WRIA 53 (Lower Lake Roosevelt Watershed)

Groundwater Inventory and Mapping Project

June 30th, 2010

Prepared for:

WRIA 53 Planning Unit
G0800258

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Introduction

The Lower Lake Roosevelt Watershed (WRIA 53) began planning under the Watershed Planning Act (RCW 90.82) in January of 2008. The Planning Unit consists of landowners, water purveyors, governments and other interested parties. The mission statement of the planning unit is:

"To develop a plan to manage and protect the water and related resources in an environmentally and economically sound manner that is in the interest of the residents and landowners of the Lower Lake Roosevelt Watershed".

Based on that mission statement and development trends in Lincoln County, the planning unit decided to include a geographic information system (GIS) based groundwater mapping program in Phase II of the planning process.

The WRIA 53 study area includes a portion of the watershed that is located mostly within northern Lincoln County with smaller portions in northeastern Grant County, southern Ferry County, and southeastern Okanogan County (Figure 1). The portions of the watershed located in Okanogan and Ferry Counties are within the boundaries of the Colville Indian Reservation. The Colville Confederated Tribes is under a resolution to not participate in any RCW 90.82 Watershed Planning activities. Therefore, the WRIA 53 Planning Unit is focused on those portions of the watershed south of the Columbia River to characterize and develop potential planning recommendations.

The watershed encompasses approximately 326,164 acres, or approximately 509.63 square miles. The Columbia River bisects the watershed with 118,730 acres (185.52 square-miles) located north of the Columbia River, primarily within the boundaries of the Colville Indian Reservation, and 207,432 acres (324.11 square miles) located south of the Columbia River, that area which was the primary focus of this assessment. Table 1 presents a summary of the area located within each County with lands located within the Lower Lake Roosevelt Watershed. In general, the watershed encompasses that portion of the Columbia River and it is tributaries between the confluence of the Spokane River to the east and the location of Grand Coulee Dam to the west. The communities of Davenport, Lincoln, Seven Bays, and numerous smaller private housing developments are within the watershed.

TABLE 1: WRIA 53 AREA PER COUNTY			
County	***Acreage***	***Square-Miles***	***Percentage***
Lincoln	206,093	322.02	63.2
Ferry	74,542	116.47	22.8
Okanogan	44,274	69.18	13.6
Grant	1,255	1.96	0.4
TOTAL	***326,164***	***509.63***	***100***

This report presents the objectives, methodologies, description of data products, and preliminary analysis of the aquifer conditions within the southern portion (south of Columbia River) of the WRIA 53 watershed. Funding for this project was provided by the Washington State Department of Ecology (Ecology) through the RCW 90.82 Watershed Planning Grant No. G0800258.

Background

During formation of the WRIA 53 Planning Unit, the top priority of the water users in the watershed was to evaluate the sustainability of water supply within the watershed. With this priority, the Planning Unit moved forward with Phase 2, only undertaking the water quantity element of watershed planning. The WRIA 53 Planning Unit conducted the Level 1 data gathering through 2009, and completed the Phase II Level 1 Hydrogeologic Technical Assessment in September 2009. Results of the Level 1 project revealed that there was limited aquifer information available in WRIA 53 to begin aquifer sustainability planning in the watershed. In order to meet the water strategies outlined above, the following specific recommendations were developed by the WRIA 53 Planning Unit during Phase 2-Level 1 Watershed Planning (Section 7 Level 1 Technical Assessment, September 2009):

With respect to the surface water system the following is recommended:

1. *Establish flow gauging stations at selected streams and springs to better characterize water flowing into and out of the hydrologic system. Focus on the Hawk Creek drainage.*
2. *Use flow measurements to establish a baseline for comparing to future conditions.*
3. *Conduct periodic water quality measurements to better understand stream and spring health, especially as rural home density increases. Monitoring should be conducted at the locations where Ecology is conducting stream flow monitoring.*

For the aquifer systems underlying the WRIA, the Planning Unit has recommendations similar to those for surface water. These recommendations, which are driven by a general scarcity of data upon which to assess baseline conditions and trends, are as follows:

1. *Develop a groundwater monitoring plan and strategy.*
2. *Establish some groundwater level monitoring areas having both high and low well density to better track pumping effects on the 3 aquifer systems and to better characterize potential aquifer recharge conditions.*
3. *Collect aquifer pumping test data, as it becomes available, to use to better characterize aquifer physical conditions for use in evaluating long term aquifer hydrologic trends.*
4. *Conduct a limited amount of groundwater geochemical sampling in order to better understand aquifer recharge conditions and evaluate surface water/groundwater continuity.*
5. *Conduct a more detailed GIS* (*Geographic Information System*) *evaluation to inventory and map available data on ground and surface water resources and the relationship to current and future land use in WRIA 53. The goal of such an evaluation would be to collect information useful in identifying aquifer boundaries, recharge areas, high groundwater pumping areas, and potential sustainable aquifer pumping targets, and areas in which potential mining of groundwater is occurring.*
6. *Compile a GIS layer identifying where potential critical aquifer recharge areas are located.*

This GIS Groundwater Mapping project was identified as a priority in order to assure that groundwater supplies are not diminished, a potential scenario which arose from the Groundwater Management Area (GWMA) mapping project, which identified most of the basalt aquifers as having 10,000 plus year old water; suggesting that there is not a direct recharge to the aquifers from Lake Roosevelt.

The WRIA 53 Groundwater Inventory & Mapping project will produce tools to aid in decision making at all levels. A GIS will be utilized to analyze the data. For example, the maps created during this project can be used by local planning officials to implement new land use codes that reflect the water availability in the area. Also, a prospective landowner could use the data when deciding which piece of property to purchase.

The goal of this project is to create a tool so that the WRIA 53 water users can economically and responsibly use the Watershed's resources to our advantage.

Project Scope of Work

This project was comprised of five main tasks:

1. Data collection: spatial distribution and growth of groundwater wells in the watershed;
2. Analysis of Well Logs: utilizing existing well logs in the Ecology Database, document total depth of wells, static water levels, and well yields;
3. Stream flow data collection: collect stream flows at several locations on Hawk Creek;
4. Groundwater monitoring: develop a groundwater monitoring program in the watershed to track trends of groundwater levels;
5. Development potential within the watershed: use results of the technical data to begin evaluation of future growth and its impact on water resources.

A preliminary analysis was conducted as part of each task. The GIS Groundwater analysis was not intended to be comprehensive, but developed to begin a preliminary evaluation of how data and tools can be developed and used in the future to understand the hydrogeology of the watershed.

Task 1 – Data collection

The objective of this task was to begin development of a database of groundwater information in the watershed which could be used by WRIA 53 water users in the future. Databases were compiled and maintained by the Lincoln County Planning Department. Maps and graphs of the hydrogeologic information were created using the Department of Ecology's well log database. Not all well logs (especially those from the earlier years) have all the information that was needed for the project. As a result of the state of the data, these maps should be considered a starting point for analyzing wells and water availability in WRIA 53. As more data is collected, this dataset will be updated to reflect the more accurate and current data.

Well logs for the Lincoln County portion of the watershed were compiled during the Level I Technical Assessment. The Department of Ecology website allows for downloading well logs by watershed in table format, which includes coordinates that were used to create a GIS layer. The State of Washington has been receiving well logs since the 1930's; however, not all wells drilled were reported to the department.

The wells north of the Colubia River were added to the master well database table and all were imported into ArcMap. The Lincoln County wells have more complete data due to the work completed in the previous Phase 1 planning efort; the remaining well data may be improved as time and budget permit.

A review of Ecology's well database for that portion of WRIA 53 reveals approximately 600 well log records in the area. Of the Ecology well records, approximately 353 were located in Lincoln County and deemed usable for this assessment. These located wells are deemed usable because: (1) they have a clear description of location, (2) they are legible, and (3) the descriptions of well geology and construction appear to be complete and interpreted to be representative of actual conditions. Well locations as reported on the well logs are assumed to be correct as most wells were not field located for this project.

Of the approximately 353 wells used in this assessment, all but 29 are listed as domestic wells. Basic well geology and construction for 344 of these wells were imported into the Lincoln County Planning Departments database. Table 2 presents a generalized distribution these wells in the WRIA.

TABLE 2: Distribution of Groundwater Wells

TN/RE	Total wells	Non-domestic wells	Hydrogeology
25/35	1	0	
25/36	39	11	1 basement
25/37	39	7	All bslt, 1 art.
25/38	2	0	Bslt
26/34	4	0	Bslt
26/35	31	1	1 sed
26/36	49	0	1 base, 1 sed, 3 sed/bslt
26/37	13	0	4 base, 1 bslt/sed
27/32-27/33	3	0	2 bslt, 1 base
27/34	27	1	Most basement
27/35	48	4	5 base; 7 sed
27/36	22	1	6 base; 10 sed/bslt
27/37	17	0	9 base, rest mixed
28/31	33	1	Mix
28/33-28/36	16	3	Mix
	344	**29**	

The portable document format (pdf) well logs were downloaded and placed into a database at the Lincoln County Planning Department. Well log information (coordinates, total depth, geology, well yield, etc.) was downloaded into an excel spreadsheet to facilitate further analysis of the

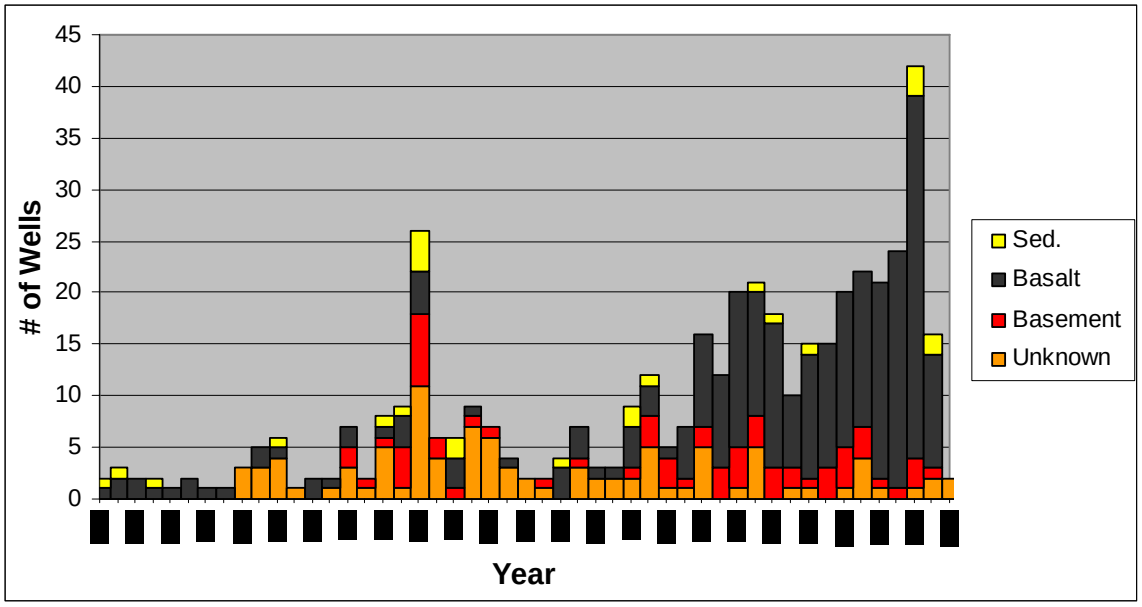
information provided for each well. This information was then utilized to conduct the GIS analysis described below.

As identified in the Phase 1 Technical Assessment (September 2009) the watershed is underlain by three basic aquifer systems: (1) a generally localized alluvial system with a high degree of hydrologic continuity with surface water, (2) the layered, generally widespread Columbia River Basalt Group (CRBG) system, and (3) a low yield, joint and fracture controlled system found within the pre-basalt basement rocks (typically granites in the southern portion of WRIA 53). Section 2 and 4 of the Phase 1 Technical Assessment provides additional information about these three systems. During analysis of the groundwater wells in the system, this project attempted to correlate only those wells founded within the same hydrogeologic system. Where multiple systems were intercepted by the groundwater well, the information was placed into the aquifer system in which the well screen was placed.

Graph 1 shows the distribution of wells drilled by year. The number of wells completed from 1940 through 1973 is not considered accurate for two reasons: 1) the practice of well drillers completing and submitting a well log to the State was not common; and 2) management of well log data changed agencies and was not the responsibility of Ecology until 1971. Data from the mid 1970's to 2009 is a better representation of the number of wells completed each year in WRIA 53.

As shown in Graph 1, prior to 1986, most wells were shallow and completed into the shallow sand and gravel aquifer, or the shallow Wanapum Basalt. In addition, during this time frame, the well logs were very generalized and did not contain detailed well completion details. Therefore, the aquifer in which the wells were screened and withdrawing groundwater is unknown.

Figure 2 presents a map of the watershed in which the groundwater wells in the southern portion of watershed are located. Only those wells which contained well construction information and in which aquifer the groundwater is being withdrawn was identified, is plotted. Figure 2 shows the distribution by year of the well completed, and from which hydrogeologic unit the groundwater is being withdrawn. Only these wells were used in the analysis outlined in the subsequent sections of this study.



Graph 1: Distribution of Groundwater Wells in Study Area by Year Drilled

Task 2 – Analysis of Well Logs

The NOI database is part of the Ecology Well Construction and Licensing System. The database contains information collected when the driller submits documentation prior to drilling a well and any report made to Ecology after the well has been drilled. The difference between this database and the well log database is that the well depth, yield, and water level are in an electronic format as opposed to just being recorded on the PDF copy of the well log. Many of the records for the NOI database also include the land parcel numbers. This coupled with the GIS data available from each county allows for more accurate location of the groundwater wells. In addition, this data can be integrated into other data sources, create spatial datasets, and analyze the data.

The next step after importing the wells into the GIS database was to analyze the spatial distribution of well depth, aquifer yield and static/potentiometric groundwater level which could be used to analyze the spatial distribution of these characteristics. This was completed by creating raster datasets using a method known as Kriging. Kriging is a geostatistical technique that is often used in soil science and geology environments.

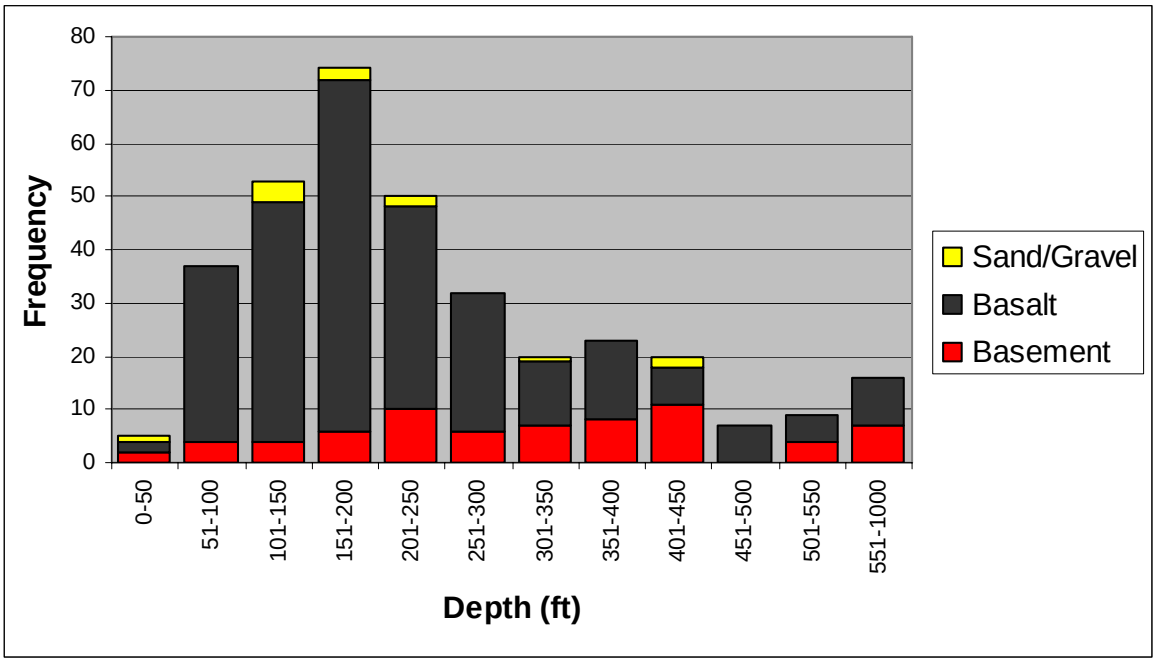
Total Depth of Groundwater Wells

An analysis was first completed on the total depth in which a well was completed. This allowed a generalized knowledge of the approximate depth a property owner would need to drill to complete a water well. This

information should be used in conjunction with static water level, as the static water level is typically higher in elevation than the depth to which the well is completed. Due to the confined and semi-confined aquifer conditions of many of the basalt and granite aquifers, a hydraulic head of tens to a hundred plus feet can occur (i.e. the pressure head on the aquifer will cause the potentiometric head or static water level to rise in the well above the depth in which the aquifer was first encountered). This information is useful to a water user by identifying what the potential depth will be required to drill a well, and to what depth a pump will need to be placed to pump the aquifer (which can be significantly shallower if the aquifer has significant hydraulic head).

Graph 2 presents a distribution of the total well depths completed in the various aquifers. This information shows that most basalt aquifers will be encountered at a depth of 50 to 300 feet. Basement aquifers (typically fractured granite) vary in depth typically from 50 to 450 feet in depth, and unconsolidated sand and gravel aquifers are most common at 50 to 250 feet in depth.

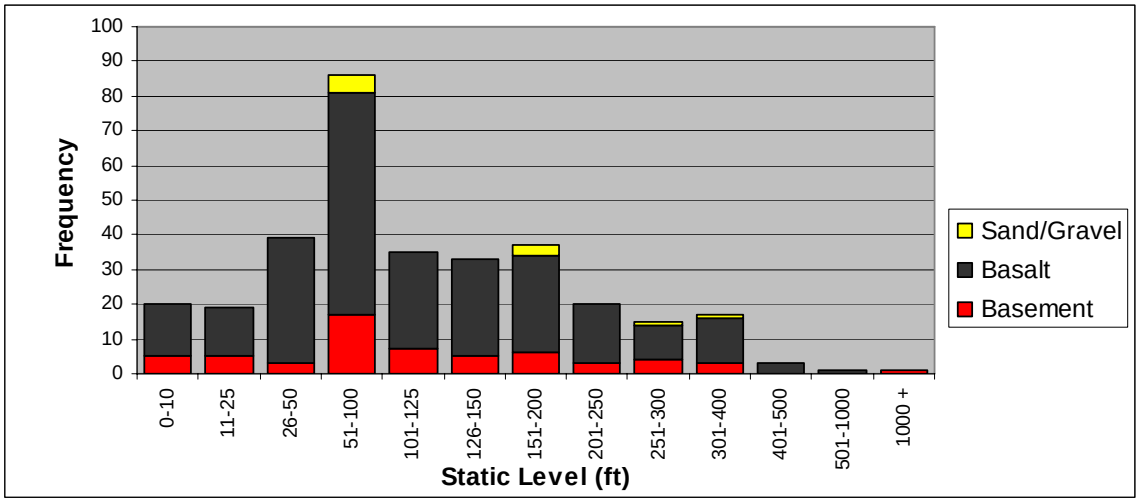
Using the GIS programming, Figure 3 presents a spatial variation of the total depth of wells throughout the watershed. Well depth is directly correlated to topography of the watershed and the type of aquifer being utilized for water production.



Graph 2: Distribution of Groundwater Wells Total Depth in Study Area

Static Water Levels in Groundwater Wells

The Static water levels in the groundwater wells were also analyzed. This information provides the depth to which the groundwater table (or potentiometric head) will be at static conditions. Graph three presents a summary of the static water levels as analyzed by depth below ground surface and hydrogeologic system. As shown on Graph 3, groundwater in the unconsolidated aquifers will typically be found at a depth of 50 to 100 feet or 150 to 200 feet. Groundwater static water levels in the basalts vary throughout the watershed, but are most commonly found from 26 to 250 feet below ground surface. Basement (mostly fractured granites) static conditions vary greatly throughout the watershed.



Graph 3: Distribution of Static Water Table in Wells in Study Area

Figure 4 presents a map showing the aquifer delineation type of wells withdrawing groundwater within the watershed. This map was developed using the well depth, static water level information, and the hydrogeologic unit within the database. The map represents a generalized representation of which hydrogeologic unit will most likely yield groundwater within a certain area of the watershed. As shown on the map, the basalt aquifers are most common throughout the watershed. Unconfined sand and gravel aquifers are most common within the drainages of the watershed. The area east of Davenport reveals mostly sand and gravel aquifers; however, it is our determination that the spatial variation program used to develop this map only had access to a few shallow wells in this area. No deep basalt wells are located throughout this area, therefore not allowing the GIS model to extrapolate out the more regional basalt aquifers. Basement rock aquifers are scattered throughout the watershed south of the Columbia River, and typically represents deeper wells with low yields.

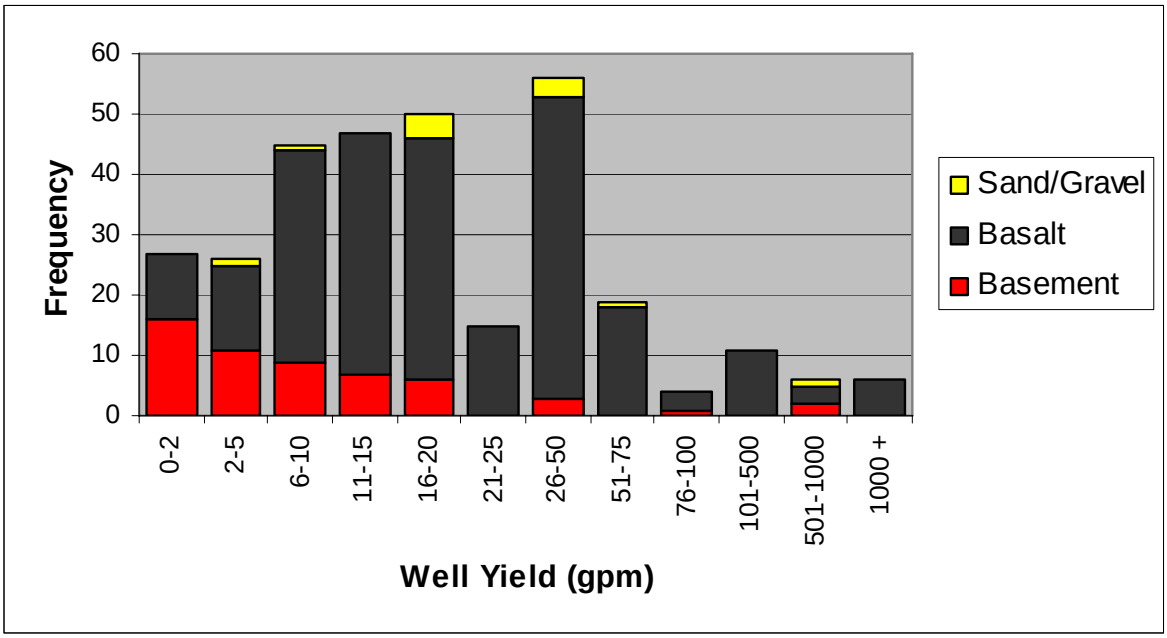
Figure 5 presents a GIS map of the static water spatial variation throughout the watershed. The map represents the static water level in all hydrogeologic units within the watershed. The map represents a generalized interpretation of the potential depth to groundwater after completion of a well. This information is useful to water users by allowing a generalized interpretation of the pump infrastructure which will be required to withdraw groundwater. As stated previously, this information should be used in conjunction with the total depth of the well.

Groundwater Yields in Wells

Groundwater well yields are the most difficult groundwater attribute to predict. Many factors can directly influence the water availability within a certain type of aquifer. Conditions such as permeability, porosity, structural controls, potential boundary conditions (e.g. valley walls in an unconfined aquifer), and facies changes (e.g. a basalt interflow of sand and gravel pinching out) will directly influence the potential yield of any given aquifer. For this task under this project, the well yields documented by the drillers at the time of drilling were used in the analysis. It should be noted that these values are yields prior to any sustained usage of the aquifer. Also, when utilizing data collected by others (e.g. air test estimates given by drillers on well logs), the quality of the well yield data is of great concern. These estimates are not based on detailed hydrogeologic studies or sustained pump tests. Past experience by the project team hydrogeologists show that the well log yields are not always accurate due to a number of factors. A primary estimate of well yield by drillers is conducting an air test, a method of using compressed air to force water out of the well, which is not considered as accurate as a pump test, and there may be an incentive for well drillers to overestimate the well yield.

To test a well yield more accurately, a minimum 4-hour pump test should be completed. The majority of wells in Lincoln County did not have an extended yield test conducted as it is not required for any building permits, as in some other counties. Therefore, the analysis of recorded well yields used in this study must be used with some limitations.

Graph 4 presents a summary of the well yields recorded on well logs within WRIA 53. As shown on this graph, there is a large variation in well yields from basalt aquifers. However, the majority of basalt aquifers yield approximately six to 75 gpm. Sand and gravel aquifers within the study area will generally yield approximately 16 to 50 gpm. Granite aquifers typically are low yielding, a result of water being derived from a fracture flow system. Fractured granite aquifers in the study area typically yield less than 20 gpm.



Graph 4: Distribution of Groundwater Yield of Wells in Study Area

The GIS analysis attempted to estimate potential aquifer yields across the watershed with the available data. The data set was configured to draw an approximate polygon around the extent of a specific hydrogeologic system, and only compute a spatial variation for the specific hydrogeologic unit within that polygon. Figure 6 shows the spatial variation of well yields throughout the watershed. As shown on the map, the lowest yielding aquifers are generally going to occur in the northwestern extent of the watershed, where the basement granitic rocks occur. Higher yield aquifers typically occur where wells are withdrawing groundwater from basalts in the central and southern portions of the watershed.

This information can be used by the watershed group and County Planning Department to begin to estimate well density and land use throughout the watershed. For example, in the areas where aquifers predominantly yield less than 10 gpm, it may be prudent to develop codes for a less development density through larger lot sizes.

Task 3 - Stream flow

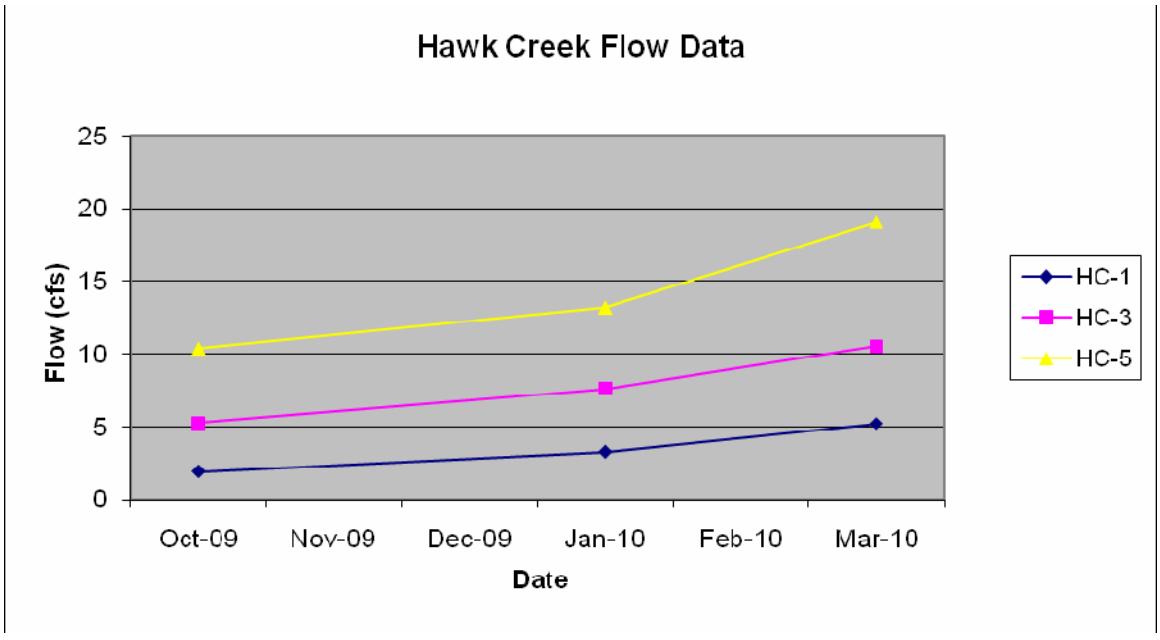
During the Phase 2 watershed planning effort, Ecology conducted some stream flow monitoring in Hawk Creek on behalf of the planning unit. Stream flow measurements were collected on October 14th, 2009, January 11th, 2010, and March 30th, 2010. The planning unit identified six potential stream monitoring locations on Hawk Creek during the

initial Phase 2 planning effort. Due to land access and stream morphology, Ecology was able to collect flow measurements at three of these locations (HC-1, HC-3, and HC-5). Locations of the monitoring stations are shown on Figure 7.

Ecology used a FlowTracker sensor to monitor flow velocity in the stream. Field data was then entered into a CPU Firmware Version 2.11. Table 3 presents a summary of the flow monitoring results collected to date. Data summery sheets are presented in Attachment A.

Table 3: Summary of Stream Flow Monitoring in Hawk Creek (all flows in cubic feet per second – cfs)			
Date	***HC-1***	***HC-3***	***HC-5***
03/30/2010	5.2151	10.5198	19.0950
01/11/2010	3.2590	7.5975	13.1940
10/14/2009	1.9122	5.2510	10.3710

As shown in Table 3 and in Graph 5, Hawk Creek appears to be a gaining stream from near the headwaters to station HC-5 which is at the bridge on Miles Creston Road. During all three monitoring dates, the stream appears to proportionally gain from each station to the next. It should be noted that all measurements collected to date have been outside of the irrigation season. The planning unit will determine whether to continue monitoring for another year.



