 1.5-inch diameter PVC Schedule 40 electrical conduit pipe, 10-foot length cut to fit specific installation
 - ¼-inch holes drilled from end to 12 inches up pipe, every 90 degrees around and every 2 inches to allow water to equilibrate in pipe
 - 3/8-inch hole drilled two inches from top of pipe, to allow water to equilibrate in pipe and for the attachment of padlock
- Two 1.5-inch PVC caps
 - Bottom cap drilled with ¼-inch holes in bottom for water to equilibrate and sediment to drop out; attached to pipe with self-tapping screws to allow removal for cleaning
 - Top cap friction fitted onto top of pipe, no modifications
- Lengths of 3/32-inch vinyl coated braided stainless-steel (SS) cable to attach pressure transducer inside PVC pipe to padlock; cut to fit specific installation
- 3/32-inch cable ferrules to attach SS cable to pressure transducer and form loop in top of cable to attach to padlock
- Attachment materials and tools
 - ¾-inch SS strapping, seals, and tensioner
 - Hammer drill, 3/32-inch masonry bits, ¼-inch X 2-inch masonry screws
 - Powder-actuated nailer, powder charges, and concrete pins
 - 1.5-inch two-hole metal conduit straps
 - 5-foot T-posts, post driver, 3 pound single jack sledgehammer, 2-foot rebar
- Keyed or combination long-shackle padlock to secure the transducer on the SS cable in the PVC pipe (Utah DWQ uses combination locks; combination code can be found in the site portfolio)
- In-Situ Inc. BaroTROLL, one unit per general geographic area to provide a log of the atmospheric pressure

9.0 PROCEDURE

9.1 Calibration

- 1) The In-Situ Level TROLL 300s are calibrated at the factory and no calibration or standardization is necessary before use.

- 2) The life of a transducer and how long it will maintain its calibration is dependent upon the duration of use, exposure to extreme environmental conditions, and how carefully it is handled during storage, transportation, and use. If needed, calibration is possible with the Level TROLL and the procedure is detailed in the Level TROLL Operators Manual.
- 3) Record the serial number and factory calibration date for the pressure transducer on the field form (**Appendix 2**) maintained in the site portfolio folder.

9.2 Installation

- 1) Determine where detailed flow measurements are required and assess the best location to install the stilling well and transducer. The stilling well should be mounted to a permanent object (e.g., bridge piling) at a location where the channel cross section is not likely to change over time. In addition, this location should be suitable for obtaining discharge measurements by wading or deploying a Q-boat from a bridge or cable.
- 2) Using Win-Situ 5 or equivalent software, program the transducers to log depth readings every 15 minutes, using the procedure outlined in the software. The Level TROLLs can be programmed to log immediately, or a delayed start may be used. In either case, ensure in the software that the unit is programmed and is logging or will begin logging at the programmed time and date. Include in the programming the name of the site and date of deployment.
- 3) Based upon the site, determine the length of the PVC pipe that is feasible to reach down to low water and ideally above high water. The transducers are water-tight, so no damage will occur if the top of the pipe is not above water throughout the year.
- 4) Using this determined length, cut the PVC pipe from the top, if necessary, to the appropriate length. The 3/8-inch hole for the padlock will need to be re-drilled 2 inches below the top of this new length of pipe.
- 5) Using the 3/32-inch SS cable and ferrules, make a tether for the pressure transducer inside the PVC pipe.
 - a) Place a ferrule on the cable, run the end through the eyelet on the top of the transducer then through the ferrule again, forming approximately a 2-inch loop. Clamp in place using a ferrule clamp or the 3-pound sledge and a hard surface.
 - b) Holding the other end of the cable, lower the transducer on the cable into the pipe until it reaches the bottom cap. Pull the transducer up approximately 1/2-inch above the cap and mark the cable at the location of the top hole in the pipe for the padlock. Form a loop with this mark at the top, and cut the cable with adequate length to make this loop. Check that the transducer will be approximately 1/2" above the bottom cap when the padlock is run through the pipe

and top loop of the tether, and clamp the top loop using one of the above methods.

- c) This will create a tether of set length with the transducer at the bottom end and an approximately 2-inch loop at the top end.
- 6) The transducer on the end of the tether can be inserted into the stilling well, and secured by inserting the free end of the padlock shackle through one of the 3/8-inch holes at the top of the well, hooking the tether loop over the shackle inside the pipe, then inserting the shackle through the other hole (other side of pipe) and locking the padlock.
- 7) Place the top cap on the stilling well.
- 8) To attach the stilling well at the determined site, one of several methods can be employed, listed in order of preference:
 - a) If using a bridge pylon or other vertical structure that extends into the stream as low as the low water mark, the stilling well can be strapped to the downstream side (to minimize wakes caused by the structure) using the SS strapping, seals and SS tensioner. Detailed instructions on using these tools can be found at: <http://www.uline.com/PDF/IH-1273.PDF>.
 - b) If using a vertical surface, such as a bridge abutment at the downstream side where the SS strapping cannot be wrapped around the surface, the 1.5-inch metal conduit straps can be used to attach the stilling well. If the vertical surface is concrete, as is likely, a hammer drill and concrete screws or powder-actuated nailer and concrete nails will be used to attach the stilling well, nailing or screwing down the straps over the stilling well in at least two spots, typically just above current water level and near the top of the well.
 - c) If no vertical surface is present, the transducer can be attached to a diagonal surface, such as a stream bank. The transducer records absolute depth of water, so the stilling well in a diagonal position will not affect readings. Determine best location of stilling well, and mark two or more locations to drive T-posts or sections of rebar into the stream bank to use as attachment points for the stilling well. Position the posts downstream of the stilling well location and drive them as deep as possible to provide a good anchor and prevent a hazard. Attach the stilling well using the SS strapping around the well and post to prevent movement and vandalism.
- 9) Record the date of deployment on the field form (**Appendix 2**).

