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HYDROGEOLOGIC ANALYSIS OF THE EASTERN AND SOUTHERN PORTIONS OF THE LEWISTON PLATEAU GROUND WATER MANAGEMENT AREA, IDAHO

PROGRESS REPORT AND REQUEST FOR SECOND YEAR FUNDING

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Submitted to the Idaho Department of Water Resources

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EXECUTIVE SUMMARY

The purpose of this project is to assess whether deep basalt aquifers within the Grande Ronde Formation underlying areas A-1 and B of the Lewiston Plateau ground-water management area (GWMA) are a viable resource for long-term ground-water development (Figure 1) . The current ground-water management plan requires new wells to be constructed into the regional aquifer which requires in many cases that new wells must be 1,000 feet or deeper. The objectives of the study are to determine whether the deep aquifers underlying area A-1 are recharged from surface water sources (Clearwater River and/or Lapwai Creek) and to gain an improved understanding of shallow and deep ground water underlying area B in the southern portion of the GWMA. The project approach involves using chemical analysis of rock (cutting) samples taken from wells during drilling to link aquifers to specific areas where these geologic units outcrop under surface water systems. The hydraulic link between the surface water and the aquifer penetrated by a specific well can be confirmed by comparing ground-water level elevations and analysis of ground-water responses to major surface water flood events.

The achievements of the project since it began in May 2016 include adding 16 monitoring wells to the Idaho Department of Water Resources (IDWR) network with most of these wells located along either the Clearwater River or Lapwai Creek. Data loggers are installed in all but one of these wells. Chemical analysis of rock cutting samples has been accomplished and interpreted for 42 samples taken from 7 wells. These data allow investigators to link specific aquifers penetrated by wells to areas where the same rock unit outcrops under either the Clearwater River or Lapwai Creek. Water-level elevation data from the wells and streams are used to determine whether an outcrop area along a stream can be a recharge area for an aquifer penetrated by the well. The most important water-level data gained from the data loggers occurs during high flow events in the surface water systems. The timing of the project is fortunate because 2017 is a very high runoff year. However, the end of the first year of the project (April 30, 2017) occurs during the runoff period.

Analysis of results to date show that the Clearwater River is hydraulically connected to aquifers within the Grande Ronde Basalt formation at two locations: 1) near the north end of Lapwai Valley and 2) near the Casino which is about half way between Lewiston and the Lapwai Valley. Water-level data from the complete set of monitoring wells during the 2017 runoff event will allow a much more extensive analysis of the area.

Activities during the second year of the project will include: 1) analysis of water-level data collected from wells during the 2017 runoff event; 2) construction of boreholes at selected locations along the Clearwater River to provide additional samples for rock chemistry analysis; 3) interpretation of the resultant rock chemistry data; 4) geologic field work along the Clearwater River and portions of area B; and 5) preparation of a final project report.

The proposed budget for the second and final year of the project is $50,000 to support work by Dr. Dale R. Ralston and field geologist, Dean Garwood. The resulting report will provide a detailed assessment of recharge to individual basalt aquifers in areas A-1 and B within the GWMA. Recommendations will be provided for ongoing data collection programs and also for potential changes to the management program for the Lewiston GWMA. This proposed scope of work and budget is based on the assumption that IDWR will have funding for drilling boreholes, installing tubing in existing wells for monitoring and providing field equipment, particularly data loggers and access to a 1,500-foot electric tape.

INTRODUCTION

Shallow basalt aquifers in areas A and A-1 of the Lewiston Plateau Ground Water Management Area (GWMA) have had problems of historic ground-water level decline (Figure 1). These aquifers occur mostly in the Saddle Mountains and Wanapum Formations of the Columbia River Basalt Group. They are topographically situated above the major surface water systems (Snake River, Clearwater River and the Lapwai/Sweetwater Creek drainages) and receive recharge only from precipitation and irrigation on the overlying land. A deeper regional aquifer has been identified within basalt flows of the Grande Ronde Formation within area A of the GWMA. The regional aquifer is important because it receives recharge from the Snake River and is the source of most of the municipal water supply wells within the Lewiston Basin. However, there is uncertainty whether the regional aquifer connected to the Snake River extends east under area A-1 and/or whether aquifers within the Grande Ronde Formation in area A-1 are hydraulically connected to another surface water source such as the Clearwater River or Lapwai Creek. Little is known about the shallow and deep aquifers underlying area B of the GWMA and whether they may be recharged from Sweetwater Creek or some other source.

