OWEB

WATERSHED RESTORATION
GRANT APPLICATION

Revised
April 2013

OWEB's Mission
To help protect and restore healthy watersheds and natural habitats that support thriving communities and strong economies.

OWEB applications were updated for the April 2013 cycle. All sections of applications must be completed using the April 2013 application forms. Applications submitted using previous forms will not be accepted.

GENERAL INSTRUCTIONS

1. Please read the "Instructions for Completing Restoration Grant Applications" before beginning your application.
2. Please use **8½″ x 11″** paper. A double-sided application and materials are **optional** except for oversized maps and designs or multiple sets for reviewers. All materials included with the application should be **single-spaced** wherever possible, **unstapled and unbound**.
3. Complete Sections I, II and III.
4. Complete the required forms and attachments: Section IV, Attachments A, B, C and D
5. Avoid color, except maps, and detail that will not photocopy clearly (see below*).
6. Read and sign the Restoration Grant Application (Section I Certification).

* **IMPORTANT:** Submit **one COLOR Project Location map** on 8½″ x 11″ paper. This map will be used to track project locations, and color will provide identifying features that are not legible in black and white. **If there are map(s), photo(s) or design(s) that you want the reviewers to see in color, supply 25 copies of each. If more than one map/photo/design is included, assemble and staple as a set; provide 25 sets for distribution to reviewers. This is the only exception to the use of staples.**

SUBMISSION OF GRANT APPLICATIONS

Grant applications may be submitted to OWEB by hard copy via mail or delivery to our Salem office.
No faxes or e-mails will be accepted.

Oregon Watershed Enhancement Board
775 Summer Street NE, Suite 360
Salem OR 97301-1290
Phone: (503) 986-0178

Section I
APPLICANT INFORMATION

Type in the information for Sections I and II.

Name of project: Mud Creek and West LWW Aquifer Recharge and Distributary/Floodplain Function

OWEB funds requested: $339,669.00 **Total cost of project:** $640,737.00

PROJECT LOCATION:

This project occurs in one region only. Region 1 ☐ Region 2 ☐ Region 3 ☐ Region 4 ☐ Region 5 ☐ Region 6 ☒

This project occurs in multiple regions. Check all that apply. Region 1☐ Region 2☐ Region 3☐ Region 4☐ Region 5☐ Region 6☒

This project occurs statewide / in all regions. ☐

This project occurs at (check one): ☐ Site unknown at this time ☐ A single site ☒ Multiple sites

Watershed Name(s)	County or Counties
Walla Walla Watershed	Umatilla

Township, Range, Section(s) (e.g., T1N, R5E, S12)	Longitude, Latitude (e.g., -123.789, 45.613) (required for federal/state reporting)	Watershed code(s) – Please note the 10-digit hydrologic unit code, previously 5th Field HUC
T6N, R35E, Sections 15,21, 22, 30; T5N, R35E, Section 3	45.987, -118.444; 45.992, -118.423; 45.973, -118.430; 45.993, -118.450; 45.941, -118.419	1707010209 & 1707010211

Applicant	Project Manager
Name: Steven Patten	**Name:** Steven Patten
Organization: Walla Walla Basin Watershed Council	**Organization:** Walla Walla Basin Watershed Council
Address: 810 S. Main Street	**Address:** 810 S. Main Street
Milton-Freewater, OR 97862	Milton-Freewater, OR 97862
Phone: 541-938-2170	**Phone:** 541-938-2170
Fax: 541-938-2170	**Fax:** 541-938-2170
Email: steven.patten@wwbwc.org	**Email:** steven.patten@wwbwc.org

Fiscal Agent	Landowner(s)
Name: Chris Sheets	☐ **Public: Agency:**
Organization: Walla Walla Basin Watershed Council	☒ **Private: Name(s):** Richard Young
Address: 810 S. Main Street	Sean Roloff
Milton-Freewater, OR 97862	Don Jackson
Phone: 541-938-2170	Lee Andrews
Fax: 541-938-2170	Monte Thomas
Email: chris.sheets@wwbwc.org	

CERTIFICATION:

I certify that this application is a true and accurate representation of the proposed work for watershed restoration and that I am authorized to sign as the Applicant or Co-Applicant. By the following signature, the Applicant certifies that they are aware of the requirements (***see Application Instructions***) of an OWEB grant and are prepared to implement the project if awarded.

Applicant Signature: [signature] Date: 4-17-13

Print Name: Steven Patten Title: Senior Environmental Scientist

Co-Applicant Signature: ____________ Date: ____________

Print Name: ____________ Agency: ____________

Section II
PROJECT INFORMATION

1. **Abstract.** In approximately 200 words, 1) identify the project location, 2) state the watershed issue or problem to be addressed, 3) the proposed solution including the area or other measurable units to be treated, 4) any proposed effectiveness monitoring, and 5) how OWEB funds will be used.
This project will occur in the Oregon portion of the Walla Walla Watershed. Aquifer recharge will address three issues: declining groundwater levels, reduced spring performance and lack of floodplain function. These issues have been precipitated by a combination of ditch piping, reduced infiltration from irrigation water due to instream minimum flows and increased use in the alluvial aquifer to supplement reduced surface water volumes. Aquifer recharge helps recover groundwater levels leading to increased spring performance and allows water during high flows to be slowed down, diverted into the distributary system and recharge the alluvial aquifer. Aquifer recharge also helps simulate lost floodplain and distributary functions. This grant will install a total of 5 aquifer recharge sites. The sites will be located in the Little Walla Walla River, Mud Creek and Dugger Creek areas (see Figure 1). OWEB funding will be used for pre-implementation & project management, site characterization, project designs, construction of the recharge sites and construction of monitoring wells. Currently the alluvial aquifer is losing approximately 8,000-9,000 acre-feet a year. The aquifer recharge program's goal is to replace this volume of water and start to build a surplus each year to restore spring flows, reduce seepage lose and increase groundwater returns to steelhead/salmon streams and rivers.

2. **Has this project or any element of this project, ever been submitted in a previous application(s) to OWEB?** ☐ Yes ☒ No

   If yes, what was the application number(s)?

3. **Is this project, or any element of this project, a continuation of a previously funded OWEB restoration project(s)?** ☒ Yes ☐ No

   If yes, what was the grant number(s)? 203-259, 204-244, 206-934, & 210-6043

4. **Is this project a result of a previously funded OWEB Technical Assistance project(s)?** ☒ Yes ☐ No

   If yes, what was the grant number(s)? 203-259

5. **Does this application propose a grant for a property in which OWEB previously invested funds for purchase of fee title or a conservation easement; or is OWEB currently considering an acquisition grant for this property?** ☐ Yes ☒ No

   If yes, what is the grant number(s)?

6. **Is this project related to a proposed or funded Oregon State Weed Board grant application(s)?** ☐ Yes ☒ No

   If yes, list the month and year, or grant application(s) number, and briefly describe how this project is related to the Weed Board application or grant.

7. **Project Partners.** Show all anticipated funding sources, and indicate the dollar value for cash or in-kind contributions. Be sure to provide a dollar value for each funding source. If the funding source is providing in-kind contributions, briefly describe the nature of the contribution in the Funding Source Column. Check the appropriate box to denote if the funding status is secured or pending. In the Amount/Value Column, provide a total dollar amount or value for each funding source.

Funding Source Name the Partner and what their contribution is.	**Cash**	**In-Kind**	**Secured (x)**	**Pending (x)**	**Amount/Value**

OWEB	$339,669.00	$	☐	☒	$339,669.00
Landowner(s) or other partners: Landowner Land Lease Value	$	$5,000.00	☐	☒	$5,000.00
BPA - 2013	$65,090.00	$	☒	☐	$65,090.00
BPA - 2014	$122,035.00	$	☐	☒	$122,035.00
BPA - 2015	$108,943.00	$	☐	☒	$108,943.00
	$	$	☒	☐	$
	$	$	☐	☐	$
	$	$	☐	☐	$
	$	$	☐	☐	$
	$	$	☐	☐	$
	$	$	☐	☐	$
	$	$	☐	☐	$
Total Estimated Funds (add all amounts in the far-right Column):					*$640,737

* The total should equal the total cost of the project on page 1 of the application.

8. Have any conditions been placed on other funds that may affect completion? ☐ Yes ☒ No

If yes, explain:

9. Are you requesting OWEB funds for Effectiveness Monitoring? ☒ Yes ☐ No

<u>If you check "Yes", follow the instructions in Question R17</u>

10. Are you requesting OWEB funds for Plant Establishment? ☐ Yes ☒ No

<u>If you check "Yes", follow the instructions in Question R18</u>

Section III
SPECIFIC RESTORATION PROJECT ACTIVITY

These essay questions and their answers are designed to guide you and reviewers through a logical process of understanding and identifying the problem to "fixing" the problem and measuring for success. **Refer to the Application Instructions for clarification and helpful examples.**

You may use the application form to respond to the questions, using additional sheets of paper as necessary **OR** answer the questions on separate pages. Be sure to include the question numbers and text of the questions before you begin typing your answers to assist the reviewers in evaluating your application.

Use 8½″ x 11″ paper. A double-sided application and materials are **optional** except for oversize maps and designs or multiple sets for reviewers. All materials should be **single-spaced** wherever possible, **unstapled** and **unbound**, except for sets of maps/photos/designs (see Page 1 of the application instructions for assembling multiples for reviewers). Use a 11-pt type size to answer the questions and a 10-pt type size for the tables. Use bullets where appropriate. Use **bold face** and *italics* for emphasis only. Do not use color highlights for text emphasis or in tables as the highlight turns black when the application is scanned. If the project involves multiple sites, be specific for each. If the question is in parts (e.g., "a" and "b"), make sure you answer in parts. **Refer to the Application Instructions for clarification and helpful examples.**

R1. Contextual Overview

Provide the location and significance of the project including why that location was chosen and a brief explanation of the history of the issues leading to the project. Describe the project in the context of the landscape including the key water quality, water quantity, species, habitat, land use and resource management issues (physical or social) that are proposed to be addressed in that watershed. **See the Application Instructions for clarification.**

The Walla Walla Basin alluvial aquifer (alluvial aquifer) is located primarily in the Walla Walla Valley northwest of Milton-Freewater, OR and southeast of Walla Walla, WA. The alluvial aquifer is highly connected with the surface water system. The alluvial aquifer starts where two of the major stream systems (Walla Walla River and Mill Creek) leave their mountain canyons and emerge onto the valley floor.

Two hundred years ago, the Walla Walla Basin had healthy populations of salmon, steelhead and bull trout. The Walla Walla River flowed from its headwaters in the Blue Mountains into the Walla Walla Valley and then spread out into a distributary network that delivered winter and spring flows out across the valley floor. This distributary network provided off-channel habitat for fish and other wildlife, but also allowed for a significant amount of water to seep into the soil and recharge the valley's alluvial aquifer system. The alluvial aquifer supplied water to the dozens of springs that emerge on the valley floor and provided cold water returns to the river during summer months, cooling the river and maintaining baseflows.

Through the process of agricultural and urban development, the hydrology of the Walla Walla Basin has been altered from a system that supported diverse wildlife and plants to a system nearly devoid of salmon, reduced populations of steelhead, bull trout and many plant species. By the mid to late 1990s, streams in the Walla Walla Basin had dry reaches during portions of late summer and early autumn, the alluvial aquifer was experiencing significant water level declines, and two fish species (steelhead and bull trout) were listed as threatened under the Endangered Species Act. Irrigators, fishery agencies, the Walla Walla Basin Watershed Council (WWBWC) and many concerned citizens stepped up to address these problems. One of the solutions these parties agreed to was the decision to reduce irrigation withdrawals from the Walla Walla River by 25 cubic feet per second (cfs). This agreement created a wet river from the headwaters to mouth for the first time in a number of years, rehydrating formerly dry reaches of the Walla Walla River in the summer. Irrigators gave up portions of their water rights to leave water instream, creating a flowing river from headwaters to mouth.

To help reduced irrigation water go farther, irrigation efficiency projects were initiated across the valley. Ditches were piped, fields that were flood irrigated were switched to sprinklers and diversion structures were updated to allow for efficient delivery and transfer of water across the valley. However, leaving water in river only fixed a portion of the water problems – the alluvial aquifer issues were not being addressed. The declining aquifer has caused problems for the surface water system throughout the valley. Spring creeks across the valley started to decline and, in some cases, went completely dry. Overtime, groundwater levels have dropped below the mainstem Walla Walla River in portions of the valley – causing increased seepage loses. This causes a significant amount, sometimes up to half or more of the water in the river, to soak into the ground. Fixing the water problems in the Walla Walla Basin needs to address more than just surface water left instream. To address that point, in 2004, the WWBWC partnered with the Hudson Bay Ditch Improvement Company (HBDIC) to develop the first alluvial aquifer recharge site in the Walla Walla Valley. The purpose of this aquifer recharge was to simulate the processes of the historic distributary network by allowing winter and spring river water to be spread out across the valley and recharge the alluvial aquifer.

R2. Problems to be Addressed

Provide information specific to the project: a) The specific problem(s) you are addressing; and b) the *root* cause(s) of the problem(s). **DO NOT describe the project here; you will do so in question #R3.** You may add narrative in addition to the table.

Specific Problem(s)	Root Cause(s) of the Problem
Declining water levels in the alluvial aquifer	Declining groundwater levels have been caused by three main changes to the Walla Walla Valley's hydrology: reduction in floodplain function, increased groundwater pumping and management changes to the distributary system. 1 – Reduction in floodplain functions and processes because of constructed flood control devices and development along rivers and streams. A flood control levee was built along the Walla Walla River in the early 1950s. This levee constrained the river preventing meanders and floods that are typical of a natural river system. These lost functions have decreased the amount of recharge that occurs during winter and spring high flow events. The levee prevents flood water from access the river's floodplain where water could slow down and infiltrate into the ground and recharge the alluvial aquifer. The levee also straightened the river reducing floodplain processes and allowed water to rush out of the valley much faster than before the levee was constructed. The straightening and confining of the river has increased water velocities leading to increased scour and erosion. These higher velocities have down-cut the river more than 10 feet in the Tum-a-Lum reach resulting in reduced recharge from the mainstem river. 2 – Development of groundwater resources has led to significant declines in the alluvial aquifer. Irrigation and domestic well use has steadily increased over the last hundred years. Further development of groundwater resources occurred after the 2000 agreement to leave 25 cfs of irrigation water in the Walla Walla River. Many irrigators drilled supplemental wells to supply water if their surface water rights did not met their water needs. 3 – The historical distributary system has been converted into the modern day irrigation system. Historically winter and spring flows would have spread across the Walla Walla River's floodplain and a portion of the flow would be distributed into smaller streams and creeks that meandered across the valley floor. This distributary system provided large amounts of recharge to the alluvial aquifer through infiltration and seepage lose. Many of these distributary channels where co-opted for irrigation use. Eventually the distributary channels were straightened and head gates were installed to manage how much and when water was diverted from the river. Over the last 10-12 years, many of these irrigation ditches have been piped to increase delivery efficiency reducing important fall, winter and spring recharge to the alluvial aquifer.
Declining (or dry) spring flows	The root cause for declining or dry spring flows is groundwater level declines. Walla Walla Valley springs are feed from the alluvial aquifer. As the aquifer levels decline spring performance declines or stops. See above for the root causes of groundwater level declines.
Seepage lose in streams and creeks	The root cause of seepage lose in streams and creeks are groundwater declines in the alluvial aquifer. As groundwater levels drop, the gradient between the surface water and groundwater steepens, increasing rates and areas of seepage

	lose. See above for the root causes of groundwater level declines.
Decreases in groundwater and surface water quality	The root cause of decreasing groundwater quality is reduced volume of new water being recharged to the alluvial aquifer. As less water is recharged to the aquifer and groundwater levels decline, concentrations of organic compounds, fertilizers and other potential contaminants will likely increase because of reduced dilution by recharge water. The root cause of surface water quality degradation is reduction in flow from irrigation withdrawals and reduced spring flows and groundwater returns to rivers and streams. Springs and groundwater returns historically cooled the streams and rivers in the Walla Walla Valley, however with declining groundwater levels springs are not performing as well and groundwater returns to streams and rivers has been reduced.
Low flow in rivers, streams and creeks	The two root causes of low flow are irrigation withdrawals and seepage lose from rivers and streams. Irrigation withdrawals are the main cause for low flow conditions in the Walla Walla River. The water that is bypassed by irrigators is reduced through seepage lose creating even lower flows in rivers and streams.

R3. Project Description

Using the table below, provide a description of the project that describes the restoration activities to occur (e.g., direct flow, remove 36″ culvert, construct free spanning bridge, place 12 three log clusters between RM 44 and 52, etc.), including a description of the methodologies (e.g., juniper – burning or cutting; tree release – manual or herbicide; etc.) and the equipment planned for use. In addition, describe any Project Management functions/ activities necessary to implement the project (e.g., acquire permits or landowner approval; solicit bids, award contracts, etc.). The degree of detail should match the project complexity and technical difficulty to allow for full evaluation of technical viability. For projects involving multiple sites, be sure to identify and describe them separately, as appropriate. **<u>This is not the place to describe the benefits of the project,</u> but rather the specific elements of the proposed project.** You may add narrative in addition to the table.

Project Element	Proposed Action
Restoration Activity	
Survey – Data Collection and map development	▪ Collect detailed topographic information with survey equipment. If available use existing Lidar data for project location (WWBWC) ▪ Generate topographic maps for design concepts and development ▪ Develop maps of water delivery and point of diversion
Hydrogeology Characterization	▪ Geology investigation to determine stratigraphy (e.g. depth to gravel layers or extent of gravel layers) ▪ Depth to water modeling using groundwater data for estimation of project performance, project mounding and downgradient responses ▪ Groundwater level changes throughout the year: yearly highs and lows ▪ Approval of Hydrogeology characterization by a license geologist/hydrogeologist
Initial Design Development	▪ Work with licensed engineer to develop initial recharge site designs ▪ Establish water delivery pathway ▪ Develop water diversion system including screening or filtering if needed ▪ Size project for appropriate volume of water as determined by the hydrogeo analysis
Final Design Development	▪ Revise initial designs to address any concerns by the landowner, hydrogeologist or project lead ▪ Create stamped designs
Construct Recharge Site	▪ Mobilize contractor and equipment to the site ▪ Excavate site for infiltration basin or infiltration gallery as needed ▪ Work with landowner to coordinate construction activities to minimize disruptions ▪ Install all required monitoring structures (minus wells) to meet requirements of the limited license water right
Drill Monitoring Wells	▪ Locate wells with feedback from ODEQ and OWRD to meet limited license and water quality monitoring requirements ▪ Work with landowners to obtain easements for the monitoring wells ▪ Solicit bids from drilling contractors ▪ Mobilize drill rigs and drill monitoring wells ▪ Deploy monitoring devices into the monitoring wells to meet limited license and water

	quality monitoring requirements.
Project Management Activity	
Landowner outreach and approval & Project Concepts	▪ Contact landowners for initial conversation of exact placement of recharge site ▪ Determine approximate size of recharge site ▪ Discuss aquifer recharge design options ▪ Discuss water delivery options ▪ Develop and sign landowner agreement that describes responsibilities and the project timeline
Finalize Designs with Landowner	▪ Discuss preliminary designs with landowner to determine any changes needed ▪ Work with landowner and engineer to finalize project designs
Develop Monitoring Plan for project	▪ Start conversation with ODEQ and OWRD on needs for monitoring plan ▪ Write draft monitoring plan including source water volume monitoring, groundwater level monitoring, source & groundwater water quality monitoring and annual reporting. Send draft plan to project partners, ODEQ and OWRD for review ▪ Write hydrogeological analysis for each site (working with consultants as needed) ▪ Incorporate comments from partners, ODEQ and OWRD into monitoring plan ▪ Resubmit monitoring plan for review ▪ Finalize monitoring plan for recharge site and get stamped by hydrogeologist
Develop Limited License Application for project	▪ Fill out OWRD application (work with the local water master as needed) ▪ Write hydrogeological analysis for each site (working with consultants as needed) ▪ Describe point of diversion and delivery system for each recharge site ▪ Provide supporting documentation as needed ▪ Revise documents as requested by OWRD and get stamped by hydrogeologist
Develop Operations Plan with Irrigation District	▪ Collect and organize existing water use information ▪ Work with irrigation district or watermaster to develop water delivery operations plan ▪ Ensure operations plan accounts for existing water use to prevent conflicts
Solicit bids and select Contractor	▪ Create request for bids with final designs ▪ Send request to at least 3 qualified contractors (unless work is being done by the irrigation district) ▪ Select contractor based upon bid price and experience
Supervise site construction activities	▪ Coordinate construction activities between contractor, landowner and irrigation district ▪ Document construction activities ▪ Ensure project is installed according to final designs

Note: The activities described above apply to each of the five recharge sites proposed in this application. Depending upon site location and work done for previous recharge sites, some steps may be skipped because the information is already available.

R4. Project Objectives

What are the proposed project objectives? Provide specific objectives based on the location, size and significance of the project and provide information on how the objectives could be evaluated. The measurements should be able to be reported to document successful implementation. **See the Application Instructions for the distinction between project objectives and achievement of goals.**

Project Element	Specific Objectives	Measure for Evaluation
Final Project Designs	Create engineered designs for each site	Design are included in report
Aquifer Recharge Site Construction	Install 5 recharge sites	Sites are constructed
Operate Recharge sites	Recharge approximately 200-300 acre-feet at each of the 5 sites	Measure water volume delivered to each site
Obtain Limited License for site operations	Obtain limited license to operate aquifer recharge sites	Whether the limited license is issued
Develop Monitoring Plan	Measure water volumes, water quality and direction of recharge water migration	Measurement of water volume delivered to each site, lab analysis of

		water quality samples and groundwater level and temperature monitoring

R5. Project Design

a) Provide a list of qualifications and experience you will require for the project designer. If a project design has been completed, identify the designer and what qualifications and experience they have.

The projects will require experience and skills in aquifer recharge, geology, hydrology, hydrogeology and water delivery including diversion structures and pipe sizing.

Steven Patten, *Senior Environmental Scientist* , *WWBWC*– Aquifer Recharge Program Lead

- M.S. in Biology
- 3 1/2 years of experience building, operating and monitoring aquifer recharge projects in the Walla Walla Basin
- Has supervised the construction of two aquifer recharge sites in Oregon and the expansion of a third site

John Fazio, *Registered Engineer, Fazio Engineering* – Aquifer Recharge site designs

- Registered Engineer in Oregon
- Created designs for a previous aquifer recharge site in Oregon
- Experience with water delivery and water infiltration

Kevin Lindsey, *Senior Hydrogeologist, GSI Water Solutions* – Hydrogeologist

- PhD in geology and License Geologist and Hydrogeologist
- More than 20 years of experience in geology and hydrogeology
- Has helped develop 8 aquifer recharge projects (some operating and some still in construction)

Additional Engineers – Aquifer recharge site designs

- Registered engineer in Oregon
- Previous experience with water delivery and infiltration projects

b) Describe the design criteria used or proposed and how those criteria take into consideration natural events and conditions (e.g., culvert design to 100-year flood event, wood placement to readjust with higher than bankfull flows, cultivation to retain at least 75% stubble, 4-strand fence to allow for wildlife passage, etc.).

Projects will be designed to accommodate excess water delivery to prevent flooding caused by rapid changes in the delivery system (e.g. user stops diverting water from irrigation ditch upstream of project). Project will be developed within managed systems behind headgates that control the amount of water diverted down the irrigation system. Sites will be designed to be cleaned out for high turbidity events. Infiltration basins will be scrapped to break up sediment layers. Infiltration galleries will be built with flush valves to remove sediments that settle in the pipes.

R6. Design Alternatives

Were alternative designs or solutions considered? (check one) ☒ **Yes** ☐ **No**

If yes, explain why the design or approach proposed was chosen. If no, explain why alternative approaches were not explored.

Multiple Site Designs

Multiple site concepts will be discussed (infiltration basins, infiltration galleries or field recharge) with the landowner. Based upon site constraints, landowner preference and potential liabilities (e.g. infiltration basin flooding without overflow capability) a site design will be chosen.

No Action

Groundwater levels continue to decline precipitating further reduction in spring flow performance across the valley and increased amounts of seepage lose in rivers, streams, springs-creeks and ditches/canals. Seepage rates in the mainstem Walla Walla River may increase leading to reduced river flows in the summer and fall months (current seepage rates can claim 50% or more of the river water in certain reaches of the river). River water temperatures could increase from their already high levels during summer and early fall low flow months. Piping of irrigation ditches and canals (some of which are old distributary channels) will reduce the amount of recharge to the alluvial aquifer, worsening current trends. Continued usage of groundwater resources will cause additional groundwater declines (potentially to the point of OWRD creating a critical groundwater area designation similar to the Hermiston area).

R7. Proposed Project Schedule

Use the table below to show the anticipated schedule for the project. Add or change the list of project elements to fit your project. **See the Application Instructions for clarification and an example.**

Project Elements	Start Date	End Date	Description
Pre-Implementation			
Permit Applications (Limited License and Monitoring Plan)	January 2014	December 2014	Work with hydrogeologist, OWRD and ODEQ to develop limited license application and monitoring plan for aquifer recharge sites
Project Designs and water delivery	January 2014	March 2015	Work with engineers and hydrogeologist to develop recharge designs for five sites
Bid Solicitation	March 2014	September 2015	After designs are completed for each project, bids will be solicited for site construction
Contracting	March 2014	September 2015	Contractor will be selected for construction of each site
Implementation			
Construction	June 2014	November 2015	Five aquifer recharge sites will be constructed
Project Inspection	June 2014	November 2015	Projects will be inspected to verify designs were followed.
Post-Implementaiton			
Project Maintenance	June/July 2014	Indefinite or until limited license ends	Projects will be maintained as long as the site holds a limited license
Project Reporting	February 2015	Project Completion	Annual reports will be created for OWRD and OWEB to track projects (including water volumes delivered and monitoring activities)
Project Completed		December 2015	Five aquifer recharge sites constructed and final report written

R8. Salmon/Steelhead Populations Targeted and Expected Benefits to Salmon/Steelhead

The information provided will be used by OWEB to better meet federal and state reporting requirements. Completion of this section is required but will not be used to evaluate this application for funding.

☐ This project is **NOT** specifically designed to benefit salmon or steelhead.

► **If you check this box, STOP here and GO TO Question R9.**

Targeted Salmon/Steelhead Populations: Select one or more of the salmon ESUs (Evolutionary Significant Unit) or steelhead DPSs (Distinct Population Segment) that the project will address/benefit. For species where the ESU/DPS name is not known or determined, use the species name with unidentified ESU (e.g., Chinook salmon – unidentified ESU). Additional information on the designation and location of the salmon/steelhead populations can be found at http://www.nwr.noaa.gov/ESA-Salmon-Listings/Salmon-Populations/Maps/Index.cfm.

Chinook Salmon (*Oncorhynchus tshawytscha*)		**Coho Salmon** (*O. kisutch*)	
☐	Deschutes River summer/fall-run ESU	☐	Lower Columbia River ESU
☐	Lower Columbia River ESU	☐	Oregon Coast ESU
☒	Mid-Columbia River spring-run ESU	☐	Southern Oregon/Northern California ESU
☐	Oregon Coast ESU	☐	unidentified ESU
☐	Snake River Fall-run ESU	**Steelhead** (*O. mykiss*)	
☐	Snake River Spring/Summer-run ESU	☐	Klamath Mountains Province DPS
☐	Southern Oregon and Northern California Coastal ESU	☐	Lower Columbia River DPS
☐	Upper Klamath-Trinity Rivers ESU	☒	Middle Columbia River DPS
☐	Upper Willamette River ESU	☐	Oregon Coast DPS
☐	unidentified ESU	☐	Snake River Basin DPS
Chum Salmon (*O. keta*)		☐	Washington Coast DPS (SW Washington)
☐	Columbia River ESU	☐	Upper Willamette River DPS
☐	Pacific Coast ESU	☐	Steelhead/Trout unidentified DPS
☐	unidentified ESU		

Expected Benefits: Write a brief description of the goals and purpose of the project and how it is expected to benefit salmon/steelhead or salmon/steelhead habitat. This answer should be no longer than 2000 characters, which is approximately 330 words. **See Application Instructions for examples and ideas on how to calculate the number of words or characters in your answer.**

The primary goal of the Aquifer Recharge Program is to recover groundwater levels in the alluvial aquifer that is highly connected to the surface water system throughout the valley. Recovering groundwater levels will reduce seepage lose in and increase groundwater returns to steelhead and salmon rivers and streams creating increased instream flows for fish. Increased groundwater levels will increase groundwater returns to rivers and streams which will increase flows as well as provide cool clean water to reduce water temperatures. Groundwater also feeds springs that provide important off-channel habitat for rearing and migrating fish. Recovering groundwater levels will also potentially provide a sustainable water resource than can be utilized in place of diverting as much river water. Aquifer recharge can be used to simulate lost floodplain functionality within the levee reach of the river helping to create a more functional hydrologic cycle in the Walla Walla Watershed. Allowing water to be distributed and spread across the valley will simulate how the historic distributary system would provide recharge to the alluvial aquifer through channel and floodplain infiltration. This system slowed water down and letting it infiltrate into the aquifer and then, later in the year, reemerge as either spring flow or groundwater returns to the rivers and streams. Currently, it is estimated that the alluvial aquifer is declining by approximately 8-9,000 acre-feet each year. If this trend continues, seepage loses seen in many of the valley's rivers and streams can be expected to continue or worsen and spring flow performance can be expected to continue to decline. Aquifer recharge can help restore natural processes and start to reduce the water deficient in the alluvial aquifer and eventually start to create a surplus of water going into the alluvial aquifer each year. Unless the alluvial aquifer is restored, the highly connected surface water system will continue to lose large amounts of water to the aquifer. Aquifer recharge is a key component in improving water resources in the Walla Walla Watershed.

R9. Project Relationship to Regional Priorities

If the project specifically implements a plan or larger conservation effort, identify the effort and the specific role of this project. Explain whether the project implements a regional plan (e.g., ESA Recovery Plan, Coastal Coho Assessment, NWPCC Subbasin Plan, Groundwater Management Area). Specifically identify the relationship between the proposed project and the OWEB Basin Priorities. Priorities can be found on the OWEB website at: www.oregon.gov/OWEB/restoration_priorities.shtml. **(See the Application Instructions for helpful links to various regional plans.)**

NOTE: the OWEB basin priorities link for the Walla Walla Basin is broken.

One of the major regional priorities is to reestablish instream flows and to restore a natural hydrograph. See the bullets below for where aquifer recharge is mentioned in regional and basin plans. As explained above and below, surface flows cannot be "fixed" until the highly connected alluvial aquifer system is also fixed.

Walla Walla Subbasin Plan – May 2004.

- Strategy MC7.1.9 – "Evaluate and implement shallow aquifer recharge programs, where appropriate" to increase summer flows. (Page 160)
- Development of off-stream water resources including "shallow aquifer recharge" (Page 171)
- Spring Source/Distributary System – "develop…shallow aquifer recharge…and pursue projects that measurably enhance flow to the Little Walla Walla system" (Page 178)

ODFW Mid-Columbia Steelhead Recovery Plan - 2008

- Use shallow aquifer recharge as an Action item to restore natural hydrograph function (Page 9-173)

Little Walla Walla Assessment and Initial Action Plan – WWBWC 2010

- Shallow aquifer recharge is listed as a recommended action

Walla Walla Basin Aquifer Recharge Strategic Plan – WWBWC 2013

- Describes existing aquifer recharge projects, future projects and describes goals, objectives and actions for the aquifer recharge program.
- Available at: http://wwbwc.org/images/pdf/Reports/RechargeStrategy_FINAL_1-29-13_sp.pdf

R10. List each component or activity of the project that requires a permit(s) and/or license(s) from a local, state or federal agency or governing body.

Use the table provided to list the activities and permit(s)/license(s) including the entity issuing the permit(s)/license(s). Every project will vary in the number and types of permits and licenses needed. In Column 1 and in separate rows, list the project activities requiring a permit or license. In Column 2, provide the name of the permit or license. In Column 3, provide the name of the entity issuing the permit or license. **See Application Instructions pages 10-12 for clarification and examples before completing the table.**

Project Activity Requiring a Permit/License	Permit or License Name	Entity Issuing Permit or License
Aquifer Recharge Operations	Limited License (water right)	OWRD
Aquifer Recharge Water Quality and Quantity Monitoring	Water Quality Monitoring Plan (a requirement for the Limited License)	ODEQ
Infiltration Gallery Operations	Underground Injection Control permit	ODEQ

R11. Project Relationship to Watershed Processes and Functions

The restoration and protection of natural watershed process is the foundation of achieving watershed health. Since natural watershed processes have been eliminated, altered or reduced in many areas, habitat restoration activities are the primary method for reintroducing the necessary functions to watersheds that have been altered due to past management practices and/or disturbance events. Restoration activities are intended to address the watershed functions necessary to support natural processes that are indicative of healthy watersheds. This includes, but is not limited to improving water quality, water quantity, habitat complexity, flood plain interaction, vegetation structure, and species diversity.

OWEB wants to be able to track how restoration projects are addressing watershed process and function. Please check all the boxes below that apply to your restoration project. You may add narrative in addition to checking the boxes.

	Project Element	Narrative
☐	Stream complexity	
☐	Riparian vegetation structure	
☐	Species diversity	
☐	Vegetative ground cover	
☒	Floodplain connectivity	The Walla Walla River has been disconnected from its floodplain through the construction of flood control levees and development along rivers and streams. The aquifer recharge program simulates floodplain processes such as recharge to the alluvial and distributary channel activation that cannot occur because of the levees. These processes help restore spring flows and groundwater returns to the river.
☐	Species migration patterns	
☐	Sediment transport	
☐	Nutrient cycling	
☒	Water quality	Aquifer recharge projects help improve surface water and groundwater quality. A large volume of clean, fresh water is recharged to the alluvial aquifer each recharge season. This recharge water typically has better water quality then what is found in the groundwater. Additionally, as the recharge water migrates through the sediments there is additional cleaning and breakdown of contaminants further improving water quality. Surface water quality is improved through groundwater inputs to the river or to springs which leads to reduced temperatures and increased flow.
☒	Water quantity	Aquifer recharge projects help improve water quantity in both the alluvial aquifer and the surface water system. Groundwater levels are improved through storage building from one recharge season to the next. The surface water system has increased flows because of groundwater returns directly to the rivers and streams or through spring discharge.
☒	Water storage	Approximately 400,000 to 500,000 acre-feet of water pass through the Walla Walla Basin each year. Approximately 1/3 of this water would be needed to satisfy plant demand (crops and riparian). However, most of the demand occurs during the summer and fall when surface water supplies are low. Aquifer recharge takes water during winter and spring high flows and puts it into the ground to slow the water down and keep it in the basin. Later, this water can either emerge as spring flow, return to the river through groundwater returns or be utilized through well pumping to reduce surface water demand. The alluvial aquifer is basically a large underground reservoir that can be used to store water during time of plentiful water and be utilized during periods of water scarcity.
☒	Hydrologic cycle	The historic hydrologic cycle in the valley included large amounts of recharge to the alluvial aquifer during winter and spring high flows that were distributed across the valley floor. As water spreads out through the distributary system a portion of it would infiltrate into the alluvial aquifer. This cycle has been broken through the development of flood control levees and headgates on diversions. The distributary system has been co-opted for irrigation use and is now managed for irrigation demands primarily during the summer and fall. Aquifer recharge helps simulate the historic hydrologic cycle and processes of floodplain function, distributary activation and storage of water during the winter and spring that would then reemerge during the summer and fall. Aquifer recharge helps to reestablish a more natural hydrologic cycle.
☒	Other (please describe)	Distributary Activation – Historically when the Walla Walla River and its tributaries would flood large amounts of water would spread across the gravelly soil and infiltrate the alluvial aquifer. Flood control levees and head gates now prevent this natural process from occurring. Aquifer recharge can simulate this process by reactivating many of the historic distributary channels (now irrigation ditches) that serve as the delivery system for recharge sites.

R12. Other Related Conservation Actions

a) Explain how the project complements other efforts under way or completed in the watershed. Identify other restoration, technical assistance, monitoring, assessment or outreach projects, conservation actions and ecological protection efforts in the watershed and explain how this project relates to those actions.

This project proposes to install 5 aquifer recharge sites to help restore the alluvial aquifer. Aquifer recharge sites are located in areas to help mitigate for ditch piping which has reduced recharge to the alluvial aquifer. In total, over 18 miles of ditches/canals have been piped in the Oregon side of the basin. This piping has allowed irrigators to maintain their crops and leave 25 cfs in the Walla Walla River year-round. However, these projects also have reduced the amount of water recharged to the alluvial aquifer. The aquifer recharge program also contributes water to mitigate for lost seepage from ditches and to simulate floodplain functions.

b) If the project is a continuation of previously completed activities, describe the results of the previous project(s) and identify what you have learned from the implementation of similar project(s).

For a complete overview of the Aquifer Recharge Program, please see the Walla Walla Basin Aquifer Recharge Strategic Plan (http://wwbwc.org/images/pdf/Reports/RechargeStrategy_FINAL_1-29-13_sp.pdf). The overall goal of the aquifer recharge program is to restore groundwater levels to improve surface flows through increased groundwater inputs, reduced seepage loses and improved spring performance. The aquifer is losing 8,000-9,000 acre-feet each year. With the existing sites and what is proposed in this grant application (a total of 12 sites) the aquifer recharge program will be able to recharge approximately 35 cfs. This will equate to 7,000-9,000 acre-feet per year depending upon operational and weather related shut down periods. That puts the program closer to meeting the goal of recovering and restoring the aquifer. As the program moves forward additional sites will be constructed in other key areas (see Figure 2) to increase the amount of recharge each year. According to the strategic plan, approximately 80 cfs of aquifer recharge is needed in the Oregon portion of the basin to overcome and start rebuilding aquifer levels.

This grant proposal is a key component of the Walla Walla Basin Aquifer Recharge Program. This program was started in 2002 with technical assistance funding from OWEB. OWEB has continued to fund aquifer recharge projects (see below). This particular grant focuses on two significant components of the Walla Walla Basin Aquifer Strategic Plan: distributary activation and aquifer recharge for spring-fed tributaries that have steelhead and salmon. First, how these particular sites address distributary activation and recharge for spring-fed tributaries. The sites chosen for this grant application were located in areas to specifically address these issues. The sites were located on spring-fed tributaries (West Little Walla Walla River, Mud Creek and Dugger Creek). In order to get water to these particular sites, the historic distributary channels of the West Little Walla Walla River and Mud Creek will need to be activated during winter months. Therefore, these projects are creating two benefits: direct aquifer recharge at the project site and "passive" recharge (i.e. infiltration through the channel bed) down the entire length of the distributary channels from the diversion to the site. These sites are also located near the spring that feed both Mud Creek and the West Little Walla Walla River – both of which are utilized by steelhead. Both systems also experience low flows and high temperatures during parts of the year. Increasing recharge near the springs for these systems will help increase spring flow performance and provide better habitat (through increase flow and reduced water temperatures) for steelhead and other fish that utilize these systems.

The Walla Walla Basin Aquifer Recharge Program has been active since 2004. The program started with a single aquifer recharge site (the Hulette Johnson site formerly known as the HBDIC site). That site has been expanded to increase the amount of water recharged each season. The current aquifer recharge grant from OWEB (210-6043-7938) helped pay for some of the expansion as well as 6 additional sites. Two of these sites have been constructed and two more are designed and awaiting construction. The final two sites are being designed and will be constructed later this year.

The Hulette Johnson aquifer recharge site recharges approximately 4,000 acre-feet of water from November-May 15th. This site has operated for 9 recharge seasons. This site has been extremely useful in learning about maximizing aquifer recharge in the Walla Walla basin. We have done cost-benefit analysis on four different infiltration gallery designs, constructed multiple different infiltration basin designs to test efficiency and collected data to analysis and improve future aquifer recharge sites. One very important thing we learned from the Hulette Johnson site was we need aquifer recharge sites spaced across the valley to improve aquifer conditions. The Hulette Johnson site only has a regional influence and is affected by the surrounding geology. Thus, building two or three large aquifer recharge sites will not create the aquifer-wide improvement needed to achieve the goals of the program. The program is not building aquifer recharge sites to target specific areas and approximate the amount of water needed in each area to improve groundwater conditions.

The aquifer recharge program has also collected water quality data over the last 9 seasons. The WWBWC worked with Kevin Lindsey, a license hydrogeologist with GSI Water Solutions, to analysis this data to see if aquifer recharge was impacted groundwater quality, either positively or negatively. Below is an excerpt from the GSI report:

Review of the groundwater quality monitoring data collected to-date at the three active AR sites, Hulette Johnson, Locher Road, and Stiller Pond and at the inactive Hall-Wentland site we conclude that while AR operations conducted in the Walla Walla Basin does influence local groundwater quality, this influence should not be construed as degradation. Based on the data reviewed here the basic changes seen include the following:

- *With respect to nutrient type constituents, including nitrate-N, TKN (Total Kjeldahl Nitrogen), phosphate, and ortho-phosphate the groundwater changes we see generally show down gradient declines in constituent concentrations, which we interpret to reflect dilution of groundwater concentrations by AR (aquifer recharge) water.*
- *Other parameters, such as TDS (total dissolved solides), chloride, and EC (electrical conductivity) also commonly show evidence of down gradient reductions through AR sites that we again interpret as evidence of dilution of these parameters in groundwater by AR water.*
- *The SOC (synthetic organic compounds) data available for these sites is interpreted to show that AR operations have essentially no influence on SOC's present in groundwater. Based on what we reviewed SOC detections are sporadic, not systematic, and at very low concentrations. With that observation, we interpret the few detections to result from background conditions reflective of activities other than AR operations.*
- *In addition to these observations, the Hall-Wentland data is instructive as it shows the importance of natural leakage from surface waters (which typically are the same waters these AR sites use for source water) influencing local groundwater chemistry.*

The water quality data collected over several AR seasons from four different sites are interpreted to have not resulted in alluvial aquifer water quality degradation. Field parameters and major ion hydrochemical trends seen in monitoring well data commonly show reduced concentrations, indicating dilution of groundwater concentrations by AR operations. A few anomalies did occur in these trends, but low source water concentrations versus high monitoring well concentrations strongly suggest that AR operations were not the cause of these anomalies. There were no significant SOC detections from any site. Of the SOC detections seen in the data sets, SOC concentrations are low enough to be considered background levels and/or these detections were instances of localized transient introduction to the water table from an unaltered ground surface AR site (specifically HW).