9.3 Inspection and Maintenance

- 1) The transducers should be inspected whenever feasible to ensure no damage, shifting, or vandalism has occurred. All DWQ monitors are provided with a list of the sites that are gaging stations. Monitors perform a visual inspection of the gage each time they visit that site. In addition, the monitor responsible for maintaining DWQ's gaging stations may visit the site to perform inspections and maintenance at more frequent intervals.
- 2) The monitor responsible for maintaining DWQ's gaging stations will determine the frequency at which more detailed inspections of the pressure transducer and inside of the stilling well will be performed. The transducer can be removed from the well to remove debris or sediment and the pressure transducer and stilling well can be cleaned. At a minimum, a detailed inspection and maintenance should be performed during data retrieval.
- 3) Record that an inspection and/or maintenance was performed on the field form (**Appendix 2**).

9.4 Data Retrieval

- 1) To retrieve the pressure transducer, remove the PVC cap and unlock the padlock. Pull on the SS cable to lift the pressure transducer out of the pipe.
- 2) To download the data, remove the protective cap from the transducer and plug it into the laptop using the RS232 Direct Connect cable. Win-Situ 5 will recognize the instrument, and prompt the user to connect and download the data.
- 3) Make certain the transducer is once again logging at the 15 minute intervals, and reinsert into the stilling well, attaching the tether with the padlock. The 2-inch loop ensures that the pressure transducer is lowered to the same depth from which it was retrieved.
- 4) Record that data retrieval was performed on the field form (**Appendix 2**).

10.0 DATA AND RECORDS MANAGEMENT

- The field form in **Appendix 2** should be included in the site portfolio of every site where a pressure transducer has been installed. Use this form to record installation of the pressure transducer, inspections and maintenance performed, data retrievals performed, and to note when a flow measurement has been performed manually by a monitor. In addition, monitors/cooperators should notify the senior monitor responsible for the gaging station when a flow measurement has been performed at that site.

- Upon returning to the office with downloaded transducer data, the file should be uploaded to the Monitors folder on the Utah DWQ server to safeguard it against loss.
- The Win-Situ 5 software will store the logged depths and the logged barometric pressures. In-Situ Inc.'s Baro Merge Software will compensate the logged depths for changes in barometric pressure, improving accuracy.
- The BaroTROLL is identical to the Level TROLL except it is deployed in air. The BaroTROLLs are set up the same way, recording barometric pressure every 15 minutes. They need to be downloaded the same way as well, at the same time as the Level TROLLs.
- Using flow determinations and the logged depth at the time of flow measurement, a stage-discharge rating curve will be created. From the curve, an equation can be made that will allow all of the logged depths to be converted into flow estimations. Flow measurements are performed each time monitors collect water samples, if conditions allow. The monitor responsible for maintaining DWQ's gaging stations will determine the frequency at which flow measurements performed specifically for rating curve assessments/adjustments need to be performed. A minimum of five flow determinations should be made for a reasonable stage-discharge rating curve.

11.0 QUALITY ASSURANCE AND QUALITY CONTROL

Follow all procedures described in this SOP to ensure valid, high quality pressure transducer measurements. Follow all procedures described in DWQ's SOP for Stream Flow Measurement to ensure valid, high quality flow measurements that can be used to develop rating curves for gaged sites.

Keep up-to-date equipment maintenance records and calibration data (**Appendix 2**) with other site records to provide defense of quality data from installed pressure transducers.

12.0 REFERENCES

The In-Situ Inc. website (<http://www.in-situ.com/>) has Win-Situ software updates and helpful Quick Guides, Instrument Manuals, Instruction Sheets and Technical Notes including:

- Level TROLL 300, 500, 700, and BaroTROLL Operator's Manual (<http://www.in-situ.com/Manuals>)
- Win-Situ 5.0 User's Guide (http://www.in-situ.com/Win_Situ5)
- Level TROLL 300, 500, and 700 Quick Start Guide (<http://www.in-situ.com/QuickStarts>)
- Technical Note: Using Baro Merge Software (http://www.in-situ.com/Baro_MergeSoftware)

Goering, T. 2008. Pressure transducer installation, removal, and maintenance. Los Alamos National Laboratory Standard Operating Procedure SOP-5227, Revision 0, Effective Date 10/28/2009. Online at http://www.lanl.gov/environment/all/docs/qa/ep_qa/SOP-5227.pdf.

Yerington Mine Site. 2009. Pressure transducer water level monitoring standard operating procedure SOP-21, Revision 1, Revision Data 4/28/2009. Online at [http://yosemite.epa.gov/r9/sfund/r9sfdocw.nsf/cf0bac722e32d408882574260073faed/120f26eb0d420d8b882575e1006899ae/\\$FILE/SOP-21r1%20Pressure%20Transducer%20Water%20Level%20Monitoring.pdf](http://yosemite.epa.gov/r9/sfund/r9sfdocw.nsf/cf0bac722e32d408882574260073faed/120f26eb0d420d8b882575e1006899ae/$FILE/SOP-21r1%20Pressure%20Transducer%20Water%20Level%20Monitoring.pdf).

Related DWQ SOPs:

Standard Operating Procedures for Stream Flow Measurement

