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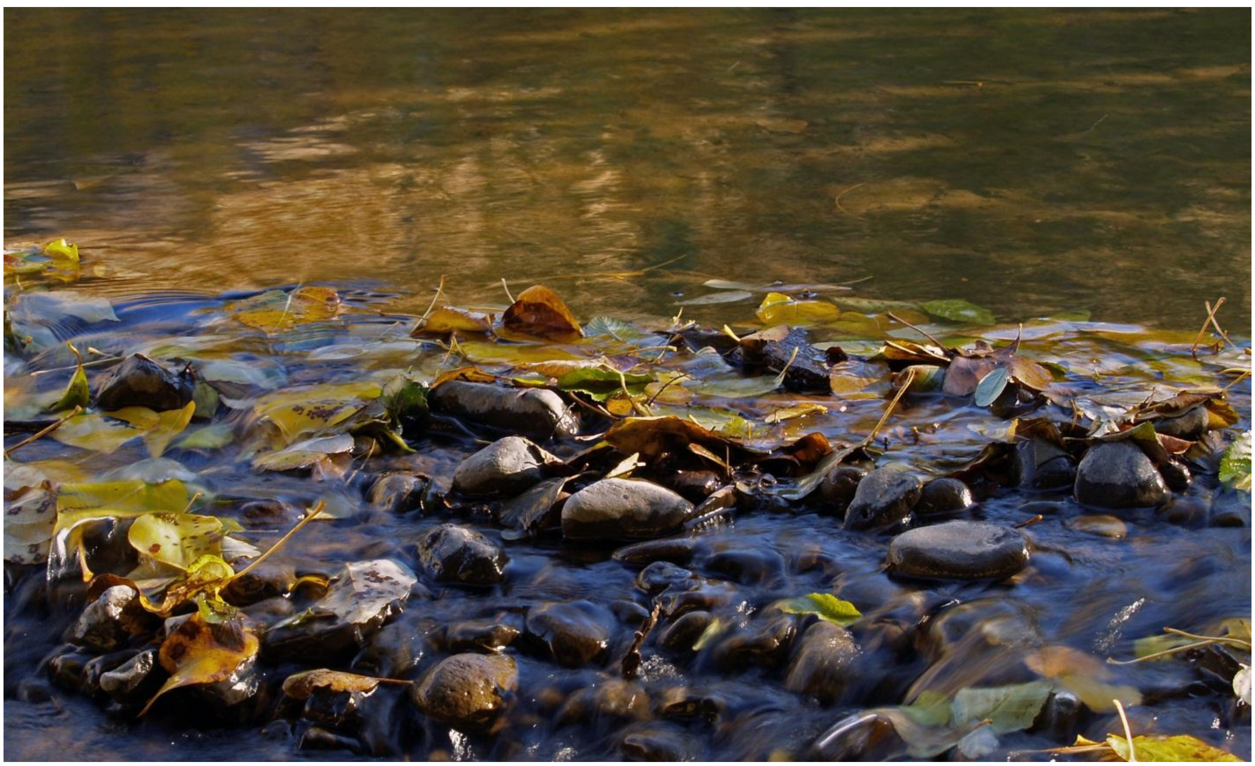
Walla Walla Basin Watershed Council
541-938-2170 or 7086 P.O.Box 68, Milton-Freewater, OR 97862

WWBWC Watershed Monitoring Program

Standard Operating Procedures



Steven Patten
Senior Environmental Scientist - WWBWC

Standard Operating Procedures

Version 1.2

April 2013

Contents

SOP Revision History

Revision Date	Revision Number	Summary of Changes	Sections Changed	Reviser(s)
11/2012	1.0	Creation of SOP document	All	Steven Patten
2/8/2013	1.1	Incorporated Review Comments	Study Design, Data Management, Surface Water monitoring and grammatical corrections	Steven Patten
4/1/2013	1.2	Photo Point Monitoring, Sampling Procedures and Grammatical changes	Photo Point Monitoring, Sampling Procedures and others	Steven Patten

DISTRIBUTION LIST

This document will be made available to the public, agencies and grant funders through the Walla Walla Basin Watershed Council's website (www.wwbwc.org). Internal distribution of the document will occur through the WWBWC's internal server. All field and technical personnel will be given an electronic copy of this document. A printed version will be available in the WWBWC office. This document will be redistributed to personnel and uploaded to the WWBWC server and website upon revision.

Background and Project Description

The Walla Walla Basin Watershed Council's Watershed Monitoring Program includes more than 60 surface water sites, more than 100 groundwater sites, 10 water temperature sites, and more than a dozen water quality sites. The monitoring program covers almost the entire watershed starting in the upper reaches of the rivers and extending to the valley floor near where the Walla Walla River drains to the Columbia River. This document describes the WWBWC's Watershed Monitoring Program and includes the standard operating procedures used to collect environmental and hydrologic data.

Program Area

The area of study for the Walla Walla Basin Watershed Council's Quality Assurance Program Plan includes the entire Walla Walla Watershed (Figure 1).

Monitoring locations for this program are spread throughout the valley (Figure 2), however the majority of the work conducted under this plan will take place on the valley floor Northwest of Milton-Freewater, OR, Southwest of Walla Walla, WA, and East of Touchet, WA. Aspects of the program (i.e. seepage runs) encompass other portions of the basin including almost the entire lengths of the Walla Walla River, the Touchet River and Mill Creek.

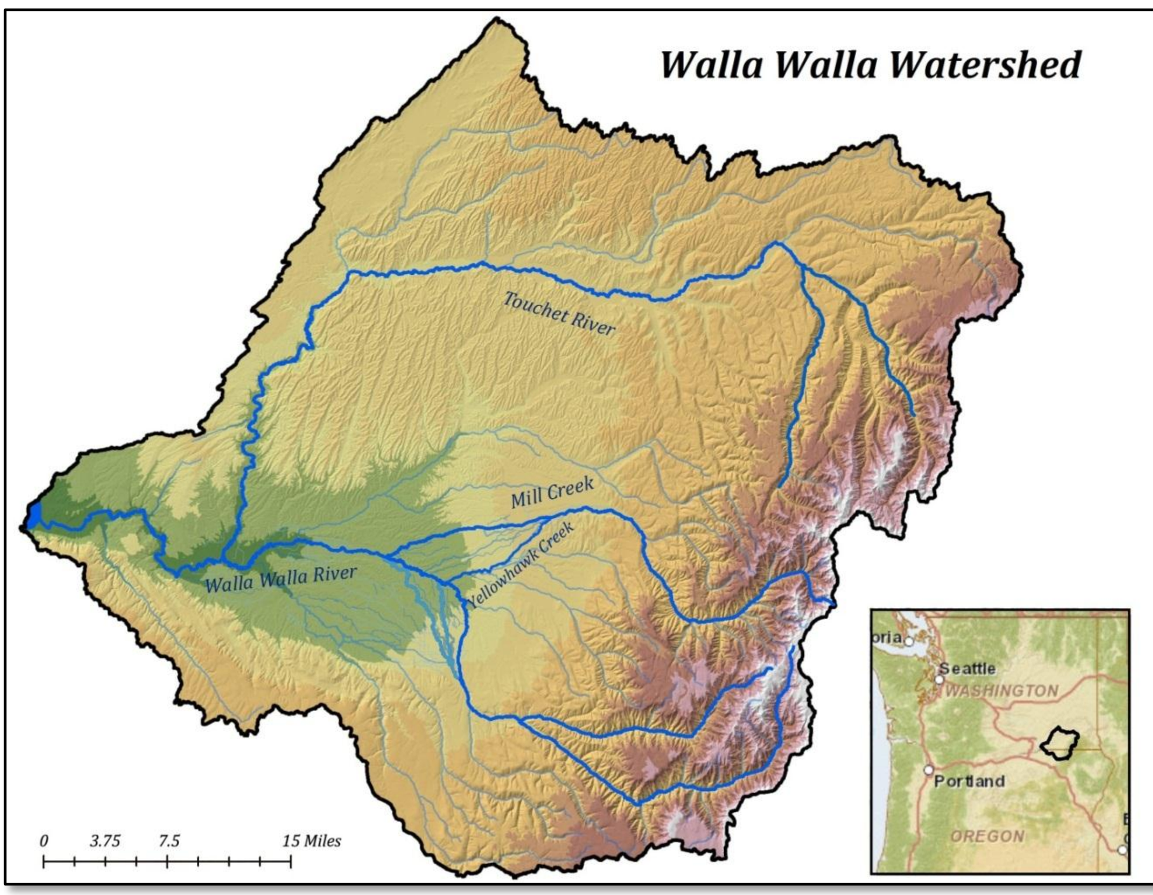


Figure 1. Map of the Walla Walla Watershed.

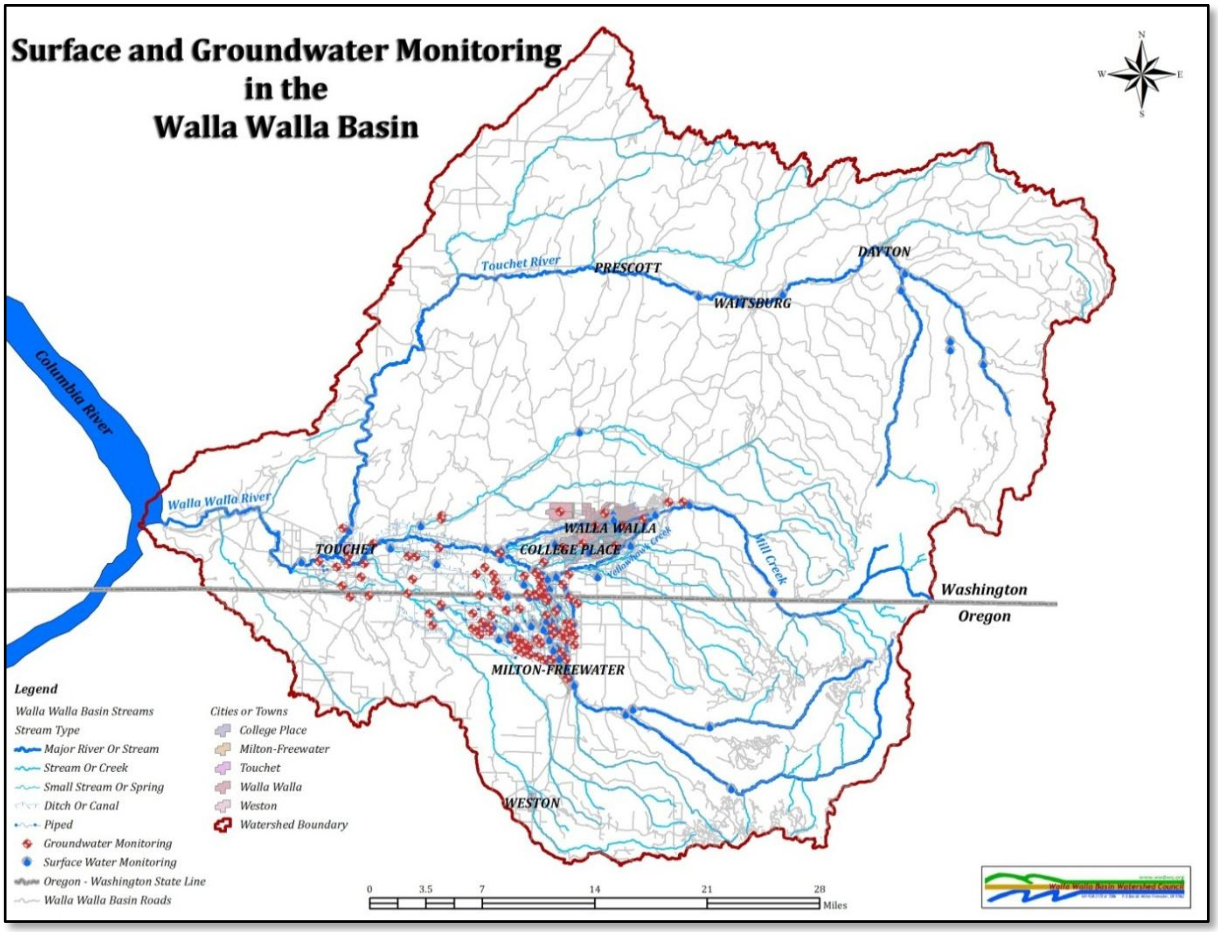


Figure 2. WWBWC Watershed Monitoring Program surface and groundwater monitoring locations.

Project Goals & Objectives

This monitoring program's goal is collect, organize, analyze and distribute hydrology related data for use by the WWBWC and other partners as projects are located, designed, installed and monitored so restoration in the Walla Walla Basin moves forward with knowledge of current and historic trends. The following objectives will achieve the program's goal.