R13. Project Inspection

Identify who will inspect and sign off on the completed project.

Name of Person & Agency/Organization	*Telephone Number*	*Email Address*	*Project Element Inspected*
Steven Patten – Walla Walla Basin Watershed Council	*541-938-2170*	*steven.patten@wwbwc.org*	*Aquifer Recharge Site Construction sign off, submit project completion*

			reports and post-implementation reports
Kevin Lindsey – GSI Water Solutions (hydrogeology consultant)	*509-735-7135*	*KLindsey@gsiws.com*	*Monitoring Well Drilling & Construction*
Jen Woody – OWRD	*503-986-0855*	*Jennifer.l.woody@state.or.us*	*Limited License*
Phil Richerson – ODEQ	*541-278-4604*	*Richerson.Phil@deq.state.or.us*	*Water Quality Monitoring Plan*

R14. Outreach

If your project proposal includes outreach activities (e.g., a site tour for local citizens, landowner meetings, informational materials), please describe the proposed activities and products and why they are necessary for the overall success of the restoration proposal. **See the Application Instructions for clarification of eligible outreach costs.** Regional review teams will evaluate the appropriateness of proposed outreach activities with respect to their necessity for success of the restoration project, budget, and other factors.

This grant does not request any funding for outreach; however the WWBWC does preform outreach activities regarding the aquifer recharge program. Updates are given to the City of Milton-Freewater City Council approximately once a quarter and aquifer recharge updates are included in the quarterly WWBWC newsletter.

R15. Project Maintenance and Reporting

Use the table below to document how the project will be maintained over time. State who will maintain the project. Identify their affiliation and provide contact information. In addition, please indicate who will conduct Post-Implementation Status Reporting following project completion.

Name of Person & Agency/Organization and Addresses	Telephone Number Email Address	What will be done and for how long?
Steven Patten Walla Walla Basin Watershed Council 810 S. Main Street Milton-Freewater, OR 97862	541-938-2170 steven.patten@wwbwc.org	▪ Maintenance, if necessary, may include flushing sediment from infiltration galleries or scraping infiltration basins. Note: Maintenance will be conducted with Hudson Bay District Improvement Company. Projects will be monitoring (see effectiveness monitoring grant) approximately once a week during recharge operations and surrounding surface and groundwater sites approximately every month. ▪ Will conduct post-implementation reporting and reporting to OWRD for the limited license.
Add rows as needed		

R16. Budget Development

There are a number of assumptions used to develop any budget. This does not mean you must provide a line by line description of costs. Use this response to provide a clear understanding of what the budget estimate was based on.

a) Explain how costs were determined for the budget elements. Describe if contractor conversations, past projects or other cost figures were used for each major element of the budget. This is particularly important for lump sum elements in the budget. For project management costs describe the time and activities that would be involved.

Past and current project costs were utilized to determine budgets for aquifer recharge sites. Aquifer recharge sites vary in cost, but the number presented in this budget represents an average cost accounting for small inflation of prices (e.g. pipe costs). The values above are based upon the three completed and two design aquifer recharge projects the WWBWC have worked on. Other budget numbers, such as GSI Water Solutions, were determined from previous projects and estimates current work.

Project management costs and in-house personnel costs include a large variety of tasks.
Pre-Implementation: This will include working with landowners to finalize exact project locations and discuss available site designs. Design concepts will be developed and given to the engineer to create project designs. Discussions with the landowner will include their future plans for the project, ways to deliver water to the recharge site, existing infrastructure and any additional information that will affect the project.

Project Management: This will include development of the Limited License application(s). Our current limited license took approximately 9 months to work through with OWRD and ODEQ. This process involves developing a water quality and water quantity monitoring plan for each site including which water quality parameters need to be tested and on what schedule. Often, there are 2-3 draft versions of the water quality monitoring plan before a final version is accepted by ODEQ. Additionally, OWRD requires mapping, hydrogeology characterization, water delivery system and point of diversion for each site. The document to satisfy ODEQ and OWRD requirements ended up totaling over 530 pages. Project management will also be utilized to solicit and award bid contracts for construction of each of the sites and oversee site construction.
In-House Personnel: This will include time for WWBWC staff to collect required data (including conducting surveys for site designs, mapping for ODEQ & OWRD requirements, hydrogeology analysis, etc.). This will also include time for staff to coordinate with landowners and to get documents signed (such as easements for monitoring wells). In-house personnel will develop initial designs from landowner input and work with the project engineer to create the designs. This time will be utilized working with the engineer(s) and consultants in designing the projects to ensure projects are properly sized for water input, properly designed to ensure safe water delivery (to prevent flooding) and to ensure the project design accounts for the hydrogeology of the location.

b) If there are any unusual cost factors, explain them. For example, if the fencing costs are unusually high because of steep, rocky terrain and unroaded access, this is the place to explain the cost elements on the budget page.

◆ **R17. Effectiveness Monitoring.** If you plan to conduct Effectiveness Monitoring beyond post-implementation status reporting and you are requesting more than $3,500 in OWEB funds to support these EM activities, complete the R17 Effectiveness Monitoring Application Insert, print it out and add after Question R16. See the R17 Effectiveness Monitoring Insert Instructions for clarification.

◆ **R18. Planting Activities.** If you are proposing a Riparian, Upland or Wetland Planting activities and you are requesting more than $3,500 in OWEB funds for planting activities and/or for post-planting activities that are necessary for long-term survival of the plantings, you **must** complete the R18 Planting Activities Insert, print it out and add after Question R17 or R18 as appropriate. Please see the definition of "plant establishment activities" in R18. If you are asking for $3,500 or less, you may answer the questions if you would like the reviewers to have additional information on the planting component of the project. See the R18 Planting Activities Application Insert Instructions for clarification.

projects the WWRWC have worked on. Other control numbers, such as OSI Water Solutions, were engineered [illegible] projects and [illegible] work.

[illegible] This will include working with landowners to finalize exact [illegible] locations and [illegible]. Design drawings will be developed and given to the engineer [illegible]. Discussions with the landowners will [illegible] project [illegible] and any additional [illegible] that will affect the project.

Project Management: This will include development of the [illegible]. [illegible]

[illegible]

10. [illegible]

[illegible]

[illegible]

EFFECTIVENESS MONITORING INSERT
(Question R17
in the Watershed Restoration Grant Application)

Revised
April 2013

OWEB's Mission
To help protect and restore healthy watersheds and natural habitats that support thriving communities and strong economies.

OWEB applications were updated for the April 2013 cycle. All sections of applications must be completed using the April 2013 application forms. Applications submitted using previous forms will not be accepted.

Respond to Question R17 if:

- You plan to conduct Effectiveness Monitoring beyond post-implementation status reporting AND
- You are requesting more than $3,500 in OWEB funds to support Effectiveness Monitoring activities.

1. Please read the "Instructions for Effectiveness Monitoring Insert" before beginning your application.
2. Please use **8½″ x 11″** paper. A double-sided application and materials are **optional** except for oversized maps and designs or multiple sets for reviewers. All materials included with the application should be **single-spaced** wherever possible, **unstapled and unbound**.
3. Avoid color, except maps, and detail that will not photocopy clearly.
4. Complete Sections I, II, and III and insert after Question R16 in the Watershed Restoration Grant Application.

SUBMISSION OF GRANT APPLICATIONS

Grant applications may be submitted to OWEB by hard copy via mail or delivery to our Salem office. No faxes or e-mails will be accepted.

Oregon Watershed Enhancement Board
775 Summer Street NE, Suite 360
Salem OR 97301-1290
Phone: (503) 986-0178

Section I

EFFECTIVENESS MONITORING PROJECT INFORMATION

Complete questions 1 - 5

1. **Is this project a part of a comprehensive monitoring strategy/program?**

☒ **Yes** ☐ **No**

If yes, provide the name of the comprehensive monitoring strategy/program. If this project is not part of a comprehensive monitoring strategy/program, enter NONE below.

WWBWC, 2013, Walla Walla Basin Aquifer Recharge Strategic Plan,Walla Walla Basin Watershed Council (http://wwbwc.org/images/pdf/Reports/RechargeStrategy_FINAL_1-29-13_sp.pdf)

WWBWC, 2013, WWBWC Watershed Monitoring Program Standard Operating Procedures, April 2013, Walla Walla Basin Watershed Council (http://www.wwbwc.org/images/pdf/WWBWC_QAPP.pdf)

Name of document (Author, date, title, source, source address in Endnote citation format)

2. **Are other organizations cooperating with this monitoring project by concurrently conducting field work on other components of a Comprehensive Monitoring Strategy or Program?**

☒ **Yes** ☐ **No**

If yes, identify the number of organizations and list their names:

2 # cooperators

Cooperating Organization Names
OWRD - Groundwater level monitoring data collection
Hudson Bay District Improvement Company - Water delivery monitoring

3. **Report the total stream miles and/or acres that will be monitored under this application.** If monitoring the same location or stream reach multiple times, do not sum the area or length metrics for each monitoring event. For example if the project monitors a 13-mile stream reach twice per year for 3 years, report the metric only as 13 stream miles. If there is more than one type of monitoring and the locations monitored will overlap, report the total miles and/or acres for all types (i.e., do not double count areas of overlap).

~20 miles Total stream miles to be monitored or assessed

~11,000 acres of the alluvial aquifer Total acres to be monitored or assessed

4. **Identify the parameters that will be measured. Check all that apply.**

☐ Adult fish presence/absence/abundance/distribution survey(s)	☐ Riparian vegetation
☐ Juvenile fish presence/absence/abundance/distribution survey(s)	☐ Spawning surveys
☐ Instream habitat surveys	☐ Upland vegetation
☐ Macroinvertebrates	☒ Water quality
☐ Noxious weeds	☒ Water quantity
☐ Other Biological Monitoring (bird counts, amphibian surveys)	☒ Other (explain):_____

4.a) If you checked Water Quality above, exactly which parameters will you be monitoring? Check all that apply.

☐ Bacteria	☒ pH	☒ Temperature
☒ Dissolved oxygen	☒ Pesticides	☒ Toxics
☒ Nitrates	☒ Phosphorus	☒ Turbidity
☐ Heavy metals (name): _____	☒ Nutrients (name): Sulfate, TKN, Orthophosphate	
☒ Other (explain): Electrical Conductivity, TOC, metals		

4.b) If you checked Riparian or Upland Vegetation above, exactly which parameters will you be monitoring? Check all that apply.

☐ Canopy cover	☐ Invasive species presence/absence	☐ Plant survival
☐ Percent cover	☐ Other (explain): _____	

5. What is the format in which the data will be stored? Check all that apply.

☒ Spreadsheet	☒ Database	☒ GIS layers
☒ Other (explain): Data will be exported into spreadsheets for public		

Section II

EFFECTIVENESS MONITORING ACTIVITY INFORMATION

These essay questions and their answers are designed to step you and reviewers through a logical process from understanding and identifying the problem to measuring for success. **Refer to the Instructions for clarification and helpful examples.**

You may use the application form to respond to the questions, using additional sheets of paper as necessary **OR** answer the questions on separate pages. Be sure to include the question numbers and text of the questions before you begin typing your answers to assist the reviewers in evaluating your application.

Use 8½″ x 11″ paper. A double-sided application and materials are **optional** except for oversize maps and designs or multiple sets for reviewers. All materials should be **single-spaced** wherever possible, **unstapled** and **unbound**, except for sets of maps/photos/designs (see page 2 of the Effectiveness Monitoring Instructions for assembling multiple sets for reviewers). Use an 11-pt type size to answer the questions and a 10-pt type size for the tables. Use bullets where appropriate. Do not use color highlights for text emphasis or in tables as the highlight turns black when the application is scanned. Instead, use **bold face** and *italics* for emphasis only. If the project involves multiple sites, be specific for each. If the question is in parts (e.g., "a" and "b"), make sure you answer is in parts.

EM1 What are the project's Effectiveness Monitoring objectives? The Effectiveness Monitoring activities must be directly related to your proposed restoration project. Tie the Effectiveness Monitoring objectives to the watershed restoration project objectives. Provide a specific hypothesis or monitoring question.

There are two primary monitoring objectives in the Walla Walla Basin Aquifer Recharge Program. 1) On-site recharge operations monitoring to document and collect data required by the Limited License permit (water quantity and water quality), 2) Up-gradient and down-gradient surface water and groundwater monitoring to track groundwater and surface water changes due to aquifer recharge operations. This data is also required by the Limited License permit. These data will help inform whether program objectives are being met – to stabilize and restore the alluvial aquifer leading to increased groundwater inputs to the surface water system and reduce surface water lose from seepage.

EM2 What are you proposing to do? Supply sufficient detail to match the Effectiveness Monitoring component's complexity and technical difficulty so that its technical viability can be evaluated.

1 – On-site recharge operations monitoring

A – Surface water monitoring

This will include either a totalizing/rate flow meter and/or an intake structure measured with a stilling well and rated weir structure. Instrumentation for an intake structure will be a pressure transducer in the stilling well (likely to be a Solinst or Campbell Scientific). If needed additional manual measurements will be taken to ensure data accuracy at intakes. This information will be collected, analyzed and converted by WWBWC staff to flow and total recharge volume. This information will be submitted as part of the limited license permit annual report to OWRD/ODEQ.

B – Groundwater monitoring

Recharge sites may have on-site monitoring wells. Monitoring wells can be one of two types: 1 – drilled monitoring wells (dedicated monitoring wells) or 2 – shallow piezometer either pounded in or excavated. Each groundwater site will be monitored with a pressure transducer (likely to be a Solinst for Campbell Scientific). Manual water level measurements will be taken approximately once a month to ensure pressure transducer data accuracy. This information will be collected, analyzed and converted by WWBWC staff to depth to water below ground surface and water level in feet above sea level. This information will be submitted as part of the limited license permit annual report to OWRD/ODEQ.

C – Groundwater and Surface Water Quality Monitoring

ODEQ has approved water quality monitoring plans for aquifer recharge project since 2004. Currently, the monitoring plan requires water quality sampling on a program level rather than a site specific level. This helps to reduce costs and allows the aquifer recharge sites to continue operating after initial funding is gone. Currently, the water quality monitoring plan stipulates that 6 groundwater wells and 3 surface water locations be sampled before recharge operations start for the season (typically late October or early November) and again just after recharge operations stop for the season (typically May 15th). The WWBWC works with Walla Walla Regional Water Testing Services (working with Edge laboratory) to conduct laboratory sampling for the water quality monitoring plan. See **Attachment A** for the Water Quality Monitoring Plan. As the aquifer recharge program grows, additional groundwater and surface water sites will likely be added to ensure water quality is not being degraded.

2 – Up-gradient and down-gradient surface water and groundwater monitoring

Up-gradient and down-gradient monitoring is a required portion of the limited license for the aquifer recharge sites. Up-gradient monitoring provides the "input" to the system, with both surface water and groundwater. Down-gradient monitoring provides the "impact" to the system. Changes between up-gradient and down-gradient sites help define how aquifer recharge benefits are helping the system (i.e. improved spring flows, improved groundwater levels, etc.)

The sites used for effectiveness monitoring are also incorporated into the WWBWC's Watershed Monitoring Program. This application's funding will be utilized to monitor these designated sites more often than would be done for the Watershed Monitoring Program. Each surface water site or groundwater site will be visited approximately every month from October till June (as opposed to every quarter for the Watershed Monitoring Program). More frequent data will allow WWBWC, OWRD and ODEQ to understand groundwater and surface water responses to aquifer recharge operations.

EM3 Describe in detail and provide the citation for the protocols that will be used.

Please see **Attachment B** for WWBWC standard operating procedures for monitoring activities.

EM4 Describe in detail the sampling design used to choose your sampling locations.

The sampling design for this project was developed in conjunction with ODEQ and OWRD. For water level monitoring (both surface and ground) a combination of monitoring locations were used. First for the groundwater, existing wells were utilized and some additional wells were drilled to fill in "gaps." Many of the existing wells were chosen because they had historic data that new data could be compared against. For surface water sites, we have utilized some existing sites and have established new sites as suggested/required by OWRD or ODEQ. Many of the surface water sites also have historic data (or at least the spring or creek has historic data if not the exact location).

For both surface water and groundwater sites monitoring locations were limited because landowner approval is needed. Locations are limited to where access was made available by the landowner or where accurate measurements could be taken.

Traditional sampling designs do not necessary hold true for groundwater and surface water monitoring. Location selection for monitoring (and operating) aquifer recharge sites is based upon nonrandom hydrogeologic conditions (including depth to water, gradient, subsurface stratigraphy, water use, etc.). Groundwater monitoring locations are limited to either existing wells or newly drilled wells. Based upon the financial constraints (a monitoring well cost ~$8,000 to drill), existing wells are preferred but the location for the monitoring site cannot be adjusted without drilling a new well (which also has to be approved by a landowner). For surface water locations we need to capture data for what is happening within a managed system (irrigation withdrawals, tail-water inputs, etc.) and therefore monitoring locations are picked based upon anthropogenic influences on the system as well as natural conditions.

EM5 Select your monitoring design from the list below and place a check mark next to it.

_X_ Before/After Control Impact - A control site is evaluated over the same time period as the treatment site, thus the study is replicated in both time and space.

NOTE: This is partially true – we are sampling up-gradient of recharge sites, at recharge sites and down-gradient of recharge sites. The up-gradient site can be considered a "control" site for groundwater that is not affected by the recharge activities.

_X_ Before/After - Data are collected both before and after treatment, so the study is replicated in time, not space.

___ Stratified Random - Dividing the population to be sampled into two or more subgroups before choosing what will be sampled.

___ Random Allocation of Treatment - Sites are randomly selected and each site has an equal chance of being selected.

_X_ Available Sites - Sites are being sampled solely based on what is available to be sampled.

___ Census - All units are sampled

___ Other: Explain.

EM6 Describe how the information to be gathered augments existing available data.

Data collected using this effectiveness monitoring funding will augment existing groundwater and surface water data, both specific to each recharge site and to the valley as a whole. Data will also be distributed to OWRD who also collects groundwater and surface water data in the valley. This more frequent data collection will help add detail to the existing data sets during recharge operations. This additional detail will help the WWBWC (in conjunction with OWRD and ODEQ) prioritize aquifer recharge projects.

EM7 Describe the quality control/quality assurance program for the project and who will be collecting your data.

Please see **Attachment B** for QA/QC program (incorporated into the Standard Operating Procedures).

EM8 What is the proposed schedule for the Effectiveness Monitoring activities? Include information on the sampling frequency and the duration of the monitoring proposed.

Effectiveness monitoring will start approximately one month (typically October) before aquifer recharge operations begin for the season to ensure data loggers are operating correctly and collecting data. This also gives the "start" conditions before aquifer recharge operations start. Pre-operation monitoring will include visiting the recharge monitoring wells, recharge surface water sites and each of the recharge site intakes (See **Attachment A**).

During recharge operations, monitoring wells and surface sites will be visited approximately once a month to take manual measurements, download data loggers and ensure data loggers they are operating correctly and collecting data. Every week all recharge sites will be visited to take manual measurements of intake values and to ensure sites are still operating and functioning correctly.

Post-operation monitoring will be done between 1-3 weeks after aquifer recharge operations have stopped for the season (typically May 15th). Monitoring wells and surface sites will be visited to take a final end of season measurement and to download data loggers. Data for the entire recharge season will be compiled in June of each year to create an annual report for recharge activities (note: a recharge season starts in November and continues through May of the following year).

EM9 Describe the data analysis process. Include the timeline for analysis, **who will be responsible for the data analysis and report writing,** who will be doing the analysis, who will review it (peer reviewers), where it will be stored, who will receive the information and the format to be used.

At the end of each recharge season (typically in June), data gathered will be compiled, verified and incorporated into the WWBWC's AQUARIUS database. Data will be analyzed by WWBWC (Project Lead and GIS Analyst) to determine recharge volumes, up-gradient and down-gradient effects on both groundwater and surface water and an estimate of "increased aquifer storage" and water discharged to surface water systems. After analysis, an annual report will be written by WWBWC staff and submitted to a hydrogeology consultant for peer review. Once approved by the consultant, a license geologist or hydrogeologist will stamp the report and it will be submitted to OWRD, ODEQ and OWEB. The annual report will include a narrative of recharge activities for the season, figures and hydrographs for monitoring locations and analysis of aquifer storage and surface water improvements. Data submitted with the annual report will be formatted to OWRD standards to allow data to be incorporated into their database. Note: Annual reports will be submitted to OWRD in February of each year per requirements in the limited license.

EM10 If activities will take place on other lands not identified under the restoration application (cite section/question #), provide a detailed description of project location, including location(s) where monitoring will occur. Also, provide geographic coordinates and or river miles whenever possible.

See **Attachment A** for monitoring locations. Note: additional sites will likely be included in the monitoring, especially new monitoring wells that will be drilled in conjunction with new recharge site construction.

If your restoration project is funded,
you will be required to submit any water quality data to
DEQ's Laboratory Analytical Storage and Retrieval Database (LASAR)
http://www.deq.state.or.us/lab/lasar.htm
and any fish habitat and distribution data to
ODFW's Natural Resource Information Management Program
https://nrimp.dfw.state.or.us/DataClearinghouse/

Section III
EFFECTIVENESS MONITORING BUDGET
IMPORTANT: Read the application instructions. Add additional lines, if necessary.

Totals automatically round to the nearest dollar

Itemize projected costs under each of the following categories.	**A** **Unit Number** (e.g., # of hours)	**B** **Unit Cost** (e.g., hourly rate)	**C** **In-Kind Match**	**D** **Cash Match Funds**	**E** **OWEB Funds**	**F** **Total Costs** (add columns C, D, E)
PRE-IMPLEMENTATION. Must occur after the OWEB grant agreement has been fully executed, unless it is a city or county charge for processing the Land Use form. OWEB funds will not be disbursed for project components requiring permits or licenses until those permits and licenses have been received by OWEB. However, funds may be released for non-permitted project components whose implementation is not affected by the required permits.						
Project Lead	90	$ 45.23		$ 1,018	$ 3,053	$ 4,071
Operations Manager	75	$ 38.58		$ 965	$ 1,928	$ 2,893
		SUBTOTAL (1)	0	$ 1,983	$ 4,981	$ 6,964
PROJECT MANAGEMENT. Includes *staff or contractors* who coordinate project implementation. Line items should identify who will be responsible for project management and their affiliation.						
Project Lead	150	$ 45.23		$ 3,393	$ 3,392	$ 6,785
Operations Manager	100	$ 38.58		$ 965	$ 2,893	$ 3,858
Director	50	$ 59.11		$ 2,956	$ -	$ 2,956
		SUBTOTAL (2)	0	$ 7,314	$ 6,285	$ 13,599
IN-HOUSE PERSONNEL. Includes *only* actual in-house staff costs and the portion of their time devoted to this project.						
Project Lead	280	$ 45.23		$ 4,342	$ 8,323	$ 12,665
GIS Analyst	160	$ 46.67		$ 3,734	$ 3,734	$ 7,468
Operations Manager	200	$ 38.58		$ 5,401	$ 2,315	$ 7,716
Environmental Tech	500	$ 28.66		$ 7,165	$ 7,165	$ 14,330
		SUBTOTAL (3)	0	$ 20,642	$ 21,537	$ 42,179
CONTRACTED SERVICES. Labor, supplies, and materials to be provided by non-*staff* for project implementation.						
Water Quality Sampling (12 sites x 2 samples per year x 2 years = 48 samples)	32	350		$ 8,500	$ 8,500	$ 17,000
		SUBTOTAL (4)	0	$ 8,500	$ 8,500	$ 17,000
TRAVEL. Mileage, per diem, lodging, etc. Must use current State of Oregon rate.						
Mileage	1800	0.565		$ 254	$ 763	$ 1,017
		SUBTOTAL (5)	0	$ 254	$ 763	$ 1,017
SUPPLIES/MATERIALS. Refers to items that typically are "used up" in the course of the project. Costs to OWEB must be directly related to on-the-ground work.						
Monitoring Supplies (staff gages, pens, pencils, waterproof paper, clipboards, t-posts, cable, batteries, desiccant, tape measures, etc.)				$ 250	$ 750	$ 1,000
		SUBTOTAL (6)	0	$ 250	$ 750	$ 1,000
EQUIPMENT. List equipment costing **$250 or more per unit**. Useful life of equipment is for the duration of project and will be used only for this project. Identify any portable equipment (items with useful life of generally 2 years or more). Must be property of a governmental entity, tribe, watershed council, SWCD, institution of higher learning or school district.						
Pressure Transducers	4	800		$ 800	$ 2,400	$ 3,200
Monitoring Field Laptop	1	400		$ 200	$ 200	$ 400
		SUBTOTAL (7)	0	$ 1,000	$ 2,600	$ 3,600
PRODUCTION COSTS. This only applies if you are conducting Effectiveness Monitoring (***see Application Instructions and R17***).						
	/yr					0
		SUBTOTAL (8)	0	0	0	0
[Add all subtotals, (1-8) above] CATEGORY TOTALS (9)			0	$ 39,943	$ 45,416	$ 85,359

Itemize projected costs under each of the following categories.	A Unit Number (e.g., # of hours)	B Unit Cost (e.g., hourly rate)	C In-Kind Match	D Cash Match Funds	E OWEB Funds	F Total Costs (add columns C, D, E)

FISCAL ADMINISTRATION Totals automatically round to the nearest dollar

FISCAL ADMINISTRATION. Not to exceed **10% of Category Totals (9) Funds**. Compute by multiplying by 0.10 or less. Costs associated with accounting; auditing (fiscal management); contract management (complying with the terms and conditions of the grant agreement); and fiscal reporting expenses for the OWEB project, including final report expenses (e.g., film developing) for the grant.						
Admin (3%)			0	0	$ 1,360	$ 1,360
FISCAL ADMINISTRATION TOTAL (10)			0	0	$ 1,360	$ 1,360

BUDGET TOTAL Totals automatically round to the nearest dollar

[Add Category Totals (9) and Fiscal Total (10)] **Effectiveness Monitoring BUDGET TOTAL (11)** **Insert this TOTAL in the EM Budget Total (14) line in the Restoration Application Budget**	0 $ 39,943	$ 46,776	$ 86,719

Section IV
WATERSHED RESTORATION BUDGET

IMPORTANT: Read the application instructions. Add additional lines, if necessary.

Totals automatically round to the nearest dollar

	A	B	C	D	E	F
Itemize projected costs under each of the following categories.	**Unit Number**	**Unit Cost**	**In-Kind Match**	**Cash Match Funds**	**OWEB Funds**	**Total Costs**
	(e.g., # of hours)	(e.g., hourly rate)				(add columns C, D, E)
PRE-IMPLEMENTATION. Must occur after the OWEB grant agreement has been fully executed, unless it is a city or county charge for processing the Land Use form. OWEB funds will not be disbursed for project components requiring permits or licenses until those permits and licenses have been received by OWEB. However, funds may be released for non-permitted project components whose implementation is not affected by the required permits.						
Project Lead	365	$ 45.23		$ 8,255	$ 8,255	$ 16,510
Operations Manager	230	$ 38.58		$ 5,945	$ 2,928	$ 8,873
		SUBTOTAL (1)	0	$ 14,200	$ 11,183	$ 25,383
PROJECT MANAGEMENT. Includes actual in-house staff or contractors who coordinate project implementation. Line items should identify who will be responsible for project management and their affiliation.						
Project Lead	750	$ 45.23		$ 20,354	$ 13,569	$ 33,923
Operations Manager	300	$ 38.58		$ 8,680	$ 2,894	$ 11,574
Executive Director	150	$ 59.11		$ 5,912	$ 2,955	$ 8,867
		SUBTOTAL (2)	$ -	$ 34,946	$ 19,418	$ 54,364
IN-HOUSE PERSONNEL. Includes *only* actual in-house staff costs for project implementation.						
Project Lead	1200	$45.23		$ 27,138	$ 27,138	$ 54,276
GIS Analyst	640	$46.67		$ 24,829	$ 5,040	$ 29,869
Operations Manager	300	$38.58		$ 9,837	$ 1,737	$ 11,574
Environmental Tech	400	$28.66		$ 8,713	$ 2,751	$ 11,464
		SUBTOTAL (3)	$ -	$ 70,517	$ 36,666	$ 107,183
CONTRACTED SERVICES. Labor, supplies, and materials to be provided by non-*staff* for project implementation.						
GSI Hydrogeo Characterization & Permitting	5	$ 3,000		$ 7,500	$ 7,500	$ 15,000
GSI Well Drilling	5	$ 8,000		$ 20,000	$ 20,000	$ 40,000
Site Prep and Construciton	5	$ 47,500		$ 75,000	$ 162,500	$ 237,500
Designs (5 sites)	5	$ 6,500		$ 20,000	$ 12,500	$ 32,500
Site Lease Value	10 (5 sites for 2 years)	$ 500	$ 5,000			$ 5,000
		SUBTOTAL (4)	$ 5,000.00	$ 122,500	$ 202,500	$ 330,000
TRAVEL. Mileage, per diem, lodging, etc. Must use current State of Oregon rate.						
Mileage	3500	$ 0.565		$ 1,187	$ 791	$ 1,978
		SUBTOTAL (5)	$ -	$ 1,187	$ 791	$ 1,978
SUPPLIES/MATERIALS. Refers to items that are "used up" in the course of the project. Costs to OWEB must be directly related to on-the-ground work.						
Field Operations Materials (Clipboards, pens, waterproof paper, measuring tapes, stakes, spray paint, tools, etc.)				$ -	$ 1,000	$ 1,000
		SUBTOTAL (6)	$ -	$ -	$ 1,000	$ 1,000
EQUIPMENT. List equipment costing **$250 or more per unit**. Useful life of equipment is for the duration of project and will be used only for this project. Identify any portable equipment (items with useful life of generally 2 years or more). Must be property of a governmental entity, tribe, watershed council, SWCD, institution of higher learning or school district						
Pressure Transducers	5	$ 800		$ 2,000	$ 2,000	$ 4,000
Water Quality Station	2	$ 10,775		$ 10,775	$ 10,775	$ 21,550
		SUBTOTAL (7)	$ -	$ 12,775	$ 12,775	$ 25,550

Itemize projected costs under each of the following categories.	A Unit Number	B Unit Cost	C In-Kind Match	D Cash Match Funds	E OWEB Funds	F Total Costs
	(e.g., # of hours)	(e.g., hourly rate)				(add columns C, D, E)
OUTREACH. Refers to informational and promotional activities associated with the project.						
				$ -	$ -	$ -
		SUBTOTAL (8)	$ -	$ -	$ -	$ -
[Add all subtotals, (1-8) above]		**CATEGORY TOTALS (9)**	$ 5,000.00	$ 256,125	$ 284,333	$ 545,458

FISCAL ADMINISTRATION *Totals automatically round to the nearest dollar

FISCAL ADMIN. Not to exceed **10% of Category Totals (9) Funds**. Compute by multiplying by 0.10 or less. Costs associated with accounting; auditing (fiscal management); contract management (complying with the terms and conditions of the grant agreement); and fiscal reporting expenses for the OWEB project, including final report expenses (e.g., film developing) for the grant.						
Fiscal Admin (~3%)					$ 8,560	$ 8,560
		SUBTOTAL (10)	$ -	$ -	$ 8,560	$ 8,560
POST-IMPLEMENTATION STATUS REPORTING. Costs associated with annual reporting requirements typically required for each grant **(see Application Instructions).**						
		/yr				$ -
		SUBTOTAL (11)	$ -	$ -	$ -	$ -
[Add the two Subtotals (10 & 11)]		**TOTAL (12)**	$ -	$ -	$ 8,560	$ 8,560

RESTORATION BUDGET TOTAL *Totals automatically round to the nearest dollar

RESTORATION BUDGET TOTAL (13) **[Add Category Totals (9) and Fiscal/PISR Total (12) from above]**	$ 5,000.00	256,125	292,893	554,018

EFFECTIVENESS MONITORING BUDGET TOTAL

EFFECTIVENESS MONITORING BUDGET TOTAL (14) This only applies if you are doing Effectiveness Monitoring; see Application Instructions and R17. Transfer Budget Total (11) from the Effectiveness Monitoring Budget Insert.	$ -	$ 39,943	$ 46,776	$ 86,719

PLANT ESTABLISHMENT BUDGET TOTAL

PLANT ESTABLISHMENT BUDGET TOTAL (15) This only applies if you are doing a planting project; see Application Instructions and R18. Transfer Budget Total (9) from the Plant Establishment Budget Insert.	$ -	$ -	$ -	$ -

PROJECT BUDGET TOTAL *Totals automatically round to the nearest dollar

PROJECT BUDGET TOTAL [Add (13), (14), AND (15) as applicable]	$ 5,000	$ 296,068	$ 339,669	$ 640,737

ATTACHMENT A

MATCH FUNDING FORM

Document here the match funding shown on the budget page of your grant application

<u>OWEB accepts all non-OWEB funds as match</u>. An applicant may <u>not</u> use *another OWEB grant* to match an OWEB grant; this includes ODA Weed Board projects because they are funded through OWEB grants. However, an applicant who benefits from a pass-through OWEB agreement with another state agency, by receiving either staff expertise or a grant from that state agency, <u>may</u> use those benefits as match for an OWEB grant. (Example: A grantee <u>may</u> use as match the effort provided by ODFW restoration biologists because OWEB funding for those positions is the result of a pass-through agreement). At the time of application, match funding for OWEB funds requested does not have to be *secured*, but you must show that <u>at least 25% of match funding has been *sought*</u>. On this form, you do not necessarily need to show authorized signatures ("secured match"), but the more match that is secured, the stronger the application. Identify the type of match (cash or in-kind), the status of the match (secured or pending), and either a dollar amount or a dollar value (based on local market rates) of the in-kind contribution. In the table below, the match may be identified as Effectiveness Monitoring (EM), Plant Establishment (PE) or Other (OTHER) Dollar Value. **<u>If you are not requesting funds from OWEB to support effectiveness monitoring or plant establishment, disregard the EM column or the PE column and use only the OTHER column.</u>**

EFFECTIVENESS MONITORING (EM): If you are requesting more than $3,500 in OWEB funds to support Effectiveness Monitoring activities as part of a Watershed Restoration Grant Application <u>and</u> filling out information for Question R17, you must include matching funds which will be used as match for the effectiveness monitoring portion of the project. This is identified in the table below as the EM Dollar Value.

PLANT ESTABLISHMENT (PE): If you are requesting more than $3,500 in OWEB funds to support Plant Establishment as part of a Watershed Restoration Grant Application <u>and</u> filling out information for Question R18, you must include matching funds which will be used as match for the Plant Establishment portion of the application. This is identified in the table below as the PE Dollar Value.

If you have questions about whether your proposed match is eligible or not, see Allowable Match document in OGMS http://apps.wrd.state.or.us/apps/oweb/fiscal/nologin.aspx under Restoration application or contact your local OWEB regional program representative (contact information available in the instructions to this application).

Project Name: Mud Creek and West LWW Recharge and Dist Function Applicant: Walla Walla Basin WC

Match Funding Source	Type (√ one)	Status (√ one)**	EM Dollar Value	PE Dollar Value	OTHER Dollar Value	Match Funding Source Signature/Date**
Bonneville Power Administration - 2013 (See Attachmented)	☒ cash ☐ in kind	☒ secured ☐ pending			$65,090.00	[signature] SEE ATTACHED CONTRACT
Bonneville Power Administration - 2014	☒ cash ☐ in kind	☐ secured ☒ pending	$31,000.00		$91,035.00	
Bonneville Power Administration - 2015	☒ cash ☐ in kind	☐ secured ☒ pending	$8,943.00		$100,000.00	
Landowner Land Lease Value	☐ cash ☒ in kind	☐ secured ☒ pending			$5,000.00	
	☐ cash ☐ in kind	☐ secured ☐ pending				
	☐ cash ☐ in kind	☐ secured ☐ pending				
	☐ cash ☐ in kind	☐ secured ☐ pending				

** **IMPORTANT**: If you checked the "Secured" box in the Status Column for any match funding source, you must provide <u>either</u> the signature of an authorized representative of the match source in the final Column, <u>or</u> attach a letter of support from the match funding source that specifically mentions the dollar amount you show in the EM, PE or OTHER Dollar Value Column(s).

UNITED STATES
GOVERNMENT

CONTRACT

BONNEVILLE
POWER ADMINISTRATION

Mail Invoice To:

fwinvoices@bpa.gov
F & W Invoices - KEWB-4
P. O. Box 3621
Portland OR 97208-3621

Contract : **00060272**
Release :
Page : **1**

Vendor:
WALLA WALLA BASIN WATERSHED FOUNDATION
810 S MAIN STREET
MILTON-FREEWATER OR 97862

Please Direct Inquiries to:

BRENDA S. HEISTER
Title: CONTRACTING OFFICER
Phone: 503-230-3531
Fax : 503-230-4508

Attn: BRIAN WOLCOTT

Contract Title: **2007-396-00 CAP RESTORE WALLA WALLA RIVER FLOW**

Total Value : **$471,178.00**
Pricing Method: **COST, NO FEE**
Performance Period: **11/01/12 - 10/31/13**

**** NOT TO EXCEED ****
Payment Terms: % Days Net 15

B R Wolcott
Contractor Signature
BRIAN R. WOLCOTT / EXECUTIVE DIRECTOR-WWBWC
Printed Name/Title
1/22/13
Date Signed

Brenda S. Heister
BPA Contracting Officer
January 18, 2013
Date Signed

ATTACHMENT B

LAND USE INFORMATION FORM

*This information is needed to determine if the proposed project complies with statewide planning goals and is compatible with local comprehensive plans (ORS 197.180). **The form must be submitted at the time of application (OAR 695-050-0035(1)(a)) with the applicant completing at least #1 below.** The completed and signed form must be submitted before OWEB releases grant funds. OWEB will release grant funds only if the project either is not regulated by, or is compatible with, the local comprehensive plan and zoning ordinance. If a project is regulated by the local comprehensive plan and zoning ordinance, OWEB will void grant agreements for projects the county determines to be incompatible with the local comprehensive plan and zoning ordinance. If the county requires additional local approvals for a project regulated by the local comprehensive plan and zoning ordinance, OWEB will not release grant funds until these conditions are satisfied.*

1. TO BE COMPLETED BY THE APPLICANT/GRANTEE

Applicant/Grantee Name: Walla Walla Basin Watershed Council

Project Name: Mud Creek and West LWW Aquifer Recharge and Distributary/Floodplain Function

2. TO BE COMPLETED BY CITY/COUNTY OR TRIBAL PLANNING OFFICIAL

Complete this section only after section 1, above, has been completed. Check the box below that applies:

☐ This project is not regulated by the local comprehensive plan and zoning ordinance.

☐ This project has been reviewed and is compatible with the local comprehensive plan and zoning ordinance.

☐ This project has been reviewed and is not compatible with the local comprehensive plan and zoning ordinance.

☐ Compatibility of this project with the local planning ordinance cannot be determined until the following local approvals are obtained:

____ Conditional Use Permit
____ Plan Amendment
____ Other
____ Development Permit
____ Zone Change

An application has ____ has not ____ been made for the local approvals checked above.

* Signature of Local Official ____________________ Date ____________________

Print Name: ____________________ Phone: ____________________

Title: ____________________ Email: ____________________

Must be an authorized signature from your local City/County or Tribal Planning Department, regardless of which box is checked above.

ATTACHMENT C

PUBLIC RECORD CERTIFICATION

Oregon Administrative Rule 695-005-0030(4) states that "All applications that involve physical changes or monitoring on private land must include certification from the applicant that the applicant has informed all landowners involved of the existence of the application and has also advised all landowners that all monitoring information obtained on their property is public record. If contact with all landowners was not possible at the time of application, explain why."

INSTRUCTIONS: All applicants must complete Part One. In Part One, if you check the first box, skip Part Two and sign and date in the signature box below. If you check the second box, you must complete Part Two and sign and date in the signature box below.

PART ONE

☐ Public land only (STOP: go to signature box and complete)

☒ Private land only, or a mix of public and private land (complete Part Two and sign and date in the signature box)

PART TWO

☒ I certify that I have informed all participating private landowners involved in the project of the existence of the application, and I have advised all of them that all monitoring information obtained on their property is public record. The following is a complete list of all participating private landowners.

1. Richard Yound
2. Lee Andrews
3. Monte Thomas
4. Don Jackson
5. Sean Roloff
6. _____
7. _____
8. _____
9. _____
10. _____

☐ I certify that contact with all participating private landowners was not possible at the time of application for the following reasons: .

Furthermore, I understand that should this project be awarded, I will be required by the terms of the OWEB grant agreement to secure cooperative landowner agreements with all participating private landowners prior to expending Board funds on a property.

APPLICANT/CO-APPLICANT SIGNATURE

[signature]	4-18-13
Applicant Signature	Date
Steven Patten	Senior Environmental Scientist
Print Name	Title
Co-Applicant Signature	Date
Print Name	Agency

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

Walla Walla Basin Aquifer Recharge Program

Letter of Support and Interest – Aquifer Recharge Project

The Walla Walla Basin Aquifer Recharge Program is designed to restore the alluvial (shallow gravel) aquifer and to improve low-flow conditions in hydraulically connected rivers, streams and spring creeks. The primary purpose of this program is for public and regional benefit. Restoring the aquifer will enhance groundwater contributions to instream flow and maximize the aquifer's potential with multiple benefits for aquatic life, recreational water use, domestic use and irrigation use.

