Whatcom County
Well Level Monitoring Pilot Project

Department of Health Contract GVS26362-0

Deliverable Task 5
Summary Report

June 30, 2022

Prepared for:
Public Utility District No.1
Of Whatcom County
1705 Trigg Road Ferndale
Ferndale, WA 98248

Prepared by:
Dave Olson
Cornerstone Management, Inc.
6993 Mission Rd.
Everson, WA 98247

Table of Contents

Introduction

Drinking water systems with ground water wells need to better understand the unique characteristic of their source of supply in order to better manage their systems and plan for sustainability. Water systems with shallow wells are particularly vulnerable to changes in ground water level and the impacts of climate change and potential drought.

The Department of Health is funding a well level monitoring pilot project in Whatcom County to better understand ground water levels of small Group A water systems and to use the study as an example to encourage other water utilities to install similar water measurement devices and monitoring networks.

The pilot project will install pressure transducers in wells located primarily in shallow alluvial aquifers at strategic locations and make the data available for use by the water systems as well as other agency and public platforms.

The Washington State Department of Health (DOH) has entered into an interagency agreement with Public Utility District No. 1 of Whatcom County (PUD) to install pressure transducers in Group A water system wells or in monitoring wells used by Group A water systems within Whatcom County for the following public health benefits:

- Provide ground water well level measurements for public water system sustainability
- Provide data for drought contingency planning and preparedness
- Provide data for long-term sustainable management of regional water resources
- Provide data available for integration with other agency public platforms

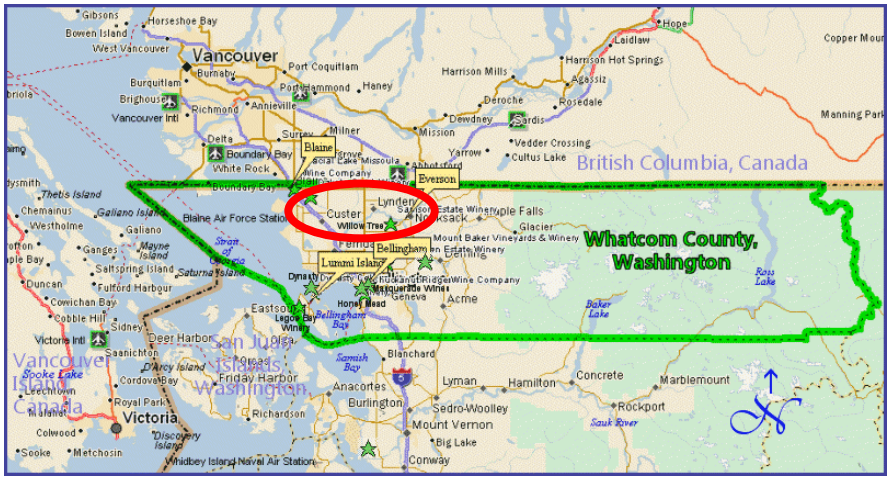


Figure 1: Regional Vicinity Map

Background

Public Utility District No. 1 of Whatcom County (PUD) is a steward of water and energy resources providing locally controlled utility services and resource protection for the benefit of the residents, businesses and agricultural community of greater Whatcom County.

Our climate is changing, and Washington is experiencing changes consistent with those observed globally. As summarized by the University of Washington, Climate Impacts Group: *The combined effects of climate change and climate variability in the Pacific Northwest are expected to result in a wide range of impacts for the region's communities, economy, and natural systems. These include projected changes in water resources. Washington's water resources will be affected by projected declines in snowpack, increasing stream temperatures, decreasing summer minimum stream flows, and widespread changes in streamflow timing and flood risk. These changes increase the potential for more frequent summer water shortages in some basins and for some water uses particularly in fully allocated watersheds with little resource management flexibility.*

As a leader in water resources management in Whatcom County, the PUD would like to better understand seasonal and long-term fluctuations in the aquifers underlying Whatcom County. Historically, aquifers in Whatcom County had adequate annual recharge and water supply shortages were infrequent. Predicted climate changes are expected to impact many water supplies, especially those in shallow, alluvial aquifers. To better identify the areas within Whatcom County that are at risk for drought, a water level measurement network is needed. The PUD proposes to install pressure transducers in wells completed primarily in the shallow alluvial aquifer at strategic locations throughout the county and make the data available for use by other agency and public platforms.

The pressure transducer project will be completed by the PUD. The PUD will work in consultation with the Washington Department of Health, Office of Drinking Water. The Department of Health is funding this pilot project in Whatcom County to better understand ground water quantities in Whatcom County and to use the study as an example to encourage other water utilities to install similar water measurement devices and/or monitoring networks.

The project includes:

Task 1: Identify up to ten Group A groundwater wells for installation of a pressure transducer to measure water levels. Wells will be owned/operated by an entity willing to participate in the pilot project. Each well will have a valid well log.

Task 2: Meet with the PUD and others as appropriate to discuss/finalize well locations and installation activities.

Task 3: Install pressure transducers in up to ten wells in Whatcom County and ensure the transducers are working properly

Task 4: Raw data will be collected and available in a universal data base format such as csv or excel and delivered on a monthly basis and at the completion of the pilot. Data will also be available online for observation during the pilot.

Task 5: Summary report of pilot activities, findings, conclusions, and recommended next steps.

Methodology

While it is certainly beneficial and recommended to monitor the level and performance of all drinking water ground water wells, the goal of this well level monitoring project is to focus on those small Group A water systems that are most vulnerable to changes in ground water level.

Well depths in Whatcom County range from less than 20 feet to over 1,000 feet. Many of the deeper wells draw from confined aquifers, often with clay serving as a confining layer, resulting in minimal hydraulic continuity with surface water. Wells in Whatcom County are also constructed in many types of soils, the most common being fractured rock, sand and gravel. Wells constructed in fractured rock vary greatly in water levels and performance and therefore must be studied on a case-by-case basis. Many wells are constructed near large surface water bodies such as Lake Whatcom, Lake Samish and the Nooksack River which runs from the snowcaps of Mt. Baker to the coastline at Bellingham Bay. The levels and performance of wells near surface water are often influenced by their continuity with the nearby water body. In order to better understand water resources in Whatcom County, the Nooksack Watershed Water Resource Inventory Area 1 (WRIA1) is divided into Aggregated Subbasins, each with unique characteristics.

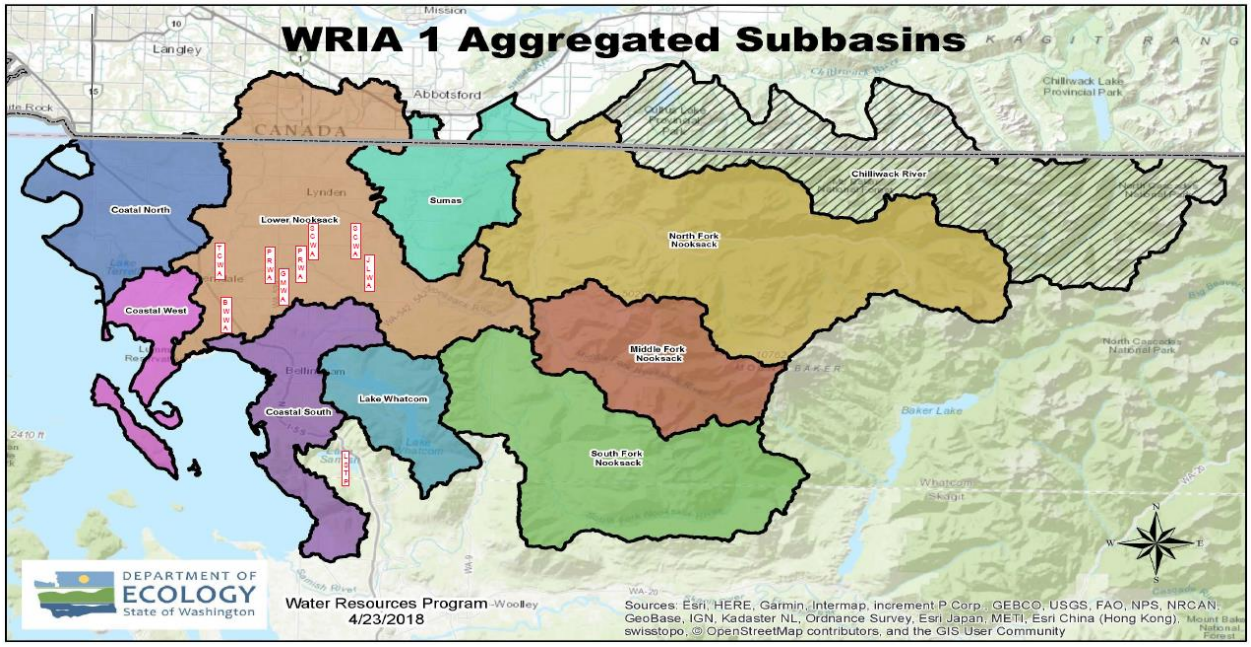


Figure 2: WRIA 1 Aggregated Subbasin Map

Many small Group A water systems are located in the Lower Nooksack Subbasin which features the Nooksack River running through the middle. The Nooksack River basin consists primarily of alluvial fan deposits rich in silt, sand, and gravel. Shallow alluvial aquifers are prevalent in the Lower Nooksack Subbasin and recharge is primarily from rainfall but may also have varying degrees of continuity with the Nooksack River which is fed by snowmelt and rain runoff. Wells constructed in alluvial aquifers are subject to fluctuating ground water levels depending largely on climate conditions such as temperature, rainfall and snowmelt.

TASK 1: IDENTIFY GROUP A GROUNDWATER WELLS FOR MONITORING

The goal of the pilot project is to identify Group A water sources primarily in shallow alluvial aquifers, at strategic locations that are vulnerable to ground water level changes due to seasonal and long-term climate impacts and install pressure transducers to monitor water level fluctuations.

STEP 1: Office of Drinking Water Sentry Database

The process of identifying Group A water system wells for monitoring began with Washington State Department of Health Office of Drinking Water database known as Sentry. We downloaded from Sentry a list of over 400 active water systems in Whatcom County. We filtered the list to include only Group A community systems, and systems with between 25 connections and 1,000 connections which are defined by DOH as small water systems. We then removed Municipal water systems such as cities, towns, and water districts as well as systems with their primary source as wholesale water. Finally, we filtered the list to include only those water systems with ground water as their primary source. The list at this point was less than 60 water systems.

Sentry: https://fortress.wa.gov/doh/eh/portal/odw/si/FindWaterSystem.aspx

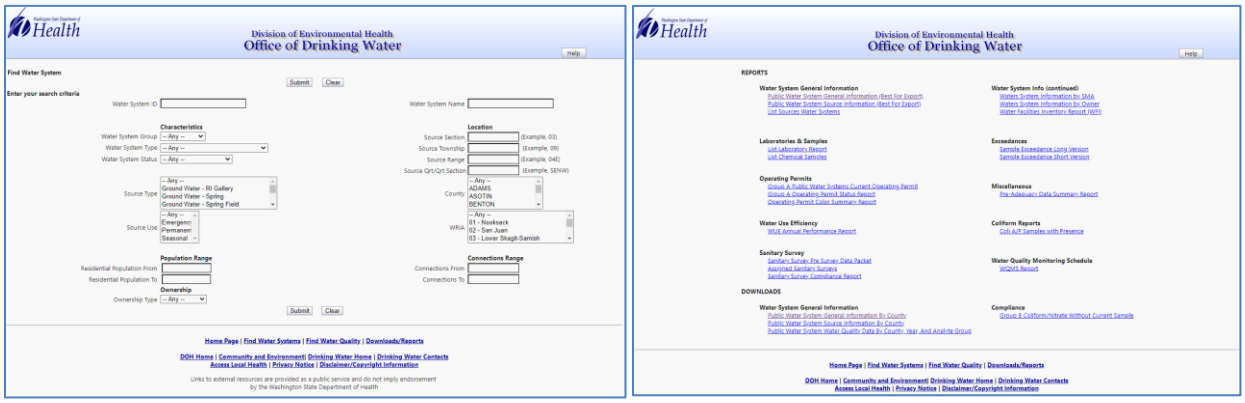


Figure 3: Office Drinking Water Sentry Website

STEP 2: Focus on Lower Nooksack Aggregated Subbasin

Based on our knowledge of the WRIA 1 Aggregated Subbasins (Figure 1) we elected to focus our search for water systems in the Lower Nooksack Subbasin because they are more likely to have wells constructed in a shallow alluvial aquifer. To accomplish this, we loosely overlayed the Lower Nooksack Subbasin boundary on a map of the Whatcom County Coordinated Water System Plan service area map (Figure 3). We then selected water systems from the list refined in Step 1 that are located within the Lower Nooksack Subbasin.

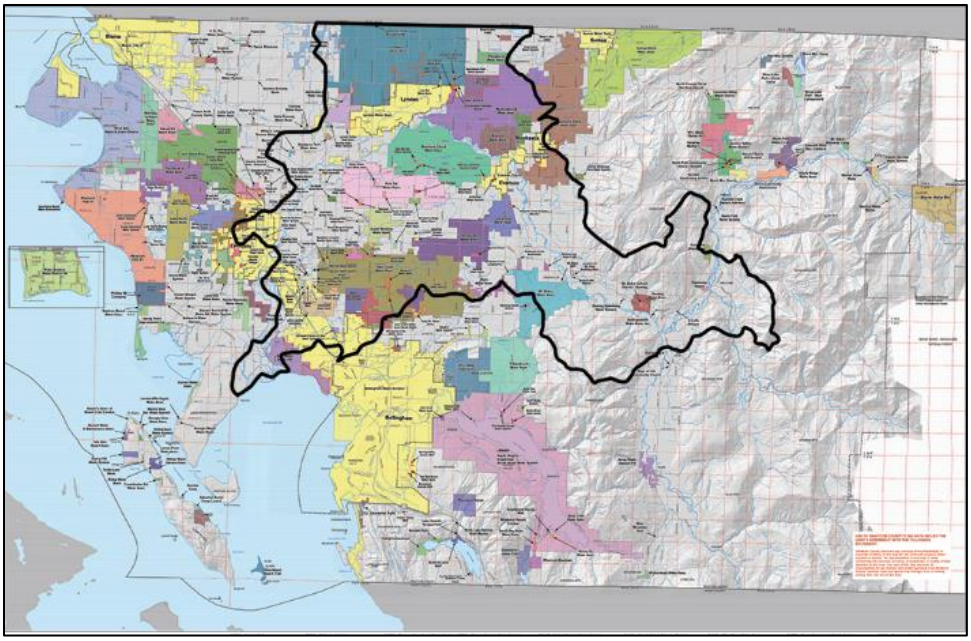


Figure 4: Lower Nooksack Subbasin Overlay on CWSP Service Area Map

STEP 3: Locate Well Logs/Water Reports

Having reduced the list of potential water systems for monitoring to approximately 25, the next step was to secure basic information for each potential water system well such as well depth, soils and construction. Basic well information can be found on a well water report, also commonly known as a well log. We began our search for well logs by using the Map Search feature on the Washington State Department of Ecology Well Report Viewer which can be found at the link below.

Well Report Viewer: https://appswr.ecology.wa.gov/wellconstruction/map/WCLSWebMap/default.aspx

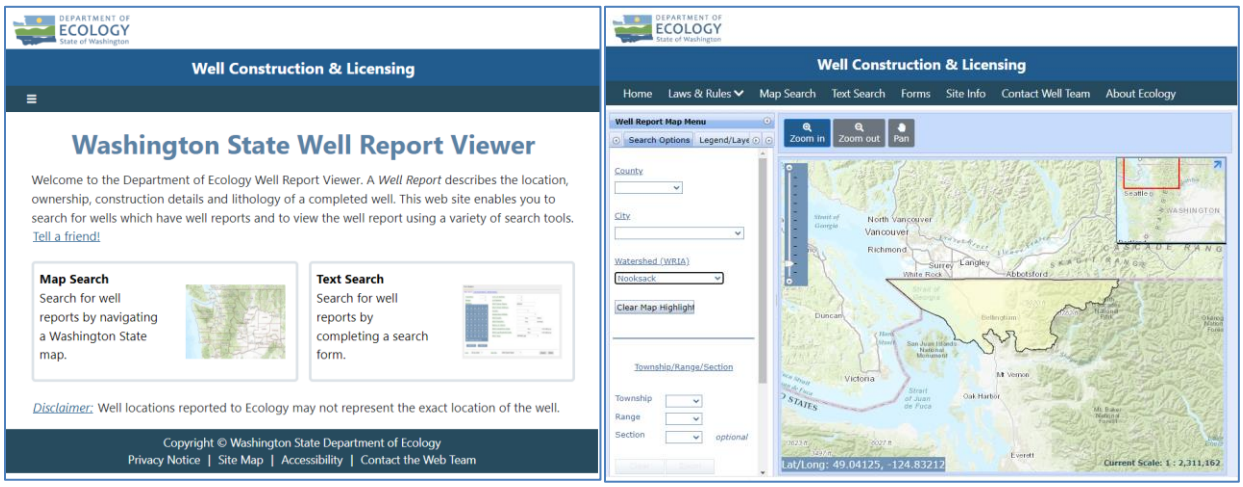


Figure 5: Ecology Well Report Viewer

We found a few well logs using this approach where the well log was in the name of the water system. However, this approach did not work as well as expected because many well logs were often recorded under the name of the property owner or a representative of the water system at the time the well was constructed. For those wells where we could not find a well log, we would need to rely on the water systems to provide a well log or more information to continue our search.

STEP 4: Initial Contact with Potential Water Systems

The next step in the selection process was to contact each of the systems remaining on the list to gain their support for the pilot project and gather missing well log information. We were fortunate to have contact information for many of the systems on our list because we had worked with them on prior projects or have provided them with technical assistance. We also relied on Sentry for contact information.

During initial contact with each system by phone, we introduced the pilot project, goals and opportunity for participation on a voluntary basis with no direct financial obligation. We explained that their primary involvement was to have a representative available to provide access to the well and to observe the installation of the well level monitoring instruments. Following the initial contact process, we ended up with a short list of 10 systems willing to participate and for which we were able to secure a well log. Well logs can be found in Appendix 3.

STEP 5: Well Site Survey

We then scheduled a site visit to inspect the well head of each system. During each site visit the primary items of consideration were:

- Access to the well head for installation and future maintenance. This is especially important if a well service vehicle is required for installation or removal of the transducer.
- Safety of personnel and security for the exposed instrumentation short-term and long-term.
- Well Head:
    - Well cap attachment:
        - Type of well cap?
        - Can the well cap be easily removed for installation of the transducer?
        - Is a new well cap readily available should it need to be modification or replaced? due to damage during installation or after the wireless unit is removed?
        - What type of well cap seal is in place and is a replacement seal readily available?
        -
    - Well cap modification for wireless unit:
        - What type of material is the well cap: plastic, aluminum, steel, stainless, cement?
        - Can the well cap be modified to hold and support the wireless unit?
        - Who will perform any well cap modifications?
        - Who will install the wireless unit onto the well cap? Utility operator, well pump service vendor, other?
        -
    - Well configuration:
        - Size and type of well casing? 4”-36” diameter casing? Steel, cement, PVC?
        - Is there a preinstalled minimum 1” sounding tube available for transducer?
        - Is there space available between the casing and the drop pipe for a 5/8”-3/4” transducer with 1/4" cable?
        - Are there any obstructions in the space between the casing and drop pipe such as excess wires, existing monitoring equipment, drop pipe stabilizers, etc?
        - Is there an electrical disconnect readily available to ensure the well is turned off during inspection, installation and maintenance of the transducer?
        - Is an electrician needed to assist with the existing well electrical during the project?
        - How to determine/confirm current well depth?
        - How to determine/confirm current depth to water?
        - What is the measuring point for depth to water? i.e. top of casing?
        - How far from the measuring point to ground level? i.e. top of casing to ground?

- Well transducer installation:
  - Who will perform the transducer installation?
  - How will the measurement from bottom of installed transducer to the well level measuring point be determined? This is needed for calibration.
  - How will the transducer be secured in place to ensure that the transducer remains at a fixed depth within the well casing?
  - How will the transducer wire transition through the well cap to the wireless unit?
  - How will the wire penetration through the well cap into the wireless unit be sealed from excessive moisture to avoid damage to instrumentation?
  - Who will connect the transducer wire to the wireless unit?
  - Is the wireless unit ready to connect from the vendor or does the vendor need to be onsite for startup? If not, who will start up the wireless unit?

STEP 6: Final Well Site Selection

Based on information gathered during Steps 1-5, we prioritized each well site based on ease of transducer installation and well cap modification for the wireless unit. During prioritization we eliminated one system with a cement lid that did not have an auxiliary access. Installing the transducer and mounting the wireless unit for this well would have required special equipment to remove the heavy cement lid and to drill at least one hole in the cement lid, both of which are risky and expensive, especially if the lid was damaged in the process. We also eliminated another system where the well is located in a building with a steel lid and no auxiliary access. Installing the transducer and mounting the wireless unit in the steel lid would have required special equipment to remove the lid and install an auxiliary access hatch at significant expense.

The 8 water system wells selected for monitoring are shown in the Table 1 and Figure 5 below with locations spread across the Lower Nooksack Subbasin known for being a shallow alluvial aquifer.

Name	Well Lo	Cap	Drilled Depth	Drilled Static	Install Static	Trans Set Depth	Measured From
Joe Louie Water Association (JLWA)	Yes	Aluminum Cap	61.0'	38.00'	36.75	54.0'	Top of casing
Belfern West Water Association (BWWA)	Yes	Cement/Plastic Lid	30.0'	9.00'	8.87	24.0'	Top of lid lip
Guide Meridian Water Association (GMWA)	Yes	Cement/Plastic Lid	36.0'	16.00'	8.71	28.0'	Top of lid lip
Tall Cedars Estates Water Association (TCWA)	Yes	Aluminum Cap	23.0'	14.00'	14.82	20.0'	Top of casing
Pole Road Water Association Site 1 (PRWA1)	Yes	Aluminum Cap	61.0'	16.30'	5.32'	48.0'	Top of casing
Pole Road Water Association Site 2 (PRWA2)	Yes	Cement/Plastic Lid	46.0'	19.00'	12.32	38.0'	Top of casing
Skookum Chuck Water Assoc Vandyk (SCWA)	Yes	Aluminum Cap	37.0'	14.75'	13.59	31.0'	Top of casing
Skookum Chuck Water Assoc Huisman (SCWH)	Yes	Aluminum Lid	32.0'	24.00'	24.1	30.0'	Top of lid lip

Table 1: Wells selected for pilot project

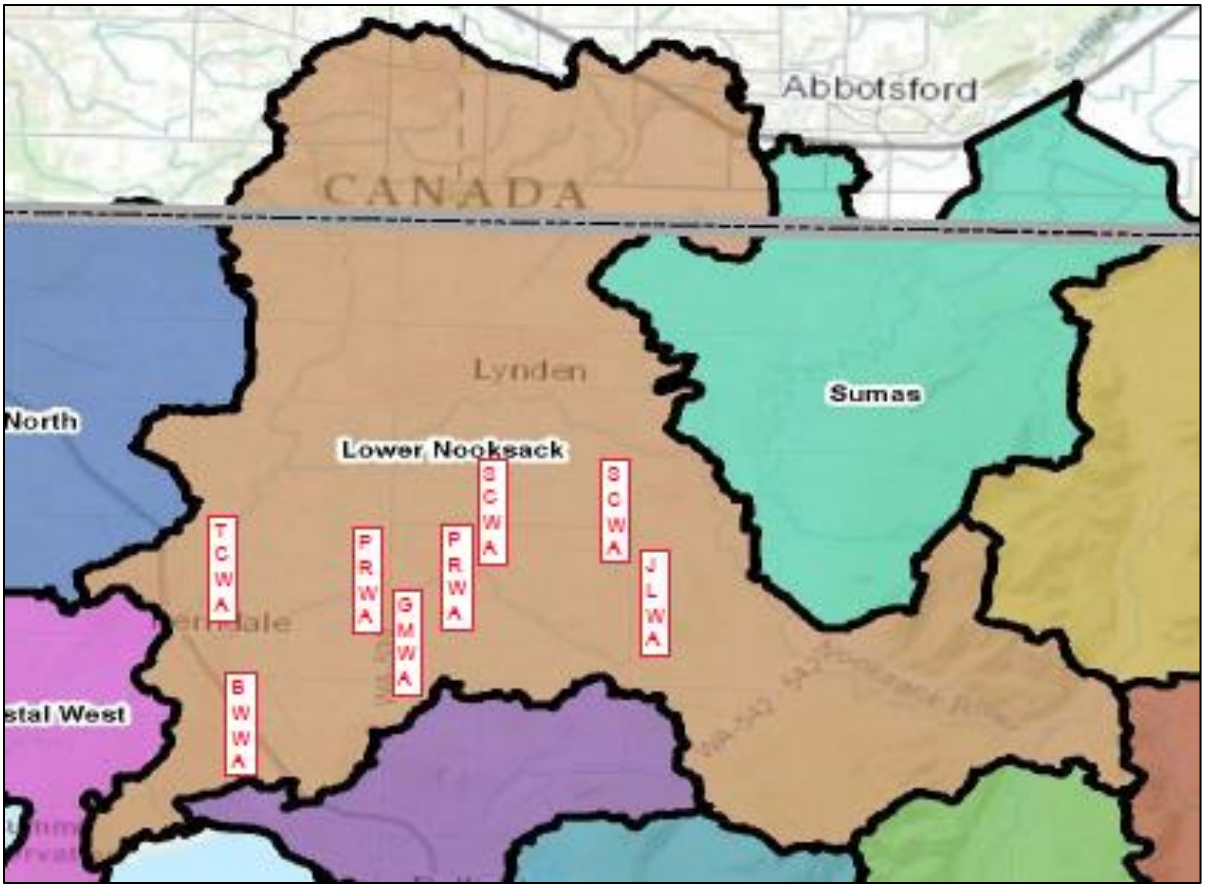


Figure 5: Well Locations in Lower Nooksack Subbasin

TASK 2: MEETING WITH PUD AND DOH TO DISCUSS AND FINALIZE WELL LOCATIONS, INSTRUMENTATION AND INSTALLATION ACTIVITIES.