- Collection of quality data utilizing well-established scientific protocols for monitoring activities.
- Organization of data into a functional system to allow use and analysis of data. Data must be organized and accessible for it to be useful.
- Analyzing data allows for trends and patterns to be determined. From these analyses we can determine how the basin is responding to changes (both environmental and project based).
- Distribution of data is critical. All of the above objectives can be completed, but without distribution of the data to other partners there cannot be a cohesive direction for restoration in the basin.

ORGANIZATION AND SCHEDULE

WALLA WALLA BASIN WATERSHED COUNCIL PERSONNEL

Name	Position	Main Tasks	Email
Brian Wolcott	Executive Director	Program Management	brian.wolcott@wwbwc.org
Steven Patten	Senior Environmental Scientist	Program Management & data collection and analysis	steven.patten@wwbwc.org
Troy Baker	Monitoring and GIS Program Manager	Monitoring Program management & data collection and analysis	troy.baker@wwbwc.org
Wendy Harris	Operations Manager	Program/Operations Management and Oversight	wendy.harris@wwbwc.org
Tara Patten	Environmental Scientist	Data collection and analysis	will.lewis@wwbwc.org
Chris Sheets	Fiscal Technician	Fiscal Oversight and management	chris.sheets@wwbwc.org
Graham Banks	Science Educator	Outreach and Education	graham.banks@wwbwc.org

The Walla Walla Basin Watershed Council's phone number is: 541-938-2170

PROGRAM PARTNERS

The Walla Walla Basin Watershed Council works with many partners throughout the basin to collect the monitoring data in the program. Program partners include: Hudson Bay District Improvement Company (HBDIC), Walla Walla River Irrigation District (WWRID), Gardena Farms Irrigation District #13 (GFID), Oregon Water Resources Department (OWRD), Washington Department of Ecology (WDOE), Confederated Tribes of the Umatilla Indian Reservation (CTUIR), City of Walla Walla, City of Milton-Freewater, City of College Place, Walla Walla Watershed Management Partnership (WWWMP), Tri-State Steelheaders (TSS), Oregon Department of Fish and Wildlife (ODFW), Washington Department of Fish and Wildlife (WDFW), Washington Water Trust, The Freshwater Trust, Walla Walla University, Whitman College, Oregon Department of Environmental Quality (ODEQ), and many businesses and individual landowners in the basin.

PROGRAM SCHEDULE

The WWBWC's monitoring program is an on-going process. A general schedule of activities is described in the table below:

Monitoring Activity	Year-round or Seasonal	General Schedule
Surface Flow (River)	Year-round and Seasonal	Sites are visited every other week to collect staff gauge measurements and perform general site maintenance. Manual discharge measurements and other data are collected during ~6 visits each year. A few river sites are only monitored seasonally during summer and fall base flows.
Surface Flow (Streams, Springs & Ditches)	Year-round	Sites are visited 4-5 times a year to download data, conduct manual flow measurements, perform site maintenance and collect other data.
Groundwater Level Monitoring	Year-round	Sites are visited ~4 times a year to download data, conduct manual groundwater level measurements, perform site maintenance and collect other data.
Water Temperature (River)	Seasonal	Data loggers are deployed in late spring or early summer and retrieved late fall or early winter dependent upon river flows.
Evaporation-Transpiration (ET) Stations	Year-round	Sites are visited ~3-4 times a year to download data and perform site maintenance.
Scour Chains and Bed Stability	Seasonal	Sites are visited ~2-3 times a year to collect data, conduct channel survey and perform any maintenance.
Seepage Analysis	Seasonal	Seepage runs occur twice a year on each river system. Typically runs are conducted late spring or early summer and late summer or early fall.
Water Quality Sampling (SAR)	Seasonal	Water quality sampling is done during the shallow aquifer recharge season which typically starts in November and continues through May.
Water Quality Sampling (PSP)	Seasonal	Water quality sampling is done from March till June during the typical pesticide application time period.
Data Analysis and Distribution	Year-round	As data are collected, analyzed and incorporated into the WWBWC's database as provisional. Data are reviewed at the end of each water year.

Quality Objectives

Parameter	Check Standard	Duplicate Samples
Water Temperature	± 0.5 °C (NIST Thermometer)	± 0.2 °C
pH	± 0.1 pH units	± 0.1 pH units
Specific Conductance	± 5% of standard	± 5% of reading
Dissolved Oxygen	± 0.2 mg/L	± 0.1 mg/L
Groundwater Level Measurement	N/A	± 0.01 feet
Manual Discharge Measurement	N/A	± 10%
Tape Down Measurement	N/A	± 0.02 feet
Vertical Staff Gauge Measurement	N/A	± 0.02 feet

Study Design

Monitoring locations were determined by availability to measure parameter of interest (e.g. groundwater can only be measured at wells or bore holes or high discharge measurements can only be taken at bridges). Professional judgment was also utilized in the placement of monitoring locations if multiple sites were available. Many monitoring locations were determined based upon anthropogenic changes to the system (e.g. irrigation diversions, flood control structures or restoration projects).

Sampling locations and frequency cover temporal and spatial variability within the valley. For example, monitoring surface flow sites 4-6 times per year allows for data collection to include high and low flow periods based upon environmental changes. The schedule provided for each sampling parameter tries to accommodate temporal variability throughout the year.

The current study design is structured for two main functions. The first function is to provide baseline and/or trend monitoring for the hydrologic system within the Walla Walla Basin - are conditions improving, remaining the same or getting worse? The second function is to provide effectiveness monitoring for projects (habitat restoration, irrigation efficiency, aquifer recharge and others) occurring in the Walla Walla Basin.

The data collected under these standard operating procedures will help answer hydrologic and restoration questions such as (but not limited to):

- Are surface flows increasing in the Walla Walla River? If present, can the increases be attributed to conservation effects?
- Are groundwater levels declining in the alluvial aquifer? If so, is aquifer recharge helping to restore aquifer storage? Can declines be attributed to piping projects or other irrigation efficiency projects?
- Are water temperatures in the Walla Walla River improving over time? Where are the hottest locations? Are habitat projects improving water temperature?

FIELD MEASUREMENTS

The majority of sampling for this program will occur in the field. Refer to the table below for which samples will be collected in the field and a sampling schedule for each.

Measurement Parameter	Monitoring Program	Schedule
River/Stream Discharge	Surface Flow Monitoring	4-6 times per year
Water Temperature	Surface Flow Monitoring	4-6 times per year
Specific Conductance	Surface Flow Monitoring	4-6 times per year
Staff Gage Reading	Surface Flow Monitoring	4-6 times per year (20+ for mainstem gage locations)
Elevation Reference Checks	Surface Flow Monitoring	4-6 times per year
Channel Survey	Surface Flow Monitoring	1 every 2-3 years
Groundwater Level Measurement	Groundwater Monitoring	4 times per year
Groundwater Temperature	Groundwater Monitoring	4 times per year
Specific Conductance	Groundwater Monitoring	4 times per year
Surface/Groundwater Temperature	Recharge Water Quality Monitoring	2-3 times per year
Surface/Groundwater Specific Conductance	Recharge Water Quality Monitoring	2-3 times per year
Surface/Groundwater Dissolved Oxygen	Recharge Water Quality Monitoring	2-3 times per year
Surface/Groundwater pH	Recharge Water Quality Monitoring	2-3 times per year
Channel Survey	Scour Chains & Bed Stability	2-3 times per year
Scour Chain Measurement	Scour Chains & Bed Stability	2-3 times per year
Pebble Counts	Scour Chains & Bed Stability	1-2 times per year
Longitudinal Survey	Scour Chains & Bed Stability	1 time per year
Water Temperature	River Temperature Monitoring	2-3 time per year
River/Stream Discharge	Seepage Runs	2 times per year per river
Water Temperature	Seepage Runs	2 times per year per river
Specific Conductance	Seepage Runs	2 times per year per river

LABORATORY MEASUREMENTS

Some of the water quality sampling that is conducted under this plan requires laboratory level analysis. Some of the sampling parameters and schedules are listed in the table below.

Sampling Parameter	Monitoring Program	Schedule
pH	Recharge Water Quality Monitoring	2-3 times per year
Electrical Conductivity	Recharge Water Quality Monitoring	2-3 times per year
Dissolved Oxygen	Recharge Water Quality Monitoring	2-3 times per year
Nitrate-N	Recharge Water Quality Monitoring	2-3 times per year
Total Organic Carbon	Recharge Water Quality Monitoring	2-3 times per year
Total Kjehldahl Nitrogen (TKN)	Recharge Water Quality Monitoring	2-3 times per year
Sulfate	Recharge Water Quality Monitoring	2-3 times per year
Chloride	Recharge Water Quality Monitoring	2-3 times per year

Sampling Parameter	Monitoring Program	Schedule
Calcium	Recharge Water Quality Monitoring	2-3 times per year
Alkalinity	Recharge Water Quality Monitoring	2-3 times per year
Ortho-Phosphate	Recharge Water Quality Monitoring	2-3 times per year
Sodium	Recharge Water Quality Monitoring	2-3 times per year
Potassium	Recharge Water Quality Monitoring	2-3 times per year
Magnesium	Recharge Water Quality Monitoring	2-3 times per year
Aluminum	Recharge Water Quality Monitoring	2-3 times per year
Iron (dissolved)	Recharge Water Quality Monitoring	2-3 times per year
Manganese (dissolved)	Recharge Water Quality Monitoring	2-3 times per year
PCBs	Recharge Water Quality Monitoring	2-3 times per year
Chlorinated Pesticides	Recharge Water Quality Monitoring	2-3 times per year
Herbicides	Recharge Water Quality Monitoring	2-3 times per year
Primary and Secondary contaminants listed in WAC 173-200, Table 1	Recharge Water Quality Monitoring	2-3 times per year

SAMPLING PROCEDURES

WATER QUALITY SAMPLING (GROUNDWATER)

Groundwater sampling is conducted utilizing the following procedures. The general overview of groundwater sampling includes gathering equipment, measuring the initial water level, installing a submersible pump in the well, purging the well at a low flow rate, collecting and labeling all required samples and delivering them to the lab or shipping company. Details on parameters sampled for each site can be found in its monitoring and reporting plan.

Note: this procedure is modified from:

Marti, 2011. Standard Operating Procedure for Purging and Sampling Monitoring Wells. Washington State Department of Ecology – Environmental Assessment Program. EAP078.

EQUIPMENT

- Sampling field data sheets (see below) or field notebook
- Chain of Custody form
- Water level measuring equipment (e-tape)
- Water quality meters and probes (Temperature, Specific Conductance, pH & Dissolved Oxygen)
- Submersible pump
- Pump controller
- Tubing and connectors
- Sample bottles/containers
- Cooler
- Ice
- Deionized water
- Diluted Bleach solution
- Non-phosphate soap
- Nitrile or latex gloves

- First aid kit
- Well keys
- Camera
- Paper towels or clean rags
- Plastic sheet for keeping equipment clean
- Buckets (5-gallon or similar for purge volumes)
- 1 liter container (for purge volumes)
- Socket set
- Screwdriver(s)

PURGING AND SAMPLING

1. Check well for any changes or potential hazards.
2. Make sure equipment has been cleaned and decontaminated (see below for details). Spread plastic or other material if needed to keep equipment clean.
3. Wear clean disposable gloves (latex or Nitrile) while performing purging and sampling. If gloves become contaminated or dirty replace with new gloves.
4. Make sure field water quality meters are calibrated according to the manufacturer's instructions.
5. If well is equipped with a pressure transducer, note how it is installed and its position to replace it after sampling. Remove the pressure transducer from the well. Note the time the pressure transducer was removed from the well on the data sheet or in the field notebook.
6. Measure the static water level in the well (see Groundwater Level and Temperature protocol below for details).
7. Measure the depth of the well or refer to the well log to determine the depth of the well.
8. Calculate the length of the water column. Calculate the volume of water in the well using the following values: 2" well = 0.1631 gallons per linear foot, 4" = 0.6524 gallons per linear foot (Equation used for water volume calculation – Volume (gal/ft) = $\pi r^2(7.48 \text{ gal/ft}^3)$ where r is the radius of the well and 7.48 is the conversion factor).
9. Install the submersible pump into the well. Be sure to slowly lower the pump into the well and through the water to avoid stirring up particulates. Place the pump in the middle of the screen section of the well (refer to well log to determine the open interval for pump placement).
10. Once the pump is installed correctly re-measure the static water level to monitor during purging.
11. Start purging. Set the pump controller to the desired pumping rate (~1 liter/minute). See notes from previous sampling for pumping rate.
12. Ideally, wells should be purged and sampled at flow rates at or less than the natural flow conditions of the aquifer in the screen interval to avoid drawing down the water level in the well. Use water level measurements to help adjust pumping rates to prevent well drawdown. Purging should not cause significant drawdown (considered to be 5% of the total height of the water column). If drawdown is significant, reduce pumping rate until water levels stabilize at an appropriate level.
13. Record pumping rate on the data sheet or field notebook.
14. Discharge evacuated water as far as possible from the wellhead and work area.
15. During purging and sampling water flow should be smooth and consistent without bubbles in the tubing.
16. Once pumping rate has been determined and flow has stabilized, start collecting field parameters (water temperature, specific conductance, pH and dissolved oxygen) at regular

intervals. The measurement interval will depend upon the pumping rate (typically 2-5 minutes between measurements).