Projects in the Walla Walla Basin Aquifer Recharge Program utilize winter and spring time high run-off water from the Walla Walla River. This process simulates the historic distributary system that spread water across the valley floor. There are three main project types that are currently being used: field recharge, infiltration basins and infiltration galleries. Field recharge is simply diverting water on to a property and allowing it to soak into the ground and recharge the aquifer. Infiltration basins are constructed leaky ponds that pool water in a confined area to recharge the aquifer. Infiltration galleries are modified drain fields (perforated pipes) installed ~5-6 feet under the ground surface that recharge the aquifer. Recharge projects are located in areas where groundwater declines have been observed or where springs/creeks have reduced flow. A typical site will recharge approximately 1-2 cubic feet per second (cfs), which is ~450-900 gallons a minute. Over the course of a recharge season this can equate to ~200 acre-feet of water (over 65 million gallons of water) per site.

This letter is submitted in support of the Walla Walla Basin Aquifer Recharge Program and confirms that I am interested in having an aquifer recharge project located on my property.

Name Don Jackson Phone/Email 509-727-1478 jackdon_2@msn.com

Project Property Address 52967 Sunquist Rd Milton FreewAteR OR

Signature Don M [signature] Date 4-18-13

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

Walla Walla Basin Aquifer Recharge Program

Letter of Support and Interest – Aquifer Recharge Project

The Walla Walla Basin Aquifer Recharge Program is designed to restore the alluvial (shallow gravel) aquifer and to improve low-flow conditions in hydraulically connected rivers, streams and spring creeks. The primary purpose of this program is for public and regional benefit. Restoring the aquifer will enhance groundwater contributions to instream flow and maximize the aquifer's potential with multiple benefits for aquatic life, recreational water use, domestic use and irrigation use.

Projects in the Walla Walla Basin Aquifer Recharge Program utilize winter and spring time high run-off water from the Walla Walla River. This process simulates the historic distributary system that spread water across the valley floor. There are three main project types that are currently being used: field recharge, infiltration basins and infiltration galleries. Field recharge is simply diverting water on to a property and allowing it to soak into the ground and recharge the aquifer. Infiltration basins are constructed leaky ponds that pool water in a confined area to recharge the aquifer. Infiltration galleries are modified drain fields (perforated pipes) installed ~5-6 feet under the ground surface that recharge the aquifer. Recharge projects are located in areas where groundwater declines have been observed or where springs/creeks have reduced flow. A typical site will recharge approximately 1-2 cubic feet per second (cfs), which is ~450-900 gallons a minute. Over the course of a recharge season this can equate to ~200 acre-feet of water (over 65 million gallons of water) per site.

This letter is submitted in support of the Walla Walla Basin Aquifer Recharge Program and confirms that I am interested in having an aquifer recharge project located on my property.

Name SEAN ROLOFF Phone/Email 509-520-2455 / KUULEI@CENTURYLINK.NET

Project Property Address 83566 CHUCKHOLE LN. MILTON FREEWATER OR 97862

Signature [signature] Date 4/19/13

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

Walla Walla Basin Aquifer Recharge Program

Letter of Support and Interest – Aquifer Recharge Project

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This letter is submitted in support of the Walla Walla Basin Aquifer Recharge Program and confirms that I am interested in having an aquifer recharge project located on my property.

Name RICHARD YOUNG Phone/Email 541-240-9289

Project Property Address 53438 TRIANGLE Rd MF, OR

Signature [signature] Date 15 APRIL 2013

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

Walla Walla Basin Aquifer Recharge Program

Letter of Support and Interest – Aquifer Recharge Project

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This letter is submitted in support of the Walla Walla Basin Aquifer Recharge Program and confirms that I am interested in having an aquifer recharge project located on my property.

Name Lee Andrews Phone/Email 541-558-3779

Project Property Address 52384 Fruitvale Rd MF-OR

Signature [signature] Date 4-15-13

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

Walla Walla Basin Aquifer Recharge Program

Letter of Support and Interest – Aquifer Recharge Project

The Walla Walla Basin Aquifer Recharge Program is designed to restore the alluvial (shallow gravel) aquifer and to improve low-flow conditions in hydraulically connected rivers, streams and spring creeks. The primary purpose of this program is for public and regional benefit. Restoring the aquifer will enhance groundwater contributions to instream flow and maximize the aquifer's potential with multiple benefits including aquatic life, recreational water use, domestic use and irrigation use.

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This letter is submitted in support of the Walla Walla Basin Aquifer Recharge Program and confirms that I am interested in having an aquifer recharge project located on my property.

Name Monte Thomas Phone/Email 541-558-3968

Project Property Address 85635 Rencken Rd MF, OR

Signature Monte Thomas Date 4/15/13

ATTACHMENT D

RESTORATION METRICS FORM

OWEB

OWEB receives a portion of its funds from the federal government and is required to report how its grantees have used both federal and state funds. The information you provide in the following form will be used for federal and state reporting purposes.

Please complete all portions of the form below as they apply to your project and submit all pages (do not exclude any pages). Please provide specific values, do not enter values like "2-3" or "<100". Enter your best approximation of what the project will accomplish.

If you have any questions, please contact Cecilia Noyes, OWEB Federal Reporting Coordinator at 503-986-0204 or cecilia.noyes@state.or.us .

Section 1 - Project Overview

Answer all five questions below, even if you have answered a similar question in a previous section in the grant application.

1. Land Use Setting: CHECK ONE BOX ONLY.

☐ **Urban/Suburban/Exurban** *(Projects located within urban growth boundaries or rural residential areas)*	☒ **Rural** *(Projects located outside urban growth boundaries or rural residential areas.)*

2. Dominant Watershed Setting: CHECK ONE BOX ONLY. Example: Your project involves managing erosion in the upland area with some erosion control extended to the riparian area. Because most of the work is to occur in the upland area, you would check only the Upland box below.

☐ **Estuary** *(where freshwater meets and mixes with saltwater of ocean tides.)*	☐ **Riparian** *(adjacent to a water body, within the active floodplain.)*
☐ **Instream** *(below the ordinary high-water mark or within the active channel — includes fish passage.)*	☐ **Upland** *(above the floodplain.)* ☒ **Groundwater** *(Projects that recharge groundwater or primarily affect the subsurface water table.)*
☐ **Wetland** *(areas inundated or saturated by surface or groundwater at a frequency and duration sufficient to support a prevalence of vegetation typically adapted for life in saturated soil conditions.*	

3. Total Acres Treated: 2-5 acres **Total Stream Miles Treated:** N/A ***(do not include** upstream stream miles made accessible to fish with passage improvements)*

4. Project Identified in Plan or Watershed Assessment: List the primary watershed/subbasin plan(s) or assessment(s) in which this project type is identified as a priority. The plans identified in Section III, question #R9 should include the plans or assessments listed below. Attach additional page, if needed.

Title	Author(s)	Date
Walla Walla Subbasin Plan	Walla Walla County and WWBWC	May 2004
Mid-Columbia Steelhead Recovery Plan	NOAA and ODFW	Sept 2009
Little Walla Walla River Assessment	WWBWC (Brian Wolcott)	2011
Walla Walla Basin Aquifer Recharge Strategic Plan	WWBWC	2013

5. Project Monitoring: All OWEB funded restoration projects require post-implementation status reporting including photo point monitoring. Please indicate below: 1) the location of the monitoring activities relative to the project, including photo point locations, 2) whether effectiveness monitoring is planned, and 3) whether additional monitoring will be conducted for this project.

5.1) Identify the location for the planned monitoring activities relative to the restoration project location. Check as many boxes as apply.

☒ Onsite	☒ Downstream	☒ Upstream	☐ Upslope

5.2) ☒ Effectiveness monitoring will be conducted for this project, this can be selected regardless of whether the effectiveness monitoring is funded by OWEB (refer to definition of effectiveness monitoring in the Application Instructions under R17).

5.3) Will this project conduct monitoring activities beyond the required post-implementation status reporting and photo point monitoring?

☒ Yes ☐ No If you answer yes, select the monitoring activities below, if you answer no proceed to Section 2.

Check all proposed monitoring activities

☐ Adult Fish presence/absence/abundance/distribution survey(s)	☐ Riparian vegetation (Presence/Absence)
☐ Juvenile Fish presence/absence/abundance/distribution survey(s)	☐ Spawning surveys
☐ Instream Habitat surveys	☐ Upland vegetation (Presence/Absence)
☐ Macroinvertebrates	☒ Water quality
☐ Noxious weed (Presence/Absence)	☒ Water quantity
☐ Other Biological Monitoring (bird counts, amphibian surveys)	☒ Other (explain): Groundwater levels and stream/spring flows

Section 2 - Project Activities

Provide values for each Project Activity applicable to your application. ***Leave blank any Project Activity or metric line that is not appropriate to your application.*** *All data entered in this form should be what you* ***plan*** *to do with the project. Data about* ***completed*** *projects will be reported at the end of the project to the Oregon Watershed Restoration Inventory (OWRI).*

For each activity type where you enter metrics, ***estimate*** *the percentage of the total cost of the project (OWEB and all other funding sources, shown on page 1 of this application) that applies to the activity. The sum of all of the activity cost percentages should equal 100%. Please distribute all administrative, project management and other general project costs among the various project activities when estimating percentages.*

Example*: A project will remove a fish passage barrier, place large boulders instream, and plant a riparian buffer. You would enter the appropriate metrics into the Fish Passage, Instream Habitat, and Riparian Habitat activity sections of this form. Then, estimate the percentage of the total cost of the project for each activity. For instance: 20% towards Fish Passage activities, 25% towards Instream Habitat activities, and 55% towards Riparian Habitat activities.*

Fish Screening Projects: *Projects that result in the installation or improvement of screening systems that prevent fish from passing into areas that do not support fish survival, for example into irrigation diversion channels.*

____ % Estimate the percentage of total cost of the project applied to fish screening activities

New Fish Screens Installed

____ # Estimate the number of new screens installed (do not count diversions where existing screens are replaced)

____ cfs Estimate the cubic feet per second of flow influenced by new screen(s) installed (to nearest 0.01 cfs)

Existing Screens Replaced, repaired or modified

____ # Estimate the number of existing screens replaced, repaired or modified

____ cfs Estimate the cubic feet per second of flow influenced by <u>existing</u> screen(s) screens (to nearest 0.01 cfs)

Fish Passage Improvement: *Projects that improve fish migration by addressing a migration barrier problem.*

Complete sections A-E as they apply to the proposed project. Projects that improve fish passage at road crossings should complete both sections A (define the problem) and B (define the treatment). Non-road crossing improvements are reported in sections C and D. Section E should be completed for all fish passage improvement projects. Refer to the application instructions for additional information and examples.

A. Road Crossings – Define *Existing* Fish Passage Problem

1. Culverts hindering fish passage	____ # crossings
2. Bridges hindering fish passage	____ # crossings
3. Fords hindering fish passage	____ # crossings

B. Road Crossings – Define the Fish Passage *Improvements* to be implemented by this project

1. Culverts installed/improved - *Improvements may include installing baffles inside culverts or installing/improving engineered bypasses (e.g. weirs) directly below a culvert outlet to improve passage.*	____ # crossings	____ str. mi with improved access*
2. Bridges installed/improved - *Improvements may include installing/improving engineered bypasses (e.g. weirs) directly below a bridge crossing to improve passage.*	____ # crossings	____ str. mi with improved access*
3. Fords installed/improved	____ # crossings	____ str. mi with improved access*
4. Road Crossings removed and <u>not</u> replaced	____ # crossings	____ str. mi with improved access*

**Estimate stream miles in the main channel and tributaries made more accessible above the crossing(s) (to nearest 0.01 mile). If a barrier exists upstream, report the length made accessible up to that next upstream barrier.*

C. Fish Passage Barriers – Other than Road Crossings

1. Type(s) of barriers to be treated/removed to improve fish passage.	☐ Diversion Dam ☐ Push-up Dam ☐ Wood or Concrete Dam ☐ Weir (not associated with a road crossing) ☐ Logs (not weirs) ☐ Debris ☐ Tidegates ☐ Boulder/Rock Barrier (not weirs) ☐ Landslide Other (explain) ____
2. ____ # Estimate the total number of **non-road** crossing barriers (listed under C.1 above) to be removed or altered to improve passage.	

D. Fish Ladders or Engineered Bypasses (not associated with Road Crossings)

1. Fish ladders will be installed/improved	____ # fish ladders to be installed/improved
2. Engineered bypasses will be installed/improved. *This includes weirs, rock boulder step pools, and chutes constructed/roughened in bed rock. Do not count engineered bypasses located at a road crossing to improve passage at the crossing. These types of improvements should be identified above in section B as a Road Crossing Fish Passage Improvement.*	____ # engineered bypasses to be installed/improved

E. Fish Passage Summary Metrics

1.____ % Estimate the percentage of total cost of the project applied to fish passage improvements

2.____ mi Estimate the total stream miles that will be made more accessible in the main channel and tributaries above the project (to nearest 0.01 mile). *This metric summarizes the stream miles for all of the proposed passage improvements (defined above in Sections A-D). If a barrier exists upstream of the project, report the length made accessible up to that next upstream barrier.*

3.____ # Estimate the total number of barriers (this includes road crossings, diversion dams, push up dams, wood or concrete dams, weirs, tidegates, etc.) to be removed or altered to improve passage.

4.____ % Estimate the percentage of fish passage activity costs applied to tidegates. If you do not select tidegate as a type of fish passage barrier for question C.1, leave this value blank. Example: Your project will remove a tidegate. You estimated that 100% of the total project cost will apply to fish passage improvements and one quarter of the fish passage improvements costs will apply to the tidegate removal, you would report 25%.

Instream Flow: *Projects that maintain and/or increase the instream flow of water.* Irrigation improvements that are primarily designed to improve water quality should be reported under Upland – Agriculture Management Activities.

Check all proposed activities.

☐ Irrigation practice improved to increase instream flows (e.g. install diversion headgate, replace open ditches with pipes)	☐ Water flow gauges installed to measure water use
☐ This project will dedicate instream flow.	☒ Other (explain): Improved groundwater levels will improve stream flow through enhanced spring creek performance and groundwater returns to streams will increase flows in them.

50 % Estimate the percentage of total cost of the project applied to instream flow activities

_____ mi. Estimate the miles of stream where increased flow is the result of decreased/eliminated water withdrawals

1.0-2.0 (seasonally) cfs Estimate the increase in flow of water in the stream as a result of conservation effort (cubic feet per second)

_____ mm/dd/yyyy Initial start date of irrigation practice improvement

_____ mm/dd/yyyy Final end date of irrigation practice improvement (if improvement is permanent enter 12/31/9999)

Instream Habitat: *Projects that are designed to improve instream habitat conditions.*

Check all proposed activities.

☐ Channel reconfiguration and connectivity (e.g., creating instream pools, meanders, improving floodplain connectivity, off-channel habitat, removal or alteration of levee or berm, removal of sediment)	☐ Spawning gravel placement
☐ Channel structure - large wood placement	☐ Plant Removal/control (instream) List scientific names of plants _____
☐ Channel structure - boulder placement	☐ Beaver introduction
☐ Channel structure placement (other than large wood or boulder placements), e.g., engineered structures or deflectors, barbs, weirs, etc.	☐ Carcass or nutrient placement: ☐ salmonid carcass; ☐fish meal brick; ☐other nutrient
☐ Streambank stabilization (includes bio-engineering)	☐ Animal species removal (e.g. northern pike minnow, non-native fish, invasive animals)
	☐ Other (explain): _____

_____ % Estimate the percentage of total cost of the project applied to instream habitat activities

_____ mi. Estimate the miles of stream to be treated with instream habitat treatments (to nearest 0.01 mile)

_____ % Estimate the percentage of insteam activity costs for carcass or nutrient placements. If you do not select carcass/nutrient placements as an instream habitat activity, leave this value blank. *Example: Your project will place salmon carcasses. You estimated that 25% of the total project cost will apply to instream habitat activities and one half of the instream improvements costs will apply to the carcass placement, you would report 50%.*

Riparian Habitat: *Projects above the ordinary high-water mark of the stream and within the floodplain of the stream.* This includes lakeshores of connected lakes.

Check all proposed activities.

☐ Riparian planting	☐ Non-native/noxious plant control
☐ Riparian fencing	☐ Vegetation management (e.g. prescribed burnings, stand thinning, stand conversions, silviculture)
☐ Riparian exclusion by means other than fencing (includes excluding livestock, people, vehicles, etc.)	☐ Debris/structure removal (e.g. tires, appliances, old cars or buildings)
☐ Water gap development (fenced livestock crossing or livestock bridge)	☐ Other (explain): _____ *Do not report livestock water developments here, report livestock water developments under upland habitat treatments.*
☐ Conservation grazing management (e.g., rotation grazing)	

_____ % Estimate the percentage of total cost of the project applied to riparian habitat activities

_____ ac. Estimate the acres of riparian habitat to be planted (to nearest 0.1 acres)

_____ ac. Estimate the acres of riparian habitat to be treated for non-native/noxious weeds (to nearest 0.1 acres)

_____ ac. Estimate the total riparian acres to be treated. (to nearest 0.1 acres)

_____ mi. Estimate the miles of riparian streambank to be treated (to nearest 0.01 mi). Stream sides treated ☐ one ☐ two
(Do not double count miles if a second side is treated)

Upland Habitat: *Projects implemented above the floodplain.* Check all proposed activities.

☐ Erosion control structures (e.g., sediment collection basins, WASCOBs)	☐ Upland Agriculture Management – (e.g., no/low-till, wind breaks, filter strips, and irrigation improvements)
☐ Planting/seeding for erosion control (e.g., convert from crops to native vegetation, plant area where non-native/noxious weeds removed, grassed waterways) List scientific names of plants _____	☐ Livestock Manure Management (e.g., feedlot improvements to reduce runoff , relocate/improve manure holding structures and manure piles to reduce/eliminate drainage into streams)
☐ Slope stabilization (e.g., grade stabilization, landslide reparation, terracing slopes)	☐ Livestock/Wildlife Water Developments
☐ Non-native/noxious plant control; List scientific names of plants: _____	☐ Upland Livestock Management (other than livestock water developments), e.g., grazing plans, fencing
☐ Juniper removal/control	☐ Restore Historic Upland Habitats (e.g. oak woodland, oak savannah, upland prairie restoration)
☐ Vegetation Management (other than non-native/noxious plant control or juniper removal, e.g. tree thinning, brush control, burning, stand conversion, silviculture) List scientific names of plants: _____	☐ Trail or Campground Improvements (to decrease upland erosion; these may extend into or are in the riparian zone)
	☐ Other (explain): _____

_____ % Estimate the percentage of total cost of the project will apply to upland habitat activities

_____ # Estimate the number of livestock/wildlife water developments

_____ac. Estimate the acres of upland habitat to be treated for non-native/noxious plants (to nearest 0.1 acres)

_____ac. Estimate the total acres of upland habitat to be treated (do not include acres of upland habitat affected by livestock water developments (to nearest 0.1 acres)

_____ % Estimate the percentage of upland activity costs applied to Livestock Manure Management. If you do not select Livestock Manure Management as an upland habitat activity, leave this value blank. *Example: Your project will relocate a feedlot to reduce livestock manure runoff. You estimated that 33% of the total project cost will apply to upland habitat activities and one half of the upland improvements costs will apply to the feedlot relocation, you would report 50%.*

Road Activities: *Projects designed to improve road impacts to watersheds.* Check all proposed activities.

☐ Road drainage system and surface improvements & reconstruction	☐ Other (explain): _____
☐ Road closure, relocation, obliteration (decommissioning)	

_____ % Estimate the percentage of total cost of the project applied to road activities

_____ mi. Estimate the miles of road treated (to nearest 0.01 mile)

Urban Impact Reduction: Check all of the urban impact related activities that will be used by this project:

☐ Sewage outfall clean-up or reducing outfall)	☐ Bioswales
☐ Pesticide reduction: list names of each pesticide: _____	☐ Detention Facility
☐ Toxin (other than pesticide) reduction (herbicides, mine dredge tailings, other toxics): list names of each toxic species, element or material: _____	☐ Other urban impact reduction (explain): _____
☐ Stormwater/wastewater modification or treatment (includes rain gardens)	

Check all of the water quality limiting factors addressed by the Urban Impact Reduction activities selected above. **Do not** select limiting factors addressed by other types of restoration activities:

☐ Bacteria	☐ Pesticides	☐ Nutrients
☐ Dissolved Oxygen	☐ Toxics	☐ Sediment
☐ Heavy Metals	☐ High Temperature	☐ Other (explain): _____

_____% Estimate the percentage of total cost of the project applied to urban impact activities

Wetland Habitat: *Projects designed to create or improve wetland or meadow areas.*

Check all proposed activities.

☐ Wetland planting	☐ Artificial wetland area created from an area not formerly a wetland
☐ Non-native/noxious/invasive plant control	☐ Other (explain): _____
☐ Wetland improvement/restoration of existing or historic wetland (other than vegetation planting or removal)	

_____ % Estimate the percentage of total cost of the project applied to wetland habitat activities

_____ ac. Estimate the acres of wetland habitat to be treated for non-native/noxious/invasive plants (to nearest 0.1 acres)

_____ ac. Estimate the acres of artificial wetland created (to nearest 0.1 acres)

_____ ac. Estimate the total acres of wetland habitat (existing or historic) treated (to nearest 0.1 acres)

Estuarine Habitat: *Projects that result in improvement or increase in the availability of estuarine habitat.*

Check all proposed activities.

☐ Estuarine planting	☐ Placement of fill material (for proper terrestrial function)
☐ Channel modification/creation (e.g., improve intertidal flow to existing estuarine habitat or create more habitat)	☐ Non-native/noxious plant control
☐ Dike or berm modification/removal	☐ Creation of new estuarine habitat where one did not exist previously by methods other than tidegates or dikes
☐ Removal of existing fill material	☐ Other (explain): _____

_____ % Estimate the percentage of total cost of the project applied to estuarine habitat activities

_____ ac. Estimate the acres of estuarine habitat to be treated for non-native/noxious plants (to nearest 0.1 acres)

_____ ac. Estimate the total acres of estuarine habitat (existing or historic) to be treated (to nearest 0.1 acres)

Proposed Aquifer Recharge Sites for OWEB Funding
Oregon

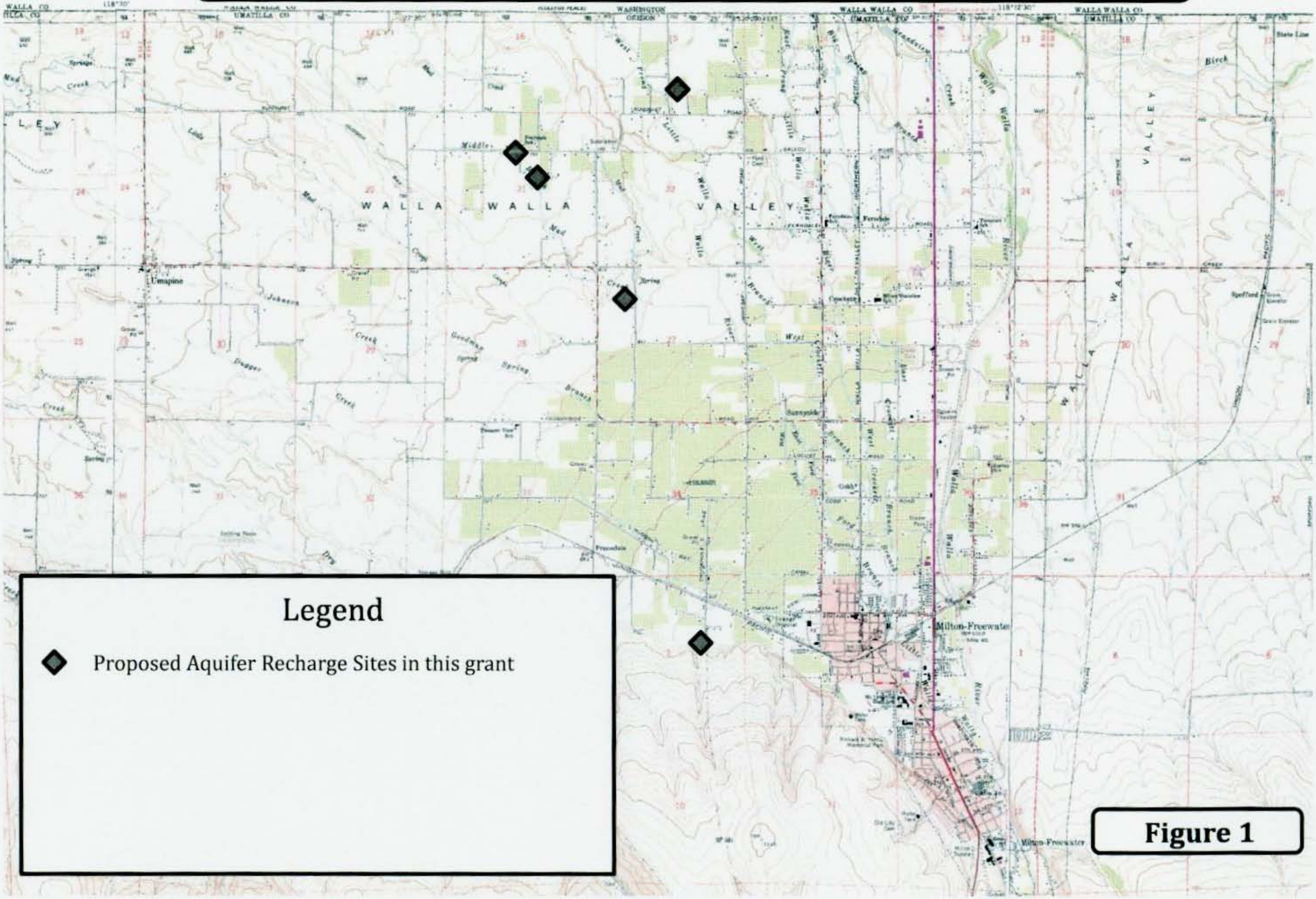


Figure 1

Current, Proposed and Future Aquifer Recharge Sites
Oregon

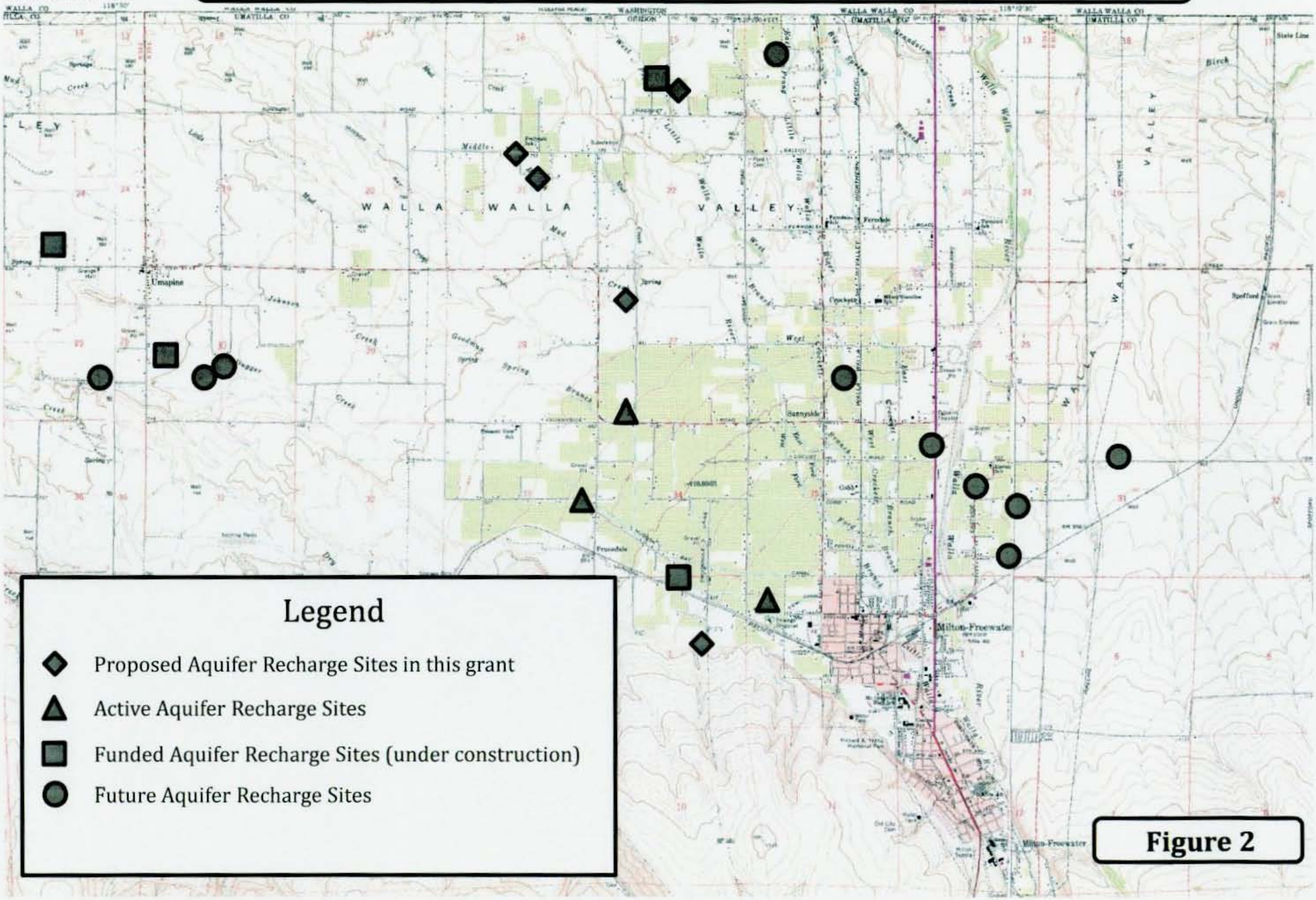
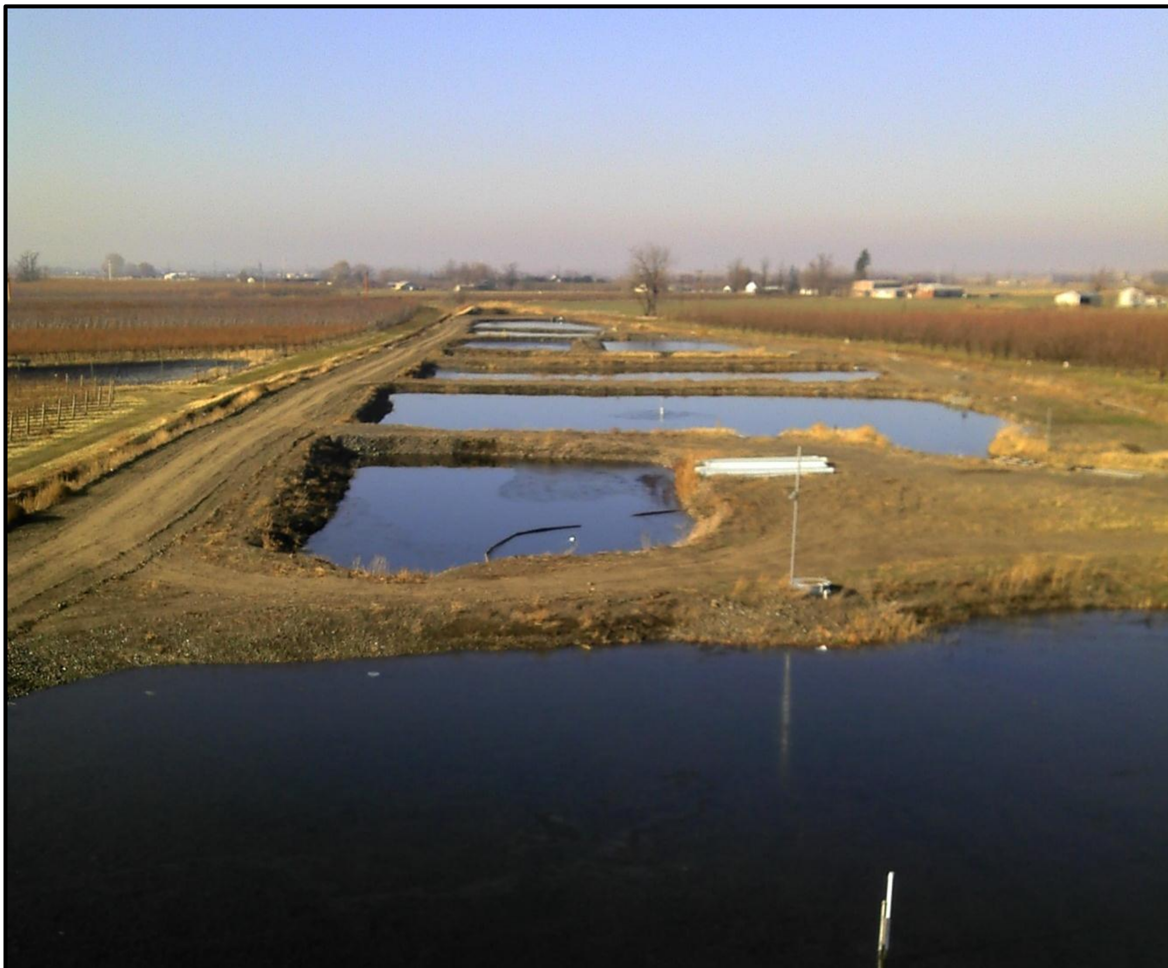


Figure 2

Attachment A

Hydrogeologic Characterization and Water Quality Monitoring Plan

Hydrogeologic Setting and Source Water and Groundwater Monitoring and Reporting Plan for the Hudson Bay District Improvement Company Multi-Site Alluvial Aquifer Limited License Application LL1433, Umatilla County, Oregon



Prepared for:

Walla Walla Basin Watershed Council and Hudson Bay District Improvement Company

Prepared by:

GSI Water Solutions, Inc.

Draft Plan – January, 3rd 2013

Hydrogeologic Setting and Source Water and Groundwater Monitoring and Reporting Plan for the Hudson Bay District Improvement Company Multi-Site Alluvial Aquifer Limited License Application LL1433, Umatilla County, Oregon

Walla Walla Basin Watershed Council

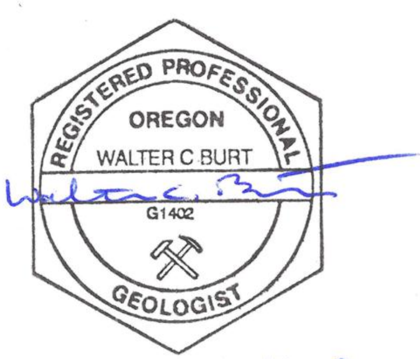
810 S. Main St., Milton-Freewater, OR 97862

And

GSI Water Solutions, Inc.

8019 W. Quinault Ave., Suite 201

Kennewick, WA 99336



Expires 05/31/2013

Contents

INTRODUCTION

This document was prepared to fulfill certain requirements in Oregon Administrative Rules (OAR) 690-350-0110 through 0130 in support of the application for artificial recharge (AR) Limited License LL1433. The Hudson Bay District Improvement Company (HBDIC) is the owner of the project, which will be jointly managed with the Walla Walla Basin Watershed Council (WWBWC). The application for Limited License LL1433 was submitted to the Oregon Water Resources Department (OWRD) in September 2012. The HBDIC project includes up to seven recharge facilities located at different sites. Because of the unique nature of this project with distributed recharge facilities, as well as the availability of a body of information from other related or nearby recharge projects, OWRD staff requested that the applicant provide a summary compilation of the hydrogeologic information relevant to the overall project area and specific recharge sites, as well as a monitoring plan for the AR project. This document has been prepared in response to OWRD's request.

The objectives of the document are three-fold: (1) summarize the hydrogeologic setting of the recharge sites listed in the application for LL1433,(2) present a proposed source water and groundwater monitoring plan and (3) present a proposed water level monitoring plan (groundwater and surface water). All of these document elements were prepared in support of the Limited License application. The project described in this document and to be permitted under LL1433 is a multi-site aquifer recharge (AR) project. The recharge sites included in this project are referred to as Anspach, Trumbull, Hulette Johnson, NW Umapine, Dugger, Barrett, and ODOT (Figure 1). At this time only one of these sites, Hulette Johnson, is active. Pilot testing at the other sites will be initiated as the HBDIC and WWBWC are able to complete infrastructure improvements necessary to operate the sites. Current information regarding each of the seven sites, including recharge facilities, local hydrogeologic conditions and proposed monitoring, are summarized in this report.

Water quality data collected from three active sites (Hewlett-Johnson, Stiller Pond and Locher Road) and one inactive site (Hall-Wentland) in the greater Walla Walla Basin have shown that AR activities conducted to-date in the Walla Walla Basin have not lead to degradation of the alluvial groundwater system (GSI, 2009a, 2009b; WWBWC, 2010). Given this, the dispersed nature of the individual AR sites, and the common source water for this proposed program, the monitoring approach described herein focused on evaluating the effects of each recharge season on water quality using a dispersed, but integrated, monitoring network.

The balance of this document includes the following:

1. A summary of AR sites to be covered under LL1433 and project goals.
2. A description of alluvial aquifer hydrogeology in the project area and immediate vicinity of each site.
3. The scope of the proposed monitoring effort, including:
    a. Proposed number, locations, and physical characteristics of monitoring points.
    b. Constituents to be monitored for.
    c. Sample collection frequency.
4. Quality assurance and quality control (QA/QC) elements.
5. Reporting.

AQUIFER RECHARGE SITES AND PROJECT GOALS

Project Goals

The overarching goal of the proposed aquifer recharge projects is to restore and maintain the shallow alluvial aquifer for the benefit of people, the environment and wildlife. Specific goals of the projects include: (1) stopping and reversing the declines seen in the shallow alluvial aquifer system throughout the Walla Walla Valley, (2) reducing the hydraulic gradient away from streams and creeks in the valley to reduce surface water seepage, especially during dry summer months, and (3) restoring flows to springs that have either dried up or have reduced flow. .

Recharge planned to be conducted under Limited License LL1433 will occur at seven separate sites shown in Figure 1. Of the seven sites listed under LL1433, one is currently active. The active site, Hulette Johnson (also commonly referred to in the past as the Hudson Bay site) has been actively monitored for several years while operating under limited license LL1189, which is still in effect. This section summarizes the basic physical layout and planned sequencing of construction and operation of each of the seven sites.

Hulette Johnson

The Hulette Johnson site is an operational recharge site consisting of a combination of infiltration basins and infiltration galleries. The recharge capacity of the site ranges between 15 to 18 cubic feet per second (cfs). The site is located between County Road 650 and Hogden Road in SE ¼, SW ¼, Sec. 33, T6N, R35E, northwest of Milton-Freewater, OR (Figures 1, 2 and 3). There are 7 wells on or very near the site, including: 3 up-gradient wells (GW40, GW39 and GW41), one mid-site well (GW45), and 5 down-gradient wells (GW35, GW46, GW47, GW48, and GW118). Wells GW45, GW46, GW47, and GW48 are purpose-built monitoring wells which were drilled and constructed as a part of the original operation of the site several years ago. These wells have been used at various times for water quality monitoring and as part of the basin-wide WWBWC water level monitoring network. The other wells noted here also have been used in the basin-wide water level monitoring network. The Hulette Johnson site will be operated during the 2012/2013 recharge season under the existing limited license LL1189 until issuance of LL1433.

Recharge source water is delivered to the site from the White Ditch. Water delivery and infiltration basin operation is managed by HBDIC. The infiltration galleries are managed by the WWBWC.

Anspach

The Anspach site is currently under construction and will be brought into use in late 2012, pending issuance of the new limited license. The Anspach site is planned to consist of an approximately 5 cfs infiltration gallery located east of Winesap Road in NW ¼, NW ¼, Sec. 30, T6N, R35E, just outside of Milton-Freewater, OR (Figures 1, 2, and 4). There is an existing well (GW135) located at the up-gradient, southeastern corner of the proposed site. A second existing well (GW23) is located generally down gradient of, and west southwest of, the proposed site. These are water wells that have been adapted for use in the basin-wide water level monitoring network. A purpose-built monitoring well, designated PMW2, is currently proposed for the east side of the proposed site.

Recharge source water will be delivered by diverting from the HBDIC canal just west of where it crosses Old Milton Highway/Lamb Street. Water will flow through a pipeline either along the north or south edge of the property to the south of the canal and then turn south to deliver water to the project property. HBDIC will be in charge of diverting recharge water to the site from the canal.

Trumbull

The Trumbull site will consist of a 3 to 5 cfs infiltration gallery, which will be located between the Umapine Highway and Trumbull Road in NW ¼, SW ¼, Sec. 27, T6N, R34E northwest of Milton-Freewater, OR (Figures 1, 2, and 5). The Trumbull site will be brought into use in late 2012, pending issuance of the limited license. There are no existing monitoring wells located at the site. However, an existing purpose-built monitoring well (GW117) used in the basin-wide water level monitoring program is located approximately 0.3 to 0.4 miles east and up-gradient of the site. Two proposed purpose built wells, PMW3 and PMW4, currently are planned for locations generally 0.3 to 0.4 miles to the west and northwest of the Trumbull site (Figure 5). These locations are generally down gradient of the proposed site, and tentatively planned for installation in the autumn of 2012.

Recharge source water would be delivered to the site from the North Lateral into an infiltration gallery. HBDIC will be responsible for diverting water to the site.

NW Umapine

The NW Umapine site is planned to consist of a 5 cfs infiltration basin located north of the Umapine-Stateline Road and west of State Road 332 in SW ¼, SE ¼, T6N, R34E just northwest of Umapine, OR (Figures 1, 2 and 6). The NW Umapine facility is anticipated to be brought on line in late 2012/early 2013, pending issuance of the limited license. The infiltration basin will be built in a previously excavated pit that exists on the site. Only a portion of the pit will be used as an infiltration basin. There are no monitoring wells or observation wells present on the site. Existing wells in the general area of the site include GW34, GW36, GW63, and GW119, all of which are part of the basin-wide water level monitoring network. GW119 is a purpose built monitoring well which the others are water wells which have been adapted for use in the water level monitoring network. Two new purpose built wells are proposed for the area of this site, PMW1 located to the south-southeast and PMW5 located just to the west.

Recharge source water would be diverted from the Richartz pipeline to the basin. HBDIC will manage water to the site by a turn out from the Richartz pipeline.