PUD Meeting with DOH

Having identified the list of proposed wells for the monitoring project, the PUD met with Department of Health personnel and other project team members to review monitoring site selection criteria (discussed above), monitoring components including instrumentation (presented below), and next steps. A copy of the meeting summary is included in Appendix 1.

Monitoring Components

There are four basic components required for this project:

- Submersible Transducer (Transducer or Waterpilot) installed in the well to measure the water level based on pressure.
- Wireless Telemetry (Telemetry or Ranger) that receives information from the Transducer and sends it to a Cloud Database Host.
- Cloud Database Host (Host or DTA) that receives and stores the data online.
- Database Interface App (Grafana) to access the database for viewing and downloading information.

Submersible Transducer (Waterpilot): The transducer is a sensor housed in a 5/8"-3/4" diameter by 8" long stainless waterproof casing attached to a cable. See Figure 6. The cable extends from the transducer lowered below the water level (See Figure 7) to the top of the well where it is secured to the well casing or well cap and connected to the to the Wireless Telemetry device mounted to the outside of the well cap. See Figure 8.

Figure 6: Transducer Image

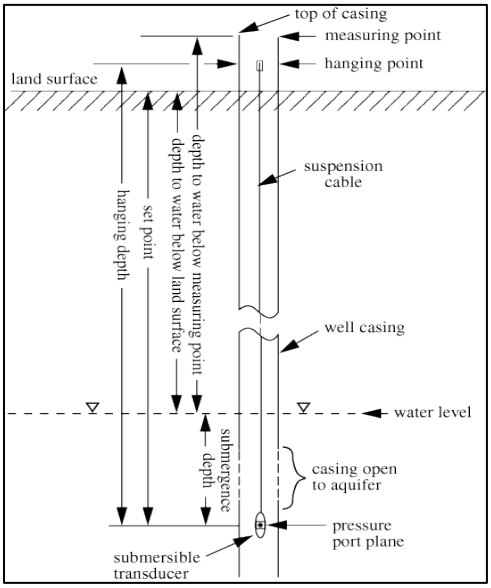


Figure 7: Well Dimension Reference Chart

There are a wide variety of submersible transducers available and it is important to choose a transducer that measures the desired parameters, such as pressure and temperature, and is compatible with the data collection device selected, the Ranger in this case. The most common transducer signals are 4-20 milliamps (mA), 0-5 or 0-10 volts DC (VDC) and digital.

The transducer selected for this project is a “Waterpilot FMX21Hydrostatic level measurement Compact device for level measurement in fresh water with communication via HART”. The WaterPilot uses a 4-20 mA signal for collecting pressure and digital signal for temperature with a superimposed HART 6.0 digital output signal. The Waterpilot Transducer technical specifications can be found in Appendix 2.

When ordering a transducer, it is important to select one that will accommodate the maximum depth of water above the transducer and a cable length to achieve the desired placement of the transducer in the well. The well log provides a wealth of information needed for selecting the transducer range and cable length. We chose a standard 0-30 psi transducer that measures a range of 0-69.3’ (30 psi x 2.31 ft/psi) of water because all of the well water levels are less than 60’ from static to the bottom of the well. We ordered all but one of the transducers with a standard cable length of 60’ because that was the maximum depth of the wells. It should be noted that the transducer cable can be ordered to any length, field shortened using a cable trim kit or the excess simply coiled and placed inside the well casing if there is adequate room.

Wireless Telemetry (SignalFire Ranger): The wireless unit (SignalFire Ranger) is mounted to the top of the well cap using a 1/2" threaded steel or brass fitting with transducer cable connected to the unit through the fitting as a wireway. The SignalFire Ranger is an IoT (internet of things) cellular transmitter utilizing LTE-M/NB-IoT technology to bring sensor data directly to the cloud. The built-in Ranger I/O consists of two (2) digital inputs, one (1) analog input and one (1) relay output. The digital inputs can detect on/off status or frequencies up to 2kHz for pulse counting and totalizing applications. The analog input supports a 1-5Vdc or 4-20mA devices and provides power to the sensor from the built-in battery pack. The interchangeable battery is expected to last for three years or longer depending on the amount of data being collected and frequency of sampling and transmission. Solar options are also available. The Ranger receives input signals from the transducer and transmits the data to the cloud over LTE cellular networks where the data is stored with a Database Host and available for viewing or download. The Signal Fire Ranger technical specifications can be found in Appendix 3.

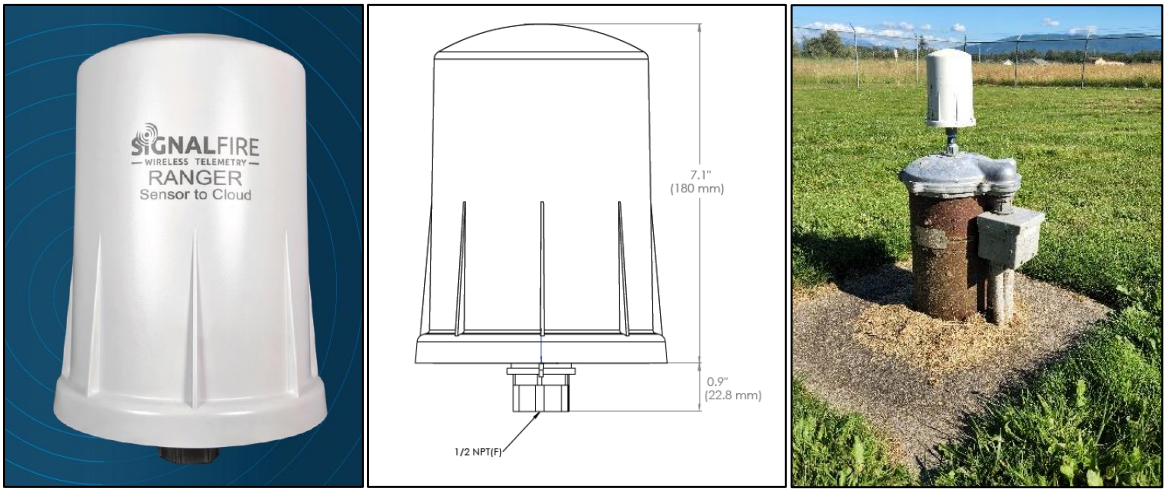


Figure 8: SignalFire Wireless Telemetry: Ranger Sensor to Cloud Platform mounted to well cap

Cloud Database Host (DTA Automation): Storing and hosting the data collected from the wells with easy access to the database is essential for this project. The Ranger is designed to integrate with third-party cloud database hosting. DTA Automation is a local supplier of the Signalfire Ranger and WaterPilot transducer and also provides a complete wireless and database hosting service for their products at a distributor level.

Database Interface App (Grafana): In order to access the database for viewing and downloading DTA Automation utilizes the Grafana application available for web access, android, and iOS devices. The database interface will be discussed in detail in Task 4.

TASK 3: INSTALL PRESSURE TRANSDUCERS IN UP TO TEN WELLS IN WHATCOM COUNTY AND ENSURE THE TRANSDUCERS ARE WORKING PROPERLY

This section walks through the steps involved with installation of each well site transducer and wireless unit. It is very important to have someone knowledgeable and experienced working with wells, especially when performing well cap modifications and installing transducers.

When working in and around a well it is essential to protect the well head inside and out from potential contamination. Best management practices include properly disinfecting tools and instruments exposed to the well or well water. Often times a well drilling or well pump vendor would be utilized to install the transducer and modify the well cap for mounting the wireless unit. For this project the PUD and its project team have over 30 years working with public water systems and ground water wells. This knowledge and experienced proved to be invaluable during this project because the project team was able to perform the installation work with minimal support from outside vendors.

In addition to the transducer and wireless unit, a variety of basic tools and supplies were required including: small wrenches and sockets, channel locks, pliers, electrical tape, electrical putty for sealing, battery operated drill, battery operated angle grinder with metal grinding wheels, various drill driver bits and screw drivers, steel drill bits up to ¾", Teflon tape and paste, ¼" stainless steel chain, miscellaneous stainless fasteners, 30 gallon garbage bags to temporarily cover open well casings, 12' x 20' plastic or tarp for measuring the transducer cable on a clean surface, duct tape, zip ties, ½" x 1-2" threaded steel or brass nipple, ½" electrical cord grip or strain relief (pictured below), ½" watertight conduit hub (Meyers hub pictured below).

Figure 9: Cord Grip

Figure 10: Strain Relief

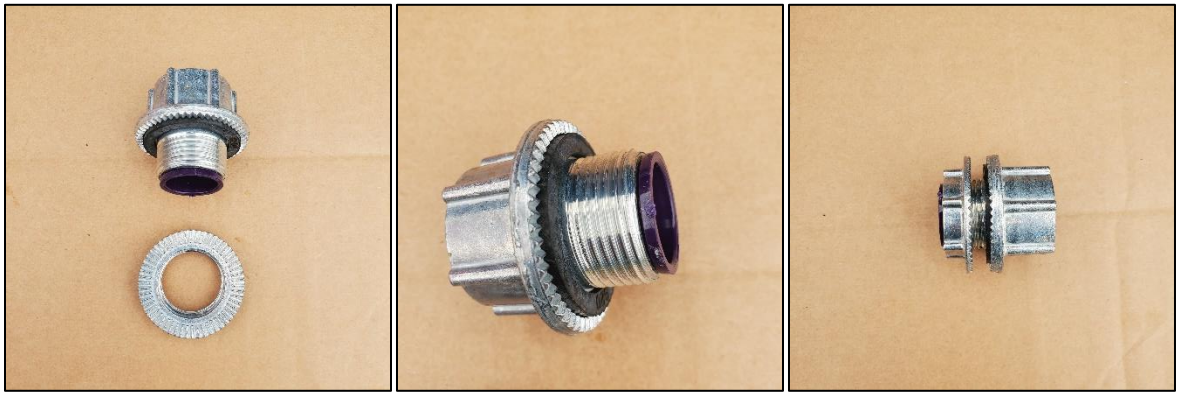


Figure 11: Watertight Hub (Meyer).

Well Cap Modification

The first step is to modify the well cap in preparation for attaching the wireless unit. The following is a brief description of the typical well cap modifications.

Figure 12: Aluminum Well Cap with ¾" hole drilled in center for watertight hub.

Figure 13: Top and bottom surface ground smooth with ½" watertight hub and nipple installed ready for the Ranger

Figure 14: 36" Cement Cap with imbedded PVC Hatch with ½" hole drilled in the center for watertight hub

Figure 15: Top surface ground smooth with silicon and ½" watertight hub and nipple installed ready for the Ranger

Figure 16: Monitoring Well 4" Aluminum cap with ½" hole, watertight hub and nipple installed with Ranger

Transducer Installation.

The next step is to install the transducer. Prior to installing the transducer, we need to determine the approximate depth to set the transducer below the top of the well casing. The goal is to set the transducer just above the pump and motor to ensure that it is always covered by water and to avoid excess movement when the well is operating. We used the well log and well pump installation information available from the water system to determine the desired depth. We then placed a clean plastic tarp on the ground and stretched out the transducer cable on the tarp. We measured from the bottom of the transducer along the cable the desired distance and then marked the cable with electrical tape.

The next step is to lower the transducer into the well stopping at the electrical tape marker. It is not necessary to know the precise final depth that the transducer is set at because we will measure the actual water level from the top of the casing and then calibrate the transducer reading to match the measured water level when the Ranger is set up.

Ideally the well will have an available sounding tube to lower the transducer into. A sounding tube is a PVC pipe preinstalled down the inside of the well casing for water level monitoring. However, a sounding tube was not available at any of our well sites.

Lowering the transducer into the well can be the most difficult part of the installation. It is very important to be sure that the top end of the cable is secured at all times before beginning to lower the transducer into the well to avoid losing the cable in the well. You also need to find a clear path along the inside edge of the well casing for the transducer and cable to pass through to the desired depth. In a 36" well casings this is not difficult. However, with smaller diameter well casings the space between the casing and drop pipe can be narrow and difficult to pass through. We had some difficulty installing a transducer in a 6" casing but we were successful. There may also be obstructions like wiring and drop pipe stabilizers the entire length of the drop pipe. The pictures below illustrate a typical well casing and potential obstructions encountered when installing a transducer.

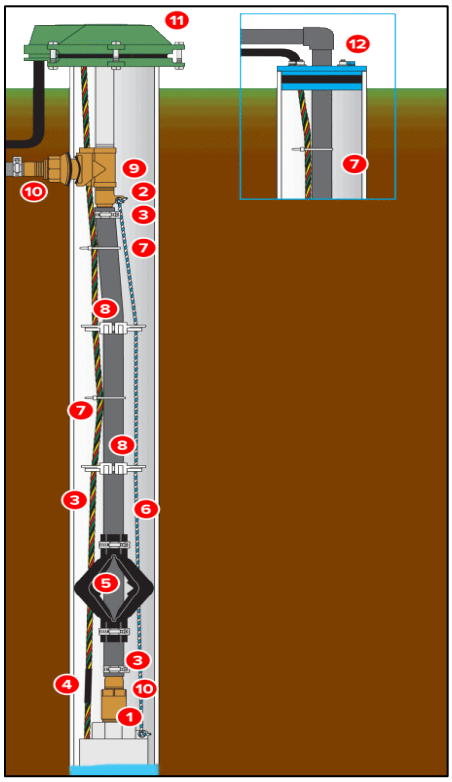


Figure 17: Typical Drilled Well Internal View


Figure 18: Common Well Obstructions

It may take several attempts to install the transducer and cable. Often times the transducer will get hung up or snagged on something in the well on the way down and will need to be pulled up and lowered again in different areas until you can find a clear pathway to the desire depth. Usually, you can sense the weight of the transducer on the cable as you lower it into the casing. If the transducer gets hung up the

cable becomes limp and will not easily drop further. In some cases, it may be necessary to have a well vendor assist with installing the transducer by lifting the well pump out of the well casing and then reinstalling the pump along with the transducer and cable or better yet installing a sounding tube. Do not force the transducer and cable up or down when installing or they can become snagged.
Unfortunately, from many years of experience we have learned that pulling too hard on the cable to free a transducer often results in the cable or transducer becoming stuck in the well casing and a well vendor is then required to pull the well pump to free the transducer and cable.

The final step is to secure the cable at the top of the well so the transducer remains fixed. A cord grip can be used to set the desired depth by resting it against the top of a sounding tube. Since we did not have any sounding tubes available, we used a cord grip or strain relief and a short length of 1/4" stainless chain to attached the strain relief or cord grip to the well casing or cap. Securing the cable to the casing requires some creativity depending on the individual well but it is not difficult.

Ranger Installation

After the well cap has been modified with a water proof hub and 1/2” threaded fitting and the transducer has been installed with wires available at the top of the casing, the fitting at the bottom of the Ranger can be threaded onto the 1/2" fitting using Teflon tape or past to ensure a watertight seal and tightened with channel locks.

Figure 19: Wireless Telemetry Ranger Installed

The Ranger cover is then unthreaded counterclockwise from the base and the electrical component removed by loosening three screws. The pictures show the transducer wires already connected but during the initial installation there will be no wires connected to the electrical component so it can be completely removed.

Figure 20: Ranger Disassembly

The battery is then lifted out of the base to reveal the wireway through the threaded fitting and well cap into the well casing. The well cap is then removed and the transducer cable is fed through the wireway into the Ranger base about 6”-9” or far enough that the wires will easily reach the terminal connections in the middle of the electrical board but not so far that there will be excess wire that has to be cut. Once the wires are through the wireway, we found it best to temporarily reinstall the well cap so that the ranger base is stable making it is easier to reassembly of the Ranger.

Figure 21: Transducer Wire Install to Ranger

The battery and electronic board are temporarily reinstalled in the Ranger base and the three transducer wires can now be connected under the terminals using a small screwdriver according to the vendor instructions. In this case we are using the HART 6.0 option with the terminals clearly marked HART + (red wire), HART - (black wire) and GND for ground (green/yellow wire). It is best to leave the battery cable disconnected until you are on the phone with technical support and ready to start up the ranger.

Having connected the transducer wires, the remaining wire should be relaxed across the circuit board, down the side of the battery and through the wireway in the bottom of the Ranger. The wire length can easily be adjusted by lifting the electronics and battery. With the battery firmly in place the electronics can be secured with the three screws and the Ranger cover installed. Before installing the Ranger cover during final assembly, it is helpful to use electrical tape to secure the wire against the battery making it easier to replace the Ranger cover.

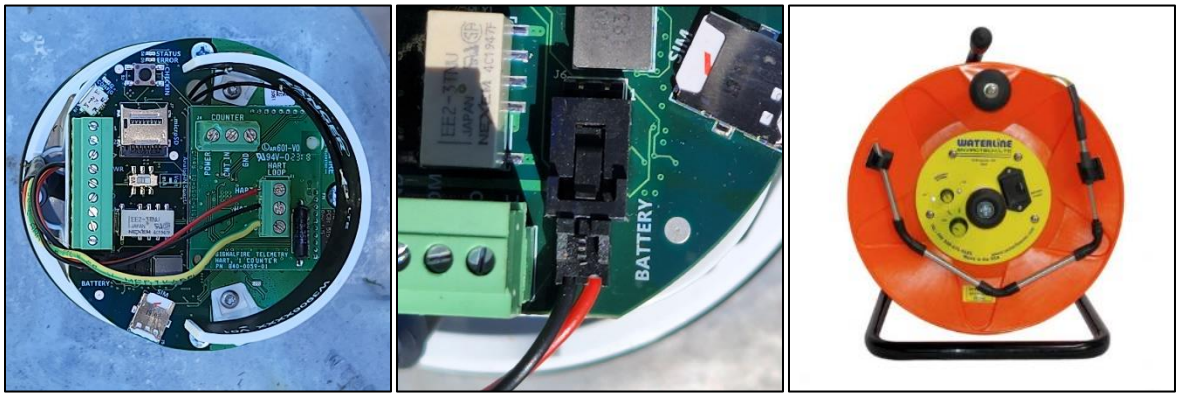


Figure 22: Transducer Wire and Battery Connection to Ranger

The final assembly step is to gain access to the underside of the well cap where the wire enters the watertight hub and fill the space around the wire with some sort of waterproof material to prevent

moisture from entering the Ranger through the base. We used electrical putty pressed into the space but any type of waterproof material such as silicone calking or spray in foam will work.

The Ranger comes preconfigured to the cellular network and database and simply needs to be turned on, activated, and calibrated to the current well water level. This step is done by scheduling a brief phone call with DTA Automation technical support. Immediately prior to the call with DTA Automation technical support we removed the Ranger cover for easy access the onboard activation button, temporarily removed the well cap leaving it offset slightly and inserted the well water level sounding tape, pictured above, so we were ready to provide the well water level needed for calibration and verification. After the Ranger is activated and calibrated, the water level tape is removed, well cap reinstalled, and Ranger cover secured.

Well Site Installation Pictures

Figure 23: Joe Louie Water Association (Code JLWA)

Figure 24: Belfern West Water Association (Code BWWA)

Well Site Installation Pictures (continued)

Figure 25: Guide Meridian Water Association (Code GMWA)

Figure 26: Tall Cedars Water Association (Code TCWA)

Figure 27: Pole Road Water Association Site 1 (Code PRWA1)

Well Site Installation Pictures (continued)

Figure 28: Pole Road Water Association Site 2 (Code PRWA2)

Figure 29: Skookum Chuck Water Association Vandyk (Code SCWA)

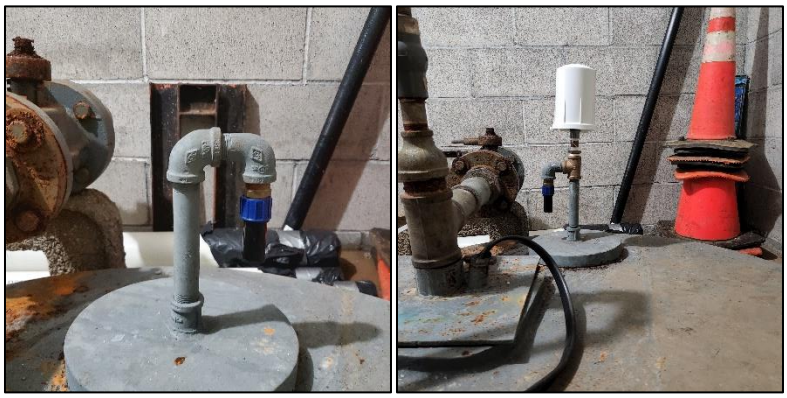


Figure 30: Skookum Chuck Water Association Huisman (Code SCWH)

TASK 4: RAW DATA WILL BE COLLECTED AND AVAILABLE IN A UNIVERSAL DATA BASE FORMAT SUCH AS CSV OR EXCEL AND DELIVERED ON A MONTHLY BASIS AND AT THE COMPLETION OF THE PILOT. DATA WILL ALSO BE AVAILABLE ONLINE FOR OBSERVATION DURING THE PILOT.

The well level and temperature data collected from the transducer by the Ranger is stored in a database hosted in the cloud and available for viewing and download. The raw data for this project is sampled every 15 minutes but can be shorter or longer as needed. The higher the sample frequency the lower the battery life. The daily lowest well level and associated temperature each 24-hour day is displayed in the graphic and data table. The mean, minimum and maximum for the selected period (i.e. days, weeks, months, years) is shown in the lower right of the graphic. The data resolution displayed can be adjusted down to the raw data sample rate to suite different project needs.

The Pilot Project data can be viewed and downloaded by logging on the website at the link below:

https://grafana.automation.daritech.com/login username: **pud_general** password: **weLOVEwaterdata**

The home page is a vicinity map showing the general location of each well. Mousing over the location shows the project code name and time since data was last received.

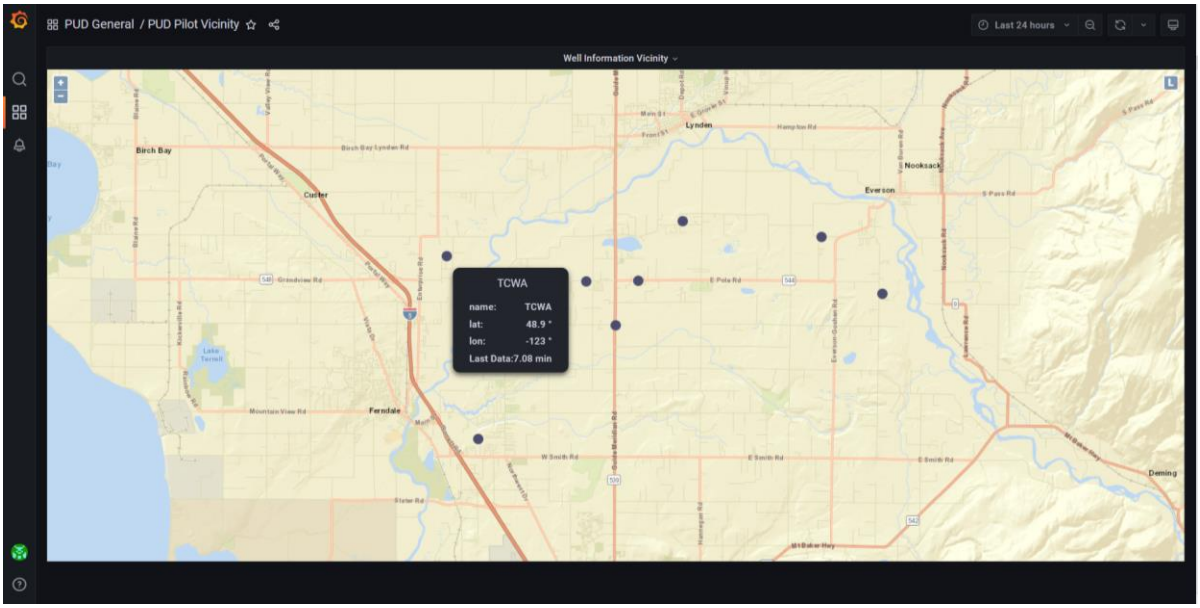


Figure 31: Grafana Well Vicinity Map

Mousing over the four-square box icon on the upper left menu and selecting Browse will reveal a Dashboard with links to each of the well locations and additional project General information.

