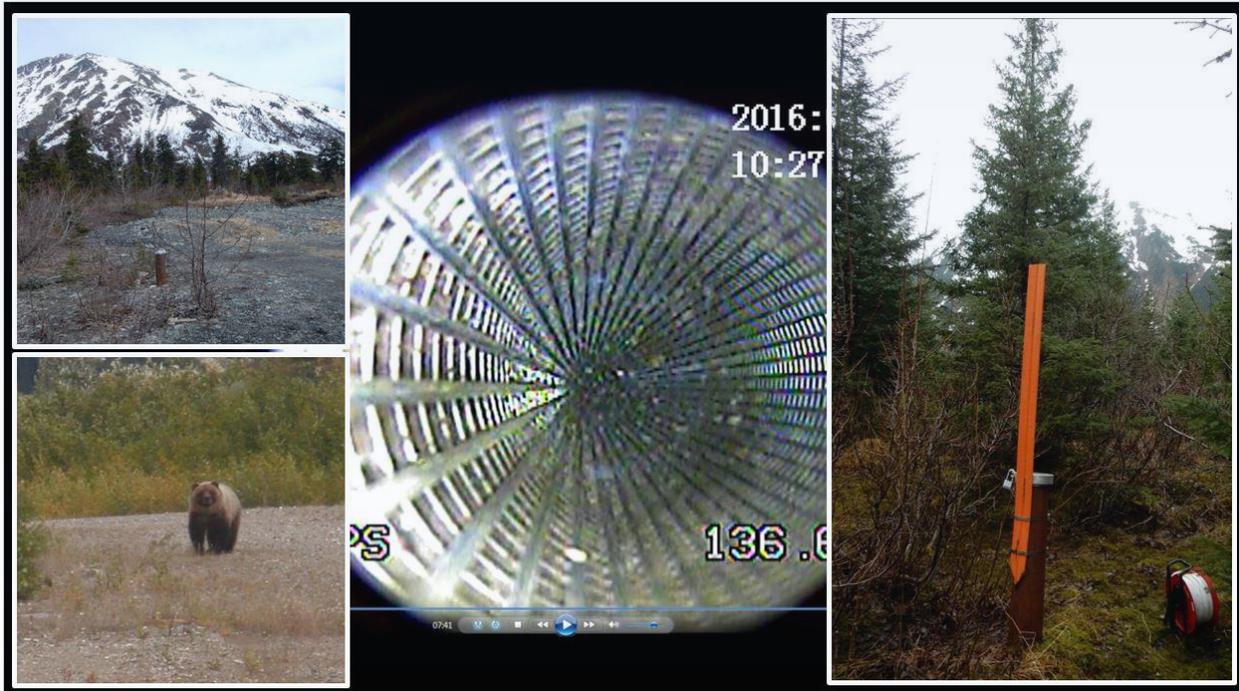


Alaska Hydrologic Survey's Procedures for Groundwater Measurements

Prepared by

Melissa E. Hill, Ph.D., C.P.G.

phone (907) 269-8646 email: melissa.hill@alaska.gov



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ACRONYMS AND ABBREVIATIONS

ADEC	Alaska Department of Environmental Conservation
ADNR	Alaska Department of Natural Resources
AHS	Alaska Hydrologic Survey
AS	Alaska State Statute
EPA	U.S. Environmental Protection Agency
NGWMN	National Groundwater Monitoring Network
NIST	National Institute of Standards and Technology
PDF	Portable Document Format
STORET	Storage and Retrieval
USGS	U.S. Geological Survey
YOWN	Yukon Observation Well Network

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INTRODUCTION

The purpose for this document is to provide the procedures used by the Alaska Hydrologic Survey (AHS) for field work preparation, measurement of groundwater levels, data processing, data archival and publication, and quality assurance. This document discusses the procedures based on: 1) the equipment currently available to personnel within the AHS, 2) the types of data collected by AHS, and 3) the type of groundwater stations within our current water level network. Therefore, this is a living document that may require periodic revision as Alaska's groundwater monitoring program expands.