Barrett

The proposed Barrett recharge facility will be located at a site between County Road 517 and Chuckhole Lane in SW ¼, SE ¼, Sec. 34, T6N, R35E, between the Anspach and Hewlett-Johnson sites (Figures 1, 2, and 7). The recharge facility is currently planned to consist of an infiltration gallery capable of 3 cfs of recharge, and is planned to be brought online in late 2012/early 2013. Only one well is in the immediate vicinity of this site, well GW62, which is located up gradient of the facility. This well is a water well adapted for use in the basin-wide water level monitoring program.

Recharge source water will be delivered from the Barrett pipeline into the currently proposed infiltration gallery. HBDIC will be responsible for operating the diversion into the site.

Dugger

This proposed recharge facility will be located at a site between Phillips Road and Ringer Road in NW ¼, SE ¼, Sec. 30, T6N, R35E (Figures 1, 2, and 8). The site is planned to be brought into operation in late 2013/early 2014, and the final design of the site has not yet been determined. There are two existing monitoring wells near the site, both part of the basin-wide water level monitoring network. Well GW36 (a water well) is located just north of the proposed site, and likely transverse to the groundwater flow direction in the area. This well, and a more distal, existing, purpose-built monitoring well, GW119, also located transverse to the anticipated groundwater flow direction, would at a minimum have utility in tracking water level changes in the area of the proposed site. On new purpose built monitoring well is proposed for the site. It (PMW1) would be located just west of the proposed recharge facility.

Water will be diverted off the White Ditch to feed the project. HBDIC will manage water to the site by a turn out from the ditch.

ODOT

The ODOT site is located SW ¼, NW ¼, Sec. 34, T6N, R35E (Figures 1, 2, and 9). The site is planned to be brought into operation in late 2013/early 2014. The facility is tentatively planned to consist of an infiltration basin. Water will be delivered to the site from the White Ditch, upstream of the Hulette Johnson site. Once the design for the site is finalized and planned monitoring points have been established, this monitoring plan will be amended to incorporate the updated information for the site.

WALLA WALLA BASIN HYDROGEOLOGIC SETTING

The goal of this section is to present a summary of alluvial aquifer hydrogeologic conditions regionally and within area of the HBDIC multi-site AR project. This summary is intended to provide the physical framework, or context, for the planned monitoring. It is not intended to provide detailed information about the groundwater system of the Walla Walla Valley. In addition, it does not include a discussion or summary of the deeper basalt aquifer systems underlying the area. For more details of area hydrogeology, the reader is referred to Newcomb (1965), Barker and McNish (1976), GSI (2007, 2009a, 2009b) and WWBWC (2010) and other citations as presented herein.

Hydrostratigraphy

Five alluvial sediment hydrostratigraphic units are mapped in the project area, including: (1) Quaternary fine unit, (2) Quaternary coarse unit, (3) Mio-Pliocene upper coarse unit, (4) Mio-Pliocene fine unit, and (5) Mio-Pliocene lower coarse unit. Figure 10 illustrates the stratigraphic relationships between the 5 mapped units and top of basalt. The following sections describe the basic physical characteristics of each suprabasalt sediment unit and top of basalt.

Quaternary Units

Quaternary Fine Unit

Newcomb (1965) and several subsequent investigators (Fecht and others, 1987; Busacca and MacDonald, 1994; Waitt and others, 1994) described a variety of Quaternary aged fine (clay/silt/fine sand dominated) units in the area of the Walla Walla Basin. Above elevations of approximately 1150 to 1200 feet above mean sea level (msl), these strata consist predominantly of loess. Isolated hills found on the valley floor and much of the upland area north of the Walla Walla River consist predominantly of Missoula flood deposited silt and sand referred to as the Touchet Beds. Reworked flood deposits and loess form local accumulations of fine strata across the valley floor near major streams. These strata are grouped into a single unit referred to as the Quaternary fine unit. The thickness of this unit varies greatly, depending on local topography, depth of stream incision, and original depositional patterns.

Variation in unit thickness and its absence locally, especially along modern stream courses, likely reflects both depositional factors and post-deposition erosion. For example, the wide distribution of the Quaternary fine unit around the northern edge of the Basin primarily reflects widespread deposition followed by localized deep erosion along relatively, ephemeral stream courses. Conversely, the fact that the unit is thin to absent along major stream courses (notably the Touchet River, Walla Walla River, and Mill Creek) likely reflects, at least in large part, the erosive effects of these major streams incising into and removing Pleistocene Cataclysmic Flood deposits and eolian deposited fines.

Quaternary Coarse Unit

Uncemented and nonindurated sandy to gravelly strata is found in the shallow subsurface beneath much of the Basin. These gravely deposits are basaltic, moderately to well bedded, have a silty to sandy matrix, and contain thin, local silt interbeds. These uncemented and nonindurated basaltic gravels generally are equivalent to Newcomb's (1965) younger alluvial sand and gravel and are referred to currently as the Quaternary coarse unit. This sequence of uncemented gravel is interpreted to record stream deposition in the Walla Walla Basin by streams draining off the adjacent Blue Mountains. These streams are inferred to include the ancestral courses of the modern stream drainage. Based on stratigraphic relationships the Quaternary coarse unit predates, is contemporaneous with, and post-dates Missoula flood deposits. Given this, the Quaternary coarse unit probably ranges in age from a few years old to as old as 1 million years or more.

Both depositional and erosional mechanisms can explain Quaternary coarse unit distribution. Its planar-tabular distribution in the Milton-Freewater area and the area beneath and east of Walla Walla probably reflects deposition in shallow, braided channel complexes on an active (or recently active) braid plain. To the west, elongate patterns may reflect gravel deposition down the topographically low axis of the Basin as it has existed in the recent geologic past (last 1 to 2 million years). The elongate areas where the unit is absent potentially reflect areas of non-deposition because of the absence of channels and/or post-depositional erosion. The highs and lows apparent in the top of this unit along the base of the Horse Heaven Hills are interpreted to be related to the deformation and uplift of these hills. During that uplift, the surface of the unit has been deformed, in some areas uplifted, in other areas, down-dropped.

Mio-Pliocene Strata

The primary basin-filling alluvial strata in the Basin include a sequence of indurated sand, gravel, siltstone, and claystone generally equivalent to Newcomb's (1965) old gravel and clay. Based on lithologic and stratigraphic relationships these indurated suprabasalt sediments are inferred to have a Miocene to late Pliocene age (10+ to ~3 million years old). These strata are subdivided into three mappable units – Mio-Pliocene upper coarse unit, Mio-Pliocene fine unit, and Mio-Pliocene basalt coarse unit.

Mio-Pliocene Upper Coarse Unit

The Mio-Pliocene upper coarse unit consists of a sequence of variably cemented sandy gravel, with a muddy to sandy, silicic to calcic matrix. This unit underlies much of the Walla Walla Basin. Field reconnaissance reveals thin, localized, discontinuous caliche at the top of these strata at some locations. Based on physical characteristics displayed by analogous strata in rare outcrops, field reconnaissance, and a small number of borehole log descriptions these strata are predominantly basaltic in composition and typically have a slightly too well developed red, red brown, and yellow brown color. The Mio-

Pliocene upper coarse unit generally is continuous beneath the entire Basin, being absent only in a few, relatively small areas.

Isopach data for this unit shows that it varies greatly in thickness, ranging from just a few feet thick to over 500 feet thick. The thickest accumulations of the unit tend to be along the southern edge of the Basin adjacent to the base of the Horse Heaven Hills where it generally ranges from 200 to more than 500 feet thick, and along the eastern edge of the Basin. The unit is interpreted to have been deposited predominantly in a braided stream system by the ancestral Walla Walla River, Mill Creek, and larger tributaries. These streams delivered large volumes of coarse detritus onto the basin floor as it subsided and the bounding uplands were uplifted. Generally, these streams merged into a single, main Walla Walla River ancestral stream that generally flowed to the west, much like the modern stream. In addition, faulting may also have played a role in unit distribution.

Mio-Pliocene Fine Unit

The Mio-Pliocene upper coarse unit generally is underlain by fine deposits variously described as silt, clay, sandy clay, and sandy mud having blue, green, gray, brown, and yellow colors. These strata are designated the Mio-Pliocene fine unit. This unit is thickest in the northeastern, north, central, and western Basin where it can range between 300 and 500 feet thick. These areas generally are located north and west of areas of thickest accumulation of the overlying Mio-Pliocene upper coarse unit. Depositional, erosional, and structural factors similar to those that are interpreted to affect the overlying unit also are interpreted to have had a role in controlling Mio-Pliocene fine unit distribution.

Mio-Pliocene Basal Coarse Unit

The basal coarse unit consists of arkosic-micaceous sand and silt in the basal portion of the Mio-Pliocene section directly overlying basalt. These strata form an interval several tens of feet to over 100 feet thick. This unit, with its distinctive arkosic mineralogy, is very different petrographically from other strata comprising the Mio-Pliocene sequence in the Basin. Because of this distinctive mineralogy, this unit is inferred to have been deposited by the ancestral Salmon-Clearwater River, which entered the Basin from the north.

Top of Basalt

The alluvial sequence overlies the Columbia River Basalt Group (CRBG) beneath the entire basin area. The top of the CRBG, while irregular, forms the base of the alluvial sequence, and it generally appears to dip downwards off the highlands surrounding the Basin, in to the center of the Basin. Given this, the top of basalt in the Basin ranges from the ground surface around the basin margins, to a depth of over 800 feet near the center of the basin.

Alluvial Aquifer Hydrogeology

Groundwater in the Walla Walla Basin region occurs in two principal aquifer systems: (1) the unconfined to confined suprabasalt sediment ("alluvial") aquifer system which is primarily hosted by Mio-Pliocene conglomerate and Quaternary Coarse Unit, and (2) the underlying confined CRBG aquifer system (Newcomb, 1965).

The majority of the alluvial aquifer is hosted by Mio-Pliocene strata, although the uppermost part of the aquifer is found, at least locally, in the overlying Quaternary coarse unit. The alluvial aquifer is generally characterized as unconfined, but it does, at least locally, display evidence of confined conditions. Variation between confined and unconfined conditions within the aquifer system is probably controlled by sediment lithology (e.g., facies – coarse versus fine) and induration (e.g., cementation, compaction). Groundwater movement into, and through, the suprabasalt aquifer also is inferred to be controlled by sediment lithology and induration. Generally, the deeper portions of the alluvial aquifer unit are more likely to exhibit confined conditions relative to the shallower portions of the aquifer.

Aquifer Properties

Given the physical properties of the Quaternary course unit (non-indurated sand and gravel) versus those of the Mio-Pliocene upper coarse unit (e.g., finer matrix and the presence of naturally occurring cement), the Mio-Pliocene upper coarse unit probably has generally lower permeability and porosity than the Quaternary coarse unit. Consequently, suprabasalt aquifer groundwater flow velocities are inferred to be less where the water table lies within the Mio-Pliocene strata and/or the gradients are higher than where it lies within the younger, more permeable Quaternary strata. In addition, where the Quaternary coarse unit is saturated, this uncemented, high permeability gravel and sand may form preferred pathways for groundwater movement and areas of increased infiltration capacity in the shallow parts of the suprabasalt aquifer system.

Very little hydraulic property information is available for the alluvial aquifer system. Newcomb (1965) reports average effective porosity of 5 percent in his old gravel (i.e., the Mio-Pliocene upper coarse unit). Given the physical characteristics of the overlying Quaternary coarse unit, we suspect its average effective porosity is higher.

Basin-wide estimates of the hydraulic properties of alluvial aquifer system were made by Barker and Mac Nish (1976) as part of their effort to produce a digital model of this aquifer system. This modeling work used estimated hydraulic conductivity of 1.5×10^{-4} feet/second to 7.6×10^{-3} feet/second and transmissivity of 10,000 $feet^2$/day to 60,000 $feet^2$/day for the entire alluvial aquifer system. As with Newcomb's (1965) effective porosity estimate, we suspect hydraulic conductivity and transmissivity would be higher in saturated Quaternary coarse unit strata than in the saturated Mio-Pliocene upper coarse unit.

Groundwater Level and Flow Direction

Recent efforts by the WWBWC have begun to build a picture of alluvial aquifer water level conditions in the eastern and southern Walla Walla Basin. This data is compiled and available online at WWBWC website at http://www.wwbwc.org. Figure 11 is a water table map for the basin built from these data. Based on these data, and earlier investigations the following basic observations relative to alluvial aquifer water level and flow direction can be made:

- Groundwater flow in the alluvial aquifer system generally is from east to west. Locally this flow may converge towards the Walla Walla River and other streams where the alluvial aquifer water table is higher than the stream. Where this occurs, streams are, in part, fed by groundwater discharge. However, along many reaches of the Walla Walla River and other streams in the Basin, the alluvial water table may at least locally be below the bed of the stream during some or all of the year. When and where this occurs, such stream reaches probably lose water to the alluvial aquifer, thus acting as a recharge source for groundwater.
- Water level within the alluvial aquifer varies seasonally. Barker and MacNish (1976, p. 25) determined that the month of January was the time of year when this aquifer is under the smallest amount of pumping stress and that water table most reflect unmodified conditions. In some portions of the Basin, seasonal changes in the water table elevation can be as great as 50 feet (Newcomb, 1965; Pacific Groundwater Group, 1995).

- Groundwater level declines have been ongoing for a number of years, although recent AR efforts have reversed these trends at least locally near existing sites, in particular the Hulette Johnson site (WWBWC, 2010 – attached as Appendix E).

Aquifer Recharge and Discharge

Recharge to the alluvial aquifer is derived from infiltration of surface waters (e.g., where streams enter the basin), leakage from irrigation ditches, applied irrigation water, direct precipitation, and to a lesser extent leakage from the CRBG aquifer system (Newcomb, 1965; Barker and MacNish, 1976; Pacific Groundwater Group, 1995). The majority of this recharge probably occurs in the spring when streams flowing into the Basin reach peak discharges. Precipitation on parts of the Basin floor where the Quaternary coarse unit and older the Miocene-Pliocene upper coarse unit lie at, or near, the surface may also provide some natural recharge. Evaluation of these various sources of recharge to the alluvial aquifer suggests that direct precipitation and applied irrigation water are the dominant sources of recharge (Bauer and Vaccaro, 1990; Pacific Groundwater Group, 1995; WWBWC, 2010). With flood control and channelization of the Walla Walla River and smaller streams, natural recharge via infiltration from surface waters has probably decreased with continued development.

Artificial recharge of the alluvial aquifer from agricultural practices and water conveyance systems has become an important component of the Basin's hydrologic system since the 1920's and 1930's. This recharge is thought to have historically contributed water to at least some shallow water wells and springs (Newcomb, 1965; WWBWC, 2010). Artificial recharge probably occurs through irrigation ditch leakage and infiltration past the root zone in irrigated fields. With the advent of ditch/channel lining and reduction in the practice of flood irrigation, this type of recharge has probably decreased. Reduced natural and artificial recharge and pumping account for decreased alluvial aquifer water table levels. Decline in water table levels in-turn probably account for reduced spring flows and base level discharge to the Walla Walla River.

Discharge from the alluvial aquifer occurs in a number of ways, including direct discharge to streams, springs and seeps, pumped water wells, evapotranspiration, and localized leakage to the CRBG aquifer system (Newcomb, 1965; Barker and Mac Nish, 1976; Pacific Groundwater Group, 1995).

Alluvial Aquifer Water Quality

Historical water quality data available include a groundwater quality report prepared by Richerson and Cole (2000) and source water and groundwater quality reporting done for several AR sites, including the Hulette Johnson site. Based on Richerson and Cole (2000), the Hulette Johnson site data (WWBWC, 2010), and groundwater quality data collected from other AR sites in the Walla Walla Basin (GSI, 2009a, 2009b) some basic observations with respect to alluvial aquifer water quality can be made, including the following:

- With respect to nutrient type constituents, including nitrate-N, TKN, phosphate, and ortho-phosphate water quality in the area generally has not been significantly degraded. In addition, the groundwater down gradient of AR sites generally show declines in constituent concentrations, which are interpreted to reflect dilution of ambient groundwater concentrations by lower concentration AR water.
- Other parameters, such as TDS, chloride, and electrical conductivity also commonly show evidence of down gradient reductions attributed to AR activities. These trends are interpreted as evidence of dilution of these parameters in groundwater by AR water.

- The synthetic organic compound (SOC) data indicate that AR operations have essentially no influence on SOC's present in groundwater.
- In addition to these observations, the Hall-Wentland data are instructive as they show the importance of natural leakage from surface waters (which typically are the same waters these AR sites use for source water) in influencing local groundwater chemistry.

RECHARGE SITE HYDROGEOLOGY

Building on the preceding summary of basin wide hydrogeologic conditions, the following sections provide basic highlights of specific hydrogeologic conditions at each HBDIC project AR site. Geologic cross-sections for each site are built from the WWBWC's basin wide geologic and hydrogeologic model.

Hulette Johnson

Figure 12 provides a geologic cross-section of the Hulette Johnson site. Geologic units present in the vicinity of the site are as follows:

- Quaternary fines unit: This unit is interpreted to be essentially absent from this site, although thin surface occurrences are present offsite to the west and east. In addition, excavation work during infiltration gallery construction revealed a thin, local surface silty-sand that could be assigned to this unit. Nevertheless, where present in the immediate area, the unit is generally less than 10 feet thick.
- Quaternary coarse unit: This unit forms the uppermost geologic unit across the site area (except for the localized fines noted in the preceding bullet). Beneath the site the unit generally is interpreted to be 20 to 30 feet thick.
- Mio-Pliocene upper coarse unit: This unit underlies the entire site area and is interpreted to range from approximately 120 to 200 feet thick.
- Mio-Pliocene fine unit: This unit also underlies the entire site area where it is interpreted to be approximately 250 to 350 feet thick, increasing to the west-northwest.
- Mio-Pliocene basal coarse unit: This unit is not present beneath the site
- Top of Basalt: Beneath the site the top of basalt generally deepens to the west-northwest, ranging from approximately 425 feet bgs to 600 feet bgs.

The hydrogeology of the Hewlett-Johnson site is better understood than the other sites because of its active status, and has been previously reported on in WWBWC (2010). The alluvial aquifer water table generally varies between the basal part of the Quaternary coarse unit and the upper part of the Mio-Pliocene upper coarse unit, rising and falling seasonally and in response to AR and canal operations. Depth to water varies seasonally from 10 to 50 feet bgs according to on-site monitoring wells. Groundwater flow at the site generally is towards the northwest. The table below shows water volumes delivered to the Hulette Johnson site for each recharge season (Nov-May).

Recharge Season								
Spring 2004	2004-2005	2005-2006	2006-2007	2007-2008	2008-2009	2009-2010	2010-2011	2011-2012
~410 Acre Feet	~1870 Acre Feet	~ 2810 Acre Feet	~3230 Acre Feet	~2740 Acre Feet	~2840 Acre Feet	~3750 Acre Feet	~ 3700 Acre Feet *	~3970 Acre Feet

* Data collected for the first two months of the 2010-2011 recharge season was erroneous and/or missing. Water volumes for the first two months have been estimated based upon the 2009-2010 & 2011-2012 seasons

Anspach

Figure 13 provides a geologic cross-section of the Anspach site. Geologic units present at the Anspach site are as follows:

- Quaternary fines unit: This unit is interpreted to not be present at the site, but it is mapped in the area just to the west where it is less than 1 foot to approximately 20-30 feet thick.
- Quaternary coarse unit: At the site this unit is interpreted to extend from the ground surface downwards approximately 60 to 70 feet.
- Mio-Pliocene upper coarse unit: This unit is approximately 70 feet thick in the immediate vicinity of the site. To the east it is interpreted to directly overlie basalt. To the west it overlies the Mio-Pliocene fine unit.
- Mio-Pliocene fine unit: This unit is mapped as pinching out directly beneath the site. Just to the west and northwest of the site it is interpreted to thicken, as the top of basalt gets deeper.
- Mio-Pliocene basal coarse unit: This unit is not present beneath the site
- Top of Basalt: The site is interpreted to overlie an area where the top of basalt gets deeper just a short distance to the west. At and beneath the eastern part of the site top of basalt may be as little as 100 feet below ground surface (bgs). To the west it is interpreted to be over 250 feet bgs.

The alluvial aquifer water table generally lies at or near the top of the Mio-Pliocene upper coarse unit. Depth to water varies from about 15-35 feet depending on season (irrigation/non-irrigation). Groundwater flow direction in the alluvial aquifer at this site is interpreted to generally be to the west-northwest.

Trumbull

Figure 14 provides a geologic cross-section of the Trumbull site. Note, the specific location of the infiltration gallery currently envisioned for this site has yet to be determined. Geologic units present in the vicinity of the Trumbull site are as follows:

- Quaternary fines unit: This unit is only present in the area west of County Road 332. In that area it is less than 1 foot to approximately 15 feet thick.
- Quaternary coarse unit: This unit forms the uppermost geologic unit across the proposed site area where it is interpreted to range from 30 to 50 feet thick, thinning and pinching out to the west.
- Mio-Pliocene upper coarse unit: This unit underlies the entire site area and is interpreted to range from approximately 220 to 250 feet thick, thickening to the west.
- Mio-Pliocene fine unit: This unit also underlies the entire site area where it is interpreted to be approximately 300 feet thick.
- Mio-Pliocene basal coarse unit: This unit is not present beneath the site
- Top of Basalt: Beneath the site the top of basalt generally deepens to the west-northwest, ranging from approximately 550 feet bgs to 650 feet bgs.

The alluvial aquifer water table generally lies in the Quaternary coarse unit, resulting in the entire Mio-Pliocene upper coarse unit being saturated. In the immediate vicinity of the site depth to groundwater generally is 20 feet or less. However, a series of seasonal springs north of the site suggest groundwater in this area can be much shallower, at least seasonally. To the west, the depth to water is 45 feet bgs or greater just to the east of this site in well GW117. The groundwater flow direction is interpreted to be to the west-northwest.

NW Umapine

Figure 15 provides a geologic cross-section of the NW Umapine. Geologic units present in the vicinity of the site are as follows:

- Quaternary fines unit: This unit is interpreted to be present in the site area where it may be as much as 20 feet thick. However, at the site itself it is absent because it was removed during the excavation of the pit that will be used as the AR facility.
- Quaternary coarse unit: This unit is mapped to be present in the site area, but it is interpreted to be very thin, possibly less than 10 feet thick. As with the Quaternary fine unit, it is interpreted to be absent (as it was removed during digging) in the excavated pit which is planned as the AR facility.
- Mio-Pliocene upper coarse unit: This unit underlies the entire site area and is interpreted to range from approximately 200 to 250 feet thick. The existing pit identified as the candidate location for the infiltration basin is excavated into the top of the Mio-Pliocene upper coarse unit.
- Mio-Pliocene fine unit: This unit also underlies the entire site area where it is interpreted to be approximately 200 feet thick.
- Mio-Pliocene basal coarse unit: This unit is not present beneath the site
- Top of Basalt: Beneath the site the top of basalt generally lies at a depth of 500 feet bgs.

The depth to the alluvial aquifer water table is approximately 25 to 30 feet bgs (based on well GW34), which places the water table in the uppermost part of the Mio-Pliocene upper coarse unit.

Barrett

Figure 16 provides a geologic cross-section of the Barrett site. Geologic units present in the vicinity of the site are as follows:

- Quaternary fines unit: This unit is interpreted to be absent beneath the site.
- Quaternary coarse unit: This unit is interpreted to underlie the entire site area, ranging from approximately 30 to 50 feet thick.
- Mio-Pliocene upper coarse unit: This unit also underlies the entire site area and is interpreted to range from approximately 110 to 130 feet thick.
- Mio-Pliocene fine unit: This unit also underlies the entire site area where it is interpreted to be approximately 100 to 120 feet thick.
- Mio-Pliocene basal coarse unit: This unit is not present beneath the site
- Top of Basalt: Beneath the site the top of basalt appears to dip to the west-northwest and it lies at depths of 240 to 260 feet.

Beneath the Barrett site, the alluvial aquifer water table appears to generally lie at, or near, the bottom of the Quaternary coarse unit, at a depth of approximately 30 to 35 feet bgs. The groundwater flow direction at the site is generally to the northwest.

Dugger

Figure 17 provides a geologic cross-section of the Dugger site. Geologic units present in the vicinity of the site are as follows:

- Quaternary fines unit: This unit is interpreted to be present across most of the site area where it is interpreted to range from approximately 10 to 20 feet thick. Just to the south of the site the unit appears to pinch out.
- Quaternary coarse unit: This unit is interpreted to underlie the entire site area, ranging from approximately 20 to 30 feet thick.
- Mio-Pliocene upper coarse unit: This unit also underlies the entire site area and is interpreted to range from approximately 110 to 130 feet thick.
- Mio-Pliocene fine unit: This unit also underlies the entire site area where it is interpreted to be 300, or more, feet thick.
- Mio-Pliocene basal coarse unit: This unit is not present beneath the site
- Top of Basalt: Beneath the site the top of basalt appears to dip to the south, towards the Horse Heaven Hills. The top of basalt is interpreted to be approximately 475 to 525 feet bgs.

Beneath the Dugger site, the alluvial aquifer water table appears to generally lie at, or near, the bottom of the Quaternary coarse unit, at a depth of approximately 20 feet bgs. Although regional water level (Figure 11) shows groundwater flow to the west-northwest, Figure 17 suggests local water level may differ from this, at least at some times during the year. This will be evaluated further during site preparation work. If this flow direction proves to be correct, it is interpreted to be a local phenomenon.

ODOT

Figure 18 provides a geologic cross-section of the ODOT site. Geologic units present in the vicinity of the site are as follows:

- Quaternary fines unit: The Quaternary fine unit is interpreted to be absent this site.
- Quaternary coarse unit: This unit is interpreted to be approximately 20 to 30 feet thick at the site.
- Mio-Pliocene upper coarse unit: This unit is interpreted to be as much as 200 feet thick at the site.
- Mio-Pliocene fine unit: This unit underlies the entire site area and is interpreted to be approximately 200 feet thick.
- Mio-Pliocene basal coarse unit: This unit is not present beneath the site
- Top of Basalt: Beneath the site the top of basalt is interpreted to the northwest, ranging from depths of approximately 400 to 475 feet.

Beneath the ODOT site the alluvial aquifer water table appears to generally occur within the upper part of the Mio-Pliocene upper coarse unit, at a depth of approximately 30 to 40 feet bgs. The direction of groundwater flow at the site is generally towards the northwest.

PROPOSED MONITORING PLAN

This section presents the monitoring plan for the proposed multi-site AR limited license. This plan includes the following elements: source water and groundwater quality sampling and analysis, water level monitoring, and recharge water flow rate measurements. The proposed plan focuses on the objective of assessing the impacts to alluvial aquifer groundwater of the entire multi-site AR program. The following sections explain how this monitoring approach would be implemented, locations and constituents proposed for monitoring, and other supporting information relative to the monitoring program.

Water Quality Monitoring

Water quality monitoring for this multi-site AR project will integrate source water quality data from several locations in the canal delivery system with groundwater quality data collected from multiple locations to assess the impacts on area groundwater of the entire AR program. Under this programmatic approach individual AR facilities will be monitored to a greater or lesser extent in support of the entire program. This proposed programmatic approach was developed from evaluation of data from recharge projects in the region using similar source waters (Appendix A). Water quality sampling will be done for field parameters, cations, anions, metals, and synthetic organic compounds (SOC). Specifics regarding these are described in the following sections.

Water Sample Collection and Analysis for Field Parameters, Cation/Anions, and Metals

Recharge source water and alluvial groundwater will be sampled twice during each recharge cycle for analysis of a select list of indicator constituents considered to be most representative of the potential for AR degradation of alluvial aquifer groundwater quality, based on recharge water sources, adjacent land uses, and a review of AR data collected to-date at several sites in the Walla Walla Basin. The list of proposed analytes for is assembled using data from previous and on-going AR operations in the region using similar source water. Basic elements of the water quality sampling and analysis include the following:

- Samples will be collected at monitoring points listed in the following sections twice each recharge cycle: (1) within one week of the start of recharge operations, and (2) within one week after termination of each recharge season, commonly in May.
- Each sample will be analyzed for the following constituents: pH, temperature, electrical conductivity, dissolved oxygen, nitrate-N, TKN, sulfate, chloride, calcium, alkalinity, ortho-phosphate, sodium, total organic carbon, potassium, aluminum, magnesium, iron (dissolved), and manganese (dissolved). Table 1 lists these analytes and recommended analytical methods and method reporting limits.
- Turbidity, total dissolved solids, and total suspended solids data also will be collected to support operational goals, but not reported as a part of this monitoring plan.

Table 1. Proposed analyte list, analytical methods, and method reporting limits.

Analyte	Analytical method	Method reporting limit (mg/L)
pH	-	-
Temperature (^oC)	-	-
Electrical conductivity (mS/cm)	-	-
Dissolved oxygen (mg/L)	-	-
Total organic carbon	SM 5310B	0.5
Nitrate-N (mg/L)	EPA 300.0	0.1
TKN (mg/L)	SM 4500 N B	0.1
Sulfate (mg/L)	EPA 300.0	0.1

Analyte	Analytical method	Method reporting limit (mg/L)
Chloride (mg/L)	EPA 300.0	0.1
Alkalinity (mg/L)	SM232OB	5
Calcium (mg/L)	EPA 200.7	0.1
Ortho-phosphate (mg/L)	EPA 300.0	0.1
Sodium (mg/L)	SPA 200.7	0.1
Potassium (mg/L)	EPA 200.7	0.1
Magnesium (mg/L)	EPA 200.7	0.1
Aluminum (mg/L)	EPA 200.7	0.01
Iron (dissolved) (mg/L)	EPA 200.7	0.01
Manganese (dissolved) (mg/L)	EPA 200.7	0.05

SOC Sample Collection and Analysis

A single SOC alluvial groundwater sample will be collected each season. This sample will be collected within one week after termination of each recharge season, commonly in May. The same analyte list currently sampled for at the Hulette Johnson site is proposed for this monitoring plan. These are as follows:

- Rubigan (Fenarimol)
- Ridomil (Metalxyl)
- Systhane/Rally (Myclobutanil)
- Devrinol (Napropamide)
- DDD-DDE-DDT
- Elgetol (DNOC sodium salt)
- Alar/B-Nine (Daminozide)
- Lindane (Lindane)

Source Water Quality Monitoring Locations

Source water quality sampling will be conducted at several locations in the canal and pipeline recharge water conveyance system. Source water monitoring sites will be in the distribution system at select locations up-stream of AR facilities. Specific source water monitoring locations, both existing and potential future locations, are shown on Figure 19 and are as follows:

- Source water monitoring location S-1 will be established in the White Ditch canal up-stream of the proposed diversion to the Anspach site. Samples from this location represent source water diverted to the Anspach site and the Barrett site. Also, this location is up-stream of all recharge sites and this is considered representative of overall source water conditions.
- Source water monitoring location S-2 will be established on the White Ditch canal immediately upstream of the proposed diversion for the ODOT and Trumball site. This site is representative of source water quality diverted to the Hulette-Johnson site, ODOT site, and the Trumball site.
- Source water monitoring point S-3 will be established at the up-stream end of the Richartz Pipeline to represent source water delivered to the NW Umapine site.

Groundwater Quality Monitoring Locations

Groundwater quality monitoring will be conducted at monitoring points located to evaluate overall AR program impacts on up-gradient and down-gradient water quality for the multi-site AR project and also provide site-specific water quality data for specific AR locations to be operated under the proposed limited license.

Planned 2012/2013 recharge season groundwater monitoring locations (all in wells built to the monitoring well standard) and the general rationale for each are listed below and shown on Figure 2.

- PNW2: provides up gradient monitoring for the entire project and specifically for the Anspach and Barrett sites.
- GW46: provides down gradient monitoring for the Hulette Johnson site.
- GW117: provides water quality information for the central region of the AR program, and up gradient monitoring for the Trumball site.
- PNW3: provides down gradient coverage for the Trumbull site.
- GW119: provides up gradient coverage for both the NW Umapine site and it would provide a programmatic monitoring location further down gradient than the aforementioned wells do.
- PMW5: provides down gradient monitoring for the NW Umapine site and it provides the furthest down gradient monitoring point in the entire program.
    - This well will be the sampling location for the proposed SOC sampling event at the conclusion of each recharge season.

Data from these 6 wells, when combined with the source water data collected at the three locations named in the preceding section will be used to interpret water quality impacts of the entire proposed AR program. As this program develops it is anticipated that these monitoring locations will be periodically re-evaluated and potentially modified. One modification would be the addition of proposed well PMW-1 to the area immediately down gradient of the Dugger site. This monitoring system could expand or contract as the number of individual AR sites covered by it changes, such as when new sites are added or old sites are decommissioned.

Flow and Water Level Monitoring

Surface Flow Monitoring

Flow monitoring will be done in the canals or pipes feeding each individual AR site. The objective of flow monitoring is to document the volumes of water delivered to each AR site during its operations. A flow monitoring point has already been established for the Hulette Johnson site, and it will continue to be used for this project. For the other sites these monitoring points will be established as each facility becomes operational.

Each aquifer recharge site will have either a rated intake structure (Hulette Johnson) or have a flow meter installed at the diversion from the irrigation canal (Anspach, Barrett, NW Umapine, ODOT, Trumbull). Water volume delivered to each site will be collected and stored by the WWBWC and reported to OWRD in a written annual report which will include digital data. See Figure 20 for surface water monitoring locations. See Appendix B for details on surface measurement protocols and data management.

Groundwater Level Monitoring

The WWBWC currently maintains a water level monitoring program in the area of this project. Figure 2 shows the locations of wells in the WWBWC program in the project area and Figure 20 shows the WWBWC Oregon monitoring network. With the addition of 5 new wells shown on Figure 2, this project proposes to use the WWBWC water level monitoring program to track water level changes related to the proposed AR efforts. See Appendix C for groundwater level data and details on groundwater level monitoring protocols and data management.

Groundwater level monitoring locations provide useful information on aquifer recharge influences to the shallow aquifer. Wells were located to try to capture up-gradient to down-gradient influences from individual recharge projects. However, based upon limited funding and the spatial nature of the aquifer, it is not possible to have wells at every desired location. Wells in the water level network provide year round data for analysis of groundwater changes during recharge activities and also for longer term analysis of groundwater recovery (i.e. increased groundwater storage). Many of the wells used for monitoring have secondary hydraulic influences other than aquifer recharge. Wells located near the White Ditch show responses to ditch activity. A few wells may show draw down caused by pumping from other wells. See Appendix D for details on well locations (GPS coordinates) and UMAT numbers. Groundwater level data will be included in digital format with the written annual report.

SAMPLING AND ANALYSIS PROCEDURES

The equipment needs and sampling procedures proposed for this investigation are provided in the following sections.

Water Level Measurements

A static water level measurement will be obtained from each well prior to initiating water quality sampling. An electronic water level meter will be used to measure the depth to groundwater in each well to the nearest 0.01 foot. Static water levels must be measured prior to introducing any purging or sampling equipment in the well. Each measurement will be taken against the reference point located on top of the well casing. The static water levels in all wells should be measured on the same day for each site. Coordination with periodic sampling of other wells in the vicinity should be attempted.

Water Sampling Equipment

Sampling will be conducted using the following specific equipment, as follows:

- Submersible pump (Grundfos or similar) or dedicated bailers/sampling line.
- Temperature measuring instrument.
- pH and specific conductivity meter(s) with calibration reagent.
- Water level meter (0.01 ft resolution).
- Shipping cooler(s) with ice packs or ice.
- Five gallon pail marked at the 5 gallon level, stopwatch.
- Laboratory supplied sample containers with appropriate preservatives.
- Tap water, deionized water, phosphate-free soap, cleaning brushes, log sheets or field notebook.
- Chain of custody forms.

Additional information relative to periodic and contingent sampling is described below.

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 Procedures

Low Flow Sampling Protocol

The purpose of using low flow rates during low-flow purging is to avoid mobilization of formation solids and reduce purge volumes required to achieve collection of a sample representative of aquifer water quality. This technique is premised on minimizing drawdown of the aquifer and stabilization of field parameters prior to and during sample collection. Pump flow rates should be less than or equal to the yield of the well, so that a stabilized pumping water level is achieved as quickly as practical, in order to then expedite the stabilization of the indicator parameters.

Minimal-drawdown procedures should consist of evacuating the total volume of groundwater present in the sampling system to clear the well pump, tubing, and flow cell, if used, of any stagnant water left from prior sampling events. In general, a minimum of one (1) volume of the sampling system (i.e. pump, associated tubing, flow cell, etc.), must be purged. The maximum flow rate is determined by pumping at a rate, which allows for stabilization of the water level surface within the well. Field measurements should be initiated at the start of purging and continued at evenly spaced intervals until stabilization. Measurements of the indicator parameters must be taken at a frequency based on the time it takes to purge one (1) volume of the pump, associated tubing, and flow cell. For example, if the volume of the pump, associated tubing, and flow cell is 500 mL and the well is being purged at 250 mL/minute, the pump, associated tubing, and flow cell will be purged in two (2) minutes. Therefore, measurements must be taken at least two (2) minutes apart.

Purging will be continued until the final three consecutive measurements for each parameter agree to within 10% of each other prior to sample collection. Measurements should be taken at appropriate intervals during the purging process to determine stabilization. Once stabilization has been achieved, sampling can be conducted at the same rate.

Bailers may be used to collect samples from select wells if a suitable pump is not available or other circumstances require (e.g. if there is inadequate volume to use a pump). Bailers should be made of suitable inert materials (such as stainless steel, PVC, or Teflon), when monitoring for organic compounds. PVC bailers with non-glued joints may also be used. When bailers are used, the bailer cord shall be fastened securely to the bailer and shall be constructed of nylon, stainless steel, or polypropylene, and be specifically manufactured for use in the collection of environmental samples. This cord must be new, clean, and in good condition. Care should be taken not to excessively disturb the column of water in the well casing. Gently lower the bailer into the well with each cycle. The sampler's knowledge of the depth to water will help in this regard. Attempt to lower the bailer into the water only to the extent necessary to fill or nearly fill the chamber. Avoid submerging the top of the bailer. Calibration records should be recorded on the sample collection forms and/or field notebook.

Sample Collection

Samples are collected once water quality parameters have stabilized sufficiently to vary less than 10% between three consecutive readings. Groundwater samples should be collected in the shortest possible time subsequent to purging the well. Discharge from a bailer will be controlled to minimize agitation and aeration. Sample containers should be sealed with tape, labeled, and immediately placed in a cooler with ice. Sample containers should be filled completely to eliminate head space. Sample containers are provided by the analytical laboratory and should be requested at least one week in advance of the sampling. The containers should meet specifications for size, type, and preservatives for parameters analyzed and all shipping coolers should have chain-of-custody seals placed on them prior to shipping. Well identification will be omitted from all sample identifications numbers and laboratory paperwork so that all samples can be analyzed in the laboratory without reference to well identification.

Sample Preservation and Holding Time

Samples should be stored immediately after collection in an ice chest containing sufficient ice to cool the samples to 4 degrees Celsius (°C). Use "blue ice" if possible. If water ice must be used, seal each bottle in a plastic bag. Make sure the ice is sealed in plastic bags too. Samples should remain cooled at 4°C and delivered to the laboratory within 24 hours of collection. Sample receipt at the laboratory must be sooner if analysis includes parameters with a shorter holding time. Care should be taken to prevent excessive agitation of samples or breakage/leakage of containers. Samples should be analyzed within the specified holding time for each constituent. One additional sample should be collected from one of the wells for quality control purposes. The well identification should be omitted from laboratory paperwork so the sample can be evaluated as a "blind duplicate."

Resampling

If monitoring results indicates a significant increase in the concentration of a monitored parameter for a well, the well will be resampled within one week of the receipt of analytical results that show the significant change. An increase or decrease is significant when the change can be considered statistically significant. Determination of a significant change in groundwater concentration is customarily done either by assessing concentrations in relation to established concentration limits or by using a statistical analysis.

Chain of Custody and Sample Handling

A chain-of-custody form will be completed and signed by the sampler on the day of sample collection. The chain-of-custody form must be signed by laboratory personnel upon receipt and any other individuals that maintain custody of the samples in the interim. An example chain-of-custody form is attached.

Coolers should be sealed and shipped or driven to the lab as soon as possible. The method of shipping (bus, next day air, etc.) is usually determined by the parameter having the shortest holding time. In any case, shipping times of more than 24 hours should not be used as the cooler(s) may warm and compromise sample quality.

Quality Assurance and Quality Control (QA/QC)

Field Records: All field notes, analytical results, and other pertinent data associated with the site should be maintained in a secure location and be archived for at least a five year period. Maintaining records will also facilitate tracking of environmental trends at the site.

Data Validation: Data validation for both field and lab QA/QC can be performed using a checklist. All pertinent information with respect to QA/QC will be checked. The following items are included:

- Completeness of field data sheets and observation (observations are used to check for potentially erroneous data)
- Completeness of chain-of-custody
- Holding times for all constituents
- Field blind duplicate results
- Laboratory method blanks, matrix spike, and matrix spike duplicates
- Surrogate percent recovery
- Completeness of laboratory quality control (duplicates, standards, QC samples)
- Comparisons between duplicates

Specific QA/QC guidance with respect to field blanks, field duplicates, and background data are summarized in the following bullets.

- Field blanks: Once per sampling event a blank sample with known concentrations of the monitored constituents will be included in the samples sent to the analytical laboratory. The field blank will be purchased from a scientific supply vender such as Hach.
- Field duplicates: Once per sampling event one additional sample will be collected from one of the wells for quality control purposes.

REPORTING

Primary reporting for this monitoring plan will focus on annual reports completed following the end of each recharge season, per OWRD requirements for the limited license and AR projects. The basic goals of the annual reports will be to: (1) analyze the data to evaluate how trends related to AR operations are influencing groundwater quality and (2) based on the results of that analysis provide recommendations (if any) for adjustments to the monitoring program and AR operations. In addition to annual reporting the monitoring data collected as described herein will be provided to OWRD and ODEQ on a periodic basis to facilitate data transfer and project communications.