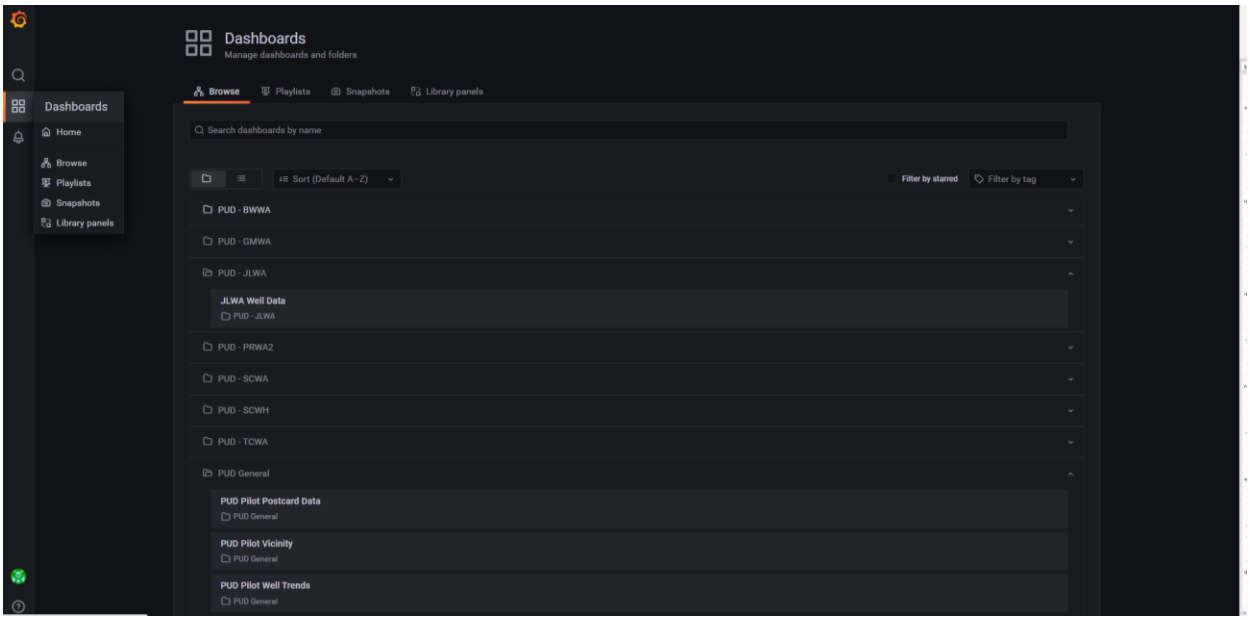


Figure 32: Grafana Well Site Data Dashboard

Selecting a location folder and then associate "Well Data" subfolder link (i.e. JLWA Well Data) will display the a graphic that shows the well water level below the respective measuring point (scale on the left) and water temperature at the transducer (scale on the right) for the given time frame selected (upper right). Notice that the mean, maximum, and minimum for the time frame is displayed in the lower right and the legend is in the lower left. Mousing over any point on the chart will display that days' data and time stamp. The time period displayed can be changed using the dropdown menu in the upper right.

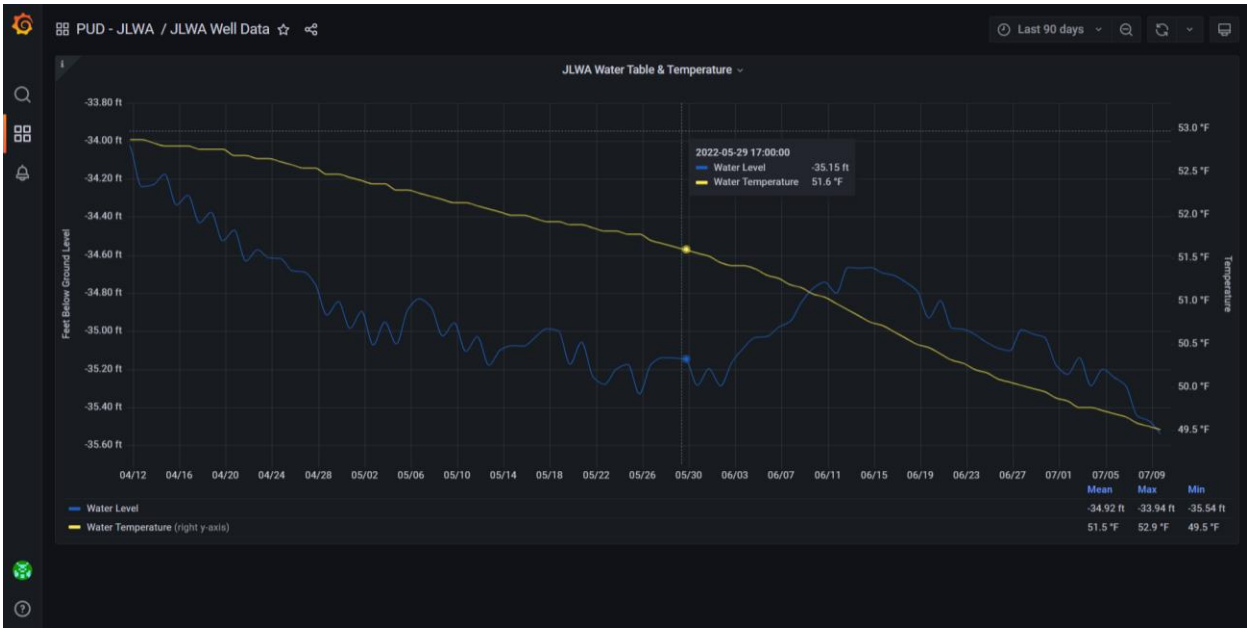


Figure 33: Grafana Data Graphic

Once the desired data is displayed, the data associated with that displayed can be downloaded for export by using the dropdown arrow to the right of the title (i.e. JLWA Water Table & Temperature) at the top center of the page and selecting “Inspect” and then “Data”.

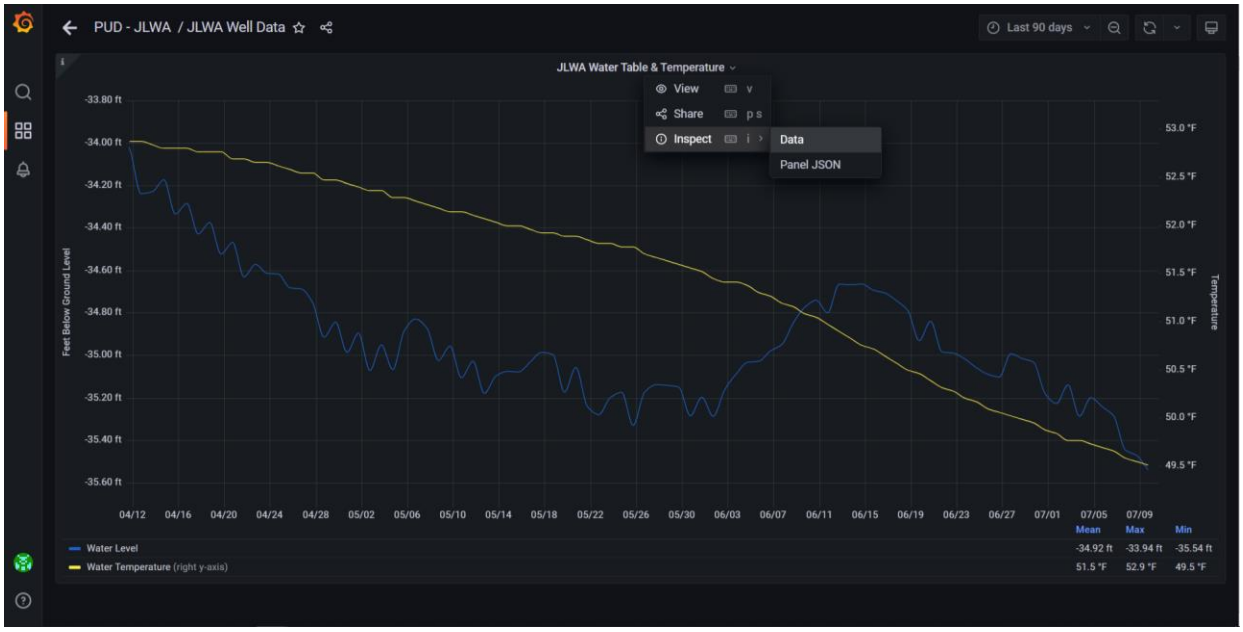


Figure 34: Grafana Data Display Menu

On the popup screen select “Data options” and then “Download CSV”. If you prefer to download data formatted with an excel header, simply toggle the “Download for Excel” button and then select “Download CSV”. In Windows using chrome the download file appears at the bottom of in browser and can also be found in your computers default (custom) download folder.

Figure 35: Grafana Data Download Options

A sample of the data downloaded is shown in the table below:

Time	Water Level	Water Temperature
4/10/2022 17:00	-33.94 ft	
4/11/2022 17:00	-34.03 ft	52.9 °F
4/12/2022 17:00	-34.24 ft	52.9 °F
4/13/2022 17:00	-34.23 ft	52.8 °F
4/14/2022 17:00	-34.17 ft	52.8 °F
4/15/2022 17:00	-34.33 ft	52.8 °F
4/16/2022 17:00	-34.28 ft	52.8 °F
4/17/2022 17:00	-34.43 ft	52.8 °F
4/18/2022 17:00	-34.37 ft	52.8 °F
4/19/2022 17:00	-34.52 ft	52.8 °F
4/20/2022 17:00	-34.47 ft	52.7 °F
4/21/2022 17:00	-34.63 ft	52.7 °F
4/22/2022 17:00	-34.57 ft	52.7 °F
4/23/2022 17:00	-34.61 ft	52.7 °F
4/24/2022 17:00	-34.62 ft	52.6 °F

Figure 36: Download Data Displayed in Excel

Finally, from the Dashboard view (shown above following the vicinity map), selecting the "PUD General" folder and then "PUD Pilot Well Trends" subfolder link will provide a view of all the project well data for the chosen time period. It is important to note in this view that the scale on the left represents the change in water level for each well and not depth of water from the measuring point.

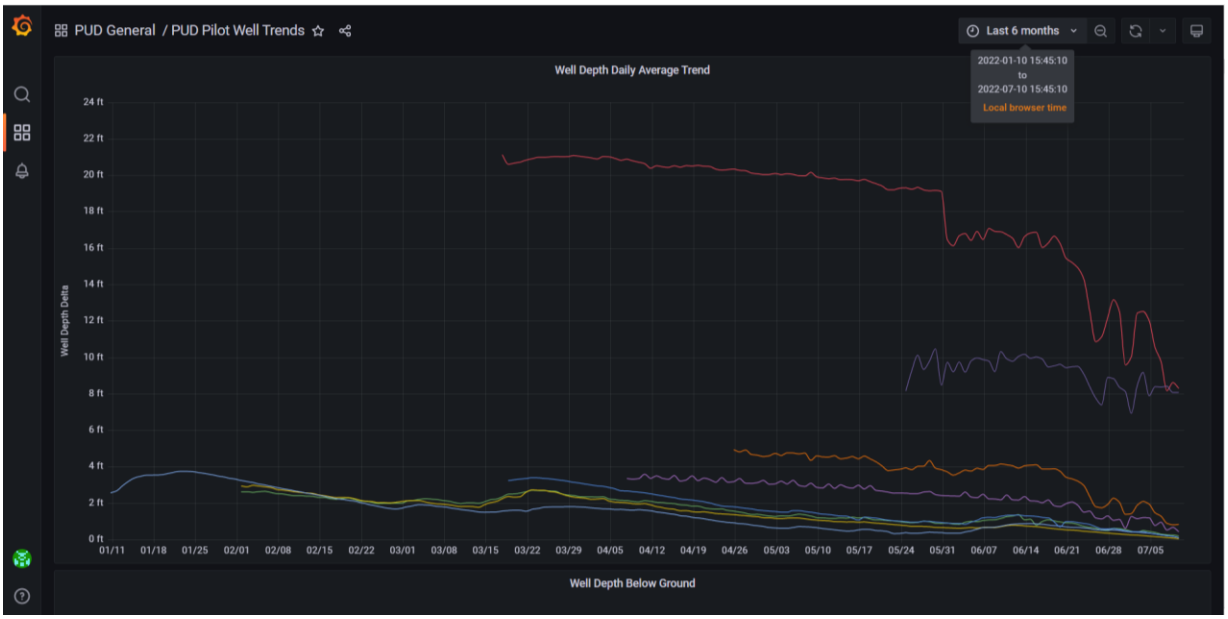


Figure 37: Project Data Trending

Conclusion and Next Steps

The primary intent of all drinking water systems is to provide safe, reliable and sustainable drinking water to the community. To accomplish this each water system must develop, maintain, and continually improve their Technical, Managerial, and Financial capacity in order to be sustainable long term.

It is recognized at the outset that this is a pilot project to explore the technical, managerial, and financial aspects associated with Group A well level monitoring and that this work will provide a foundation for future and expanded well level monitoring projects.

While the data collected to date for this project is less than six months, one observation that stands out is that all the wells are trending lower. In some situations, this might be alarming. However, given that all the project wells are constructed in shallow alluvial aquifer and primarily recharged by rainfall, the trend is not surprising in these situations.

The well level pilot project provides a baseline of information to better understand short and long-term well level trends. With climate change impacts, such as recent low rainfall and declared droughts, it is important to be aware of source water changes and to develop mitigation plans and be prepared with water shortage response actions before they are needed.

The pilot project database will continue through December 31, 2024. At that point the annual hosting services would need to be renewed for each well site. It is recommended that the well level be checked with a well level tape to verify and calibrate if necessary, with the database interface. The Ranger batteries are expected to last approximately 3 years and should be replaced in December 2024.

We were successful making the data readily available to any party for download in both CSV and Excel format. Time and budget did not allow for exploring how the available format would interface with other entities interested in the data. The PUD plans to share this project report with Whatcom County and others who are interested such as Ecology and will discuss how the available data might integrate with current and future efforts such as regional and subbasin ground water monitoring and watershed management.

A future piece of information for ground water management would be to add elevation information for each well site to provide a better understanding of the relationship between well levels, particularly those in close proximity within a given subbasin or drainage. If needed, existing well site elevations could be collected and applied for purposes of understanding a given alluvial aquifer.

Finally, a copy of the Project Budget Summary is in the Table 2 below.

Date	Invoice #	Total	Materials	Install	Hosting	Management	Subtotal
Total		$ 40,000.00	$19,399.37	$3,349.00	$6,519.20	$ 10,732.43	$40,000.00
cost Per Unit	8	$ 5,000.00	$ 2,424.92	$ 418.63	$ 814.90	$ 1,341.55	$ 5,000.00

Table 2: Project Budget Summary

References

Department of Ecology, State of Washington, Water Resources Explorer

Washington State Department of Health, Office of Drinking Water, Sentry Data Base

Washington State Department of Health, Office of Drinking Water, Water System Design Manual

Washington Administrative Code Chapters 249-290 “Group A public water systems”

Appendix 1

- Memo: January 20, 2022 Meeting summary between DOH Sheryl Howe and PUD project team to discuss and finalize well locations and installation activities.

PUBLIC UTILITY DISTRICT NO. 1
of Whatcom County
1705 Trigg Road ● Ferndale, WA 98248
P: (360) 384-4288 ● F: (360) 384-4849

Memo

To: Sheryl Howe, Washington State Dept. of Health

From: Stephan Jilk, General Manager

Date January 20, 2022

Re: Whatcom County Well Level Monitoring Project – Contract No. GVS 26362

This memo will serve to summarize the meeting between Steve Jilk and Rebecca Schlotterback of PUD No. 1 of Whatcom County (Whatcom PUD), Dave Olson of Cornerstone Management and Sheryl Howe of Washington State Dept. Health (DOH) to discuss the Whatcom County Well Level Monitoring Project (Contract No. GVS 26362).

A virtual meeting was held on January 12, 2022 to discuss the project. The meeting satisfies Task 2 as described below. Task 1 information had been provided to DOH previously within the agreed upon time frame. The tasks completed to date are:

Task 1:
Identify up to ten Group A groundwater wells for installation of a pressure transducer to measure water levels. Wells will be owned/operated by an entity willing to participate in the pilot project. Each well will have a valid well log.

Task 2:
Meet with Whatcom PUD and others as appropriate to discuss/finalize well locations and installation activities**.**

Olson shared his research on the sub basins within Whatcom County and identified the Lower Nooksack Sub basin as the appropriate area to focus this project as it is at a greater risk to drought relative to other parts of the county.
Having identified the area to focus this effort, Olson discussed his criteria for appropriate well locations. These are:

1. Willingness of the owner/operator to participate
2. A valid well log
3. Accessibility of the well
4. Impacts to the well head are feasible

Olson inspected approximately 20 well locations and shared his list of eight that met the criteria above.

- Belfern West Water Association
- Cedar Lynn Water Association
- Guide Meridian Water Association
- Joe Louie Water Association
- Pole Road Water Association (2)
- Skookum Chuck Water Association (2)

Olson ordered and received the first six transducers to have the installation of the first six wells completed by the end of the January. Data specifications for the transducers have been provided to DOH previously. Primary data is hosted in the cloud on the "automation.daritech" servers and will initially be logged at 1 hour intervals but timing can be increased or decreased as appropriate. Pilot Data will be available for viewing by pilot project participants.

It is anticipated that the remaining transducers will be installed later this spring and Howe hopes to be able to observe the installation in order to take photos and better understand the installation process.

If the project proceeds in a timely manner as expected and the budget allows, Olson hopes to begin exploring the data management options available for broadly sharing the information collected.

Howe indicated she would ask how DOH prefers Whatcom Co. submit invoices on this project.

Olson stated he would notify the project participants when the first transducers are installed and identify which six out of the eight were selected.

Attachments:
DOH GVS 26362 Google Earth Priority 1 Systems
DOH GVS 26362 Project Status

Appendix 2

- Transducer Technical Information: Waterpilot FMX21

Technical Information
Waterpilot FMX21

Hydrostatic level measurement
Compact device for level measurement in fresh water, wastewater and saltwater, communication via HART

Reliable and robust level probe with ceramic measuring cell

Application

The Waterpilot FMX21 is a pressure sensor for hydrostatic level measurement. Endress+Hauser offers three different versions of the FMX21 sensor:
- FMX21 with a stainless steel housing, outer diameter of 22 mm (0.87 in): Standard version suitable for drinking water applications and for use in bore holes and wells with small diameters.
- FMX21 with a stainless steel housing, outer diameter of 42 mm (1.65 in): Heavy duty version, easy clean flush-mounted process diaphragm. Ideally suited for wastewater and sewage treatment plants.
- FMX21 with a plastic insulation, outer diameter of 29 mm (1.14 in): Corrosion resistant version generally for use in saltwater, particularly for ship ballast water tanks.

Your benefits

- High resistance to overload and aggressive media
- High-precision, robust ceramic measuring cell with long-term stability
- Climate proofed sensor thanks to completely potted electronics and 2-filter pressure compensation system
- 4 to 20 mA with superimposed HART 6.0 output signal
- Simultaneous measurement of level and temperature with optionally integrated Pt100 temperature sensor
- Accuracy
  - Reference accuracy ±0.2 %
  - PLATINUM version ±0.1 %
- Automatic density compensation to increase accuracy
- Usage in drinking water: KTW, NSF, ACS
- Approvals: ATEX, FM, CSA
- Marine certificate: GL, ABS, LR, BV, DNV
- Extensive range of accessories provides complete measuring point solutions

Endress+Hauser
People for Process Automation

Table of contents

Document information

Document conventions

Safety symbols

Symbol	Meaning
 A0011189-DE	**DANGER!** This symbol alerts you to a dangerous situation. Failure to avoid this situation will result in seriousor fatal injury.
 A0011190-DE	**WARNING!** This symbol alerts you to a dangerous situation. Failure to avoid this situation can result in seriousor fatal injury.
 A0011191-DE	**CAUTION!** This symbol alerts you to a dangerous situation. Failure to avoid this situation can result in minoror medium injury.
 A0011192-DE	**NOTICE!** This symbol contains information on procedures and other facts which do not result in per-sonalinjury.

Electrical symbols

Symbol	Meaning
A0018335	**Direct current** A terminal to which DC voltage is applied or through which direct current flows.
A0018336	**Alternating currrent** A terminal to which alternating voltage is applied or through which alternating current flows.
 A0018337	**Direct current and alternating current** ▪ A terminal to which alternating voltage or DC voltage is applied. ▪ A terminal through which alternating current or direct current flows.
 A0018338	**Ground connection** A grounded terminal which, as far as the operator is concerned, is grounded via a grounding system..
 A0018339	**Protective ground connection** A terminal which must be connected to ground prior to establishing any other connections.
 A0011201	**Equipotential connection** A connection that has to be connected to the plant grounding system: This may be a potential equalization line or a star grounding system depending on national or company codes of praxis.

Symbols for certain types of information

Symbol	Meaning
 A0011193	**Tip** Indicates additional information.
 A0015484	**Reference to page** Refers to the corresponding page number.

Symbols in graphics

Symbol	Meaning
1, 2, 3, 4, ...	Item numbers
A, **B**, **C**, **D**, ...	Views

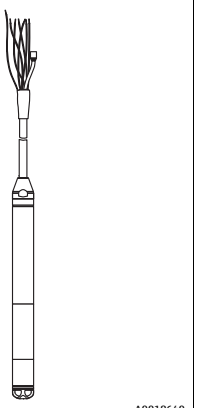
 A0011187	**Hazardous area** Indicates a hazardous area.
 A0011188	Safe area (non-hazardous area) Indicates a non-hazardous location.

Symbols at the device

Symbol	Meaning
	**Connecting cable immunity to temperature change** Indicates that the connecting cables must be able to withstand temperatures of at least 85 °C (185 °F).

Function and system design

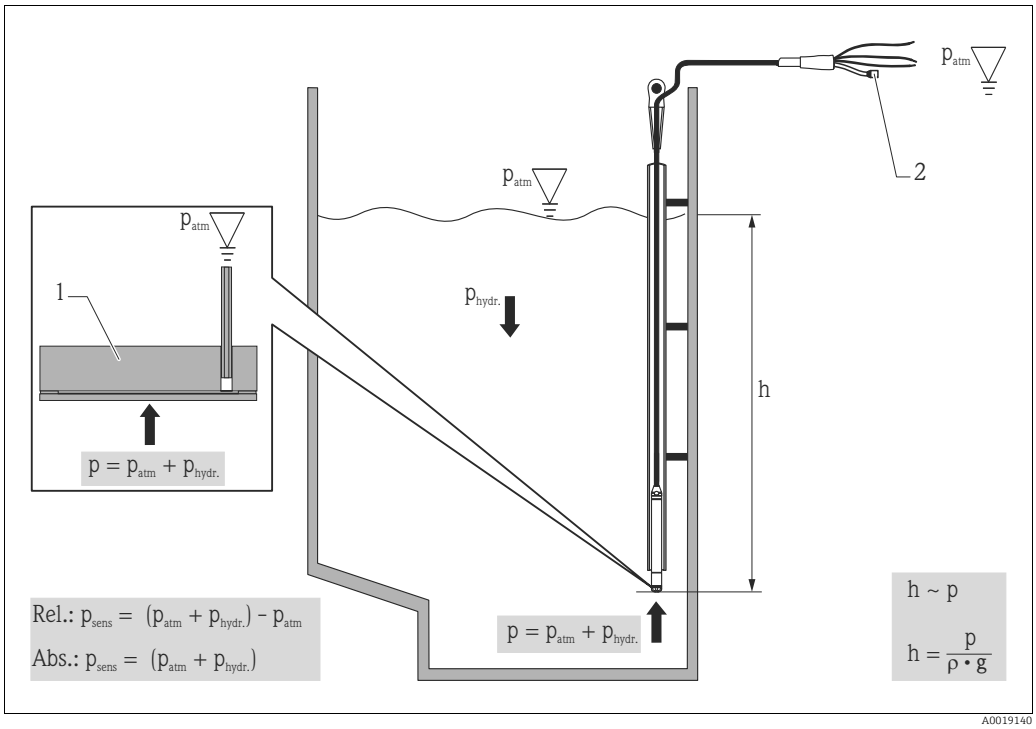
Device selection

Waterpilot FMX21	 A0018640	 A0018641	 A0018642
Field of application	Hydrostatic level measurement in deep wells e.g. drinking water	Hydrostatic level measurement in wastewater	Hydrostatic level measurement in saltwater
	NOTICE **The Waterpilot is not suitable for use in biogas plants since the gases can diffuse through the elastomers (seals, extension cable).** ▸ For applications with biogas Endress+Hauser offers the level transmitter Deltapilot.		
Process connection	▪ Mounting clamp ▪ Extension cable mounting screw with G 1½" A or NPT 1½" thread		
Outer diameter	22 mm (0.87 in)	42 mm (1.65 in)	max. 29 mm (1.14 in)
Extension cable	PE, PUR, FEP (→ 📄 25)		
Seals	▪ FKM Viton ▪ EPDM [1]	FKM Viton	▪ FKM Viton ▪ EPDM [1]
Measuring ranges	▪ Gauge pressure: from 0 to 0.1 bar to 0 to 20 bar (0 to 1.5 psi to 0 to 300 psi) ▪ Absolute pressure: from 0 to 2 bar to 0 to 20 bar (0 to 30 psi to 0 to 300 psi)		▪ Gauge pressure: from 0 to 0.1 bar to 0 to 4 bar (0 to 1.5 psi bis 0 to 60 psi) ▪ Absolute pressure: from 0 to 2 bar to 0 to 4 bar (0 to 1.5 psi bis 0 to 60 psi)
	▪ Customer-specific measuring ranges; factory-calibrated ▪ The following output units can be configured: %, mbar, bar, kPa, MPa, mmH_2O, mH_2O, inH_2O, ftH_2O, psi and numerous level units.		
Overload	Up to 40 bar (600 psi)		Up to 25 bar (375 psi)
Process temperature range	−10 to +70 °C (+14 to +158 °F)		0 to +50 °C (+32 to +122 °F)
Reference accuracy	▪ ±0.2 % of the set span ▪ Optional: ±0.1 % of set span (PLATINUM version)		
Supply voltage	10.5 to 35 V DC, Ex: 10.5 to 30 V DC		
Output	4 to 20 mA (invertible) with superimposed digital communication protocol HART 6.0, 2-wire		
Options	Drinking water approval	—	
	▪ Large selection of approvals, including ATEX, FM, CSA ▪ Broad range of accessories ▪ Integrated Pt100 temperature sensor and TMT182 temperature head transmitter (4 to 20 mA HART) ▪ Marine certificate		
Specialties	▪ High-precision, robust ceramic measuring cell with long-term stability ▪ Automatic density compensation ▪ Customer specific cable marking ▪ Absolute pressure measuring cell		

1) Recommended for drinking water applications and not for use in hazardous areas.