17. Record field parameters, water level measurement, and estimated amount of water purged. Note any changes in purged water's appearance (clear, turbid, odor, etc.).
18. Continue purging well until field parameters stabilize. Parameters should be considered to be stabilized when 3 consecutive measurements fall within the following ranges:

Field Parameter	Stabilized Range
Temperature	± 0.1 ° Celsius
Specific Conductance <1000 µs/cm	± 10 µs/cm
Specific Conductance >1000 µs/cm	± 20 µs/cm
Dissolved Oxygen < 1 mg/L	± 0.05 mg/L
Dissolved Oxygen > 1 mg/L	± 0.2 mg/L
pH	± 0.1 pH units

19. Collect samples once field parameters have stabilized. Do not stop or change pumping rate during the final phase of purging and sampling.
20. Collect most sensitive analytes first (i.e. organics) followed by less sensitive analytes (i.e. nutrients). This order can be modified if using sulfuric or nitric acid preservatives to prevent contamination of sulfate and/or nitrogen samples.
    Collect any duplicate or quality control samples (see below for details).
21. Place samples in an ice-cooled cooler for delivery to the lab or shipping company. Make sure samples do not freeze during transport.
22. Complete chain of custody form. Record sample date and time, final water level and estimated total purge volume on the data sheet or in the field notebook. Also record any comments or observations regarding the purging and sampling process.
23. Replace pressure transducer if the well was equipped with one. Note re-install time on the data sheet or in the field notebook.
24. Clean and disinfect sampling equipment for next sampling event.

DECONTAMINATION

All non-disposable field equipment that may potentially come in contact with any soil or water sample shall be decontaminated in order to minimize the potential for cross-contamination between sampling locations. Thorough decontamination of all sampling equipment shall be conducted prior to each sampling event. In addition, the sampling technician shall decontaminate all equipment in the field as required to prevent cross-contamination of samples collected in the field. The procedures described in this section are specifically for field decontamination of sampling equipment.

At a minimum, field-sampling equipment should be decontaminated following these procedures:

- Wash the equipment in a solution of non-phosphate detergent (Liquinox® or equivalent) and distilled or deionized water. All surfaces that may come in direct contact with the samples shall be washed. Use a clean Nalgene and/or plastic tub to contain the wash solution and a scrub brush to mechanically remove loose particles. Wear clean latex, plastic, or equivalent gloves during all washing and rinsing operations.

- ♦ Rinse twice with distilled or deionized water.
- ♦ Dry the equipment before use, to the extent practicable.

Water Quality Sampling (Surface water)

Surface water sampling is conducted utilizing the following procedures.

Note: this procedure is a modified from:

Anderson, 2011. Standard Operating Procedure for Sampling of Pesticides in Surface Waters. Washington State Department of Ecology – Environmental Assessment Program. EAP003.

Equipment

- Sampling field data sheets (see below) or field notebook
- Chain of Custody form
- Water quality meters and probes (Temperature, Specific Conductance, pH & Dissolved Oxygen)
- Sample bottles/containers
- Cooler
- Ice
- Deionized water
- Diluted Bleach solution
- Non-phosphate soap (Liquinox or similar)
- Nitrile gloves
- First aid kit
- Camera
- Paper towels or clean rags
- Plastic sheet for keeping equipment clean
- Screwdriver(s)

Sampling

1. Check for any changes or potential hazards.
2. Make sure equipment has been cleaned and decontaminated (see below for details). Spread plastic or other material if needed to keep equipment clean.
3. Wear clean disposable gloves (Nitrile) while performing purging and sampling. If gloves become contaminated or dirty replace with new gloves.
4. Make sure field water quality meters are calibrated according to the manufacturer's instructions.
5. Collect required field water quality parameters and record on data sheet. Also note weather conditions
6. Fill out labels on each sample bottle with all necessary information.
7. Samples will be collected using the "Grab Sample" method described in EAP 003.
8. Take sample bottles and sampling equipment to the sample site and put on nitrile gloves.
9. Carefully collect samples by filling each container with water from the site. Note marked fill lines or preservatives to prevent over or under filling of the sample bottle.
10. Collect any duplicate or quality control samples (see below for details).

11. Place samples in an ice-cooled cooler for delivery to the lab or shipping company. Make sure samples do not freeze during transport.
12. Complete chain of custody form. Record sample date and time on the data sheet or in the field notebook. Also record any comments or observations regarding the sampling process.
13. Clean and disinfect sampling equipment for next sampling event.

DECONTAMINATION

All non-disposable field equipment that may potentially come in contact with any soil or water sample shall be decontaminated in order to minimize the potential for cross-contamination between sampling locations. Thorough decontamination of all sampling equipment shall be conducted prior to each sampling event. In addition, the sampling technician shall decontaminate all equipment in the field as required to prevent cross-contamination of samples collected in the field. The procedures described in this section are specifically for field decontamination of sampling equipment.

At a minimum, field-sampling equipment should be decontaminated following these procedures:

- Wash the equipment in a solution of non-phosphate detergent (Liquinox® or equivalent) and distilled or deionized water. All surfaces that may come in direct contact with the samples shall be washed. Use a clean Nalgene and/or plastic tub to contain the wash solution and a scrub brush to mechanically remove loose particles. Wear clean latex, plastic, or equivalent gloves during all washing and rinsing operations.
- Rinse twice with distilled or deionized water.
- Dry the equipment before use, to the extent practicable.

WATER QUALITY SAMPLING DATASHEET

Aquifer Recharge Water Quality Field Datasheet Page 1

Walla Walla Basin Watershed Council

Date:_____ **Time:**_____ **Sampler:**_____ **Recharge Site Name:**_____ **Sample: Beginning Middle End**

Up Gradient Well

Well #:_____ Water Level (Feet bmp):_____ ± _____ Time:_____

Well Depth (From Well Log or Measure):_____

Water Column (Well Depth - Water Level) = _____

Water Colum Volume (Water Column x volume per linear foot) = _____

(0.1631 per linear foot for 2" well or 0.6524 per linear foot for 4" well)

Water Level Measurement After Installing Pump

(Feet below measurement point):_____ Time:_____

Approximate Pump Flow Rate:_____ units:_____

Time	Temp (°C)	Conductivity (µs/cm)	DO (mg/L)	pH

Comments/Notes:

Down Gradient Well (Close)

Well #:_____ Water Level (Feet bmp):_____ ± _____ Time:_____

Well Depth (From Well Log or Measure):_____

Water Column (Well Depth - Water Level) = _____

Water Colum Volume (Water Column x volume per linear foot) = _____

(0.1631 per linear foot for 2" well or 0.6524 per linear foot for 4" well)

Water Level Measurement After Installing Pump

(Feet below measurement point):_____ Time:_____

Approximate Pump Flow Rate:_____ units:_____

Time	Temp (°C)	Conductivity (µs/cm)	DO (mg/L)	pH

Comments/Notes:

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Aquifer Recharge Water Quality Field Datasheet Page 2

Down Gradient Well (Distal)

Well #:_______ Water Level (Feet bmp):_______ ± _____ Time:______

Well Depth (From Well Log or Measure):___________

Water Column (Well Depth - Water Level) = ______________

Water Colum Volume (Water Column x volume per linear foot) = _________

(0.1631 per linear foot for 2" well or 0.6524 per linear foot for 4" well)

Water Level Measurement After Installing Pump

(Feet below measurement point):___________ Time:___________

Approximate Pump Flow Rate:_________________ units:____________

Time	Temp (°C)	Conductivity (µs/cm)	DO (mg/L)	pH

Comments/Notes:

Source Water

Source Water #:_______ Flow Rate (or Staff Gage):___________ Time:________

Weather Conditions:____

Field Parameters

Time	Temp (°C)	Conductivity (µs/cm)	DO (mg/L)	pH

Duplicate Samples:____

Comments/Notes:

General Sampling Notes

Measurement Procedures

Photo Point Monitoring

Note: these procedures are based upon and modified from:
Hall, F.C., 2002. Photo Print Handgook: Part A – Field Procedures and Part B – Concepts and Analysis.

Photo point monitoring will be used to document changes at measurement points over time. For surface sites this will include change in channel shape, vegetation, and land use changes. For groundwater sites this can include casing changes, pump changes or land use changes.

Equipment

- Camera
- GPS (to find photo point)
- Clipboard
- Pencil or pen
- Datasheet (for appropriate monitoring site)
- Previous picture or description of photo point

Establishing a Photo Point

1. Reconnoiter the area to determine the best location for the photo point. Take note of sun direction, potential vegetation growth and main objectives (i.e. channel shape, well casing, pump, etc.).
2. Record GPS coordinates for the photo point and record in the comments section of the data sheet. Also note the direction the photo should be taken and include a description of the main objectives of the photo (i.e. channel shape, vegetation, etc.)
3. Take photo point picture and review. Determine if all of the main objectives are visible in the picture.

Visiting a Photo Point

Photo point monitoring should be conducted during every site visit.

1. Look at previous pictures taken at the photo point to orient. Look at site data sheets to determine GPS coordinates, photo direction and main objectives.
2. Take picture of site. Determine if all of the main objectives are visible in the picture.

Surface Water Monitoring

Note: These procedures are based on and modified from:

Myers, J. 2009. Standard Operation Procedure for Conducting Stream Hydrology Site Visits. Version 1.0. Washington Department of Ecology – Environmental Assessment Program. EAP057.

ODEQ, 2009. Water Monitoring and Assessment Mode of Operations Manual. Watersheds Quality Monitoring Field Sampling Standard Operating Procedure – Laboratory and Environmental Assessment Division. Version 3.2

Rantz, S. E., and others. 1982 Measurement and Computation of Streamflow: Volume I. Measurment of Stage and Dischage. U.S. Geological Survey Water-Supply Paper 2175.

Rantz, S. E., and others. 1982 Measurement and Computation of Streamflow: Volume II. Computation of Discharge. U.S. Geological Survey Water-Supply Paper 2175.

Shedd, J. R. 2011. Standard Operating Procedure for Measuring and Calculating Stream Discharge. Version 1.1. Washington Department of Ecology – Environmental Assessment Program. EAP056.

Shedd, J.R. 2008. Standard Operating Procedure for Measuring Gage Height of Streams. Version 1.0. Washington Department of Ecology – Environmental Assessment Program. EAP042.

Equipment

- Four foot top set wading rod
- Mechanical Current Meter (Price AA or pygmy), Swoffer, or Marsh-McBirney Velocity Meter
- AquaCalc computer
- Bridge Board
- Sounding Reel
- Columbus sounding weight
- Tape Down Measuring Tape (with weight attached)
- Laser Level
- Stadia Rod
- NIST Thermometer
- YSI-30 Temperature and Conductivity Meter
- Measuring tape (100' or 200')
- Chest or Hip Waders
- Laptop Computer
- Cables for connecting to Data logger
  - LT-300 Cable
  - LT-500 Cable
  - WaterLog Cable or Memory Card
  - Campbell Scientific Cable or Card
- Pen or Pencil
- Data sheets

Vertical Stage Measurement

Vertical stage measurements are obtained from mounted staff gauges. Most staff gauges used by the WWBWC are graduated in 0.01 feet increments. Measurements should be recorded to 0.01 feet resolution. Below is a photo of a typical WWBWC staff gauge.

1. Read the water level on the staff gauge to the nearest 0.01. If the water level is fluctuating during the reading take the average water level and note the range of fluctuation (1.25 ±0.04 where 1.25 is the average water level and 0.04 is the range above or below the average).
2. If water level fluctuations are excessive you can create a temporary stilling well around the staff gauge to get a more accurate reading. You can use a 5-gallon bucket with the bottom cut out for the temporary stilling well.
3. Take the necessary time to obtain an accurate staff gauge reading – both the water level and uncertainty.
4. Record the date, time and measurement data on the data sheet.

TAPE-DOWN STAGE MEASUREMENT

Measuring tape-down stage involves lowering a measuring tape with a weight attached to the end to the water surface from a reference point. Often the reference point is a metal washer attached to a bridge railing.

1. Locate the reference point
2. Lower the weighted tape down to the water surface. The weight should only just touch the water surface creating a small "V" shape on the water surface.
3. Read the tape at the edge of the reference point and record to the nearest 0.01. Include uncertainty caused by wave action or wind.
4. Because the weight is attached to the end of the measuring tape, record the correction factor that needs to be applied to the reference point reading.