This project was funded in May 2016 with the objective of improving understanding about the presence and location of regional and shallow aquifers in the eastern and southern portions (A-1 and B) of the GWMA. The focus in both areas is on the potential for recharge from surface water sources. The report is divided into the following sections: 1) executive summary, 2) introduction, 3) hydrogeologic setting, 4) study approach, 5) summary of results to date and 6) proposal for a second year of effort.

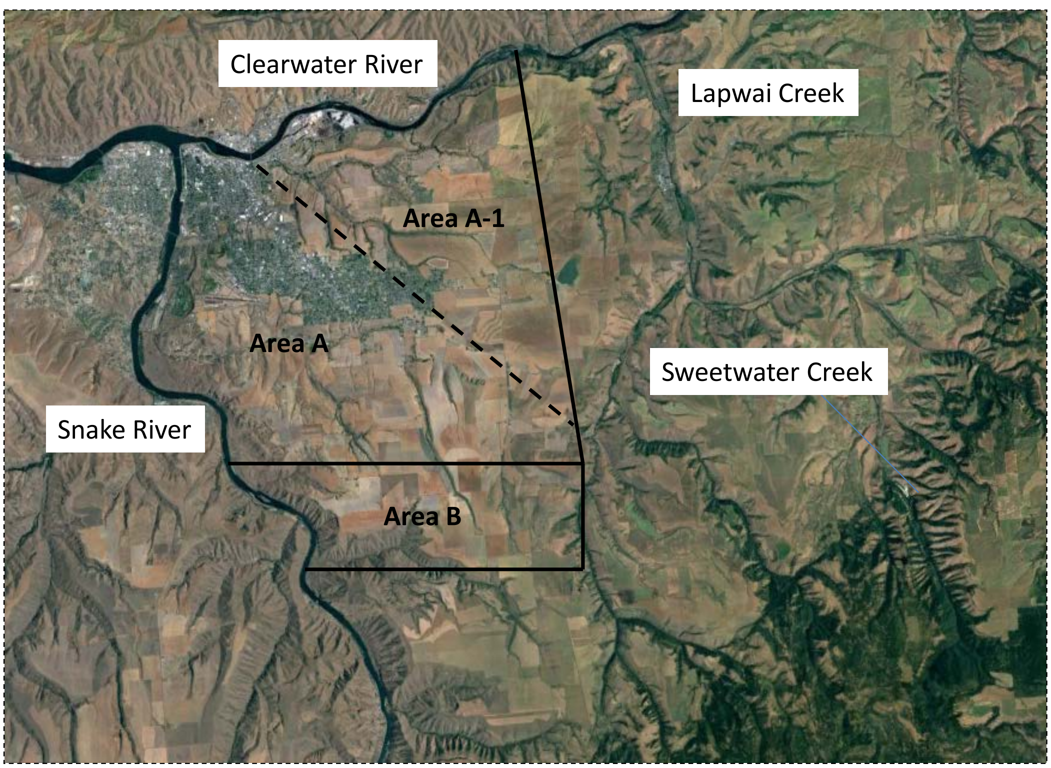

Figure 1 Location map for the Lewiston Plateau Ground Water Management Area (LPGWMA), showing the three subareas of the LPGWMA.

HYDROGEOLOGIC SETTING

The focus of the study is on aquifers within the Grande Ronde Formation. The formation includes three members that occur within the Lewiston Basin (Tgr_2, Tgn_1 and Tgr_1) (Figure 2). Bush and others (2005, map legend) indicate that the uppermost Grande Ronde Formation member (Tgr_2) consists of 2 or 3 basalt flows with a thickness of 500 to 600 feet. The middle member (Tgn1) is about 500 to 600 feet thick with several flows and the lower member (Tgr1) is about 400 feet thick with several flows. Thus, the Grande Ronde Formation in the area has a total estimated thickness of 1,400 to 1,600 feet.