This document is not intended to be an exhaustive review of techniques for field work or measurement of groundwater levels. Publications (Cunningham and Schalk, 2011; Sanders, 1998) are available that provide a comprehensive discussion of procedures and technical methods for interested readers.

AUTHORITY

Alaska Statute (AS) 41.08.020(b)(1)(2) directs the AHS within the Alaska Department of Natural Resources (ADNR) to collect, distribute, and publish data on the quantity, quality and location of subsurface, surface and coastal water of the state (Noah, 1994).

Access to monitoring wells are the result of multiple Memorandum of Agreements between ADNR and local, state, and federal partners. These wells are typically abandoned and are no longer in service or equipped with pumps. Stations within the network are instrumented and monitored by AHS personnel, or by our cooperative partners. Citizens also occasionally volunteer access to their domestic wells that are in-service via temporary access agreements. Participation in the groundwater monitoring program is voluntary.

HISTORY OF GROUNDWATER MONITORING IN ALASKA AND THE INFLUENCE OF THE NATIONAL GROUNDWATER MONITORING NETWORK (NGWMN)

The value of a long-term groundwater monitoring network was recognized when Alaska was still a U.S. territory. During that time, the U.S. Geological Survey (USGS) was the lead agency to maintain groundwater stations. Recognition to continue and expand the number of groundwater stations persisted after statehood. By the early 1970's, the need for these and additional data culminated in publication of the Alaska Ten-Year Comprehensive Plan for Climatologic and Hydrologic Data (1970), which contains recommendations by the Interagency Technical Committee for Alaska. At the time of the Alaska Ten-Year Comprehensive Plan's publication, 80 groundwater stations and one spring were maintained by the USGS.

Results from the 2007 State/Regional Ground Water Monitoring Networks Survey¹, indicate that state-maintained groundwater level and quality monitoring programs did not exist in our state at that time. Moreover, the number of groundwater level stations maintained by the USGS in Alaska had decreased to 15 with only one groundwater quality station (Subcommittee on Groundwater of the Advisory Committee on Water Information, 2009).

Alaska also trails our British Columbia and Yukon neighbors, which formally established the Provincial Groundwater Observation Well Network in 1961², and the Yukon Observation Well Network (YOWN) in 2001³. Both the British Columbia and Yukon monitoring programs consist of water level and water quality networks.

In 2013, AHS initiated an ad hoc water level monitoring program, which culminated in the establishment of cooperative partnerships with private landowners, local, state, and federal agencies. These efforts led to the recognition of a groundwater level monitoring program in 2016, primarily due to influence from the NGWMN and support provided by USGS Cooperative Agreements G16AC00076 and G16AC00368, as AS 41.08.020(b)(1)(2) are unfunded mandates.

Currently, AHS personnel do not collect water quality samples from our groundwater stations. However, the Alaska Department of Environmental Conservation (ADEC) provides AHS with water quality data for select public supply wells in the state.

FIELD WORK PREPARATION

Successful, safe, and efficient fieldwork is highly dependent on adequate in-office preparation prior to travel. Adequate preparation consists of multiple steps that include: safety training, reviewing existing data and conditions, acquiring travel authorization, reservation of safety equipment, reservation of vehicle(s), contacting cooperators and property owners, submitting a safety plan, reviewing the equipment checklist, conducting equipment verification, equipment cleaning, and inspection of the vehicle(s).

Step 1: Safety Training

AS 18.60.075(a) states that an employer shall do everything necessary to protect the life, health, and safety of employees. AS 18.60.075(a)(2) requires employers to furnish and prescribe suitable protective equipment, safety devices, and safeguards for the work and work place. Pertinent safety training and reservation of protective equipment and safety devices should be completed prior to requesting travel authorization. Safety training courses, such as Bear Awareness and Defense, Wilderness First Aid, and any additional training that may be applicable based on the modes of transportation or field work that will be encountered should be completed prior to conducting field work. Periodic refresher courses should also be completed to maintain active certifications.