LASER LEVEL STAGE MEASUREMENT

Laser levels are used to measure stage height from a known elevation and allow a check on the vertical staff gauge elevation.

1. Place the laser level on the platform of known elevation.
2. Confirm that the platform's elevation has not changed by measuring the elevation of reference marks/points with the stadia rod. Record data on the Stream Gage Logger Notes datasheet. Reference marks or points are placed near the laser level platform and are typically bolts in large boulders or other stable objects. Compare reference point elevations to ensure platform has not moved.
3. Place the stadia rod as close as possible to the primary staff gauge (typically the vertical staff gauge).
4. Read the laser level using the laser sensor on the stadia rod. Record level.
5. Observe and record the water level (including level of uncertainty) on the stadia rod.
6. Complete the calculations on the Stream Gage Logger Notes datasheet to compute the laser level stage. For the calculations you take the laser rod reading minus the depth of water and that equals the differential laser to water surface. Take the elevation of the laser beam minus the differential to get the laser level stage.

DISCHARGE MEASUREMENT (WADING)

1. Select an appropriate location to perform a discharge measurement (refer to Rantz, 1982 for full details). A good cross section will typically have the following characteristics: relatively straight channel with parallel edges, defined edges, uniform shape, free of vegetative growth and large cobbles or boulders, free of eddies, slack water and turbulence, depths greater than 0.5 feet, velocities greater than 0.5 feet per second that are evenly distributed, close to the gauging station. Often some or many of the above criteria cannot be met. The best available cross section location should be chosen.
2. Stretch a measuring tape across the channel where the measurement will be taken. The tape should be perpendicular to as much of the flow as possible to reduce oblique flow angles.
3. Determine the width of the wetted channel and divide the width into 25-30 segments. Cells should be divided such that each cell has approximately 5% of the total flow and no more than 10%. Segments should be shorter where flow is more concentrated or the bottom is irregular. The width of any segment should not be less than three tenths of a foot (0.3 feet).
4. Start at either the right or left edge of water (REW or LEW). Record tape distance for edge of water.
5. Set wading rod at location for the first measurement. Determine the depth of water.
6. If depth is less than 1.5 feet use the one point method of measuring velocity at 0.6 of the depth.
7. If depth is equal to or greater than 1.5 feet use the two point method of measuring at both 0.2 and 0.8 of the depth and average the velocities.
8. In cases where there is no logarithmic relationship to the velocities in the water column (this is when the 0.2 velocity is less than the 0.8 velocity or the 0.2 velocity is more than twice the 0.8 velocity) the three point method should be used. The three point method measures at 0.2, 0.6 and 0.8. The 0.2 and 0.8 velocities should be averaged and then that result should be averaged with the 0.6 velocity. This weights the 0.6 velocity at 50% and the 0.2 and 0.8 each at 25%.
9. Each velocity measurement should average velocity data for 40 seconds to address variations in water velocity over time at a single measurement point.
10. If water flow direction is not perpendicular to the measuring tape the meter should be pointed directly into the direction of flow. Use the data sheet to measure the angle coefficient (and apply a correction to the velocity) for velocity measurements not perpendicular to the measuring tape (see figure below). Align the point of origin on the measuring tape. Rotate the data sheet until the opposite long edge is parallel to the direction of flow (the same direction the meter is pointed). The angle coefficient is read where the measuring tape intersects the data sheet. Multiply the velocity measurement by the angle coefficient to calculate the perpendicular velocity.

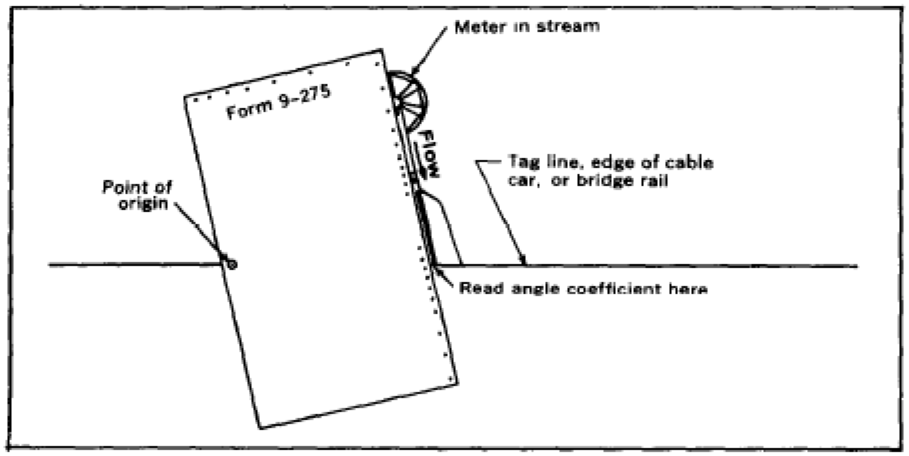


Figure taken from Rantz, 1982.

11. Repeat steps 5-10 for each of the subsequent measurement locations across the cross section until you reach the opposite edge of water.
12. Rate the measurement on a scale from excellent to poor. Rating can be based upon observed conditions as well as information from the AquaCalc file. Observations that can influence the rating of a measurement include (but are not limited to): channel characteristics, proximity to bridges or other structures, number and degree of oblique current angles, condition of equipment, weather, water level bounce and velocity pile up on wading rod and others. Use observations and professional judgment in rating a measurement. Measurements are rated excellent if the discharge value is with 2% of the actual flow value, good if within 5%, fair if within 8% and poor if within 13%.

Discharge Measurement (Bridge)

This section will describe differences between wading and bridge discharge measurements. Follow the procedure for wading discharge measurements above with the following changes:

1. The choice of cross section locations is obviously limited when measuring from a bridge.
2. Use a bridge board, sounding reel, and Columbus weight instead of a wading rod
3. Increase velocities measurements near bridge piers
4. Use the one point method on depths less than 2.5 feet and the two point method on depths equal to or greater than 2.5 feet.
5. Sometimes, water flow direction is all oblique to the bridge. In these cases multiply the raw average velocity of the measurement by the cosine of the angle between current direction and the cross section.

Discharge Calculation

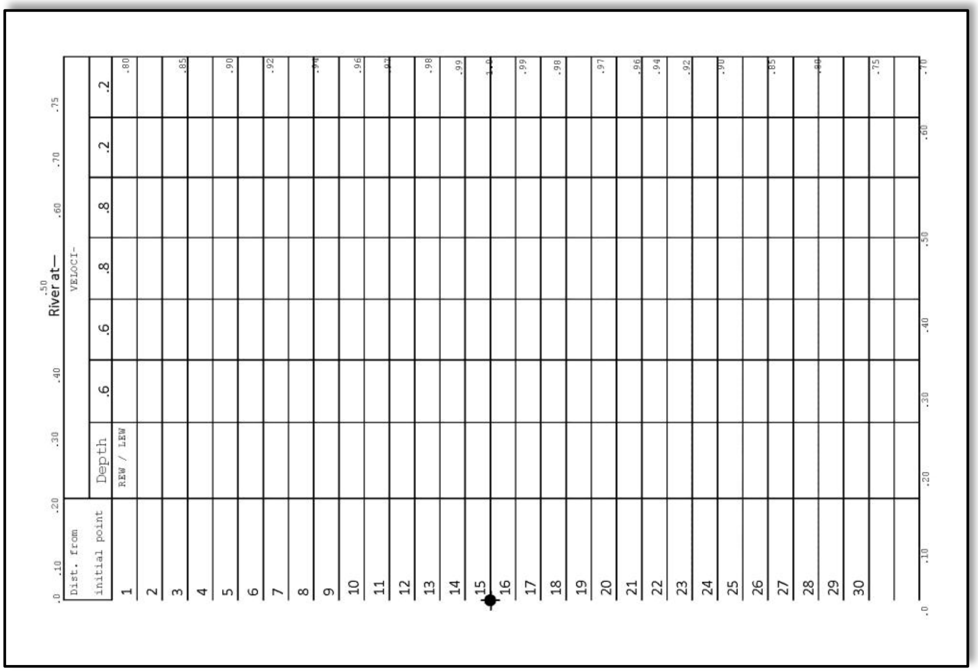
Discharge is calculated using the mid-section method in which each section extends halfway between measurement locations. The flow through each section is calculated by multiplying the average velocity with the cross-sectional area of the section. See references for a complete description of discharge calculations.

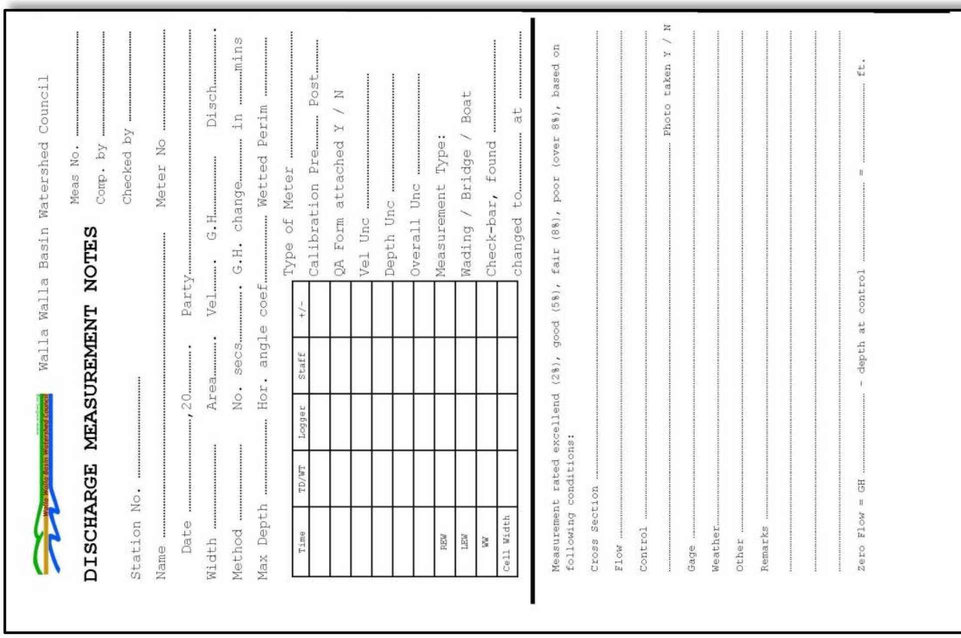
Station Visit (without Discharge Measurement)

River gauging stations and real-time stations are visited twice a month to collect staff gauge readings, perform any site maintenance and download data. These visits do not include a discharge measurement.

1. Open gauge station and retrieve data sheet.
2. Record primary gauge reading in the PGI row (see above for procedure). This is often a vertical staff gauge.
3. Record secondary gauge reading in the SGI row (see above for procedure). Often this is a tape-down measurement.
4. Record auxiliary gauge reading if present in the AUX row. Used for alternate staff gauge readings.
5. Record water temperature from the gauge station.
6. Record water temperature with the NIST thermometer or the YSI-30.
7. Record air temperature from the gauge station.
8. Record air temperature from the NIST thermometer or the YSI-30.
9. Record battery volts.
10. Download data from the data logger and record on the data sheet.
11. Purge the pressure sensor (if equipped).
12. Record battery minimum and maximum.
13. Reset Stats screen.
14. Note any problems, maintenance issues or other information at the bottom of the data sheet.
15. Close and secure the gauge station.

DISCHARGE NOTES DATA SHEET




DISCHARGE MEASUREMENT NOTES

Walla Walla Basin Watershed Council

Meas No. ....
Comp. by ....
Station No. .... Checked by ....
Name .... Meter No ....
Date ...., 20.......... Party..........
Width .... Area.......... Vel.......... G.H.......... Disch..........
Method .... No. secs.......... G.H. change.......... in ....mins
Max Depth .... Hor. angle coef.......... Wetted Perim ....

Time	TD/WT	Logger	Staff	+/-
REW				
LEW				
WW				
Cell Width				

Type of Meter ....
Calibration Pre.......... Post..........
QA Form attached Y / N
Vel Unc ....
Depth Unc ....
Overall Unc ....
Measurement Type:
Wading / Bridge / Boat
Check-bar, found ....
changed to.......... at ....

Measurement rated excellend (2%), good (5%), fair (8%), poor (over 8%), based on following conditions:

Cross Section ....
Flow ....
Control ....
.... Photo taken Y / N
Gage ....
Weather..........
Other ....
Remarks ....

Zero Flow = GH .... - depth at control .... = ... ft.