Measuring principle

The ceramic measuring cell is a dry measuring cell, i.e. pressure acts directly on the robust ceramic process isolating diaphragm of the Waterpilot FMX21.
Any changes in the air pressure are routed through the extension cable, via a pressure compensation tube, to the rear of the ceramic process isolating diaphragm and compensated for. A pressure-dependent change in capacitance caused by the movement of the process isolating diaphragm is measured at the electrodes of the ceramic carrier. The electronics then convert this into a signal which is proportional to the pressure and is linear to the level of the medium.



1 *Ceramic measuring cell*
2 *Pressure compensation tube*

h *Level height*
p *Total pressure = atmospheric pressure + hydrostatic pressure*
ρ *Density of the medium*
g *Gravitational acceleration*
$p_{hydr.}$ *Hydrostatic pressure*
p_{atm} *Atmospheric pressure*
p_{sens} *Pressure displayed on the sensor*

Temperature measurement with optional Pt100 resistance thermometer [1)]

Endress+Hauser also offers the Waterpilot FMX21 with an optional 4-wire Pt100 resistance thermometer to measure level and temperature simultaneously (→ 30). The Pt100 belongs to Accuracy Class B in accordance with DIN EN 60751.

Temperature measurement with optional Pt100 and TMT182 temperature head transmitter [1)]

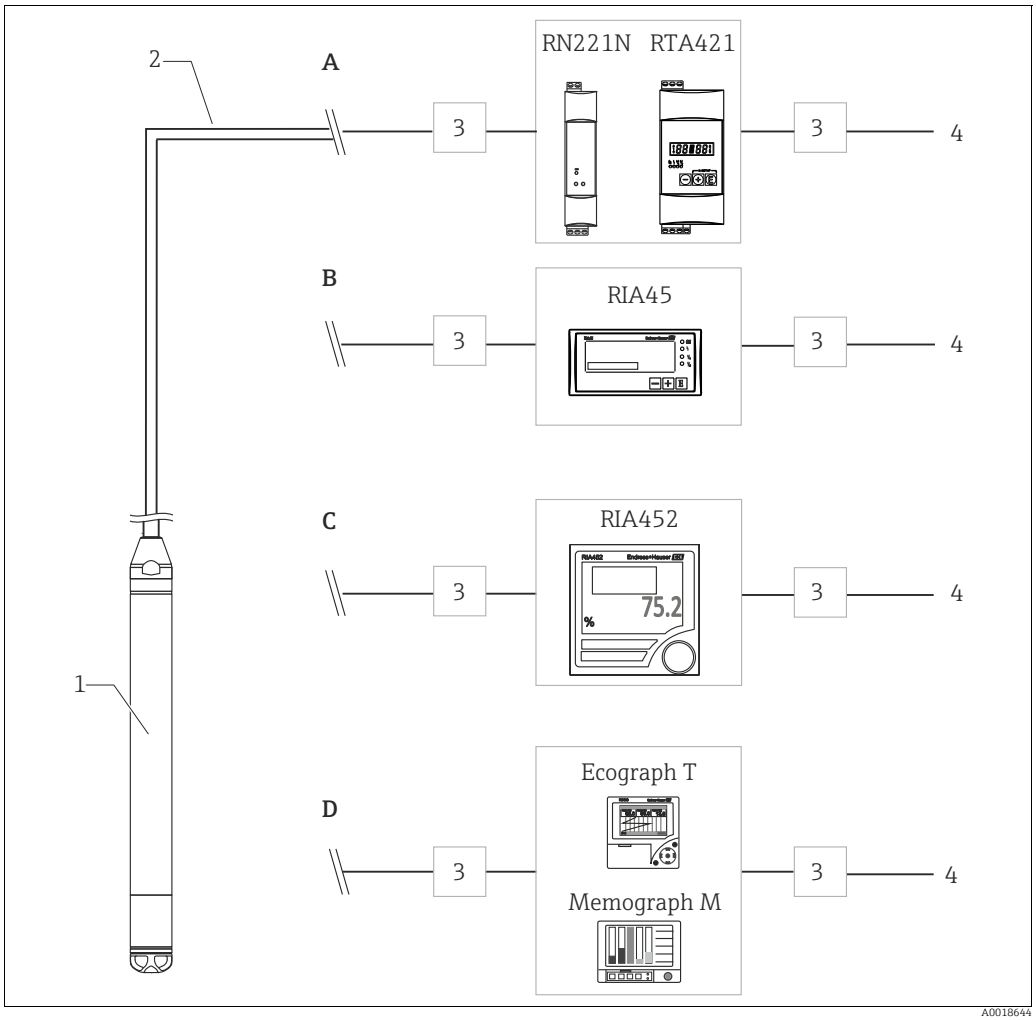
Endress+Hauser also offers the TMT182 temperature head transmitter with the HART protocol to convert the temperature signal to an analog, scalable 4 to 20 mA output signal superimposed with HART 6.0.
See also: "Density compensation with Pt100 temperature sensor" (→ 9); "Ordering information" (→ 28); "Accessories" (→ 30) and Technical Information TI00078R.

1) Not for use in hazardous areas.

Measuring system

As standard, the complete measuring system consists of a Waterpilot FMX21 and a transmitter power supply unit with a supply voltage of 10.5 to 30 V DC (hazardous areas) or 10.5 to 35 V DC (non-hazardous areas).

Possible measuring point solutions with a transmitter and evaluation units from Endress+Hauser:



A0018644

Application examples

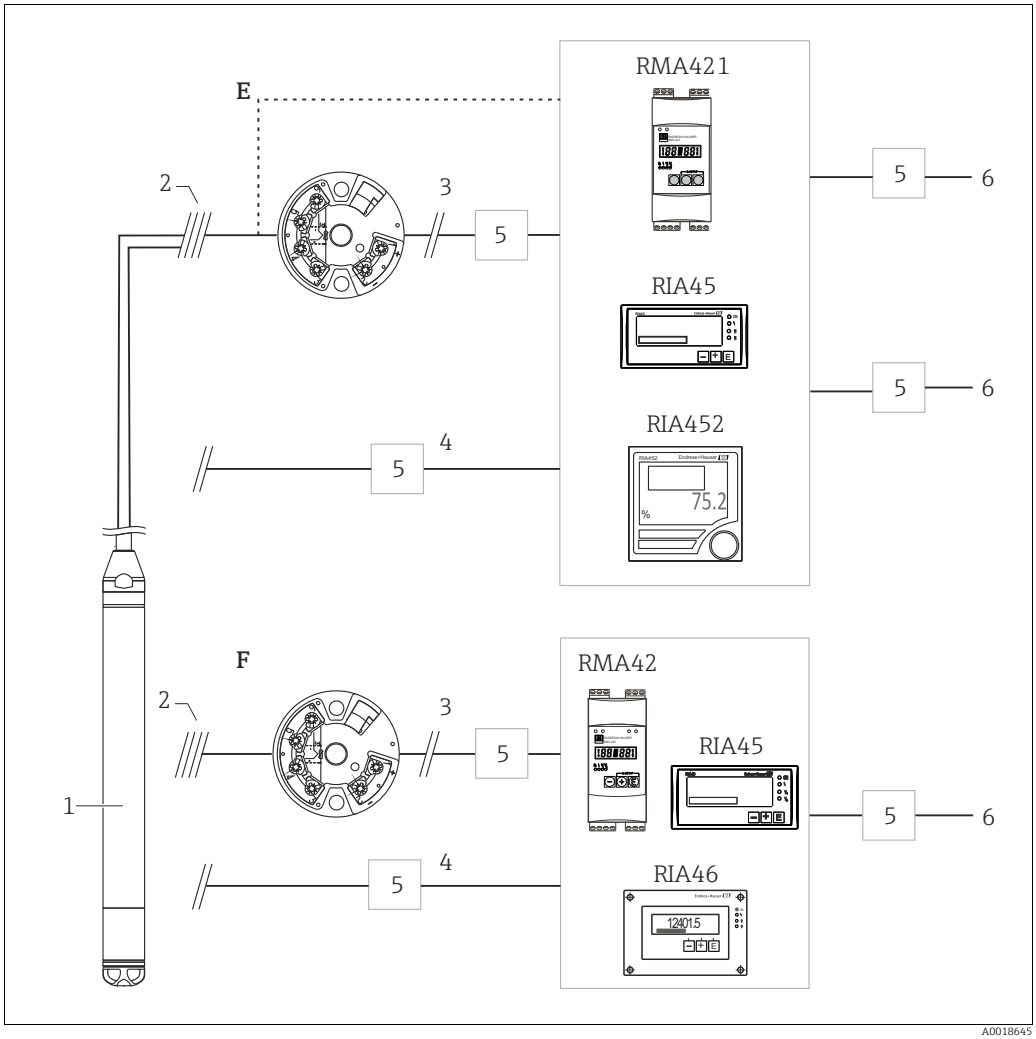
1 Waterpilot FMX21 HART
2 4 to 20 mA HART
3 Overvoltage protection (OP), e.g. HAW from Endress+Hauser (not for use in hazardous areas)
- OP on the sensor side for field installation: HAW569; for top-hat rail/DINrail: HAW562/intrinsically safe HAW562Z
- OP on the supply side for top-hat rail/DINrail: HAW561 (115/230 V) and HAW561K (24/48 V AC/DC)
The overvoltage protection selected must be appropriate for the supply voltage.
4 Power supply

A Simple cost-effective measuring point solution: Power supply of Waterpilot in hazardous and non-hazardous areas using RN221N active barrier. Power supply and additional control of two consumers, e.g. pumps, via limit switch RTA421 with onsite display.

B Evaluation unit RIA45 (for panel mounting) provides a power supply system, an onsite display and two switch outputs.

C If several pumps are used, the pump service life can be prolonged by alternate switching. With alternating pump control, the pump which was out of service for the longest period of time is switched on. The evaluation unit RIA452 (for panel mounting) provides this option in additional to several other functions.

D State-of-the-art recording technology with graphic display recorders from Endress+Hauser, such as Ecograph T, Memograph M, or paper recorders such as Alphalog for documenting, monitoring, visualizing and archiving purposes.



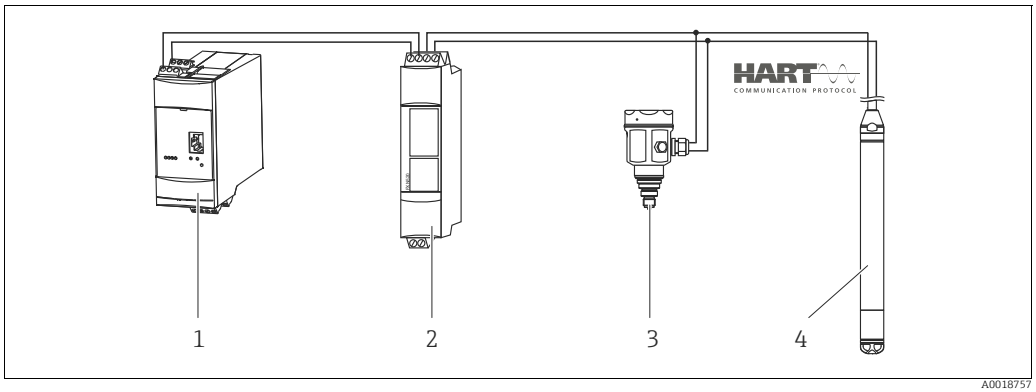
Application examples with Pt100

1 Waterpilot FMX21 HART
2 Connection for integrated Pt100 temperature sensor in the FMX21
3 4 to 20 mA HART (Temperature)
4 4 to 20 mA HART (Level)
5 Overvoltage protection (OP), e.g. HAW from Endress+Hauser (not for use in hazardous areas)
- OP on the sensor side for field installation: HAW569; for top-hat rail/DINrail: HAW562/intrinsically safe HAW562Z
- OP on the supply side for top-hat rail/DINrail: HAW561 (115/230 V) and HAW561K (24/48 V AC/DC)
The overvoltage protection selected must be appropriate for the supply voltage.
6 Power supply

E If you want to measure, display and evaluate the temperature as well as the level, e.g. to monitor temperature in fresh water to detect temperature limits for germ formation, you have the following options:
The optional TMT182 temperature head transmitter can convert the Pt100 signal to a 4 to 20 mA HART signal and transfer it to any common evaluation unit. The RMA421, RIA45 and RIA452 evaluation units also offer a direct input for the Pt100 signal.

F If you want to record and evaluate the level and temperature measured value with one device, use the RMA42, RIA45 and RIA46 evaluation units with two inputs. It is even possible to mathematically link the input signals with this unit. These evaluation units are not HART-compatible.

Level measurement with absolute pressure probe and external pressure signal



1 Fieldgate FXA520
2 Multidrop-Connector FXN520
3 Cerabar
4 Waterpilot FMX21

It is advisable to use an absolute pressure probe for applications in which condensation can occur. In the case of level measurement with an absolute pressure probe, the measured value is affected by fluctuations in the ambient pressure. To correct the resulting measured error, you can connect an external absolute pressure sensor (e.g. Cerabar) to the HART signal cable, switch the waterpilot to the burst mode and the Cerabar to operate in mode "Electr. Delta P".
The external absolute pressure sensor then calculates the difference between the two pressure signals and can thus determine the level precisely. Only one level measured value can be corrected in this way.

If using intrinsically safe devices, strict compliance with the rules for interconnecting intrinsically safe circuits as stipulated in IEC60079-14 (proof of intrinsic safety) is mandatory.

Density compensation with Pt100 temperature sensor

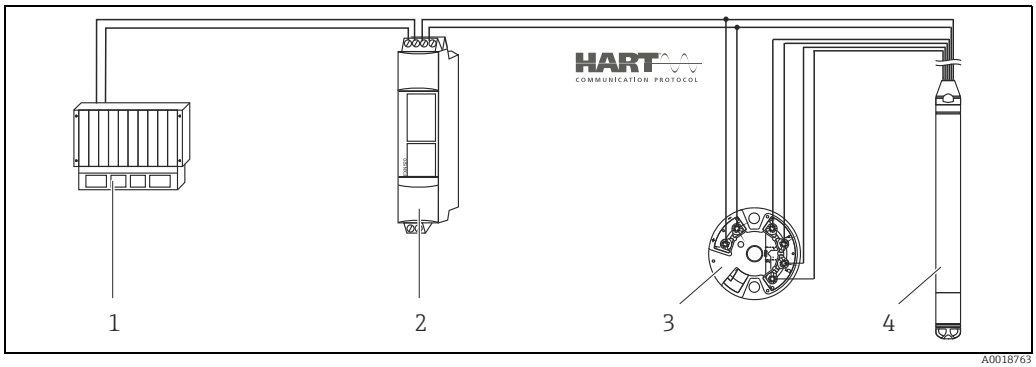
The Waterpilot FMX21 can correct measured errors that result from fluctuations in the density of the water caused by temperature. Users can choose from the following options:

Use the internally measured sensor temperature of the FMX21

The internally measured sensor temperature is calculated in the Waterpilot FMX21 for density compensation. The level signal is thus corrected according to the density characteristic line of the water.

Use the optional internal temperature sensor for density compensation in a suitable HART master (e.g. PLC)

The Waterpilot FMX21 is available with an optional Pt100 temperature sensor. Endress+Hauser additionally offers the TMT182 temperature head transmitter to convert the Pt100 signal to a 4 to 20 mA HART signal.
The temperature and pressure signals are transmitted to the HART master (e.g. PLC) where a corrected level value can be generated using a stored linearization table or the density function (of a chosen medium).

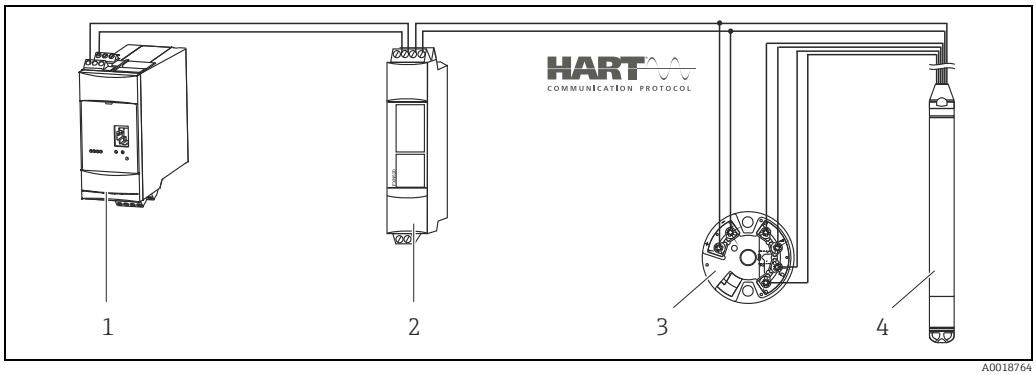


1 HART Master, e.g. PLC (programmable logic controller)
2 FXN520 Multidrop-Connector
3 TMT182 Temperature head transmitter
4 Waterpilot FMX21

Use an external temperature signal which is transmitted to the FMX21 via HART burst mode

The Waterpilot FMX21 is available with an optional Pt100 temperature sensor. In this case, the signal of the Pt100 is analyzed using a HART-compliant (at least HART 5.0) temperature transmitter that supports BURST mode. The temperature signal can thus be transmitted to the FMX21. The FMX21 uses this signal for the density correction of the level signal.

The TMT182 temperature head transmitter is not suitable for this configuration.



1 Fieldgate FXA520
2 Multidrop-Connector FXN520
3 TMT182 Temperature head transmitter
4 Waterpilot FMX21

Without additional compensation due to the anomaly of water, errors of up to 4 % may occur at a temperature of +70 °C (+158 °F), for example. With density compensation, this error can be decreased to 0.5% in the entire temperature range from 0 to +70 °C (+32 to +158 °F).

For further information please refer to the appropriate Technical documentation:
- TI00078R: TMT182 temperature head transmitter (4 to 20 mA/HART)
- TI00369F: FXA520 Fieldgate
- TI00400F: FXN520 multidrop connector

Communication protocol	4 to 20 mA HART with communication protocol
System integration	The device can be fitted with a tag name, "Ordering information", feature 895 "Marking" version "Z1" (→ 28).

Input

Measured variable

FMX21 + Pt100 (optional)

- Hydrostatic pressure of a liquid
- Pt100: temperature

TMT182 temperature head transmitter (optional)

Temperature

Measuring range

- Customer-specific measuring ranges or factory calibration
- Temperature measurement from −10 to +70 °C (+14 to +158 °F) with Pt100 (optional)

Sensor measuring range [bar (psi)]	Smallest span that can be calibrated [1] [bar (psi)]	Vacuum resistance [bar_{abs} (psi_{abs})]	Version in the order code [2]
Gauge pressure			
0.1 (1.5)	0.01 (0.15)	0.3 (4.5)	1C
0.2 (3.0)	0.02 (0.3)	0.3 (4.5)	1D
0.4 (6.0)	0.04 (1.0)	0	1F
0.6 (9.0)	0.06 (1.0)	0	1G
1.0 (15.0)	0.1 (1.5)	0	1H
2.0 (30.0)	0.2 (3.0)	0	1K
4.0 (60.0)	0.4 (6.0)	0	1M
10.0 (150) [3]	1.0 (15)	0	1P
20.0 (300) [3]	2.0 (30)	0	1Q
Absolute pressure			
2.0 (30.0)	0.2 (3.0)	0	2K
4.0 (60.0)	0.4 (6.0)	0	2M
10.0 (150) [3]	1.0 (15)	0	2P
20.0 (300) [3]	2.0 (30)	0	2Q

1) Recommended Turn down: Max 100:1
Factory calibration Turn down: Max 20:1, higher on request.

2) Ordering information (→ 28)

3) These measuring ranges are not offered for the probe version with plastic insulation, outer diameter 29 mm (1.14 in) .

Input signal

FMX21 + Pt100 (optional)

- Change in capacitance
- Pt100: change in resistance

TMT182 temperature head transmitter (optional)

Pt100 resistance signal, 4-wire

Output

Output signal

FMX21 + Pt100 (optional)

- 4 to 20 mA with overlying digital HART 6.0 communication protocol, 2-wire for hydrostatic pressure measured value
- Pt100: Temperature-dependent resistance values

TMT182 temperature head transmitter (optional)

4 to 20 mA with overlying digital HART 5.0 communication protocol for temperature measured value, 2-wire

Signal range

3.8 to 20.5 mA

Signal on alarm

FMX21 + Pt100 (optional)

4 to 20 mA HART
Options:
- Max. alarm (factory setting 22mA): can be set from 21 to 23 mA
- Hold measured value: last measured value is held
- Min. alarm: 3.6 mA

TMT182 temperature head transmitter (optional)

Options:
- Max. alarm ≥ 21.0 mA
- Min. alarm ≤ 3.6 mA

Load

FMX21

$$R_{Lmax} \leq \frac{U - 10.5\ V}{23\ mA} - 2 \cdot 0.09\ \frac{\Omega}{m} \cdot L - R_{add}$$

A0018753-EN

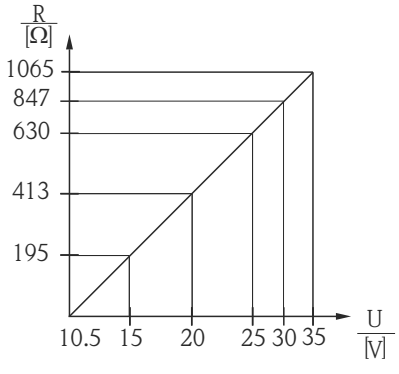
TMT182 temperature head transmitter (optional)

$$R_{Lmax} \leq \frac{U - 11.5\ V}{0.023\ A} - R_{add}$$

A0018754-EN

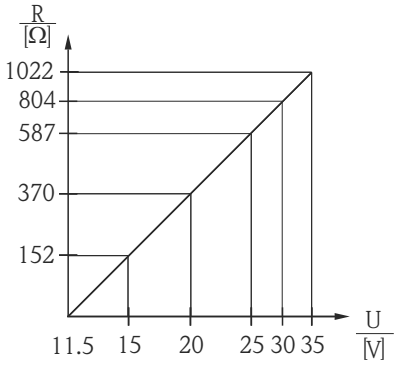
R_{Lmax} = *Max. load resistance [Ω]*
R_{add} = *Additional resistances such as resistance of evaluation unit and/or display unit, cable resistance [Ω]*
U = *Supply voltage [V]*
l = *Simple length of extension cable [m], (cable resistance per wire ≤ 0.09 Ω/m)*

When using the measuring device in hazardous areas, installation must comply with the corresponding national standards and regulations and the Safety Instructions or Installation or Control Drawings (XA).