Graph 5: Graphical Presentation of Flow Data from Hawk Creek

Task 4 – Groundwater Monitoring Program

The WRIA 53 Planning Unit also developed a groundwater level monitoring program in order to develop a database of groundwater level elevations throughout the watershed. The Lincoln County Conservation District (LCCD) is conducting the monitoring program through June 2011. The Lincoln County Planning Department solicited landowners in WRIA 53 by sending out a letter request to approximately 700 property owners in the WRIA 53 watershed. The County received responses from approximately 50 landowners, of which 70 wells were evaluated to determine if they were suitable for the groundwater level monitoring program. A list encompassing information of all the wells reviewed is presented in Attachment B. After review of the well information, property owners were requested to sign an access agreement to monitor wells. The Planning Unit and Conservation District was granted access to sixty (60) wells. Of these wells, 47 were suitable to collect groundwater level measurements. It should be noted that additional wells are being sought and added to the monitoring program as the project progresses. Figure 8 presents a map showing the location of wells that were evaluated for the study and wells that are currently being monitored for the project.

The LCCD began monitoring water levels in some wells in December 2009. An attempt is made to collect groundwater levels every six to eight weeks. To date, there are only 22 wells that have three or four measurements collected. A summary of data collected to date is presented in Appendix B. Data has only been collected for several months on the wells, and no significant trends have been identified to date. No data has been collected during the irrigation season, and defining seasonal trends will be more effective after a full year of monitoring. The project has been approved for funding through June 2011, and a summary report will be completed at that time.

Task 5 – Evaluation of potential development in WRIA 53 (Lincoln County portion only)

The purpose of Task 5 was to estimate the amount of potential future development in WRIA 53, given the current development standards; this is often known as a build out analysis. Since Lincoln County is not required to plan fully under the Growth Management Act (GMA), there is not an official minimum lot size. Lot size is driven by the ability to provide on-site water and septic systems. Five (5) and ten (10) acre lots are very popular in Lincoln County, therefore that is what was used in this evaluation. The following is how the final numbers were calculated (using a GIS):

1. All parcels within WRIA 53 were selected.
2. Removed parcels that were/could be served by a water purveyor.
3. For the remaining parcels, the following information was collected:
    a. Total acreage
    b. Value of improvements
    c. Utilization (effective parcel size/density)
4. Parcels were then separated into 5 groups:
    a. Parcels with an effective size at or below the study density (utilization less than 2) and have greater than $5,000 of improvements.
    b. Parcels with utilization less than 2 and have less than $5,000 of improvements.
    c. Parcels with utilization greater than 2 and greater than $5,000 of improvements.
    d. Parcels with utilization greater than 2 and less than $5,000 of improvements.
    e. Public Lands.
5. Final calculation was:

Potential Residential Units = (Type b parcels) + (Type c parcel utilization – 1) + (Type d parcels utilization)

Table 4 shows the results of the build out analysis, using the two different parcel sizes.

Table 4: WRIA 53 Build Out Analysis

Parcel Type	***Potential Residential Units (based on a 5 acre average)***	***Potential Residential Units (based on a 10 acre average)***
Undeveloped parcels without further subdivision potential	552	734
Undeveloped parcels that can be subdivided	26,487	12,989
Developed parcels that can be subdivided further	3,039	2,667
Total	**30,078**	**16,390**

The significance of this analysis is that each of these residential units could potentially have a separate well, potentially placing strain on the groundwater supply. One goal of this Groundwater Inventory Assessment is to identify areas with lower water availability so that the zoning and development regulations can be amended to reduce densities in areas of limited water and encourage in areas with more water and/or

water systems. The build out analysis shows that the majority of potential units come from undeveloped parcels, which most are currently in timber, farming or grazing zones.

Project Data Outputs, Conclusions and Recommendations

Raster Images

Well yield analysis
Well total depth analysis
Well static water level analysis

Map Layers (shape file format)

WRIA53_wells.shp *(this layer is used for many maps with different symbology)*
WRIA53granite_wells.shp
WRIA53basalt_wells.shp
WRIA53sediment_wells.shp

Maps

Figure 1: WRIA 53 Location and Topography (color hillshade)
Figure 2: Groundwater Wells by year drilled & geology
Figure 3: Total Depth (ft) Spatial Variation
Figure 4: Groundwater Well Aquifer Type Delineation
Figure 5: Static Water Level (ft) Spatial Variation
Figure 6: Well Yield (gpm) Spatial Variation
Figure 7: Location of Hawk Creek Stream Monitoring Locations
Figure 8: Location of Groundwater Wells being monitored

Next Steps

As stated in the introduction, it is a priority of the WRIA 53 Planning Unit to develop a complete understanding of the aquifer conditions in the watershed in order to develop appropriate land management alternatives for sustainable water supplies. This project developed the preliminary databases to initiate this goal. This project allows the Planning Unit to manage these datasets and tools to better understand the hydrogeology of the watershed. Through these data sets, the group can further delineate the spatial distribution of the permit exempt wells and an understanding of how this distribution through well characteristics (total depth, yields, and static water levels) may affect the sustainability of groundwater for the WRIA 53 water users. This may result in additional planning efforts to restrain growth in areas of limited water availability.

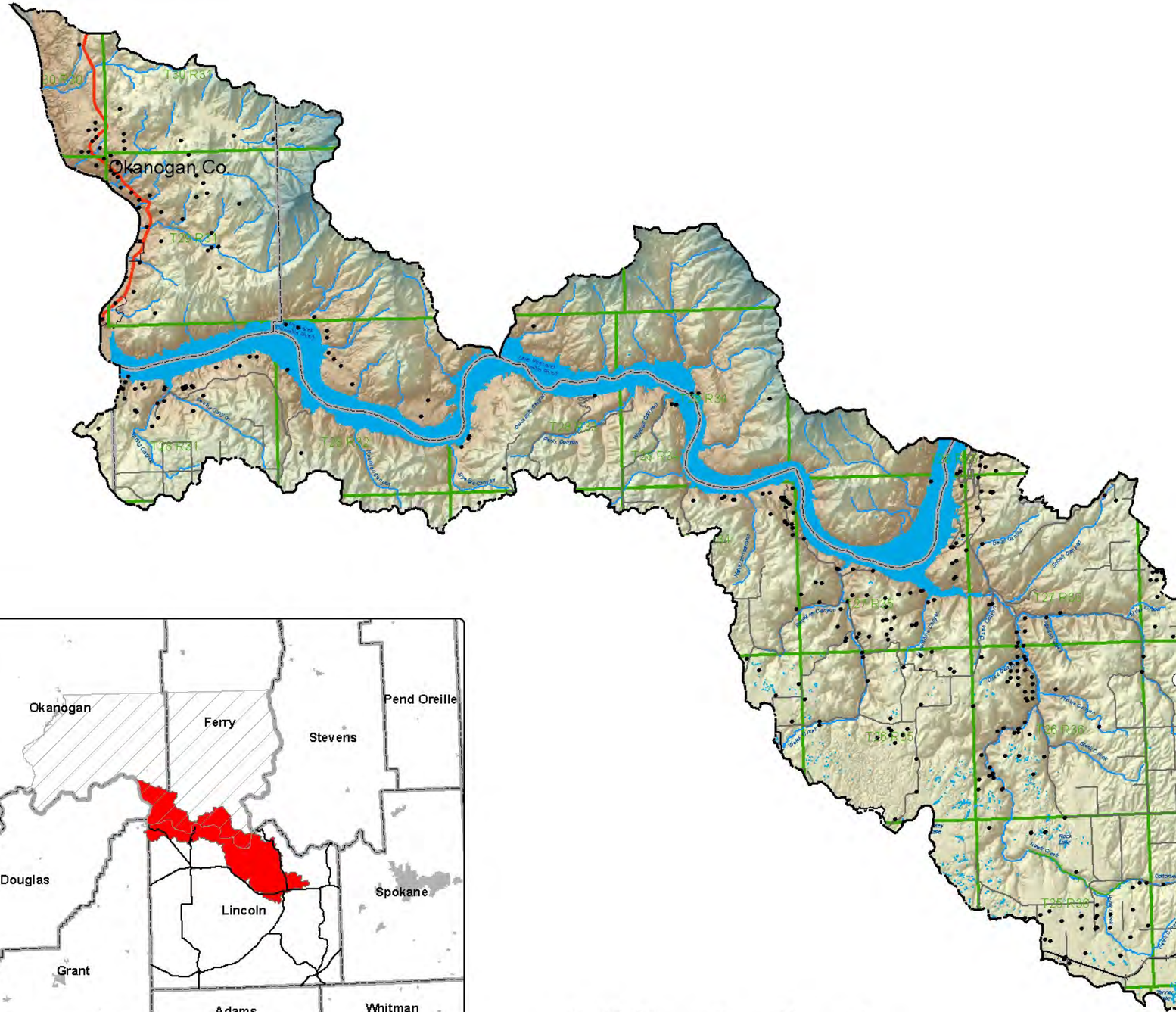
The following are recommendations that the Planning Unit should conduct in order to meet the goals and objectives of sustainable water supplies:

1) Continue the groundwater level monitoring program;
2) Continue development of the Hawk Creek surface water flow database;
3) Further evaluate domestic water demand patterns, and correlation to lot size development;
4) Evaluate residential water demands;
5) Continue development of the hydrogeologic database, specifically by encouraging private land owners to provide results of their pump tests to the County.

Figure 1

Location & Topography

Wells •



*Well data not available for area north of Columbia River

0 1.25 2.5 5 7.5 10

Miles

N

W E

S

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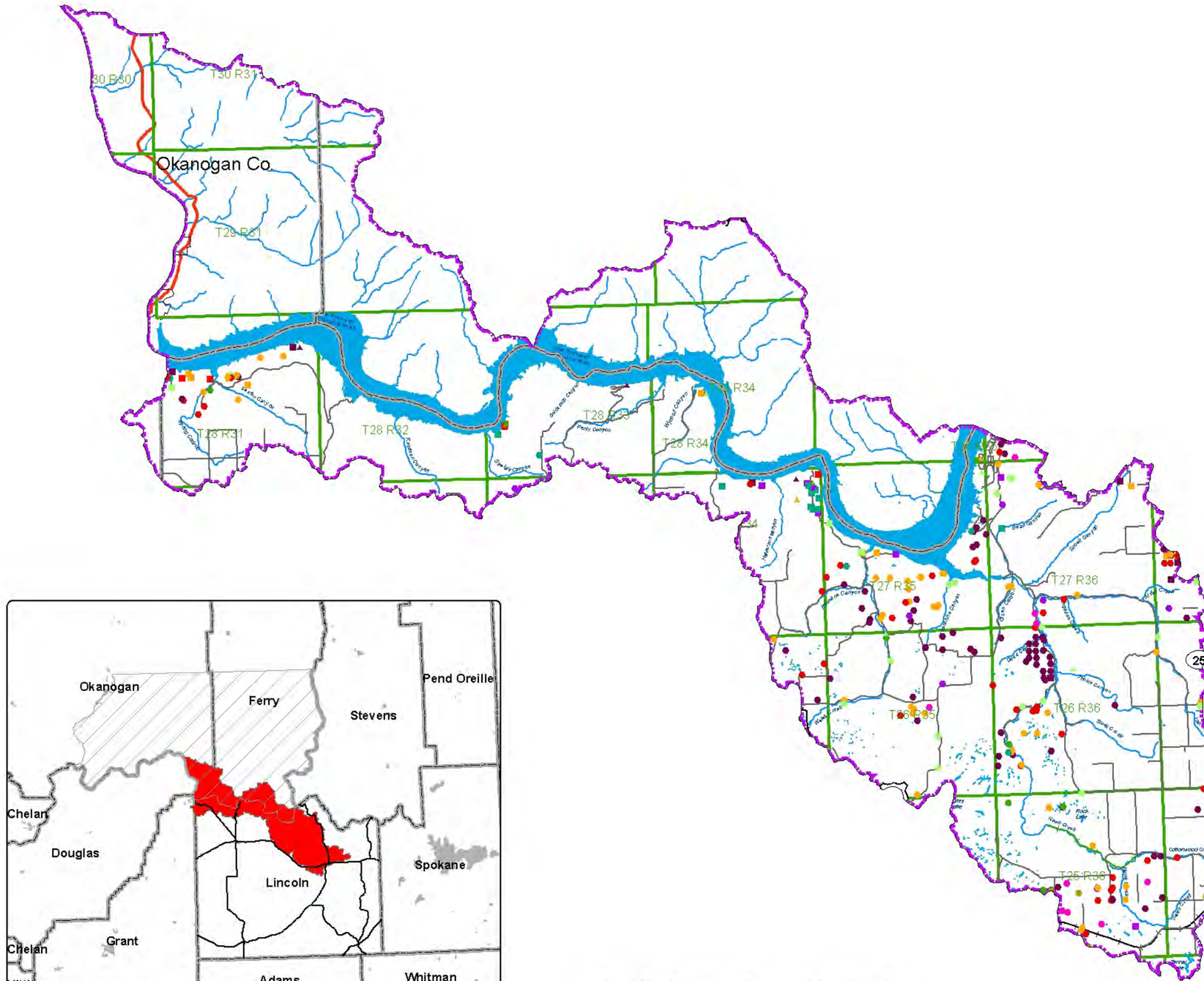
Figure 2

Groundwater Wells Year Drilled w/Geology



	Basalt	Granite	Sediment
Pre 1962	●		
1962 - 1973	●	■	▲
1973 - 1979	●	■	▲
1979 - 1984	●	■	▲
1984 - 1990	●	■	▲
1990 - 1995	●	■	▲
1995 - 2000	●	■	▲
2000 - 2004	●	■	▲
2004 - 2009	●	■	▲

*Well data not available for area north of Columbia River

0 1.25 2.5 5 7.5 10

Miles

N W E S

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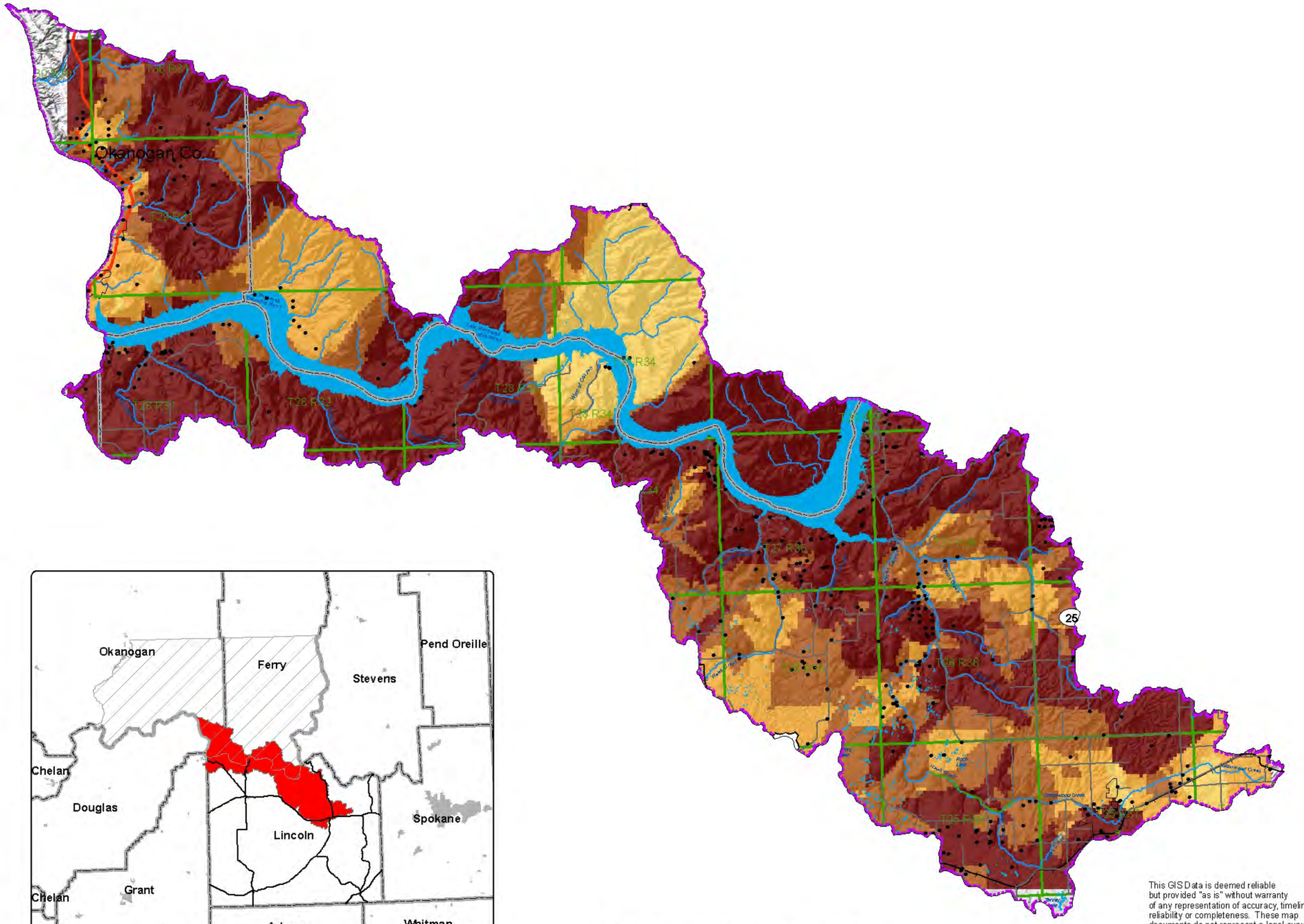
Figure 3

Total Depth Spatial Variation (feet)



*Well data not available for area north of Columbia River

0 1.25 2.5 5 7.5 10
Miles

Wells
Less than 60 ft
60 - 100 ft
100 - 150 ft
150 - 200 ft
200 + ft

N
W E
S

Land Services
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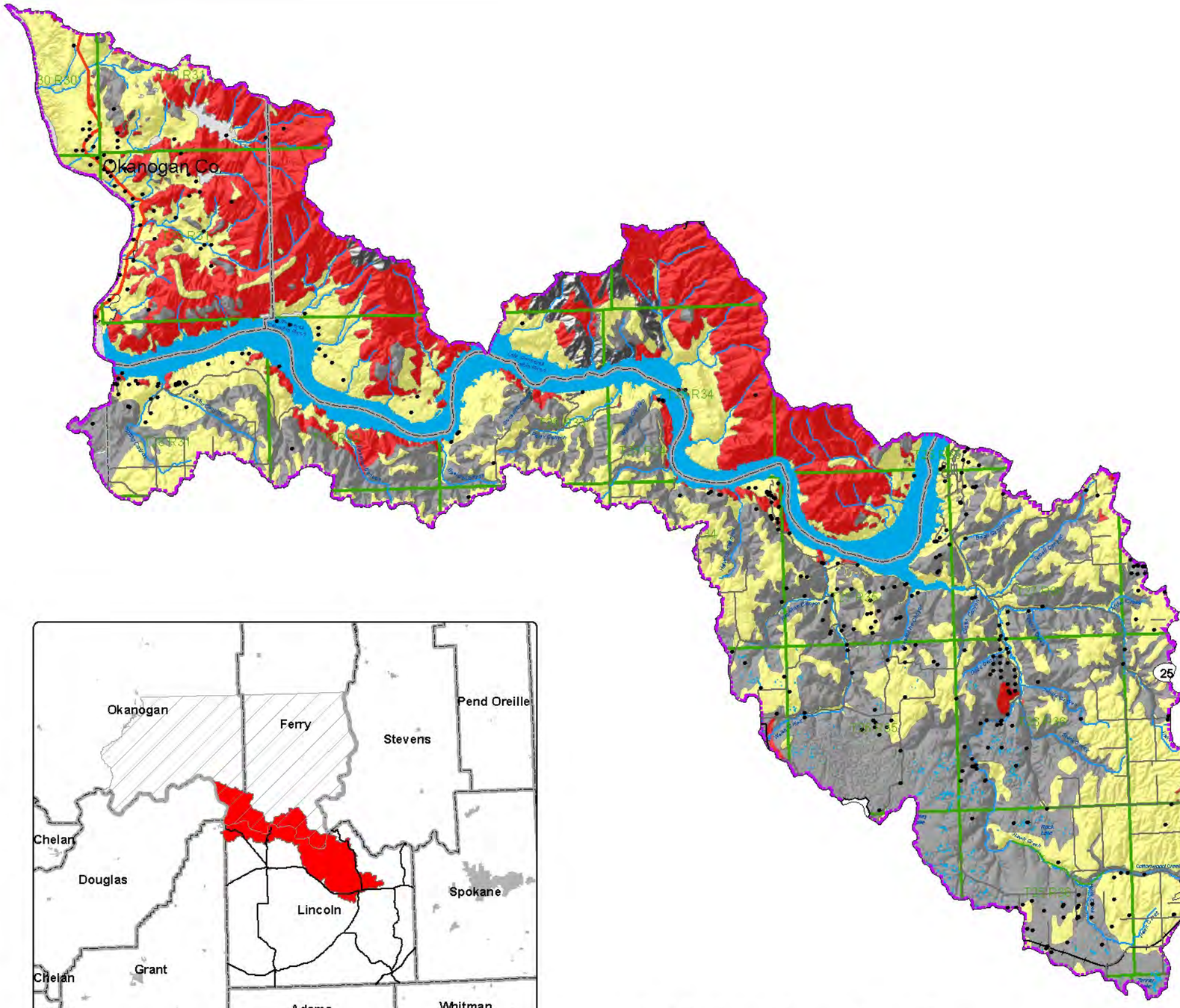
Figure 4

Groundwater Well Aquifer Type Delineation



Wells
Basalt
Granite & other bedrock
Unconfined sand/gravel

*Well data not available for area north of Columbia River

0 1.25 2.5 5 7.5 10
Miles

N
W E
S

Land Services
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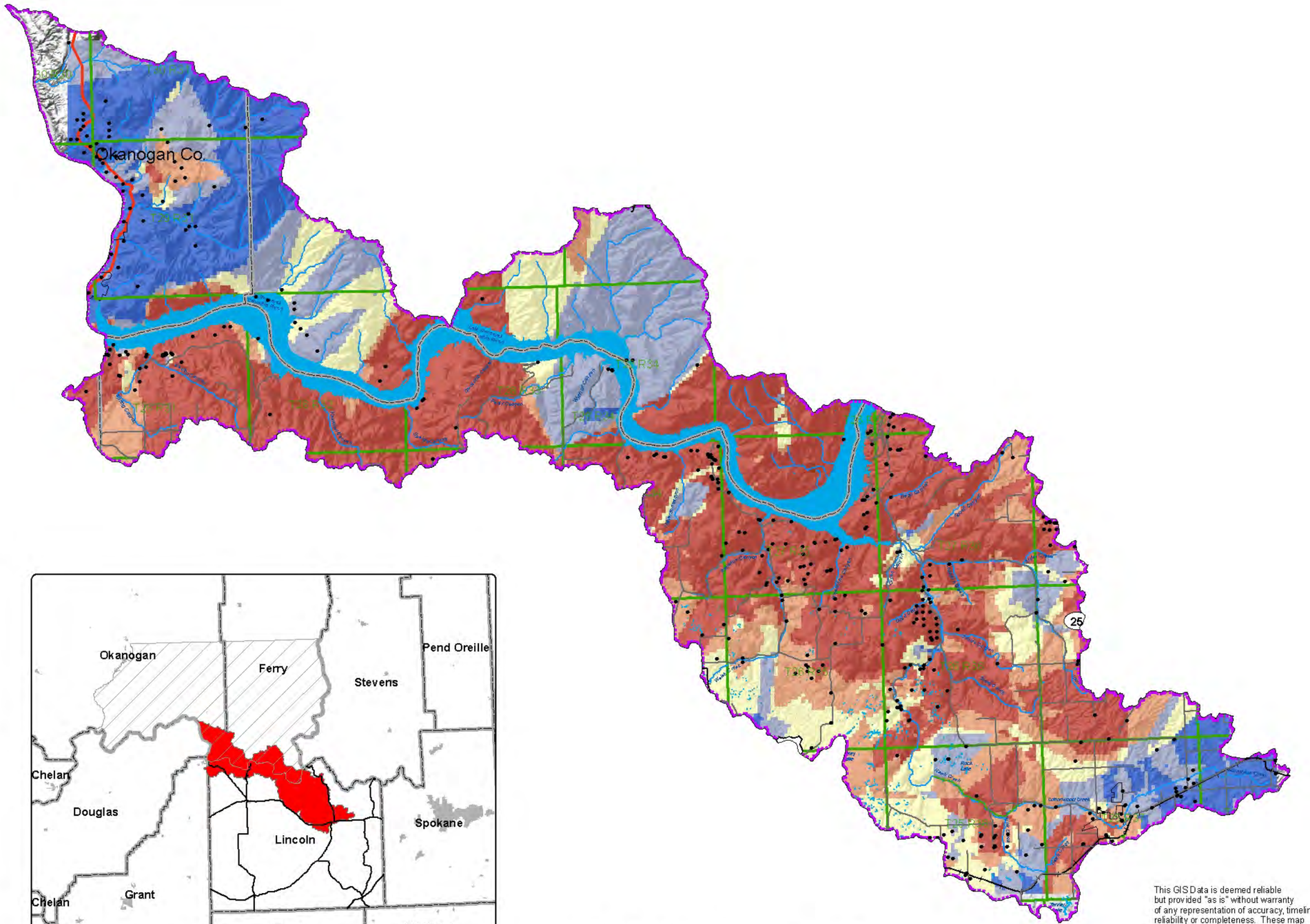
Figure 5

Static Level Spatial Variation (feet)



*Well data not available for area north of Columbia River

Wells •
0 - 40 ft
40 - 60 ft
60 - 80 ft
80 - 100 ft
100 + ft

N
W E
S

0 1.25 2.5 5 7.5 10
Miles

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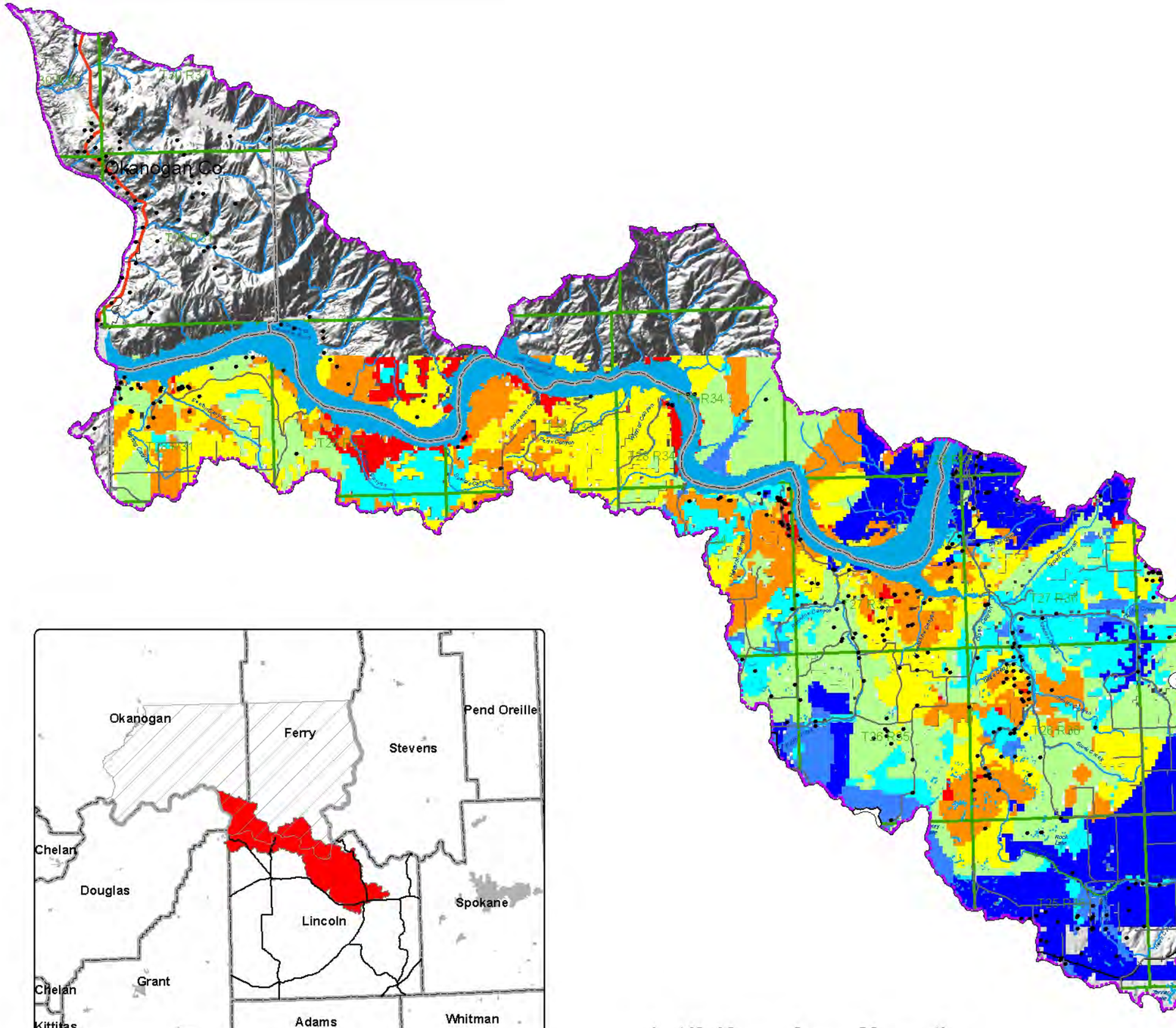
Figure 6

Well Yield Spatial Variation (gallons per min)



Wells •

GPM

1 - 5	
5 - 10	
10 - 15	
15 - 25	
25 - 35	
35 - 50	
50 +	

N

W E

S

0 1.25 2.5 5 7.5 10

Miles

*Well data not available for area north of Columbia River

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Figure 7

Location of Streamflow Measuring Stations

Okanogan Co.