Step 2: Review Existing Data and Conditions

A vital step for field work planning is to review existing site and regional data. Database searches and compilation of water well construction, lithologic, historic water level and water quality data, property ownership boundaries, topographic maps, and published reports are necessary for planning field work. Additionally, weather conditions and seasonal (avalanche risk) or wildlife hazards should be considered when planning field work.

Step 3: Travel Authorization

Travel request forms shall be submitted for business travel that exceeds 50 miles of an employee's home or duty station. In general, travel request forms should be submitted no later than 2 weeks prior to the anticipated travel and should include the charge code and the names of additional travelers. As appropriate, it should be noted on the travel request form that the anticipated dates of travel may change due to weather conditions.

Step 4: Reservation of Safety Equipment

A satellite phone is available for business travel and may be reserved. *The satellite phone requires adequate charging prior to use in the field.* A limited number of reflective vests and gloves are also available and may be reserved. Check with your supervisor for additional safety equipment needs, such as bear spray and first aid kits.



Step 5: Reservation of Vehicle(s)

A state vehicle should be reserved for business travel. Alternative methods for travel, if needed, should also be reserved and noted in the travel request form. Vehicle keys, the certificate of insurance, fleet fuel card, the claims reporting procedure manual, and operator's manual for state vehicles and equipment are in the vehicle's satchel. Each state vehicle has its own satchel that should be checked-out and used on business travel.

Step 6: Contact Cooperators/Property Owners

Cooperators and property owners shall be notified 48 hours prior to visiting the site. In addition to professional courtesy, this provides an opportunity for property owners to notify house guests that you will be onsite, restrain pets, and inform state employees of potentially dangerous conditions, such as auffs or hazardous wildlife observed in the area. State employees must follow the popular mantra and *leave nothing but footprints, kill nothing but time, and take nothing but pictures* while on others property.

Step 7: Submittal of Safety Plan

A safety plan shall be submitted in writing to the supervisor (or the supervisor's delegated authority, if the supervisor is out-of-the office) prior to going on travel. The safety plan shall contain the following information:

- a. Date(s) of travel
- b. Purpose for travel
- c. Destination(s)
- d. Method(s) of transportation

- e. Trip plan (anticipated departure date and time with the return date and time)
- f. List of bear protection (bear spray, bear guard)
- g. List of communication equipment
- h. List of protective personal equipment
- i. List of first aid kit(s)/wilderness first aid booklet(s)
- j. List of all travelers with emergency point-of-contact information for each traveler



Step 8: Equipment Checklist

Reviewing the equipment check list prior to travel improves efficiency and diminishes the likelihood of not having the right equipment in the field. Below is a list of equipment and items that may be needed while working in the field:

- maps
- copies of access agreements/land use permits
- keys for well cap and barometer housing locks
- software/field computer
- interface cable
- 1-foot direct read cable extension
- water level meter (electric)
- Rite-in-the rain notebook
- Rite-in-the rain pressurized ink cartridge trekker pen
- tools (12-inch crescent wrench, pipe wrench, allen wrenches, socket wrench, phillips head screwdriver, flathead screwdriver, multi-tool, multi-meter)
- batteries
- camera
- Global Positioning System (GPS)
- sonic water level meter
- cover plates
- extra screws/washers/nuts
- metal file/permanent marker
- carpenter's chalk
- steel tape
- 1% solution of Liquinox (10 milliliters per liter)
- Material Safety Data Sheet (MSDS)
- paper towels
- jump drive
- spare pressure transducers (in case instrument replacement is needed)

- video logger (if applicable)

Step 9: Equipment Verification

AHS personnel currently use pressure transducers, steel tapes of various lengths graduated in feet, tenths and hundredths of feet, and an electric tape graduated in feet, tenths and hundredths of feet to measure water levels in our dedicated monitoring wells. AHS also uses a sonic water level meter to estimate water levels in domestic wells.

AHS' pressure transducers are laboratory calibrated by the manufacturer. Calibration certificates are maintained in the office and periodic hand-tape verifications in the field using the steel or electric tapes are conducted to monitor instrument drift.