A0018765

FMX21 load chart for estimating the load resistance. Additional resistances, such as the resistance of the extension cable, have to be subtracted from the value calculated as shown in the equation.



A0018766

Temperature head transmitter TMT182 load chart for estimating the load resistance. Additional resistances have to be subtracted from the value calculated as shown in the equation.

When operating using a HART handheld terminal or a PC with an operating program, a minimum communication resistance of 250 Ω has to be taken into account.

Damping

- Continuously 0 to 999 s via HART handheld terminal or PC with operating program
- Factory setting: 2 s

Power supply

When using the measuring device in hazardous areas, installation must comply with the applicable national standards and regulations and the Safety Instructions (XAs) and the Installation or Control Drawings (ZDs). All explosion-protection data are given in a separate documentation which is available upon request. This documentation is provided with the devices as standard (→ 32).

Supply voltage

FMX21 + Pt100 (optional)	TMT182 temperature head transmitter (optional)
▪ 10.5 to 35 V (non-hazardous area) ▪ 10.5 to 30 V (hazardous area)	11.5 to 35 V DC

Power consumption

FMX21 + Pt100 (optional)	TMT182 temperature head transmitter (optional)
▪ ≤ 0.805 W at 35 V DC (non-hazardous area) ▪ ≤ 0.690 W at 30 V DC (hazardous area)	≤ 0.805 W at 35 V DC

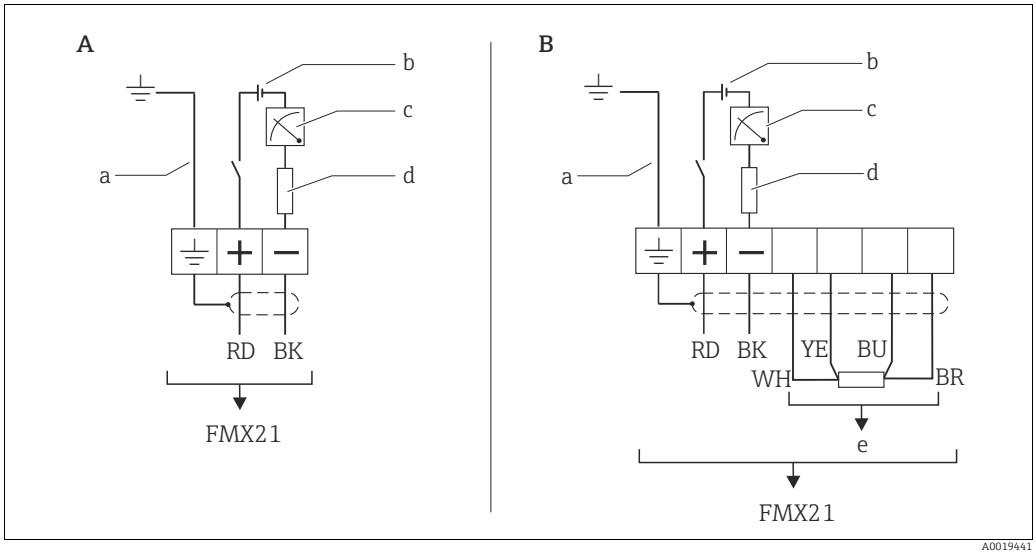
Current consumption

FMX21 + Pt100 (optional)	TMT182 temperature head transmitter (optional)
▪ Max. current consumption: ≤ 23 mA Min. current consumption: ≥ 3.6 mA ▪ Pt100: ≤ 0.6 mA	▪ Max. current consumption: ≤ 23 mA Min. current consumption: ≥ 3.5 mA ▪ Pt100 via temperature head transmitter: ≤ 0.6 mA

Measuring unit electrical connection

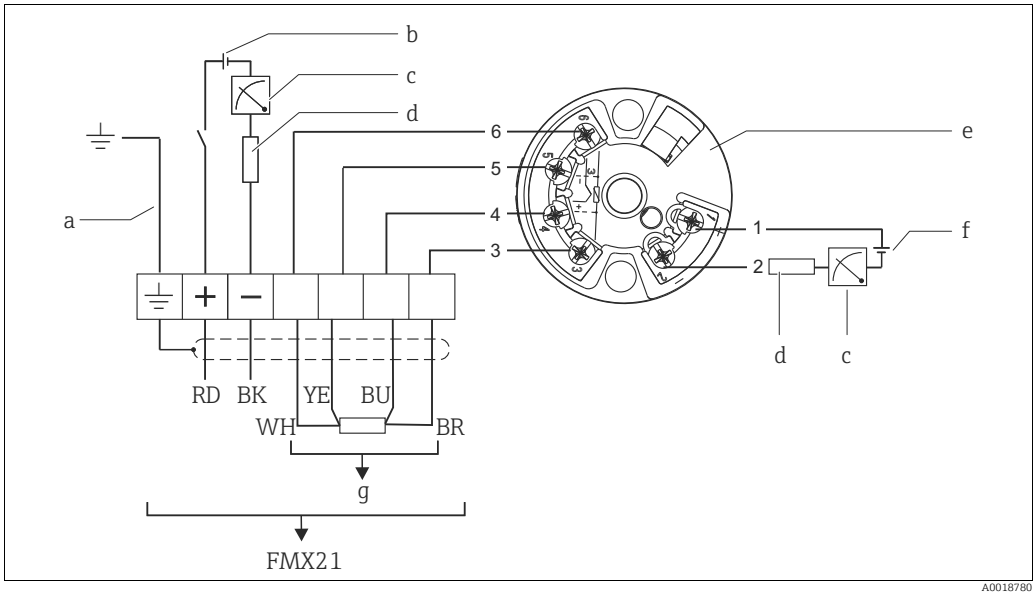
- Reverse polarity protection is integrated in the Waterpilot FMX21 and in the TMT182 temperature head transmitter. Changing the polarities will not damage the devices.
- The cable must end in a dry room or a suitable terminal box. The terminal box (IP66/IP67) with a GORE-TEX® filter from Endress+Hauser is suitable for outdoor installations. The terminal box can be ordered as an accessory using the order code for FMX21 version "PS" for feature 620 (→ 28).

The electrical connection is made with the corresponding wires of the probe cable and with the optional use of the terminal box (Commubox FXA) or an active barrier (e.g. RN221N).



A *Waterpilot FMX21*
B *Waterpilot FMX21 with Pt100 [1]; Version "NB" for feature 610 "Accessories" in the order code (→ 28)*

a Not for FMX21 with an outer diameter of 29 mm (1.14 in)
b 10.5 to 30 V DC (Ex), 10.5 to 35 V DC
c 4 to 20 mA
d Resistance (R_L)
e Pt100



Waterpilot FMX21 with Pt100 and TMT182 temperature head transmitter (4 to 20 mA) [1] versions "NB" und "PT", feature 610 and 620 in the order code (→ 28)

a Not for FMX21 with an outer diameter of 29 mm (1.14 in)
b 10.5 to 35 V DC
c 4 to 20 mA
d Resistance (R_L)
e TMT182 temperature head transmitter (4 to 20 mA)
f 11.5 to 35 V DC
g Pt100

[1] Not for use in hazardous areas.

Wire colors
RD = red, BK = black, WH = white, YE = yellow, BU = blue, BR = brown

Connection classification as per IEC 61010-1:

- Overvoltage category 1
- Pollution degree 1

Connection data in the hazardous area

4 to 20 mA	Ex ia IIC T4 to T6
Ui	30 V DC
Ii	133 mA
Pi	1.0 W
Ci	10.3 nF (sensor); 180 pF/m (cable)
Li	0 µH (sensor); 1 µH/m (cable)
Ta	−10 °C (+14 °F) ≤ Ta ≤ +70 °C (+158 °F) for T4; −10 °C (+14 °F) ≤ Ta ≤ +40 °C (+104 °F) for T6

Cable specifications

FMX21 + Pt100 (optional)

- Commercially available instrument cable
- Terminal, terminal box: 0.08 to 2.5 mm^2 (28 to 14 AWG)
- If the Pt100 signal is directly connected to a display and/or evaluation unit, Endress+Hauser recommends using a shielded cable.

TMT182 temperature head transmitter (optional)

- Commercially available instrument cable
- Terminal, terminal box: 0.08 to 2.5 mm^2 (28 to 14 AWG)
- Transmitter connection: max. 1.75 mm^2 (15 AWG)

Residual ripple

FMX21 + Pt100 (optional)

No impact on the 4 to 20 mA signal to ±5 % residual ripple within the permitted voltage range (according to HART Hardware Specification HCF_SPEC-54 (DIN IEC 60381-1))

TMT182 temperature head transmitter (optional)

$U_{ss} \geq 3$ V at U ≥ 13 V, $f_{max.}$ = 1 kHz

Performance characteristics

Reference operating conditions

FMX21 + Pt100 (optional)

- As per IEC 60770
- Ambient temperature T_A = constant, in range: +21 to +33 °C (+70 °F to +91 °F)
- Humidity φ = constant, in range: 20 to 80 % RH
- Ambient pressure p_A = constant, in range: 860 to 1060 mbar (13 to 16 psi)
- Position of the measuring cell = constant, in range, vertical: ±1°
- Supply voltage constant: 21 V DC to 27 V DC
- Load with HART: 250 Ω
- Pt100: DIN EN 60770 T_A = 25 °C (77 °F)

TMT182 temperature head transmitter (optional)

Calibration temperature 25 °C (77 °F) ±5 K

Reference accuracy

FMX21 + Pt100 (optional)

The reference accuracy comprises the non-linearity after limit point configuration, hysteresis and non-repeatability in accordance with IEC 60770.

- Setting ±0.2 %
  - to TD 5:1: < 0.2 % of the set span
  - from TD 5:1 to TD 10:1 ±(0.02 x TD+0.1)

PLATINUM version:
- Setting ±0.1 % (optional)
  - to TD 5:1: < 0.1 % of the set span
  - from TD 5:1 to TD 10:1 ±(0.02 x TD)
- Class B to DIN EN 60751
  - Pt100: max. ±1 K

TMT182 temperature head transmitter (optional)

- ±0.2 K
- With Pt100: max. ±0.9 K

Resolution

Current output: 1 µA

Read cycle
HART commands: 2 to 3 per second on average

Long-term stability

FMX21 + Pt100 (optional)

- ≤ 0.1 % of URL/year
- ≤ 0.25 % of URL/5 years

TMT182 temperature head transmitter (optional)

≤ 0.1 K per year

Influence of medium temperature

- Thermal change in the zero output and the output span
  0 to +30 °C (+32 to +86 °F): <(0.15 + 0.15 x TD)%
  −10 to +70 °C (+14 to +158 °F): <(0.4 + 0.4 x TD)%
- Temperature coefficient (T_K) of the zero output and output span
  −10 to +70 °C (+14 to +158 °F): 0.1 % / 10 K URL

Warm-up period

FMX21 + Pt100 (optional)

- FMX21: < 6 s
- Pt100: 20 ms

TMT182 temperature head transmitter (optional)

4 s

Step response time

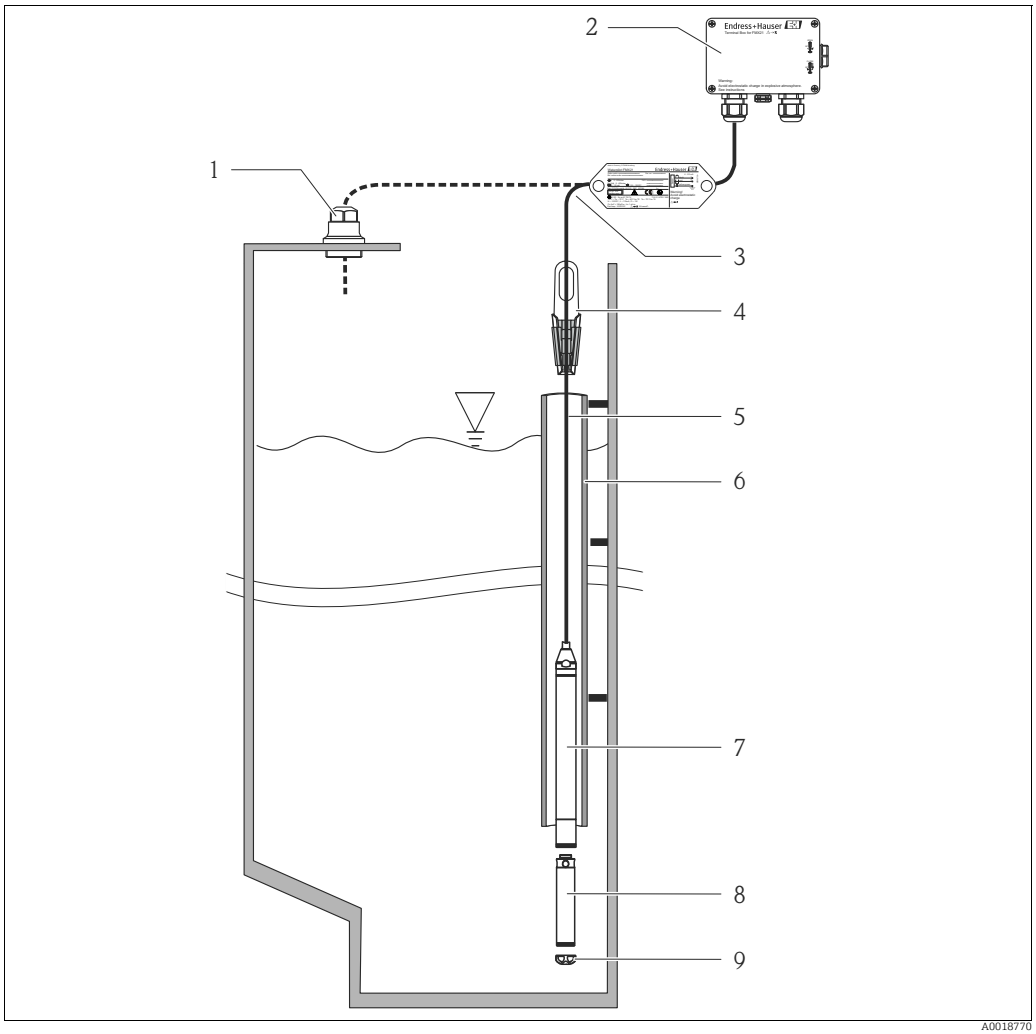
FMX21 + Pt100 (optional)

- FMX21: 400 ms (T90 time), 500 ms (T99 time)
- Pt100: 160 s (T90 time), 300 s (T99 time)

—

Installation

Installation instructions



Installation examples, here illustrated with FMX21 with an outer diameter of 22 mm (0.87 in)

1 *Extension cable mounting screw can be ordered via order code or as an accessory (→ 28)*
2 *Terminal box can be ordered via order code or as an accessory (→ 28)*
3 *Extension cable bending radius > 120 mm (4.72 in)*
4 *Mounting clamp can be ordered via order code or as an accessory (→ 28)*
5 *Extension cable, length (→ 25)*
6 *Guide pipe*
7 *Waterpilot FMX21*
8 *Additional weight can be ordered as an accessory for FMX21 with an outer diameter of 22 mm (0.87 in) and 29 mm (1.14 in)*
9 *Protection cap*

Additional installation instruction

- Sideways movement of the level probe can result in measuring errors. For this reason, install the probe at a point free from flow and turbulence, or use a guide tube. The internal diameter of the guide tube should be at least 1 mm (0.04 in) bigger than the outer diameter of the selected FMX21.
- The device is provided with a protection cap to prevent mechanical damage to the measuring cell.
- The cable must end in a dry room or a suitable terminal box. The terminal box from Endress+Hauser provides optimum humidity and climatic protection and is suitable for outdoor installation (→ 30).
- Rod length tolerances: < 5 m (16 ft): ±17.5 mm (0.69 in); > 5 m (16 ft): ±0.2 % (→ 31)
- If the cable is shortened, the filter at the pressure compensation tube has to be reattached. Endress+Hauser offers a cable shortening kit for this purpose → 28 ff; (SD00552P/00/A6).
- Endress+Hauser recommends using twisted, shielded cables.
- Note for ship building applications: Measures for limitation of the propagation of fire along cable bundles are required (fire stops).

Environment

Ambient temperature range

FMX21 + Pt100 (optional)

- With outer diameter of 22 mm (0.87 in) and 42 mm (1.65 in):
  −10 to +70 °C (+14 to +158 °F)
  (= medium temperature)
- With outer diameter of 29 mm (1.14 in):
  0 to +50 °C (+32 to +122 °F)
  (= medium temperature)

Cable
(fixed installation)
- PE: −30 to +70 °C (−22 to +158 °F)
- FEP: −40 to +70 °C (−40 to +158 °F)
- PUR: −40 to +70 °C (−40 to +158 °F)

Terminal box

−40 to +80 °C (−40 to +176 °F)

TMT182 temperature head transmitter (optional)

−40 to +85 °C (−40 to +185 °F)

Storage temperature range

FMX21 + Pt100 (optional)

−40 to +80 °C (−40 to +176 °F)

Cable
(fixed installation)
- PE: −30 to +70 °C (−22 to +158 °F)
- FEP: −30 to +80 °C (−22 to +176 °F)
- PUR: −40 to +80 °C (−40 to +176 °F)

Terminal box

−40 to +80 °C (−40 to +176 °F)

TMT182 temperature head transmitter (optional)

−40 to +100 °C (−40 to +212 °F)

Degree of protection

FMX21 + Pt100 (optional)

IP68, permanently hermetically sealed at 20 bar (290 psi)(~200 m H_2O)

Terminal box (optional)

IP66, IP67

TMT182 temperature head transmitter (optional)

IP00, condensation permitted

Geometric height according to IEC61010-1 Ed.3

Up to 2 000 m (6 600 ft) above MSL.

Electromagnetic compatibility (EMC)

FMX21 + Pt100 (optional)

- EMC in accordance with all the relevant requirements of the EN 61326 series. Details are provided in the Declaration of Conformity.
- Maximum deviation < 0.5 % of the span.

TMT182 temperature head transmitter (optional)

EMC in accordance with all the relevant requirements of the EN 61326 series. Details are provided in the Declaration of Conformity.

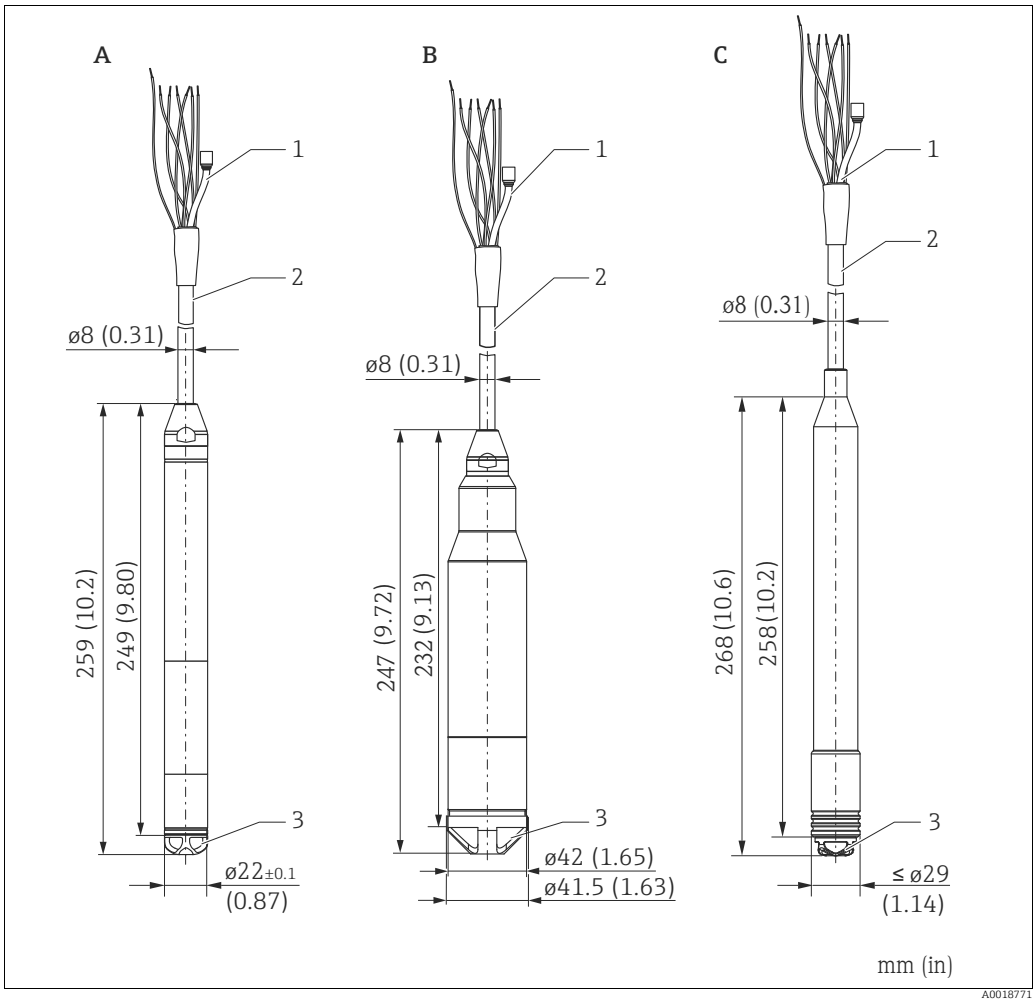
Overvoltage protection	**FMX21 + Pt100 (optional)** ▪ Integrated overvoltage protection to EN 61000-4-5 (500 V symmetrical/1000 V asymmetrical) ▪ Install overvoltage protection ≥ 1.0 kV, external if necessary	**TMT182 temperature head transmitter (optional)** Install overvoltage protection, external if necessary.