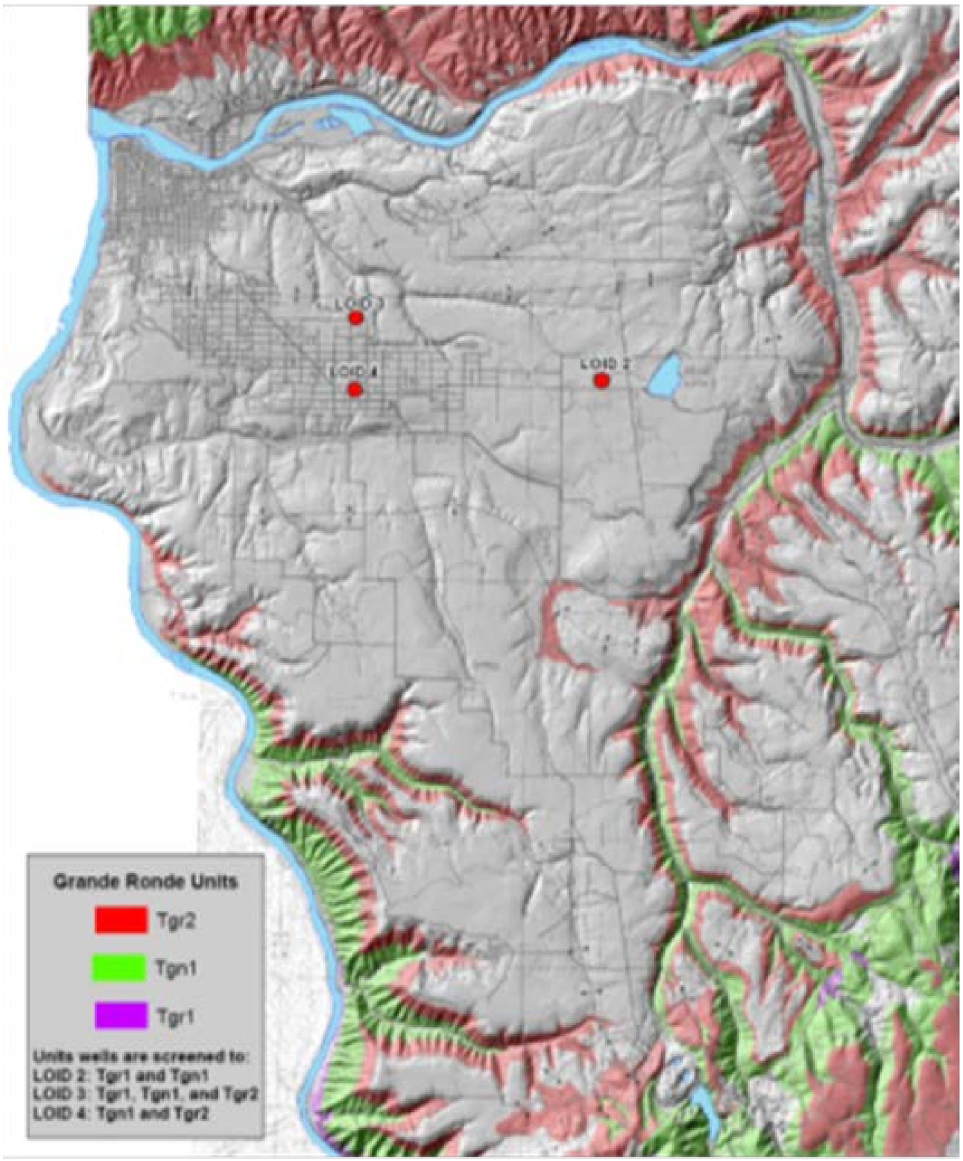

Figure 2 Map showing outcrop areas of Grande Ronde Formation units (Garwood, 2014).