GAGING STATION LOG DATA SHEET

Walla Walla Basin Watershed Council

Gaging Station Log

Station Name: ______________________ Station Number ____________ Water Year ________

Party												
Date												
Time												
PGI												
SGI												
AUX												
LOGGER												
H20 TEMP.												
THERMISTOR												
AIR TEMP.												
THERMISTOR												
BATT. V												
REPLACED (Y / N)												
DOWNLOADED (Y / N)												
PURGE (Y / N)												
SYNCED (Y / N)												
SYSTEM RESETS												
BATT. V (MIN/MAX)												
RESET STAT SCREENS (Y / N)												
MEASUREMENT (Y / N)												
MGH												
MEASURED Q												
PROFESSIONAL RATING												
METHOD												
LOCATION												
MAX DEPTH												
MAX VELOCITY												
PZF												
CONTROL (LOCATION, CONDITION, ETC.)												

STREAM GAGE NOTES DATA SHEET

Batt V .... Min .... Max ....

Reset Stats Y / N   Batt Replaced Y / N

GOES Time OK Y / N

Data Downloaded Y / N   .NEW File Erased Y / N

Desiccant Condition .... Changed Y / N

CSG checked Y / N

HWM .... ft on stick + Ref Elev .... ft

= HWM Elev .... ft.   Cleaned Y / N

Added Cork Y / N

Remarks: ....

Walla Walla Basin Watershed Council

WWBWC Stream Gage Logger Notes

Station name .... Party ....

Station # ....

DATE					
TIME (PST)					
LOGGER					
STAFF GAGE					
WIRE WEIGHT					
CHECK BAR					
TAPE DOWN					
CORR. FACTOR					
CORRECTED TD					
TD RP ELEVATION					
CORRECTED TD					
- WS ELEV @ TD					
LASER: LASER ROD READING					
- WATER SURFACE, ROD READING					
= DIFFERENTIAL, LASER TO WATER SURFACE					
LASER BEAM ELEVATION					
DIFFERENTIAL					
= STAGE					
WATER TEMP				ELEVATION	READING
THERMISTER			LL RP1		
AIR TEMP			LL RP2		
THERMISTER			LL RP3		

GROUNDWATER MONITORING

These procedures are for monitoring groundwater levels and groundwater temperature and specific conductivity. The procedure covers equipment needed, establishing a measuring point, manual water level measurements, pressure transducer deployment, download and maintenance, groundwater grab samples for temperature and specific conductivity and site maintenance.

Note: These procedures are modified from Drost, B.W., 2005, Quality-assurance plan for ground-water activities, U.S. Geological Survey, Washington Water Science Center: U.S. Geological Survey Open-File Report 2005-1126, 27 p.

EQUIPMENT

- E-tape (Solinst model 102 Water Level Meter)
- Laptop
- Extra pressure transducers (if available)
- Cables for downloading pressure transducers
  - LT-300
  - MicroDiver/Solinst
  - MicroDiver (direct connect cable)
  - Solinst (direct connect cable)
  - MiniTroll
- Bailer
- Graduated Cylinder
- Temperature and Conductivity meter (YSI 30)
- Sounding Tape
- Measurement tape (measured in tenths of a foot)
- Data sheet (waterproof paper)
- Pen (waterproof) or pencil
- Well keys
- Battery removal tool for MiniTroll pressure transducers
- GPS
- Extra Batteries (AA lithium for pressure transducers & 9v for E-tape)
- Flashlight
- Screwdrivers
- Hammer
- Pipe wrench
- Socket set
- Crescent wrench
- Cable snips
- Pliers (preferably needle-nose)
- Camera
- Well Field Instructions and Procedures binder
- WellNet binder for site references and maps
- Business cards
- U-bolts and cable crimps
- Inverter (for charging laptop from vehicle)
- Cable (speaker wire or 1/16" aviation cable)
- Extra sacrificial weights for E-tape
- Work gloves

- Disposable gloves (nitrile)
- Disinfectant (Lysol or diluted bleach)
- Sharpie or other marking device (for measuring point)
- WD-40

Establishing a Measuring Point

This procedure is for establishing a measuring point on wells from which all water levels are measured.

1. Measuring point (MP) must be permanent as possible, clearly defined and easily located. Typical locations include the top of the well casing or access ports.
2. MP should be located so that the measuring tape can hang freely during water level measurements.
3. Mark MP with Sharpie or other marker (paintstick, etc).
4. Measure distance from the MP to the land surface and record on the data sheet. This measurement is called the top of grade (TOG) for the well. MP's located below the land surface are positive and MP's located above the land surface are negative. If the well has been GPS surveyed, measure TOG from the MP to the surveyed elevation.
5. Take a photograph of the MP to document location Well Network Database or in case the marker wears off.

Manual Groundwater Level Measurement (E-tape)

1. Before measuring the water level in a well utilized for drinking-water supply, disinfect the first 5-10 feet of the E-tape with diluted bleach water and dry with single-use towels (e.g. Kimwipes). Use latex or nitrile gloves for drinking-water supply wells and disinfection.
2. Review well info page in the Well Network binder for the MP.
3. Record if the Pump is On (1) or Off (0) in the "Pump" field.
4. Test the E-tape by turning it to "test" or by pressing the "test" button. If the E-tape does not buzz, check the battery. Start with sensitivity set to the mid-range and adjust as necessary.
5. Carefully lower the tape (and weight) into the well. The tape should be lowered slowly to prevent splashing or excess wear on the E-tape.
6. When the E-tape buzzes, pull the tape up and down a few inches to determine the exact level. Hold the tape at the MP and record the value to the nearest 0.01 feet in the "Static" field.
7. Repeat water level measurement. If measurements differ by more than 0.02 feet determine why (well pumping, well recovering, etc) and document reason on data sheet.
8. Periodically check the E-tape to make sure it is in good working condition.

Pressure Transducer Deployment

1. Sound well and record measurement or, if available, consult the well log to determine well depth and pump location.
2. Take a manual water level measurement (see above) and record measurement on data sheet.
3. Program and start the pressure transducer. Pressure transducers should collect data every 15 minutes. Pressure transducer should be started so that data will be recorded on the hour (i.e. 12:00, 12:15, 12:30, 12:45, 13:00…). Program transducer with the well's GW

number. Follow the manufacturer's instructions on how to program and start the transducer.

4. Attached pressure transducer to one end of the cable using two wire crimps and a stainless steel U-bolt. Do not use crimps and do not over tighten the U-bolt if using a communication cable.
5. Measure and cut aviation cable or speaker wire to suspend the pressure transducer approximately 5-10 feet above the bottom of the well. This value can change depending upon the depth of the well and the pressure range of the pressure transducer. Make sure to not deploy the pressure transducer below its rated pressure range (typically marked on the side of the device). If the well is deeper than the pressure range, place the pressure transducer at a depth so there is 10-15 feet of pressure range still available (to account for potential water level increases). Pressure transducers should not rest on the bottom of the well or be surrounded by silts/fines that have accumulated in the well. Remember to account for the length of the logger when measuring the length of the cable.
6. If using a communication cable for the manufacturer, following the steps above to determine cable length.
7. Record length of cable, pressure transducer serial number and communication cable serial number if used.
8. Slowly lower pressure transducer and cable into the well making sure the transducer is not free falling. Take extra care as the transducer passes through the water-air interface to prevent damage to the transducer or entrainment of air bubbles.
9. Attach cable to the well at the surface using wire crimps and a stainless steel U-bolt.
10. Mark the cable so that cable slippage, if it occurs, can be accounted for during future site visits.
11. Make sure that all of the cable is deployed and the transducer is hanging on the cable rather than caught on a pump or some other obstruction.
12. Photograph the well to document the pressure transducer deployment and well. Try to capture the area around the well, any well apparatus and the measuring point. Multiple photos may be required.

PRESSURE TRANSDUCER DOWNLOAD AND MAINTENANCE

1. Record manual water level measurement, date, time and whether the well is being pumped.
2. Retrieve pressure transducer to the surface (if not attached to a communication cable).
3. Connect the pressure transducer, using the appropriate cable, to the field laptop.
4. Record the following information on the data sheet: Download start time (DL), Logger Time (LT – difference between pressure transducer time and computer time), Restart Time (RT – if the pressure transducer was stopped and restarted), Serial number (S#), Battery level (Batt - % of battery left or if batteries were replaced) and U-bolt and crimp conditions (Ubolts).
5. Follow manufacturer's protocol for downloading, saving and exporting data from the pressure transducer. Data should be saved in the proprietary format and in comma separated value format (.csv). File names should be in the following format: GW_xx_Data start date_Data end date_data collector's initials (For example: GW_129_3-3-11_7-6-11_sp – This file is for well GW_129 and the data in the file is from March 3rd through July 6th and was collected by Steven Patten).
6. Visually check the graphed data to ensure there are not any major issues that should be addressed. Raw data visual checks may be able to determine if the transducer came out of the water, the cable slipped/shifted or other issues that can be resolved through site

maintenance. Potential fixes could include readjusting/lengthening cable length or tighten U-bolts.

7. Note when the pressure transducer will run out of memory so a future visit will occur before that time.
8. Examine the pressure transducer for indications of damage or wear. Make sure access ports for the pressure diaphragm are clear of obstructions so the pressure transducer performs correctly.
9. Slowly lower transducer back into the well taking extra care as it transitions between air and water.

Grab Samples for Groundwater Temperature and Specific Conductivity

1. Check the bailer to determine if the string/cable is attached properly and that it is not frayed or damaged and that the bailer is in proper working order.
2. Slowly lower the bailer into well until is below the water level and fills with water. NOTE: Do not put the bailer down access or vent holes. If unsure do not put the bailer down the well. The data sheet indicates which wells should have water grab samples taken – if the temperature and conductivity fields are grayed out do not take a sample. The Well Network database also indicates whether a water grab sample should be collected.
3. Slowly reel the bailer back to the surface taking care to limit it banging/hitting the well casing.
4. Empty the water in the bailer into the graduated cylinder.
5. Put the temperature/EC probe into the water in the graduated cylinder.
6. Turn on the YSI-30 (temperature/EC meter). Ensure that the meter is correctly set to measure temperature in degrees Celsius and specific conductivity in µs/cm.
7. Wait for the reading to stabilize and then record temperature and conductivity values in their appropriate fields on the data sheet. In the summer or winter water temperature may increase or decrease depending upon the ambient air temperature. If the reading does not stabilize in 15-20 seconds, record the mean value over the 15-20 second period.
8. Turn off the YSI-30.
9. Discard water from the graduated cylinder.

Site Maintenance

1. Check the well casing and surrounding area for any changes that have occurred since the last field visit. If needed document the changes on the data sheet and with photographs.
2. Check TOG measurement approximately once a year to determine if there are any changes.
3. If well has not been surveyed in, survey well using Magellan ProMark 3 GPS system at earliest opportunity.
4. Check cable integrity and other well monitoring components for wear or damage. Replace as needed.
5. Photograph the site during every field visit to visually track changes to the site.

GROUNDWATER MONITORING DATA SHEETS

Shallow Aquifer Monitoring Network
OR Well Monitoring Field Notes

Well_ID	Name	Date	Time	Static	Pump	TOG	Temp (C)	Cond
GW_48								
DL=	LT=	RT=		S#		Batt	Ubolts	
GW_58								
GW_60								
DL=	LT=	RT=		S#		Batt	Ubolts	
GW_61								
DL=	LT=	RT=		S#		Batt	Ubolts	
GW_62								
DL=	LT=	RT=		S#		Batt	Ubolts	
GW_63								
DL=	LT=	RT=		S#		Batt	Ubolts	
GW_64								
GW_65								
DL=	LT=	RT=		S#		Batt	Ubolts	
GW_67								
GW_68								
DL=	LT=	RT=		S#		Batt	Ubolts	
GW_69								
GW_73								
DL=	LT=	RT=		S#		Batt	Ubolts	
GW_74								
DL=	LT=	RT=		S#		Batt	Ubolts	
GW_75								
DL=	LT=	RT=		S#		Batt	Ubolts	
GW_98								
GW_115								
DL=	LT=	RT=		S#		Batt	Ubolts	
GW_116								
DL=	LT=	RT=		S#		Batt	Ubolts	
GW_119								
DL=	LT=	RT=		S#		Batt	Ubolts	
GW_120								
DL=	LT=	RT=		S#		Batt	Ubolts	
GW_135								
DL=	LT=	RT=		S#		Batt	Ubolts	
Notes								

Shallow Aquifer Monitoring Network
OR Well Monitoring Field Notes

Well_ID	Name	Date	Time	Static	Pump	TOG	Temp (C)	Cond
GW_04								
GW_05								
DL=	LT=	RT=		S#		Batt	Ubolts	
GW_06								
GW_07								
DL=	LT=	RT=		S#		Batt	Ubolts	
GW_08								
DL=	LT=	RT=		S#		Batt	Ubolts	
GW_09								
DL=	LT=	RT=		S#		Batt	Ubolts	
GW_10								
GW_11								
GW_13								
GW_14								
DL=	LT=	RT=		S#		Batt	Ubolts	
GW_28								
DL=	LT=	RT=		S#		Batt	Ubolts	
GW_31								
DL=	LT=	RT=		S#		Batt	Ubolts	
GW_33								
DL=	LT=	RT=		S#		Batt	Ubolts	
GW_34								
DL=	LT=	RT=		S#		Batt	Ubolts	
GW_35								
DL=	LT=	RT=		S#		Batt	Ubolts	
GW_36								
GW_37								
GW_38								
DL=	LT=	RT=		S#		Batt	Ubolts	
GW_39								
GW_40								
DL=	LT=	RT=		S#		Batt	Ubolts	
GW_41								
GW_45								
DL=	LT=	RT=		S#		Batt	Ubolts	
GW_46								
DL=	LT=	RT=		S#		Batt	Ubolts	
GW_47								
DL=	LT=	RT=		S#		Batt	Ubolts	

WATER TEMPERATURE MONITORING

This procedure is for monitoring water temperature in rivers and streams using data loggers. The procedure covers equipment needed, pre & post deployment accuracy check, field accuracy check (site visits), deployment, and recovery.