Process

Medium temperature range	**FMX21 + Pt100 (optional)** ▪ With outer diameter of 22 mm (0.87 in) and 42 mm (1.65 in): −10 to +70 °C (+14 to +158 °F) ▪ With outer diameter of 29 mm (1.14 in): 0 to +50 °C (+32 to +122 °F)	**TMT182 temperature head transmitter (optional)** —
Medium temperature limits	**FMX21 + Pt100 (optional)** ▪ With outer diameter of 22 mm (0.87 in) and 42 mm (1.65 in): −20 to +70 °C (−4 to +158 °F) In hazardous areas incl. CSA GP, the medium temperature limit is at −10 to +70 °C (+14 to +158 °F). ▪ With outer diameter of 29 mm (1.14 in): 0 to +50 °C (+32 to +122 °F) The FMX21 can be operated in this temperature range. The specification can then be exceeded, e.g. measuring accuracy.	—

Mechanical construction

Dimensions of the level probe

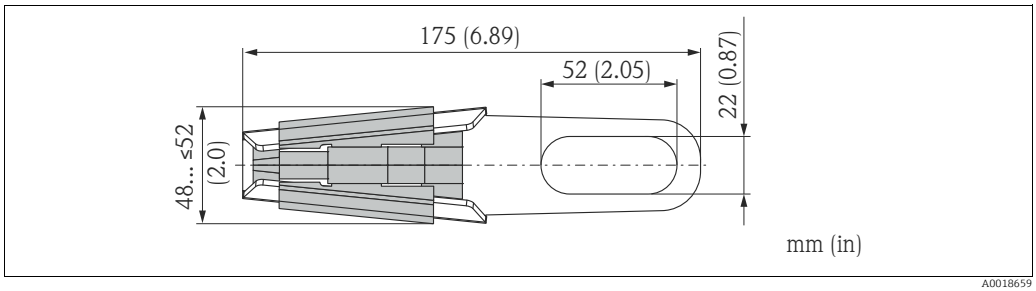


Versions of the FMX21

A *In the order code: feature 45 "Probe tube", version "1" or "Accessories" (→ 28)*
B *In the order code: feature 45 "Probe tube", version "2" (→ 28)*
C *In the order code: feature 45 "Probe tube", version "5" (→ 28)*

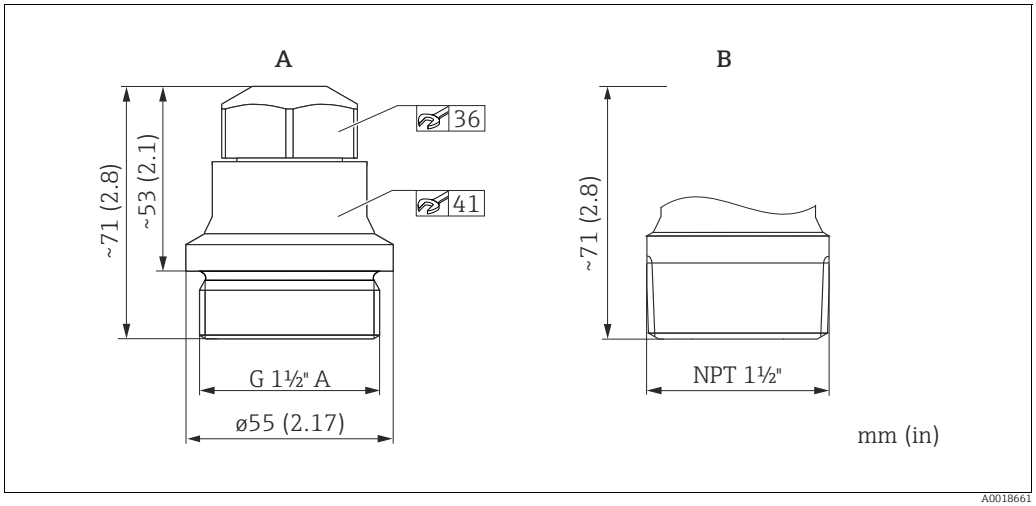
1 Pressure compensation tube
2 Extension cable ((Length, see → 25)
3 Protection cap

Dimensions of the mounting clamp



In the order code: feature 620 "Accessories", version "PO" (→ 28)

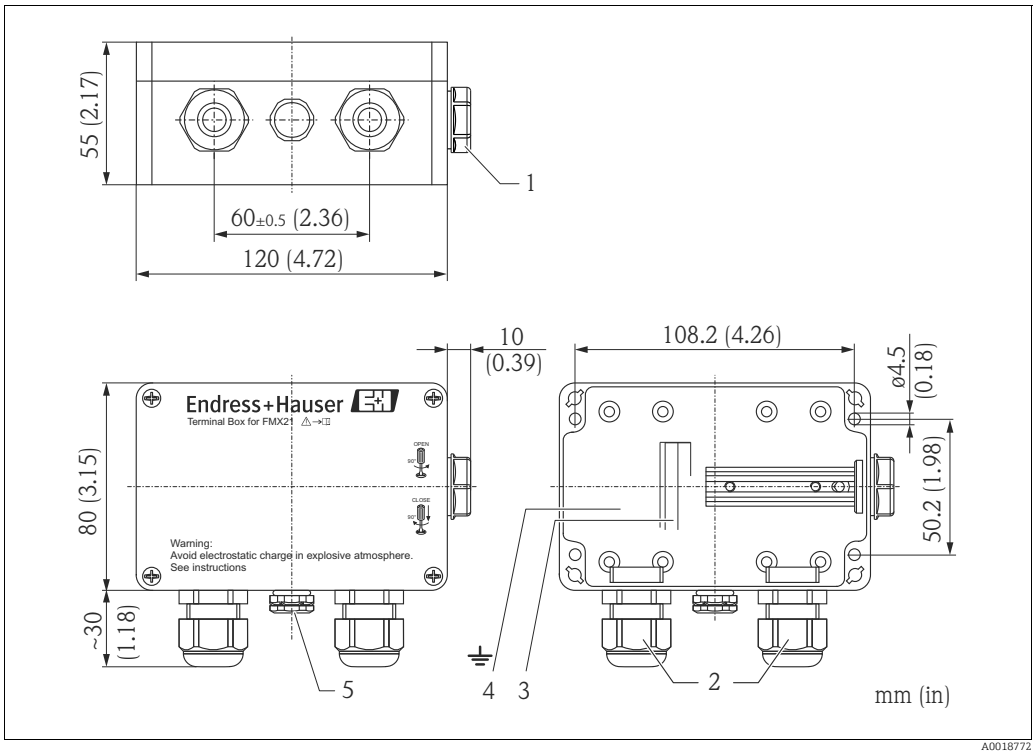
Dimensions of the extension cable mounting screws



A *G 1½" A, in the order code: feature 620 "Accessories", version "PQ" (→ 🖹 28)*
B *NPT 1½", in the order code: feature 620 "Accessories", version "PR" for (→ 🖹 28)*

Application in unpressurized containers only.

Dimensions of the IP66, IP67 terminal boxes with filters



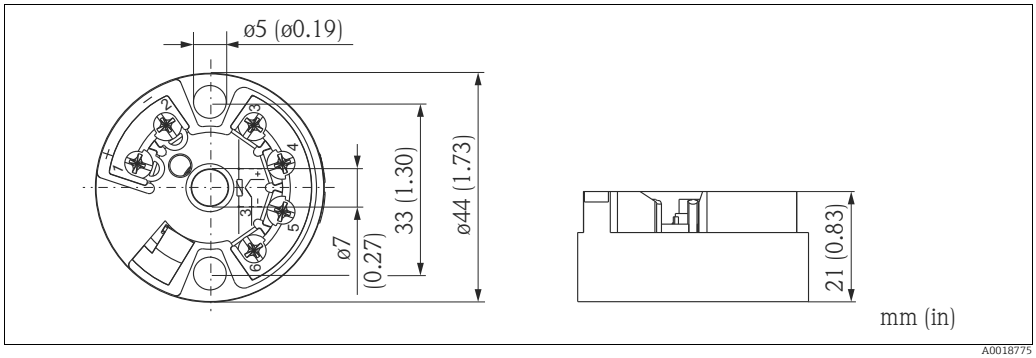
In the order code: feature 620, version "PS" or "PT" (→ 🖹 28)

1 *Dummy plug M20x1.5*
2 *Cable gland M20x1.5*
3 *4 to 20 mA; terminals for 0.08 to 2.5 mm² (28 to 14 AWG)*
4 *Ground connection; terminals for 0.08 to 2.5 mm² (28 to 14 AWG)*
5 *GORE-TEX® filter*

If ordered together with FMX21 but without the optional TMT182 temperatur transmitter, the terminal box is incl. a 4-terminal strip.

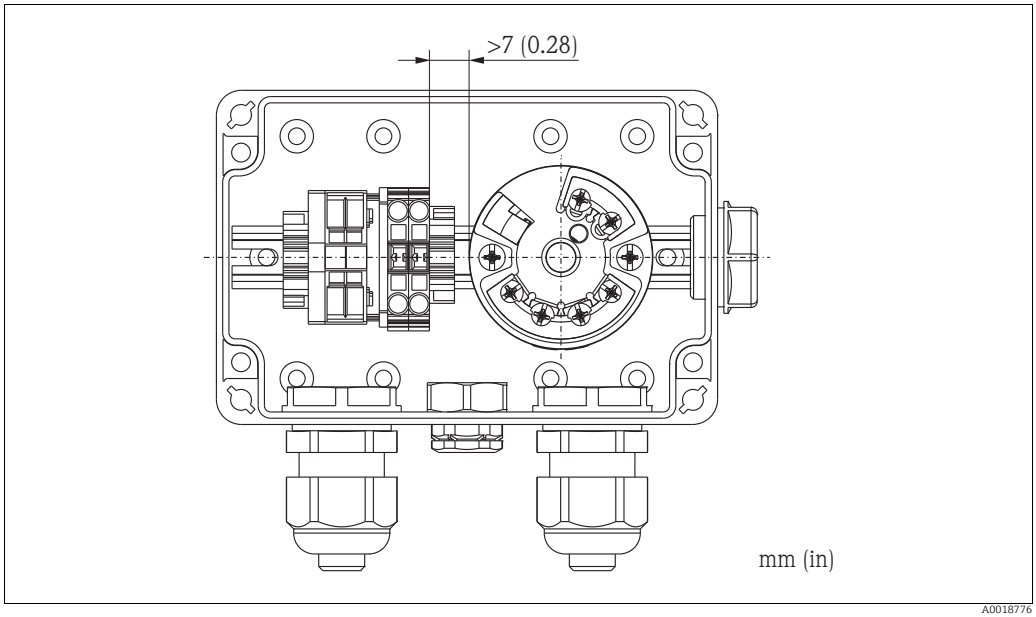
The 4-terminal strip is not intended for use in hazardous areas incl. CSA GP.

Dimensions of the TMT182 temperature head transmitter



In the order code: feature 620 "Accessories", version "PT" for (→ 28)

Terminal box with integrated TMT182 temperature head transmitter (4 to 20 mA HART)

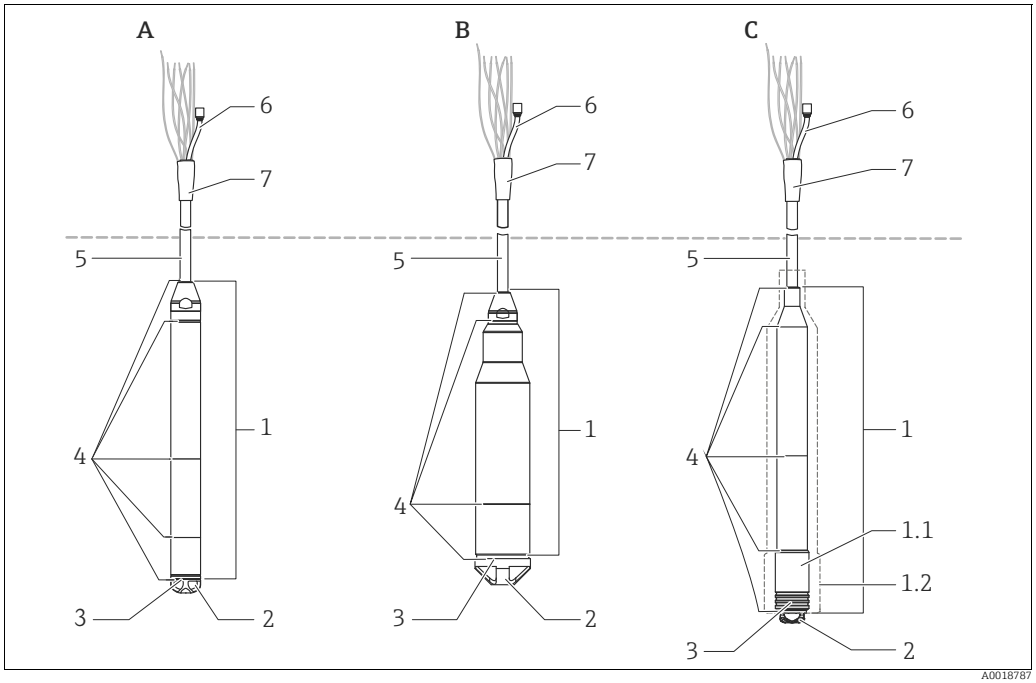


A distance of > 7 mm (> 0.28 in mm) must be maintained between the terminal strip and the TMT182 temperature head transmitter.

Weight

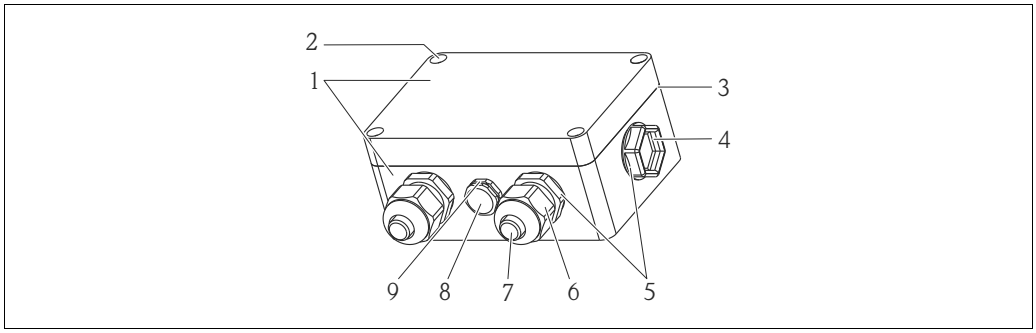
Component part		Weight
Level probe, outer diameter 22 mm (0.87 in)		344 g (12.133 oz)
Level probe, outer diameter 42 mm (1.65 in)		1376 g (48.532 oz)
Level probe, outer diameter 29 mm (1.14 in)		394 g (13.896 oz)
Extension cable	▪ PE ▪ PUR ▪ FEP	▪ 52 g/m (0.035 lbs/1 ft) ▪ 60 g/m (0.040 lbs/1 ft) ▪ 108 g/m (0.072 lbs/1 ft
Mounting clamp		170 g (5.996 oz)
Extension cable mounting screw G 1½" A		770 g (27.158 oz
Extension cable mounting screw NPT 1½"		724 g (25.535 oz)
Terminal box		235 g (8.288 oz)
Temperature head transmitter TMT182		40 g (1.411 oz)
Additional weight		300 g (10.581 oz)
Testing adapter		39 g (1.376 oz)

Material



Material in contact with process		
Position number	**Component part**	**Material**
1	**A**: Level probe, outer diameter 22 mm (0.87 in) **B**: Level probe, outer diameter 42 mm (1.65 in) **C**: Level probe, outer diameter max. 29 mm (1.14 in)	316L (1.4404/1.4435)
1.1	Sensor sleeve	PPS (polyphenylene sulfide)
1.2	Heat-shrink sleeve	Polyolefin and hot-melt adhesive
	The heat-shrink sleeve at the level probe acts as an insulation. It prevents electrical contact between the probe and the tank. Electrochemical corrosion is thus avoided.	
2	Protection cap ▪ **A** and **C**: with outer diameter 22 mm (0.87 in) and 29 mm (1.14 in) ▪ **B**: with outer diameter 42 mm (1.65 in)	▪ PPO (Polyphenylenoxid) ▪ PFA (Perfluoralkoxy)
3	Process ceramic	Al_2O_3 (aluminum oxide ceramic)
4	Seal	EPDM or FKM Viton
5	Extension cable insulation For more information → 25	Either: ▪ PE-LD (low-density polyethylene) ▪ FEP (fluorinated ethylene propylene) ▪ PUR (polyurethane)
Material not in contact with process		
6	Pressure compensation tube	PA
7	Heat-shrink sleeve	Polyolefin

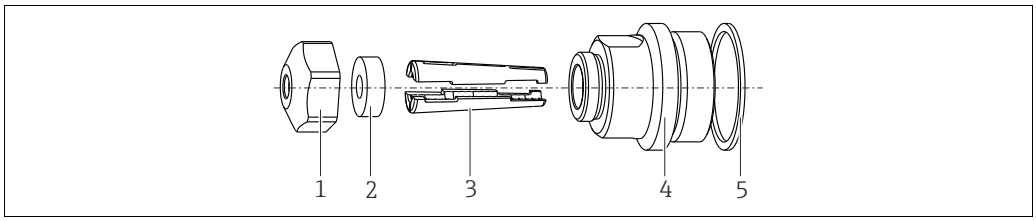
Terminal box (not in contact with process)



A0018917

Position number	Component part	Material
1	Housing	PC
2	Mounting screws (4 x)	A2
3	Seal	CR (Chloropren-Unvulcanized rubber)
4	Dummy plug M20x1.5	PBT-GF30
5	Cable gland M20x1.5	PE-HD
6		PA6
7		PA6-GF30
8	Pressure compensation tube	PA6-GF10, ePTFE
9	Pressure compensation tube O-ring	Silicone (VMQ)

Cable mounting screw (not in contact with process)



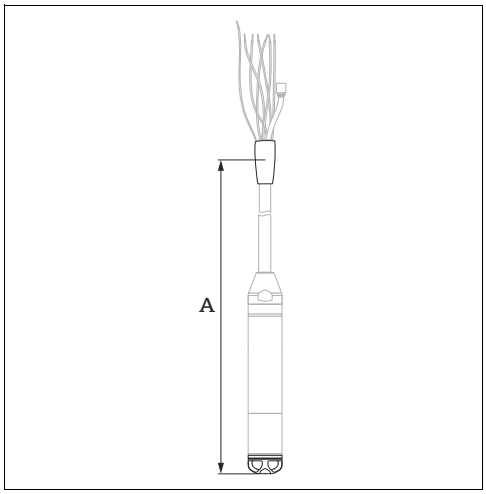
A0018918

Position number	Component part	Material
1	Cover cable gland	304 (1.4301)
2	Seal	NBR
3	Klemmhülsen	PA66-GF35
4	Anschlussstück cable gland G 1½" A, NPT 1½"	304 (1.4301)
5	Seal → only for G 1½" A	EPDM

Extension cable

PE	PUR	FEP
▪ Abrasion-resistant extension cable with Dynema strain-relief members ▪ Shielded with aluminum-coated film ▪ Insulated with polyethylene (PE), black ▪ Copper wires, twisted ▪ Pressure compensation tube with Teflon filter	▪ Abrasion-resistant extension cable with Dynema strain-relief members ▪ Shielded with aluminum-coated film ▪ Insulated with polyurethane (PUR), black ▪ Copper wires, twisted ▪ Pressure compensation tube with Teflon filter	▪ Abrasion-resistant extension cable ▪ Shielded with galvanized steel wire netting ▪ Insulated with fluorinated ethylene propylene (FEP), black ▪ Copper wires, twisted ▪ Pressure compensation tube with Teflon filter

Cable length



A Cable length

- Please refer also to "Load" (→ 12).
- Cable lengths that can be ordered
  - Customer-specific length in meters or feet (→ 28, "Ordering information")
  - Limited cable length when performing installation with freely suspended device with extension cable mounting screw or mounting clamp, as well as for hazardous areas: max. 300 m (984 ft).

When using the measuring device in hazardous areas, installation must comply with the applicable national standards and regulations and the Safety Instructions (XAs) or the Installation or Control Drawings (ZDs) "Documentation"

Cross-section

- Total outer diameter: 8.0 mm (0.31 in) ±0.25 mm (±0.01 in)
- FMX21: 3 x 0.227 mm^2 (3 x 26 AWG) + pressure compensation tube with Teflon filter
- FMX21 with Pt100 (optional): 7 x 0.227 mm^2 (7x 26 AWG) + pressure compensation tube with Teflon filter
- Pressure compensation tube with Teflon filter:
  outer diameter 2.5 mm (0.1 in), internal diameter 1.5 mm (0.06 in)

Cable resistance

per wire: ≤ 0.09 Ω/m

Further technical data

- Minimum bending radius: 120 mm (4.72 in)
- Tensile strength: max. 950 N (213.56 lbf)
- Cable extraction force (= necessary tensile force to extract the cable from the level probe):
  - PE, FEP: typical ≥ 400 N (89.92 lbf), PUR: typical ≥ 150 N (33.72 lbf)
  - for use in hazardous areas: ≥ 100 N (73,75 lbf)
- Resistance to UV light
- PE: Usage in drinking water

Terminals

- Three terminals as standard in the terminal box
- 4-terminal strip can be ordered as an accessory, Order No: 52008938
  Conductor cross-section 0.08 to 2.5 mm^2 (28 to 14 AWG)

The 4-terminal strip is not intended for use in hazardous areas incl. CSA GP.

Operability

FieldCare

FieldCare is Endress+Hauser's plant asset management tool based on FDT technology. You can use FieldCare to configure all Endress+Hauser devices as well as third-party devices which support the FDT standard.

FieldCare supports the following functions:
- Configuration of transmitters in offline and online mode
- Loading and saving device data (upload/download)
- Documentation of the measuring point

Connection options:
- Via Commubox FXA195 and the USB port of a computer
- Via Fieldgate FXA520

For further information and free download of FieldCare see → www.endress.com → Download → Search: FieldCare

Field Xpert SFX

Field Xpert is an industrial PDA with integrated 3.5" touchscreen from Endress+Hauser based on Windows Mobile. It communicates via wireless with the optional VIATOR® Bluetooth® modem connected to a HART device point-to-point or wireless via WiFi and Endress+Hauser's Fieldgate FXA520. Field Xpert also works as a stand-alone device for asset management applications. For details refer to BA00060S/00/EN.

Certificates and approvals

CE mark

The device meets the legal requirements of the applicable EC Directives. Endress+Hauser confirms successful testing of the device by affixing to it the CE mark.

Ex approval

- ATEX
- CSA C/US
- FM
- IEC
- NEPSI
- INMETRO

- The approvals to apply only for Waterpilot FMX21 without Pt100 and without TMT182.
- Waterpilot FMX21 is only available for use in hazardous areas with the FKM Viton seal.
- All explosion protection data are given in separate documentation which is available upon request. The Ex documentation is supplied as standard with all devices approved for use in explosion hazardous areas (→ 32).

Drinking water approval

For FMX21 with outer diameter 22 mm (0.87 in)
- KTW certificate
- NSF 61 approval
- ACS approval

Marine certificate

- GL (Germanischer Lloyd)
- ABS (American Bureau of Shipping)
- LR (Lloyds Register)
- BV (Bureau Veritas)
- DNV (Det Norske Veritas)

Standards and guidelines

The European standards and guidelines that have been applied are listed in the associated EC Declarations of Conformity. In addition, the following standards were also applied for the Waterpilot FMX21:

- DIN EN 60770 (IEC 60770):
  Transmitters for use in industrial process control systems
  Part 1: Methods for performance evaluation
- DIN 16086:
  Electrical pressure measuring instruments,
  pressure sensors, pressure transmitters,
  pressure measuring instruments, concepts, specifications on data sheets
- EN 61326:
  Electrical equipment for measurement, control and laboratory use – EMC requirements
- EN 61010-1 (IEC 61010-1):
  Safety requirements for electrical equipment for measurement, control and laboratory use
- IEC 60529:
  Degrees of protection provided by enclosures

Ordering information

FMX21

You can enter the versions for the specific feature in the following table. The versions entered make up the complete order code. Options which are mutually exclusive are not marked.

10	**Approval:**	
	AA	Non-hazardous area
	BE	ATEX II 2 G Ex ia IIC T6
	BD	ATEX II 3 G Ex nA IIC T6
	FE	FM IS, Cl. I Division 1, Groups A – D, AEx ia, zone 1
	CE	CSA C/US IS Cl. I Division 1, Groups A – D, Ex ia, zone 1
	CD	CSA General Purpose
	IC	IEC Ex ia IIC T6 Gb
	MA	INMETRO Ex ia IIC T6
	NA	NEPSI Ex ia IIC T6

20	**Output:**	
	2	4-20 mA HART

45	**Probe tube:**	
	1	Outer diameter d = 22 mm, AISI 316L
	2	Outer diameter d = 42 mm, flush-mounted, AISI 316L
	5	Outer diameter d = 29 mm, AISI 316L, PPS/polyolefin for saltwater applications

70	**Sensor range:**	
	Measuring range	
	1C	100 mbar/10 kPa/1.5 psi gauge, 1 m H_2O/3 ft H_2O/40 in H_2O
	1D	200 mbar/20 kPa/3 psi gauge, 2 m H_2O/6 ft H_2O/80 in H_2O
	1F	400 mbar/40 kPa/6 psi gauge, 4 m H_2O/13 ft H_2O/160 in H_2O
	1G	600 mbar/60 kPa/9 psi gauge, 6 m H_2O/20 ft H_2O/240 in H_2O
	1H	1 bar/100 kPa/15 psi gauge, 10 m H_2O/33 ft H_2O/400 in H_2O
	1K	2 bar/200 kPa/30 psi gauge, 20 m H_2O/67 ft H_2O/800 in H_2O
	1M	4 bar/400 kPa/60 psi gauge, 40 m H_2O/133 ft H_2O/1600 in H_2O
	1P	10 bar/1 MPa/150 psi gauge, 100 m H_2O/333 ft H_2O/4000 in H_2O
	1Q	20 bar/2 MPa/300 psi gauge, 200 m H_2O/667 ft H_2O/8000 in H_2O
	2K	2 bar/200 kPa/30 psi absolute, 20 m H_2O/67 ft H_2O/800 in H_2O
	2M	4 bar/400 kPa/60 psi absolute, 40 m H_2O/133 ft H_2O/1600 in H_2O
	2P	10 bar/1 MPa/150 psi absolute, 100 m H_2O/333 ft H_2O/4000 in H_2O
	2Q	20 bar/2 MPa/300 psi absolute, 200 m H_2O/667 ft H_2O/8000 in H_2O

80	**Reference accuracy:**	
	D	Platinum
	G	Standard

90	**Calibration, unit:**	
	A	Sensor range; %
	B	Sensor range; mbar/bar
	C	Sensor range; kPa/MPa
	D	Sensor range; mm/mH_2O
	E	Sensor range; in H_2O/ft H_2O
	F	Sensor range; psi
	J	Customized pressure; see additional specification
	K	Customized level; see additional specification

FMX21-										Order code

→ Ordering information for continued on next page

FMX21 (continued)

100	Probe connection:
10	10 m cable, shortable, PE
11	20 m cable, shortable, PE
15	..... m cable, shortable, PE
20	30 ft cable, shortable, PE
21	60 ft cable, shortable, PE
25	..... ft cable, shortable, PE
30	10 m cable, shortable, FEP
31	20 m cable, shortable, FEP
35	..... m cable, shortable, FEP
40	30 ft cable, shortable, FEP
41	60 ft cable, shortable, FEP
45	..... ft cable, shortable, FEP
50	10 m cable, shortable, PUR
51	20 m cable, shortable, PUR
55	..... m cable, shortable, PUR
60	30 ft cable, shortable, PUR
61	60 ft cable, shortable, PUR
65	..... ft cable, shortable, PUR

190	Seal:
A	FKM Viton
H	EPDM

FMX21-											Order code

Additional ordering information (optional)

550	Calibration
F1	Works calib. certificate 5-point

570	Service
IA	Adjusted min alarm current
IB	Adjusted HART Burst Mode PV
IR	... m cable marking>installation
IS	... ft cable marking>installation
I9	Special version

590	Additional approval
LE	GL Marine certificate
LF	ABS Marine certificate
LG	LR Marine certificate
LH	BV Marine certificate
LI	DNV Marine certificate
LQ	KTW potable water approval
LR	NSF potable water approval
LS	ACS potable water approval

610	Accessories mounted
NB	Temperature sensor Pt100, 4-wire

620	Accessories enclosed
PO	Suspension clamp, 316L
PQ	Cable mounting screw G1½", 304
PR	Cable mounting screw NPT1½", 304
PS	Terminal box IP66/67
PT	Temperature head transmitter TMT182, 2-wire, 4-20 mA, −20 to 80 °C
PU	Additional weight, 316L
PV	Adapter, function test
PW	Shortening kit, extension cable

895	Marking
Z1	Tagging (TAG)

FMX21-											Order code

Accessories

Mounting clamp

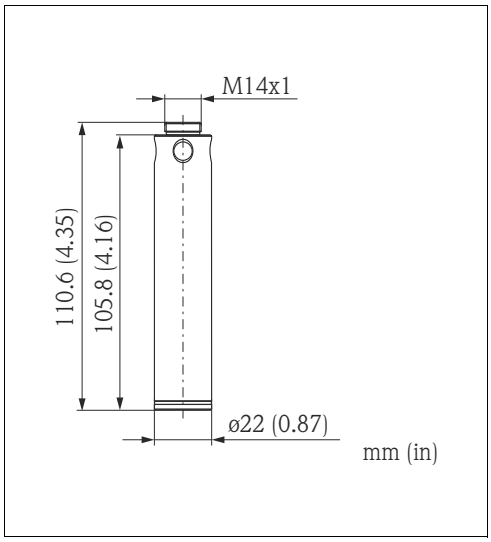
- Endress+Hauser offers a mounting clamp for easy FMX21 mounting (→ 20).
- Material: 316L (1.4404) and fiberglass reinforced PA (polyamide)
- Order number 52006151, "Ordering information" (→ 28)

Terminal box

- IP66/IP67 terminal boxes with GORE-TEX® filter incl. 3 integrated terminals.
  The terminal box is also suitable for installing a TMT182 temperature head transmitter or for four additional terminals (Order No. 52008938) → 21, "Ordering information" (→ 28).