Currently, steel and electric tapes are verified by cross-checking against each other side-by-side, but a more thorough approach using a National Institute of Standards and Technology (NIST) traceable steel reference tape reserved solely for calibrations as described in Fulford and Clayton (2015) is warranted.

The sonic water level meter requires that the appropriate depth and monthly temperature controls be set for the region of use. Performance of the sonic water level meter is verified in the office by conducting 5 repetitive measurements using a close-ended PVC pipe of known length prior to use in the field. Water level measurements collected using a sonic water level meter also require, at a minimum, one field verification per station, which is discussed in more detail in the Quality Assurance section of this document.

Step 10: Equipment Cleaning

Equipment used to measure groundwater levels are cleaned using a 1-percent solution of Liquinox prior to instrument deployment, and in-between use in wells to mitigate the potential for cross-contamination.

Step 11: Inspection of Vehicle(s)

A state vehicle, and any other vehicle that may be used, should be reserved for the anticipated travel dates. It is prudent to ensure that jumper cables, rotating beacon light, compressor, and a spare tire are in the state vehicle before departure. The tires (winter steel-studded/summer non-studded) on the vehicle and pressures should be checked. Additionally, the oil/fluid levels should be examined to ensure that the vehicle is in good working condition prior to departure.

GROUNDWATER LEVEL MEASUREMENTS AND THE NGWMN

AHS currently collects water level data from two types of groundwater stations: 1) dedicated monitoring stations that are no longer in service and 2) in-service stations. Dedicated monitoring stations are abandoned wells in which the pump and electrical wiring have been removed. In-service stations are domestic wells that are equipped with a pump and electrical wiring. Dedicated monitoring stations are eligible for the NGWMN if they meet the quality and

density requirements provided in the National Framework for Groundwater Monitoring (Subcommittee on Groundwater of the Advisory Committee on Water Information, 2009). Stations for the NGWMN water level network are not selected from AHS' in-service stations (domestic wells).

AHS personnel do not currently collect water quality samples from our groundwater stations. However, water quality data for select public supply wells are provided to AHS from ADEC.

Dedicated Monitoring Stations

AHS' equipment for measuring water levels in dedicated monitoring stations come into direct contact with groundwater. Currently all of AHS' dedicated monitoring stations are equipped with pressure transducers. Instrument set depths are determined using the instrument's pressure rating and historic water level measurements. The frequency for water level measurements among the dedicated monitoring stations varies from 15 minutes to hourly.

The measuring point on groundwater stations is typically delineated by a file mark or a black line on the top of casing. The measuring point is the reference point for hand-tape (steel or electric) verifications. In general, hand tape verifications are repeated until two consecutive measurements within a hundredth of a foot are collected. The exception being when field work is conducted under challenging conditions, such as subzero temperatures, rain falling on the carpenter's chalk during the measurement reading, or hazardous wildlife in the area which requires termination of field work.

Data downloads from the pressure transducers are conducted 3 to 4 times per year for stations that are easily accessible. Stations located in remote areas, or that require a bear guard, are downloaded on an annual basis.

In-service Stations

The use of equipment that does not require direct contact with groundwater is preferred by most property owners for measuring water levels at in-service stations. Currently all of AHS' in-service stations are domestic wells. The sonic water level instrument has two cover plate sizes that fit most domestic well diameters. Depths to water are measured by removing the well cap and placing the instrument onto the top of casing. The frequency for water level measurements from domestic wells varies from monthly, to an annual basis.

DATA PROCESSING

Water Level Data

Water level data collected by AHS, or submitted by its cooperators, are processed by computing the daily average water levels for dedicated monitoring stations instrumented with pressure transducers. If necessary, data are converted to the same unit of measure. Accuracy for water level measurements are estimated by calculating the absolute difference between the average

daily value of instrument records for depth to water from the measuring point and hand-tape verifications.

Values for depth to water from land surface are calculated by subtracting the length of the well casing, or stick-up above land surface from values for depth to water from the measuring point.