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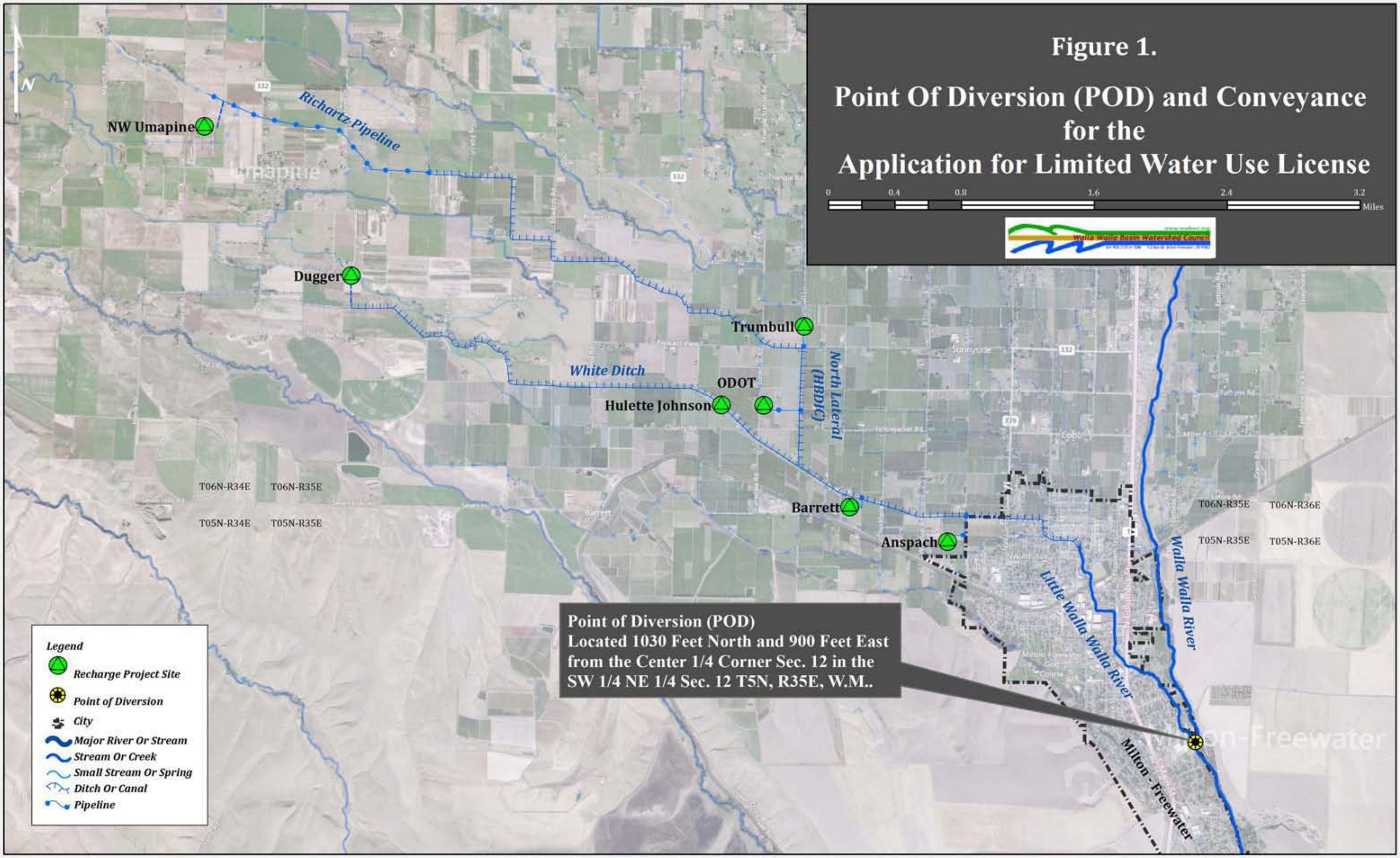


Figure 1.
Point Of Diversion (POD) and Conveyance for the Application for Limited Water Use License
0 0.4 0.8 1.6 2.4 3.2 Miles
Walla Walla Basin Watershed Council
N
NW Umapine
Richartz Pipeline
Dugger
Trumbull
White Ditch
ODOT
Hulette Johnson
North Lateral (HBDIC)
Barrett
Anspach
T06N-R34E
T06N-R35E
T05N-R34E
T05N-R35E
T06N-R35E
T06N-R36E
T05N-R35E
T05N-R36E
Little Walla Walla River
Walla Walla River
Milton - Freewater
Point of Diversion (POD)
Located 1030 Feet North and 900 Feet East from the Center 1/4 Corner Sec. 12 in the SW 1/4 NE 1/4 Sec. 12 T5N, R35E, W.M..
Legend
Recharge Project Site
Point of Diversion
City
Major River Or Stream
Stream Or Creek
Small Stream Or Spring
Ditch Or Canal
Pipeline

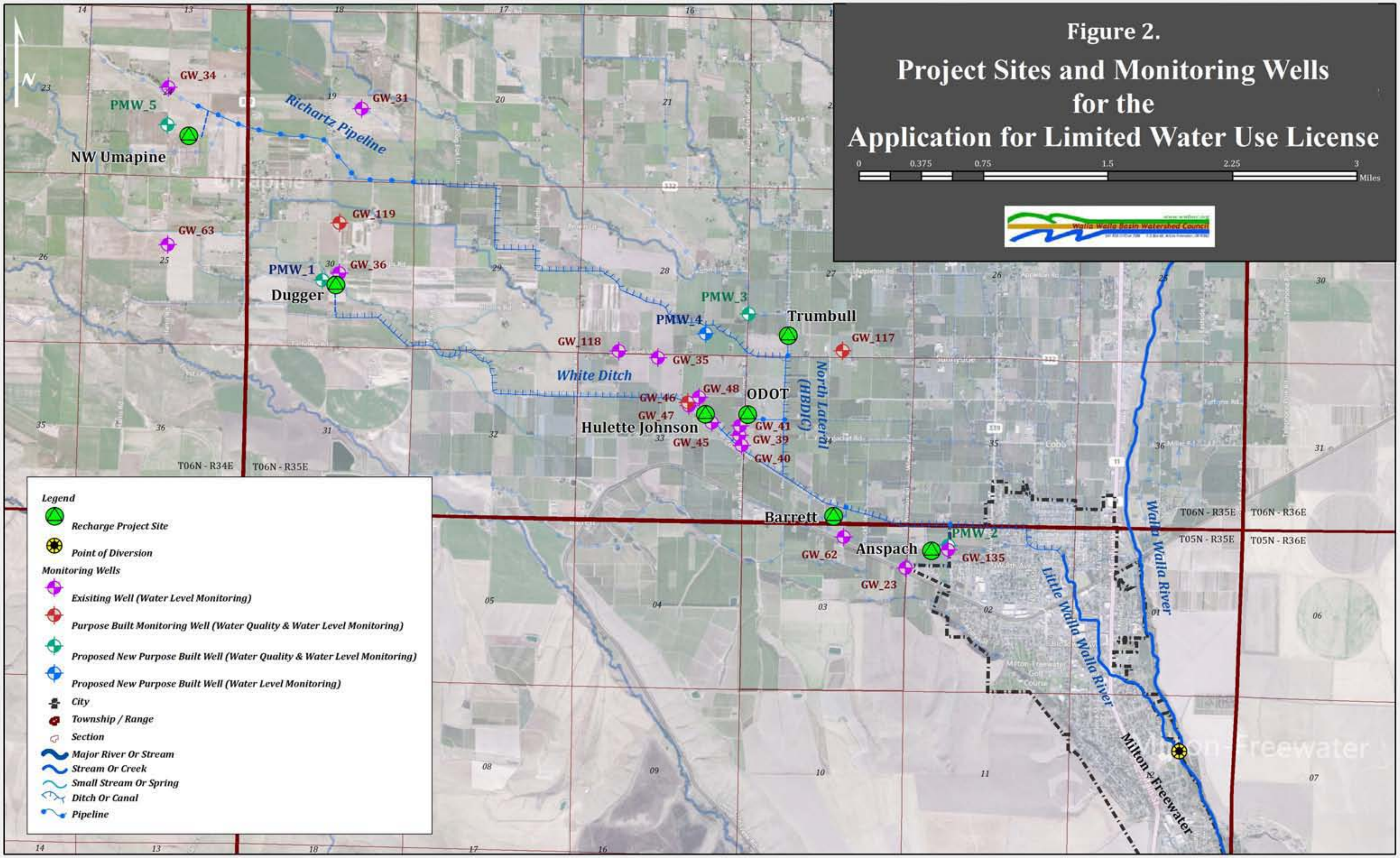


Figure 2.
Project Sites and Monitoring Wells
for the
Application for Limited Water Use License
0
0.375
0.75
1.5
2.25
3
Miles
Walla Walla Basin Watershed Council
NW Umapine
PMW_5
GW_34
GW_31
Richartz Pipeline
GW_119
GW_63
PMW_1
GW_36
Dugger
PMW_3
Trumbull
PMW_4
GW_118
GW_35
GW_117
White Ditch
North Lateral
(HBDIC)
GW_48
GW_46
ODOT
GW_47
Hulette Johnson
GW_41
GW_39
GW_45
GW_40
T06N - R34E
T06N - R35E
Barrett
PMW_2
Anspach
GW_135
GW_62
GW_23
T06N - R35E
T06N - R36E
T05N - R35E
T05N - R36E
Walla Walla River
Little Walla Walla River
Milton-Freewater
Legend
Recharge Project Site
Point of Diversion
Monitoring Wells
Exisiting Well (Water Level Monitoring)
Purpose Built Monitoring Well (Water Quality & Water Level Monitoring)
Proposed New Purpose Built Well (Water Quality & Water Level Monitoring)
Proposed New Purpose Built Well (Water Level Monitoring)
City
Township / Range
Section
Major River Or Stream
Stream Or Creek
Small Stream Or Spring
Ditch Or Canal
Pipeline

Figure 3. Hulette Johnson Recharge Project

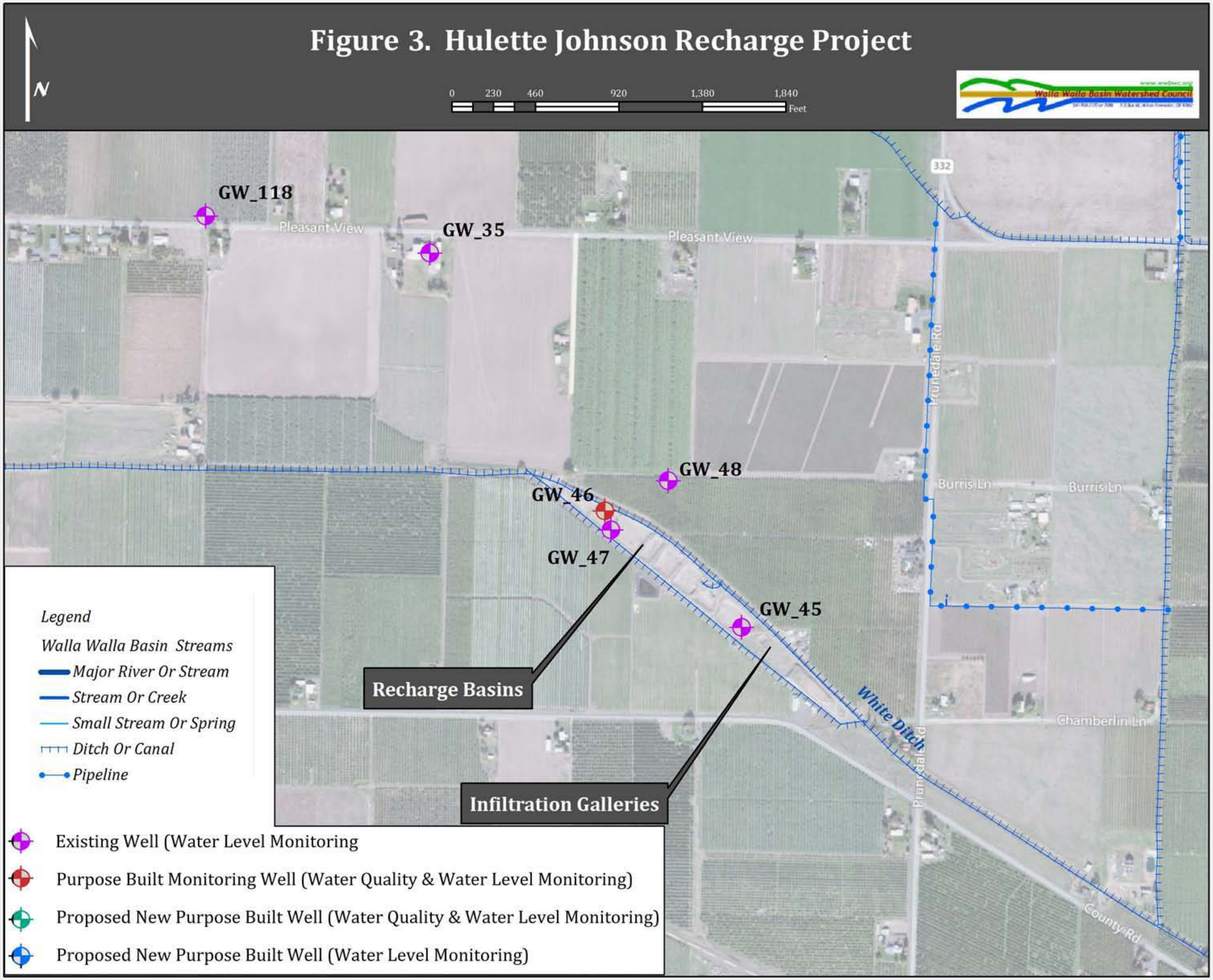


Figure 4. Anspach Project Monitoring Wells

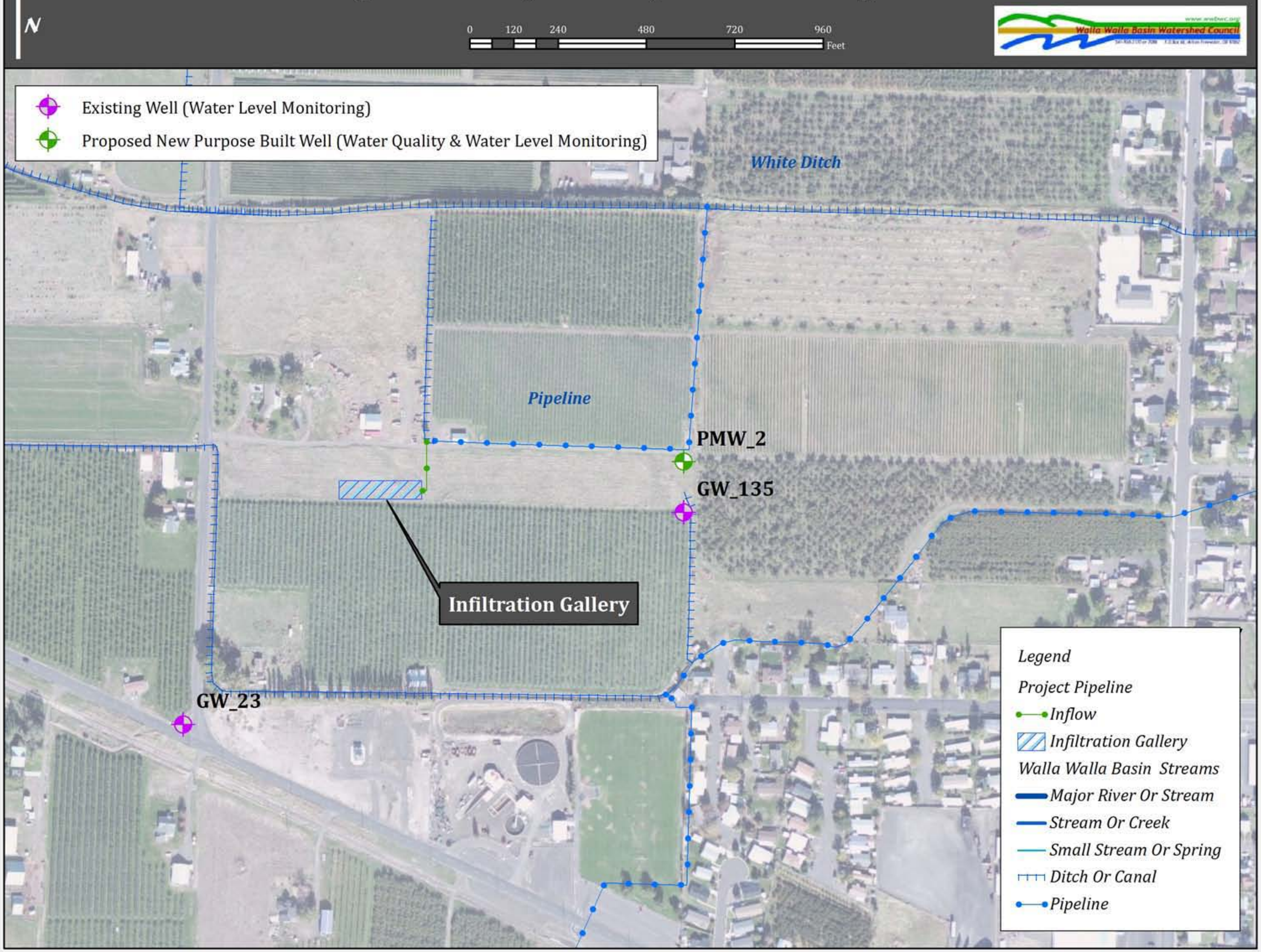


Figure 5. Trumbull Recharge Infiltration Gallery

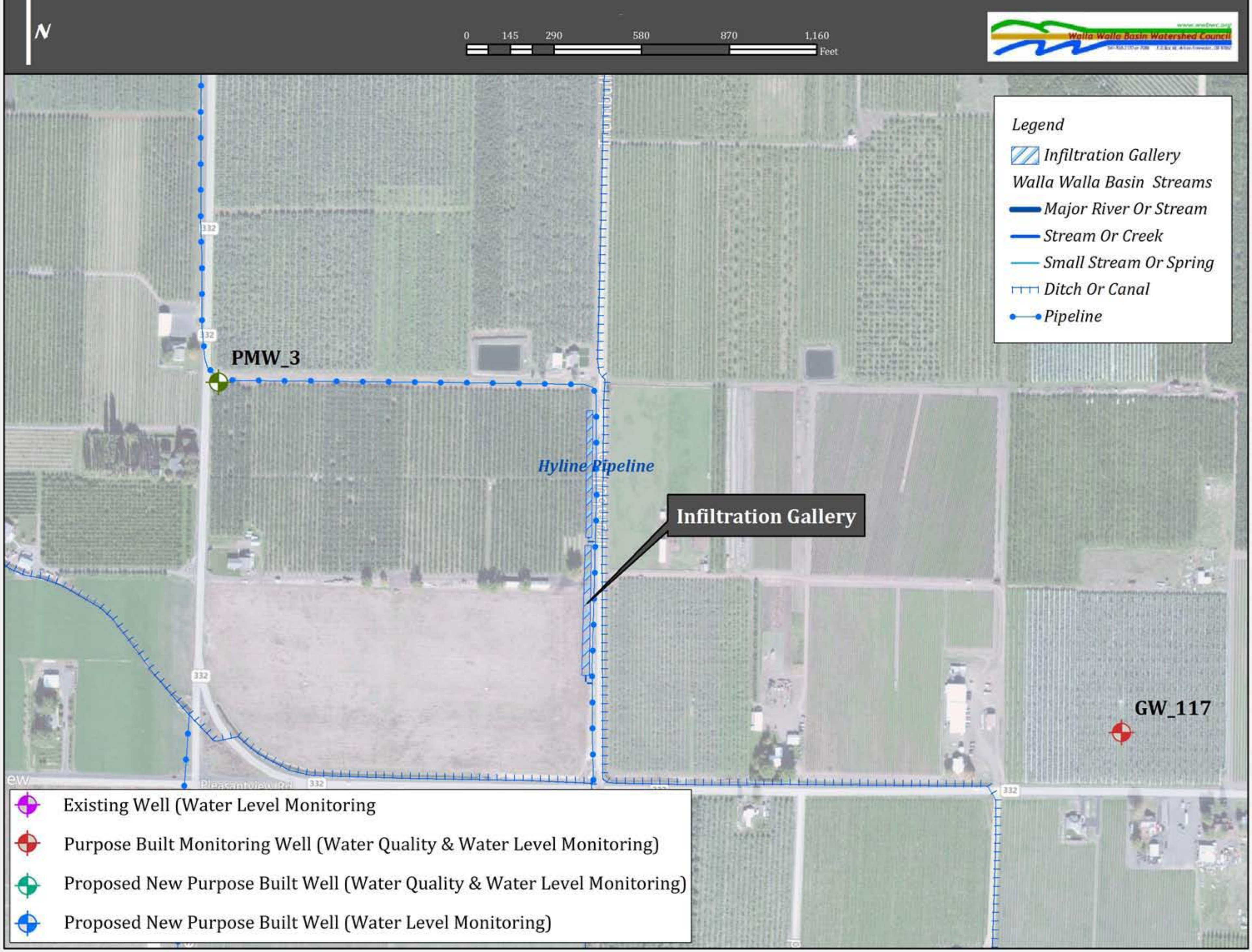
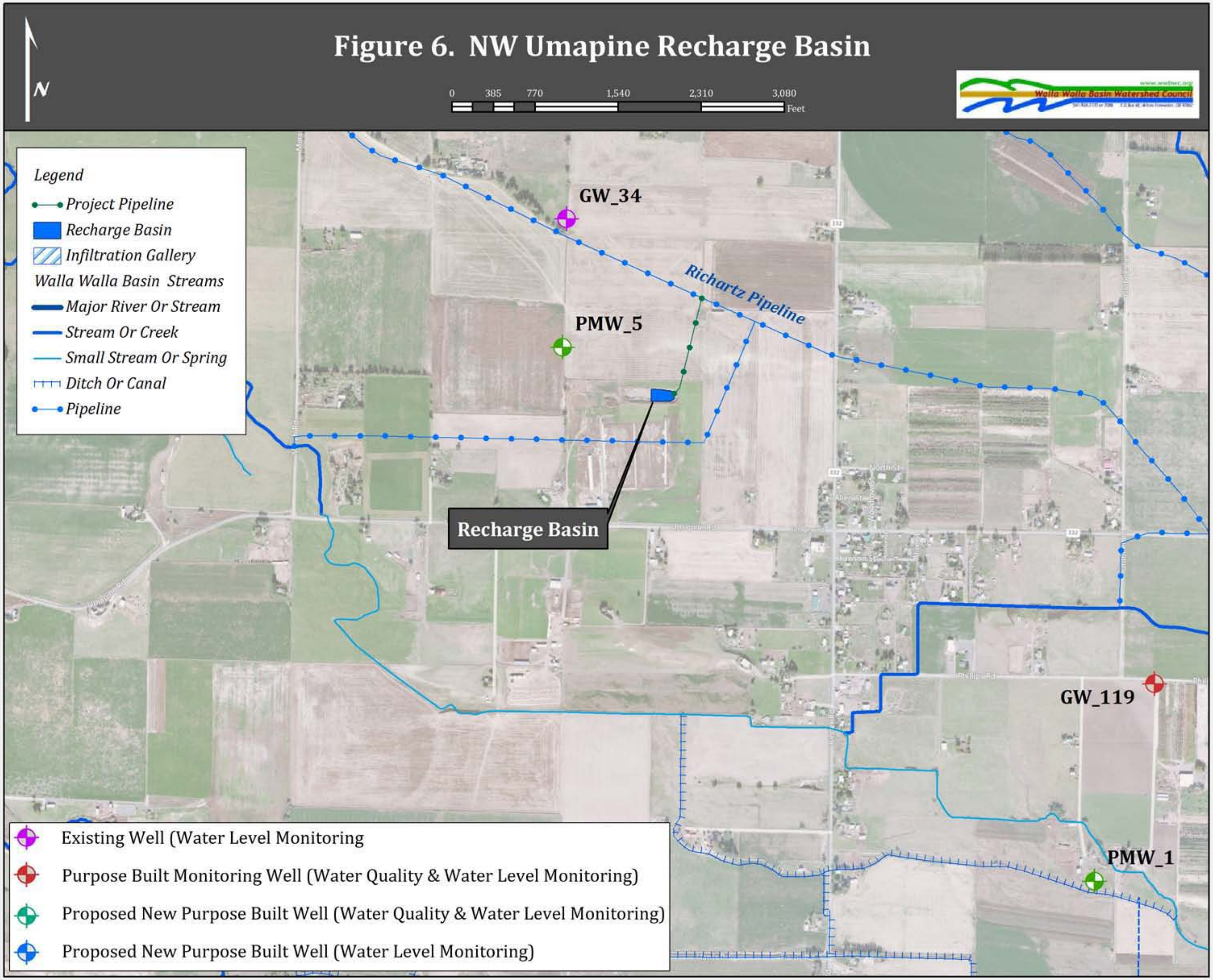


Figure 6. NW Umapine Recharge Basin



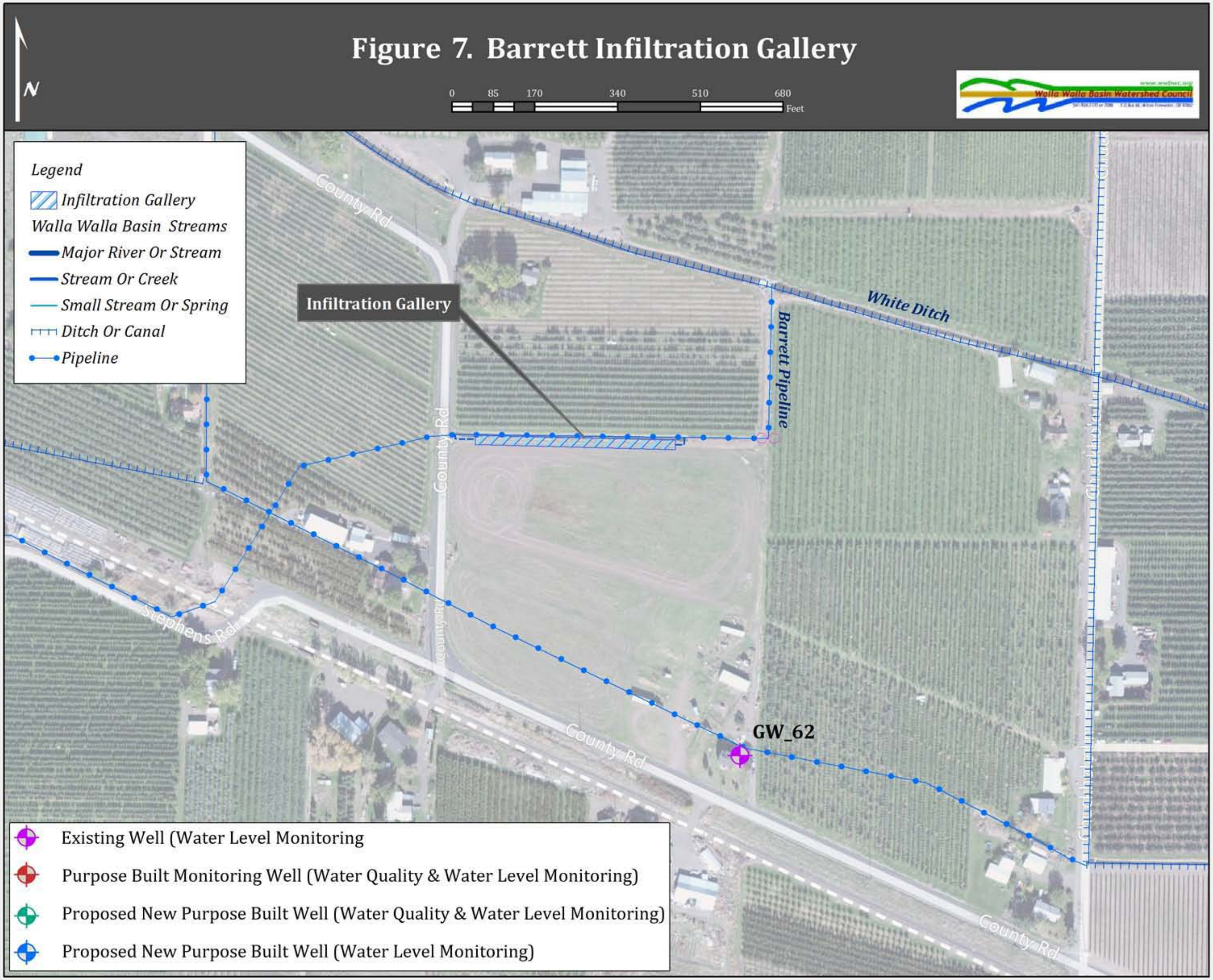


Figure 7. Barrett Infiltration Gallery

Figure 8. Dugger Infiltration Gallery

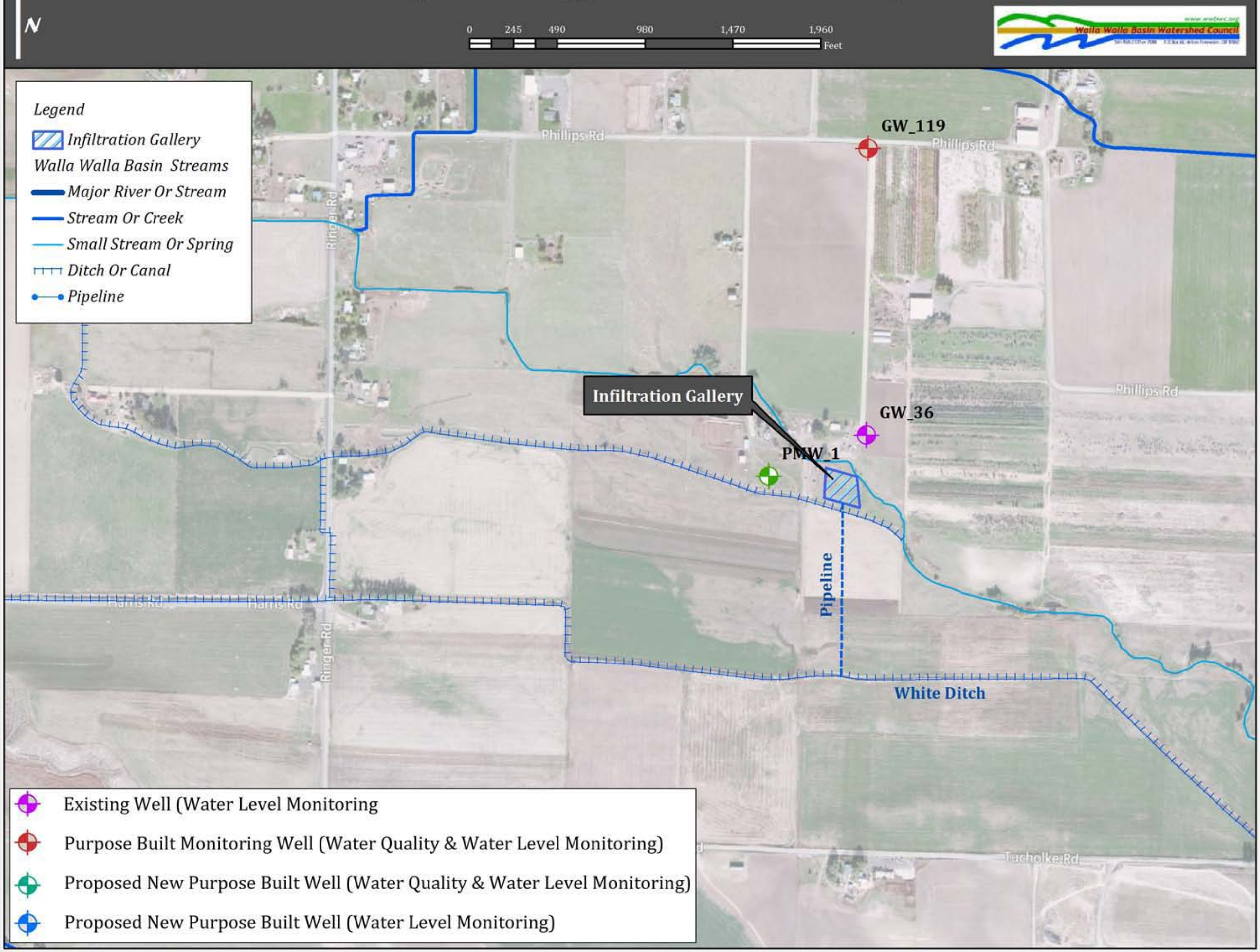


Figure 9. ODOT Recharge Basin

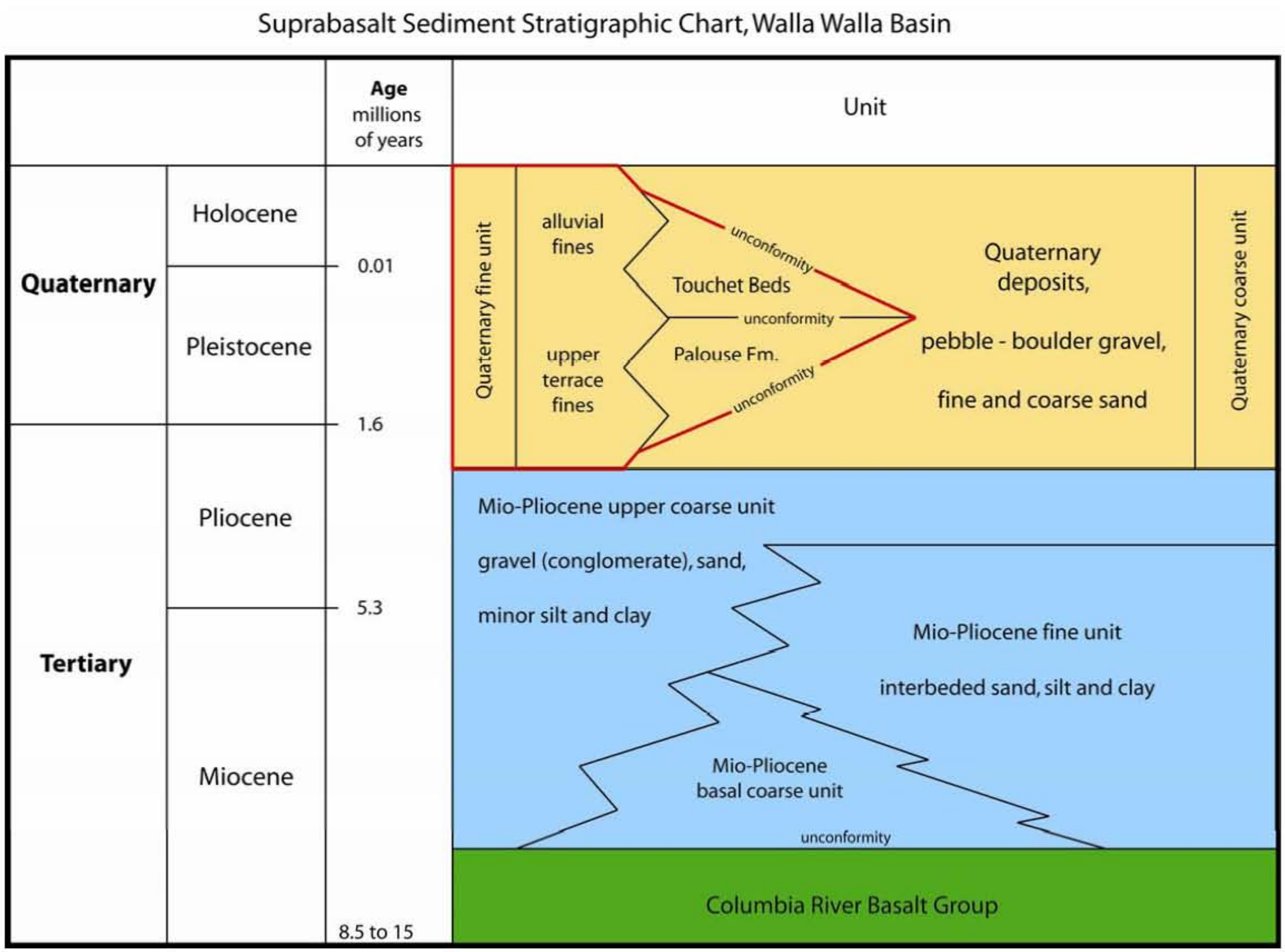


Figure 10. Suprabasalt sediment stratigraphy in the Walla Walla Basin as used in this report.