The outcrop patterns of the three members of the Grande Ronde Formation are shown on Figure 2 with the uppermost member (Tgr2) shown in red, the middle member (Tgn1) shown in green and the lowermost member (Tgr1) shown in purple. The uppermost member (Tgr2 -- red) outcrops along the Snake River canyon starting southwest of Lewiston and along the Clearwater River starting about midway between Lewiston and the confluence of the river with Lapwai Creek. The Tgr2 member also outcrops along the Lapwai valley and Sweetwater Creek valley. Figure 2 shows that the middle member (Tgn1 -- green) outcrops upstream along the Snake River and is present along the Clearwater River only upstream of the confluence with Lapwai Creek. The Tgn1 unit also outcrops at the southern end of the Lapwai Valley and along Sweetwater Creek. The lowermost Grande Ronde Formation member (Tgr1 -- purple) outcrops further upstream along the Snake River (near the bottom of Figure 2). There is a small outcrop area of Tgr1 near the south end of the GWMA area near the Waha Fault and a second small outcrop area along the Clearwater River upstream of the confluence with Lapwai Creek that is not shown on Figure 2.

STUDY APPROACH

The study approach is to use the basalt stratigraphy to evaluate the connection between water producing zones in wells to areas where the same basalt units outcrop under potential surface water recharge areas. Figure 3 is a diagrammatic cross section that shows dipping basalt flows, a stream valley and four hypothetical wells. This cross section could be oriented east - west and represent recharge from the Lapwai Creek Valley or it could be oriented northeast - southwest and represent recharge from the Clearwater River. The two red lines represent flow contact aquifers that outcrop under the valley and receive recharge from the stream via the underlying valley alluvium. Wells D (located near the stream) and A (located on the plateau) penetrate the flow contact aquifers that are recharged from the surface water and should have a water-level elevation similar to the stream. Wells B and C penetrate aquifers that do not receive recharge from the surface water. Temporal water-level data from wells D and A should show a response to spring high water flow events in the stream. These wells should not have long-term water level decline because of the hydraulic connection to surface water. The water-levels in wells B and C should not respond to flood events in the surface water and could have long-term water-level decline if pumping is significant.

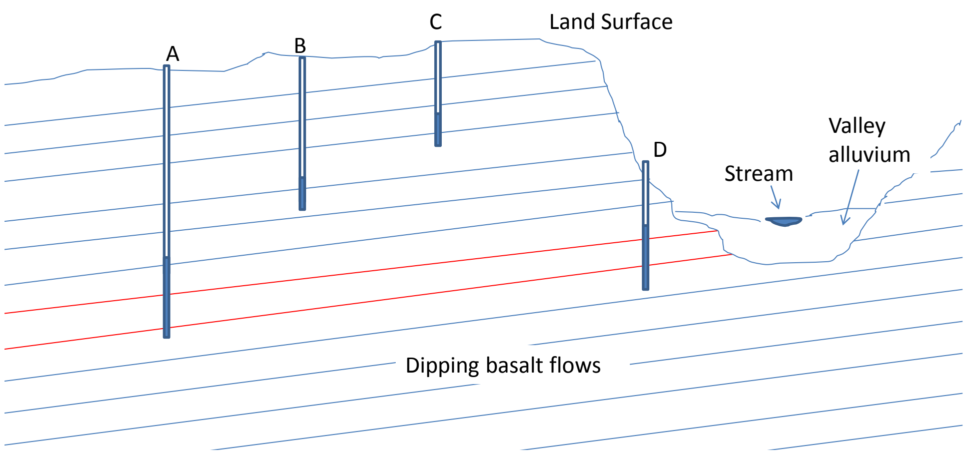

Figure 3 Diagrammatic hydrogeologic cross section showing a stream valley and wells.