Douglas Co.

Ferry Co.

Stevens Co.

HC5

HC3

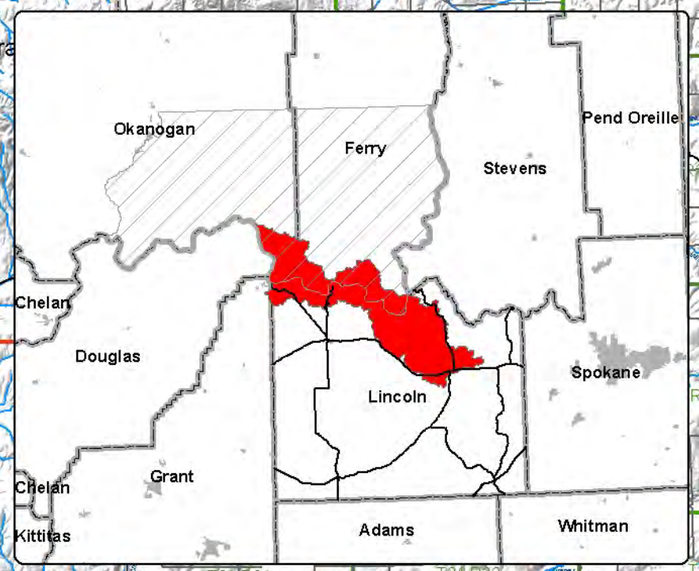
HC1

Surface Water Monitoring

N

W E

S



*Well data not available for area north of Columbia River

0 1.25 2.5 5 7.5 10

Miles

Land Services
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Lincoln County Washington USA

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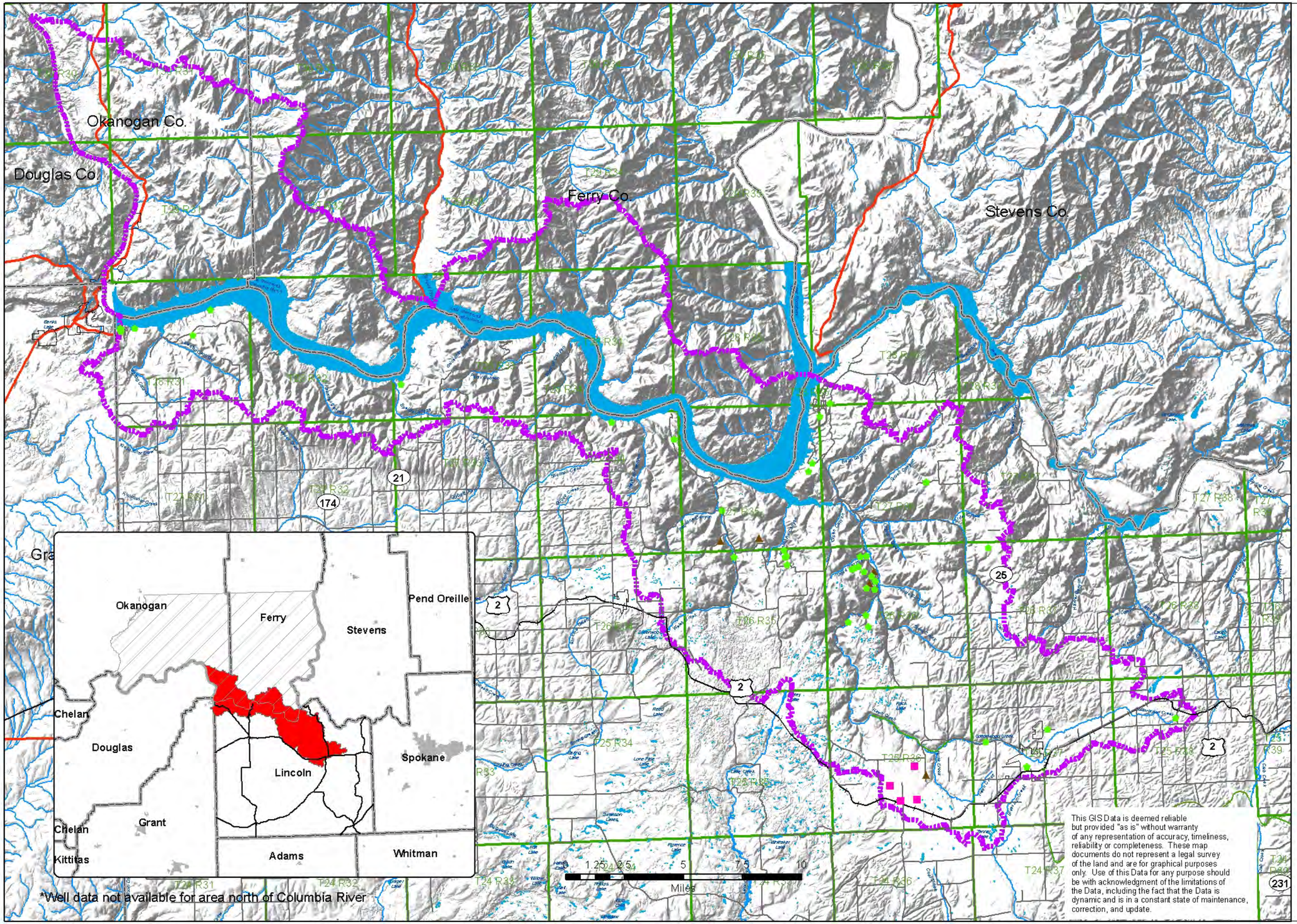
Figure 8

Location of Groundwater Wells being Monitored



Land Services
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WRIA 53

Groundwater Inventory & Mapping Project

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ATTACHMENT A

HAWK CREEK STREAM FLOW MONITORING DATA

WASHINGTON STATE DEPARTMENT OF ECOLOGY

Discharge Measurement Summary

Date Generated: Thu Nov 19 2009

File Information	
File Name	HC1.WAD
Start Date and Time	2009/10/14 08:27:45

Site Details	
Site Name	HC1
Operator(s)	MGW

System Information	
Sensor Type	FlowTracker
Serial #	P1789
CPU Firmware Version	3.4
Software Ver	2.11

Units	(English Units)
Distance	ft
Velocity	ft/s
Area	ft^2
Discharge	cfs

Discharge Uncertainty		
Category	ISO	Stats
Accuracy	1.0%	1.0%
Depth	0.1%	1.6%
Velocity	3.3%	2.6%
Width	0.1%	0.1%
Method	1.7%	-
# Stations	2.0%	-
Overall	**4.4%**	**3.2%**

Summary			
Averaging Int.	40	# Stations	26
Start Edge	REW	Total Width	13.100
Mean SNR	18.5 dB	Total Area	11.358
Mean Temp	39.22 °F	Mean Depth	0.867
Disch. Equation	Mid-Section	Mean Velocity	0.1684
		Total Discharge	**1.9122**

Measurement Results

St	Clock	Loc	Method	Depth	%Dep	MeasD	Vel	CorrFact	MeanV	Area	Flow	%Q
0	08:27	5.40	None	0.000	0.0	0.0	0.0000	1.00	0.0000	0.000	0.0000	0.0
1	*08:27*	*6.40*	*0.6*	*0.550*	*0.6*	*0.220*	*0.0184*	*1.00*	*0.0184*	*0.440*	*0.0081*	*0.4*
2	*08:29*	*7.00*	*0.6*	*1.140*	*0.6*	*0.456*	*0.0922*	*1.00*	*0.0922*	*0.684*	*0.0631*	*3.3*
3	08:30	7.60	0.6	1.100	0.6	0.440	0.1667	1.00	0.1667	0.660	0.1100	5.8
4	08:31	8.20	0.6	1.110	0.6	0.444	0.2835	1.00	0.2835	0.499	0.1416	7.4
5	08:32	8.50	0.6	1.000	0.6	0.400	0.3140	1.00	0.3140	0.300	0.0942	4.9
6	08:33	8.80	0.6	1.030	0.6	0.412	0.3455	1.00	0.3455	0.309	0.1067	5.6
7	08:34	9.10	0.6	1.030	0.6	0.412	0.3563	1.00	0.3563	0.309	0.1100	5.8
8	08:35	9.40	0.6	1.120	0.6	0.448	0.3671	1.00	0.3671	0.336	0.1233	6.4
9	08:36	9.70	0.6	1.100	0.6	0.440	0.3622	1.00	0.3622	0.330	0.1195	6.2
10	08:37	10.00	0.6	1.120	0.6	0.448	0.3287	1.00	0.3287	0.336	0.1104	5.8
11	08:38	10.30	0.6	1.220	0.6	0.488	0.2789	1.00	0.2789	0.366	0.1020	5.3
12	08:39	10.60	0.6	1.270	0.6	0.508	0.2405	1.00	0.2405	0.381	0.0916	4.8
13	08:40	10.90	0.6	1.270	0.6	0.508	0.3054	1.00	0.3054	0.381	0.1163	6.1
14	08:41	11.20	0.6	1.210	0.6	0.484	0.2569	1.00	0.2569	0.363	0.0932	4.9
15	*08:42*	*11.50*	*0.6*	*1.200*	*0.6*	*0.480*	*0.2566*	*1.00*	*0.2566*	*0.360*	*0.0923*	*4.8*
16	*08:43*	*11.80*	*0.6*	*1.120*	*0.6*	*0.448*	*0.2139*	*1.00*	*0.2139*	*0.393*	*0.0840*	*4.4*
17	*08:44*	*12.20*	*0.6*	*1.100*	*0.6*	*0.440*	*0.1768*	*1.00*	*0.1768*	*0.442*	*0.0781*	*4.1*
18	*08:45*	*12.60*	*0.6*	*0.980*	*0.6*	*0.392*	*0.1946*	*1.00*	*0.1946*	*0.394*	*0.0766*	*4.0*
19	*08:47*	*13.00*	*0.6*	*1.010*	*0.6*	*0.404*	*0.1247*	*1.00*	*0.1247*	*0.454*	*0.0565*	*3.0*
20	*08:48*	*13.50*	*0.6*	*0.980*	*0.6*	*0.392*	*0.0686*	*1.00*	*0.0686*	*0.733*	*0.0503*	*2.6*
21	*08:49*	*14.50*	*0.6*	*1.000*	*0.6*	*0.400*	*0.0541*	*1.00*	*0.0541*	*1.000*	*0.0541*	*2.8*
22	08:50	15.50	0.6	0.820	0.6	0.328	0.0384	1.00	0.0384	0.820	0.0315	1.6
23	*08:51*	*16.50*	*0.6*	*0.770*	*0.6*	*0.308*	*-0.0016*	*1.00*	*-0.0016*	*0.770*	*-0.0013*	*-0.1*
24	*08:53*	*17.50*	*Input V*	*0.300*	*0.0*	*0.000*	*0.0000*	*1.00*	*0.0000*	*0.300*	*0.0000*	*0.0*
25	08:53	18.50	None	0.000	0.0	0.0	0.0000	1.00	0.0000	0.000	0.0000	0.0

Rows in italics indicate a QC warning. See the Quality Control page of this report for more information.

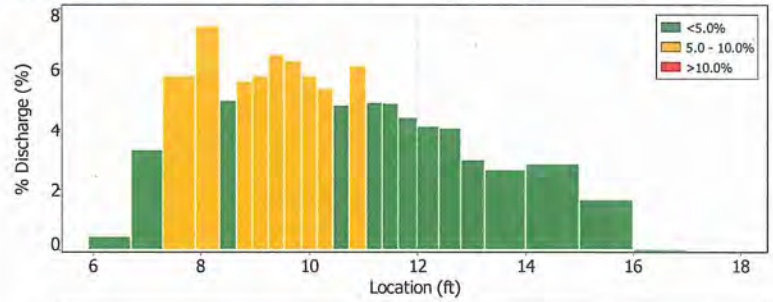
WASHINGTON STATE DEPARTMENT OF ECOLOGY

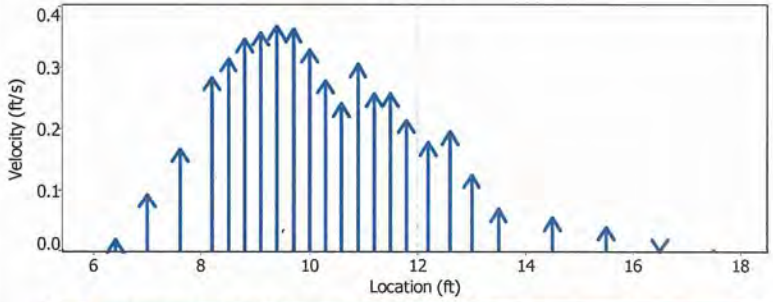
Discharge Measurement Summary

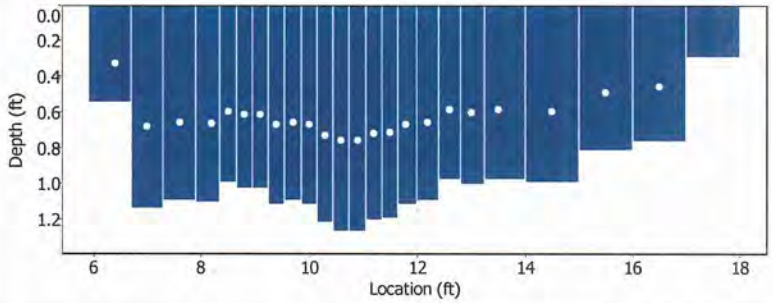
Date Generated: Thu Nov 19 2009

File Information
File Name HC1.WAD
Start Date and Time 2009/10/14 08:27:45

Site Details
Site Name HC1
Operator(s) MGW







WASHINGTON STATE DEPARTMENT OF ECOLOGY

Discharge Measurement Summary

Date Generated: Thu Nov 19 2009

File Information		Site Details	
File Name	HC1.WAD	Site Name	HC1
Start Date and Time	2009/10/14 08:27:45	Operator(s)	MGW

Quality Control

St	Loc	%Dep	Message
1	6.40	0.6	High SNR variation during measurement: 6.9,4.3
2	7.00	0.6	High angle: 26
15	11.50	0.6	High angle: -21
16	11.80	0.6	High angle: -23
17	12.20	0.6	High angle: -23
18	12.60	0.6	High angle: -21
19	13.00	0.6	High angle: -33
20	13.50	0.6	High angle: -40
21	14.50	0.6	High angle: -34
		0.6	Boundary QC is Good; possible boundary interference
23	16.50	0.6	Low SNR: 0.8,3.0
		0.6	SNR (1.9) is different from typical SNR (19.3)
		0.6	High standard error: 0.081
		0.6	Boundary QC is Fair; possible boundary interference
24	17.50	0.0	Low SNR: 0.0,0.0
		0.0	SNR (0.0) is different from typical SNR (19.3)
		0.0	High standard error: 0.000

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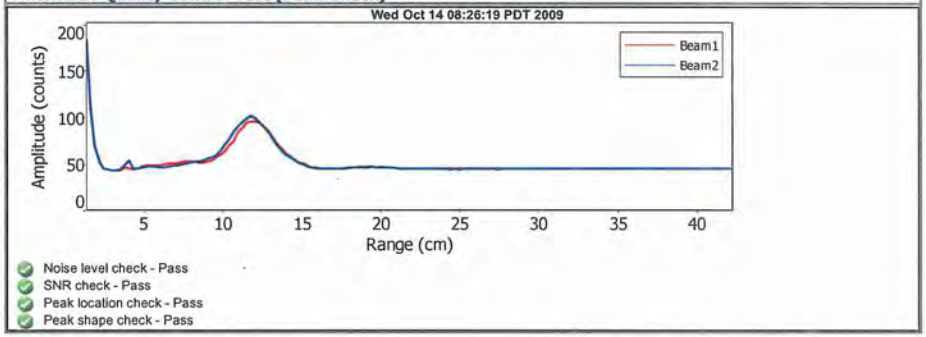
Discharge Measurement Summary

Date Generated: Thu Nov 19 2009

File Information
File Name HC1.WAD
Start Date and Time 2009/10/14 08:27:45

Site Details
Site Name HC1
Operator(s) MGW

Automatic Quality Control Test (BeamCheck)



- Noise level check - Pass
- SNR check - Pass
- Peak location check - Pass
- Peak shape check - Pass

WASHINGTON STATE DEPARTMENT OF ECOLOGY

Discharge Measurement Summary

Date Generated: Thu Nov 19 2009

File Information	
File Name	HC3.WAD
Start Date and Time	2009/10/14 09:55:09

Site Details	
Site Name	HC3
Operator(s)	MGW

System Information	
Sensor Type	FlowTracker
Serial #	P1789
CPU Firmware Version	3.4
Software Ver	2.11

Units	(English Units)
Distance	ft
Velocity	ft/s
Area	ft^2
Discharge	cfs

Discharge Uncertainty		
Category	ISO	Stats
Accuracy	1.0%	1.0%
Depth	0.4%	2.2%
Velocity	1.5%	9.9%
Width	0.1%	0.1%
Method	1.8%	-
# Stations	2.0%	-
Overall	**3.3%**	**10.2%**

Summary			
Averaging Int.	40	# Stations	25
Start Edge	REW	Total Width	9.400
Mean SNR	32.5 dB	Total Area	4.910
Mean Temp	47.54 °F	Mean Depth	0.522
Disch. Equation	Mid-Section	Mean Velocity	1.0694
		Total Discharge	**5.2510**

Measurement Results

St	Clock	Loc	Method	Depth	%Dep	MeasD	Vel	CorrFact	MeanV	Area	Flow	%Q
0	09:55	4.00	None	0.000	0.0	0.0	0.0000	1.00	0.0000	0.000	0.0000	0.0
1	09:55	4.70	0.6	0.550	0.6	0.220	0.0095	1.00	0.0095	0.302	0.0029	0.1
2	*09:56*	*5.10*	*0.6*	*0.500*	*0.6*	*0.200*	*0.4820*	*1.00*	*0.4820*	*0.200*	*0.0964*	*1.8*
3	*09:59*	*5.50*	*0.6*	*0.610*	*0.6*	*0.244*	*0.2782*	*1.00*	*0.2782*	*0.244*	*0.0679*	*1.3*
4	10:01	5.90	0.6	0.690	0.6	0.276	1.9672	1.00	1.9672	0.276	0.5428	10.3
5	*10:02*	*6.30*	*0.6*	*0.570*	*0.6*	*0.228*	*0.6434*	*1.00*	*0.6434*	*0.228*	*0.1466*	*2.8*
6	*10:03*	*6.70*	*0.6*	*0.500*	*0.6*	*0.200*	*1.0164*	*1.00*	*1.0164*	*0.200*	*0.2032*	*3.9*
7	10:04	7.10	0.6	0.520	0.6	0.208	1.9636	1.00	1.9636	0.182	0.3574	6.8
8	*10:05*	*7.40*	*0.6*	*0.510*	*0.6*	*0.204*	*1.5827*	*1.00*	*1.5827*	*0.153*	*0.2422*	*4.6*
9	*10:06*	*7.70*	*0.6*	*0.730*	*0.6*	*0.292*	*1.0594*	*1.00*	*1.0594*	*0.219*	*0.2322*	*4.4*
10	*10:07*	*8.00*	*0.6*	*0.650*	*0.6*	*0.260*	*1.7165*	*1.00*	*1.7165*	*0.195*	*0.3349*	*6.4*
11	*10:08*	*8.30*	*0.6*	*0.500*	*0.6*	*0.200*	*1.5240*	*1.00*	*1.5240*	*0.150*	*0.2287*	*4.4*
12	*10:10*	*8.60*	*0.6*	*0.580*	*0.6*	*0.232*	*1.0666*	*1.00*	*1.0666*	*0.174*	*0.1857*	*3.5*
13	*10:11*	*8.90*	*0.6*	*0.570*	*0.6*	*0.228*	*1.8691*	*1.00*	*1.8691*	*0.171*	*0.3198*	*6.1*
14	10:12	9.20	0.6	0.620	0.6	0.248	1.0584	1.00	1.0584	0.186	0.1970	3.8
15	*10:13*	*9.50*	*0.6*	*0.600*	*0.6*	*0.240*	*0.9938*	*1.00*	*0.9938*	*0.180*	*0.1790*	*3.4*
16	10:14	9.80	0.6	0.580	0.6	0.232	1.1312	1.00	1.1312	0.174	0.1970	3.8
17	*10:15*	*10.10*	*0.6*	*0.610*	*0.6*	*0.244*	*0.9485*	*1.00*	*0.9485*	*0.183*	*0.1737*	*3.3*
18	*10:18*	*10.40*	*0.6*	*0.660*	*0.6*	*0.264*	*0.4150*	*1.00*	*0.4150*	*0.230*	*0.0956*	*1.8*
19	*10:19*	*10.80*	*0.6*	*0.620*	*0.6*	*0.248*	*1.4117*	*1.00*	*1.4117*	*0.247*	*0.3484*	*6.6*
20	10:20	11.20	0.6	0.520	0.6	0.208	1.4770	1.00	1.4770	0.207	0.3057	5.8
21	*10:21*	*11.60*	*0.6*	*0.580*	*0.6*	*0.232*	*0.9295*	*1.00*	*0.9295*	*0.233*	*0.2162*	*4.1*
22	*10:23*	*12.00*	*0.6*	*0.490*	*0.6*	*0.196*	*-1.4160*	*-1.00*	*1.4160*	*0.344*	*0.4873*	*9.3*
23	*10:24*	*13.00*	*0.6*	*0.330*	*0.6*	*0.132*	*-0.3911*	*-1.00*	*0.3911*	*0.231*	*0.0903*	*1.7*
24	10:24	13.40	None	0.000	0.0	0.0	0.0000	1.00	0.0000	0.000	0.0000	0.0

Rows in italics indicate a QC warning. See the Quality Control page of this report for more information.

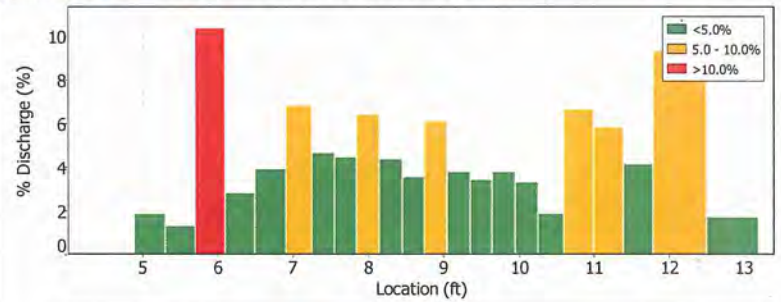
WASHINGTON STATE DEPARTMENT OF ECOLOGY

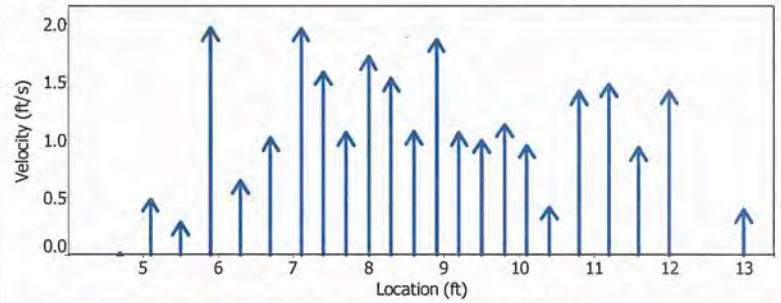
Discharge Measurement Summary

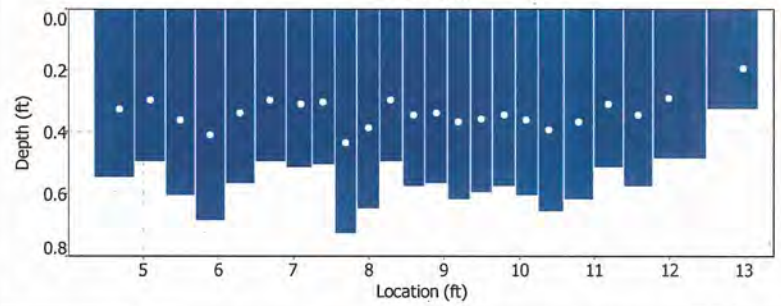
Date Generated: Thu Nov 19 2009

File Information
File Name HC3.WAD
Start Date and Time 2009/10/14 09:55:09

Site Details
Site Name HC3
Operator(s) MGW







WASHINGTON STATE DEPARTMENT OF ECOLOGY

Discharge Measurement Summary

Date Generated: Thu Nov 19 2009

File Information	
File Name	HC3.WAD
Start Date and Time	2009/10/14 09:55:09

Site Details	
Site Name	HC3
Operator(s)	MGW

Quality Control

St	Loc	%Dep	Message
2	5.10	0.6	High angle: 21
		0.6	High SNR variation during measurement: 5.6,5.6
3	5.50	0.6	High SNR variation during measurement: 6.9,8.2
		0.6	Boundary QC is Fair; possible boundary interference
5	6.30	0.6	High standard error: 0.108
6	6.70	0.6	High standard error: 0.124
8	7.40	0.6	High number of spikes: 6
9	7.70	0.6	High standard error: 0.081
10	8.00	0.6	Boundary QC is Fair; possible boundary interference
11	8.30	0.6	High standard error: 0.098
12	8.60	0.6	High standard error: 0.101
13	8.90	0.6	High standard error: 0.102
15	9.50	0.6	High standard error: 0.094
17	10.10	0.6	High standard error: 0.088
		0.6	Boundary QC is Fair; possible boundary interference
18	10.40	0.6	High angle: 27
19	10.80	0.6	High standard error: 0.115
21	11.60	0.6	High SNR variation during measurement: 9.0,12.9
		0.6	High standard error: 0.108
22	12.00	0.6	High angle: -165
23	13.00	0.6	High angle: -135

WASHINGTON STATE DEPARTMENT OF ECOLOGY

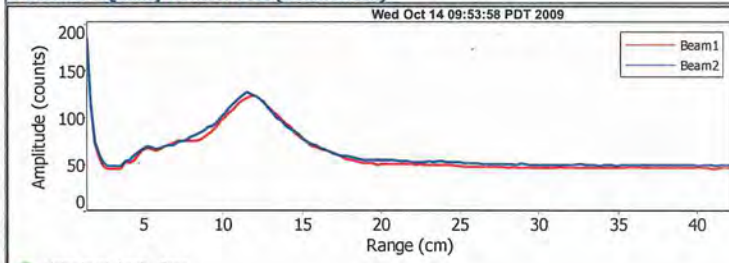
Discharge Measurement Summary

Date Generated: Thu Nov 19 2009

File Information
File Name HC3.WAD
Start Date and Time 2009/10/14 09:55:09

Site Details
Site Name HC3
Operator(s) MGW

Automatic Quality Control Test (BeamCheck)



- Noise level check - Pass
- SNR check - Pass
- Peak location check - Pass
- Peak shape check - Pass

WASHINGTON STATE DEPARTMENT OF ECOLOGY

Discharge Measurement Summary

Date Generated: Thu Nov 19 2009

File Information

File Name	HC5.WAD
Start Date and Time	2009/10/14 11:40:29

Site Details

Site Name	HC5
Operator(s)	MGW

System Information

Sensor Type	FlowTracker
Serial #	P1789
CPU Firmware Version	3.4
Software Ver	2.11

Units (English Units)

Distance	ft
Velocity	ft/s
Area	ft^2
Discharge	cfs

Discharge Uncertainty

Category	ISO	Stats
Accuracy	1.0%	1.0%
Depth	0.1%	1.0%
Velocity	0.7%	5.6%
Width	0.1%	0.1%
Method	1.4%	-
# Stations	2.0%	-
Overall	**2.8%**	**5.7%**

Summary

Averaging Int.	40	# Stations	25
Start Edge	REW	Total Width	13.600
Mean SNR	29.0 dB	Total Area	15.641
Mean Temp	48.10 °F	Mean Depth	1.150
Disch. Equation	Mid-Section	Mean Velocity	0.6631
		Total Discharge	**10.3710**

Measurement Results

St	Clock	Loc	Method	Depth	%Dep	MeasD	Vel	CorrFact	MeanV	Area	Flow	%Q
0	11:40	4.40	None	1.620	0.0	0.0	0.0000	1.00	0.0017	0.486	0.0008	0.0
1	*11:40*	*5.00*	*0.2/0.6/0.8*	*1.700*	*0.2*	*1.360*	*-0.0522*	*1.00*	*0.0017*	*1.020*	*0.0018*	*0.0*
1	*11:42*	*5.00*	*0.2/0.6/0.8*	*1.700*	*0.6*	*0.680*	*-0.0036*					
1	*11:41*	*5.00*	*0.2/0.6/0.8*	*1.700*	*0.8*	*0.340*	*0.0663*					
2	11:44	5.60	0.2/0.6/0.8	1.810	0.2	1.448	0.2001	1.00	0.3583	1.086	0.3892	3.8
2	11:46	5.60	0.2/0.6/0.8	1.810	0.6	0.724	0.4032					
2	11:45	5.60	0.2/0.6/0.8	1.810	0.8	0.362	0.4268					
3	11:48	6.20	0.8/0.2	1.810	0.2	1.448	0.6831	1.00	0.5671	1.086	0.6159	5.9
3	11:47	6.20	0.8/0.2	1.810	0.8	0.362	0.4511					
4	11:49	6.80	0.2/0.8	1.730	0.2	1.384	1.0541	1.00	0.7925	1.038	0.8227	7.9
4	11:50	6.80	0.2/0.8	1.730	0.8	0.346	0.5308					
5	*11:52*	*7.40*	*0.2/0.6/0.8*	*1.720*	*0.2*	*1.376*	*1.3780*	*1.00*	*1.0316*	*1.032*	*1.0648*	*10.3*
5	*11:53*	*7.40*	*0.2/0.6/0.8*	*1.720*	*0.6*	*0.688*	*1.1263*					
5	*11:51*	*7.40*	*0.2/0.6/0.8*	*1.720*	*0.8*	*0.344*	*0.4957*					
6	*11:55*	*8.00*	*0.2/0.6/0.8*	*1.550*	*0.2*	*1.240*	*1.4606*	*1.00*	*0.6580*	*0.697*	*0.4587*	*4.4*
6	*11:56*	*8.00*	*0.2/0.6/0.8*	*1.550*	*0.6*	*0.620*	*0.5692*					
6	*11:55*	*8.00*	*0.2/0.6/0.8*	*1.550*	*0.8*	*0.310*	*0.0328*					
7	11:58	8.30	0.6	1.460	0.6	0.584	1.4505	1.00	1.4505	0.437	0.6343	6.1
8	*11:59*	*8.60*	*0.6*	*1.400*	*0.6*	*0.560*	*1.5443*	*1.00*	*1.5443*	*0.419*	*0.6476*	*6.2*
9	12:00	8.90	0.6	1.220	0.6	0.488	1.6247	1.00	1.6247	0.365	0.5938	5.7
10	12:01	9.20	0.6	1.170	0.6	0.468	1.5896	1.00	1.5896	0.350	0.5571	5.4
11	12:03	9.50	0.6	1.120	0.6	0.448	1.4711	1.00	1.4711	0.336	0.4936	4.8
12	12:04	9.80	0.6	1.300	0.6	0.520	1.4491	1.00	1.4491	0.389	0.5642	5.4
13	12:05	10.10	0.6	1.100	0.6	0.440	1.2864	1.00	1.2864	0.330	0.4239	4.1
14	12:07	10.40	0.6	1.200	0.6	0.480	1.3501	1.00	1.3501	0.359	0.4853	4.7
15	12:08	10.70	0.6	1.130	0.6	0.452	1.2579	1.00	1.2579	0.338	0.4257	4.1
16	12:09	11.00	0.6	1.130	0.6	0.452	1.1017	1.00	1.1017	0.398	0.4380	4.2
17	12:10	11.40	0.6	1.100	0.6	0.440	1.1440	1.00	1.1440	0.445	0.5087	4.9
18	12:11	11.80	0.6	1.100	0.6	0.440	0.7795	1.00	0.7795	0.495	0.3859	3.7
19	12:12	12.30	0.6	1.100	0.6	0.440	0.7244	1.00	0.7244	0.545	0.3951	3.8
20	12:13	12.80	0.6	1.000	0.6	0.400	0.5515	1.00	0.5515	0.500	0.2758	2.7
21	12:15	13.30	0.6	0.880	0.6	0.352	0.2762	1.00	0.2762	0.662	0.1828	1.8
22	*12:16*	*14.30*	*0.6*	*0.860*	*0.6*	*0.344*	*0.0013*	*1.00*	*0.0013*	*1.161*	*0.0015*	*0.0*
23	*12:17*	*16.00*	*0.6*	*0.900*	*0.6*	*0.360*	*0.0023*	*1.00*	*0.0023*	*1.665*	*0.0038*	*0.0*
24	12:17	18.00	None	0.000	0.0	0.0	0.0000	1.00	0.0000	0.000	0.0000	0.0

Rows in italics indicate a QC warning. See the Quality Control page of this report for more information.