Figure 11. Walla Walla Valley - Water Table October, 2009

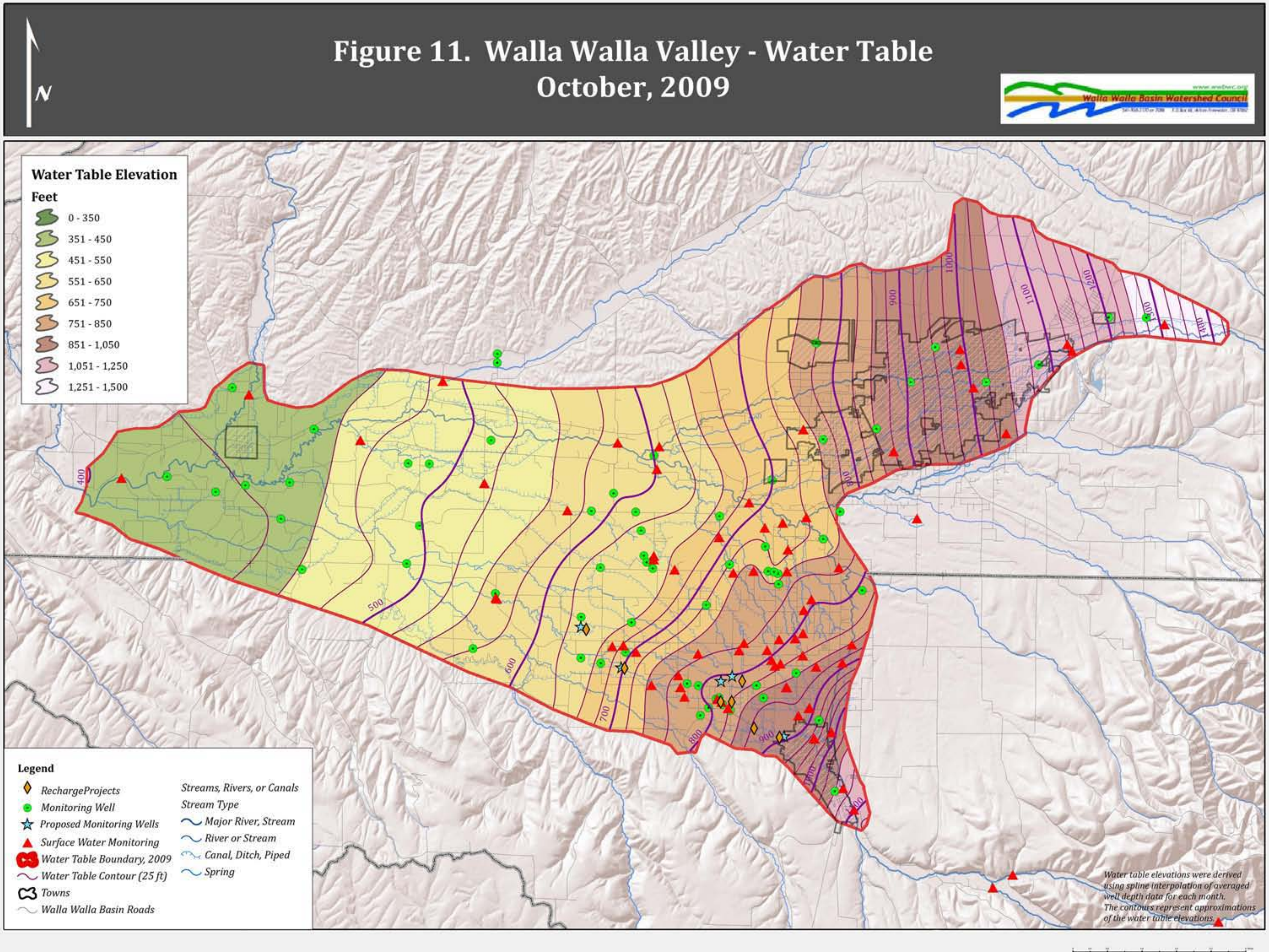
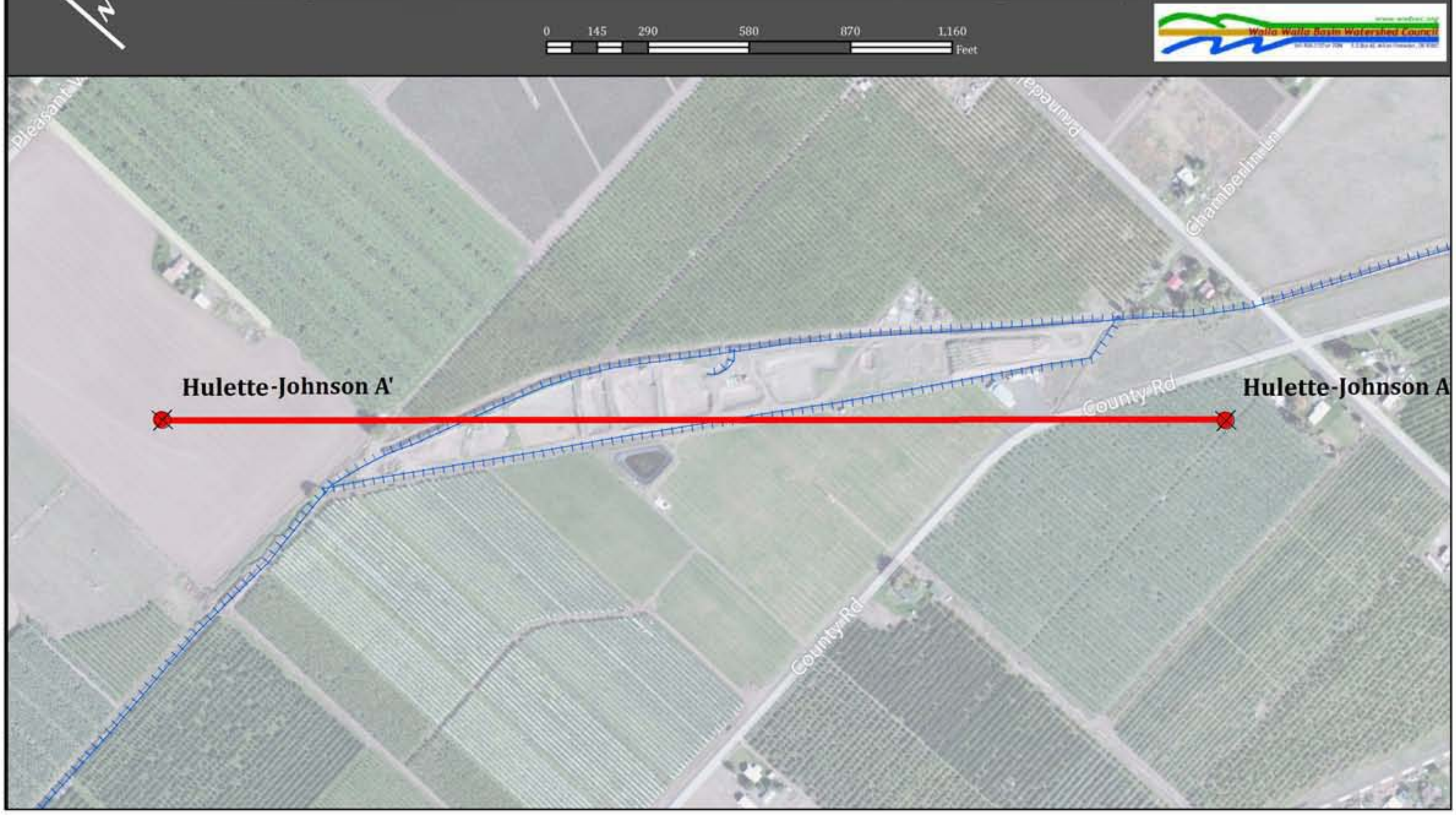


Figure 12. Hulette Johnson Recharge Project



Geologic Cross Section

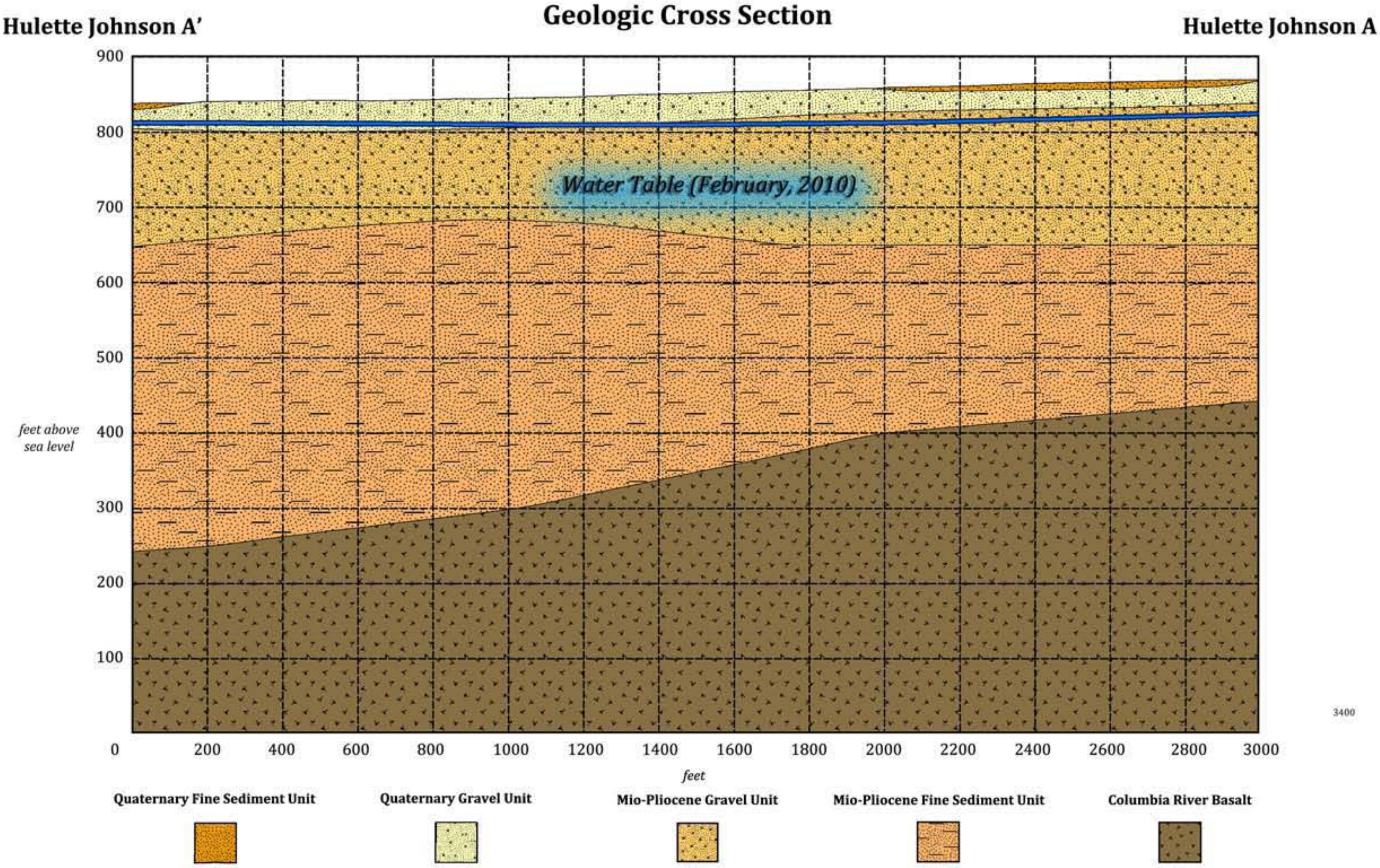


Figure 13. Anspach Recharge Project

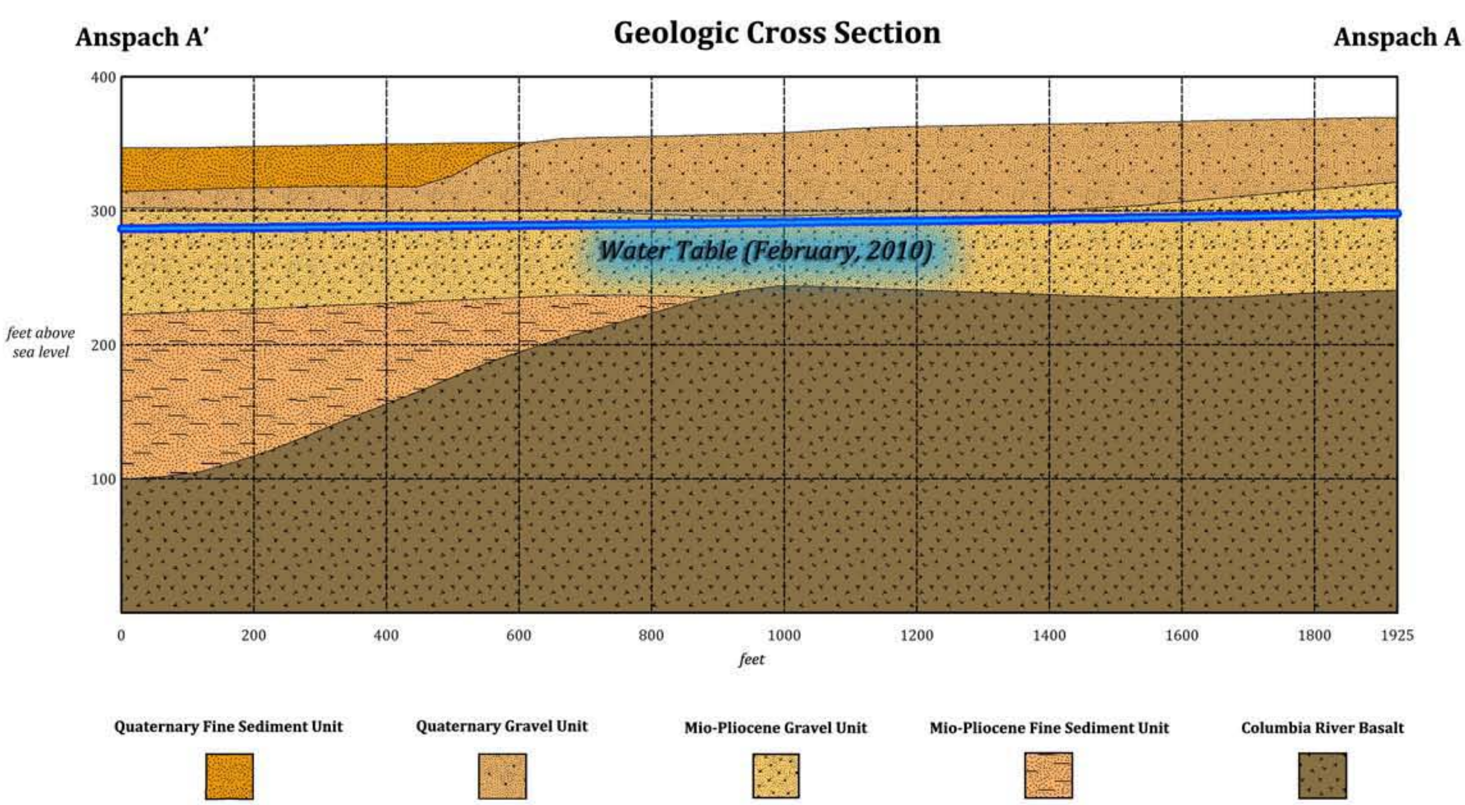
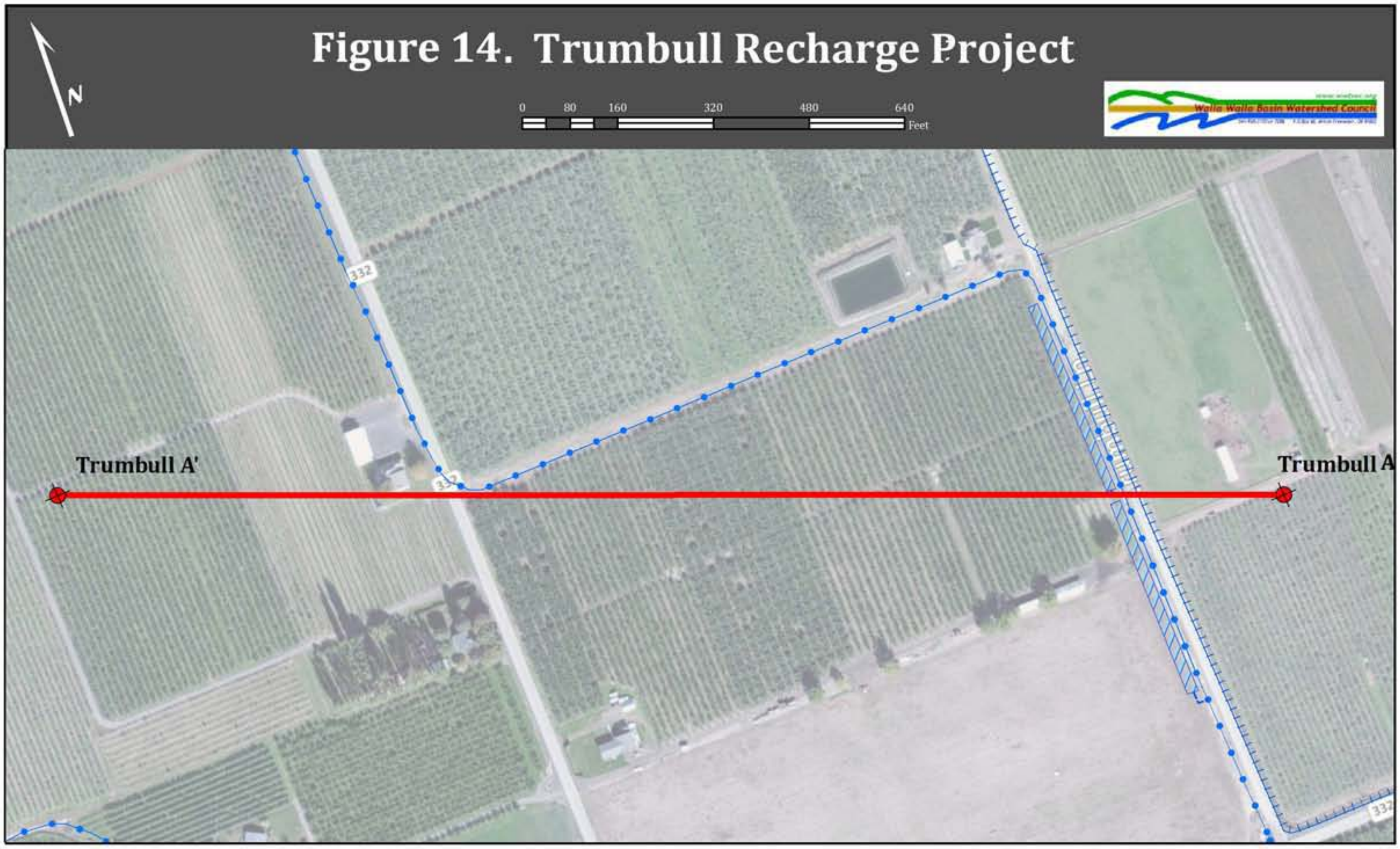


Figure 14. Trumbull Recharge Project



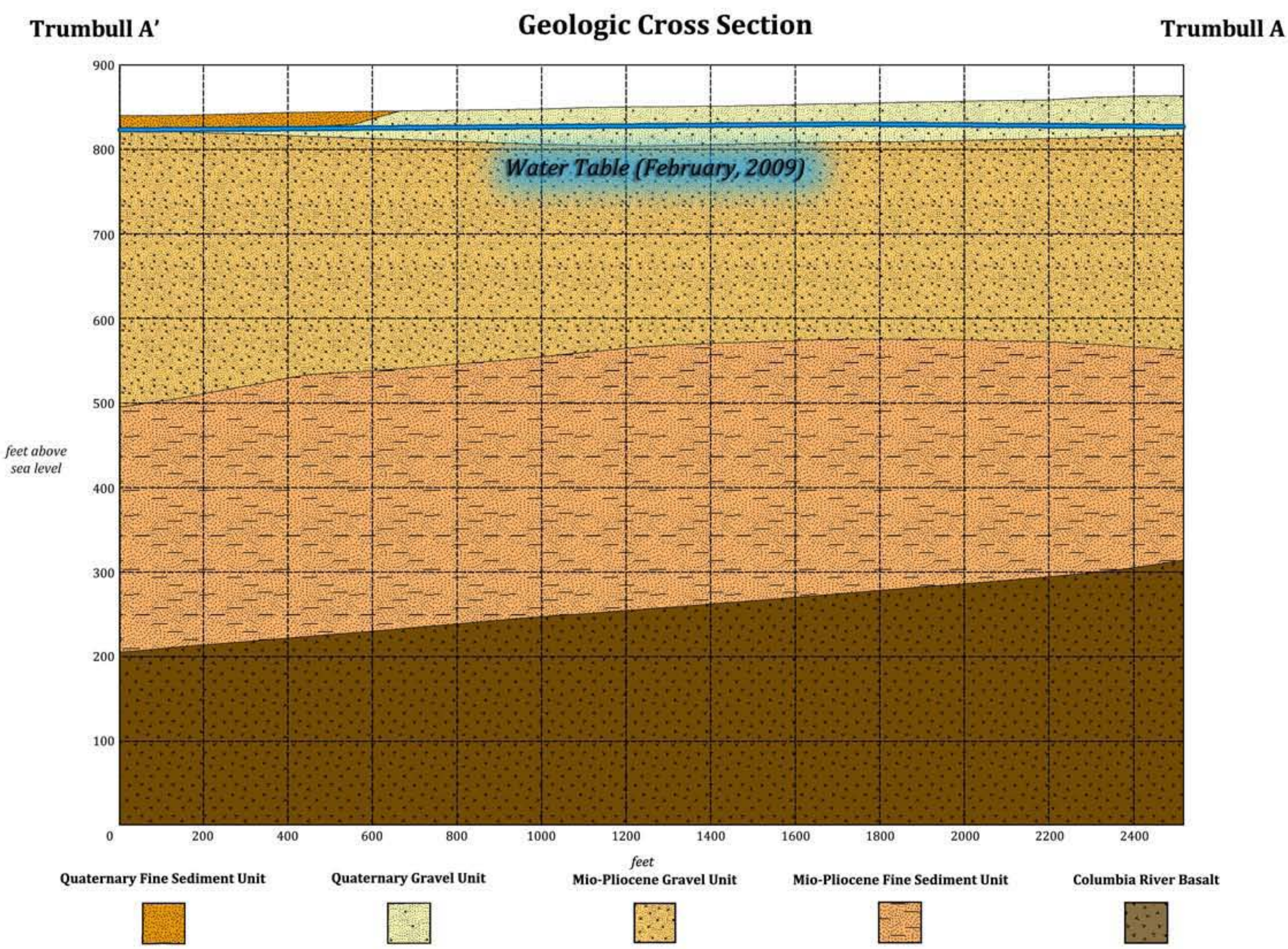
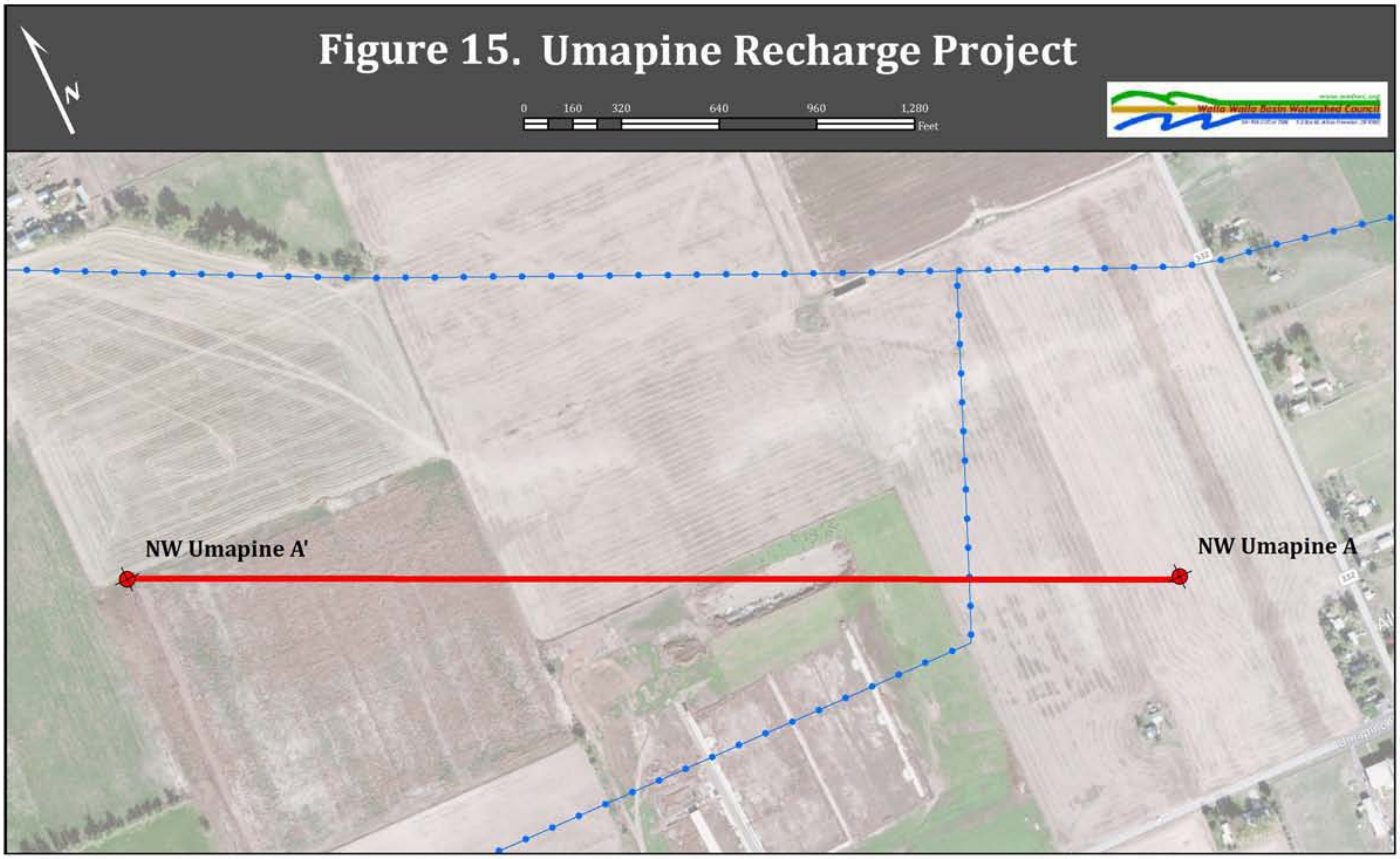


Figure 15. Umapine Recharge Project



Geologic Cross Section

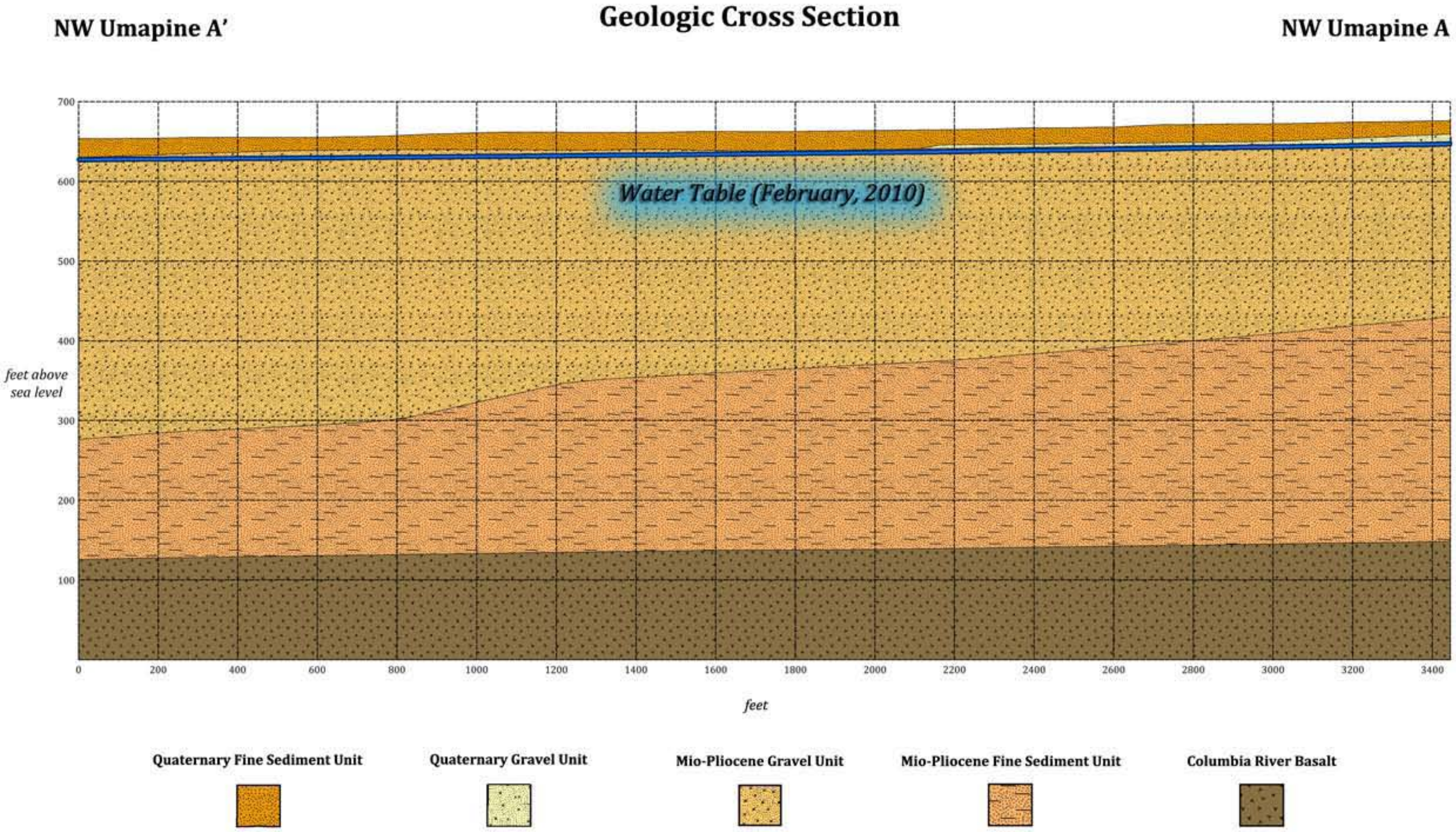
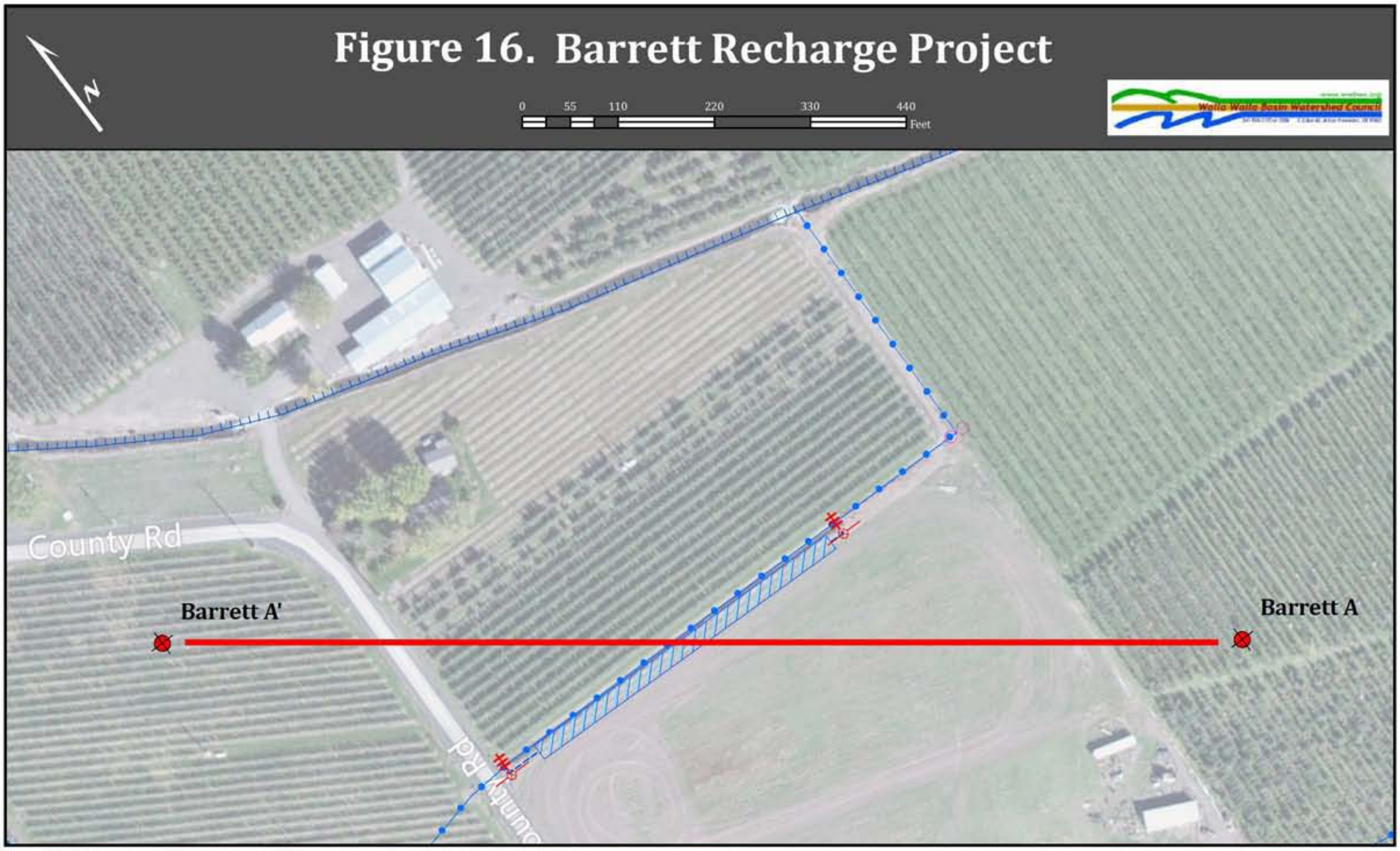


Figure 16. Barrett Recharge Project



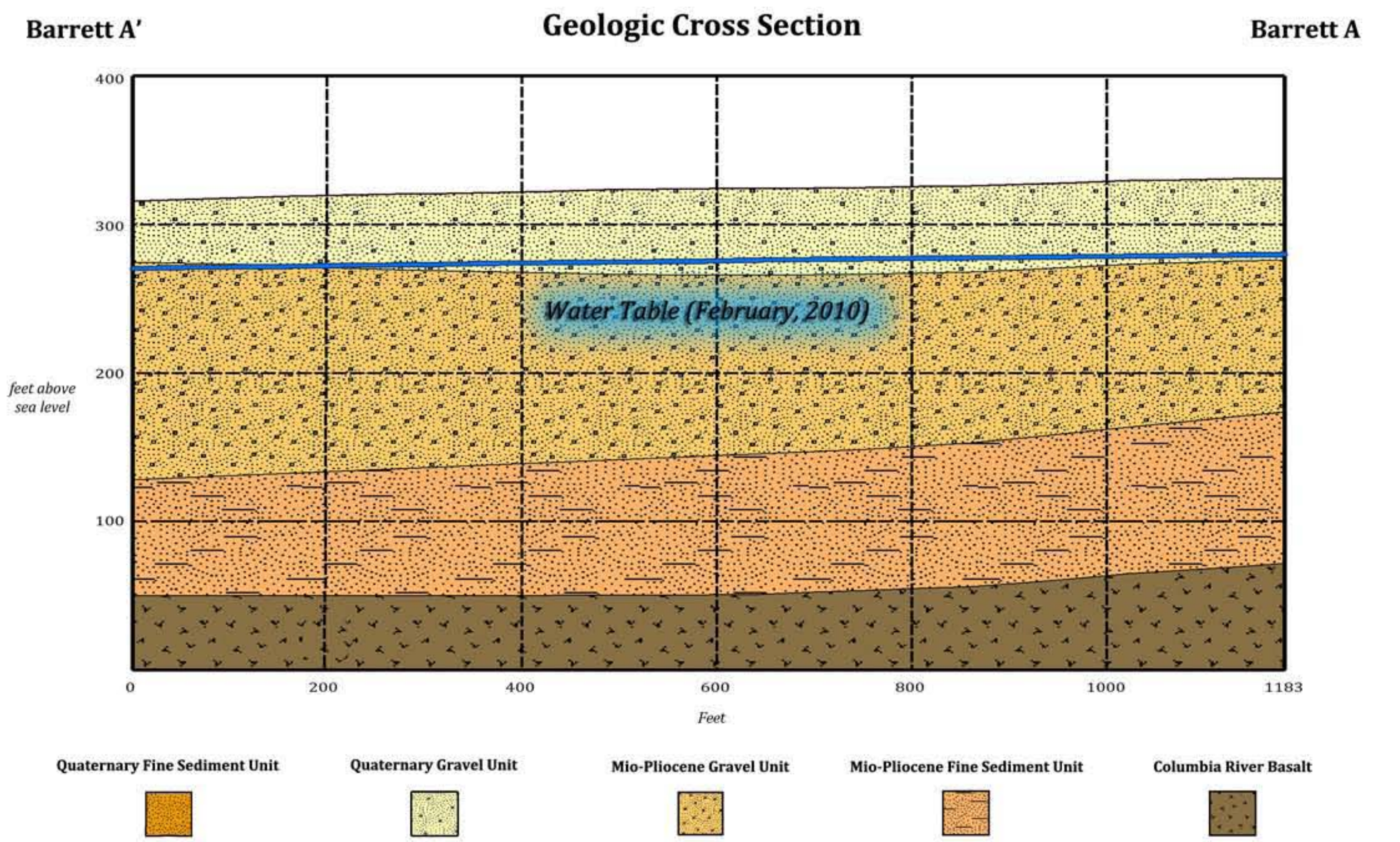
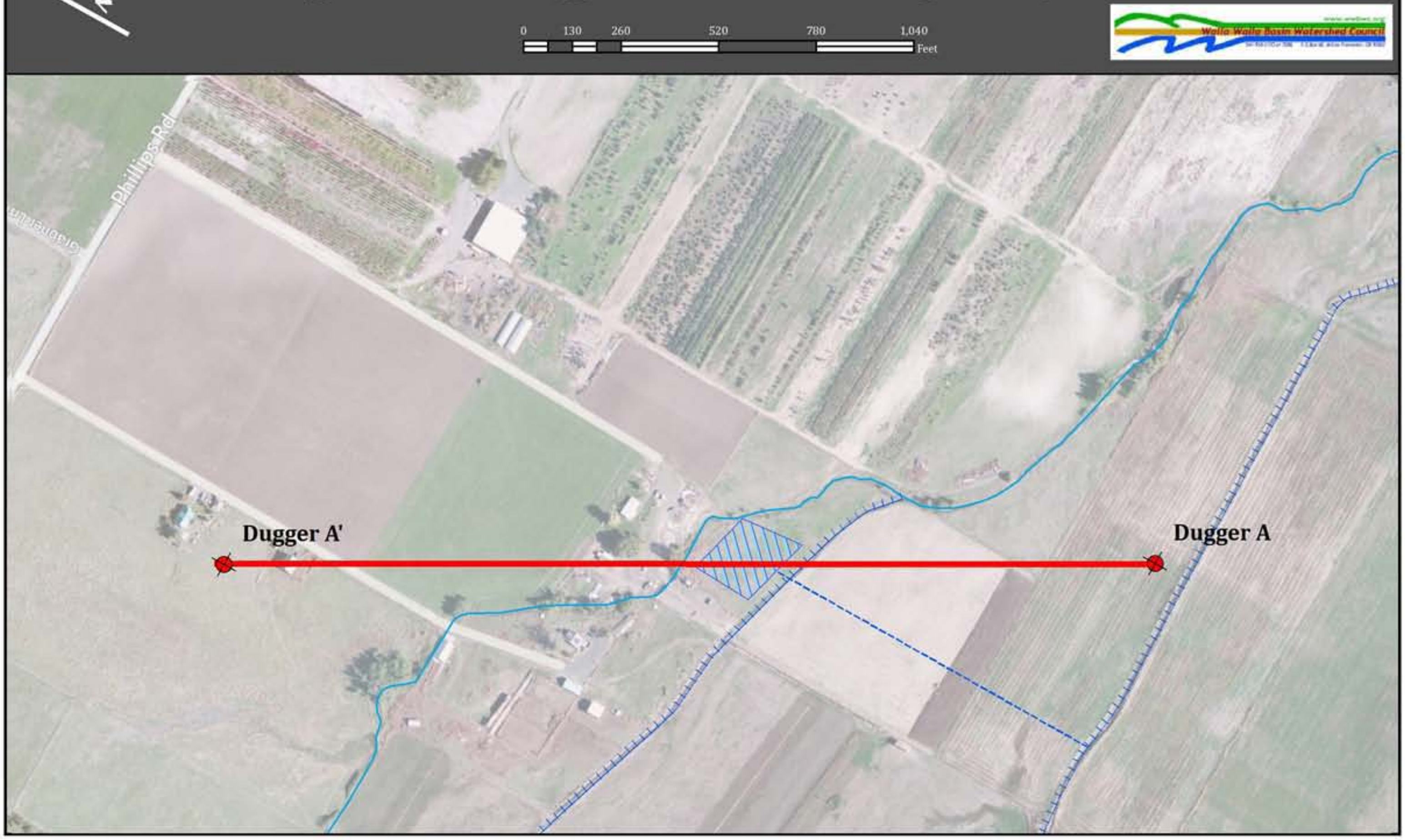


Figure 17. Dugger Creek Recharge Project



Geologic Cross Section

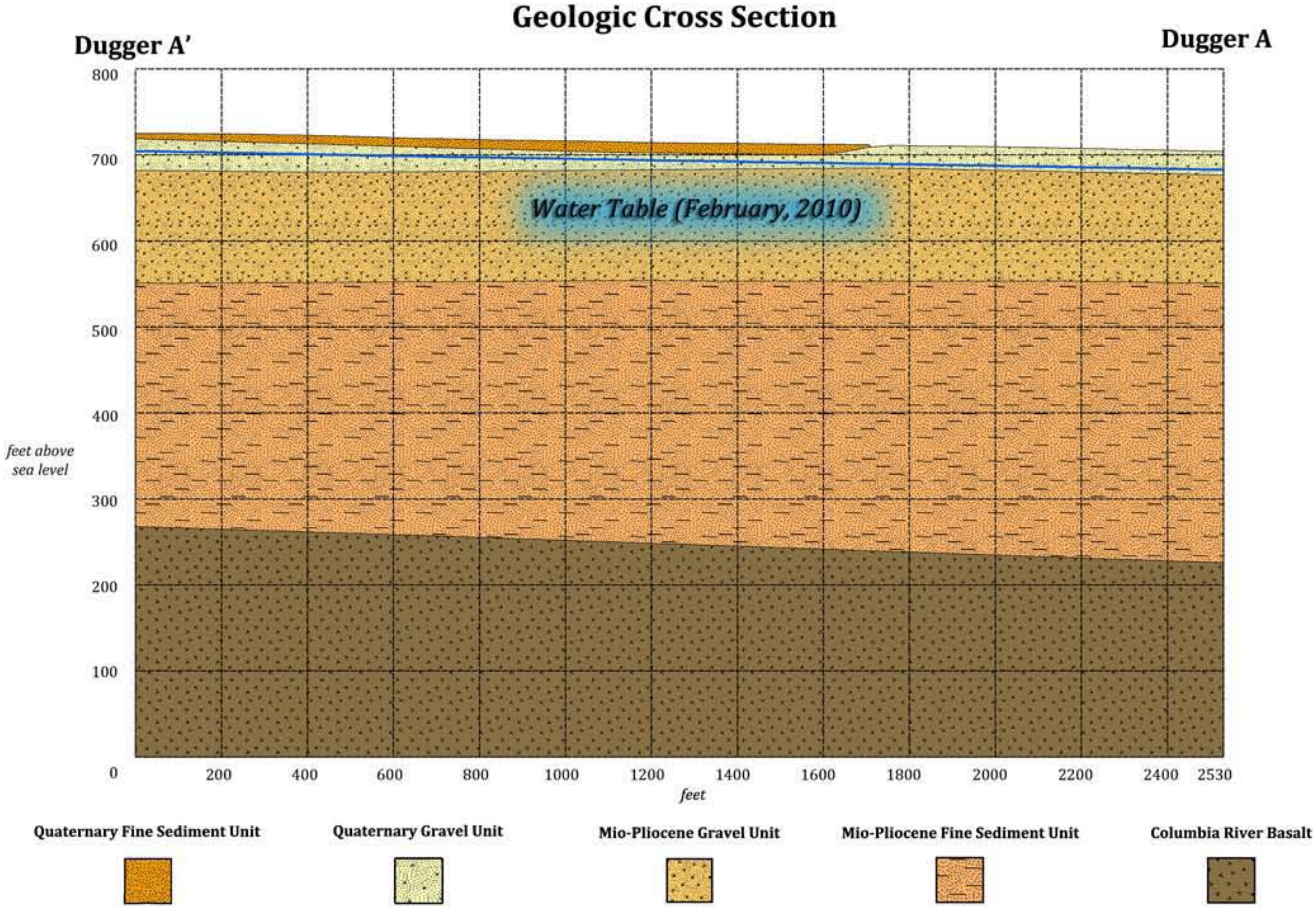
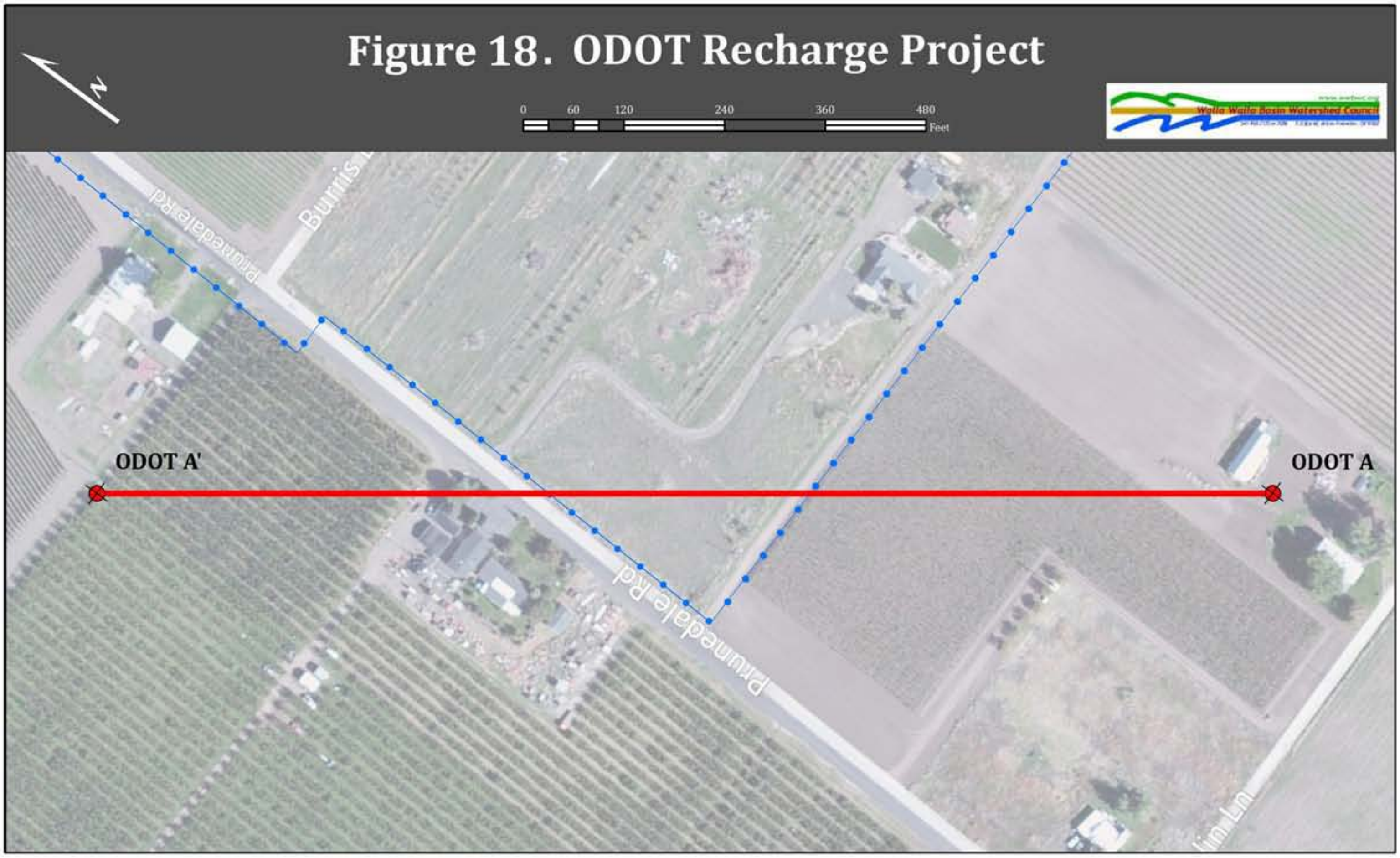
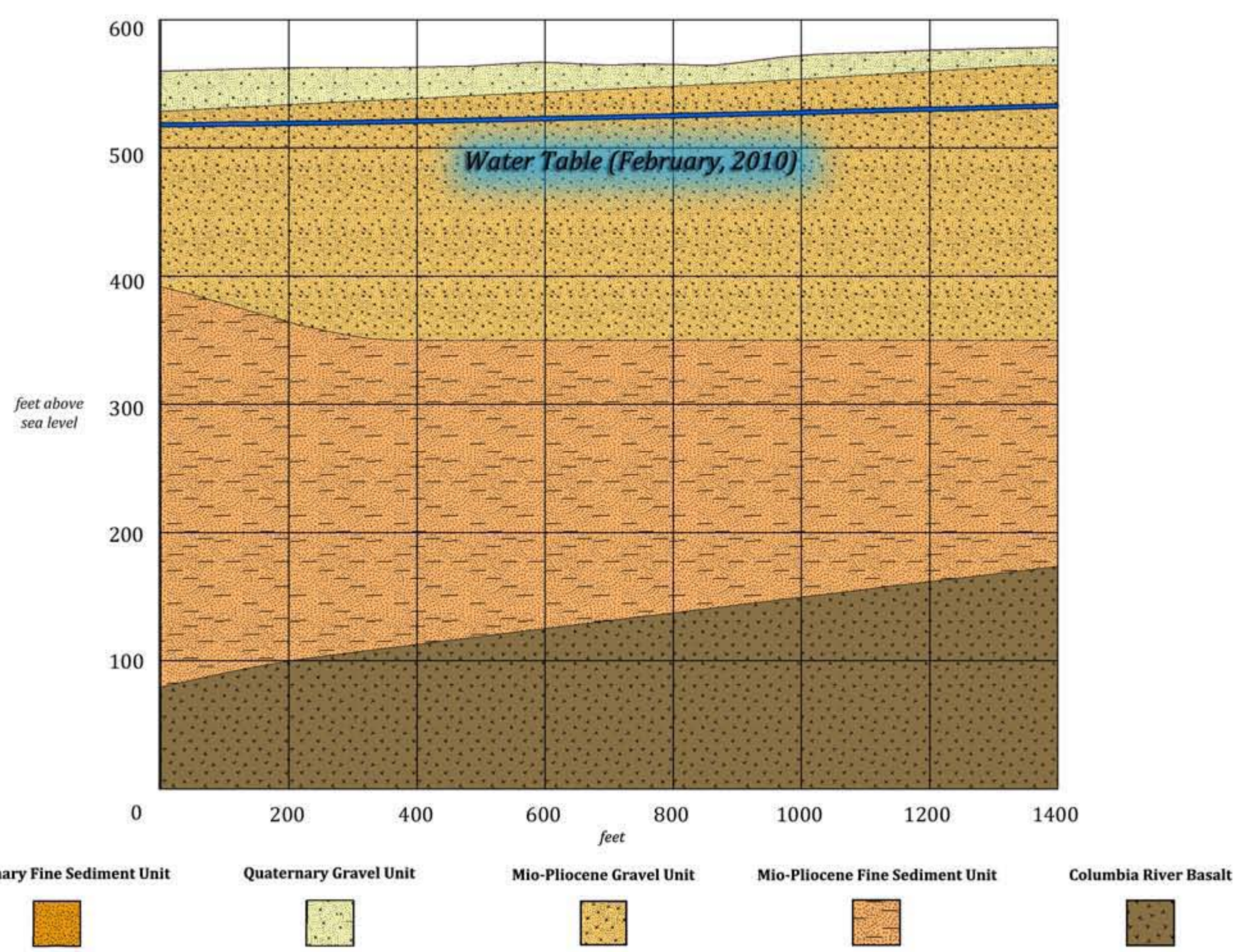