The study has included three types of data collection and analysis in addition to review of existing reports, geologic maps and well logs. First, chemistry analyses of rock samples obtained during well drilling are used to correlate water producing zones in wells to rock outcropping under the surface water systems based on geologic maps. For example, the rock near the bottom of well A in Figure 3 should be the same geologic unit as the rock underlying the valley floor. Second, temporal ground-water level data as well as water-level elevation in wells are used to correlate with temporal stream discharge and stream stage elevation data to determine the degree of hydraulic connection and continuity of the postulated flow paths shown on Figure 3. Water-level data collected during peak flow surface water events provide an excellent opportunity to evaluate the hydraulic connection between surface water and ground water. Third, discharge data from upstream and downstream sites on several small streams (Sweetwater and Webb Creeks) are used to assess stream loss (recharge to ground water) or stream gain (discharge from ground water) in selected reaches. This approach could not be applied to the Clearwater River because of lack of upstream and downstream data gaging stations and the potential error involved in calculating stream loss or gain with large discharge rates. The approach cannot be applied to Lapwai Creek because there is only one gaging station on the stream. The following sections describe how each of these data sets are used to analyze recharge characteristics to aquifers within areas A-1 and B within the GWMA.

Rock chemistry data

The three units of the Grande Ronde Formation that are present in the Lewiston Basin (Tgr_2, Tgn_1 and Tgr_1) were initially identified in the field by using a field magnetometer to determine the magnetic signature of basalt outcrops. The basalt retains the magnetic signature of the earth at the time the units were erupted. The lowest unit (Tgr1) is so designated because the magnetic pole of the earth was reversed (south pole rather than the north pole) at the time the basalt was erupted. The middle unit (Tgn1) unit has a normal magnetic polarity (north pole) and the uppermost unit (Tgr2) has a reversed magnetic polarity. More recently, rock chemistry data have been used to identify not only each of the three units within the Grande Ronde Formation but also members within each unit. The GeoAnalytical Laboratory at Washington State University has the required equipment for providing rock chemistry analyses for the project. Dean Garwood, coauthor of many of the geologic maps of the area while an employee of the Idaho Geological Survey (IGS), was employed to interpret the rock chemistry data.

A search was made of possible sources of cutting samples obtained from the construction of wells within the Lewiston Basin. A total of 42 rock samples were analyzed from seven wells. The bulk of the samples were obtained from three wells (red circles on Figure 4): 13 samples from LOID well #5; 10 samples from the Red Pheasant #3 well and 9 samples from the Nez Perce Tribe BioControl #1 well . Cutting samples were obtained from the Lewiston Orchards Irrigation District for LOID well #5, from Bill Hobbs for the Red Pheasant #3 well and from Kevin Brackney of the Nez Perce Tribe for the BioControl #1 well. The sources for the remaining samples are as follows: Kevin Brackney for the Calkins well, the bus barn monitoring well and the BioControl #2 well and Erik Forsman of Stuivenga-Vessey Drilling for the Howell well (blue circles on Figure 4). The yellow circle on Figure 4 shows the location of new monitoring well that was constructed in March 2017 on Nez Perce County road right-of-way. Rock samples from 11 depth intervals from the County well were submitted to the WSU GeoAnalytical lab in April 2017; the analysis results should be available in late May of 2017.

Ground-water level data

Water-level data were obtained from 16 wells that were added to the IDWR monitoring well network as part of this project plus a number of existing wells within the IDWR network in the Lewiston Basin. Figure 5 shows the locations of monitoring wells including two wells in the

Clearwater River valley near area A-1, two wells in the southern portion of area B and one well in area A. Figure 6 shows in more detail the locations of 11 wells in the Lapwai Valley and the Clearwater River valley near the confluence with Lapwai Creek superimposed on a geologic map of the area. Data loggers have been installed in all but one of the wells. Water-level data for the remaining well is supplied by the operators. Well elevation data were obtained with a GPS survey for most of the wells by IDWR personnel. The GPS survey also included determining the elevation of the Clearwater River at selected sites.