Note: this procedure is modified from the following references:

Water Quality Monitoring – Technical Guide Book, 2001. Oregon Watershed Enhancement Board.

ODEQ, 2009. Water Monitoring and Assessment Mode of Operations Manual. Watersheds Quality Monitoring Field Sampling Standard Operating Procedure – Laboratory and Environmental Assessment Division. Version 3.2

EQUIPMENT

- Data Logger (Vemco, Tidbit, etc)
- Laptop/Computer
- Computer interface cable for Data Logger
- NIST-traceable thermometer
- 1 medium sized cooler
- Ice
- Temperature Accuracy Check form (see below)
- 1 ½" PVC Pipe (to reduce temperature variations due to solar radiation)
- 1/16" aviation cable
- Wire cutters
- Cable crimps
- Pliers or other device to secure crimps and cut the cable
- Forestry Flagging/Surveyors Tape
- GPS unit
- Camera
- Waders
- Field Notebook
- First Aid Kit

PRE & POST DEPLOYMENT ACCURACY CHECK

1. For 20°C calibration test, pour room temperature water into the cooler. Adjust temperature in the cooler with ice, cold water or hot water to the desired 20°C. If ice is used make sure it is completely melted. Close lid.
2. Insert the NIST thermometer probe into the cooler. Pull it through enough so that when the lid is closed, the probe will be suspended midway (or slightly lower) in the water bath.
3. Use the computer and manufacturer's software to start the temperature data loggers and set them to record data every 1-minute.
4. Place temperature data loggers directly into the water bath.
5. Allow water bath to stabilize (for 15-30 minutes) before recording NIST thermometer temperatures. After stabilization, record temperatures from the NIST thermometer every minute for ten minutes. More readings may be necessary if there is suspicion the water bath temperature changed or was not stabilized.

6. Download data from the temperature data loggers and audit thermometer results with time of record on an audit form. Water temperatures should not vary more than ± 0.5°C between the NIST thermometer and the data logger's temperature. Units not passing this accuracy test should not be used.
7. Repeat accuracy test for cold water bath at 5°C.

Field Accuracy Checks (Site visits)

During a typical season of water temperature monitoring (June-November), two field accuracy checks will be conducted using the following procedure:

1. Determine if the data logger is still adequately placed in the river (see deployment procedure for details) to record water temperatures.
2. Place field thermometer (NIST thermometer) in the water directly next to the temperature data logger. (Note: if a NIST thermometer is not available use a thermometer with an accuracy of ± 0.5°C and a resolution of ± 0.2°C)
3. Allow field thermometer to stabilize and then record the temperature reading.
4. After the temperature data loggers have been retrieved and data download, compare the field thermometer's reading to that from the temperature data logger. Data accuracy should be ± 0.5°C.

Deployment

1. Start temperature data logger either prior to going to the field or in the field with a laptop. Data loggers should be set to record data every thirty minutes. Data loggers should be set to start collecting data either at the hour or half hour (e.g. 12:00 or 12:30).
2. Secure data logger inside of the 1 ½" PVC pipe using the aviation cable ensuring that the entire length of the logger is covered by the PVC.
3. Secure data logger at the site using the aviation cable. Often the cable can be secured to trees, logs, large rocks or other stable structures. Make sure that the logger is in a well-mixed portion of the river to ensure accurate readings. Also, place the data logger to ensure that it will stay submerged in the water as river flows drop.
4. Record in the fieldbook the time of deployment and when the data logger will run out of memory for logging data. Record site name and data logger serial number. Check stream temperature as an additional accuracy check.
5. Record site GPS coordinates using a GPS unit.
6. Take pictures of site for future reference and recovery.
7. Write a short description and create a sketch of the site including approximate distances from structures (bridges, log jams, etc.).

Recovery

1. Locate Temperature data logger and check stream temperature with a field thermometer.
2. Record time of data logger recovery and note any site conditions that may have affected data accuracy or reliability. Cut the cable to free the data logger and return to the office and download the data. Data loggers should be stopped after data download to prevent unnecessary battery use.

PRE & POST DEPLOYMENT ACCURACY CHECK DATA SHEET

Accuracy Check Summary

Data Logger Serial #	Pass / Fail

Walla Walla Basin Watershed Council

www.wwbwc.org

541-938-2170 or 7086 P.O. Box 68, Milton-Freewater, OR 97862

Walla Walla Basin Watershed Council

Temperature Data Logger Accuracy Test - Audit Form

Date & Time ____________ Performed by: ____________

NIST Thermometer ____________ Pre / Post Check

Low Temp (°C) ____________

Room Temp (°C) ____________

Time	NIST reading(°C)	# -	# -	# -	# -	# -	# -
	Pass / Fail						

**NOTE: If data logger is more than ± 0.5 °C from the NIST it fails the accuracy check*

Time	NIST reading(°C)	# -	# -	# -	# -	# -	# -
	Pass / Fail						

**NOTE: If data logger is more than ± 0.5 °C from the NIST it fails the accuracy check*

Comments:

Scour Chains and Bed Stability

This procedure is for monitoring bed scour and fill to look at river bed stability and river bed conditions. The procedure covers the construction, installation and monitoring of scour chains (including cross-sectional surveys) and pebble counts.

Note: Scour chain procedures were based upon the following sources:

Lisle and Eads. 1991 Methods to measure sedimentation of spawning gravels. Res. Note PSW-411. Berkley, CA: Pacific Southwest Research Station, Forest Service, U.S. Department of Agriculture; 7 p.

Nawa and Frissell. 1993. Measuring Scour and Fill of Gravel Streambeds with Scour Chains and Sliding-Bead Monitors. North American Journal of Fisheries Management. 13: 634-639.;

Leopold, Wolman and Miller. 1964. Fluvial Process in Geomorphology. Freeman, San Francisco.

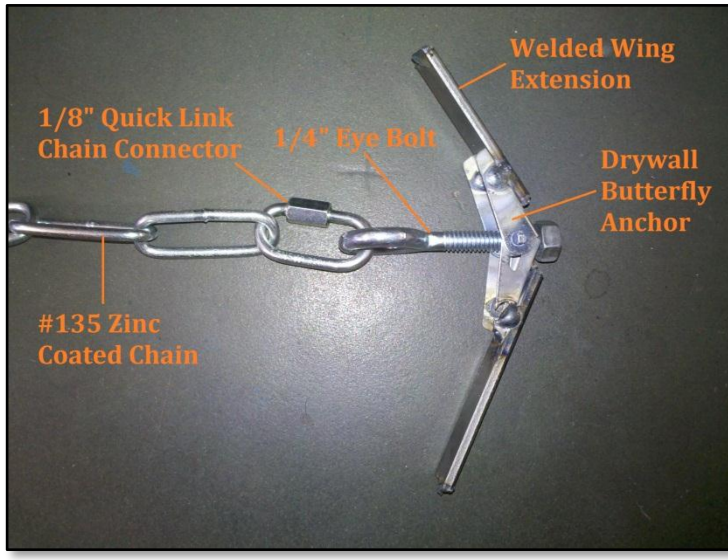
Pebble count procedures where based upon Wolman, M.G. 1954. A Method of Sampling Coarse River-Bed Material. Transactions of the American Geophysical Union. 35(6):951-956.

Equipment

- Scour Chains
    - 2.5-3.0 feet of #135 Zinc Coated Chain (links are ~1.5")
    - Chain Quick-Link Connector (1/8")
    - Anchor (Modified Drywall Butterfly Anchor)
    - Eye bolts
- 100' or 200' tape
- Waders (hip or chest)
- Laser Level with Stadia rod
- Flow meter
- Shovel
- Hand Trowel
- Fence Post Driver
- 1 ½" galvanized steel pipe
- 1" metal rod
- Rubber bands
- Fishing line
- Forestry Flagging Tape
- Pipe Wrenches
- Data Sheets or Field Notebooks
- Pen or Pencil
- First Aid Kit

Scour Chain Construction

Scour chains are constructed by WWBWC staff to help reduce costs. Scour chain anchors are created by modifying drywall butterfly anchors (1/4" bolt/screw). Extensions (1/2" flat metal) are welded to each wing of the anchor creating ~2-3 inch wing on each side. Eye bolts are then welded on to the anchor to prevent them from detaching. A ~2.5-3.0 foot section of #135 chain is attached to the eye bolt with a quick link chain connector. See figures below.

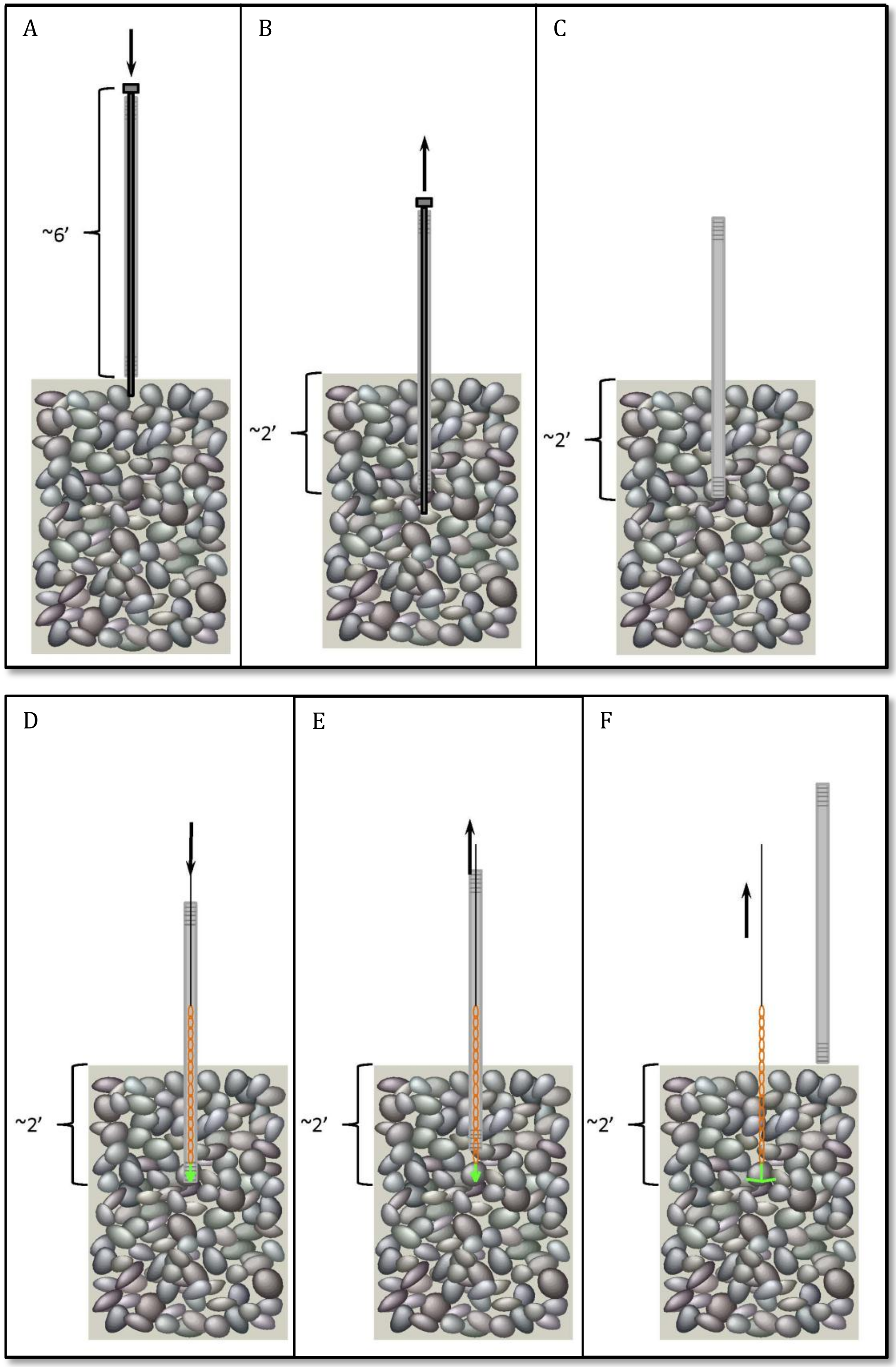


Scour Chain Installation

Scour chains are installed perpendicular to the direction of flow in the river (similar to a discharge measurement). 4-5 chains are typically installed across the width of the river, but this will increase or decrease depending upon the width of the river. Chains are installed approximately 10-12 feet apart across the channel.