The terminal box is not intended for the FMX21 with Ex nA explosion protection in the hazardous area. When using the terminal box in hazardous areas, installation must comply with the corresponding national standards and regulations and the Safety Instructions or Installation or Control Drawings.

Additional weight



For FMX21 with outer diameter of 22 mm (0.87 in) or 29 mm (1.14 in)

- Endress+Hauser offers additional weights to prevent sideways movement that results in measuring errors, or to make it easier to lower the device in a guide tube.
  You can screw several weights together. The weights are attached directly to the FMX21. For FMX21 with an outer diameter of 29 mm (1.14 in) a maximum of 5 weights may be attached. In combination with the Ex nA approval, for FMX21 with an outer diameter of 29 mm (1.14 in) a maximum of 1 additional weight may be attached.
- Material: 316L (1.4435)
- Weight: 300 g (10.581 oz)
- Order number 52006153, "Ordering information" (→ 28)

TMT182 temperature head transmitter (4 to 20 mA HART)

- 2-wire temperature head transmitter, configured for a measuring range from −20 to +80 °C (-4 to +158 °F). This setting offers a temperature range of 100 K which can be easily mapped. Please note that the Pt100 resistance thermometer is designed for a temperature range from −10 to +70 °C (−14 to +176 °F) → 22.
- Order number: 51001023, Ordering information (→ 28)

The TMT182 temperature head transmitter is not intended for use in hazardous areas incl. CSA GP.

Extension cable mounting screw

Endress+Hauser offers extension cable mounting screws to ease FMX21 mounting and to seal the measuring aperture (→ 21).

- Order number for extension cable mounting screw:
  - 52008264 (G 1½" A)
  - 52009311 (NPT 1½")
- Material (→ 23)

Terminals

- Four terminals in strip for terminal box, suitable for wire cross-section: 0.08 to 2.5 mm² (28 to 14 AWG)
- Order number: 52008938

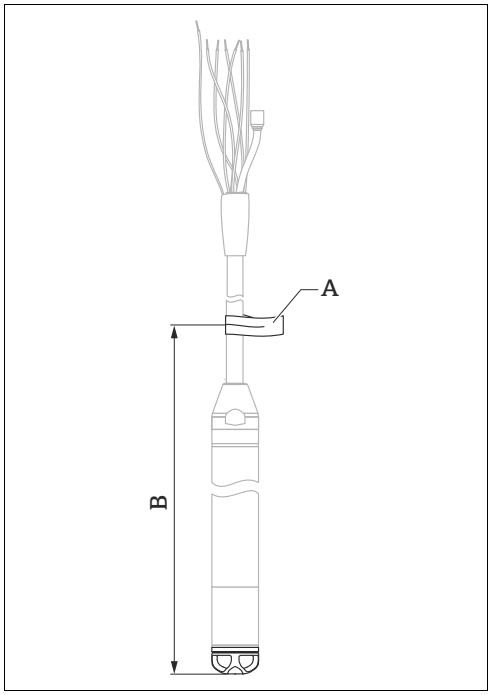
The 4-terminal strip is not intended for use in hazardous areas incl. CSA GP.

Cable shortening kit

- The cable shortening kit is used to easily and professionally shorten a cable.
- Order Number: 71222671, "Ordering information" and the documentation SD00552P/00/A6 (→ 28)

The cable shortening kit is not intended for the FMX21 with FM/CSA approval.

Cable marking



A Cable marking
B Cable marking tolerance

- To make installation easier, Endress+Hauser offers a mark on the extension cable for a customer-specific length, see also → 28, "Ordering information".
- Cable marking tolerance (distance to the lower end of the cable probe):
  Cable length < 5 m (16 ft): ±17.5 mm (0.69 in)
  Cable length > 5 m (16 ft): ±0,2 %
- Material: PET, Adhesive: acrylic
- Immunity to temperature change:
  −30 to +100 °C (-22 to +212 °F)

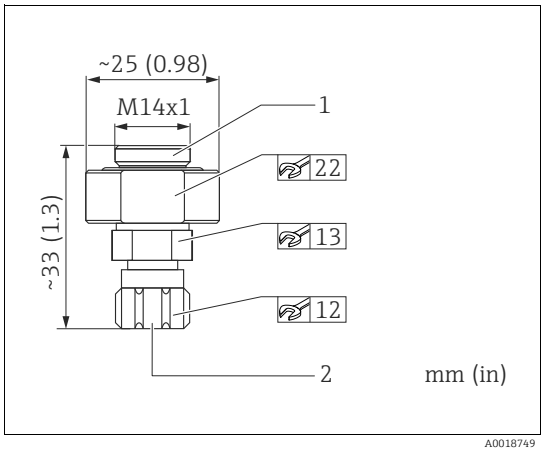
NOTICE

The mark is for installation purposes only.

- ▸ It must be thoroughly removed without trace in the case of devices with drinking water approval. The extension cable must not be damaged in the process

Not for use in hazardous areas.

Testing adapter



1 FMX21 level probe connection
2 Compressed air hose connection, internal diameter of quick coupling piece 4 mm (0.16 in)

For FMX21 with outer diameter of 22 mm (0.87 in) and 29 mm (1.14 in)

- Endress+Hauser offers a testing adapter to ease function-testing of the level probes.
- Observe the maximum pressure for the compressed air hose and the maximum overload for the level probe (→ 11).
- Maximum pressure of the quick coupling piece supplied: 10 bar (145 psi)
- Adapter material: 304 (1.4301)
- Quick coupling piece material: anodized aluminum
- Adapter weight: 39 g (1.376 oz)
- Order number 52011868 (→ 28)

Documentation

The following document types are also available in the Download Area of the Endress+Hauser website: www.endress.com → Download

Field of activities

- Pressure measurement: FA00004P/00/EN
- Recording technology: FA00014R/09/EN
- System components: FA00016K/09/EN

Technical Information

- Waterpilot FMX167 with 4 to 20 mA analog output: TI00351P/00/EN
- Deltapilot M: TI00437P/00/EN
- Temperature head transmitter iTEMP HART TMT182: TI00078R/09/EN

Operating Instructions

- Waterpilot FMX21: BA00380P/00/EN
- Cable shortening kit: SD00552P/00/A6
- Field Xpert: BA01211S/04/EN

Safety instructions

Safety Instructions (XA) are supplied with the device depending on the approval. These instructions are anintegral part of the Operating Instructions.

Approval	Feature in Order code	Types of protection	Category	Documentation
ATEX	BD	Ex ia IIC	II 2 G	XA00454P
ATEX	BE	Ex nA IIC	II 3 G	XA00485P
IECEx	IC	Ex ia IIC	n/a	XA00455P
CSA C/US	CE	Ex ia IIC	n/a	ZD232P (960008976)
FM	FE	AEx ia IIC	n/a	ZD231P (960008975)
NEPSI	NA	Ex ia IIC	n/a	XA00456P
INMETRO	MA	Ex ia IIC	n/a	XA01066P

The nameplate provides information on the Safety Instructions (XA) that are relevant for the device.

Drinking water approval

- SD00289P/00/A3 (NSF)
- SD00319P/00/A3 (KTW)
- SD00320P/00/A3 (ACS)

Patents

This product is protected by at least one of the following patents. Further patents are pending.

- US 6,427,129 B1 ≙ EP 0 892 249 B1
- US 6,703,943 A1
- DE 203 13 744.2 U1

Configuration data sheet

Level

The following configuration data sheet has to be filled in and included with the order if the option "K: customized level" has been selected in feature "090: Calibration; unit" in the product structure.

Pressure Engineering Unit

❑ mbar	❑ mmH_2O	❑ mmHg	❑ hPa
❑ bar	❑ mH_2O		❑ kPa
	❑ ftH_2O		❑ MPa
❑ psi	❑ inH_2O	❑ kgf/cm^2	

Output Unit (Scaled unit)

Mass	Length	Volume	Volume	Percent
❑ kg	❑ m	❑ l	❑ gal	❑ %
❑ t	❑ dm	❑ hl	❑ Igal	
❑ lb	❑ cm			
	❑ mm	❑ m^3		
		❑ ft^3		
	❑ ft	❑ in^3		
	❑ inch			

Empty calibration [a]:
low pressure value (empty) _____ [pres.eng.unit]

Empty calibration [a]:
low level value (empty) _____ [scaled unit]

Full calibration [b]:
high pressure value (full) _____ [pres.eng.unit]

Full calibration [b]:
high level value (full) _____ [scaled unit]

Damping

Damping: _____ sec

Pressure

The following configuration data sheet has to be filled in and included with the order if the option "J: customized pressure" has been selected in feature "090: Calibration; unit" in the product structure.

Pressure Engineering Unit

❑ mbar	❑ mmH_2O	❑ mmHg	❑ Pa
❑ bar	❑ mH_2O		❑ kPa
	❑ ftH_2O		❑ MPa
❑ psi	❑ inH_2O	❑ kgf/cm^2	

Calibration Range / Output

Low range value (LRV) _____ [pressure engineering unit]
Upper range value (URV): _____ [pressure engineering unit]

Damping

Damping: _____ sec

www.addresses.endress.com

Endress+Hauser

People for Process Automation

Appendix 3

- Wireless Telemetry Technical Information: Signal Fire Ranger Sensor to Cloud Platform

RANGER

Sensor to Cloud Platform

PLUG-&-PLAY, INSTANT CONNECTIVITY OF A SENSOR TO THE CLOUD OVER CELLULAR NETWORKS

OPTIMIZED FOR BATTERY LIFE USING LATEST CELL MODEM TECHNOLOGY LTE CAT M1 / NB-IOT

MULTI INPUT/OUTPUT TO CONNECT TO A VARIETY OF SENSORS INCLUDING ANALOG, HART, SDI-12, AND MODBUS

MQTT & SPARKPLUG-B READY TO INTEGRATE WITH HOSTS OTHER THAN SIGNALFIRE CLOUD

FEATURES

- LTE CAT M1 / NB-IoT connectivity to cloud services
- Integrated inputs/output for multi-sensors
- Data location from built-in GPS
- SignalFire cloud monitoring/alarming service
- Powers sensors from battery or external solar

PRODUCT OVERVIEW

The SignalFire Ranger is an IoT (internet of things) cellular transmitter utilizing LTE-M/NB-IoT technology to bring sensor data directly to the cloud. Data is transmitted over cellular networks using the MQTT/Sparkplug protocol directly to the SignalFire Cloud for a complete monitoring and alarming service or can easily be integrated into a customer's existing system.

The built-in Ranger I/O consists of two (2) digital inputs, one (1) analog input and one (1) relay output. The digital inputs can detect on/off status or frequencies up to 2kHz for pulse counting and totalizing applications. The analog input supports a 1-5Vdc or 4-20mA device and provides power to the sensor from the built-in battery pack. The relay output is a latching single pole single to provide on/off control to a local device.

In addition to the built-in I/O the Ranger supports an optional expansion modules to support additional sensor types including Modbus, HART, SDI-12, and additional analog and digital inputs.

The Ranger comes complete with the mobile device ready SignalFire cloud interface to monitor, trend and receive alarms either by text or email message. In addition, the cloud platform provides for remote configuration and troubleshooting of the Ranger node and its attached sensor(s) and the relay output may be controlled from the cloud interface to remotely control pumps, motors, and valves.

SIGNALFIRE
WIRELESS TELEMETRY

www.signal-fire.com | 140 Locke Drive, Suite B, Marlborough, MA 01752 USA | 978.212.2868

RANGER

Sensor to Cloud Platform

TECHNICAL SPECIFICATIONS

Operating Temp:
-40 to +185°F (-40 to 85°C)

Humidity: 0% - 100% condensing

Input Power:
- Battery Pack: Four D-cell Lithium Thionyl Chloride, 76AHr
- Optional solar power
- Optional 10-30Vdc input

Input/Output:

Standard
- 1 Latching Relay Output (2A @ 30Vdc; 0.3A @ 110Vac; 0.5A @ 125Vac). Failsafe & local automation configurable
- 2 Digital Inputs report state, total counts, frequency (2kHz max), volume total with K Factor
- Analog Input (1-5Vdc or 4-20mA). Configurable for flow totalizing mode
- Provides a configurable 13V or 18V to attached sensor(s). Maximum current of 60mA.

Expansion Module Options:
(one module possible per RANGER)

2AI1DI Module:
- Adds 2 additional analog inputs and 1 additional digital input

Modbus Module:
- Modbus RTU - RS485 up to 8 slaves, 32 total registers (read/write)

HART Module:
- Supports 1-15 HART sensors in multi-drop mode
- Reports 4 process variables, field device status, unique identifier and device tag for each HART device
- Scan and configure HART IDs with the Ranger, separate HART modem not required

SDI-12 Module:
- Monitors and powers one to eight SDI-12 sensors at 13V, 60mA max
- Reads/reports up to 16 measurements
- Supports reading the default measurement and all additional measurements from connected SDI-12 devices

Battery Life: Up to 8 years

Data Interface:
- LTE CAT M1 / NB-IoT, auto-selectable
- SparkPlug B messaging

Cellular Radio Power: 23dBm

Antenna Type: LTE w/ Internal GPS

Enclosure: Industrial polycarbonate UV Rated; IP64

Safety Rating: Class 1 Division 2 Certified, Groups A, B,C, D. Temperature Code T5. Certified to CSA C22.2 No. 213:2017, Conforms to UL 121201:2017, CE Approved

Electrical Connection: Pluggable terminal block, 16-30AWG screw terminals

Local Micro-USB Configuration Port

Weight: 1 lbs (0.6kg)

Estimated Monthly Data Usage:
Check-in interval dependent
- 1 min = 27 MB
- 5 min = 5.4 MB
- 15 min = 1.08 MB
- 60 min = 0.27 MB

Cellular Specifications:
- LTE band support:
  Cat-M1 / NB-IoT: B1, B2, B3, B4, B5, B8, B12, B13, B14, B17, B20, B25, B26, B28, B66
- Supports 4FF SIM type
- Power saving features: eDRX
- Secure socket using TLS
- PTCRB Certified

connected by verizon

SIGNALFIRE WIRELESS TELEMETRY

www.signal-fire.com | 140 Locke Drive, Suite B, Marlborough, MA 01752 USA | 978.212.2868

RANGER

Sensor to Cloud Platform

HOW TO ORDER

RANGER LTE M1 Transmitter

RANGER – [ ] – [ ] – [ ]

Power Source

4DPak	=	"D" Cell Lithium battery pack (Class 1, Div. 1)
HCSolar	=	High Capacity Solar System
DCDC	=	DC Step Down Adapter 10-30Vdc to 3.3Vdc (fits in battery compartment)

Antenna Type

IntAnt	=	Internal LTE Antenna
ExtAnt	=	No Antenna Provided

Additional I/O

NONE	=	Standard I/O package 1 AI, 2 DI, 1 Relay
2AI1DI	=	Expansion Module adding 2 Analog Input and 1 Digital Input
Modbus	=	Expansion Module with RS485 Modbus Serial Port
HART	=	Expansion Module with HART protocol interface. Supports 15 multidrop devices
SDI-12	=	Expansion Module with SDI-12 protocol interface. Supports 8 multidrop devices

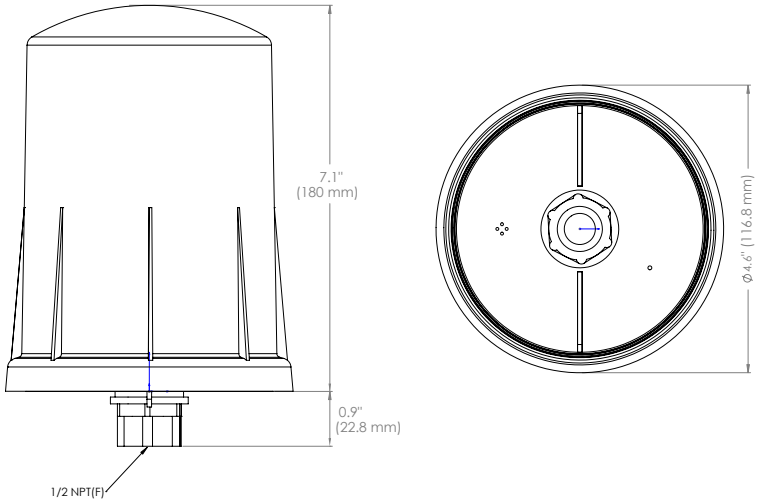
RANGER Accessories

RANGER_Acc – [ ]

Optional Accessories

SIM/Extend	=	2 Year Data Plan extension, SignalFire Cloud Connectivity
SFCloud	=	2 Year SignalFire Cloud extension. No data SIM Card. User provided LTE CAT M1 SIM
4DPak	=	4 D Cell battery replacement package
2AI1DI	=	Expansion Module adding 2 Analog Input and 1 Digital Input
Modbus	=	Expansion Module with RS485 Modbus Serial input
HART	=	Expansion Module with HART protocol interface. Supports 15 multidrop devices
SDI-12	=	Expansion Module with SDI-12 protocol interface. Supports 8 multidrop devices
RangerJBox	=	RANGER Junction Box, field mountable enclosure with termination
RangerDCDC	=	DC step down adapter 10-30Vdc down to 3.3Vdc. Fits in battery compartment.
BKT-Sentinel-Remote	=	Remote bracket to mount Sentinel or RANGER on pole or flat surface

DIMENSIONS



SIGNALFIRE
WIRELESS TELEMETRY

www.signal-fire.com | 140 Locke Drive, Suite B, Marlborough, MA 01752 USA | 978.212.2868

Appendix 4

- Well Logs

Well #2

AGK316

File Original and First Copy with Department of Ecology
Second Copy—Owner's Copy
Third Copy—Driller's Copy

WATER WELL REPORT

STATE OF WASHINGTON

Start Card No. 078790

Water Right Permit No. #2

(1) OWNER: Name Joe Louie Water Assn. Address Mission Rd

(2) LOCATION OF WELL: County Whatcom NW¼ NW¼ Sec. 7 T. 39 N., R. 5 W.M.

(2a) STREET ADDRESS OF WELL (or nearest address)

(3) PROPOSED USE: [X] Domestic [ ] Industrial [ ] Municipal [ ] Irrigation [ ] Test Well [ ] Other [ ] DeWater

(4) TYPE OF WORK: Owner's number of well (if more than one)
Abandoned [ ] New well [X] Method: Dug [ ] Bored [ ]
Deepened [ ] Cable [X] Driven [ ]
Reconditioned [ ] Rotary [ ] Jetted [ ]

(5) DIMENSIONS: Diameter of well 8 inches.
Drilled 61 ft. Depth of completed well 61 ft.

(6) CONSTRUCTION DETAILS:
Casing installed: [ ] " Diam. from +2 ft. to 56 ft.
Welded [ ] " Diam. from ft. to ft.
Liner installed [ ] " Diam. from ft. to ft.
Threaded [ ]
Perforations: Yes [ ] No [X]
Type of perforator used
SIZE of perforations by
perforations from ft. to ft.
perforations from ft. to ft.
perforations from ft. to ft.
Screens: Yes [X] No [ ]
Manufacturer's Name Pacific Well
Type S Model No.
Diam. 8 Slot size .020 from 56 ft. to 61 ft.
Diam. Slot size from ft. to ft.
Gravel packed: Yes [ ] No [X] Size of gravel
Gravel placed from ft. to ft.
Surface seal: Yes [X] No [ ] To what depth? 20 ft.
Material used in seal Bentonite
Did any strata contain unusable water? Yes [ ] No [ ]
Type of water? Depth of strata
Method of sealing strata

(7) PUMP: Manufacturer's Name
Type: H.P.

(8) WATER LEVELS: Land surface elevation above mean sea level
Static level 38 ft. below top of well Date 6/10/91
Artesian pressure lbs. per square inch Date
Artesian water is controlled by (Cap, valve, etc.)

(9) WELL TESTS: Drawdown is amount water level is lowered below static level
Was a pump test made? Yes [X] No [ ] If yes, by whom?
Yield: 100 gal/min with ft. drawdown after 2 hrs.
gal/min with ft. drawdown after hrs.
Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level

Date of test
Bailer test gal/min. with ft. drawdown after hrs.
Airtest 100 gal/min. with stem at ft. for 2 hrs.
Artesian flow g.p.m. Date
Temperature of water Was a chemical analysis made? Yes [ ] No [ ]

(10) WELL LOG or ABANDONMENT PROCEDURE DESCRIPTION

Formation: Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of information.

MATERIAL	FROM	TO
Top Soil	0	8
Brown Clay	8	9
Gravel / Clay	9	61
H2O 52-61		

Work started 6/6 19 Completed 6/10 19 91

WELL CONSTRUCTOR CERTIFICATION:

I constructed and/or accept responsibility for construction of this well, and its compliance with all Washington well construction standards. Materials used and the information reported above are true to my best knowledge and belief.

NAME B+C Well Drilling (PERSON, FIRM, OR CORPORATION) (TYPE OR PRINT)

Address 883 E Colly Rd

(Signed) (WELL DRILLER) License No. 0086

Contractor's Registration No. BCWELCDP097KZ Date 6/10 91

(USE ADDITIONAL SHEETS IF NECESSARY)

Bell Firm Well Water Assoc

File Original and First Copy with Department of Ecology
Second Copy — Owner's Copy
Third Copy — Driller's Copy

WATER WELL REPORT

39/02-28J

STATE OF WASHINGTON

Application No. ....

Permit No. G1-23158

(1) OWNER: Name Howard Gerard Address 5419 N.W. Rd, Bellingham, Wash.

(2) LOCATION OF WELL: County Whatcom ~~[illegible]~~ NE ¼ SE ¼ Sec. 28 T. 39 N., R. 2E W.M.

Bearing and distance from section or subdivision corner 600' S & 510' W of E¼ cor - Sec. 28

(3) PROPOSED USE: Domestic ☐ Industrial ☐ Municipal ☒ Irrigation ☐ Test Well ☐ Other ☐

(4) TYPE OF WORK: Owner's number of well (if more than one) #1

New well ☒ Method: Dug ☒ Bored ☐
Deepened ☐ Cable ☐ Driven ☐
Reconditioned ☐ Rotary ☐ Jetted ☐

(5) DIMENSIONS: Diameter of well 36 inches.
Drilled 30 ft. Depth of completed well 30 ft.

(6) CONSTRUCTION DETAILS:

Casing installed: 36" Diam. from 0 ft. to 30 ft.
Threaded ☐ 18" Diam. from 0 ft. to 30 ft.
Welded ☐ ...... Diam. from ...... ft. to ...... ft.

Perforations: Yes ☒ No ☐
Type of perforator used ....
SIZE of perforations 3/8 in. by 3/8 in.
...... perforations from 24 ft. to 30 ft.
...... perforations from ...... ft. to ...... ft.
...... perforations from ...... ft. to ...... ft.

Screens: Yes ☐ No ☐
Manufacturer's Name ....
Type .... Model No. ....
Diam. ...... Slot size ...... from ...... ft. to ...... ft.
Diam. ...... Slot size ...... from ...... ft. to ...... ft.