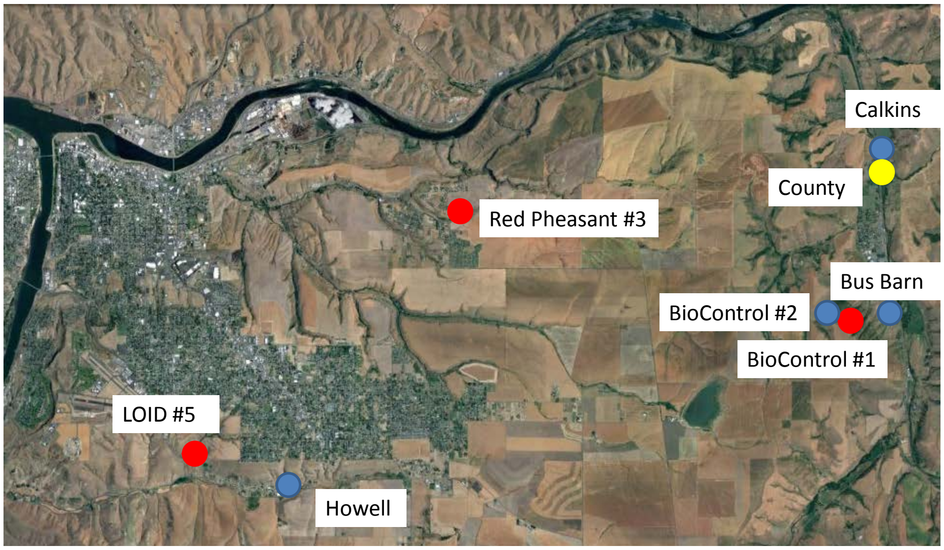

Figure 4 Location map for wells with rock chemistry analyses.

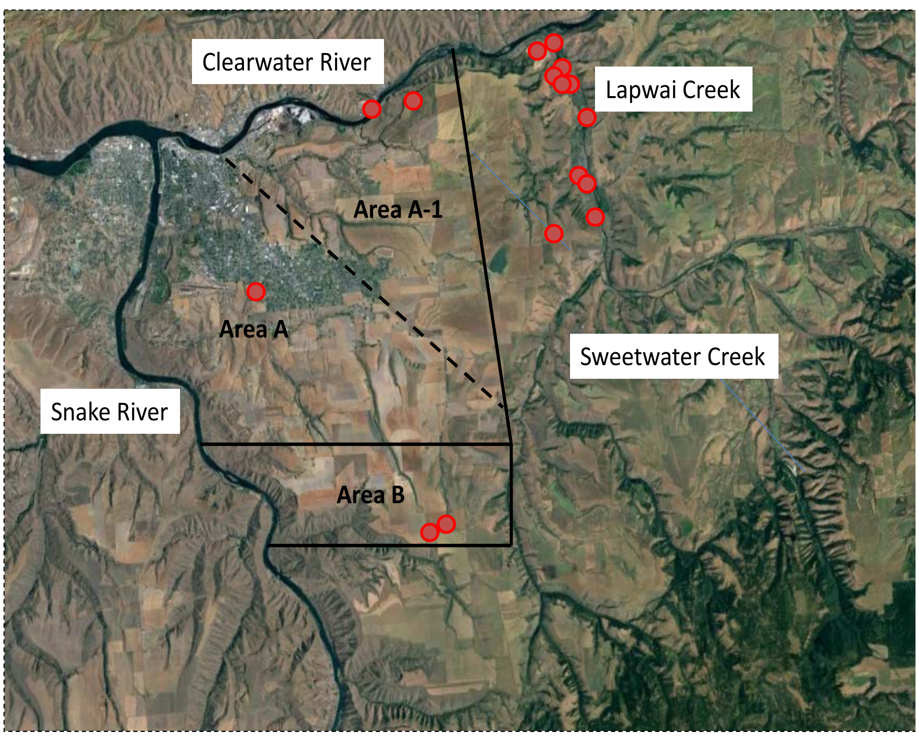

Figure 5 Map showing locations of monitoring wells established as part of this project.