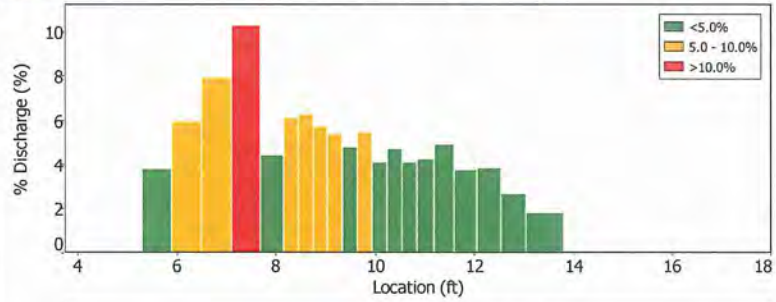
WASHINGTON STATE DEPARTMENT OF ECOLOGY

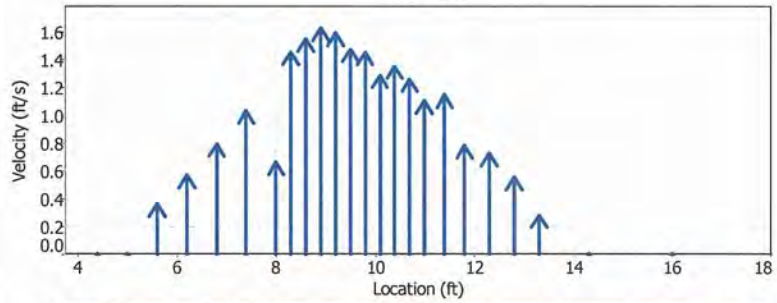
Discharge Measurement Summary

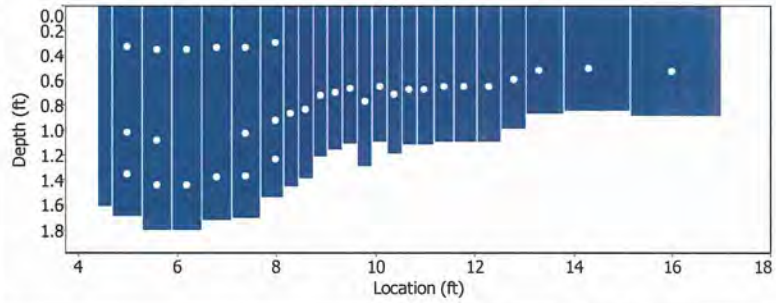
Date Generated: Thu Nov 19 2009

File Information
File Name HC5.WAD
Start Date and Time 2009/10/14 11:40:29

Site Details
Site Name HC5
Operator(s) MGW







WASHINGTON STATE DEPARTMENT OF ECOLOGY

Discharge Measurement Summary

Date Generated: Thu Nov 19 2009

File Information		Site Details	
File Name	HC5.WAD	Site Name	HC5
Start Date and Time	2009/10/14 11:40:29	Operator(s)	MGW

Quality Control

St	Loc	%Dep	Message
1	5.00	0.2	High angle: -179
5	7.40	0.6	High number of spikes: 5
		0.8	High angle: 22
		0.8	High standard error: 0.048
6	8.00	0.6	High standard error: 0.073
		0.8	High angle: 81
		0.8	High standard error: 0.046
8	8.60	0.6	High number of spikes: 5
22	14.30	0.6	SNR (41.1) is different from typical SNR (29.0)
		0.6	High SNR variation during measurement: 15.0,10.3
		0.6	Boundary QC is Good; possible boundary interference
23	16.00	0.6	High SNR variation during measurement: 5.2,8.6

WASHINGTON STATE DEPARTMENT OF ECOLOGY

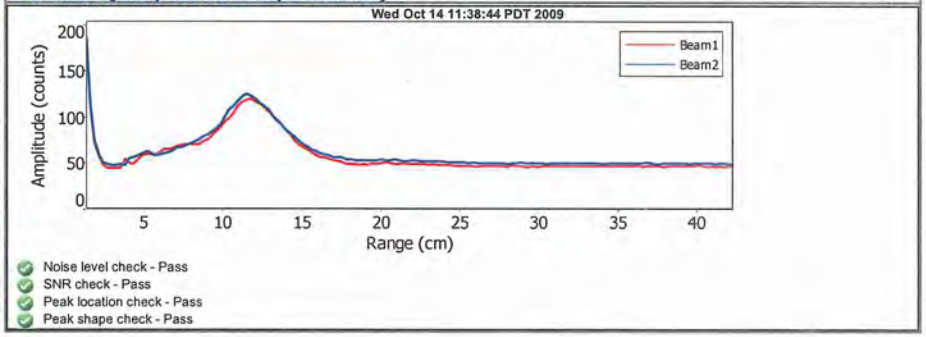
Discharge Measurement Summary

Date Generated: Thu Nov 19 2009

File Information
File Name HC5.WAD
Start Date and Time 2009/10/14 11:40:29

Site Details
Site Name HC5
Operator(s) MGW

Automatic Quality Control Test (BeamCheck)



- Noise level check - Pass
- SNR check - Pass
- Peak location check - Pass
- Peak shape check - Pass

WASHINGTON STATE DEPARTMENT OF ECOLOGY

Discharge Measurement Summary

Date Generated: Tue Feb 2 2010

File Information	
File Name	HC1.WAD
Start Date and Time	2010/01/11 10:20:09

Site Details	
Site Name	HC1
Operator(s)	MGW

System Information	
Sensor Type	FlowTracker
Serial #	P1789
CPU Firmware Version	3.4
Software Ver	2.11

Units	(English Units)
Distance	ft
Velocity	ft/s
Area	ft^2
Discharge	cfs

Discharge Uncertainty		
Category	ISO	Stats
Accuracy	1.0%	1.0%
Depth	0.1%	1.1%
Velocity	1.6%	5.4%
Width	0.1%	0.1%
Method	1.3%	-
# Stations	2.3%	-
Overall	**3.2%**	**5.6%**

Summary			
Averaging Int.	40	# Stations	22
Start Edge	REW	Total Width	12.700
Mean SNR	25.8 dB	Total Area	14.217
Mean Temp	35.65 °F	Mean Depth	1.119
Disch. Equation	Mid-Section	Mean Velocity	0.2292
		Total Discharge	**3.2590**

Measurement Results

St	Clock	Loc	Method	Depth	%Dep	MeasD	Vel	CorrFact	MeanV	Area	Flow	%Q
0	10:20	4.50	None	0.000	0.0	0.0	0.0000	1.00	0.0000	0.000	0.0000	0.0
1	*10:20*	*6.00*	*0.6*	*0.670*	*0.6*	*0.268*	*0.0295*	*1.00*	*0.0295*	*1.005*	*0.0297*	*0.9*
2	*10:21*	*7.50*	*0.6*	*0.940*	*0.6*	*0.376*	*-0.0259*	*1.00*	*-0.0259*	*1.410*	*-0.0365*	*-1.1*
3	*10:22*	*9.00*	*0.6*	*0.910*	*0.6*	*0.364*	*-0.0062*	*1.00*	*-0.0062*	*1.365*	*-0.0085*	*-0.3*
4	*10:23*	*10.50*	*0.6*	*1.100*	*0.6*	*0.440*	*0.0387*	*1.00*	*0.0387*	*1.100*	*0.0426*	*1.3*
5	*10:24*	*11.00*	*0.6*	*1.100*	*0.6*	*0.440*	*0.1250*	*1.00*	*0.1250*	*0.495*	*0.0619*	*1.9*
6	*10:25*	*11.40*	*0.6*	*1.120*	*0.6*	*0.448*	*0.1847*	*1.00*	*0.1847*	*0.448*	*0.0827*	*2.5*
7	*10:27*	*11.80*	*0.6*	*1.340*	*0.6*	*0.536*	*0.4570*	*1.00*	*0.4570*	*0.536*	*0.2449*	*7.5*
8	10:28	12.20	0.6	1.480	0.6	0.592	0.5495	1.00	0.5495	0.518	0.2847	8.7
9	10:29	12.50	0.2/0.8	1.530	0.2	1.224	0.8100	1.00	0.7311	0.459	0.3358	10.3
9	10:30	12.50	0.2/0.8	1.530	0.8	0.306	0.6522					
10	*10:32*	*12.80*	*0.8/0.2*	*1.670*	*0.2*	*1.336*	*0.8337*	*1.00*	*0.6288*	*0.501*	*0.3152*	*9.7*
10	*10:31*	*12.80*	*0.8/0.2*	*1.670*	*0.8*	*0.334*	*0.4239*					
11	*10:33*	*13.10*	*0.2/0.8*	*1.800*	*0.2*	*1.440*	*0.7556*	*1.00*	*0.5407*	*0.540*	*0.2921*	*9.0*
11	*10:35*	*13.10*	*0.2/0.8*	*1.800*	*0.8*	*0.360*	*0.3258*					
12	*10:37*	*13.40*	*0.8/0.2*	*1.700*	*0.2*	*1.360*	*0.6903*	*1.00*	*0.6073*	*0.510*	*0.3099*	*9.5*
12	*10:36*	*13.40*	*0.8/0.2*	*1.700*	*0.8*	*0.340*	*0.5243*					
13	*10:38*	*13.70*	*0.2/0.8*	*1.880*	*0.2*	*1.504*	*0.5945*	*1.00*	*0.6350*	*0.564*	*0.3584*	*11.0*
13	*10:39*	*13.70*	*0.2/0.8*	*1.880*	*0.8*	*0.376*	*0.6755*					
14	*10:41*	*14.00*	*0.8/0.2*	*1.890*	*0.2*	*1.512*	*0.3960*	*1.00*	*0.4700*	*0.567*	*0.2667*	*8.2*
14	*10:40*	*14.00*	*0.8/0.2*	*1.890*	*0.8*	*0.378*	*0.5440*					
15	*10:43*	*14.30*	*0.2/0.8*	*1.790*	*0.2*	*1.432*	*0.2963*	*1.00*	*0.3880*	*0.537*	*0.2085*	*6.4*
15	*10:44*	*14.30*	*0.2/0.8*	*1.790*	*0.8*	*0.358*	*0.4797*					
16	10:46	14.60	0.8/0.2	1.800	0.2	1.440	0.2730	1.00	0.3307	0.629	0.2080	6.4
16	10:45	14.60	0.8/0.2	1.800	0.8	0.360	0.3885					
17	*10:47*	*15.00*	*0.2/0.8*	*1.800*	*0.2*	*1.440*	*0.2172*	*1.00*	*0.2239*	*0.809*	*0.1811*	*5.6*
17	*10:48*	*15.00*	*0.2/0.8*	*1.800*	*0.8*	*0.360*	*0.2306*					
18	*10:50*	*15.50*	*0.8/0.2*	*1.630*	*0.2*	*1.304*	*0.1391*	*1.00*	*0.1301*	*0.815*	*0.1060*	*3.3*
18	*10:49*	*15.50*	*0.8/0.2*	*1.630*	*0.8*	*0.326*	*0.1211*					
19	10:52	16.00	0.6	1.350	0.6	0.540	-0.0121	1.00	-0.0121	0.675	-0.0082	-0.3
20	*10:53*	*16.50*	*0.6*	*1.220*	*0.6*	*0.488*	*-0.0217*	*1.00*	*-0.0217*	*0.732*	*-0.0159*	*-0.5*
21	10:53	17.20	None	0.000	0.0	0.0	0.0000	1.00	0.0000	0.000	0.0000	0.0

Rows in italics indicate a QC warning. See the Quality Control page of this report for more information.

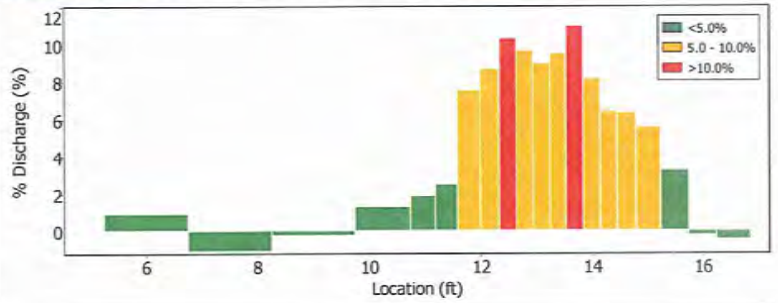
WASHINGTON STATE DEPARTMENT OF ECOLOGY

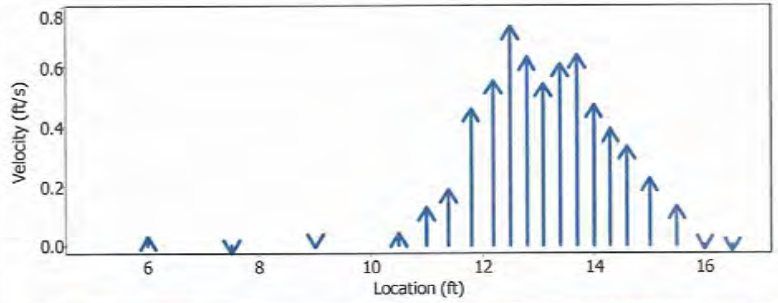
Discharge Measurement Summary

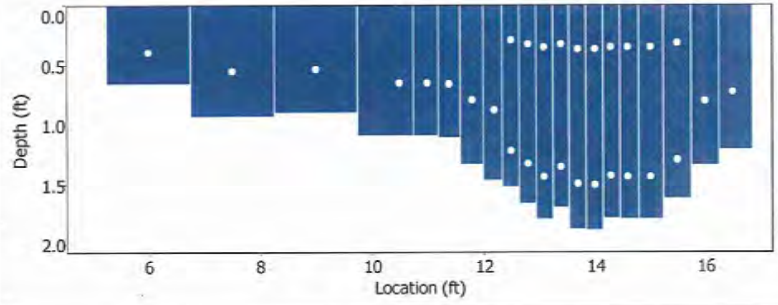
Date Generated: Tue Feb 2 2010

File Information: File Name HC1.WAD; Start Date and Time 2010/01/11 10:20:09

Site Details: Site Name HC1; Operator(s) MGW







WASHINGTON STATE DEPARTMENT OF ECOLOGY

Discharge Measurement Summary

Date Generated: Tue Feb 2 2010

File Information		Site Details	
File Name	HC1.WAD	Site Name	HC1
Start Date and Time	2010/01/11 10:20:09	Operator(s)	MGW

Quality Control

St	Loc	%Dep	Message
1	6.00	0.6	High differences in beam SNR: 33.1,44.7
		0.6	SNR (38.9) is different from typical SNR (25.8)
		0.6	High SNR variation during measurement: 5.2,4.7
2	7.50	0.6	High angle: 131
		0.6	SNR (47.1) is different from typical SNR (25.8)
3	9.00	0.6	SNR (44.9) is different from typical SNR (25.8)
4	10.50	0.6	High angle: 45
		0.6	SNR (44.1) is different from typical SNR (25.8)
5	11.00	0.6	High angle: 35
		0.6	SNR (40.6) is different from typical SNR (25.8)
6	11.40	0.6	High angle: 25
		0.6	SNR (41.1) is different from typical SNR (25.8)
		0.6	High SNR variation during measurement: 7.7,7.7
7	11.80	0.6	High SNR variation during measurement: 4.7,5.2
10	12.80	0.8	High standard error: 0.040
11	13.10	0.2	High standard error: 0.048
		0.8	High standard error: 0.039
12	13.40	0.8	High standard error: 0.041
13	13.70	0.8	High standard error: 0.039
14	14.00	0.8	High standard error: 0.036
15	14.30	0.8	High angle: 27
17	15.00	0.2	High angle: 22
		0.8	High angle: 27
18	15.50	0.8	High angle: 52
20	16.50	0.6	High angle: 111
		0.6	Boundary QC is Poor; possible boundary interference

WASHINGTON STATE DEPARTMENT OF ECOLOGY

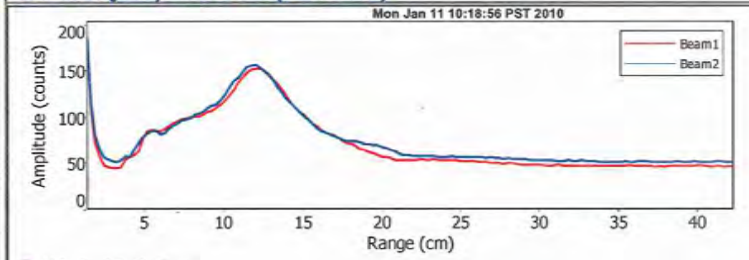
Discharge Measurement Summary

Date Generated: Tue Feb 2 2010

File Information
File Name HC1.WAD
Start Date and Time 2010/01/11 10:20:09

Site Details
Site Name HC1
Operator(s) MGW

Automatic Quality Control Test (BeamCheck)



- Noise level check - Pass
- SNR check - Pass
- Peak location check - Pass
- Peak shape check - Pass

WASHINGTON STATE DEPARTMENT OF ECOLOGY

Discharge Measurement Summary

Date Generated: Tue Feb 2 2010

File Information	
File Name	HC3.WAD
Start Date and Time	2010/01/11 11:33:54

Site Details	
Site Name	HC2
Operator(s)	MGW

System Information	
Sensor Type	FlowTracker
Serial #	P1789
CPU Firmware Version	3.4
Software Ver	2.11

Units	(English Units)
Distance	ft
Velocity	ft/s
Area	ft^2
Discharge	cfs

Discharge Uncertainty		
Category	ISO	Stats
Accuracy	1.0%	1.0%
Depth	0.2%	1.6%
Velocity	0.8%	3.7%
Width	0.1%	0.1%
Method	1.7%	-
# Stations	2.0%	-
Overall	**2.9%**	**4.2%**

Summary			
Averaging Int.	40	# Stations	25
Start Edge	REW	Total Width	27.200
Mean SNR	34.0 dB	Total Area	23.456
Mean Temp	43.71 °F	Mean Depth	0.862
Disch. Equation	Mid-Section	Mean Velocity	0.3239
		Total Discharge	**7.5975**

Measurement Results

St	Clock	Loc	Method	Depth	%Dep	MeasD	Vel	CorrFact	MeanV	Area	Flow	%Q
0	11:33	5.00	None	0.000	0.0	0.0	0.0000	1.00	0.0000	0.000	0.0000	0.0
1	11:33	8.00	0.6	0.320	0.6	0.128	0.1886	1.00	0.1886	0.720	0.1358	1.8
2	11:34	9.50	0.6	0.320	0.6	0.128	0.2615	1.00	0.2615	0.480	0.1255	1.7
3	11:36	11.00	0.6	0.600	0.6	0.240	0.1621	1.00	0.1621	0.810	0.1313	1.7
4	11:37	12.20	0.6	0.670	0.6	0.268	0.2923	1.00	0.2923	0.804	0.2350	3.1
5	11:38	13.40	0.6	0.880	0.6	0.352	0.3645	1.00	0.3645	0.968	0.3528	4.6
6	11:39	14.40	0.6	1.000	0.6	0.400	0.3156	1.00	0.3156	1.000	0.3155	4.2
7	11:40	15.40	0.6	1.150	0.6	0.460	0.3471	1.00	0.3471	1.150	0.3990	5.3
8	11:41	16.40	0.6	1.120	0.6	0.448	0.2559	1.00	0.2559	1.120	0.2865	3.8
9	11:42	17.40	0.6	1.150	0.6	0.460	0.3461	1.00	0.3461	1.150	0.3979	5.2
10	11:43	18.40	0.6	1.100	0.6	0.440	0.3802	1.00	0.3802	1.100	0.4182	5.5
11	11:44	19.40	0.6	1.230	0.6	0.492	0.4242	1.00	0.4242	1.230	0.5216	6.9
12	11:45	20.40	0.6	1.110	0.6	0.444	0.4213	1.00	0.4213	1.110	0.4674	6.2
13	11:47	21.40	0.6	1.210	0.6	0.484	0.3602	1.00	0.3602	1.210	0.4357	5.7
14	11:48	22.40	0.6	1.110	0.6	0.444	0.2982	1.00	0.2982	1.110	0.3309	4.4
15	11:49	23.40	0.6	1.030	0.6	0.412	0.3550	1.00	0.3550	1.030	0.3655	4.8
16	11:50	24.40	0.6	1.230	0.6	0.492	0.3091	1.00	0.3091	1.230	0.3800	5.0
17	11:51	25.40	0.6	1.190	0.6	0.476	0.3556	1.00	0.3556	1.190	0.4231	5.6
18	11:52	26.40	0.6	1.170	0.6	0.468	0.3842	1.00	0.3842	1.170	0.4493	5.9
19	11:54	27.40	0.6	1.310	0.6	0.524	0.2762	1.00	0.2762	1.310	0.3618	4.8
20	11:55	28.40	0.6	1.100	0.6	0.440	0.3573	1.00	0.3573	1.100	0.3929	5.2
21	11:56	29.40	0.6	0.970	0.6	0.388	0.4879	1.00	0.4879	0.972	0.4744	6.2
22	11:57	30.40	0.6	0.970	0.6	0.388	0.2533	1.00	0.2533	0.779	0.1972	2.6
23	*11:59*	*31.00*	*0.6*	*0.800*	*0.6*	*0.320*	*0.0003*	*1.00*	*0.0003*	*0.720*	*0.0002*	*0.0*
24	11:59	32.20	None	0.000	0.0	0.0	0.0000	1.00	0.0000	0.000	0.0000	0.0

Rows in italics indicate a QC warning. See the Quality Control page of this report for more information.

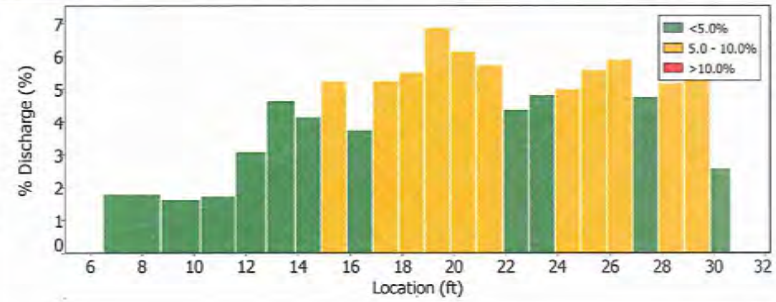
WASHINGTON STATE DEPARTMENT OF ECOLOGY

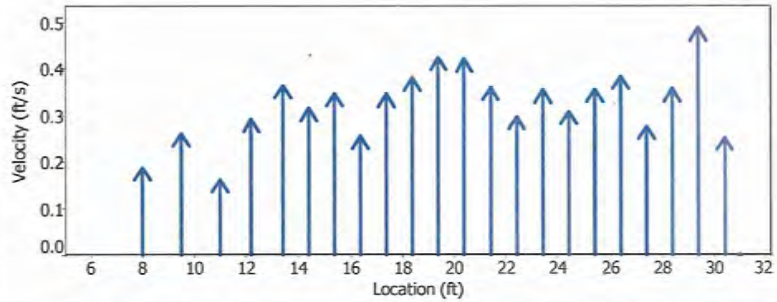
Discharge Measurement Summary

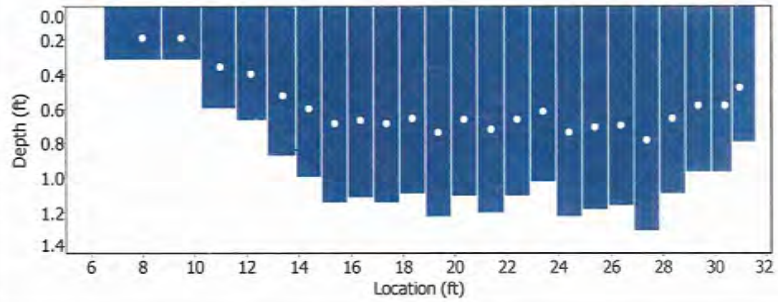
Date Generated: Tue Feb 2 2010

File Information
File Name HC3.WAD
Start Date and Time 2010/01/11 11:33:54

Site Details
Site Name HC2
Operator(s) MGW







WASHINGTON STATE DEPARTMENT OF ECOLOGY

Discharge Measurement Summary

Date Generated: Tue Feb 2 2010

File Information		Site Details	
File Name	HC3.WAD	Site Name	HC2
Start Date and Time	2010/01/11 11:33:54	Operator(s)	MGW

Quality Control

St	Loc	%Dep	Message
23	31.00	0.6	SNR (57.0) is different from typical SNR (34.0)
		0.6	High SNR variation during measurement: 2.6,5.2
		0.6	Boundary QC is Good; possible boundary interference

WASHINGTON STATE DEPARTMENT OF ECOLOGY

Discharge Measurement Summary

Date Generated: Tue Feb 2 2010

File Information

File Name HC3.WAD

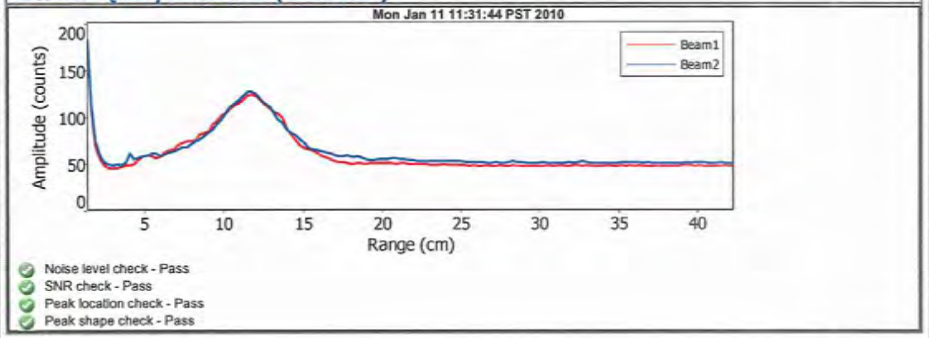
Start Date and Time 2010/01/11 11:33:54

Site Details

Site Name HC2

Operator(s) MGW

Automatic Quality Control Test (BeamCheck)



- Noise level check - Pass
- SNR check - Pass
- Peak location check - Pass
- Peak shape check - Pass

WASHINGTON STATE DEPARTMENT OF ECOLOGY

Discharge Measurement Summary

Date Generated: Tue Feb 2 2010

File Information	
File Name	HC5.WAD
Start Date and Time	2010/01/11 12:24:57

Site Details	
Site Name	HC5
Operator(s)	MGW

System Information	
Sensor Type	FlowTracker
Serial #	P1789
CPU Firmware Version	3.4
Software Ver	2.11

Units	(English Units)
Distance	ft
Velocity	ft/s
Area	ft^2
Discharge	cfs

Discharge Uncertainty		
Category	ISO	Stats
Accuracy	1.0%	1.0%
Depth	0.2%	1.1%
Velocity	0.8%	2.7%
Width	0.1%	0.1%
Method	1.7%	-
# Stations	2.0%	-
Overall	**2.9%**	**3.0%**

Summary			
Averaging Int.	40	# Stations	26
Start Edge	REW	Total Width	13.295
Mean SNR	32.2 dB	Total Area	11.643
Mean Temp	41.87 °F	Mean Depth	0.876
Disch. Equation	Mid-Section	Mean Velocity	1.1333
		Total Discharge	**13.1940**

Measurement Results

St	Clock	Loc	Method	Depth	%Dep	MeasD	Vel	CorrFact	MeanV	Area	Flow	%Q
0	12:24	4.70	None	0.000	0.0	0.0	0.0000	1.00	0.0000	0.000	0.0000	0.0
1	12:24	6.00	0.6	1.130	0.6	0.452	0.0449	1.00	0.0449	1.299	0.0584	0.4
2	12:26	7.00	0.6	1.270	0.6	0.508	0.4888	1.00	0.4888	0.889	0.4346	3.3
3	12:27	7.40	0.6	1.200	0.6	0.480	0.5978	1.00	0.5978	0.480	0.2869	2.2
4	12:28	7.80	0.6	1.270	0.6	0.508	0.8504	1.00	0.8504	0.508	0.4319	3.3
5	12:29	8.20	0.6	1.180	0.6	0.472	0.9741	1.00	0.9741	0.472	0.4597	3.5
6	12:30	8.60	0.6	1.110	0.6	0.444	1.1099	1.00	1.1099	0.444	0.4927	3.7
7	12:31	9.00	0.6	1.200	0.6	0.480	1.3770	1.00	1.3770	0.480	0.6609	5.0
8	12:32	9.40	0.6	1.300	0.6	0.520	1.6759	1.00	1.6759	0.520	0.8712	6.6
9	12:33	9.80	0.6	1.320	0.6	0.528	1.9879	1.00	1.9879	0.528	1.0493	8.0
10	12:34	10.20	0.6	1.300	0.6	0.520	2.1969	1.00	2.1969	0.520	1.1421	8.7
11	12:35	10.60	0.6	1.320	0.6	0.528	2.0417	1.00	2.0417	0.528	1.0777	8.2
12	12:36	11.00	0.6	1.120	0.6	0.448	1.7684	1.00	1.7684	0.448	0.7922	6.0
13	12:37	11.40	0.6	1.200	0.6	0.480	1.6004	1.00	1.6004	0.480	0.7681	5.8
14	*12:38*	*11.80*	*0.6*	*1.100*	*0.6*	*0.440*	*1.4085*	*1.00*	*1.4085*	*0.440*	*0.6197*	*4.7*
15	*12:39*	*12.20*	*0.6*	*1.000*	*0.6*	*0.400*	*1.4068*	*1.00*	*1.4068*	*0.400*	*0.5626*	*4.3*
16	12:41	12.60	0.6	0.900	0.6	0.360	1.5584	1.00	1.5584	0.360	0.5609	4.3
17	12:41	13.00	0.6	0.800	0.6	0.320	1.4085	1.00	1.4085	0.360	0.5075	3.8
18	12:43	13.50	0.6	0.650	0.6	0.260	1.5279	1.00	1.5279	0.326	0.4975	3.8
19	12:44	14.00	0.6	0.600	0.6	0.240	1.7024	1.00	1.7024	0.301	0.5118	3.9
20	*12:45*	*14.50*	*0.6*	*0.580*	*0.6*	*0.232*	*1.2139*	*1.00*	*1.2139*	*0.291*	*0.3528*	*2.7*
21	12:46	15.00	0.6	0.580	0.6	0.232	1.3448	1.00	1.3448	0.291	0.3908	3.0
22	12:47	15.50	0.6	0.620	0.6	0.248	1.3097	1.00	1.3097	0.311	0.4069	3.1
23	12:48	16.00	0.6	0.670	0.6	0.268	0.5118	1.00	0.5118	0.501	0.2565	1.9
24	*12:49*	*17.00*	*0.6*	*0.470*	*0.6*	*0.188*	*0.0030*	*1.00*	*0.0030*	*0.468*	*0.0014*	*0.0*
25	12:49	18.00	None	0.000	0.0	0.0	0.0000	1.00	0.0000	0.000	0.0000	0.0

Rows in italics indicate a QC warning. See the Quality Control page of this report for more information.