Water Quality Data

Data for groundwater quality stations are provided to AHS by the ADEC Drinking Water Program. Water quality data currently published on the Alaska Groundwater Database are a small subset of ADEC's water quality data for public supply wells. The water quality parameters measured and the frequency of sampling fall within ADEC's jurisdiction. Most of the water quality data submitted to ADEC are done so electronically via an online reporting system (Newman, 2017). Therefore, links to laboratory results in portable document format (pdf) are not available. Individuals interested in statewide water quality data for public supply wells should contact ADEC directly to request those data.

Water quality data provided by ADEC often contain units of measure that may vary through time for a single water quality parameter. For example, reported units of measure for arsenic varies through time from values reported in milligrams per liter, to values reported in micrograms per liter. Units of measure that vary through time for a single parameter are converted to the same unit of measure by AHS personnel.

Data received from ADEC are not published on STORET, which is maintained by the U.S. Environmental Protection Agency (EPA).

DATA ARCHIVAL AND PUBLICATION

Station information, well construction, lithologic, water quality, and daily average water level and temperature data are published on the Alaska Groundwater Database. The Alaska Groundwater Database and associated metadata are available for download at: <http://dnr.alaska.gov/groundwater/>

A subset of the data archived in the Alaska Groundwater Database are served to the NGWMN Data Portal, which is maintained by the USGS. The NGWMN may be accessed at: <https://cida.usgs.gov/ngwmn/index.jsp>

QUALITY ASSURANCE

Quality assurance is implemented throughout AHS' procedures for groundwater measurements. Brief descriptions for key quality assurance procedures are provided below.

Equipment Verifications

Equipment verifications are conducted during field work preparation (see Equipment Verification under Field Work Preparation).

Field Notebooks

AHS uses Rite-in-the-Rain field notebooks to document equipment verifications, equipment cleanings, dates, hand-tape verifications, station coordinates, weather conditions, stick-up measurements, and any additional pertinent field observations. AHS personnel practice strike-through with initials and dates. Field notebooks are also assigned identification numbers to facilitate inventory and tracking.

Hand-tape Verifications - Dedicated Monitoring Stations

Hand-tape verifications are periodically performed in the field to monitor instrument drift. Well depths are verified using an electric tape or video logger. Additionally, depths for perforated and screened intervals are verified using a video logger for wells 6-inches or greater in diameter that are road accessible.

Hand-tape Verifications - In-service Stations

At least one hand-tape verification using a steel or electric tape with the sonic water level meter is required for each in-service station (domestic well) to evaluate the sonic water level meter's performance. Water level measurements using the sonic water level meter that lack at least one hand-tape verification as described above are not published on the Alaska Groundwater Database.

Well depth and open interval verifications are not performed by AHS personnel on domestic wells. Therefore, wells that do not have a water well log on file with AHS as required by AS 41.08.020(b)(4) are not eligible for in-service stations.

Data Processing – Water Level

Graphical representations of processed data, specifically hydrographs with total well depths and time series plots showing air and groundwater temperatures are generated to: 1) facilitate detection of anomalies, and 2) compare period-of-record water levels with hand-tape verifications. Hydrographs for processed data are archived in a scientific notebook with an assigned identification number.

Data Processing – Water Quality

AHS visually scans tabular representations of processed water quality data and notifies ADEC of any apparent anomalies.

Geologic Hazards

The occurrence of geologic hazards, such as notable earthquakes and seismic activity associated with volcanic eruptions, which may affect groundwater levels, are tracked to assist with interpretations of the processed data. However, no changes are made to the data sets.

Archival and Publication

Data archived on the Alaska Groundwater Database are reviewed following new entries to detect errors that may be introduced during upload onto the database. Thereafter, reviews of data published on the Alaska Groundwater Database are periodically conducted for quality assurance.

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- ² BC, <http://www2.gov.bc.ca/gov/content/environment/air-land-water/water/groundwater-wells/aquifers/groundwater-observation-well-network> (accessed on June 21, 2017).
- ³ Yukon, <http://yukonwater.ca/monitoring-yukon-water/networks/details?network=19> (accessed on June 21, 2017).

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