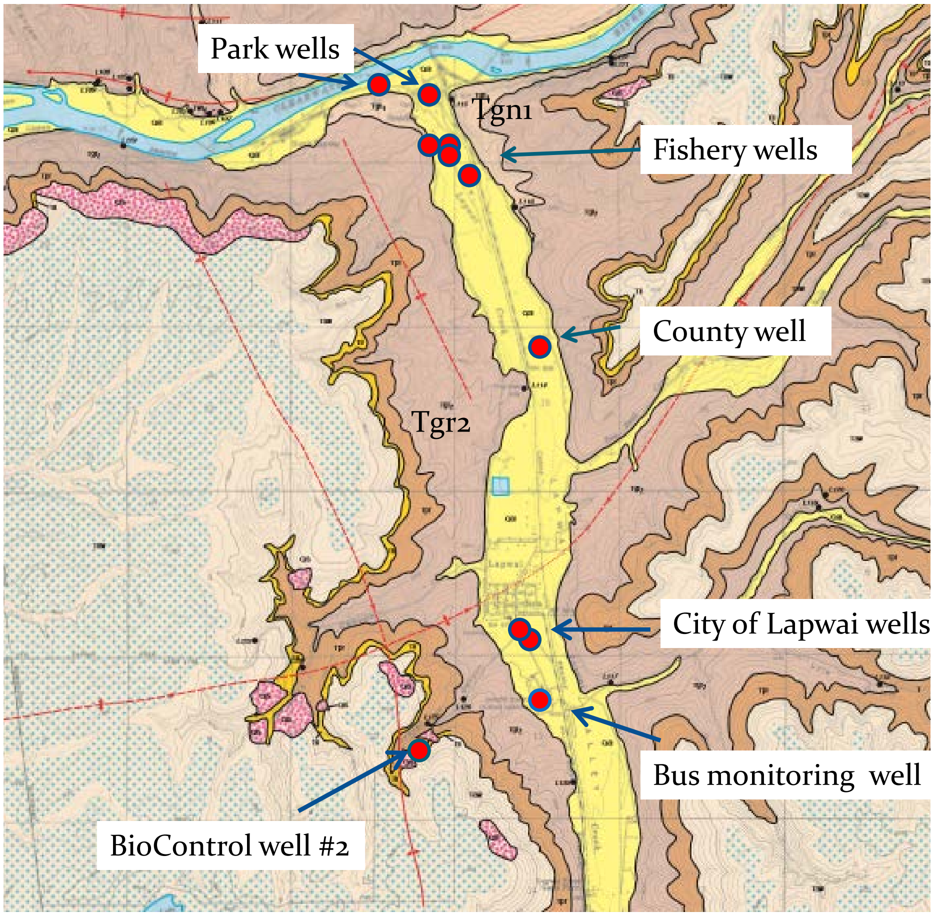

Figure 6 Geologic map showing locations of monitoring wells established as part of this project in the Lapwai Valley area (Bush and others, 2005).

<u>Streamflow data</u>

Streamflow data were downloaded from the U.S. Geological Survey website for stations on the Clearwater River near Spalding and Lapwai Creek near Lapwai. These data were used to compare to temporal water-level data from the monitoring wells.

The gain/loss characteristics of Sweetwater and Webb Creeks were determined based on flow data collected at four locations within the watershed. Daily streamflow data for these four stations were downloaded from the website of the U.S. Bureau of Reclamation.

SUMMARY OF RESULTS TO DATE

Rock chemistry data

Two batches of rock samples have been analyzed by the WSU GeoAnalytical Laboratory and the results interpreted by Dean Garwood. A third batch of samples was submitted to the WSU laboratory in April 2017. This analysis is focused on the three members of the Grande Ronde Formation. Table 1 provides the data interpretation in the form of identifying the unit (Tgr2, Tgn1 and Tgr1) plus members within each of these units. Figure 4 shows the locations of the wells.

Table 1 Rock chemistry interpretation for Grande Ronde Formation units for seven wells.