1. Determine location for scour chain installation.
2. Establish a control point on both banks. Make sure the location of each control point is as stable as possible and will not be damaged by higher flows. Preferably the control points should be located above the bank full width to avoid frequent flood damage. Drive a piece of ½” rebar into the ground as far as possible. Place a blue WWBWC control point marker on the end of the rebar and flag it with forestry flagging.
3. Run a tape across the width of the channel between the control points on either bank. You can tie off the tape to the control points or to rocks/trees on the shore. If not tying off to the control points make sure the tape goes directly over each of the control points.
4. Determine the width of the river – typically this will be the bank full width as to capture river scour/fill influences during frequent high flow events.
5. Decide how many scour chains to install based upon width. Chains are installed ~10 feet apart. So if the river is 40 feet across plan on installing 4 chains.
6. Divide the river into approximately even sections and make note where each scour chain should be installed. The exact location of each chain will vary side to side by a small amount based upon sediments present at each location (see 7 below).
7. Drive pipe and metal rod into the river bed substrate using the fence post driver to a depth of ~2 feet. Because river bed sediments in the Walla Walla Basin are often gravels and cobbles (and sometime boulders) you may have to try multiple locations to find a successful spot where the pipe can be driven in ~2 feet (Figure A).
8. Remove metal rod from inside the pipe. Be sure to not remove the pipe. You may have to turn the metal rod using pipe wrenches to loosen it before it can be removed. (Figure B & C)

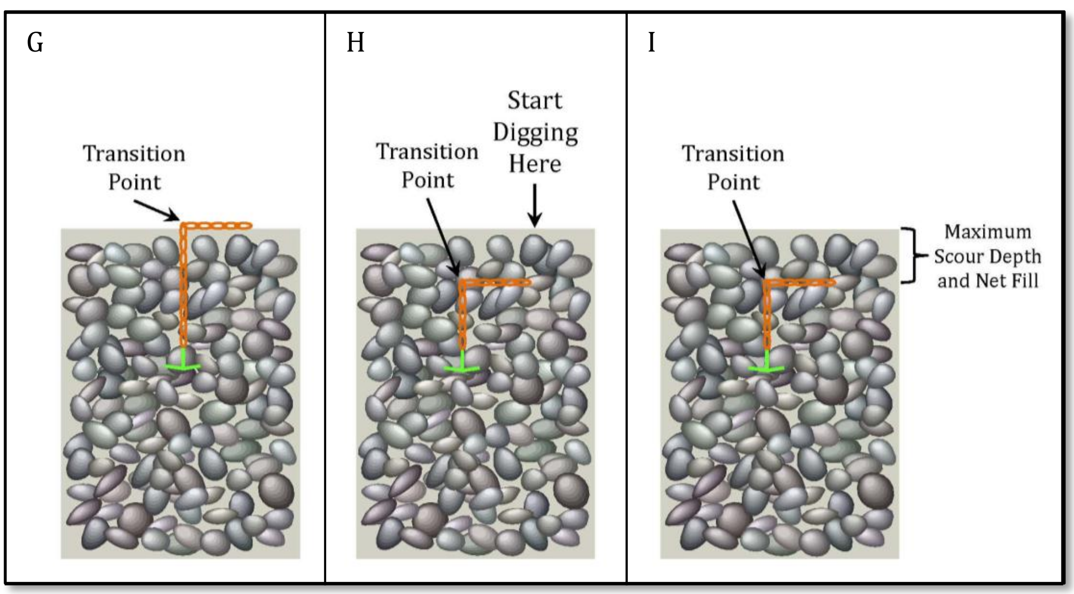
9. Prepare a scour chain anchor with ~2.5-3.0 feet of chain attached to it with the 1/8" quick link connector. Attach fishing line to the end of the chain to allow it to be lowered into the pipe. Count the number of links and record on the datasheet or in the field notebook.
10. Use a small rubber band to hold the two wings of the anchor device together so it will slide down into the pipe. When the anchor wings are held together the anchor is considered "closed" and when the rubber band is removed to allow the wings to spring apart the anchor is considered "open." Tie fishing line on to the rubber band so it can be pulled off and allow the wings to spread and anchor the device.
11. Slowly slide the "closed" anchor down the inside of the pipe (Figure D).
12. Once the anchor is at the bottom of the pipe (make sure by slowly pulling up and dropping the anchor) gently lift the pipe 6-8" upwards. This should allow the "closed" anchor to be exposed to the sediments (Figure E).
13. Pull on the fishing line attached to the rubber band to release the wings and "open" the anchor.
14. Remove the pipe completely making sure to keep holding the fishing line attached to the chain to prevent the chain from falling into the hole.
15. Gently pull up on the chain/fishing line to set the anchor in the sediments. Once the anchor is set you can pull harder to verify it is solidly anchored (Figure F).
16. Count the number of links that are exposed above the river bed and lay chain downstream. Record number of links on the data sheet or in the field notebook (Figure G).
17. Take note of the distance from both the left and right bank control points to the scour chain.
18. Repeat process for the other scour chains to be installed in the set.
19. After all scour chains have been installed conduct a perpendicular channel survey (see below for procedure). Scour chain location accuracy is extremely important for finding each scour chain in the future especially since some chains will be covered by sediments.
20. Also conduct a river discharge measurement at or near the site (see above for procedure).


A
~6'
B
~2'
C
~2'
D
~2'
E
~2'
F
~2'

SCOUR CHAINS SCOUR/FILL MONITORING

This procedure will provide information on how to locate and measure scour chain data. Data collected at each chain will provide information on maximum scour since the last monitoring and net fill since last monitoring.

1. Locate both left and right bank control points.
2. Using a 100' or 200' tape, measure from the control points to the find the scour chain closest to the right bank (you can also start near the left bank if that is more convenient). Note – refer back to installation notes on datasheet or the field notebook to determine the location for each scour chain.
3. Once you have determined the location for the first scour chain, look to see if the chain is exposed. If the chain is not exposed on the river bed it may be buried under the sediments. Carefully and slowly dig just downstream of where the chain was installed. Dig until you find the chain and then slowly work upstream until the chain changes from lying horizontally to vertical. This transition point is the maximum scour depth. (Figure G & H)
4. Measure the vertical distance between the transition point and the river bed surface (see figures below). (Figure I)
5. Count the number of links from the transition point to the end of the chain. This can be used to verify the vertical measurement taken in step 4.
6. Hold scour chain vertically while excavated sediments are replaced.
7. Count the number of links that are exposed above the transition point (on the river bed surface).
8. Place the exposed chain on the river bed surface facing downstream.
9. Repeat process for other scour chains in the set.



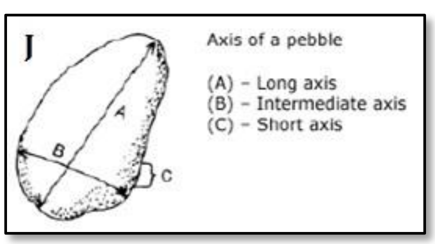
Channel Survey

This procedure provides information for preforming a channel survey for scour/fill within a scour chain set. All changes are relative to the control point(s) established for the scour chain set (see above).

1. Place the laser level in a location where it will be visible when measuring at each scour chain in the set and visible at each control point.
2. Adjust laser as close to level as possible.
3. Turn on laser and allow it to auto level. Once the laser has leveled it should start spinning. If it does not the laser may be tilted too much and cannot level itself – turn the laser off, readjust it and turn it back on to auto level.
4. Stretch a 100' or 200' tape across the channel. Make sure the tape goes directly over each of the control points.
5. Take the stadia rod with the laser sensor attached to the control point on the right bank (you can start on the left bank if that is more convenient). Place the stadia rod on the control point and read the height with the laser sensor. Record laser height value, depth of water and the tape distance on the datasheet or field notebook.
6. Continue measuring height and tape distance values as you move across the channel until you reach the opposite control point. Make sure to capture changes in the river bed as well as important locations such as edge of water, gravel bars, thalweg and each scour chain.
7. Return to the first control point and measure the height and tape distance a second time to verify that the tape or the laser has not moved.

Pebble Counts

1. Select reach of the river for sediment particle size distribution (typically between two closely spaced scour chains sets).
2. Start transect randomly between the scour chain sets by throwing a rock along the stream edge. Take a step into the river, perpendicular to the flow, from that point and pick up the first pebble you touch with your index finger next to your big toe. Avert your eyes to prevent as much bias as possible when pick up pebbles.
3. Measure the intermediate axis (see Figure J below) by determining the smallest hole the pebble will fit through using the gravelometer. For embedded pebbles or those too large to pick up, use the side of the gravelometer to measure the shortest visible axis
4. Record info on the datasheet.
5. Take another step across the river and repeat the steps of picking and measuring pebbles until you reach the opposite bank. Once you reach the opposite bank, throw another rock and start back towards the first bank repeating the steps above.
6. Continue collecting pebble data until you have recorded 100 measurements.



PEBBLE COUNT DATA SHEETS

Data Computation

Inches	PARTICLE	Millimeters		Particle Count	Total #	Item %	% Cum
< 0.08	Sand	< 2	Silt/Clay/Sand				
0.08—0.16	Very Fine	2—4	Gravels				
0.16—0.22	Fine	4—5.7					
0.22—0.31	Fine	5.7—8					
0.31—0.44	Medium	8—11.3					
0.44—0.63	Medium	11.3—16					
0.63—0.89	Coarse	16—22.6					
0.89—1.26	Coarse	22.6—32					
1.26—1.77	Very Coarse	32—45					
1.77—2.5	Very Coarse	45—64					
2.5—3.5	Small	64—90	Cobbles				
3.5—5.0	Small	90—128					
5.0—7.1	Large	128—180					
7.1—10.1	Large	180—256					
10.1—14.3	Small	256—362	Boulders				
14.3—20	Small	362—512					
20—40	Medium	512—1024					
40—80	Large	1024—2048					
80—160	Very Large	2048—4096					
	Bedrock		Bedrock				
			TOTALS				

Walla Walla Basin Watershed Council
www.wwbwc.org
541-938-2170 or 7086 P.O.Box 68, Milton-Freewater, OR 97862

Walla Walla Basin Watershed Council
Pebble Count Datasheet

Date & Time ________ Site Name: ________
Data Collected by: ________ GPS Coord: ________ River/Stream: ________

Data #	Largest Size b-axis will fit through	Data #	Largest Size b-axis will fit through	Data #	Largest Size b-axis will fit through	Data #	Largest Size b-axis will fit through
1		26		51		76	
2		27		52		77	
3		28		53		78	
4		29		54		79	
5		30		55		80	
6		31		56		81	
7		32		57		82	
8		33		58		83	
9		34		59		84	
10		35		60		85	
11		36		61		86	
12		37		62		87	
13		38		63		88	
14		39		64		89	
15		40		65		90	
16		41		66		91	
17		42		67		92	
18		43		68		93	
19		44		69		94	
20		45		70		95	
21		46		71		96	
22		47		72		97	
23		48		73		98	
24		49		74		99	
25		50		75		100	

NOTES:

Seepage Analysis

Seepage analysis protocols are discussed in the Seepage Report (found on the WWBWC website – www.wwbwc.org). The WWBWC performs seepage analyzes on multiple stream systems within the Walla Walla Basin to determine the water budget for each system and to determine gain/loss reaches. The primary measurement procedure used during a seepage analysis is a stream discharge measurement. The procedure described above for stream discharge measurements is used during seepage measurements.

Water Quality Monitoring (Field Measurements)

ODEQ, 2009. Water Monitoring and Assessment Mode of Operations Manual. Watersheds Quality Monitoring Field Sampling Standard Operating Procedure – Laboratory and Environmental Assessment Division. Version 3.2

Water Temperature and Conductivity (YSI-30)

1. Check sensor calibration to NIST thermometer and standard conductivity solution (typically done in the office before field visit). Recalibrate if necessary.
2. Turn the YSI-30 unit on.
3. Make sure units are set to °C for temperature and to µs for conductivity. The °C should blink indicating the YSI-30 is in temperature compensating mode.
4. Gently place the sensor in the water. Make sure that the sensors are completely covered by water. Gently agitate the probe to ensure air bubbles are dislodged.
5. Allow the values to stabilize and then record on the data sheet or field notebook.
6. Replace the sensor in the holder and turn the unit off.