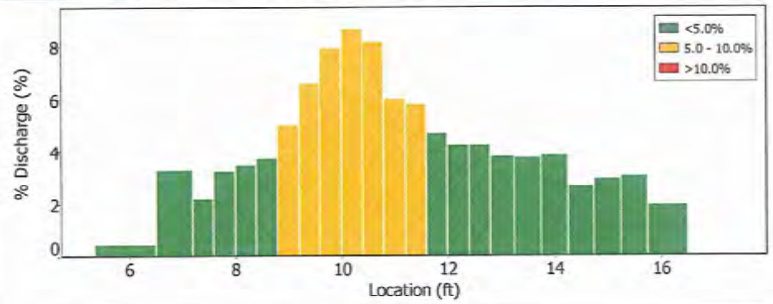
WASHINGTON STATE DEPARTMENT OF ECOLOGY

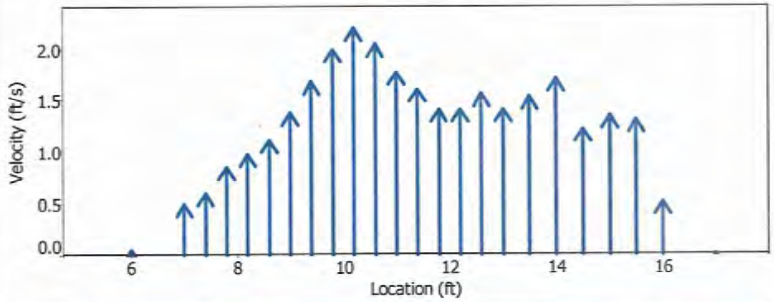
Discharge Measurement Summary

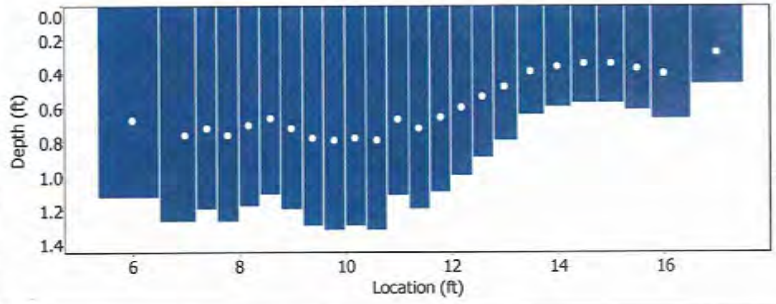
Date Generated: Tue Feb 2 2010

File Information: File Name HC5.WAD; Start Date and Time 2010/01/11 12:24:57

Site Details: Site Name HC5; Operator(s) MGW







WASHINGTON STATE DEPARTMENT OF ECOLOGY

Discharge Measurement Summary

Date Generated: Tue Feb 2 2010

File Information		Site Details	
File Name	HC5.WAD	Site Name	HC5
Start Date and Time	2010/01/11 12:24:57	Operator(s)	MGW

Quality Control

St	Loc	%Dep	Message
14	11.80	0.6	High standard error: 0.075
15	12.20	0.6	High number of spikes: 5
20	14.50	0.6	High number of spikes: 5
24	17.00	0.6	High number of spikes: 6
		0.6	SNR (51.4) is different from typical SNR (32.2)
		0.6	High SNR variation during measurement: 7.3,9.9

WASHINGTON STATE DEPARTMENT OF ECOLOGY

Discharge Measurement Summary

Date Generated: Tue Feb 2 2010

File Information

File Name HC5.WAD

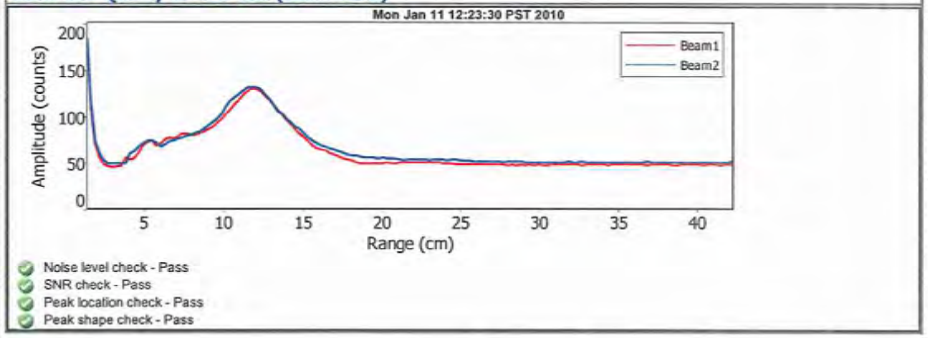
Start Date and Time 2010/01/11 12:24:57

Site Details

Site Name HC5

Operator(s) MGW

Automatic Quality Control Test (BeamCheck)



- Noise level check - Pass
- SNR check - Pass
- Peak location check - Pass
- Peak shape check - Pass

WASHINGTON STATE DEPARTMENT OF ECOLOGY

Discharge Measurement Summary

Date Generated: Tue Apr 6 2010

File Information	
File Name	HC1.WAD
Start Date and Time	2010/03/30 08:44:59

Site Details	
Site Name	HC1
Operator(s)	MGW

System Information	
Sensor Type	FlowTracker
Serial #	P1789
CPU Firmware Version	3.4
Software Ver	2.11

Units	(English Units)
Distance	ft
Velocity	ft/s
Area	ft^2
Discharge	cfs

Discharge Uncertainty

Category	ISO	Stats
Accuracy	1.0%	1.0%
Depth	0.1%	1.3%
Velocity	1.1%	6.3%
Width	0.1%	0.1%
Method	1.4%	-
# Stations	2.3%	-
Overall	**3.1%**	**6.5%**

Summary

Averaging Int.	40	# Stations	22
Start Edge	REW	Total Width	13.999
Mean SNR	30.4 dB	Total Area	16.603
Mean Temp	42.90 °F	Mean Depth	1.186
Disch. Equation	Mid-Section	Mean Velocity	0.3141
		Total Discharge	**5.2151**

Measurement Results

St	Clock	Loc	Method	Depth	%Dep	MeasD	Vel	CorrFact	MeanV	Area	Flow	%Q
0	08:44	5.00	None	0.000	0.0	0.0	0.0000	1.00	0.0000	0.000	0.0000	0.0
1	*08:44*	*7.00*	*0.6*	*0.750*	*0.6*	*0.300*	*0.0148*	*1.00*	*0.0148*	*1.313*	*0.0194*	*0.4*
2	*08:46*	*8.50*	*0.6*	*1.180*	*0.6*	*0.472*	*0.0164*	*1.00*	*0.0164*	*1.475*	*0.0242*	*0.5*
3	*08:47*	*9.50*	*0.6*	*1.100*	*0.6*	*0.440*	*-0.0207*	*1.00*	*-0.0207*	*1.100*	*-0.0227*	*-0.4*
4	*08:49*	*10.50*	*0.6*	*1.060*	*0.6*	*0.424*	*-0.0531*	*1.00*	*-0.0531*	*0.795*	*-0.0423*	*-0.8*
5	*08:50*	*11.00*	*0.6*	*1.150*	*0.6*	*0.460*	*0.1358*	*1.00*	*0.1358*	*0.575*	*0.0781*	*1.5*
6	08:51	11.50	0.6	1.300	0.6	0.520	0.3720	1.00	0.3720	0.650	0.2418	4.6
7	08:52	12.00	0.6	1.300	0.6	0.520	0.7352	1.00	0.7352	0.585	0.4300	8.2
8	08:53	12.40	0.6	1.200	0.6	0.480	0.8251	1.00	0.8251	0.480	0.3960	7.6
9	08:54	12.80	0.6	1.400	0.6	0.560	0.8301	1.00	0.8301	0.560	0.4647	8.9
10	08:55	13.20	0.2/0.8	1.530	0.2	1.224	0.9629	1.00	0.9596	0.612	0.5872	11.3
10	08:56	13.20	0.2/0.8	1.530	0.8	0.306	0.9564					
11	08:58	13.60	0.8/0.2	1.650	0.2	1.320	1.0082	1.00	0.9872	0.660	0.6514	12.5
11	08:58	13.60	0.8/0.2	1.650	0.8	0.330	0.9662					
12	09:00	14.00	0.2/0.8	1.800	0.2	1.440	0.8320	1.00	0.8742	0.720	0.6293	12.1
12	09:01	14.00	0.2/0.8	1.800	0.8	0.360	0.9163					
13	*09:04*	*14.40*	*0.8/0.2*	*2.030*	*0.2*	*1.624*	*0.5394*	*1.00*	*0.4308*	*0.812*	*0.3497*	*6.7*
13	*09:03*	*14.40*	*0.8/0.2*	*2.030*	*0.8*	*0.406*	*0.3222*					
14	*09:05*	*14.80*	*0.2/0.8*	*2.000*	*0.2*	*1.600*	*0.5095*	*1.00*	*0.5285*	*0.800*	*0.4228*	*8.1*
14	*09:06*	*14.80*	*0.2/0.8*	*2.000*	*0.8*	*0.400*	*0.5476*					
15	*09:09*	*15.20*	*0.8/0.2*	*1.920*	*0.2*	*1.536*	*0.2592*	*1.00*	*0.3898*	*0.768*	*0.2993*	*5.7*
15	*09:08*	*15.20*	*0.8/0.2*	*1.920*	*0.8*	*0.384*	*0.5203*					
16	*09:10*	*15.60*	*0.2/0.6/0.8*	*1.840*	*0.2*	*1.472*	*0.1713*	*1.00*	*0.4244*	*0.736*	*0.3123*	*6.0*
16	*09:12*	*15.60*	*0.2/0.6/0.8*	*1.840*	*0.6*	*0.736*	*0.5784*					
16	*09:11*	*15.60*	*0.2/0.6/0.8*	*1.840*	*0.8*	*0.368*	*0.3694*					
17	*09:14*	*16.00*	*0.2/0.6/0.8*	*1.790*	*0.2*	*1.432*	*0.2434*	*1.00*	*0.3659*	*0.806*	*0.2949*	*5.7*
17	*09:16*	*16.00*	*0.2/0.6/0.8*	*1.790*	*0.6*	*0.716*	*0.4423*					
17	*09:15*	*16.00*	*0.2/0.6/0.8*	*1.790*	*0.8*	*0.358*	*0.3356*					
18	*09:19*	*16.50*	*0.2/0.8*	*1.550*	*0.2*	*1.240*	*0.1178*	*1.00*	*0.1332*	*0.776*	*0.1034*	*2.0*
18	*09:20*	*16.50*	*0.2/0.8*	*1.550*	*0.8*	*0.310*	*0.1486*					
19	*09:22*	*17.00*	*0.8/0.2*	*1.510*	*0.2*	*1.208*	*-0.0351*	*1.00*	*-0.0218*	*1.132*	*-0.0247*	*-0.5*
19	*09:21*	*17.00*	*0.8/0.2*	*1.510*	*0.8*	*0.302*	*-0.0085*					
20	*09:23*	*18.00*	*0.6*	*1.250*	*0.6*	*0.500*	*0.0003*	*1.00*	*0.0003*	*1.249*	*0.0004*	*0.0*
21	09:23	19.00	None	0.000	0.0	0.0	0.0000	1.00	0.0000	0.000	0.0000	0.0

Rows in italics indicate a QC warning. See the Quality Control page of this report for more information.

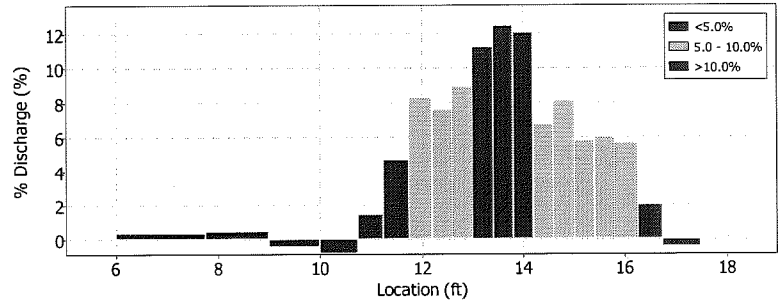
WASHINGTON STATE DEPARTMENT OF ECOLOGY

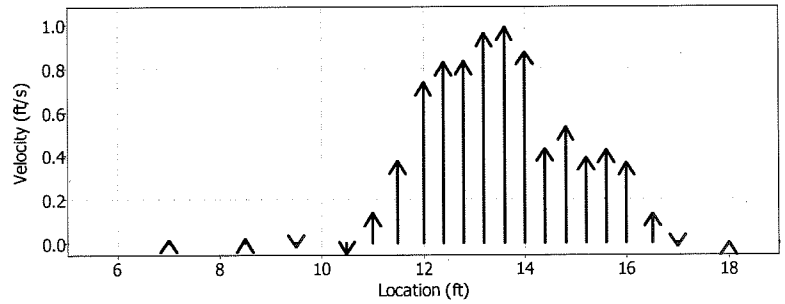
Discharge Measurement Summary

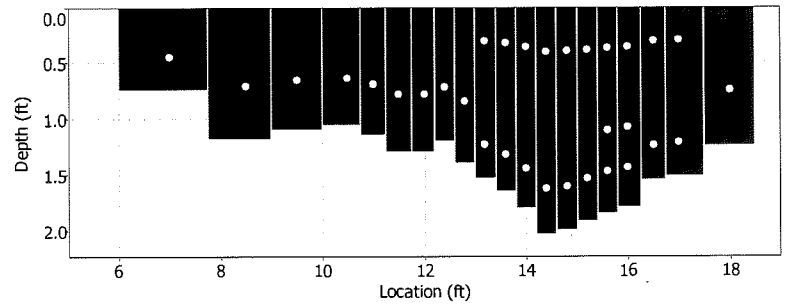
Date Generated: Tue Apr 6 2010

File Information
File Name HC1.WAD
Start Date and Time 2010/03/30 08:44:59

Site Details
Site Name HC1
Operator(s) MGW







WASHINGTON STATE DEPARTMENT OF ECOLOGY

Discharge Measurement Summary

Date Generated: Tue Apr 6 2010

File Information		Site Details	
File Name	HC1.WAD	Site Name	HC1
Start Date and Time	2010/03/30 08:44:59	Operator(s)	MGW

Quality Control

St	Loc	%Dep	Message
1	7.00	0.6	SNR (43.4) is different from typical SNR (30.4)
		0.6	High SNR variation during measurement: 8.6,7.7
2	8.50	0.6	High SNR variation during measurement: 6.5,6.9
3	9.50	0.6	High angle: 116
		0.6	SNR (48.6) is different from typical SNR (30.4)
4	10.50	0.6	High angle: 134
		0.6	SNR (46.2) is different from typical SNR (30.4)
5	11.00	0.6	High angle: 25
		0.6	SNR (41.1) is different from typical SNR (30.4)
13	14.40	0.2	High standard error: 0.041
14	14.80	0.8	High standard error: 0.035
15	15.20	0.8	High angle: 22
16	15.60	0.8	High angle: 27
17	16.00	0.8	High angle: 27
		0.8	High standard error: 0.034
18	16.50	0.8	High angle: 28
19	17.00	0.2	High angle: 179
		0.8	High SNR variation during measurement: 9.0,6.9
20	18.00	0.6	SNR (52.2) is different from typical SNR (30.4)
		0.6	High SNR variation during measurement: 7.3,4.7

WASHINGTON STATE DEPARTMENT OF ECOLOGY

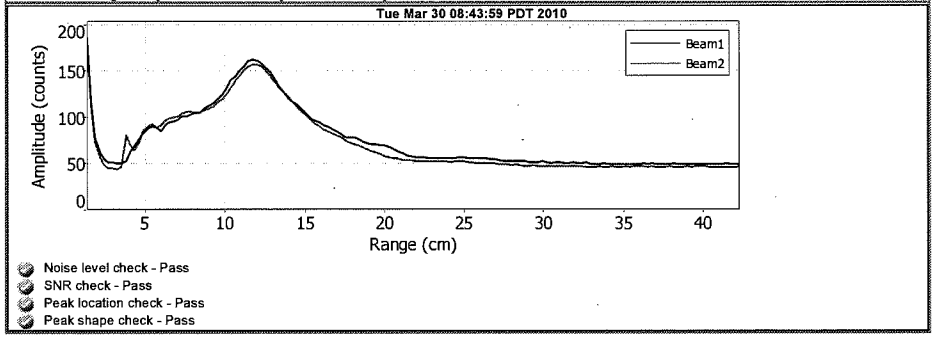
Discharge Measurement Summary

Date Generated: Tue Apr 6 2010

File Information
File Name HC1.WAD
Start Date and Time 2010/03/30 08:44:59

Site Details
Site Name HC1
Operator(s) MGW

Automatic Quality Control Test (BeamCheck)



- Noise level check - Pass
- SNR check - Pass
- Peak location check - Pass
- Peak shape check - Pass

WASHINGTON STATE DEPARTMENT OF ECOLOGY

Discharge Measurement Summary

Date Generated: Tue Apr 6 2010

File Information		Site Details	
File Name	HC3.WAD	Site Name	HC3
Start Date and Time	2010/03/30 09:54:28	Operator(s)	MGW

System Information	
Sensor Type	FlowTracker
Serial #	P1789
CPU Firmware Version	3.4
Software Ver	2.11

Units	(English Units)
Distance	ft
Velocity	ft/s
Area	ft^2
Discharge	cfs

Discharge Uncertainty

Category	ISO	Stats
Accuracy	1.0%	1.0%
Depth	0.2%	0.8%
Velocity	0.7%	2.7%
Width	0.1%	0.1%
Method	1.8%	-
# Stations	2.1%	-
Overall	**3.0%**	**3.0%**

Summary

Averaging Int.	40	# Stations	24
Start Edge	REW	Total Width	24.000
Mean SNR	25.6 dB	Total Area	22.918
Mean Temp	46.25 °F	Mean Depth	0.955
Disch. Equation	Mid-Section	Mean Velocity	0.4590
		Total Discharge	**10.5198**

Measurement Results

St	Clock	Loc	Method	Depth	%Dep	MeasD	Vel	CorrFact	MeanV	Area	Flow	%Q
0	09:54	5.00	None	0.000	0.0	0.0	0.0000	1.00	0.0000	0.000	0.0000	0.0
1	09:54	7.50	0.6	0.200	0.6	0.080	0.1604	1.00	0.1604	0.350	0.0562	0.5
2	09:55	8.50	0.6	0.480	0.6	0.192	0.2995	1.00	0.2995	0.480	0.1438	1.4
3	09:56	9.50	0.6	0.610	0.6	0.244	0.3868	1.00	0.3868	0.610	0.2359	2.2
4	09:57	10.50	0.6	0.740	0.6	0.296	0.4396	1.00	0.4396	0.740	0.3254	3.1
5	09:58	11.50	0.6	0.840	0.6	0.336	0.4984	1.00	0.4984	0.840	0.4186	4.0
6	09:59	12.50	0.6	0.910	0.6	0.364	0.5059	1.00	0.5059	0.910	0.4604	4.4
7	10:00	13.50	0.6	0.980	0.6	0.392	0.4400	1.00	0.4400	0.980	0.4312	4.1
8	10:01	14.50	0.6	1.100	0.6	0.440	0.5591	1.00	0.5591	1.100	0.6150	5.8
9	10:02	15.50	0.6	1.290	0.6	0.516	0.5404	1.00	0.5404	1.290	0.6971	6.6
10	10:04	16.50	0.6	1.230	0.6	0.492	0.4193	1.00	0.4193	1.230	0.5157	4.9
11	10:05	17.50	0.6	1.200	0.6	0.480	0.5745	1.00	0.5745	1.200	0.6894	6.6
12	10:06	18.50	0.6	1.230	0.6	0.492	0.4551	1.00	0.4551	1.230	0.5597	5.3
13	10:07	19.50	0.6	1.120	0.6	0.448	0.3927	1.00	0.3927	1.120	0.4399	4.2
14	10:08	20.50	0.6	1.140	0.6	0.456	0.4275	1.00	0.4275	1.140	0.4874	4.6
15	10:09	21.50	0.6	1.250	0.6	0.500	0.4967	1.00	0.4967	1.250	0.6209	5.9
16	10:10	22.50	0.6	1.300	0.6	0.520	0.5420	1.00	0.5420	1.300	0.7045	6.7
17	10:11	23.50	0.6	1.400	0.6	0.560	0.5797	1.00	0.5797	1.400	0.8116	7.7
18	10:12	24.50	0.6	1.430	0.6	0.572	0.4692	1.00	0.4692	1.430	0.6710	6.4
19	10:14	25.50	0.6	1.400	0.6	0.560	0.5653	1.00	0.5653	1.400	0.7914	7.5
20	10:15	26.50	0.6	1.280	0.6	0.512	0.4767	1.00	0.4767	1.280	0.6101	5.8
21	10:16	27.50	0.6	1.000	0.6	0.400	0.2106	1.00	0.2106	1.000	0.2106	2.0
22	*10:17*	*28.50*	*0.6*	*0.850*	*0.6*	*0.340*	*0.0377*	*1.00*	*0.0377*	*0.638*	*0.0241*	*0.2*
23	10:17	29.00	None	0.000	0.0	0.0	0.0000	1.00	0.0000	0.000	0.0000	0.0

Rows in italics indicate a QC warning. See the Quality Control page of this report for more information.

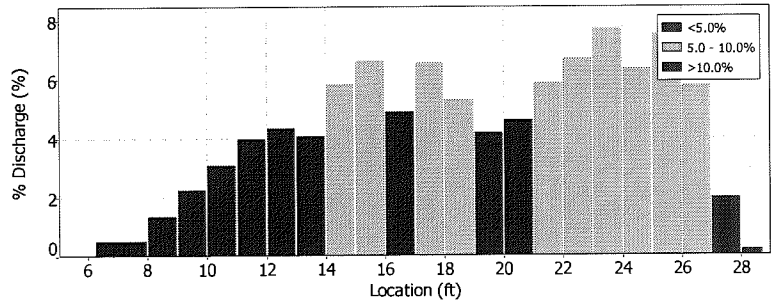
WASHINGTON STATE DEPARTMENT OF ECOLOGY

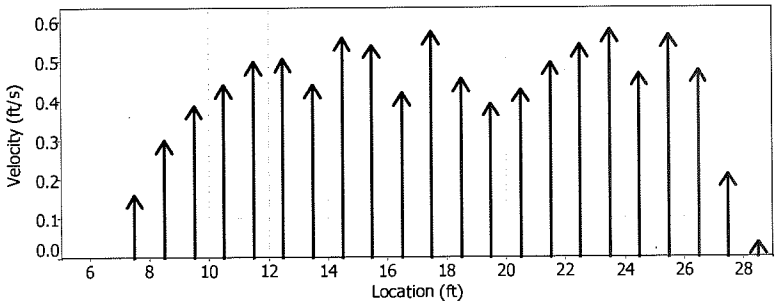
Discharge Measurement Summary

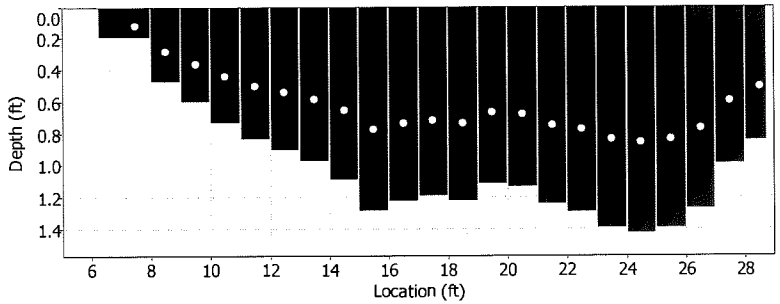
Date Generated: Tue Apr 6 2010

File Information
File Name HC3.WAD
Start Date and Time 2010/03/30 09:54:28

Site Details
Site Name HC3
Operator(s) MGW







WASHINGTON STATE DEPARTMENT OF ECOLOGY

Discharge Measurement Summary

Date Generated: Tue Apr 6 2010

File Information		Site Details	
File Name	HC3.WAD	Site Name	HC3
Start Date and Time	2010/03/30 09:54:28	Operator(s)	MGW

Quality Control

St	Loc	%Dep	Message
22	28.50	0.6	High angle: -27
		0.6	High SNR variation during measurement: 9.0,6.0
		0.6	Boundary QC is Fair; possible boundary interference

WASHINGTON STATE DEPARTMENT OF ECOLOGY

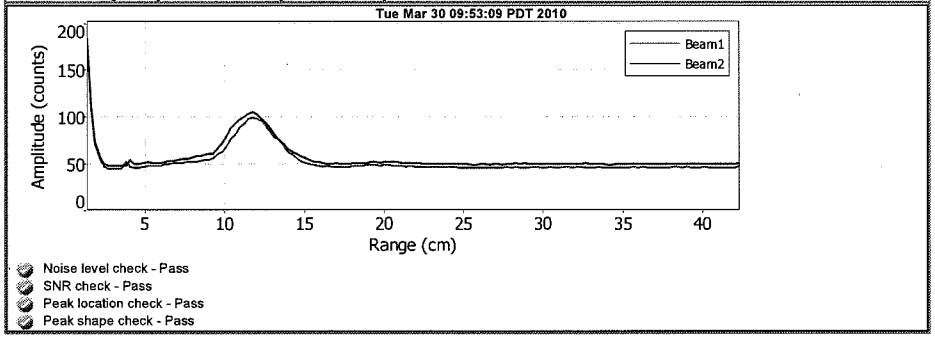
Discharge Measurement Summary

Date Generated: Tue Apr 6 2010

File Information
File Name HC3.WAD
Start Date and Time 2010/03/30 09:54:28

Site Details
Site Name HC3
Operator(s) MGW

Automatic Quality Control Test (BeamCheck)



- Noise level check - Pass
- SNR check - Pass
- Peak location check - Pass
- Peak shape check - Pass