Figure 18. ODOT Recharge Project



Geologic Cross Section



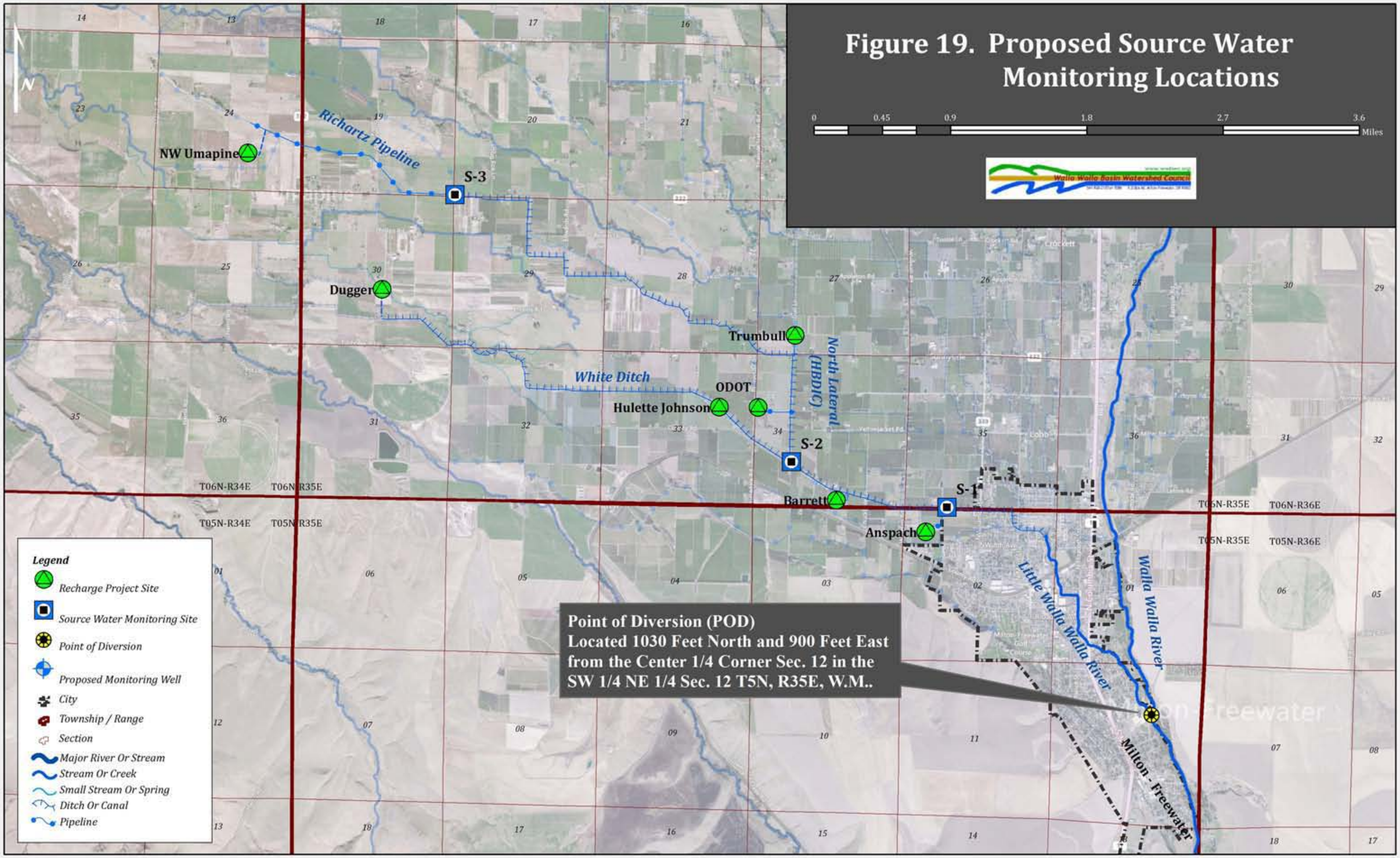
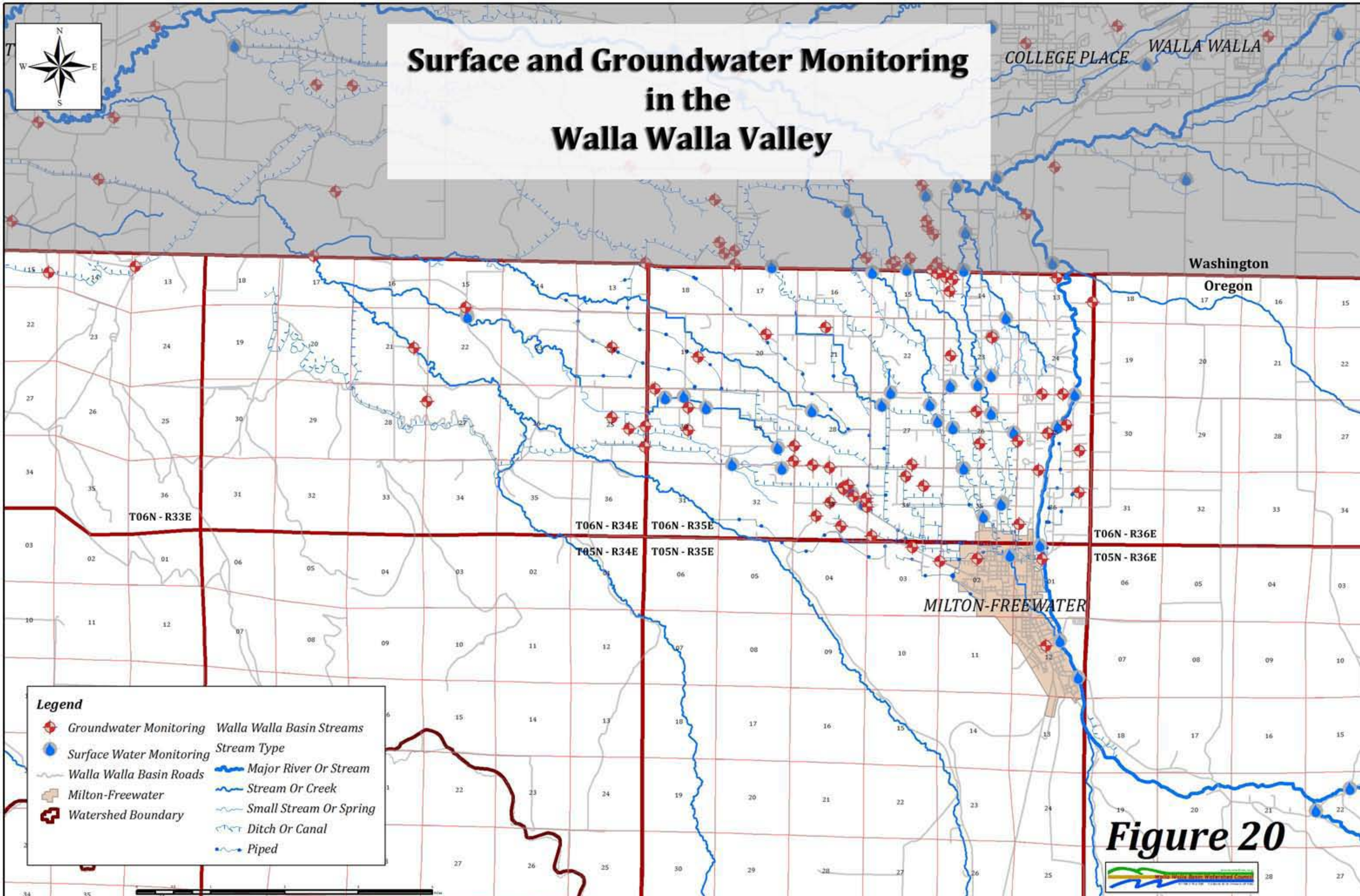


Figure 19. Proposed Source Water Monitoring Locations
0
0.45
0.9
1.8
2.7
3.6
Miles
Walla Walla Basin Watershed Council
NW Umapine
Richartz Pipeline
S-3
Dugger
Trumbull
North Lateral (HBDIC)
White Ditch
ODOT
Hulette Johnson
S-2
S-1
Barrett
Anspach
T06N-R34E
T06N-R35E
T05N-R34E
T05N-R35E
T06N-R35E
T06N-R36E
T05N-R35E
T05N-R36E
Little Walla Walla River
Walla Walla River
Milton - Freewater
Point of Diversion (POD)
Located 1030 Feet North and 900 Feet East from the Center 1/4 Corner Sec. 12 in the SW 1/4 NE 1/4 Sec. 12 T5N, R35E, W.M..
Legend
Recharge Project Site
Source Water Monitoring Site
Point of Diversion
Proposed Monitoring Well
City
Township / Range
Section
Major River Or Stream
Stream Or Creek
Small Stream Or Spring
Ditch Or Canal
Pipeline



Surface and Groundwater Monitoring
in the
Walla Walla Valley
COLLEGE PLACE
WALLA WALLA
Washington
Oregon
T06N - R33E
T06N - R34E
T06N - R35E
T06N - R36E
T05N - R34E
T05N - R35E
T05N - R36E
MILTON-FREEWATER
Legend
Groundwater Monitoring
Surface Water Monitoring
Walla Walla Basin Roads
Milton-Freewater
Watershed Boundary
Walla Walla Basin Streams
Stream Type
Major River Or Stream
Stream Or Creek
Small Stream Or Spring
Ditch Or Canal
Piped
Figure 20

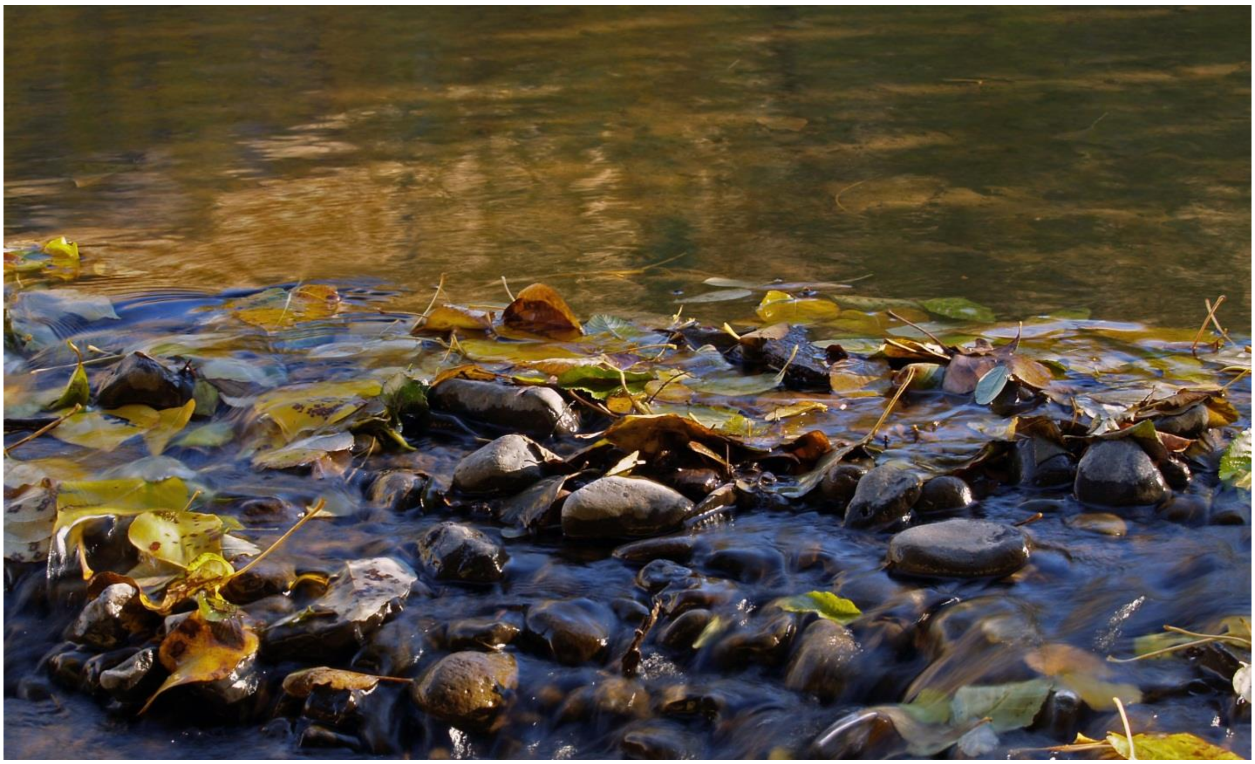
Attachment B

Walla Walla Basin Watershed Council
Watershed Monitoring Program
Standard Operating Procedures

www.wwbwc.org
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.

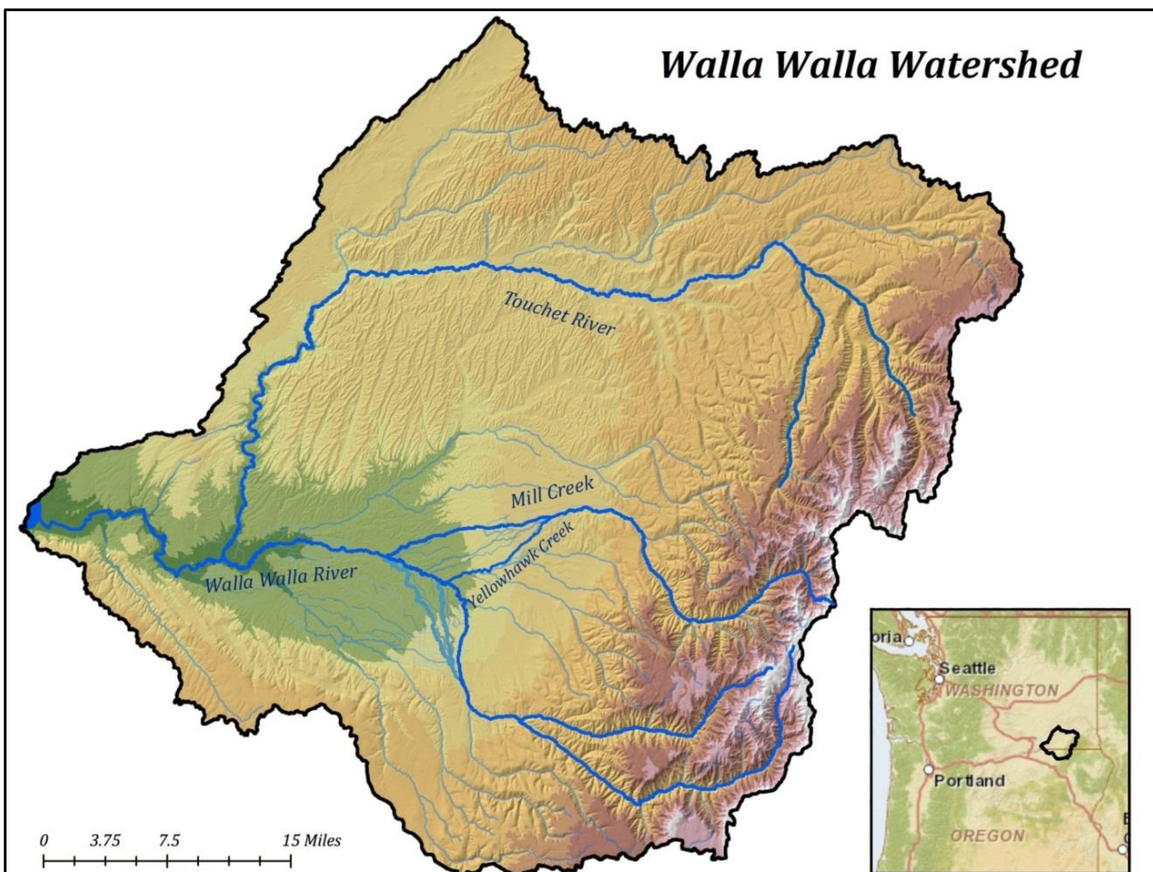


Figure 1. Map of the Walla Walla Watershed.

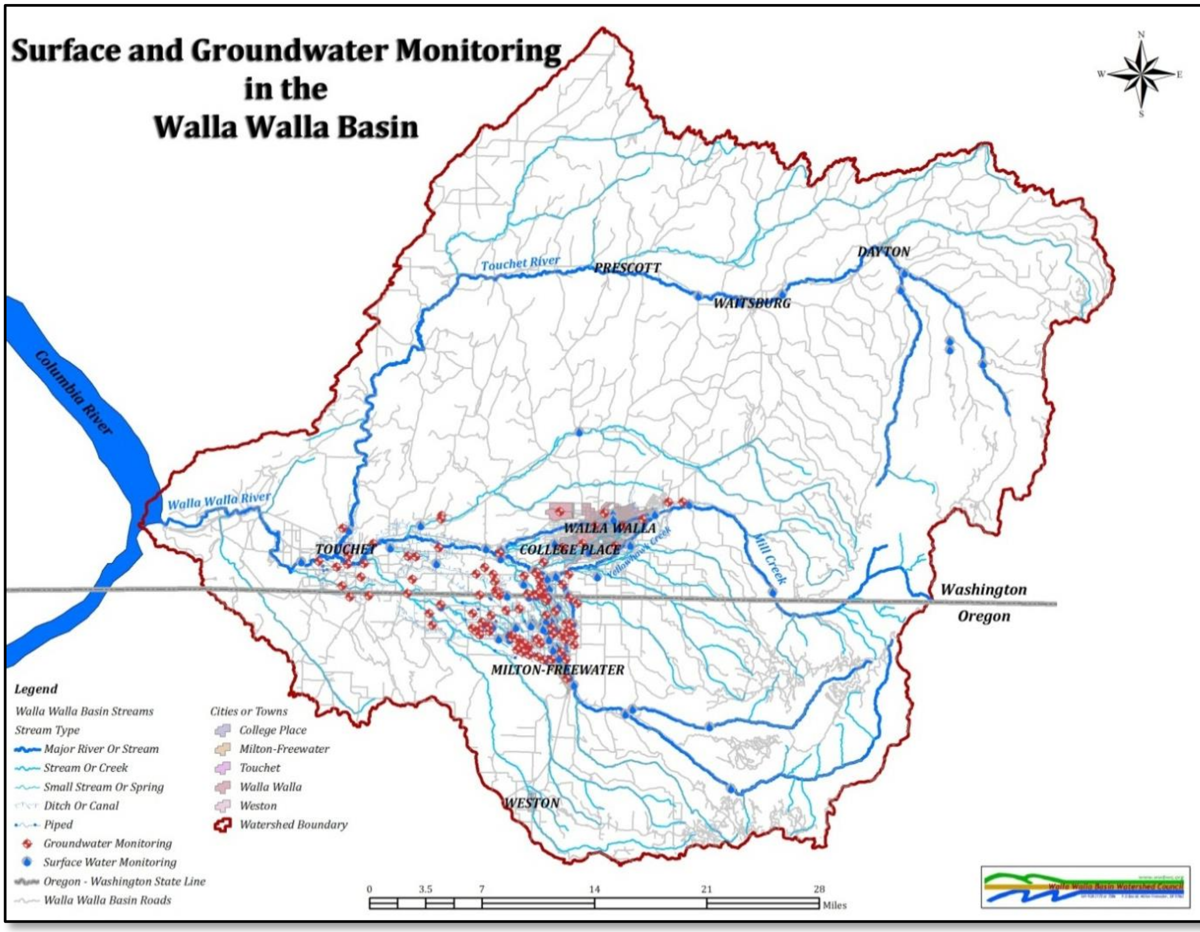


Figure 2. WWBWC Watershed Monitoring Program surface and groundwater monitoring locations.

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	GIS/Geodatabase Analyst	Geodatabase management & data collection and analysis	troy.baker@wwbwc.org
Wendy Harris	Operations Manager	Program/Operations Management and Oversight	wendy.harris@wwbwc.org
Will Lewis	Environmental Scientist	Data collection and analysis	will.lewis@wwbwc.org
Lyndsi Hersey	Environmental Scientist	Data collection and analysis	lyndsi.hersey@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) = πr^2(7.48 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

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:

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

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.

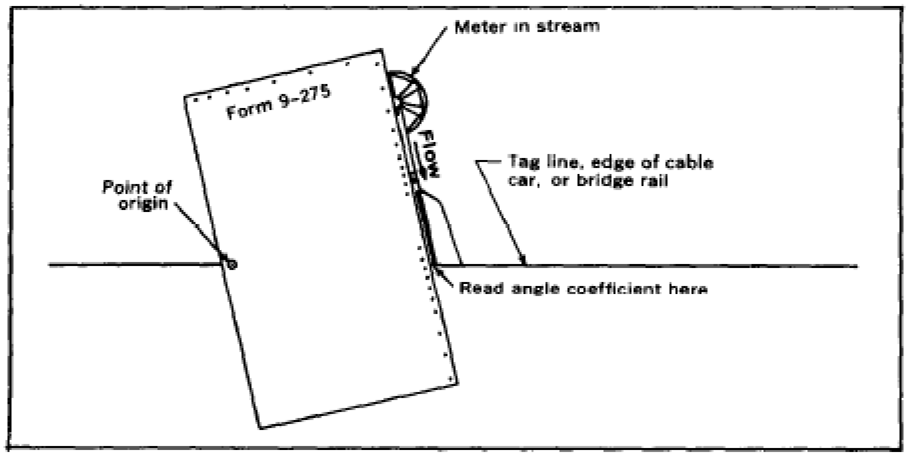


Figure taken from Rantz, 1982.

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

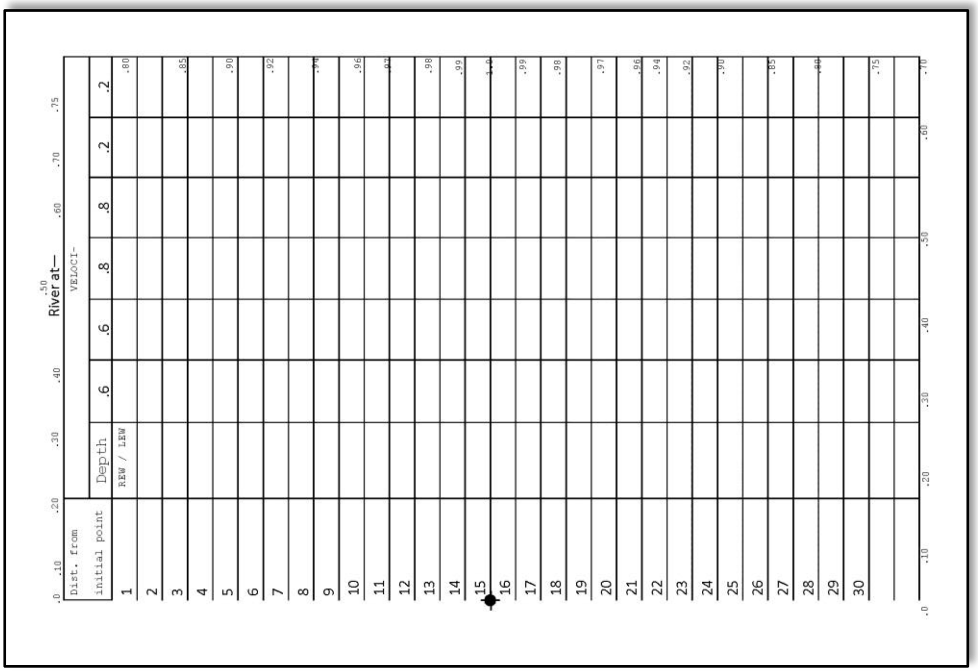
Discharge is calculated using the mid-section method in which each section extends halfway between measurement locations. The flow through each section is calculated by multiplying the average velocity with the cross-sectional area of the section. See references for a complete description of discharge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



River at—

Dist. from initial point	Depth REW / LEW	VELOCI- .6	.6	.8	.8	.2	.2
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							
17							
18							
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26							
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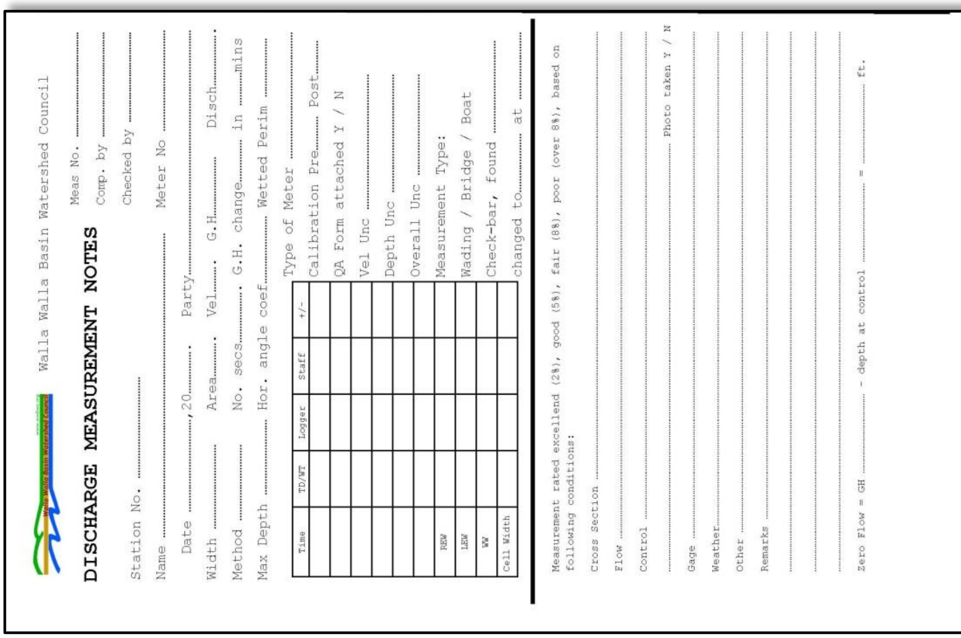
28							
29							
30							



Walla Walla Basin Watershed Council

DISCHARGE MEASUREMENT NOTES 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 ....

Type of Meter ....

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

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 ....

Station # .... Party ....

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 ____________
NIST Thermometer ____________
Low Temp (°C) ____________
Room Temp (°C) ____________

Performed by: ____________

Pre / Post 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

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.

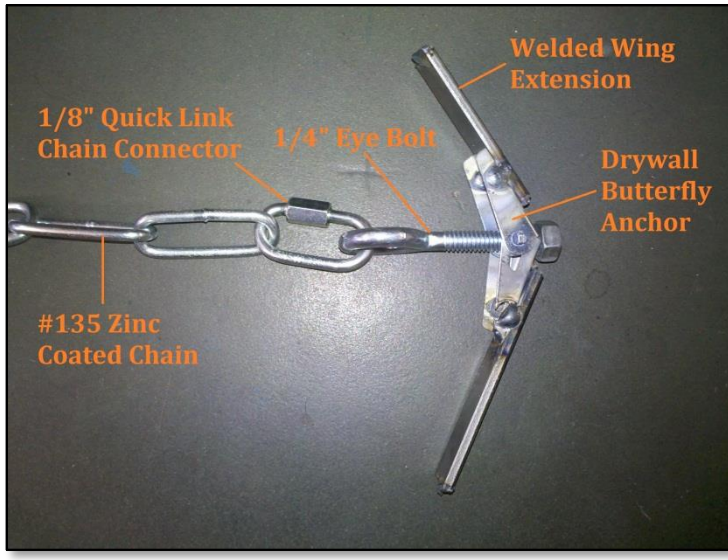
Pebble count procedures where based upon Wolman, M.G. 1954. A Method of Sampling Coarse River-Bed Material. Transactions of the American Geophysical Union. 35(6):951-956.

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.

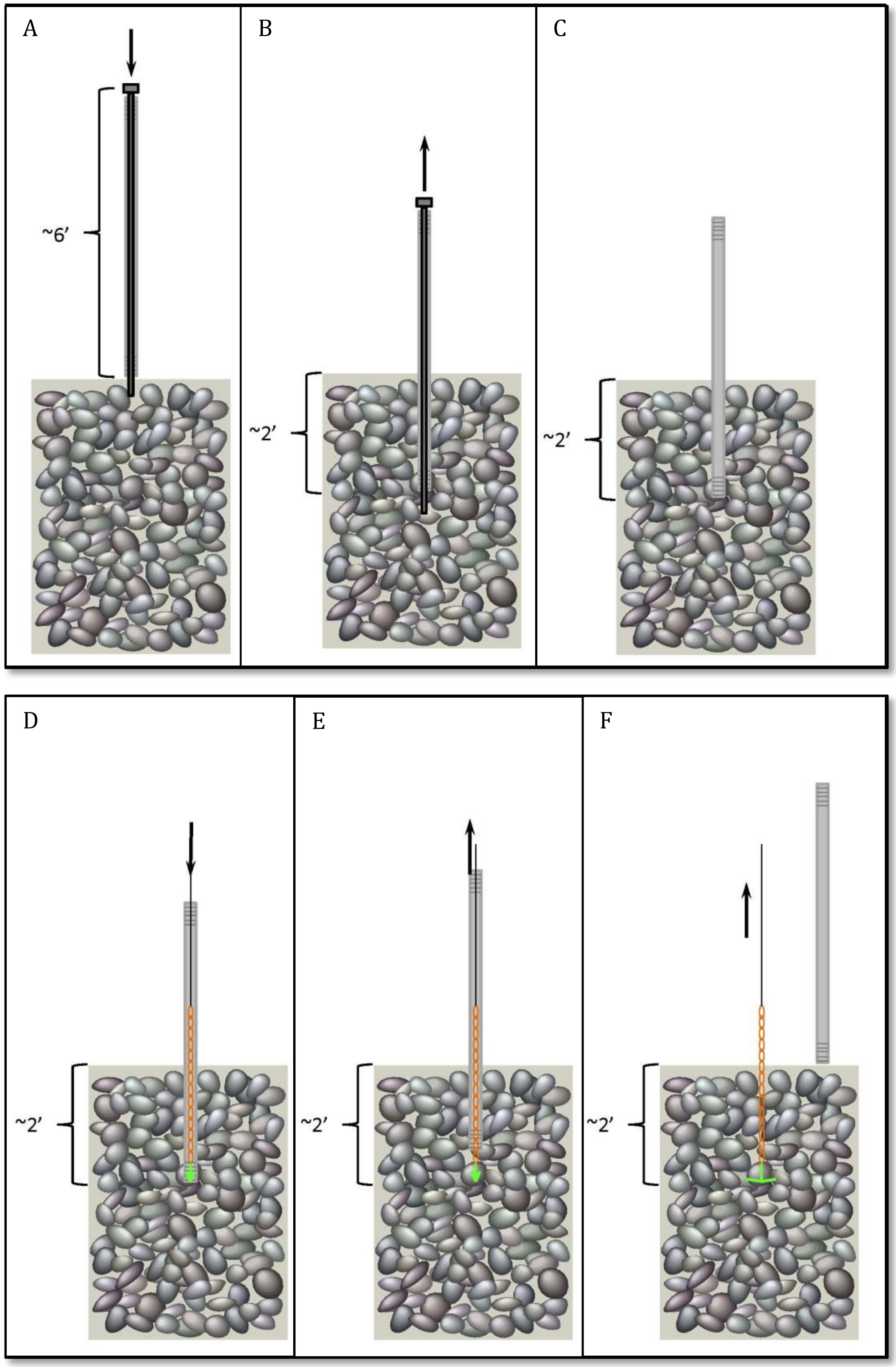


Scour Chain Installation

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).

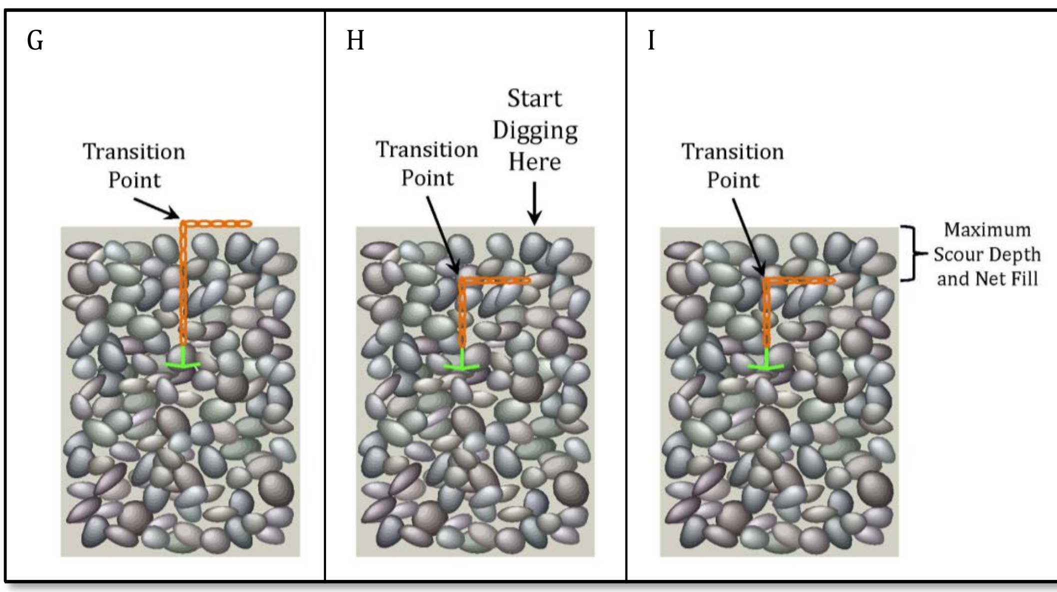


A
~6'
B
~2'
C
~2'
D
~2'
E
~2'
F
~2'

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.



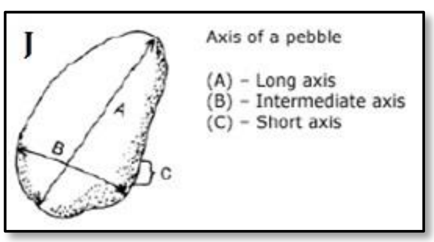
CHANNEL SURVEY

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

www.wwbwc.org
Walla Walla Basin Watershed Council
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:

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				

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

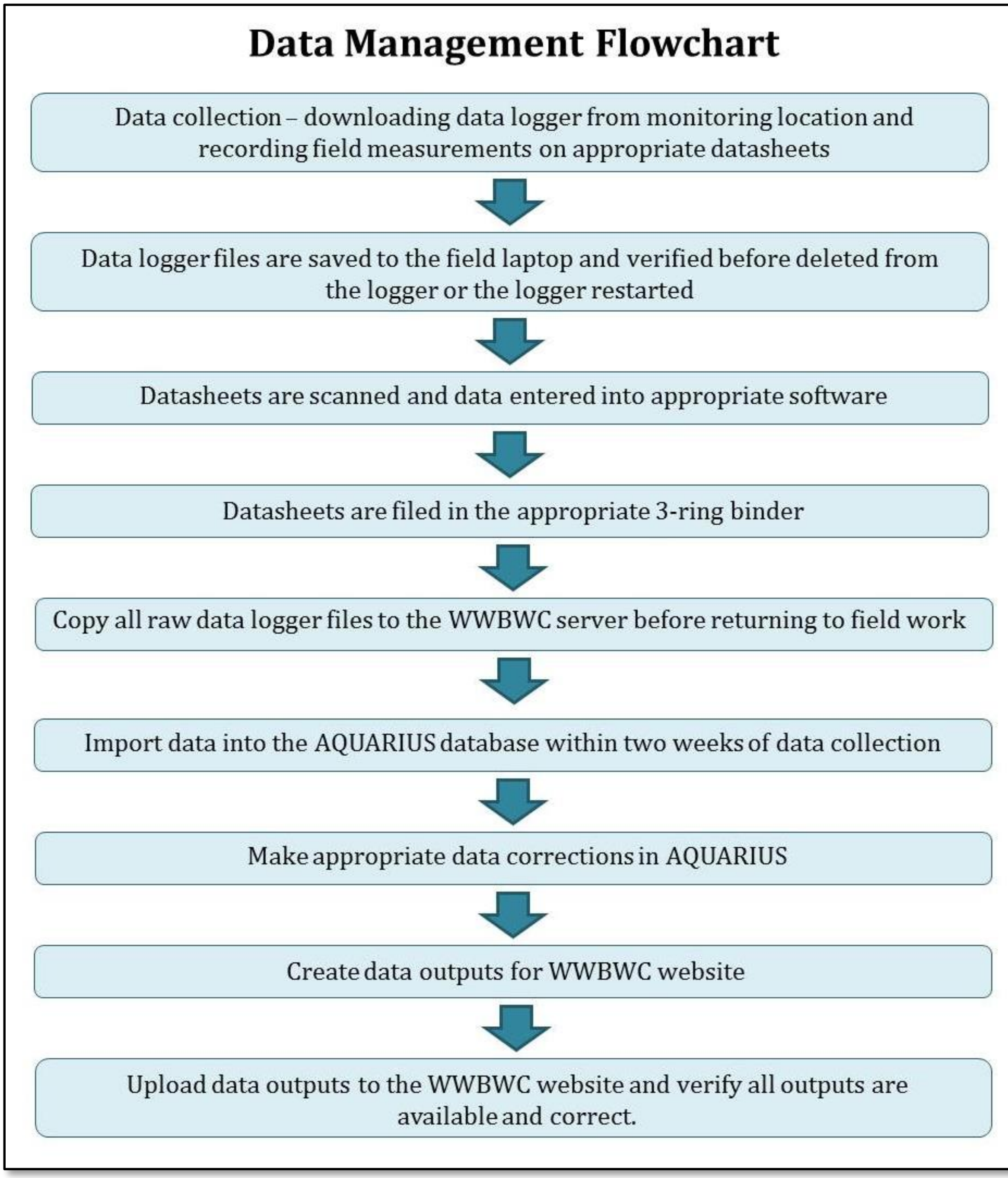
All raw data logger files collected during a day of field work should be transferred to the WWBWC server before going back out in the field to ensure data are not lost due to laptop failure or damage.