Dissolved Oxygen

1. Connect the dissolved oxygen sensor to the meter.
2. Turn on the Thermo Scientific Orion 5-Star meter.
3. Check sensor calibration (typically done in the office before field visit). Recalibrate if necessary.
4. Make sure units are set correctly for dissolved oxygen (mg/L).
5. Gently place the sensor in the water. Make sure that the sensor is completely covered by the water.
6. Allow the value to stabilize and then record on the data sheet or field notebook.
7. Replace the sensor in the holder and turn the unit off.

pH

1. Connect the pH sensor to the meter.
2. Turn on the Thermo Scientific Orion 5-Star meter.
3. Check sensor calibration using a standard pH solution (typically done in the office before field visit). Recalibrate if necessary.
4. Gently place the sensor in the water. Make sure that the sensor is completely covered by the water.
5. Allow the value to stabilize and then record on the data sheet or field notebook.
6. Replace the sensor in the holder and turn the unit off.

Conductivity

1. Connect the conductivity sensor to the meter.
2. Turn on the Thermo Scientific Orion 5-Star meter.
3. Check sensor calibration using a standard conductivity solution (typically done in the office before field visit). Recalibrate if necessary.
4. Gently place the sensor in the water. Make sure that the sensor is completely covered by the water.
5. Allow the value to stabilize and then record on the data sheet or field notebook.
6. Replace the sensor in the holder and turn the unit off.

Turbidity

1. Turn on the Hach 2100P Turbidimeter.
2. Check sensor calibration using a standard turbidity solution (typically done in the office before field visit). Recalibrate if necessary.
3. Collect water sample in glass vial and wipe clean. Insert the vial into the turbidimeter, cover and read the sample.
4. Record the value on the data sheet or field notebook.
5. Empty the vial and turn on the meter.

Quality Control

Quality Control for Laboratory Measurements

Field duplicates and blanks will be used to ensure quality control for lab samples.

- Field blanks: Once per sampling even a blank sample with known concentrations of the monitored constituent will be included in the samples sent to the analytical laboratory. The field blank will be purchased from a scientific supply vender.
- Field duplicates: Once per sampling event one additional sample will be collected from one of the sites.
- Analytical laboratory will also have internal QA/QC procedures to ensure data validation.

Quality Control for Field Measurements

Field Records

Field notes and other pertinent data associated with the monitoring program will be maintained at the WWBWC office and archived for reference. Completeness of data sheets and chain of custody forms and verifying holding times for samples will also be used for data validation.

Surface Water Monitoring
Surface water monitoring will use the following quality control measures:

- Measure a duplicate discharge measurement on approximately 5% of field visits.
- Field equipment will be maintained and calibrated to ensure proper operation and accuracy.
- Comparison of equipment to other equipment or rated structures (such as flumes, etc).
- Primary and secondary stage height values are referenced to benchmarks to ensure no elevation changes.
- Comparison of primary, secondary and laser level stage height values.

Groundwater Monitoring
Groundwater monitoring will use the following quality control measures:

- Yearly comparison of E-tape measurements against other tapes.
- Duplicate groundwater level measurements during every field visit.
- If available, comparison of manual measurements to other agencies' data.
- Duplicate water sample for groundwater temperature and conductivity at approximately 5% of the sites.

Water Temperature Monitoring
Water temperature monitoring will use the following quality control measures:

- Pre and Post data logger accuracy testing.
- Manual field checks during deployment.

Water Quality Monitoring
Water quality monitoring will use the following quality control measures:

- Field equipment will be maintained and calibrated to ensure proper operation and accuracy.
- Duplicate samples will be taken at approximately 5% of the sites.
- Comparison of field and laboratory values.

Data Management Procedures

Field Notes

In The Field
Data should be recorded on WWBWC datasheets (if available) printed on waterproof paper (Rite-in-the-Rain). Notes should be clearly and legibly written so data and remarks are easily read and interpreted. If a mistake is made, draw a single line through the bad data and record the data next to it. Do not erase or completely mark out mistakes. All datasheets should be completed as fully as possible during data collection.

At The Office

Upon returning to the office scan all datasheets and place a scanned copy on the WWBWC server in the appropriate location and incorporated into the AQUARIUS database. After scanning the datasheets, use them to input the data into the appropriate software (AQUARIUS, Excel, etc.). After all data from the datasheet has been incorporated into the software, place the datasheet in the project's 3-ring binder.

Data Loggers

In The Field

Data loggers should be downloaded during every site visit if practical. Data from the data logger should be downloaded and saved to the field laptop before the data logger file(s) is deleted or restarted to ensure data are not lost. After restarting a data logger take note of when the logger's memory will be full so a site visit can be scheduled before that date. Files should be saved in the following format: type of file (gh = gauge height, mmt = measurement and temp = temperature)_site number_data start date_data end date_downloader's initials. For a surface water example the file format for site S105 with stage data from March 1st, 2012 through July 15th, 2012 and downloaded by Steven Patten would look like: gh_S105_3-1-12_7-15-12_sp. For a groundwater example the file format for site GW_115 with water level (stage) data from May 1st, 2012 through September 29th, 2012 and downloaded by Steven Patten would look like: gh_GW115_5-1-12_9-29-12_sp.

At The Office

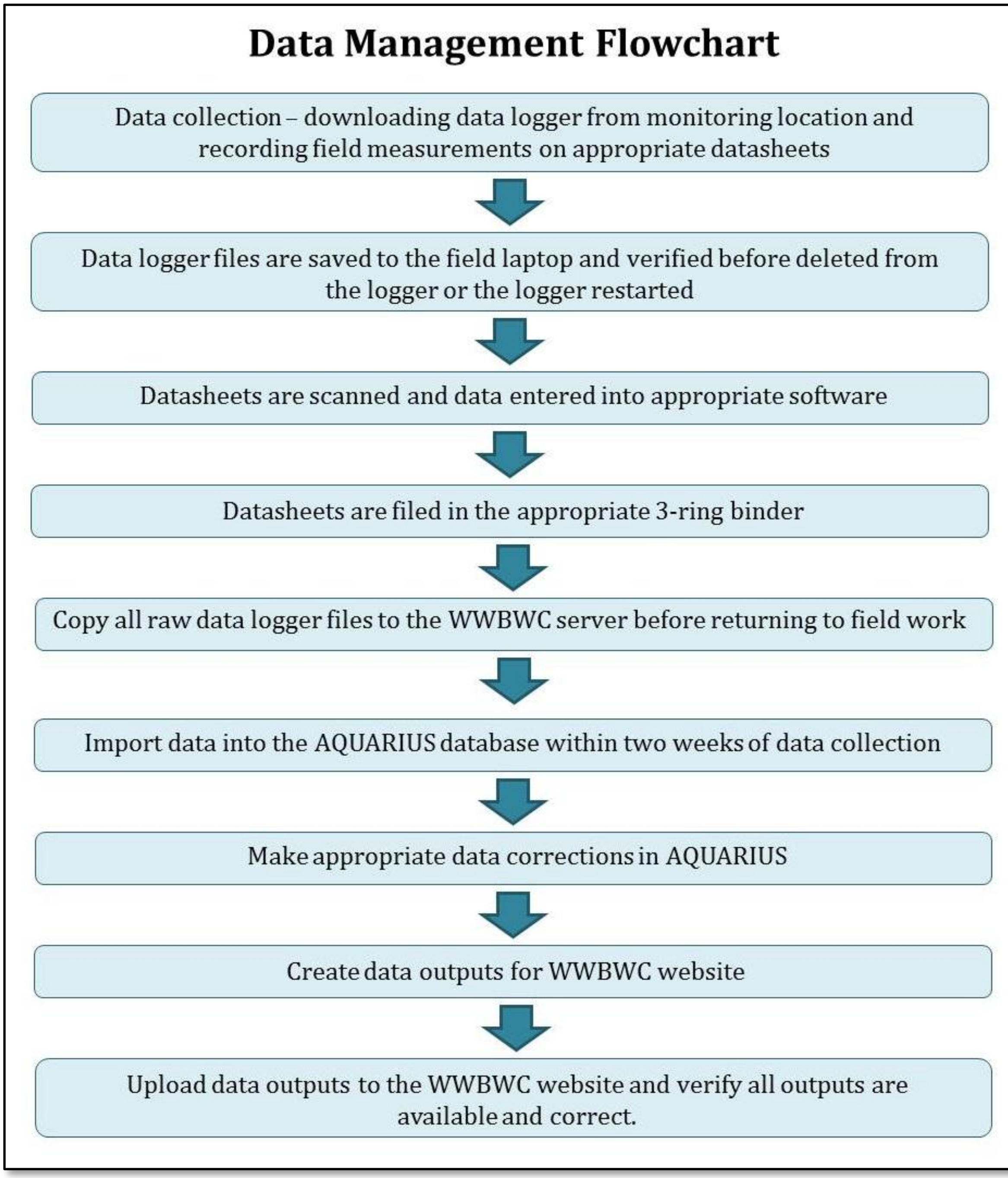
All raw data logger files collected during a day of field work should be transferred to the WWBWC server before going back out in the field to ensure data are not lost due to laptop failure or damage.

Data Input (AQUARIUS)

Data should be incorporated into the AQUARIUS database within two weeks of data collection. Both manually collected data and data logger files should be imported into the AQUARIUS database. After data have been imported, data should be adjusted to account for stage shifts or cable length corrections. For surface monitoring locations, the rating curve should be checked to ensure the new discharge measurement does not indicate a change in the stream channel. If needed, adjust the rating curve with the new discharge measurement. After data are imported and corrected, outputs should be created including a hydrograph (or similar data graph), hourly data set for the entire range of data, and daily average data set for the entire range of data. All data in AQUARIUS should be rated as "unverified" until the end of the water year (Sept 30th) and a review of the entire water year's data can be completed.

Data Access (WWBWC Website)

AQUARIUS data outputs should be uploaded to the WWBWC's website (typically accomplished through Fling software). Verify that all data outputs have been successfully uploaded to the website for public and agency access. Data and information for each surface monitoring location includes: current hydrograph, hourly data set, daily average data set, rating curve, metadata and site photograph. Data and information for each groundwater monitoring location includes: current hydrograph, hourly data set, daily average data set, metadata and manual water level measurements.



Data Security and Backups

All data incorporated into the AQUARIUS database or located on the WWBWC server has redundancy backup (i.e. stored on multiple hard drives through the use of RAID). The WWBWC server and AQUARIUS database are backed-up monthly and stored at the WWBWC office and off-site for additional security.

Data Quality Assessment

Initial Posting of Data/Near-Real Time Data

All data posted to the WWBWC website should be considered provisional unless otherwise stated. Near-real time data from surface gauges and other sites goes through an automated process without constant human oversight. Data discrepancies will be fixed as soon as possible. Until data are reviewed and published (see below) data quality will remain "unverified" or "provisional" and are subject to change. Data may be given an initial estimated data quality (estimated excellent, good, fair or poor) however this quality rating should be considered provisional and subject to change during review.

Data Quality Review

After each water year (typically in October), "unverified" or "provisional" data will be reviewed by WWBWC staff and any necessary changes will be made. After any revisions, data quality will be changed to "published" and a quality grade will be assigned. The published data will be available at the WWBWC's website

Data Quality Rating

Surface Water

Surface water data will be given a quality rating based upon the following factors:

- Rating curve distribution and number of discharge measurements for rating curve development.
- Accuracy of discharge measurements to calculated discharge flow from stage data.
- Site maintenance issues including sediment build-up, vegetation growth, channel migration and other localized influences.
- Accuracy of individual discharge measurements including variation in duplicate discharge measurements.
- Gauge location (e.g. concrete structure, silty channel, or stable stream bed).
- Site manipulation (especially in irrigation canals or ditches).
- Data set completeness.

All stage height measurements will include a margin of error.

GROUNDWATER

Groundwater data will be given a quality rating based upon the following factors:

- Number of manual water level measurements.
- Accuracy of manual water level measurements to cable-length adjusted transducer data.
- Accuracy of manual water level measurements (e.g. cascading well, pumping well, etc.).
- Data set completeness

All manual water level measurements will include a margin of error.

TEMPERATURE

Temperature data will be given a quality rating based upon the following factors:

- Accuracy of data logger's Pre and Post deployment accuracy checks.
- Accuracy of field accuracy checks with thermometer (NIST or YSI-30).
- Data set completeness.