WASHINGTON STATE DEPARTMENT OF ECOLOGY

Discharge Measurement Summary

Date Generated: Tue Apr 6 2010

File Information

File Name	HC5.WAD
Start Date and Time	2010/03/30 10:43:09

Site Details

Site Name	HC5
Operator(s)	MGW

System Information

Sensor Type	FlowTracker
Serial #	P1789
CPU Firmware Version	3.4
Software Ver	2.11

Units (English Units)

Distance	ft
Velocity	ft/s
Area	ft^2
Discharge	cfs

Summary

Averaging Int.	40	# Stations	26
Start Edge	REW	Total Width	14.000
Mean SNR	33.3 dB	Total Area	17.715
Mean Temp	46.09 °F	Mean Depth	1.265
Disch. Equation	Mid-Section	Mean Velocity	1.0731
		Total Discharge	**19.0095**

Discharge Uncertainty

Category	ISO	Stats
Accuracy	1.0%	1.0%
Depth	0.1%	1.0%
Velocity	0.7%	4.8%
Width	0.1%	0.1%
Method	1.4%	-
# Stations	2.0%	-
Overall	**2.8%**	**5.0%**

Measurement Results

St	Clock	Loc	Method	Depth	%Dep	MeasD	Vel	CorrFact	MeanV	Area	Flow	%Q
0	10:43	5.00	None	0.000	0.0	0.0	0.0000	1.00	0.0000	0.000	0.0000	0.0
1	10:43	6.00	0.6	1.420	0.6	0.568	0.0079	1.00	0.0079	1.420	0.0112	0.1
2	*10:44*	*7.00*	*0.2/0.8*	*1.870*	*0.2*	*1.496*	*0.1332*	*1.00*	*0.2021*	*1.403*	*0.2835*	*1.5*
2	*10:45*	*7.00*	*0.2/0.8*	*1.870*	*0.8*	*0.374*	*0.2710*					
3	*10:47*	*7.50*	*0.8/0.2*	*1.900*	*0.2*	*1.520*	*0.1791*	*1.00*	*0.2779*	*0.950*	*0.2640*	*1.4*
3	*10:46*	*7.50*	*0.8/0.2*	*1.900*	*0.8*	*0.380*	*0.3766*					
4	*10:48*	*8.00*	*0.2/0.8*	*1.700*	*0.2*	*1.360*	*0.2290*	*1.00*	*0.3791*	*0.850*	*0.3223*	*1.7*
4	*10:49*	*8.00*	*0.2/0.8*	*1.700*	*0.8*	*0.340*	*0.5292*					
5	*10:52*	*8.50*	*0.8/0.2*	*1.500*	*0.2*	*1.200*	*0.6657*	*1.00*	*0.8273*	*0.750*	*0.6204*	*3.3*
5	*10:51*	*8.50*	*0.8/0.2*	*1.500*	*0.8*	*0.300*	*0.9888*					
6	*10:53*	*9.00*	*0.2/0.8*	*1.710*	*0.2*	*1.368*	*1.4341*	*1.00*	*1.3056*	*0.855*	*1.1163*	*5.9*
6	*10:54*	*9.00*	*0.2/0.8*	*1.710*	*0.8*	*0.342*	*1.1772*					
7	*10:56*	*9.50*	*0.8/0.2*	*1.710*	*0.2*	*1.368*	*1.8822*	*1.00*	*1.5284*	*0.855*	*1.3067*	*6.9*
7	*10:55*	*9.50*	*0.8/0.2*	*1.710*	*0.8*	*0.342*	*1.1745*					
8	*10:57*	*10.00*	*0.2/0.8*	*1.710*	*0.2*	*1.368*	*2.0348*	*1.00*	*1.4432*	*0.855*	*1.2340*	*6.5*
8	*10:58*	*10.00*	*0.2/0.8*	*1.710*	*0.8*	*0.342*	*0.8517*					
9	*11:00*	*10.50*	*0.8/0.2*	*1.620*	*0.2*	*1.296*	*2.0062*	*1.00*	*1.3752*	*0.810*	*1.1139*	*5.9*
9	*10:59*	*10.50*	*0.8/0.2*	*1.620*	*0.8*	*0.324*	*0.7441*					
10	*11:01*	*11.00*	*0.2/0.8*	*1.570*	*0.2*	*1.256*	*2.0515*	*1.00*	*1.5305*	*0.785*	*1.2014*	*6.3*
10	*11:02*	*11.00*	*0.2/0.8*	*1.570*	*0.8*	*0.314*	*1.0095*					
11	11:03	11.50	0.6	1.430	0.6	0.572	1.6302	1.00	1.6302	0.715	1.1657	6.1
12	11:04	12.00	0.6	1.320	0.6	0.528	1.9341	1.00	1.9341	0.660	1.2764	6.7
13	*11:06*	*12.50*	*0.6*	*1.320*	*0.6*	*0.528*	*1.4728*	*1.00*	*1.4728*	*0.660*	*0.9719*	*5.1*
14	11:07	13.00	0.6	1.260	0.6	0.504	1.7244	1.00	1.7244	0.630	1.0862	5.7
15	11:08	13.50	0.6	1.250	0.6	0.500	1.6007	1.00	1.6007	0.625	1.0005	5.3
16	11:09	14.00	0.6	1.200	0.6	0.480	1.3809	1.00	1.3809	0.600	0.8286	4.4
17	11:10	14.50	0.6	1.120	0.6	0.448	1.5837	1.00	1.5837	0.560	0.8869	4.7
18	11:11	15.00	0.6	1.150	0.6	0.460	1.4820	1.00	1.4820	0.575	0.8521	4.5
19	11:12	15.50	0.6	1.100	0.6	0.440	1.4934	1.00	1.4934	0.550	0.8214	4.3
20	11:13	16.00	0.6	1.100	0.6	0.440	1.7231	1.00	1.7231	0.550	0.9478	5.0
21	11:14	16.50	0.6	1.000	0.6	0.400	1.8077	1.00	1.8077	0.500	0.9039	4.8
22	*11:16*	*17.00*	*0.6*	*1.000*	*0.6*	*0.400*	*0.6660*	*1.00*	*0.6660*	*0.500*	*0.3330*	*1.8*
23	*11:17*	*17.50*	*0.6*	*0.900*	*0.6*	*0.360*	*-1.0256*	*-1.00*	*1.0256*	*0.450*	*0.4615*	*2.4*
24	*11:19*	*18.00*	*Input V*	*0.810*	*0.0*	*0.000*	*0.0000*	*1.00*	*0.0000*	*0.608*	*0.0000*	*0.0*
25	11:19	19.00	None	0.000	0.0	0.0	0.0000	1.00	0.0000	0.000	0.0000	0.0

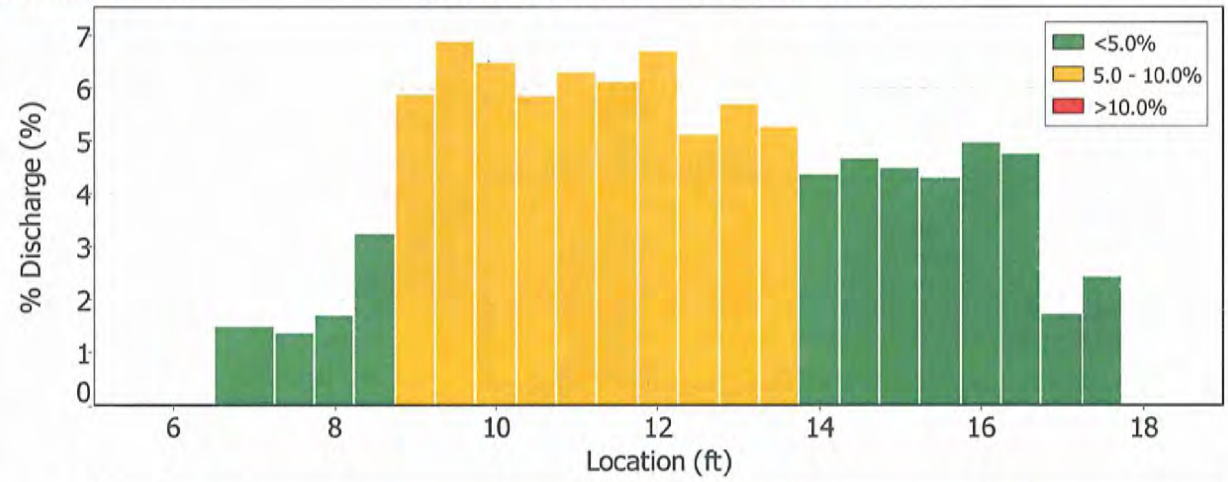
Rows in italics indicate a QC warning. See the Quality Control page of this report for more information.

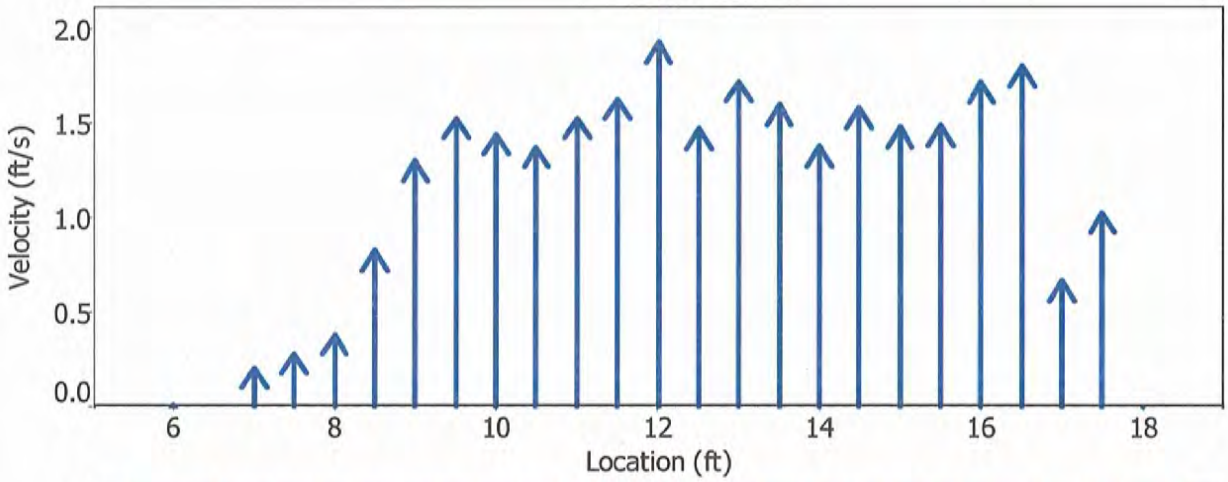
WASHINGTON STATE DEPARTMENT OF ECOLOGY

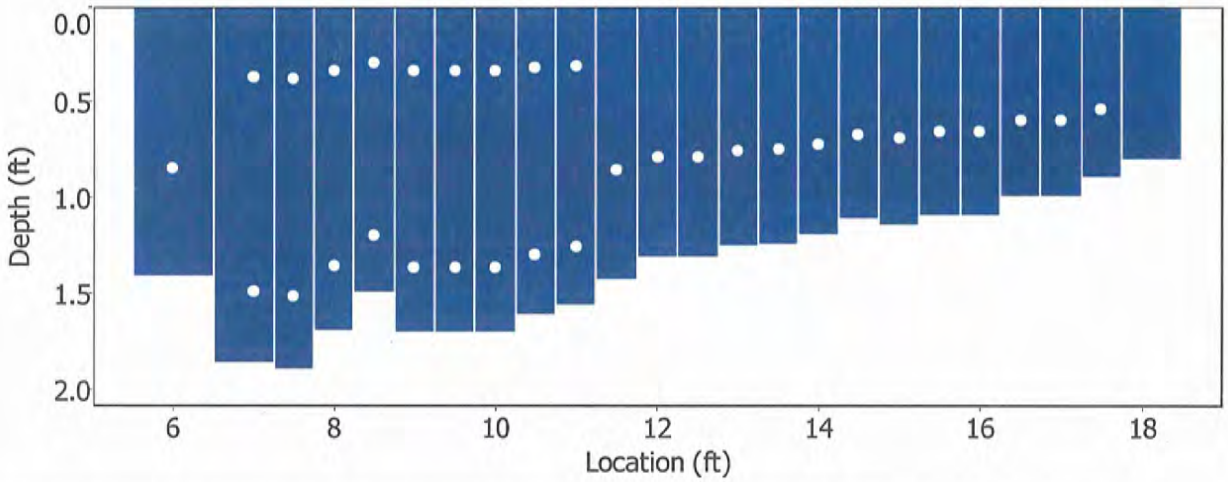
Discharge Measurement Summary

Date Generated: Tue Apr 6 2010

File Information		Site Details	
File Name	HC5.WAD	Site Name	HC5
Start Date and Time	2010/03/30 10:43:09	Operator(s)	MGW







WASHINGTON STATE DEPARTMENT OF ECOLOGY

Discharge Measurement Summary

Date Generated: Tue Apr 6 2010

File Information		Site Details	
File Name	HC5.WAD	Site Name	HC5
Start Date and Time	2010/03/30 10:43:09	Operator(s)	MGW

Quality Control

St	Loc	%Dep	Message
2	7.00	0.8	High angle: -27
3	7.50	0.8	High angle: -47
4	8.00	0.8	High angle: -42
5	8.50	0.8	High angle: -27
6	9.00	0.8	High angle: -27
7	9.50	0.2	High number of spikes: 5
		0.8	High standard error: 0.087
8	10.00	0.8	High standard error: 0.058
9	10.50	0.8	High standard error: 0.094
10	11.00	0.8	High standard error: 0.058
13	12.50	0.6	High standard error: 0.097
22	17.00	0.6	High SNR variation during measurement: 3.4,5.2
		0.6	Boundary QC is Good; possible boundary interference
23	17.50	0.6	High angle: 176
24	18.00	0.0	Low SNR: 0.0,0.0
		0.0	SNR (0.0) is different from typical SNR (34.7)
		0.0	High standard error: 0.000

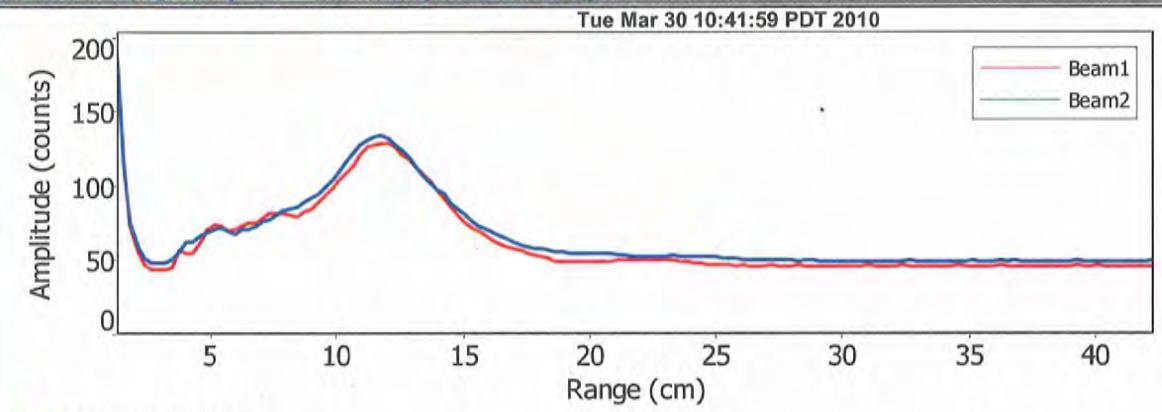
WASHINGTON STATE DEPARTMENT OF ECOLOGY

Discharge Measurement Summary

Date Generated: Tue Apr 6 2010

File Information		Site Details	
File Name	HC5.WAD	Site Name	HC5
Start Date and Time	2010/03/30 10:43:09	Operator(s)	MGW

Automatic Quality Control Test (BeamCheck)



- Noise level check - Pass
- SNR check - Pass
- Peak location check - Pass
- Peak shape check - Pass

ATTACHMENT B

GROUNDWATER LEVEL MONITORING DATA

Well Location Worksheet, WRIA 53 Well Water Level Measurement Study 04/29/2010

Well_ID	Date	Depth H2O (feet)	Casing Height (inches)	EPE (feet)	WAAS	Garmin GPS Casing Elevation (feet)	DRG Topo Map Elevation NGVD29 (feet)	DRG Topo Map Name	Garmin Topo Map Ground Elevation NAVD88 (feet)	VERTCON NGVD29 - NAVD88 Elev. Shift (feet)	Latitude Decimal Degrees	Longitude Decimal Degrees	UTM_E (meters)	UTM_N (meters)	Notes
APQ814	12/29/2009	41.63	24.00	~~16~~	~~yes~~	~~1468~~					~~47.78204~~	~~118.29546~~	~~402959~~	~~5292887~~	Lowrance; Blue Grouse Drive close to Hawk Creek Rd; no pump
APQ814	1/29/2010	41.28	24.00	9.1	yes	1495	1515	Olsen Canyon (047118g3)	1519	3.91	47.78204	118.29546	402959	5292888	WP-020 Garmin, averaging; no well measurements for the 12/29 wells, just relocated with new Garmin GPS; use the new Garmin locations/elevations for the location data
APQ806	12/29/2009	232.20	11.25	~~54~~	~~no~~	~~2155~~					~~47.77236~~	~~118.29784~~	~~402762~~	~~5291816~~	Lowrance; Panoramic 1, flat mid level hilltop, intersection; no pump
APQ806	1/29/2010	234.91	11.25	6.3	yes	2185	2195	Olsen Canyon (047118g3)	2198	3.92	47.77238	118.29783	402764	5291817	WP-021 Garmin, averaging
APP839	12/29/2009	169.00	12.00	~~46~~	~~no~~	~~2323~~					~~47.77451~~	~~118.30860~~	~~401960~~	~~5292069~~	Lowrance; Big Buck 2; hilltop between house and lodge; no pump
APP839	1/29/2010	168.9	12.00	6.8	yes	2363	2360	Olsen Canyon (047118g3)	2382	3.92	47.77451	118.30860	401960	5292068	WP-022 Garmin, averaging
ALN861	12/29/2009	24.70	18.50	~~14~~	~~yes~~	~~2054~~					~~47.76227~~	~~118.29628~~	~~402865~~	~~5290693~~	Lowrance; Meadow Lark 4; high granitic steptoe on curve on Ruffed Grouse Drive;no pump
ALN861	1/29/2010	23.8	18.50	6.7	yes	2066	2080	Olsen Canyon (047118g3)	2087	3.94	47.76227	118.29617	402869	5290692	WP-024 Garmin, averaging
ALN867	12/29/2009	272.48	34.00	~~17~~	~~yes~~	~~1735~~					~~47.76958~~	~~118.29105~~	~~403267~~	~~5291497~~	Lowrance; moderately steep grade, basalt bluff to NW
ALN867	1/29/2010	270.85	34.00	9.2	yes	1865	1760	Olsen Canyon (047118g3)	1763	3.93	47.76957	118.29106	403265	5291496	WP-025 Garmin, averaging
AHJ350	1/8/2101	20.50	24.50	22	yes	~~2251~~					~~47.66560~~	~~118.19265~~	~~410460~~	~~5279823~~	WP-002 Lowrance; black dog, geese are OK; casing south of house and just wests of driveway; keep tape on south/south southwest side of casing
AHJ350	3/8/2010	21.40	24.50	6.8	yes	2293	2305	Davenport (047118f2)	2312	4.06	47.66561	118.19269	410459	5279824	WP-050 Garmin, averaging. Water depth today from sonic meter. Not much space between PVC liner and pipe.
AHC407	1/8/2010	72.70	35.00	~~20~~	~~yes~~	~~1630~~					~~47.74575~~	~~118.29758~~	~~402732~~	~~5288859~~	WP-003 Lowrance; little dogs, OK; GPS coordinates taken on pile of plywood at SE corner of well house with green roof on small terrace above Cisco's house. Cisco will probably be home, so stop by and tell what the water level is.
AHC407	2/19/2010	66.50	35.00	9.4	yes	1690	1720	Rocklyn (047118f3)	1702	3.96	47.74574	118.29763	402729	5288856	WP-040 Garmin, averaging. Sonic meter - 66.5 normal mode, 43 F. Unable to get Etape down to water. GPS reading taken from plywood pile again at SE corner of well house.

Well Location Worksheet, WRIA 53 Well Water Level Measurement Study 04/29/2010

Well_ID	Date	Depth H2O (feet)	Casing Height (inches)	EPE (feet)	WAAS	Garmin GPS Casing Elevation (feet)	DRG Topo Map Elevation NGVD29 (feet)	DRG Topo Map Name	Garmin Topo Map Ground Elevation NAVD88 (feet)	VERTCON NGVD29 - NAVD88 Elev. Shift (feet)	Latitude Decimal Degrees	Longitude Decimal Degrees	UTM_E (meters)	UTM_N (meters)	Notes
Gordon Ellis	1/8/2010	4.70	12.00	~~33~~	~~yes~~	~~1705 at GPS site on house deck; 1692 in front of wellhouse~~					~~47.74177~~	~~118.31371~~	~~401515~~	~~5288438~~	WP-004 Lowrance; GPS taken at NW edge of deck on house above red well house below and out of the trees a little for better locating. The deck site is 40-50 ft from well house and about 15-20 feet above well house
Gordon Ellis	2/19/2010	4.15	13.00	16.9	yes	1748	1720	Rocklyn (047118f3)	1730	3.98	47.74189	118.31377	401512	5288449	WP-041 Garmin, averaging. The GPS unit was placed on the SE corner of the red pumphouse roof for better reception in amongst the trees here.
BAC969	1/8/2010	176.50	17.25	~~24~~	~~yes~~	~~2411~~					~~47.77824~~	~~118.36769~~	~~397540~~	~~5292559~~	WP-006 Lowrance; gasket on cover stretched, not located for good seal like it should be
BAC969	2/19/2010	176.54	17.25	6.4	yes	2490	2460	Olsen Canyon (047118g3)	2458	3.97	47.77823	118.36767	397542	5292558	WP-039 Garmin, averaging
BAS262	1/8/2010	247.00	15.50	~~21~~	~~yes~~	~~2404~~					~~47.78363~~	~~118.36818~~	~~397514~~	~~5293160~~	WP-007 Lowrance; this well is the north well of the two wells together here
BAS262	2/19/2010	284.60	15.50	6.3	yes	2433	2450	Olsen Canyon (047118g3)	2444	3.96	47.78364	118.36819	397513	5293159	WP-037 Garmin, averaging. 284.60 Etape reading was confirmed by 283.1 sonic meter reading
BAC976	1/8/2010		11.00	~~24~~	~~yes~~	~~2360~~					~~47.78738~~	~~118.37023~~	~~397369~~	~~5293579~~	WP-008 Lowrance; located towards far north end of lane in weedy CRP; good view of the arm of the Spokane River, hence "Arm View Lane"; tape went slack at 300 ft, couldn't reach water; try doing this well again later
BAC976	2/19/2010	292.15	11.00	6.3	yes	2442	2420	Olsen Canyon (047118g3)	2421	3.96	47.78743	118.37020	397371	5293583	WP-042 Garmin, averaging. Used flashlight to confirm that Etape went inside liner
BAC970	1/8/2010	100.00	12.00	~~17~~	~~yes~~	~~2422~~					~~47.78299~~	~~118.36952~~	~~397414~~	~~5293089~~	WP-009 Lowrance; tape wouldn't stop beeping after hitting water due to iron sediment in sensor; 100 ft is best estimate when tape first started beeping
BAC970	2/19/2010	142.01	12.00	6.2	yes	2487	2470	Olsen Canyon (047118g3)	2469	3.96	47.78299	118.36950	397415	5293089	WP-038 Garmin, averaging. 142.01 Etape measurement is close to 138 ft depth to water when drilled
Palanuk 1984	1/19/2010		6.00	6	yes	1595	1600	Grand Coulee Dam (047118h8)	1614	3.93	47.93281	118.96852	352969	5310708	WP-004 Garmin, averaging; lot of cable at top of well casing, not much room to get probe down; tape stopped at 68 feet first try, then 110 feet; couldn't reach water; just north of driveway before house in front of pressure tank house with red roof; Marvin has done level measurements in the past, see master work sheet.

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AHC421	1/19/2010	233.00	17.50	7.8	yes	1551	1570	Grand Coulee Dam (047118h8)	1582	3.93	47.93328	118.96889	352943	5310760	WP-007 Garmin, averaging; well not being used, no pump in it, will be deepened to find more & better water in the near future. A metal cap was welded on top but then cut with a torch, and cap just sitting on top of the casing
AHC420	1/19/2010	187.00	32.50	7.1	yes	1516	1550	Grand Coulee Dam (047118h8)	1554	3.93	47.93419	118.96844	352980	5310861	WP-006 Garmin, averaging; this well is higher up hill than APC 863, but GPS measured it as lower; Ray Burge can only run this well once a day for a limited time. It is not used unless APC863 can't provide all the needed water.
APC865	1/19/2010	272.30	34.00	8.1	yes	1525	1540	Grand Coulee Dam (047118h8)	1542	3.93	47.93480	118.96844	352958	5310930	WP-005 Garmin, averaging; this well is farther down Eden Harbor drive to the left and northwest of Ray Burge's shop. This well provides most of Ray's water. Both wells drop quite a bit in summer.
BBH538	1/19/2010	77.73	25.75	7.4	yes	1357	1360	Grand Coulee Dam (047118h8)	1368	3.98	47.94476	118.88613	359155	5311882	WP-008 Garmin, averaging; just to west of new light forest green house and roof; take Spring Canyon, Sunny Hill Ln, and then turn right at T on Plum Pt. Ln E; turn down narrow unfinished gravel lane
BAC955	1/19/2010	149.70	22.00	7.1	yes	1817	1830	Grand Coulee Dam (047118h8)	1846	3.99	47.92931	118.90302	357852	5310196	WP-009 Garmin, averaging; go up another 80 or so feet up past the gravel on Summers Lane, turn right on dirt lane with new sagebrush, well casings in small excavation. This is the better producing west well.
APF669	1/19/2010	150.70	22.50	6.6	yes	1831	1830	Grand Coulee Dam (047118h8)	1849	3.99	47.92931	118.90302	357863	5310197	WP-010 Garmin, averaging; this is Scott Summers east well that isn't producing and needs to be deepened. Both of Summers' wells are at about the same elevation, but the GPS measured 14 feet higher for this well.
Didrickson 1982	1/19/2010		17.00	6.8	yes	2643	2650	Keller Ferry (047118h6)	2658	4.15	47.88488	118.68060	374358	5304872	WP-011 Garmin, averaging; tape went down well just fine until 240 feet when it got stopped; the tape is stuck at about 140 feet, apparently on the well pump wires. If the tape can ever be removed, don't measure this well again with the Solinst Etape.

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ABQ390	1/22/2010		14.50	6.5	yes	1521	1530	Keller Ferry (047118h6)	1529	4.12	47.89578	118.71457	371846	5306140	WP-013 Garmin, averaging; well tag said ABQ390, but it is not available on Ecology well log site. Paper copy of well log from Ellen says depth is 410 feet and it goes into granite. This is a shared well, located behind big shop but in fron to short cut bank with small tank house in front of gray A frame house. Tape stopped for awhile at 40, 65 and then102.5 feet, sounded like metal, couldn't reach water. Tape temporarily stuck when reeled up, but got tape out. Try sonic meter next.
BBH041	1/22/2010	55.20	27.75	6.3	yes	1577	1590	Lincoln (047118g4)	1601	3.96	47.85754	118.46696	390271	5301509	WP-015 Garmin, averaging; go past blue rental trailer house, well casing is off to right 150 ft or so in middle of CRP-like grass field with 6 to 12" eroded around casing due to pump test. Field muddy do not drive in, call Lauri before sampling. No pump in well. Well tag is BBH041, but it is not on Ecology website. Michael has another well but he is using it.
APQ811	1/22/2010	218.35	18.00	9.4	yes	1686	1680	Olsen Canyon (047118g3)	1692	3.91	47.78175	118.30109	402537	5292863	WP-017 Garmin, averaging; well is just downhill at end of Blue Grouse lane; DTW-ATD was 140
APB762	1/22/2010		9.50	7	yes	2335	2340	Olsen Canyon (047118g3)	2347	3.92	47.77492	118.30683	402094	5292111	WP-018 Garmin, averaging; well is just downhill from Barnetts house on Mourning Dove lane between Big Buck lots 3 & 4 just uphill from lane. Tape hit bottom or something at 431 feet, but no beep, no water on probe, and no sediment on probe either. DTW-ATD was 240, and total depth was 540
Platt 1992	1/22/2010	141.35	9.00	8.2	yes	2530	2520	Inkster Lake (047118g2)	2520	4.17	47.78471	118.18465	411264	5293052	WP-019 Garmin, averaging; well casing is in small electric fenced enclosure at 90 degree bend in lane below Tom's house - need to go up to house, just to far left of blue garage is the orange electric fence shut off, make sure it is off. Need to take cap off of well, pull wires up out of way, and only put tape down the west side of casing. Sounded like there was some water cascading down the casing.