Gravel packed: Yes ☒ No ☐ Size of gravel: 3/8"
Gravel placed from 9 ft. to 30 ft.

Surface seal: Yes ☒ No ☐ To what depth? 9 ft.
Material used in seal 5 sack concrete
Did any strata contain unusable water? Yes ☐ No ☒
Type of water? ...... Depth of strata ......
Method of sealing strata off 18" galvanized liner sealed to 18' between casings

(7) PUMP: Manufacturer's Name Jacuzzi
Type: Cent. H.P. 2

(8) WATER LEVELS: Land-surface elevation above mean sea level ...... ft.
Static level 9 ft. below top of well Date 9-1-76
Artesian pressure ...... lbs. per square inch Date ......
Artesian water is controlled by ...... (Cap, valve, etc.)

(9) WELL TESTS: Drawdown is amount water level is lowered below static level
Was a pump test made? Yes ☒ No ☐ If yes, by whom? B&K Water Wells
Yield: 65 gal./min. with 15 ft. drawdown after 4 hrs.
" " " "
" " " "

Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level
0	24'	10 min	16'		
3 min	21'	15 min	13'		
6 min	18'	25 min	11'		

Date of test ....
Bailer test ...... gal./min. with ...... ft. drawdown after ...... hrs.
Artesian flow ...... g.p.m. Date ......
Temperature of water ...... Was a chemical analysis made? Yes ☐ No ☐

G1-23158

(10) WELL LOG:

Formation: Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of formation.

MATERIAL	FROM	TO
Top Soil	0	2'
sand & gravel	2'	18'
sand, fine	18'	30'

Work started Sept 1, 1976. Completed Sept 10, 1976

WELL DRILLER'S STATEMENT:

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

NAME B&K Water Wells (Person, firm, or corporation) (Type or print)

Address 432 W. King Tut Rd Bellingham

[Signed] Jeff Kimbrough (Well Driller)

License No. 0256 Date 2-1, 1977

(USE ADDITIONAL SHEETS IF NECESSARY)

S. F. No. 7356—OS—(Rev. 4-71).

OFFICE 3

39/02-28

File Original and First Copy with Department of Ecology
Second Copy — Owner's Copy
Third Copy — Driller's Copy

WATER WELL REPORT
STATE OF WASHINGTON

— Dave Bater — North Well

Application No. 1
Permit No.

(1) OWNER: Name Guide Meridian Water Association Address 231 Ten Mile Rd Lynden Wa 98264

(2) LOCATION OF WELL: County Whatcom County — NW¼ NW¼ Sec 18 T. 39 N., R. 3E W.M.
Bearing and distance from section or subdivision corner

(3) PROPOSED USE: Domestic ☐ Industrial ☐ Municipal ☒
Public — Irrigation ☐ Test Well ☐ Other ☐

(4) TYPE OF WORK: Owner's number of well (if more than one)....
New well ☒ Method: Dug ☒ Bored ☐
Deepened ☐ Cable ☐ Driven ☐
Reconditioned ☐ Rotary ☐ Jetted ☐

(5) DIMENSIONS: Diameter of well 36 inches.
Drilled 36 ft. Depth of completed well 36 ft.

(6) CONSTRUCTION DETAILS:
Casing installed: 36 " Diam. from 0 ft. to 36 ft.
Threaded ☐ ____ " Diam. from ____ ft. to ____ ft.
Welded ☐ ____ " Diam. from ____ ft. to ____ ft.

Perforations: Yes ☒ No ☐
Type of perforator used 3/8 X 3/8
SIZE of perforations ____ in. by ____ in.
24 perforations from 24 ft. to 36 ft.
____ perforations from ____ ft. to ____ ft.
____ perforations from ____ ft. to ____ ft.

Screens: Yes ☐ No ☒
Manufacturer's Name
Type Model No
Diam. Slot size from ft. to ft.
Diam. Slot size from ft. to ft.

Gravel packed: Yes ☒ No ☐ Size of gravel: 3/8 " pea gravel
Gravel placed from ft. to ft.

Surface seal: Yes ☒ No ☐ To what depth? 18 ft.
Material used in seal concrete
Did any strata contain unusable water? Yes ☐ No ☒
Type of water? Depth of strata
Method of sealing strata off

(7) PUMP: Manufacturer's Name
Type: H.P.

(8) WATER LEVELS: Land-surface elevation above mean sea level.... ft.
Static level 16 ft. below top of well Date 8-85
Artesian pressure lbs. per square inch Date
Artesian water is controlled by (Cap, valve, etc.)

(9) WELL TESTS: Drawdown is amount water level is lowered below static level
Was a pump test made? Yes ☐ No ☐ If yes, by whom?
Yield: 90 gal./min. with 3 ft. drawdown after 3 hrs.
" 130 " 7'4" " 3 "
" " " "

Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level
	Recovers	in	5 minutes		

Date of test
Bailer test gal./min. with ft. drawdown after hrs.
Artesian flow g.p.m. Date
Temperature of water Was a chemical analysis made? Yes ☐ No ☐

(10) WELL LOG:
Formation: Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of formation.

MATERIAL	FROM	TO
Top Soil	0	2'
Brown Sand	2'	16'
Gray Sand - sand getting finer with depth	16'	36'

Work started 8, 19 85 Completed 8, 19 85

WELL DRILLER'S STATEMENT:
This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

NAME B E K Water Wells Inc.
(Person, firm, or corporation) (Type or print)
Address P.O. Box 147 Custer Wa. 98240
[Signed] [signature] (Well Driller)
License No. 0256 Date 9, 19 85

(USE ADDITIONAL SHEETS IF NECESSARY)

ECY 050-1-20

07457

File Original and First Copy with Department of Ecology
Second Copy — Owner's Copy
Third Copy — Driller's Copy

WATER WELL REPORT

STATE OF WASHINGTON

Start Card No. _____

UNIQUE WELL I.D. # _____

Water Right Permit No. _____

(1) OWNER: Name TALL CEDARS W/A Address P.O. Box 670

(2) LOCATION OF WELL: County WHATCOM SW 1/4 NW 1/4 Sec 4E T. 39 N., R. 2E WM.

(2a) STREET ADDRESS OF WELL (or nearest address) 7106 TALL CEDARS LANE

(3) PROPOSED USE: ☒ Domestic ☐ Industrial ☐ Municipal ☐ ☐ Irrigation ☐ Test Well ☐ Other ☐ ☐ DeWater

(4) TYPE OF WORK: Owner's number of well (if more than one) _____

Abandoned ☐ New well ☐ Method: Dug ☐ Bored ☐ Deepened ☐ Cable ☐ Driven ☐ Reconditioned ☐ Rotary ☐ Jetted ☒

(5) DIMENSIONS: Diameter of well 42 inches. Drilled 29 feet. Depth of completed well 27 ft.

(6) CONSTRUCTION DETAILS:

Casing Installed: ~~4"~~ Diam. from _____ ft. to _____ ft.
Welded ☐ ~~3-4"~~ Diam. from ~~0~~ ft. to 27 ft.
Liner Installed ☒ Threaded ☐ 2" Diam. from 4 ft. to _____ ft.

Perforations: Yes ☒ No ☐
Type of perforator used _____
SIZE of perforations 1/4 in. by 1 1/2" in.
12 perforations from 16 ft. to 27 ft.
_____ perforations from _____ ft. to _____ ft.
_____ perforations from _____ ft. to _____ ft.

Screens: Yes ☐ No ☒
Manufacturer's Name _____
Type _____ Model No. _____
Diam. ____ Slot size _____ from _____ ft. to _____ ft.
Diam. ____ Slot size _____ from _____ ft. to _____ ft.

Gravel packed: Yes ☒ No ☐ Size of gravel Pea
Gravel placed from 16' ft. to 33' ft.
27 16'

Surface seal: Yes ☐ No ☐ To what depth? _____ ft.
Material used in seal Concrete Grout
Did any strata contain unusable water? Yes ☐ No ☐
Type of water? _____ Depth of strata _____
Method of sealing strata off _____

(7) PUMP: Manufacturer's Name FRANKLIN ELECTRIC
Type: SUBMERSIBLE H.P. 3

(8) WATER LEVELS: Land-surface elevation above mean sea level _____ ft.
Static level 14 ft. below top of well Date 9/2/98
Artesian pressure _____ lbs. per square inch Date _____
Artesian water is controlled by _____ (Cap, valve, etc.)

(9) WELL TESTS: Drawdown is amount water level is lowered below static level
Was a pump test made? Yes ☒ No ☐ If yes, by whom? owner
Yield: 15 gal./min. with 4 ft. drawdown after 6 hrs.
" " " "
" " " "

Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level

Date of test _____
Bailer test _____ gal./min. with _____ ft. drawdown after _____ hrs.
Airtest _____ gal./min. with stem set at _____ ft. for _____ hrs.

(10) WELL LOG or ABANDONMENT PROCEDURE DESCRIPTION

Formation: Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of information.

MATERIAL	FROM	TO
Top Soil	0	1
Sandy Loam	1	4
SAND (DRY)	4	16
& WATER	16	27

Work Started _____ 19. Completed _____ 19

WELL CONSTRUCTOR CERTIFICATION:

I constructed and/or accept responsibility for construction of this well, and its compliance with all Washington well construction standards. Materials used and the information reported above are true to my best knowledge and belief.

NAME _____ (PERSON, FIRM, OR CORPORATION) (TYPE OR PRINT)

Address _____

(Signed) _____ (WELL DRILLER) License No. _____

Contractor's Registration No. _____ Date _____ 19

(USE ADDITIONAL SHEETS IF NECESSARY)

Ecology is an Equal Opportunity and Affirmative Action employer. For special accommodation needs, contact the Water Resources Program at (206)

WATER WELL REPORT
STATE OF WASHINGTON

Start Card No. 071961
Water Right Permit No.

(1) OWNER: Name POLE ROAD WATER ASSOC. Address POLE ROAD LYNDEN, WA 98264-

(2) LOCATION OF WELL: County WHATCOM - NW 1/4 NE 1/4 Sec 7 T 39 N., R 3E WM
(2a) STREET ADDRESS OF WELL (or nearest address) POLE ROAD

(3) PROPOSED USE: MUNICIPAL

(4) TYPE OF WORK: Owner's Number of well (If more than one) 2
NEW WELL Method: ROTARY

(5) DIMENSIONS: Diameter of well 8 inches
Drilled 102 ft. Depth of completed well 102 ft.

(6) CONSTRUCTION DETAILS:
Casing installed: 8 " Dia. from +2.5 ft. to 37.5 ft.
WELDED " Dia. from ft. to ft.
" Dia. from ft. to ft.

Perforations: NO
Type of perforator used
SIZE of perforations in. by in.
perforations from ft. to ft.
perforations from ft. to ft.
perforations from ft. to ft.

Screens: YES
Manufacturer's Name JOHNSON/HOUSTON
Type STAINLESS STEEL Model No. KO
Diam. 6 slot size 50 from 35 ft. to 40 ft.
Diam. 6 slot size 40 from 40 ft. to 45 ft.
Diam. 6 ---- 40 ---- 45 ---- 50 ----
Gravel packed: YES Size of gravel 8/12
Gravel placed from 25 ft. to 51 ft.

Surface seal: YES To what depth? 19 ft.
Material used in seal BENTONITE
Did any strata contain unusable water? NO
Type of water? Depth of strata ft.
Method of sealing strata off

(7) PUMP: Manufacturer's Name
Type H.P.

(8) WATER LEVELS: Land-surface elevation above mean sea level ... ft.
Static level 16.3 ft. below top of well Date 08/15/91
Artesian Pressure lbs. per square inch Date
Artesian water controlled by

(9) WELL TESTS: Drawdown is amount water level is lowered below static level.
Was a pump test made? NO If yes, by whom?
Yield: gal./min with ft. drawdown after hrs.

Recovery data

Time	Water Level	Time	Water Level	Time	Water Level

Date of test / /
Bailer test 20 gal/min. 1 ft. drawdown after 1 hrs.
Air test gal/min. w/ stem set at ft. for hrs.
Artesian flow g.p.m. Date
Temperature of water Was a chemical analysis made? NO

(10) WELL LOG

Formation: Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change in formation.

MATERIAL	FROM	TO
TOPSOIL	0	3
BROWN SAND	3	17
BROWN SAND & WATER	17	32
GRAY SAND & WATER	32	45
GRAY CLAY	45	46
GRAY SAND & WATER	46	50
GRAY SAND	50	61
GRAY CLAY	61	

Work started 08/15/91 Completed 08/15/91

WELL CONSTRUCTOR CERTIFICATION:
I constructed and/or accept responsibility for construction of this well, and its compliance with all Washington well construction standards. Materials used and the information reported above are true to my best knowledge and belief.

NAME HAYES DRILLING, INC.
(Person, firm, or corporation) (Type or print)

ADDRESS 556 ERSHIG RD. BOW, WA

[SIGNED] Steve Gilbert License No. 762

Contractor's
Registration No. HAYESDI106J5 Date 08/22/91

2R 2C

WATER WELL REPORT

DEPARTMENT OF ECOLOGY State of Washington

Type of Work:
☑ Construction
☐ Decommission ⇒ Original installation NOI No. _____

Notice of Intent No. W 362074
Unique Ecology Well ID Tag No. BMG 013
Site Well Name (if more than one well): _____
Water Right Permit/Certificate No. G1 23 492
Property Owner Name Pole Water Assn
Well Street Address 359 Pole Road
City Lynden County Whatcom
Tax Parcel No. 390212193517
Was a variance approved for this well? ☐ Yes ☒ No
If yes, what was the variance for? _____

Proposed Use: ☐ Domestic ☐ Industrial ☒ Municipal ☐ Dewatering ☐ Irrigation ☐ Test Well ☐ Other _____

Construction Type: ☒ New well ☐ Alteration ☐ Deepening ☐ Other _____
Method: ☐ Driven ☐ Jetted ☐ Cable Tool ☒ Dug ☐ Air ☐ Mud-Rotary

Dimensions: Diameter of boring 48 in. to 45 ft.
Depth of completed well 44 ft.

Construction Details:

Casing	Liner	Diameter	From	To	Wall Thickness	Steel	PVC	Welded	Thread
☒	☐	36 in.	+1	46	3 in.	☐	☒	☐	☐
☐	☐	____ in.	____	____	____ in.	☐	☐	☐	☐
☐	☐	____ in.	____	____	____ in.	☐	☐	☐	☐
☐	☐	____ in.	____	____	____ in.	☐	☐	☐	☐

Location (see instructions on page 2): ☐ WWM or ☒ EWM
NE ¼-¼ of the NW ¼; Section 12 Township 39 Range 2
Latitude (Example: 47.12345) _____
Longitude (Example: -120.12345) _____

Perforations: ☒ Yes ☐ No Type of perforator used Perforating
No. of perforations 400 Size of perforations 1/2 in. by 1/2 in.
Perforated from 21 ft. to 45 ft. below ground surface

Screens: ☒ Yes ☐ No ☐ K-Packer ⇒ Depth ____ ft.
Manufacturer's Name Western Well
Type PVC Model No. _____
Diameter 24 in. Slot size 040 in. from 18 ft. to 29 ft.
Diameter 24 in. Slot size 050 in. from 29 ft. to 45 ft.

Sand/Filter pack: ☒ Yes ☐ No Size of pack material #4 in.
Materials placed from 18 ft. to 46 ft.

Surface Seal: ☒ Yes ☐ No To what depth? 18 ft.
Material used in seal Concrete
Did any strata contain unusable water? ☐ Yes ☐ No
Type of water? _____ Depth of strata _____
Method of sealing strata off _____

Pump: Manufacturer's Name _____ Type: no
H.P. ____ Pump intake depth: ____ ft. Designed flow rate: ____ gpm

Water Levels: Land-surface elevation above mean sea level ____ ft.
Stick-up of top of well casing 1 ft. above ground surface
Static water level 19 ft. below top of well casing Date 9/1/19
Artesian pressure ____ lbs. per square inch Date _____
Artesian water is controlled by _____ (cap, valve, etc.)

Well Tests:
Was a pumping test performed? ☐ No ☒ Yes ⇒ by whom? David
Yield 200 gpm with 16 ft. drawdown after 4 hrs.
Yield ____ gpm with ____ ft. drawdown after ____ hrs.
Yield ____ gpm with ____ ft. drawdown after ____ hrs.
Recovery data (time = zero when pump is turned off – water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level

Date of pumping test _____
Bailer test ____ gpm with ____ ft. drawdown after ____ hrs.
Air test ____ gpm with stem set at ____ ft. for ____ hrs. Date _____
Artesian flow ____ gpm
Temperature of water ____ °F Was a chemical analysis made? ☐ Yes ☐ No

Driller's Log/Construction or Decommission Procedure
Formation: Describe by color, character, size of material and structure, and the kind and nature of the material in each layer penetrated, with at least one entry for each change of information. Use additional sheets if necessary.

Material	From	To
Brown sandy topsoil	0	2
Light tan sand fine	2	25
dark tan silty	25	31
light tan sand	31	40
Light Gray to dark Gray silty	40	45
	46	

Start Date 8/21/19 Completed Date 9/1/19

WELL CONSTRUCTION CERTIFICATION: I constructed and/or accept responsibility for construction of this well, and its compliance with all Washington well construction standards. Materials used and the information reported above are true to my best knowledge and belief.

☐ Driller ☐ Trainee ☐ PE – Print Name David Rathvon
Signature _____
License No. 1207
IF TRAINEE: Sponsor's License No. _____
Sponsor's Signature _____

Drilling Company AZ Drilling and Pump Inc
Address PO Box 1207
City, State, Zip Stanwood
Contractor's Registration No. AZDRIDI042RK Date 9/5/19

ECY 050-1-20 (Rev 11/18) *If you need this document in an alternate format, please call the Water Resources Program at 360-407-6872. Persons with hearing loss can call 711 for Washington Relay Service. Persons with a speech disability can call 877-833-6341.*

VANDYK WELL #3

90153

8731

WATER WELL REPORT
STATE OF WASHINGTON

Unique Well # AFN 058
Start Card No W117685
Water Right Permit No. 3641

(1) OWNER Name SKOOKUM CHUCK WATER ASSOC Address LYNDEN, WA

(2) LOCATION OF WELL: County WHATCOM - NE 1/4 NE 1/4 Sec 2 T 39 N , R 3E WM

(2a) STREET ADDRESS OF WELL (or nearest address) VAN DYK ROAD

01 FEB -5 P1 :20

(3) PROPOSED USE: DOMESTIC

(4) TYPE OF WORK Owner's Number of well (If more than one)
NEW WELL Method ROTARY

DEPT OF ECOLOGY FISCAL/BUDGET

(5) DIMENSIONS: Diameter of well 8 inches
Drilled 63 ft Depth of completed well 38 ft

(6) CONSTRUCTION DETAILS
Casing installed: 8 " Dia from +2 ft to 24 ft.
WELDED " Dia from ft to ft
" Dia from ft to ft

Perforations: NO
Type of perforator used
SIZE of perforations in—by in
perforations from ft to ft
perforations from ft to ft
perforations from ft to ft

Screens. YES
Manufacturer's Name JOHNSON & COOK
Type STAINLESS STEEL Model No
Diam 8 slot size 20 from 22 ft. to 38 ft
Diam slot size from ft to ft

Gravel packed· NO Size of gravel
Gravel placed from ft. to ft.

Surface seal YES To what depth? 20 ft
Material used in seal BENTONITE
Did any strata contain unusable water? NO
Type of water? Depth of strata ft
Method of sealing strata off

(7) PUMP· Manufacturer's Name
Type H P

(8) WATER LEVELS Land-surface elevation above mean sea level ft
Static level 14 75 ft below top of well Date 01/12/01
Artesian Pressure lbs. per square inch Date
Artesian water controlled by

(9) WELL TESTS Drawdown is amount water level is lowered below static level
Was a pump test made? YES If yes, by whom? NW HYDRO GEO
Yield 105 gal./min with 10.5 ft drawdown after 6 hrs

Recovery data
Time Water Level Time Water Level Time Water Level

Date of test / /
Bailer test gal/min ft drawdown after hrs.
Air test 60-70 gal/min w/ stem set at 24 ft for 4 hrs
Artesian flow g p m Date
Temperature of water Was a chemical analysis made? NO

(10) WELL LOG 39-3E-24

Formations Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change in formation.

MATERIAL	FROM	TO
TOPSOIL	0	5
BROWN GRAVEL COBBLES & SILT	5	10
BROWN GRAVEL & CLAY	10	15
BROWN GRAVEL SAND & SILT	15	20
BROWN SAND & GRAVEL & WATER	20	25
BROWN SAND & WATER	25	35
GRAY SAND & WATER	35	37
GRAY CLAY	37	

RECEIVED
FEB-0-8 2001
DEPARTMENT OF ECOLOGY
WELL DRILLING UNIT

Work started 01/10/01 Completed 01/12/01

WELL CONSTRUCTOR CERTIFICATION
I constructed and/or accept responsibility for construction of this well, and its compliance with all Washington well construction standards Materials used and the information reported above are true to my best knowledge and belief

NAME HAYES DRILLING, INC
(Person, firm, or corporation) (Type or print)

ADDRESS 5696 ERSHIG RD, BOW, WA

[SIGNED] Ryan Wilkerson License No 2190

Contractor's Registration No. HAYESDI106J5 Date 01/29/01

7206

90153

HUISMAN WELL #2

File Original and First Copy with the Division of Water Resources
Second Copy — Owner's Copy
Third Copy — Driller's Copy

WATER WELL REPORT
STATE OF WASHINGTON

Application No. 9728
Permit No. 8062

(1) OWNER: Name Skookum Chuck Water Assn. Address 1960 Lynden Rd. Lynden Wash. 98264

(2) LOCATION OF WELL: County Whatcom NE¼SW¼NW¼SE¼ ¼ Sec. 32 T. 40 N., R. 3 E W.M.
Bearing and distance from section or subdivision corner 1000'S, 650'E, of center of Sec. 32.

(3) PROPOSED USE: Domestic ☒ Industrial ☐ Municipal ☐ (Community)
Irrigation ☐ Test Well ☐ Other ☐

(4) TYPE OF WORK: Owner's number of well (if more than one)
New well ☒ Method: Dug ☐ Bored ☐
Deepened ☐ Cable ☐ Driven ☐
Reconditioned ☐ Rotary ☐ Jetted ☒

(5) DIMENSIONS: Diameter of well 36 inches.
Drilled ft. Depth of completed well 32 ft.

(6) CONSTRUCTION DETAILS:
Casing installed: Concrete Diam. from 0 ft. to 32 ft.
Threaded ☐ 36 " Diam. from ft. to ft.
Welded ☐ " Diam. from ft. to ft.

Perforations: Yes ☒ No ☐
Type of perforator used Slot Concrete
SIZE of perforations ½ in. by in.
20 perforations from 20 ft. to 32 ft.
perforations from ft. to ft.
perforations from ft. to ft.

Screens: Yes ☐ No ☒
Manufacturer's Name
Type Model No.
Diam. Slot size from ft. to ft.
Diam. Slot size from ft. to ft.

Gravel packed: Yes ☒ No ☐ Size of gravel: 3/4
Gravel placed from 10 ft. to 32 ft.

Surface seal: Yes ☒ No ☐ To what depth? 10 ft.
Material used in seal Clay
Did any strata contain unusable water? Yes ☐ No ☒
Type of water? Depth of strata
Method of sealing strata off

(7) PUMP: Manufacturer's Name Floway Mfg. Co.
Type: Turbine H.P. 1½

(8) WATER LEVELS: Land-surface elevation above mean sea level ft.
Static level 24 ft. below top of well Date 4/22/69
Artesian pressure lbs. per square inch Date
Artesian water is controlled by (Cap, valve, etc.)

(9) WELL TESTS: Drawdown is amount water level is lowered below static level
Was a pump test made? Yes ☒ No ☐ If yes, by whom? driller
Yield: 60 gal/min. with 5 ft. drawdown after 3 hrs
" " " "
" " " "
Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level
9:00	24 ft	12:00	29 ft		

Date of test 5/5/1969
Bailer test gal/min with ft. drawdown after hrs
Artesian flow g.p.m. Date
Temperature of water 51 Was a chemical analysis made? Yes ☒ No ☐
O.K./W.H.M.

(10) WELL LOG:

Formation: Describe by color, character, size of material and structure, and show thicknesses of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of formation.

MATERIAL	FROM	TO
Brown Loam	0	2
gray Sand	2	32
Brown Clay	32	

Work started 5/22 1969 Completed 6/5 1969

WELL DRILLER'S STATEMENT:

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

NAME HERMAN ELLINGSON (Person, firm, or corporation) (Type or print)

Address 417 EAST BAATTLE Rd

[Signed] Herman Ellingson (Well Driller)

License No. 223-01-7534 Date June 23, 1969

(USE ADDITIONAL SHEETS IF NECESSARY)

S. F. No. 1334—(Rev. 3-68)—3-68—5M. 4516