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

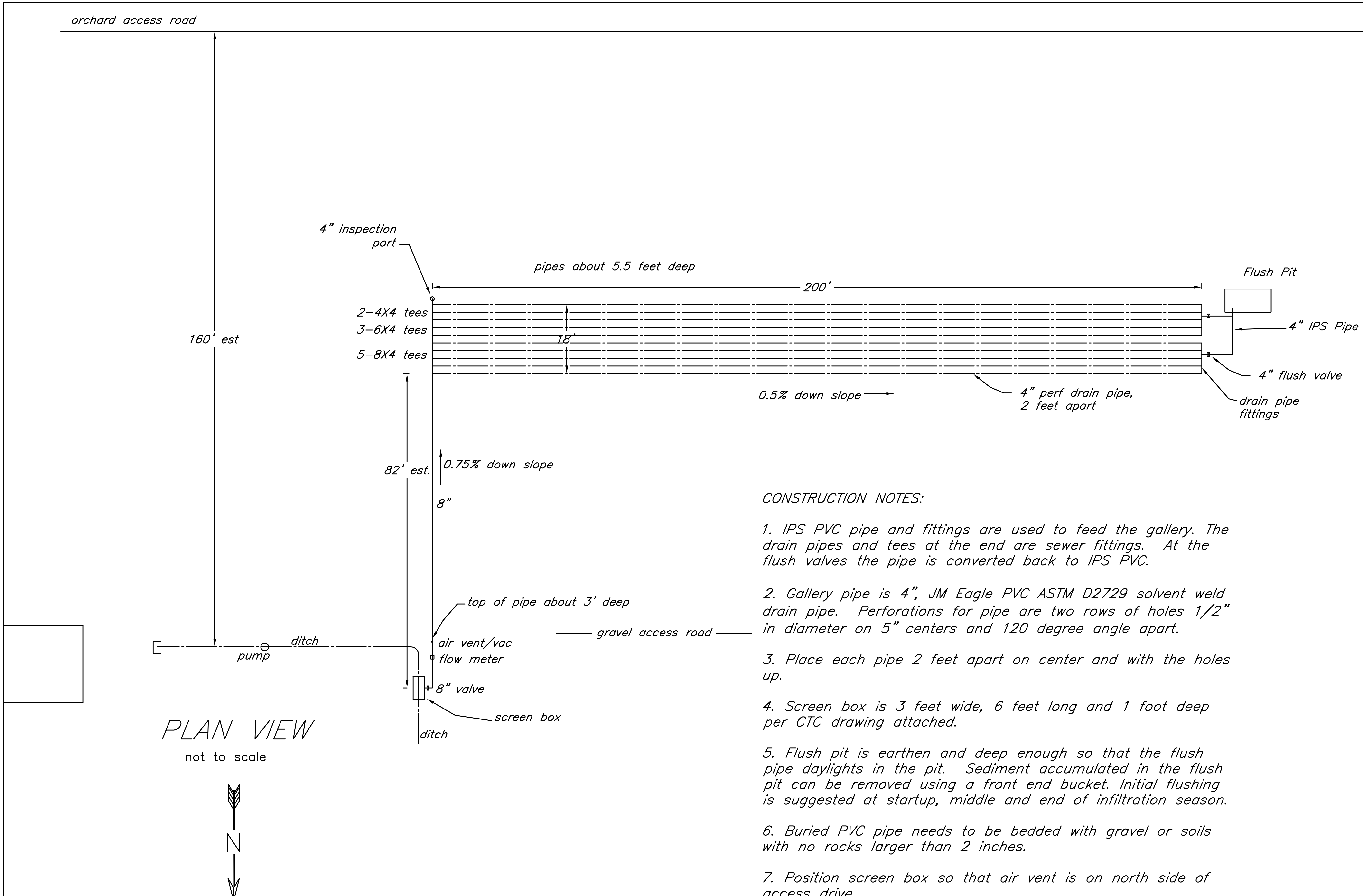
Temperature data will be given a quality rating based upon the following factors:

- 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.

Attachment C

Example Aquifer Recharge Designs

(From previous aquifer recharge projects)



CONSTRUCTION NOTES:

1. IPS PVC pipe and fittings are used to feed the gallery. The drain pipes and tees at the end are sewer fittings. At the flush valves the pipe is converted back to IPS PVC.

2. Gallery pipe is 4", JM Eagle PVC ASTM D2729 solvent weld drain pipe. Perforations for pipe are two rows of holes 1/2" in diameter on 5" centers and 120 degree angle apart.

3. Place each pipe 2 feet apart on center and with the holes up.

4. Screen box is 3 feet wide, 6 feet long and 1 foot deep per CTC drawing attached.

5. Flush pit is earthen and deep enough so that the flush pipe daylights in the pit. Sediment accumulated in the flush pit can be removed using a front end bucket. Initial flushing is suggested at startup, middle and end of infiltration season.

6. Buried PVC pipe needs to be bedded with gravel or soils with no rocks larger than 2 inches.

7. Position screen box so that air vent is on north side of access drive.

FOR REVIEW

DESIGN	jaf	8/12
DRAWN	jaf	9/12
CHECKED		
APPROVED		
TITLE		

File: InfGalleries.dwg

FAZIO ENGINEERING
P.O. BOX 246
MILTON-FREEWATER, OR 98762
(541) 938-6084

SITE LAYOUT
Anspach Recharge
MILTON-FREEWATER, OR

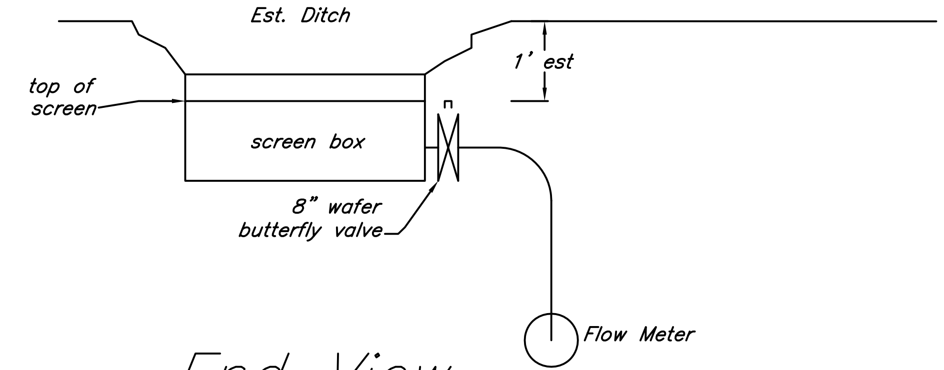
SHEET
1 OF 2

CONSTRUCTION NOTES:

1. The gallery requires 2,000 feet of drian pipe as noted. Cover drain pipe about 2" with gravel, with drain holes up.

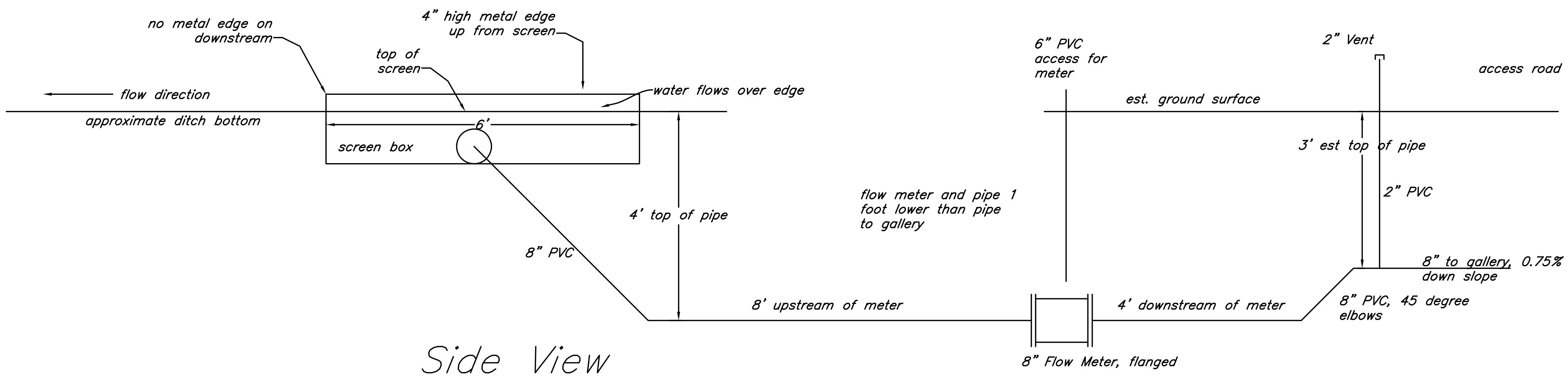
2. Proposed gravel material is 1-1/2" to 3/4" "Switch Yard", Koncrete Industries, or similar angular crushed rock with minimal fines. About 272 yards needed assuming 24' X 204' X 1.5' volume.

3. Filter fabric is a nonwoven geotextile, Mirafi MSCAPE or equivalent. About 544 square yards required, assume 24' X 204'.

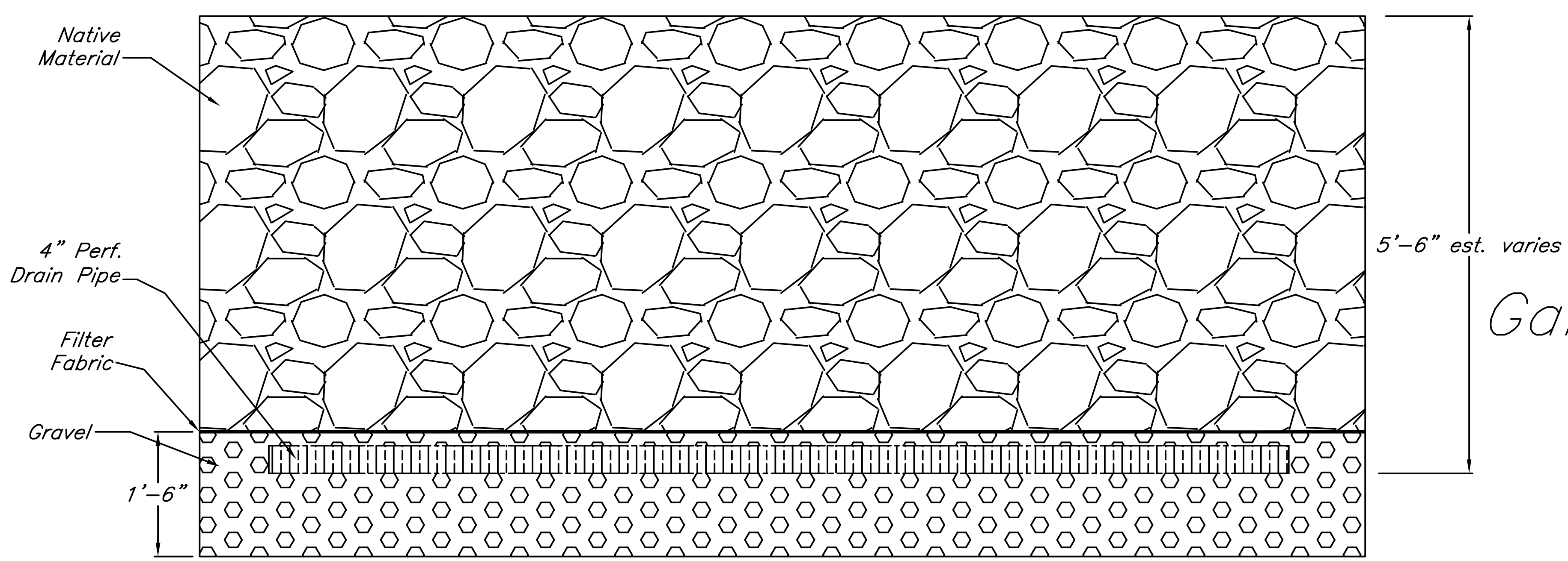


End View

Screen Box Area Details



Side View



Gallery Profile

FOR REVIEW

DATE	
DESIGN	jaf 8/12
DRAWN	jaf 9/12
CHECKED	
APPROVED	
TITLE	

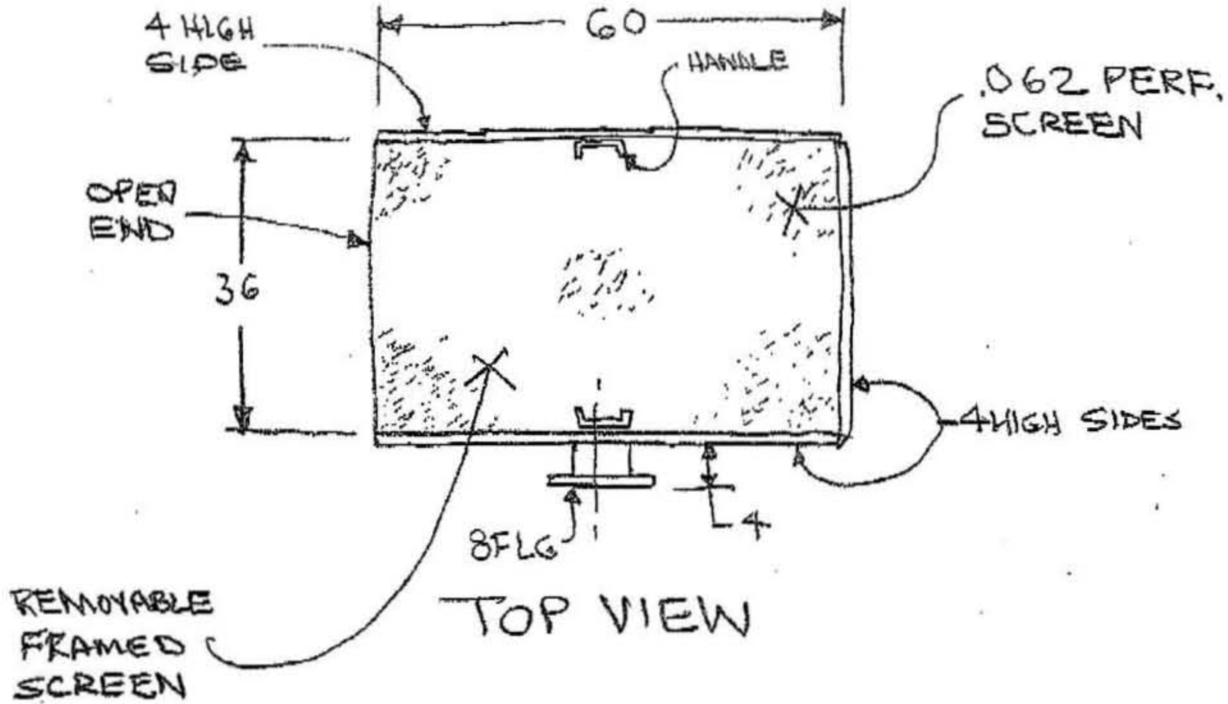
File: InfGalleries.dwg

FAZIO ENGINEERING
P.O. BOX 246
MILTON-FREEWATER, OR 98762
(541) 938-6084

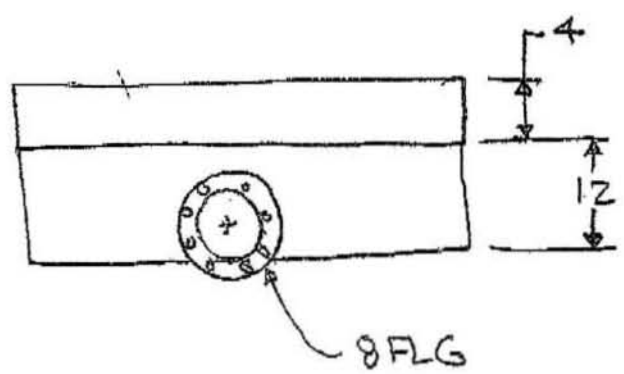
DETAILS
Anspach Recharge
MILTON-FREEWATER, OR

CTC 480 McLaughlin Road Yakima, WA 98908 USA INNOVATIVE ENGINEERING AND MANUFACTURING

PROJECT JOHN FAZIO SHT 1 OF 1
SCREEN BOX DATE 4SEPT 12
BY BobB. JOB NO. ~



TOP VIEW



SIDE VIEW

SOLVENT WELD

SUBMITTAL AND DATA SHEET

PERFORATED UNDERDRAIN PIPE : :

JM EAGLE™ PVC ASTM D3034 SOLVENT WELD SDR35 SEWER PIPE

JM EAGLE™ SOLVENT WELD SEWER PIPE CONFORMS TO SPECIFICATIONS PRIOR TO PERFORATION AND CELL CLASS 12454 OR 12364 AS DEFINED IN ASTM D1784

NOM. PIPE SIZE (IN)	O.D. (IN)	NOM. I.D. (IN)	MIN T. (IN)	APPROX. WEIGHT (LBS/FT)
4”	4.215	3.961	0.120	1.022
4” x 10’ Perf	4.215	3.961	0.120	1.022
6”	6.275	5.893	0.180	2.285
6” x 10’ Perf	6.275	5.893	0.180	2.285

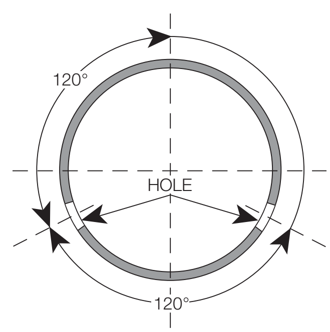
: : Standard Color: Green, Standard length: 10’ or 20’ Overall, Belled End Only
: : Standard perforations for pipe are two rows of holes 1/2” in diameter on 5” centers and 120° angle apart. Perforated pipe does not have ASTM designation on print line.

When using JM Eagle™ PVC ASTM D3034 Solvent Weld Sewer Pipe for septic tank fields, please install in accordance with ASTM D2321, and JM Eagle™ Publication JME-05B, “Gravity Sewer Installation Guide.”

JM EAGLE™ PVC ASTM D2729 SOLVENT WELD DRAIN PIPE

JM EAGLE™ SOLVENT WELD DRAIN PIPE CONFORMS TO SPECIFICATIONS AND CELL CLASS 12454 OR 12164 AS DEFINED IN ASTM D1784

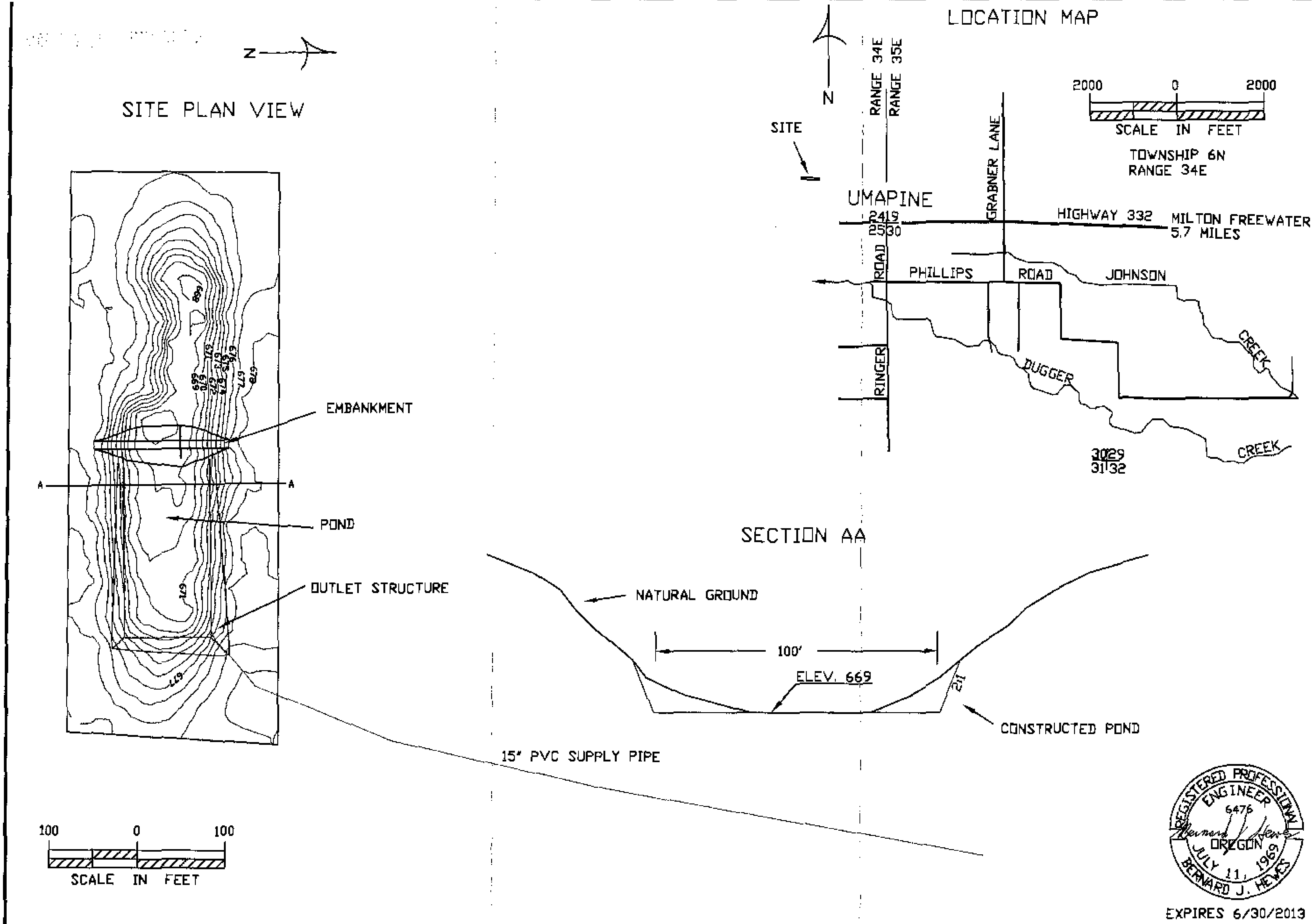
NOM. PIPE SIZE (IN)	O.D. (IN)	NOM. I.D. (IN)	MIN T. (IN)	APPROX. WEIGHT (LBS/FT)
3” Solid	3.250	3.102	0.070	0.465
3” Perf	3.250	3.102	0.070	0.465
4” Solid	4.215	4.056	0.075	0.648
4” Perf	4.215	4.056	0.075	0.648
6” Solid	6.275	6.063	0.100	1.300
6” Perf	6.275	6.063	0.100	1.300



: : Standard Color: White, Standard length: 10’ Overall, Belled End Only
: : Standard perforations for pipe are two rows of holes 1/2” in diameter on 5” centers and 120° angle apart. Three perforation rows may be available.

When using JM Eagle™ PVC ASTM D2729 Solvent Weld Drain Pipe for septic tank fields, please install in accordance with ASTM F481, and JM Eagle™ Publication JME-05B, “Gravity Sewer Installation Guide.”

* Prior to ordering or specifying, please consult JM Eagle™ for product and /or listing availability.
I.D. : Inside Diameter
O.D. : Outside Diameter
T. : Wall Thickness



WWBWC/HBDIC UMAPINE RECHARGE PROJECT
PROJECT SITE PLAN AND LOCATION MAP
UMATILLA COUNTY, OREGON

DESIGNED	B. HEWES	DATE 5/12
CHECKED		
APPROVED		

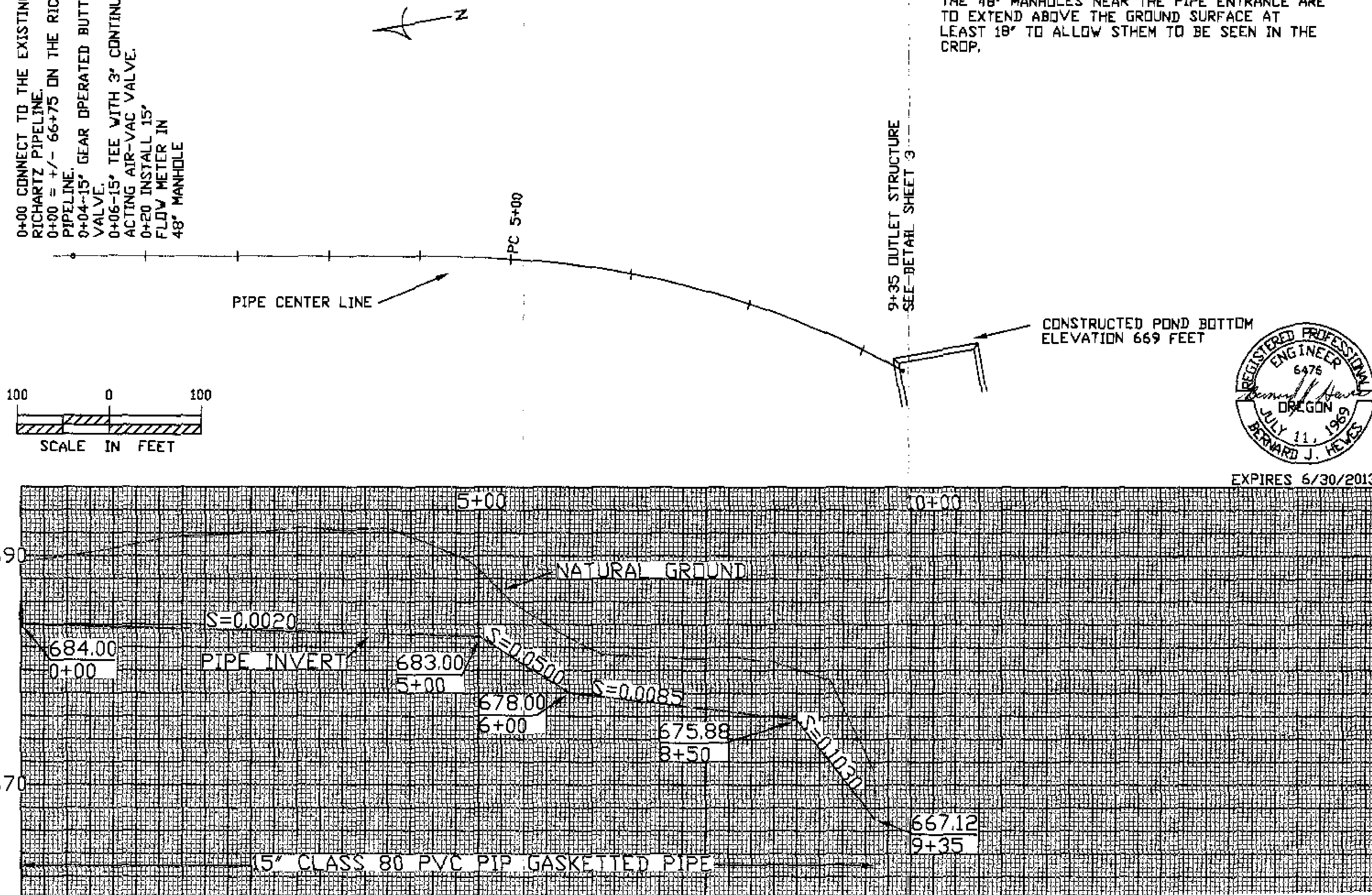
CAD FILE umarcgpln

SHEET 1 OF 4

0+00 CONNECT TO THE EXISTING RICHARTZ PIPELINE.
0+00 = +/- 66+75 ON THE RICHARTZ PIPELINE.
0+04-15" GEAR OPERATED BUTTERFLY VALVE.
0+06-15" TEE WITH 3" CONTINUOUS ACTING AIR-VAC VALVE.
0+20 INSTALL 15" FLOW METER IN 48" MANHOLE

NOTES

INSTALL PIPE ACCORDING TO NATURAL RESOURCES CONSERVATION SERVICE SPECIFICATION 430DD.
CURVE RADIUS IS 1000 FEET.
THE 48" MANHOLES NEAR THE PIPE ENTRANCE ARE TO EXTEND ABOVE THE GROUND SURFACE AT LEAST 18" TO ALLOW STHEM TO BE SEEN IN THE CROP.



REGISTERED PROFESSIONAL ENGINEER 6476 OREGON JULY 11, 1969 BERNARD J. HEWES

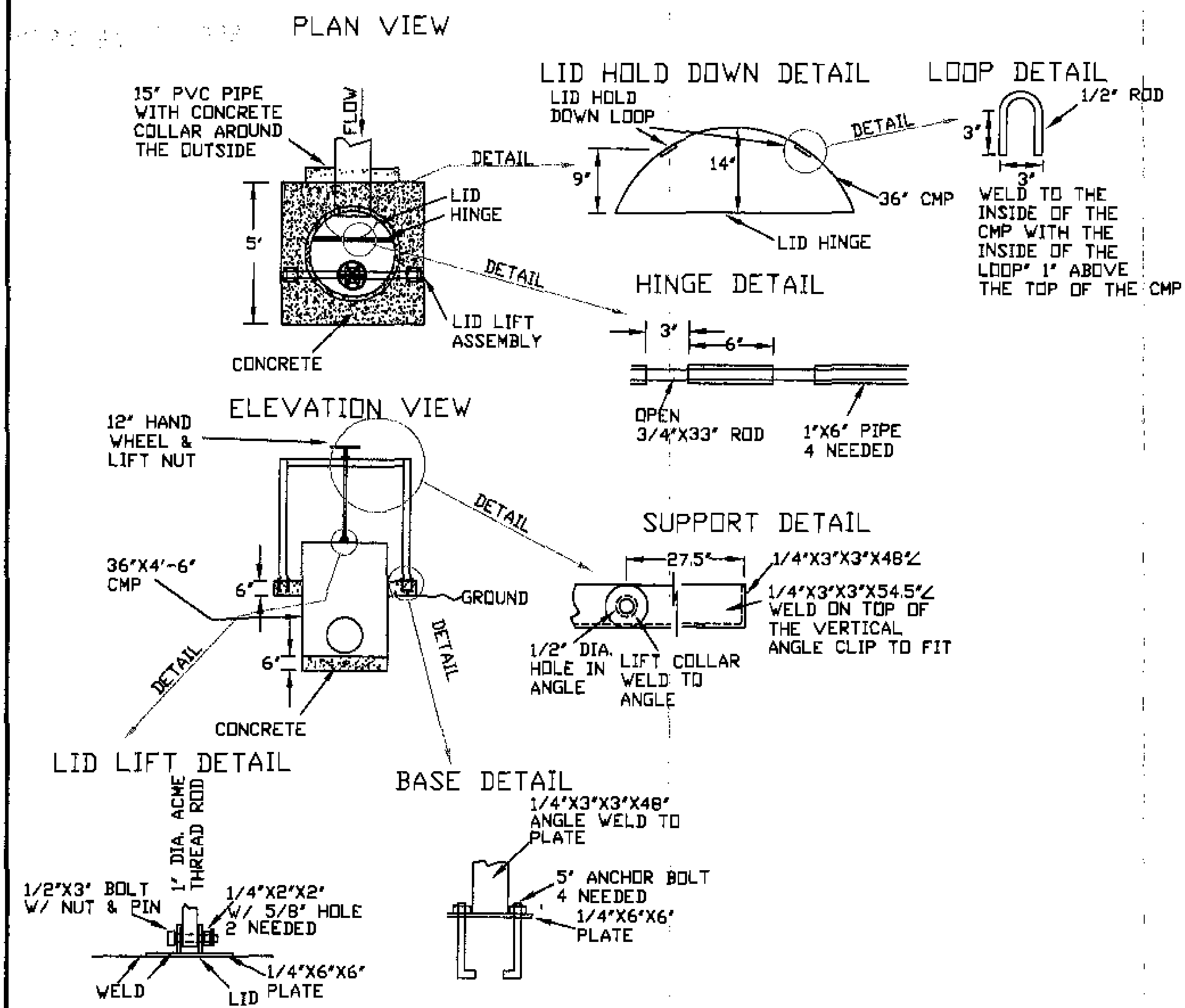
EXPIRES 6/30/2013

WWBWC/HBDIC UMAPINE RECHARGE PROJECT
SUPPLY PIPE PLAN & PROFILE
UMATILLA COUNTY, OREGON

DESIGNED B. HEWES DATE 5/12
PLOTTED
APPROVED

CAD FILE umarcgpp

SHEET 2 OF 4



NOTES

AT THE ESTIMATED DESIGN FLOW THE LID OPENING SHOULD BE ABOUT 6".
USE 4000 PSI STRENGTH CONCRETE, NEED 0.5 CU. YD. REINFORCE THE UPPER SLAB WITH A #4 BAR LOCATED 3" FROM THE OUTER EDGE, NEED 4-4'-6" BARS.
LID FOR THE OUTLET TO BE FABRICATED OUT OF 3/16" STEEL AND BE 40" IN DIAMETER.
USE 1" PIPE PIECES THROUGH THE LOOPS ON THE CMP TO TIGHTLY HOLD THE LID DOWN.

REGISTERED PROFESSIONAL ENGINEER 6476 OREGON JULY 11, 1969 BERNARD J. HEWES

EXPIRES 6/30/2013

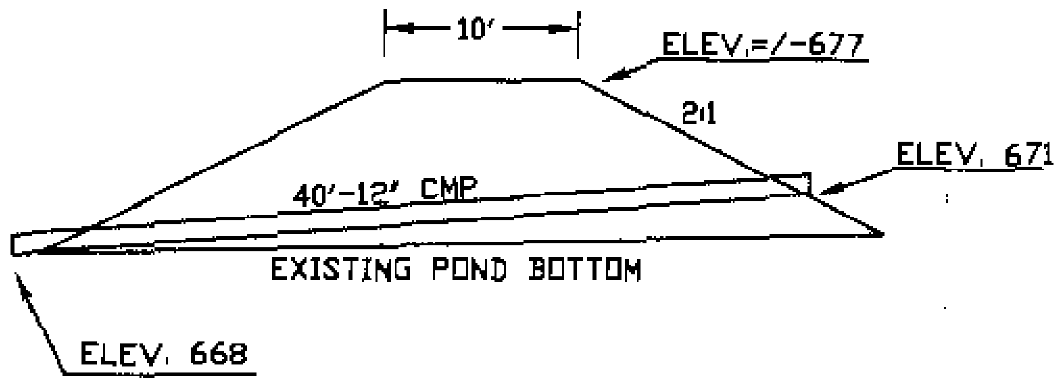
WWBWC/HBDIC UMAPINE RECHARGE PROJECT
MISCELLANEOUS DETAILS
UMATILLA COUNTY, OREGON
B. H. ENGINEERING

DESIGNED	CHECKED	APPROVED	DATE
B. HEWES			5/12

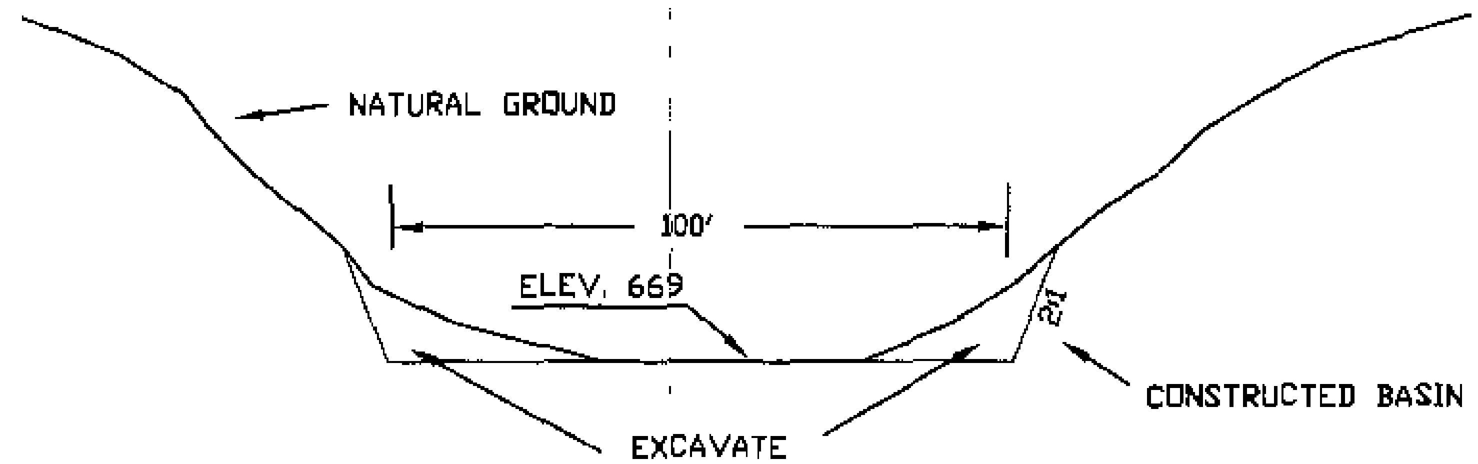
CAD FILE umarcgout

SHEET 3 OF 4

EMBANKMENT CROSS SECTION

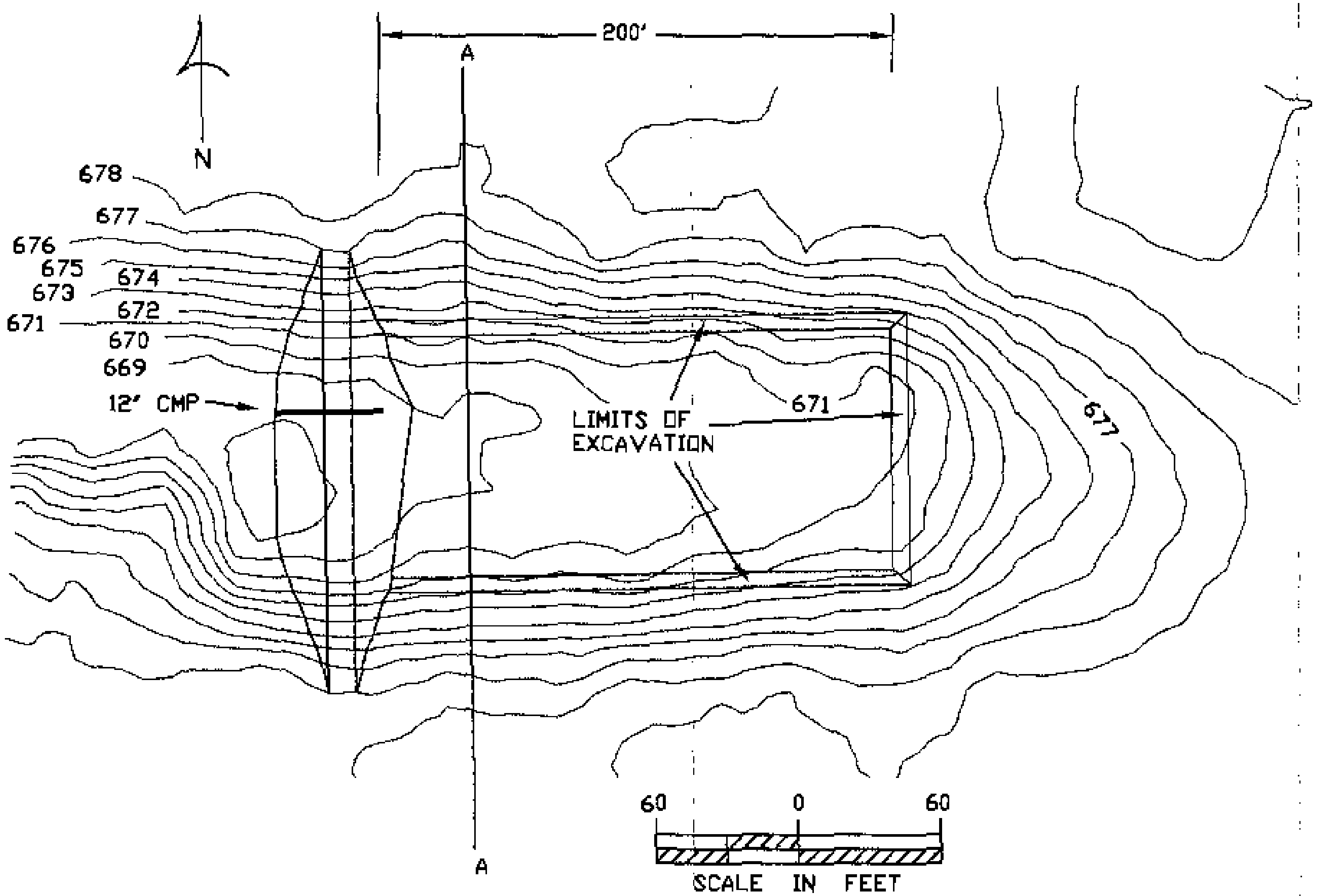


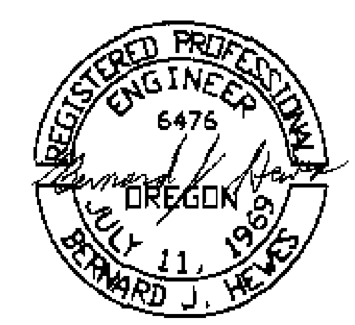
SECTION AA



NOTES

ESTIMATED EXCAVATION VOLUME ABOUT 900 CU. YD.
CONSOLIDATE THE EMBANKMENT FILL USING A VIBRATING ROLLER COMPACTOR. USE AT LEAST TWO PASSES OVER 1' THICK, LOOSE LAYERS.





EXPIRES 6/30/2013

DESIGNED B. HEWES DATE 5/12
CHECKED
APPROVED

WWBWC/HBDIC UMAPINE RECHARGE PROJECT
BASIN DETAILS
UMATILLA COUNTY, OREGON
B H ENGINEERING

CAD FILE umarcgpond

SHEET 4 OF 4