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BAC950	1/29/2010		18.50	6.7	yes	2214	2220	Olsen Canyon (047118g3)	2211	3.92	47.77583	118.30314	402373	5292208	WP-023 Garmin, averaging; Depth to Water = 540, well depth = 642 feet; lowered the tape down to 475 feet and then quit, expect the water level to be beyond the 500 feet length of the tape; PVC liner extends all of the way to the surface. Mr. Pease, who lives year round in the house just above just bought the lot and this well; no pump
ALN860	1/29/2010		24.50	6.7	yes	1806	1820	Olsen Canyon (047118g3)	1825	3.95	47.76149	118.28912	403396	5290596	WP-028 Garmin, averaging; DTW = 30 feet, depth = 100 feet. Should have been hit water easily in this shallow well, but tape kept hitting obstructions like rocks starting at 30 feet and then stopped/went slack at 33.57 feet. Try sonic meter; no pump
ALN853	1/29/2010	85.25	16.00	5.7	yes	1610	1600	Olsen Canyon (047118g3)	1603	3.94	47.76662	118.28796	403492	5291165	WP-029 Garmin, averaging; DTW = 120 feet, well depth = 680 feet; no pump
BAC967	1/29/2010		21.50	6.8	yes	1606	1570	Olsen Canyon (047118g3)	1568	3.92	47.84018	118.34171	399607	5299409	WP-030 Garmin, averaging; DTW = 300 ft, well depth = 412 feet; this is the backup well on the south side of the pumphouse just west of Airport Way. Already has pump and large 4-5" pipe the wires inside the 10" casing; there is only about 2" space on the east side of casing. Talked to Gene; this well mimics the river level and so decided not to risk getting tape stuck.
AKL333	1/29/2010		34.00	7.9	yes	1689	1670	Olsen Canyon (047118g3)	1676	3.91	47.83523	118.34534	399325	5298863	WP-031 Garmin, averaging; go through black gate, uphill to Y and take right; well casing close to Y. Upper well casing so full of wires and pump pressure switch that the flashlight couldn't see down very far. Wires would only pull up a little and would pull out of the way easily. Try sonic meter. Pump in well.
Terry Johnson	1/29/2010		3.00	6.7	yes	1844	1810	Olsen Canyon (047118g3)	1809	3.95	47.86678	118.32230	401109	5302340	WP-032 Garmin, averaging; well is off to NW of older blue and white farmhouse just across barbwire fence; turnoff just south of Deer Meadows Rd and go uphill to the farmhouse. A iron plate is welded on top of the well. Since remaining casing is so low to the ground, it would need to be extended upward by several feet or perhaps a sealed port could be cut into the cap to try Etape/sonic meter measurements

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BAF483	2/4/2010	281.90	28.75	10.5	yes	1686	1560	Olsen Canyon (047118g3)	1562	3.93	47.86866	118.33349	400276	5302564	WP-033 Garmin, averaging; took GPS measurement just outside green and white well house for better signal, but vertical elevation still off by about 120 feet. Only way to access this well setup for the Deer Meadows golf course is through a 1" threaded port on the side of the top of the well casing. Used the sonic meter, appeared to work OK.
Royall 1991	2/12/2010	59.41	34.25	4.2	yes	1304	1350	Grand Coulee Dam (047118h8)	1357	3.93	47.93456	118.95539	353955	5310877	WP-034 Garmin, averaging; go all the way down FDR Estates drive to Mike Ianetta's house, walk about 80 yds due west through lawn and trees to flagged bitterbrush with sagebrush all around. No pump; iron top now held down with cobble
Nelson 1968	2/19/2010	131.27	9.00	5.6	yes	1588	1620	Lincoln (047118g4)	1640	3.94	47.81281	118.42562	393272	5296479	WP-035 Garmin, averaging. This is a large irrigation well located just northeast of Welsh Creek Road at the curve close to Redwine Canyon Road. Sonic meter didn't work, just use Etape. This well used to pump 500 gpm,now pumps about 300 GPM due to ?partially plugged screen?
Livingston 1987	3/8/2010	295.00	11.25	4.8	yes	1900	1875	Fort Spokane (047118h3)	1880	3.95	47.87645	118.32402	400999	5303417	WP-049 Garmin, averaging. Well casing is inside green and white pumphouse that is inside fenced boat storage area and is just north of cell phone tower, just west of Miles-Creston Rd. Need to step over pipes, compressor to get to casing in SW corner of pumphouse. GPS reading taken on concrete pad by SW corner of pump house. Need to contact George Livingston Jr. to get access to well.
Davenport Well #2	3/11/2010	136.27	8.25	8.1	yes	2464	2425	Davenport (047118f2)	2421	4.02	47.64940	118.15644	413152	5277982	WP-051 Garmin, averaging. This well is currently not being used and has no pump in it. It is located outside between the south end of the brick pump house and a small red outbuilding at 11th & Washington. In 1948 it was rated at 500 GPM. Sonic meter could not be used because a 2.5 foot diameter cardboard was needed to cover the top of the casing. Doesn't have the normal detailed well log but does have a well video.

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Davenport Well #1	3/11/2010	134.95	7.25	5.8	yes	2430	2425	Davenport (047118f2)	2421	4.03	47.64960	118.15656	413144	5278004	WP-052 Garmin, averaging. This well is not currently being used and has no pump in it. It is located inside the brick pumphouse at 11th and Washington. The GPS measurement was taken on the NE corner of the concrete border around the casing. Fred saw water cascading down the casing. There was a false Etape light and beep that started flickering/wavering at about 86 feet, Turned down sensitivity to get beep on and off at 134.95 feet. Sonic meter could not be used because a 2.5 foot diameter cardboard was needed to cover the top of the casing. Fred noted that this well had been previously measured for many years by Ecology.
ACW361	1/8/2010		24.00	~~60~~	no	~~2270~~	2305				~~47.73908~~	~~118.29548~~	~~402878~~	~~5288114~~	WP-005, location averaging; long steep curvy gravel road to get up the back way on John's Rocky Way to Richardson's house; tape stopped at 408 ft, couldn't reach water; Also, at second 200 ft. well, couldn't get door of pump house open plus it would be hard to get sensor down into casing.
ACW361	3/16/2010	480.80	25.00	7.5	yes	2239	2305	Rocklyn (047118f3)	2312	3.97	47.73896	118.29549	402876	5288100	WP-054 Garmin, averaging. Drove in the back way from Ellis's, drove out the front way, OK. Sonic meter - 480.8 deep, 44 F. Because the well is 590 feet deep, the sonic meter reading is plausible. Measure with sonic meter next month. Because a 4" PVC liner runs from 10 to 590 feet along with the well pipe and cable, it was not worth taking the risk dropping almost all of the 500 ft Etape down the liner to confirm the sonic meter.
AHS539	3/16/2010	47.43	16.50	4.7	yes	1526	1500	Creston (047118g5)	1509	4.01	47.86895	118.52311	386097	5302858	WP-053 Garmin, averaging. Sonic meter - 47.8 feet normal, 44 F. Take north road, better gravel road across ditch from Jump Canyon Rd, continue past Torrison house to cable gate with Weber/Russel on it. Well casing is inside 12" red metal casing with padlock on it. Need 7/16" wrench plus tape and extra nuts.
Hopkins 1991	4/27/2010	32.20	11.00	5.6	yes	1734	1740	Lincoln (047118g4)	1754	3.96	47.78413	118.41568	393958	5293277	WP-061, Garmin averaging. The well casing is south of the house in the horse pasture next to the water troughs. If nobody is home and the horses are in the pasture, walk out to the well to measure. Just use the sonic meter only.

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Stuckle 1979	4/28/2010		13.0	5.5	yes	2415	2370	Rocklyn (047118f3)	2369	4.08	47.65191	118.25833	405505	5278380	WP-062, Garmin averaging. Casing itself is located at the bottom of a round concrete well box between the house and the shop. The top of the port pipe is about 36" below ground level here, so the depth of water below ground surface would be any new sonic meter readings plus 3 feet. The GPS measurement was taken at ground level next to the concrete ring.
AFA197	4/28/2010		37.25	6	yes	2399	2385	Rocklyn (047118f3)	2388	4.07	47.63105	118.27187	404450	5276078	WP-063, Garmin averaging. Well casing is located west of house and east of shop buildings along north side of driveway.
Schneider South Irr	4/28/2010			8.8	yes	2353	2385	Rocklyn (047118f3)	2389	4.07	47.64054	118.28079	403798	5277144	WP-064, Garmin averaging. Well is located in a metal pump house in grass/alfalfa field about 300 ft south of Hwy 2. GPS measurements taken on mainline pipe on east side of pump house for better reception.
Ron Ensor 1965	4/28/2010		3.00	13.3	yes	2378	2365	Rocklyn (047118f3)	2369	4.07	47.63154	118.25662	405597	5276113	WP-065, Garmin averaging. Pump is in metal pumphouse next to power pole at end of winding driveway past red barn and yellow shop. The 2" pipe port goes down at a 45 degree angle for about 3 feet until it meets the casing below the large vertical irrigation pump with drive shaft. Need new sonic meter and/or flexible end Etape to measure this well. The GPS measurement was taken in front of the door on the south side for better reception.
Reinbold 300+ ft	4/28/2010	224.60	12.00	2.4	yes	2566	2545	Inkster Lake (047118g2)	2551	3.99	47.82598	118.23863	407294	5297702	WP-068, Garmin averaging. The well casing is below ground level in a concrete well box below the windmill. Top of casing was measured to be about 42 inches below the ground surface, and so the depth to water will be the sonic meter reading plus 3.5 ft. This older 300+ ft well is about 20 yards north of the newer 715 feet well.

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Reinbold 715 ft	4/28/2010		21.50	6	yes	2557	2545	Inkster Lake (047118g2)	2551	3.99	47.82598	118.23892	407272	5297703	WP-069, Garmin averaging. This well is located in the concrete "well bunker" about 20 yds west of the older 300+ ft. well. The top of the well casing inside the bunker is about 24" below the ground level on the south side of the bunker, and so the depth to water will be the sonic meter reading plus 2 ft. The GPS measurement was taken on top of the dirt mound on top of the "well bunker" about over the top of the well casing for better reception.
Stiles 1987	4/28/2010		7.00	5	yes	2441	2435	Davenport (047118f2)	2437	4.02	47.67201	118.13633	414699	5280472	WP-070, Garmin averaging. This short, older style well cap and casing is located at SE corner of property of first house along Cline Rd, about even with the windbreak.
ABI086	4/29/2010		22.50	5.4	yes	2542	2540	Mondovi (047118f1)	2539	3.98	47.67616	118.01979	423454	5280811	WP-071, Garmin averaging. No well tag was seen on the well casing. Old style iron well cap has 9/16 and 1/2 nuts. Well is east of house and just west of electric fence.

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Dropped Wells Located in Field															
APQ818	12/29/2009			14	yes	1900	1950	Olsen Canyon (047118g3)			47.76509	118.293441	403084	5291003	**DROPPED WELL**; 3 gpm; Tacoma Land Co. well APQ818 dropped due to plugged well at 50.5 feet
AKT389	1/22/2010			7.4	yes	1830	1800	Lincoln (047118g4)	1810	3.95	47.79396	118.42748	393094	5294387	**DROPPED WELL**; WP-014 Garmin, averaging; there is a pressure tank, wires and pipe in the upper well casing, didn't even try to put sensor down well, and probably too much stuff for a sonic meter to work either. Sonic meter tried on 02/19/2010, but it did not work either.

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APC480	1/29/2010														**Dropped Well**; Could not find this well along Partridge Lane; found APP850 and APB748 just uphill from the lane, but these wells were not selected for measurement.
ALN857	1/29/2010		18.50	6.3	yes	1648	1640	Olsen Canyon (047118g3)	1645	3.93	47.77225	118.28897	403427	5291792	**Dropped Well;** WP-026 Garmin, averaging; Etape sensor kept hitting something at 69.3 feet, weight lost/tape started going slack; no pump in well. Try sonic meter
APB747	1/29/2010														**Dropped Well**; Found the well drilling mound above Partridge Lane, which is extensive, but there was no well casing to be found. For well APP846 just downhilll from the APB747 mound, the well cap was just sitting loose on top, and so the iron collar, gasket and cap were reattached
AGG084	1/19/2010		25.75	5.1	yes	2363	2355	Davenport (047118F2)	2359	4.08	47.64635	118.24760	406300	5277748	**Dropped Well**; WP-003 Garmin, averaging; DTW = 140 feet when drilled; tape stopped at 40 ft., couldn't reach water
APC864	1/8/2010		26.00	~~18~~	~~yes~~	~~2382~~					~~47.79516~~	~~118.39241~~	~~395722~~	~~5294474~~	**Dropped Well**; WP-010 Lowrance; tape apparently stopped by pump wiring on tries on north side and middle of casing; tape stopped at 97 ft, couldn't reach water; turn off of Bachelor Flats Rd onto Morain Rd, go past 3 small pull trailers and green fabric Quonset hut to next group of trailers/houses; "Spunky" the neighbor (208 755-8580) lives year round close to the well
APC864	2/19/2010		26.00	5.6	yes	2463	2435	Lincoln (047118g4)	2441	3.96	47.79522	118.39243	395721	5294478	**Dropped Well**; WP-036 Garmin, averaging. Sonic meter would not work in this well either. Drop this well, unless sonic meter can be reconfigured to ignore upper depths of the well
Fink1_16in 506ft	4/28/2010			6.4	yes	2356	2375	Bluestem (047118e2)	2379	4.04	47.60479	118.23913	406864	5273119	WP-066, Garmin averaging. a large vertical irrigation pump with drive shaft sits on top of casing. There is no port to access the casing below the well. This pump hasn't been run in 10 to 20 years and will probably never again. This well is inside a metal A frame pump house at the end of dirt lane that runs north and then east from Old Kuchs Rd. **Drop this well.**

Well Location Worksheet, WRIA 53 Well Water Level Measurement Study 04/29/2010

Well_ID	Date	Depth H2O (feet)	Casing Height (inches)	EPE (feet)	WAAS	Garmin GPS Casing Elevation (feet)	DRG Topo Map Elevation NGVD29 (feet)	DRG Topo Map Name	Garmin Topo Map Ground Elevation NAVD88 (feet)	VERTCON NGVD29 - NAVD88 Elev. Shift (feet)	Latitude Decimal Degrees	Longitude Decimal Degrees	UTM_E (meters)	UTM_N (meters)	Notes
Fink2_6in_165ft_shallow	4/28/2010		34.75	5.6		2337	2375	Bluestem (047118e2)	2379	4.04	47.60469	118.23972	406818	5273110	WP-067, Garmin averaging. This well is located only about 25 yards west of the large irrigation well. No complete fences to keep cows in, doesn't look like well has been used for awhile. **Drop this well.**

Notes: To determine the estimated elevations of the located wells on the topo maps, the coordinates from Garmin eTrex Vista HCx GPS in UTM11, NAD 83 units were added to an ArcGIS 9.2 project, saved as a shape file, transformed to UTM11 NAD 27, and then overlayed on the DRG's (digital raster graphs) of the topo maps for the WRIA 53 area. However, some of the topo maps have 40 foot contours, and only a best guess for the elevation of the land surface at the well site could be determined. But the eTrex Vista with the micro SD card for 1:24K topo maps for Washington and Oregon also reports the elevation off of this electronic topo map for each well elevation that is separate from the elevation recorded on the waypoint. In most cases, the topo elevation from the electronic topo map in the eTrex Vista appears to be the most accurate value for elevation, and thus is best suited for determining the elevation of the ground surface at well sites. The lat/long coordinates for the well locations from the eTrex Vista were then used in the VERTCON website program from NGS (http://www.ngs.noaa.gov/cgi-bin/VERTCON/vert_con.prl) to determine the shift in elevation between NGVD 29 (vertical datum used for the paper topo maps) and NAVD 88, the required vertical datum for the WRIA 53 well water measuring grant. *The vertical elevations from the 1:24K topo maps for Washington and Oregon that are loaded on the micro SD card are already in NAVD 88 vertical datum according to Garmin.

Field Worksheet for WRIA 53 Well Level Measurement Study 04/29/2010

Date	Well ID	Casing Elev.'	Garmin Topo Map Ground Elev.' (NAVD 88)	Casing Height"	Well Depth	Depth to Water When Drilled'	Depth to Water, **Etape'**	Depth to Water, **Sonic Meter'**	Ground** water Table Elev.' (NAVD 88) (Etape; if none, then sonic meter)	Notes
1/8/2010	AHJ350	~~2251~~	2312	24.50	98	22	20.50		2293.54	
3/8/2010	AHJ350	2293	2312	24.50	98	22		21.4	2292.64	sonic meter - 44 F, 21.4 normal mode; not much room between liner and pipe, so Etape not used at end of day today.
4/20/2010	AHJ350	2293	2312	24.50	98	22	20.82	21.5	2293.22	sonic meter - 45 F, normal mode. Found and marked with felt pen an OK spot on WSW side of casing to drop Etape down between PVC casing and pipe.
12/29/2009	APQ814	~~1468~~	1519	24.00	76	35	41.63		1479.37	
2/4/2010	APQ814	1495	1519	24.00	76	35	41.28	41.8	1479.72	sonic meter - 43 F, normal mode
3/8/2010	APQ814	1495	1519	24.00	76	35	40.94	41.6	1480.06	sonic meter - 44 F, normal mode
4/20/2010	APQ814	1495	1519	24.00	76	35	38.78	39.5	1482.22	sonic meter - 45 F, normal mode
1/22/2010	APQ811	1686	1692	18.00	300	140	218.35		1475.15	DTW-ATD was 140, so water level has dropped
2/4/2010	APQ811	1686	1692	19.25	300	140	218.75		1474.85	sonic meter - 43 F, 434.2 deep mode; 5.4 normal mode. Tried several different location from the top of the well casing, but the sonic meter just wouldn't work in this well, perhaps due to 4" PVC liner from 20 to 300 feet. Just use the Etape only on this well
3/8/2010	APQ811	1686	1692	19.25	300	140	218.11		1475.49	sonic meter - 44 F, 5.4 normal mode, 433.6 deep mode. Sonic meter just would not work again. Used flashllight to just barely see that Etape was inside liner at about 20 feet down.
4/20/2010	APQ811	1686	1692	19.25	300	140	217.61		1475.99	sonic meter would not work again in this well
12/29/2009	APQ806	~~2155~~	2198	11.25	420	150	232.20		1966.74	
2/4/2010	APQ806	2185	2198	11.25	420	150	234.91	234.0	1964.03	sonic meter - 43 F, 234.0 deep mode; 233.8 normal mode
3/8/2010	APQ806	2185	2198	11.25	420	150	233.71	232.8	1965.23	sonic meter - 44 F, 232.8 deep mode; 5.4 to 232.6 normal mode
4/20/2010	APQ806	2185	2198	11.25	420	150	232.55	231.8	1966.39	sonic meter - 45 F; 231.8 in both deep and normal mode
1/29/2010	BAC950	2214	2211	18.5	642	540				Depth to Water = 540, well depth = 642 feet; lowered the tape down to 475 feet and then quit, expect the water level to be beyond the 500 feet length of the tape; PVC liner extends all of the way to the surface. The well owners, who live year round in the house just above just bought the lot and this well;
2/4/2010	BAC950	2214	2211	18.5	642	540		508.6	1703.94	sonic meter - 43 F; 508.6 deep mode. Do this well with the sonic meter only; If the depth changes, the measured level probably is the water level
3/8/2010	BAC950	2214	2211	18.5	642	540		508.9	1703.64	sonic meter - 44 F, 508.9 deep mode. Got property access form signed by one of the landowners.
4/20/2010	BAC950	2214	2211	18.5	642	540		508.8	1703.74	sonic meter - 45 F, deep mode

Date	Well ID	Casing Elev.'	Garmin Topo Map Ground Elev.' (NAVD 88)	Casing Height"	Well Depth	Depth to Water When Drilled'	Depth to Water, **Etape'**	Depth to Water, **Sonic Meter'**	Ground** water Table Elev.' (NAVD 88) (Etape; if none, then sonic meter)	Notes
1/22/2010	APB762	2335	2347	9.50	540	240				tape stopped at 431 feet ?hit bottom?, couldn't reach water; no pump in well; DTW was 240, depth 540 ft.
2/4/2010	APB762	2335	2347	9.50	540	240		408.2	1939.59	sonic meter - 43 F, 408.2 deep mode; when the Etape got to about 250 feet, the tape was not stopped but the drag on the tape felt like it was going down between a llner and the casing. Didn't like the way the tape felt, so quit before getting the tape stuck. Only do this well again with sonic meter; if the level changes by several feet or more after several months, than the depth measured could be the depth to water, especially if the measured level is deeper
3/8/2010	APB762	2335	2347	9.50	540	240		408.8	1938.99	sonic meter - 44 F, 408.8 deep mode. Didn't take time to try Etape again.
4/20/2010	APB762	2335	2347	9.50	540	240		409.2	1938.59	sonic meter - 45 F, deep mode. With new flashlight, was able to see that this well also has a PVC liner at about 10 feet. With more time, should try the Etape once again inside the liner.
12/29/2009	APP839	~~2323~~	2382	12.00	300	190	169.00		2214.00	
2/4/2010	APP839	2363	2382	12.00	300	190	168.90	168.7	2214.10	sonic meter - 43 F, 168.7, normal; 332.6, deep
3/8/2010	APP839	2363	2382	12.00	300	190	168.74	168.5	2214.26	sonic meter - 44 F, 168.5 normal; 322.4, deep mode. Had to hold cardboard disk down with fingers to get reading in normal mode. Also used flashlight to confirm Etape was inside liner.
4/20/2010	APP839	2363	2382	12.00	300	190	168.72	168.7	2214.28	sonic meter - 45 F, normal mode. Hade to use meter in the WNW part of the casing in order to get to work; marked with felt pen
12/29/2009	ALN861	~~2054~~	2087	18.50	640	300	24.70		2063.84	
2/4/2010	ALN861	2066	2087	18.50	640	300	23.80	24.4	2064.74	sonic meter - 43 F, 24.4 normal mode
3/8/2010	ALN861	2066	2087	18.50	640	300	23.66	24.6	2064.88	sonic meter - 44 F, 24.6 normal mode. Could see water in well 25 ft down with flashlight.
4/20/2010	ALN861	2066	2087	18.50	640	300	24.15	25.1	2064.39	sonic meter - 45 F, normal mode
12/29/2009	ALN867	~~1735~~	1763	34.00	360	150	272.48		1493.35	
2/4/2010	ALN867	1865	1763	34.00	360	150	270.85	268.8	1494.98	sonic meter - 43 F, 268.8 deep mode; 269.3 normal mode
3/8/2010	ALN867	1865	1763	34.00	360	150	270.03	268.2	1495.80	sonic meter - 44 F, 268.2 deep mode; 268.8 normal mode
4/20/2010	ALN867	1865	1763	34.00	360	150	269.35	267.8	1496.48	sonic meter - 45 F, 267.8 deep mode; 268.2 normal mode
1/29/2010	ALN860	1806	1825	24.50	100	30				DTW = 30 feet, depth = 100 feet. Should have been hit water easily in this shallow well, but tape kept hitting obstructions like rocks starting at 30 feet and then stopped/went slack at 33.57 feet. Try sonic meter

Date	Well ID	Casing Elev.'	Garmin Topo Map Ground Elev.' (NAVD 88)	Casing Height"	Well Depth	Depth to Water When Drilled'	Depth to Water, **Etape'**	Depth to Water, **Sonic Meter'**	Ground** water Table Elev.' (NAVD 88) (Etape; if none, then sonic meter)	Notes
2/4/2010	ALN860	1806	1825	24.50	100	30		43.9	1783.14	sonic meter - 43 F; 43.9 normal mode. Etape got stopped again at about 30.4 feet. Don't know if the 4" PVC liner from 20 - 100 feet is somehow catching the Etape. Just measure with the sonic meter from now on.
3/8/2010	ALN860	1806	1825	24.50	100	30	41.29	42.1	1785.75	sonic meter - 44 F; 42.1 normal mode. This time used the flashlight to see the liner, and also saw water not very far down into the liner. Even with flashlight, it still took several times to get Etape inside liner for once so that the water could be reached. There is granodiorite rock outcrop just uphill.
4/20/2010	ALN860	1806	1825	24.50	100	30	40.65	41.4	1786.39	sonic meter - 45 F, normal mode. Even with the new flashlight, it still took about 5 tries to get the Etape inside the PVC liner at 20 ft down
1/29/2010	ALN853	1610	1603	16.00	680	120	85.25		1519.08	no pump; DTW = 120 ft., well depth = 680 ft.
2/4/2010	ALN853	1610	1603	16.00	680	120	85.03	85.2	1519.30	sonic meter - 43 F, 85.2 normal mode
3/8/2010	ALN853	1610	1603	16.00	680	120	84.27	84.4	1520.06	sonic meter - 44 F, 84.4 normal mode
4/20/2010	ALN853	1610	1603	16.00	680	120	83.18	83.4	1521.15	sonic meter 45 F, normal mode
1/29/2010	BAC967	1606	1568	21.50	412	300				DTW = 300 ft, well depth = 412 feet; this is the backup well on the south side of the pumphouse just west of Airport Way. Already has pump and large 4-5" pipe the wires inside the 10" casing; there is only about 2" space on the east side of casing. Talked to Gene; this well mimics the river level and so decided not to risk getting tape stuck.
2/4/2010	BAC967	1606	1568	21.50	412	300		283.8	1285.99	sonic meter - 43 F, 283.8 deep mode; 5.4 normal mode. Tried several different positions in deep mode and kept getting 283.8 feet. Use the sonic meter on this well, appears to work
3/8/2010	BAC967	1606	1568	21.50	412	300		290.4	1279.39	sonic meter - 44 F, 290.4 deep mode measured in several different spots around the casing. The water level by sonic meter has dropped 6.6 feet compared to 02/04
4/20/2010	BAC967	1606	1568	21.50	412	300		297.4	1272.39	sonic meter - 45 F, deep mode. About 50% more sandy beaches exposed on the west side of Lake Roosevelt.
1/29/2010	AKL333	1689	1676	34.00	447	395				go through black gate, uphill to Y and take right; well casing close to Y. Upper well casing so full of wires and pump pressure switch that the flashlight couldn't see down very far. Wires would only pull up a little and would pull out of the way easily. Try sonic meter
3/8/2010	AKL333	1689	1676	34.00	447	395				The swinging electronic black gate was closed, and so the sonic meter could not be tried today, too far to walk in to well. Drop well?
4/20/2010	AKL333	1689	1676	34.00	447	395		404.4	1274.43	The black gate was open today, and the sonic meter on the S to SW side of the casing appears to give a reasonable water depth reading.

Date	Well ID	Casing Elev.'	Garmin Topo Map Ground Elev.' (NAVD 88)	Casing Height"	Well Depth	Depth to Water When Drilled'	Depth to Water, **Etape'**	Depth to Water, **Sonic Meter'**	Ground** water Table Elev.' (NAVD 88) (Etape; if none, then sonic meter)	Notes
1/29/2010	Johnson 1978	1844	1809	3.00	420					well is off to NW of older blue and white farmhouse just across barbwire fence; turnoff just south of Deer Meadows Rd and go uphill to the farmhouse. A iron plate is welded on top of the well. Since remaining casing is so low to the ground, it would need to be extended upward by several feet or perhaps a sealed port could be cut into the cap to try Etape/sonic meter
2/4/2010	BAF483	1686	1562	28.75	483	303		281.9	1282.50	well is in green and white well house in middle west side of golf course by intermittent pond; need crescent wrench to remove 1" plug to access well. Use sonic meter, appears to work
3/8/2010	BAF483	1686	1562	28.75	483	303		287.8	1276.60	sonic meter - 44 F, 287.8 in both deep mode and normal mode. Water level by sonic meter has dropped 5.9 feet since 02/04. Can see more sandy beaches exposed along Lake Roosevelt, so it looks like the river is being dropped. BAF483 and BAC 967 have dropped fairly similar amounts and appear to be related to the reservoir level. There is a big power cable just below the 1.5" threaded port, and so using the Etape does not seem advisable.
4/20/2010	BAF483	1686	1562	28.75	483	303		293.2	1271.20	sonic meter - 45 F, deep mode. About 50% more sandy beaches exposed on the west side of Lake Roosevelt.
3/8/2010	Livingston 1987	1900	1880	11.25	640	300		295.0	1585.94	sonic meter - 44 F, 295.0 deep mode; 5.0 normal mode. Use the blue plastic plug to measure, most open port down the casing. However, other metal plug gave 295.0 measurement also. Only the sonic meter will work here, as the ports are too small for the Etape. Well casing is inside green and white pumphouse that is inside fenced boat storage area and is just north of cell phone tower, just west of Miles-Creston Rd. Need to step over pipes, compressor to get to casing in SW corner of pumphouse. GPS reading taken on concrete pad by SW corner of pump house. Need to contact George Livingston Jr. to get access to well.
4/20/2010	Livingston 1987	1900	1880	11.25	640	300		295.2	1585.74	sonic meter - 45 F, deep mode
May-05	Palanuk 1984	1595	1614	6.00			235.00		1379.50	1984 well depth was 230 ft, with water at 200 ft. Well was deepened to 335 ft. in 2005; well owner measured with own Etape
Sep-05	Palanuk 1984	1595	1614	6.00	335		277.00		1337.50	well owner measured with own Etape;
Sep-05	Palanuk 1984	1595	1614	6.00	335		279.00		1335.50	well owner measured with own Etape; after well was pumped hard for 6 hours
3/15/2006	Palanuk 1984	1595	1614	6.00	335		226.00		1388.50	well owner measured with own Etape
Jul-06	Palanuk 1984	1595	1614	6.00	335		249.00		1365.50	well owner measured with own Etape
5/19/2007	Palanuk 1984	1595	1614	6.00	335		235.00		1379.50	well owner measured with own Etape
Jul-07	Palanuk 1984	1595	1614	6.00	335		271.00		1343.50	well owner measured with own Etape; with pump running

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Jul-07	Palanuk 1984	1595	1614	6.00	335		264.00		1350.50	well owner measured with own Etape; with pump off
7/13/2008	Palanuk 1984	1595	1614	6.00	335		274.00		1340.50	well owner measured with own Etape; after pump run all night
1/19/2010	Palanuk 1984	1595	1614	6.00	335					tape stopped at 68 feet first try, 110 feet second try; couldn't reach water
2/12/2010	Palanuk 1984	1595	1614	6.00	335			231.5	1383.00	sonic meter - 43 F (should have been 45 F, but not much difference) 231.50, deep mode, appears to be reasonable measurement; 5.0 normal mode; had to try different areas to get 231.50 multiple times, but sometimes read 1200 - 1600 feet in deep mode. Etape was not used, too much cable in upper well casing.
3/9/2010	Palanuk 1984	1595	1614	6.00	335			232.8	1381.70	sonic meter - 47 F, deep mode, 5.0 normal. Marvin pulled the top wires out and tried his Etape, but he couldn't get it measure water depth. His tape also got temporarily hung up at 240 and 200 feet on the way out.
4/22/2010	Palanuk 1984	1595	1614	6.00	335		249.2 ??	232.9	1381.60	sonic meter - 49 F, deep mode on SW side of casing. Marvin used his own Etape, which read 249.20 feet to water. This leads to a 16+ difference between Marvin's Etape and the sonic meter. The sonic meter is usually with 1 to 2 feet or less of the District's Etape reading. Marvin's eTape may or may not be right on the actual water depth; it got caught up temporarily again at 233 feet. Marvin pulled up his Etape to about 220 feet and is leaving it in the well for easier measuring next time.
1/19/2010	AHC421	1551	1582	17.50	255	205	233.00		1350.46	
2/12/2010	AHC421	1551	1582	17.50	255	205	230.58	227.6	1352.88	sonic meter - 43 F (should have been 45 F, but not much difference) 227.6 deep mode, 227.9 normal mode. The AHC421 tag is on the well
3/9/2010	AHC421	1551	1582	17.50	255	205	230.43	228.4	1353.03	sonic meter - 47 F, 228.4 deep mode; 228.6 normal mode
4/22/2010	AHC421	1551	1582	17.50	255	205	229.77	228.2	1353.69	sonic meter - 49 F; 228.2 deep mode, 228.6 normal mode
1/19/2010	AHC420	1516	1554	32.50	300	130	187.00		1369.71	
2/12/2010	AHC420	1516	1554	32.50	300	130	183.75	182.5	1372.96	sonic meter - reset to 45 F for region 7, Grand Coulee dam area; 182.5 normal. Initially tried at 43 F - 181.2 normal, 363.3 deep
3/9/2010	AHC420	1516	1554	32.50	300	130	181.21	180.4	1375.50	sonic meter - 47 F, 180.4 normal mode; 360.0 deep mode
4/22/2010	AHC420	1516	1554	32.50	300	130	177.46	176.8	1379.25	sonic meter - 49 F, normal mode
1/19/2010	APC865	1525	1542	34.00	404	244	272.30		1272.53	
2/12/2010	APC865	1525	1542	34.00	404	244	260.00	258.4	1284.83	sonic meter - 45 F; 258.40 normal mode. The well owner marked the top of casing/collar with red pencil, only run the Etape down here at the red pencil to avoid getting hung up on the poor job of taping the pump wires to the pump pipe
3/9/2010	APC865	1525	1542	34.00	404	244	244.22	243.2	1300.61	sonic meter - 47 F, 243.2 deep mode; 5.5 normal mode

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4/22/2010	APC865	1525	1542	34.00	404	244		259.2	1285.63	sonic meter - 49 F, deep mode. The Etape got stopped twice at about 180 feet on the NE side of the casing where the tape had dropped down OK the previous 3 times. Unable to reach water with the Etape, try again in May. The sonic meter reading should be within 1 - 2 feet of what the Etape would have measured.
2/12/2010	Royall 1991	1304	1357	34.25	198	105	59.41	59.4	1300.44	need to drive to Mike Ianetta's house, walk about 80 yds due west through lawn and trees to flagged bitterbrush with sagebrush all around. No pump; iron top now held down with large cobble.
3/9/2010	Royall 1991	1304	1357	34.25	198	105	64.80	64.9	1295.05	sonic meter - 47 F, 64.9 normal mode. This well has dropped 5.39 feet since February, which corresponds to the sandy beaches exposed now along the south side of the river.
4/22/2010	Royall 1991	1304	1357	34.25	198	105	71.07	71.1	1288.78	sonic meter - 49 F, normal mode. Note: On the nearby bedrock shoreline, the current water level is about 15 to 20 feet down from the high water mark.
1/19/2010	BBH538	1357	1368	25.75	165	91	77.73		1292.42	
2/12/2010	BBH538	1357	1368	25.75	165	91	81.80	80.9	1288.35	sonic meter - 45 F, 80.90, normal mode; a pump, pipe and wires are now installed; only put the Etape down the casing side next to wire input from outside to avoid any cables.
3/9/2010	BBH538	1357	1368	25.75	165	91	86.85	86.6	1283.30	sonic meter - 47 F, 86.6 normal mode. This well has dropped 5.05 feet since February, appears to be related to the drop in river level with more sandy beaches exposed on the south side.
4/22/2010	BBH538	1357	1368	25.75	165	91	94.79	94.5	1275.36	sonic meter - 49 F, normal mode. This well's water levels seem to be pretty closely tied to the level of Lake Roosevelt
1/19/2010	BAC955	1817	1846	22.00	228	170	149.70		1698.13	
2/12/2010	BAC955	1817	1846	22.00	228	170	150.22	149.8	1697.61	sonic meter - 45 F, 149.8 normal mode
3/9/2010	BAC955	1817	1846	22.00	228	170	150.30	150.2	1697.53	sonic meter - 47 F, 150.2 normal mode; 299.2 deep mode
4/22/2010	BAC955	1817	1846	22.00	228	170	150.15	150.3	1697.68	sonic meter - 49 F, normal mode
1/19/2010	APF669	1831	1849	22.50	200	160	150.70		1700.18	
2/12/2010	APF669	1831	1849	22.50	200	160	150.40	149.7	1700.48	sonic meter - 45 F, 149.7 normal mode
3/9/2010	APF669	1831	1849	22.50	200	160	150.45	150.0	1700.43	sonic meter - 47 F, 150.0 normal mode
4/22/2010	APF669	1831	1849	22.50	200	160	150.38	150.2	1700.50	sonic meter - 49 F, normal mode
1/22/2010	ABQ390	1521	1529	14.50	410	275				well tag on casing, couldn't find it on Ecology website; tape stopped for awhile at 40, 65, and finally 102.5 ft, sounded like metal; couldn't reach water; stuck temporarily on way out; try sonic meter next time

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2/12/2010	ABQ390	1521	1529	14.50	410	275		243.2	1287.01	sonic meter - 43 F, 243.2 deep mode, 5.4 normal. 243.2 appears to be reasonable for water level, try sonic meter again to see if measurement changes.
3/9/2010	ABQ390	1521	1529	14.50	410	275		248.8	1281.41	sonic meter - 44 F, 248.8 deep mode; also tried at 47 F, 249.4 deep mode. Keller Ferry is close to the region 9 / region 7 line on the sonic meter map for temperature adjustment. This well has dropped about 5.6 feet, which corresponds to the stony bars now exposed on the north side of the river.
4/22/2010	ABQ390	1521	1529	14.50	410	275		256.5	1273.71	sonic meter - 256.5 ft, 49 F, deep mode. Since it has been warm here recently, the 49 F temp setting for Zone 7 is probably more accurate. In comparison, 45 F and deep mode for Zone 9 (cooler zone to east) read 255.5 ft, which is only 1 foot difference for 4 degrees difference in temp setting on the sonic meter. Roger reports that the reservoir level several days ago was down 17 feet from its high point this season, and so this well is falling with the river also.
1/19/2010	Didrickson 1982	2643	2658	17.00	353					Etape stopped at 240 ft, then stuck at 140 ft; never reached water
2/12/2010	Didrickson 1982	2643	2658	17.00	353			231.2	2428.22	sonic meter 43 F, 231.2 deep mode; 5.4 normal mode. Etape not used due to other Etape still stuck in well. Ask the well owner if 231.2 ft. seems believablefor water level. If so, try sonic meter again, see if measurement changes. But Etape got to 240 feet last time without reaching water.
3/9/2010	Didrickson 1982	2643	2658	17.00	353			231.6	2427.82	sonic meter - 44 F, 231.6 deep mode. It seems unlikely that the measurement is reflecting off of the water surface but is instead reflecting off of something else in the well at about 231 feet.
4/22/2010	Didrickson 1982	2643	2658	17.00	353			231.8	2427.62	sonic meter - 45 F, deep mode. Keep on measuring this well? Sonic meter may not be reflecting the water level, which should be significantly deeper.
3/16/2010	AHS539	1526	1509	16.50	100	60	47.43	47.8	1462.95	WP-053 Garmin, averaging. Sonic meter - 47.8 feet normal, 44 F. Take north road, better gravel road across ditch from Jump Canyon Rd, continue past Torrison house to cable gate with Weber/Russel on it. Well casing is inside 12" red metal casing with padlock on it. Need 7/16" wrench plus tape and extra nuts.
4/22/2010	AHS539	1526	1509	16.50	100	60	48.74	49.1	1461.64	sonic meter - 45 F, normal mode. Note: As with March, the sonic meter and Etape measurements are taken from the top of the 6" casing, and not the top of the 12" outer casing.

Date	Well ID	Casing Elev.'	Garmin Topo Map Ground Elev.' (NAVD 88)	Casing Height"	Well Depth	Depth to Water When Drilled'	Depth to Water, **Etape'**	Depth to Water, **Sonic Meter'**	Ground** water Table Elev.' (NAVD 88) (Etape; if none, then sonic meter)	Notes
3/11/2010	Davenport Well #2	2464	2421	8.25	503	172	136.27		2285.42	WP-051 Garmin, averaging. This well is currently not being used and has no pump in it. It is located outside between the south end of the brick pump house and a small red outbuilding at 11th & Washington. In 1948 it was rated at 500 GPM. Sonic meter could not be used because a 2.5 foot diameter cardboard was needed to cover the top of the casing. Doesn't have the normal detailed well log but does have a well video.
4/27/2010	Davenport Well #2	2464	2421	8.25	503	172	135.90		2285.79	sonic meter would not work on this big and empty 15" casing well, even with large piece of cardboard on top; meter read 4.9 ft. normal mode, 241 ft. deep mode, which are both incorrect readings. Etape had weak, wavering beep with cascading water at about 100 feet, had to turn down sensitivity quite a bit to get beep off and on at 135.90 ft.
3/11/2010	Davenport Well #1	2430	2421	7.25	?	?	134.95		2286.65	WP-052 Garmin, averaging. This well is not currently being used and has no pump in it. It is located inside the brick pumphouse at 11th and Washington. The GPS measurement was taken on the NE corner of the concrete border around the casing. Fred saw water cascading down the casing. There was a false Etape light and beep that started flickering/wavering at about 86 feet, Turned down sensitivity to get beep on and off at 134.95 feet. Sonic meter could not be used because a 2.5 foot diameter cardboard was needed to cover the top of the casing. Fred noted that this well had been previously measured for many years by Ecology.
4/27/2010	Davenport Well #1	2430	2421	7.25	?	?	135.60		2286.00	sonic meter would not work on this big and empty 15" casing well either, even with large piece of cardboard on top; meter read 5.4 ft. normal mode, 271 ft. deep mode, which are both incorrect readings. Etape had weak, wavering beep with cascading water from 73 ft down to 135 ft, had to turn down sensitivity quite a bit to get beep off and on at 135.60 ft. With new flashlight, could see stream of water coming in from the SE side of the casing at about 73 feet. Ran the Etap down the opposite NW side, but cascading water still affected the tape.
1/22/2010	BBH041	1577	1601	27.75	92	54	55.20		1548.11	well tag on casing, couldn't find it on Ecology website; no pump in well, not being used for now
2/19/2010	BBH041	1577	1601	27.75	92	54	55.13	55.2	1548.18	sonic meter - 43 F, 55.2 normal mode, 225.2 deep mode
3/16/2010	BBH041	1577	1601	27.75	92	54	55.05	55.4	1548.26	sonic meter - 55.4 normal mode, 44 F. Was able to get hard copy of well log.
4/27/2010	BBH041	1577	1601	27.75	92	54	54.98	55.2	1548.33	sonic meter - 45 F, normal mode

Date	Well ID	Casing Elev.'	Garmin Topo Map Ground Elev.' (NAVD 88)	Casing Height"	Well Depth	Depth to Water When Drilled'	Depth to Water, **Etape'**	Depth to Water, **Sonic Meter'**	Ground** water Table Elev.' (NAVD 88) (Etape; if none, then sonic meter)	Notes
2/19/2010	Nelson 1968	1588	1640	9.00	240	145	131.27		1509.48	sonic meter - 43 F, 262.0 deep mode. Sonic meter just didn't work on this well through the 1" threaded port, just use Etape
3/16/2010	Nelson 1968	1588	1640	9.00	240	145	130.92		1509.83	sonic meter - 5.2 normal mode, 44 F. Sonic meter just won't in this well.
4/27/2010	Nelson 1968	1588	1640	9.00	240	145	129.88		1510.87	sonic meter would not work, 5.9 ft normal mode, 268 ft deep mode. This irrigation well was not running. The pump looks to be a submersible pump and not driven by a shaft, so it may possible to use Etape with it running in May & June.
4/27/2010	Hopkins 1991	1734	1754	11.00	125	30		32.2	1722.72	sonic meter - 45 F, normal mode. Upper 5 to 10 feet of casing is full of wires, pipe and yellow air hose, can't even see the new pressure tank in the casing below. Way too much stuff in the casing to use the Etape, but the sonic meter measurement appears to be reasonable. The well casing is south of the house in the horse pasture next to the water troughs. If nobody is home and the horses are in the pasture, walk out to the well to measure. Just use the sonic meter only.
1/8/2010	BAC976	~~2360~~	2421	11.00	502	290				tape went slack at 300 ft, couldn't reach water
2/19/2010	BAC976	2442	2421	11.00	502	290	292.15	290.6	2129.77	sonic meter - 43 F, 290.6 deep mode, 5.4 normal mode. Used flashlight to confirm that Etape was inside liner
3/16/2010	BAC976	2442	2421	11.00	502	290	292.17	291.2	2129.75	sonic meter - 291.2 deep mode, 44 F
4/27/2010	BAC976	2442	2421	11.00	502	290	292.36	291.5	2129.56	sonic meter - 45 F, deep mode
1/8/2010	BAS262	~~2404~~	2444	15.50	362	304	247.00		2198.29	There are valid concerns that the 247.00 measurement on this date is **NOT** accurate, after having initial continuous tape beep again at 244 ft, with final OK measurement at 284.60 feet (Etape beeped on and off, as expected) and correlation with sonic meter at 283.1 ft. on 02/19/2010. Also, the amount of rust on Etape on 01/08/2010 may indicate that tape was between the liner and the casing and not inside the liner.
2/19/2010	BAS262	2433	2444	15.50	362	304	284.60	283.1	2160.69	sonic meter - 43 F, 283.1 deep, south side; 5.2 normal. This well is tricky to measure with Etape. Used flashlight to confirm tape inside 4" PVC liner. Etape started continuous beep at about 244 feet, but turned sensitivity down, got Etape to beep off and on as expected, at 284.60 feet, so measurement seems valid. Note - much of the Etape got wet from this well.
3/16/2010	BAS262	2433	2444	15.50	362	304	284.29	283.2	2161.00	sonic meter - 283.2 deep mode, 44 F. Could here a trickle of water cascading down well again, but was able to have the sensitivity on the Etape turned up all the way down.

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4/27/2010	BAS262	2433	2444	15.50	362	304		283.3	2161.99	sonic meter - 45 F, deep mode. Note: A pump, piping and wiring have now been installed in this well along with pressure tank. There is only about a 1" gap on the south side of the PVC liner. Not worth trying to get the Etape down almost 300 feet when the sonic meter readings on the south side of the casing still appear to be very close to what the Etape would read.
1/8/2010	BAC970	~~2422~~	2469	12.00	242	138	100.00		2370.00	about 100 ft to water; tape wouldn't stop beeping due to sediment in probe sensor. There are valid concerns that the 100.00 measurement on this date is **NOT** accurate, due to OK measurement of 142.01 ft on 02/19 and intitial static water level of 138 feet.
2/19/2010	BAC970	2487	2469	12.00	242	138	142.01		2327.99	sonic meter - 43 F, 271.6 deep mode, 5.2 normal mode. The sonic meter just wouldn't work in this well. This well is tricky to measure with Etape. Used flashlight to confirm tape inside 4" PVC liner. Etape went past 150 feet without beeping with sensitivity on just enough to beep with button. Turned sensitivity up, reeled back up to 140 feet until tape stopped beeping, then got tape to beep off and on as expected at 142.01 feet. Measurement seems valid with initial water level at 138 feet.
3/16/2010	BAC970	2487	2469	12.00	242	138	141.90		2328.10	sonic meter - 5.2 normal mode, 271.9 deep mode. Sonic meter just won't work on this well. Was able to leave Etape sensivity up all the way down this time.
4/27/2010	BAC970	2487	2469	12.00	242	138	141.85		2328.15	sonic meter would not work again
1/8/2010	BAC969	~~2411~~	2458	17.25	360	182	176.50		2282.94	
2/19/2010	BAC969	2490	2458	17.25	360	182	176.54	175.6	2282.90	sonic meter - 43 F, 175.6 normal, 352.8 deep. The liner almost to top of well is iron, not PVC
3/16/2010	BAC969	2490	2458	17.25	360	182	176.73	176.0	2282.71	sonic meter - 176.0 normal mode, 44 F
4/27/2010	BAC969	2490	2458	17.25	360	182	176.41	176.0	2283.03	sonic meter - 45 F, normal mode
1/8/2010	AHC407	~~1630~~	1702	35.00	160	120	72.70		1632.22	
2/19/2010	AHC407	1690	1702	35.00	160	120		66.5	1638.42	sonic meter - 43 F, 66.5 normal mode, 225.9 deep mode; tried twice with Etape, couldn't get tape into liner, and not much room inside liner with pipe and wires. Both times at opposite sides of well, stopped at about 40 feet between liner and casing. Ask where the first Etape measurement was done.
3/16/2010	AHC407	1690	1702	35.00	160	120	64.61	65.2	1640.31	sonic meter - 65.2 normal mode, 44 F. Found good spot on N/NE side of casing to drop Etape down with no obstructions. Only drop the Etape down where marked.
4/27/2010	AHC407	1690	1702	35.00	160	120	67.65	68.2	1637.27	sonic meter - 45 F, normal mode
1/8/2010	Ellis 1977	~~1692~~	1730	13.00	7	2	4.70		1726.38	

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2/19/2010	Ellis 1977	1748	1730	13.00	7	2	4.15		1726.93	sonic meter - 43 F, 5.0 to 5.4 ft. normal mode; couldn't really cover the small irregular opening, so meter really didn't work so well
3/16/2010	Ellis 1977	1748	1730	13.00	7	2	4.16		1726.92	sonic meter - 5.4 normal mode, 44 F. Sonic meter just isn't going to work.
4/27/2010	Ellis 1977	1748	1730	13.00	7	2	4.27		1726.81	didn't try sonic meter, as it doesn't work in this shallow well
1/8/2010	ACW361	~~2270~~		24.00	590	453				Etape stopped at 408 ft, couldn't reach water; long, potentially treacherous route to get to the well using the back way in with snow/slick roads
3/16/2010	ACW361	2239	2312	25.00	590	453		480.8	1833.28	WP-054 Garmin, averaging. Drove in the back way from Ellis's, drove out the front way, OK. Sonic meter - 480.8 deep, 44 F. Because the well is 590 feet deep, the sonic meter reading is plausible. Measure with sonic meter next month. Because a 4" PVC liner runs from 10 to 590 feet along with the well pipe and cable, it was not worth taking the risk dropping almost all of the 500 ft Etape down the liner to confirm the sonic meter.
4/27/2010	ACW361	2239	2312	25.00	590	453		479.7	1834.38	sonic meter - 45 F, deep mode. Note: There was a significant breeze blowing out of the well casing all of the time while at the well today. The breeze coming up out of the well casing and coming out of the vent holes on the underside of the well cap was enough to blow the grass at the base of the casing. The breeze interfered with sonic meter reading, but after trial and error, folding up a small part of the cardboard along the edge would let enough breeze out of the casing to get readings of 479.7 and 479.6 five to six different times, and so this may be the water level. However, the sonic meter would also bounce around up to 1200 and 1600 plus ft. and also go as low as 200 and 500 plus ft. Not worth dropping the Etape down an estimated 480 ft within the small gap between the PVC liner and the pipe. The breeze from the well might be generated by an underground cave in the basalt which is being refilled with water and is pushing a substantial amount of air out of the well.
1/22/2010	Platt 1992	2530	2520	9.00	180	145	141.35		2379.40	take cap off, pull wires out of way, put tape down west side of well; sounded like water cascading down well
3/16/2010	Platt 1992	2530	2520	9.00	180	145				sonic meter - 6.1 normal, 279.1 deep. Sonic meter would just not work on this well. Could here a substantial stream of water cascasing down the well, starting about 27-28 feet on the Etape. Tried two times to get Etape down W side of well, but was stopped by basalt at 36-38 feet. Same result on the south side of well. Tried the north side of well, felt drag at 73, 80 and 93 feet before giving up, got temporarily hung up at 25 feet on the way out.

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4/27/2010	Platt 1992	2530	2520	9.00	180	145				sonic meter would not work again, 6.2 ft normal mode, 279.0 ft deep mode. Used new flashlight, but could not see any good open area to drop Etape down. Tried once again on West side of casing, but stopped again at 37 feet. Cascading water caused wavering beep from about 27-28 feet down to 37 feet. Could hear the cascading water, but couldn't see it, and could also not see the liner that is supposed to be in the well. Need new sonic meter to ignore the top 50 to 100 feet of the well.
4/28/2010	Stuckle 1979	2415	2369	13.00	185	60				sonic meter would not work through the 1" port pipe; 45 F, 6.0 ft normal mode, 287.1 deep. Port not big enough to use Etape in 6" casing. Casing itself is located at the bottom of a round concrete well box between the house and the shop. The top of the port pipe is about 36" below ground level here, so the groundwater elevation would be the new sonic meter reading plus 3 feet, subtracted from the Garmin topo map ground elevation. The GPS measurement was taken at ground level next to the concrete ring. Have to remove wooden lid and step on blue pressure tank to get to bottom of well box. Don't step on plastic pipe fittings.
4/28/2010	AFA197	2399	2388	37.25	180	150				sonic meter would not work; 45 F, 5.4 ft normal, 1200-1600 deep mode. Difficult to try to get Etape inside liner on south side 17 ft down. Couldn't tell for sure if Etape inside liner, but got stopped and hung up a little bit at 41 feet.. Need new sonic meter to disregard top 50 or so feet of well.
4/28/2010	Schneider South Irr	2353	2389		400	66				a large vertical irrigation pump with drive shaft sits on top of casing. There is no port to access the inner casing. There is an air pressure line that might be able to be used when the pump is running later in the season. The well is inside a tin roof well house at the west edge of grass/alfalfa field about 300 ft south of Hwy 2

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4/28/2010	Ron Ensor 1965	2378	2369	3.00	324	37				a large vertical irrigation pump with drive shaft sits on top of casing. An 2" port at a 45 degree angle gives access to the casing below the pump. Sonic meter would not work in port; 45 F, 5.4 ft normal, 1200 ft deep mode. Etape only made it 3 feet down port pipe until the long metal sensor could not make the corner to go down the casing. WSU did measure this well through the port in the past with a different type of Etape, but stopped taking measurements because the water level never changed much. Currently, it sounds like the irrigation wells north of Hwy 2 have declining water levels. Ensors would really like to measure this well with a new sonic meter before and after irrigation season. Pump is in metal pumphouse next to power pole at end of winding driveway past red barn and yellow shop.
4/28/2010	Reinbold 715 ft	2557	2551	21.50	715	NA		402.4	??	sonic meter - 45 F, first 402.4 ft, then 580.3 feet, then 402.4 ft afterwards. Sonic meter just fit through 5/8" port on top of the casing; Etape will not work here. Question on which measurement is more likely to be the water level. How could the meter go through water to get the 580.3 ft. depth? But the 402.4 ft depth was the most repeatable. Is this some other non-water feature in the well? No well log could be found, but the well owner says there was about 20 ft of loess over 300-400 ft of basalt over ancient river gravel over granitic bedrock. This well was only drilled after the well in the Atlas missile site a mile to the east was drilled and took most of the water away from the older 300 plus ft well. After the missile base was closed down, the water returned to the older 300+ ft well, and so this newer and deeper 715 feet well has not been used in 5 years due to the low water yield and high carbonates in the water. This well is located in the concrete "well bunker" about 20 yds west of the older 300+ ft. well. The top of the well casing inside the bunker is about 24" below the ground level on the south side of the bunker, and so the depth to water will be the sonic meter reading plus 2 ft. Need to run old sonic meter or new sonic meter to confirm depth measurement.
4/28/2010	Reinbold 300+ ft	2566	2551	12.00	300+	NA		224.6	2322.90	sonic meter - 45 F, deep mode, consistent measurement made through 5/8" port with blue plug. Etape will not work here. The well casing is below ground level in a concrete well box below the windmill. Top of casing was measured to be about 42 inches below the ground surface, and so the groundwater elevation will be the sonic meter reading plus 3.5 ft, subtracted from the Garmin topo map ground elevation. This well is used to supply house water. This older well regained its water after the Atlas missile base 1 mile to the east was closed down. There is no well log available. The well depth could be 325 ft or could be 425 or 465 ft.
4/28/2010	Stiles 1987	2441	2437	7.00	79	NA				This short, older style well cap and casing is located at SE corner of property of first house along Cline Rd, about even with the windbreak. Four of the cap bolts had nuts siezed on them that WD-40 could not loosen right away. Come back in several days with replacement bolts in case the bolts twist off.
4/29/2010	Stiles 1987	2441	2437	7.00	79	NA	25.85	26.4	2411.73	sonic meter - 45 F, normal mode. Open spot, can see water at bottom of casing next to south side of casing. No PVC liner, so sonic meter actually worked. Replaced 4 of the bolts on the cap with hard or siezed nuts. PVC pipe with power cord in it was full of water, notified well owner.

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4/29/2010	ABI086	2542	2539	22.50	245	70	64.69		2476.19	sonic meter - 45 F, 5.4 normal, 235.5 deep. Sonic meter just would not work in this well with the PVC liner. PVC liner at 17 feet looked full with the pipe and wire, but was able to get Etape down in the NW side of liner the first time. Went down slow, felt no obstructions down to the water, but was hung up for a very little bit at about 23 feet. coming back up. Need to go slow down and back up this well. Old style iron well cap has 9/16 and 1/2 nuts. Well is east of house and just west of electric fence.

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Dropped Wells Visited in Field										
12/29/2009	APQ818	1900			680	120				**Dropped well;** tape stopped by plugged well at 50.5 ft, couldn't reach water
1/22/2101	AKT389	1830	1810		180	135				**Dropped well;** pressure tank, wires, and pipe in casing, way too much stuff in casing to use Etape and probably sonic meter also.
2/19/2010	AKT389	1830	1810		180	135				Dropped well; sonic meter - 43 F, 254.9 deep mode, 6.0 normal mode. Sonic meter would also not work in this well either. Drop well for good, unless meter can be adjusted to ignore upper depths.
1/29/2010	ALN857	1648	1645	18.50	220	40				**Dropped well**; Etape sensor kept hitting something at 69.3 feet, weight lost/tape started going slack; no pump in well. Try sonic meter
2/4/2010	ALN857	1648	1645	18.50	220	40				**Dropped well;** sonic meter - 43 F, 5.4 normal mode; 244.4 deep mode. The sonic meter just wouldn't work in this well, perhaps due to 4" PVC liner from 40 to 220 feet. The well is only 220 feet deep, and DTW-ATD was 40 feet. The Etape got stopped again at 70.4 feet without reaching water. Something is wrong with this well, drop it.
1/29/2010	APC480									**Dropped Well**; Could not find this well along Partridge Lane; found APP850 and APB748 just uphill from the lane, but these wells were not selected for measurement.
1/29/2010	APB747									**Dropped Well**; Found the well drilling mound above Partridge Lane, which is extensive, but there was no well casing to be found.
1/19/2010	AGG084	2363	2359	25.75	260	140				**Dropped Well;** tape stopped at 40 ft, couldn't reach water

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2/12/2010	AGG084	2363	2359	25.75	260	140				**Dropped Well:** sonic meter - 43 F, 272. 4 deep mode, 5.0 normal mode. The sonic meter just would not work for this well, and it would not go into setup mode to work around this either. There is a 4" PVC liner from 10 to 260 feet. Drop this well.
1/8/2010	APC864	2382	2441	26.00	178	101				tape stopped at 97 ft due to wires, couldn't reach water
2/19/2010	APC864	2463	2441	26.00	178	101				sonic meter - 43 F, 6.1 normal mode, 238.7 deep mode. Sonic meter just won't work in this well either. Drop this well, unless sonic meter can ever be adjusted to ignore the upper depths.
4/28/2010	Fink1_16in 506ft	2356	2379		506	NA				a large vertical irrigation pump with drive shaft sits on top of casing. There is no port to access the casing below the well. This pump hasn't been run in 10 to 20 years and will probably never again. This well is inside a metal A frame pump house at the end of dirt lane that runs north and then east from Old Kuchs Rd. Drop this well.
4/28/2010	Fink2_6in_165ft _shallow	2337	2379	34.75	165	50				the sonic meter could not fit down into the 1/2" port and did not work; 45 F, 5.4 ft normal, 272 feet deep. The Etape would not fit through port, not useable here. Tried to take off south half of metal cover plate but 1 bolt was froze up. This well is located only about 25 yards west of the large irrigation well. No complete fences to keep cows in, doesn't look like well has been used for awhile. Drop this well.

Note - the ground water table elevation is calculated from the following formula: Ground water table elevation = Garmin topo map ground elevation - (Etape measured distance [or sonic meter measured distance if there is no Etape measured distance] minus the casing height converted to feet). For example, for the first measurement in row 3, ground water table elevation = D3 - [H3 - (E3/12.00)]. The Garmin topo map ground elevation that is recorded for each well casing waypoint is used because it is much more reliable and accurate than the elevation reading from the Garmin eTrex Vista HCx GPS unit placed on top of the well casing, and because the Garmin topo map elevations are already reported in the NAVD 88 vertical datum.