Well	Depth (ft)	Elev. (ft)	Unit	Unit	Member
BioControl 1 well	110	1410	Tgr2	Grande Ronde R2	Meyer Ridge
BioControl 1 well	200	1320	Tgr2	Grande Ronde R2	Wapshilla Ridge
BioControl 1 well	308	1212	Tgr2	Grande Ronde R2	Wapshilla Ridge
BioControl 1 well	435	1085	Tgr2	Grande Ronde R2	Wapshilla Ridge
BioControl 1 well	490	1030	Tgr2	Grande Ronde R2	Wapshilla Ridge
BioControl 1 well	550	970	Tgr2	Grande Ronde R2	Wapshilla Ridge
BioControl 1 well	680	840	Tgn1	Grande Ronde N1	Downey Gulch
BioControl 1 well	711	809	Tgn1	Grande Ronde N1	Downey Gulch
BioControl 1 well	800	720	Tgn1	Grande Ronde N1	Downey Gulch
BioControl 2 well	660	860	Tgn1	Grande Ronde N1	China Creek
Bus barn well	45	960	Tgn1	Grande Ronde N1	Downey Gulch
Calkins well	30	860	Tgn1	Grande Ronde N1	China Creek
Calkins well	100	790	Tgn1	Grande Ronde N1	Downey Gulch
Calkins well	137	753	Tgn1	Grande Ronde N1	Downey Gulch
LOID 5 well	700	625	Tgr2	Grande Ronde R2	Wapshilla Ridge
LOID 5 well	725	600	Tgr2	Grande Ronde R2	Wapshilla Ridge
LOID 5 well	840	485	Tgr2	Grande Ronde R2	Wapshilla Ridge
LOID 5 well	920	405	Tgr2	Grande Ronde R2	Wapshilla Ridge
LOID 5 well	1040	285	Tgr2	Grande Ronde R2	Wapshilla Ridge
LOID 5 well	1170	155	Tgn1	Grande Ronde N1	China Creek
LOID 5 well	1285	40	Tgn1	Grande Ronde N1	China Creek
LOID 5 well	1320	5	Tgn1	Grande Ronde N1	China Creek
LOID 5 well	1340	-15	Tgn1	Grande Ronde N1	Downey Gulch
LOID 5 well	1370	-45	Tgn1	Grande Ronde N1	Downey Gulch
LOID 5 well	1430	-105	Tgn1	Grande Ronde N1	Downey Gulch
LOID 5 well	1720	-395	Tgr1	Grande Ronde R1	Center Creek
LOID 5 well	1890	-565	Tgr1	Grande Ronde R1	Center Creek
Red Pheasant 3 well	850	600	Tgr2	Grande Ronde R2	Wapshilla Ridge
Red Pheasant 3 well	910	540	Tgr2	Grande Ronde R2	Wapshilla Ridge
Red Pheasant 3 well	950	500	Tgr2	Grande Ronde R2	Wapshilla Ridge
Red Pheasant 3 well	1000	450	Tgr2	Grande Ronde R2	Wapshilla Ridge
Red Pheasant 3 well	1140	310	Tgn1	Grande Ronde N1	China Creek
Howell well	850	615	Tgr2	Grande Ronde R2	Wapshilla Ridge

The BioControl wells are located along on the west side of Lapwai Valley about 600 feet above the valley floor; the bus barn well and Calkins well are located on the floor of Lapwai Valley. Table 1 shows that the floor of Lapwai Valley near the town of Lapwai is underlain by the Tgn1 unit of the Grande Ronde Formation. These Lapwai valley wells are located near the axis of the Lewiston syncline (Figure 6). Wells located in the northern and southern ends of Lapwai Valley should penetrate a lower section of the Tgn1 unit or perhaps the upper section of the Tgr1 unit. The remaining wells on Table 1 (LOID #5, Red Pheasant #3 and Howell) are all located a considerable distance west of the Lapwai Valley (see Figure 4). The approximate elevation of the contact between the Tgr2 unit and the Tgn1 unit in each of these wells (about 400 feet in the Red Pheasant #3 well and about 200 feet in LOID well #5) is lower than at the BioControl well (about 900 feet) because the Lewiston syncline plunges to the west. The Howell well is not deep enough to penetrate into the Tgn1unit. The upper member of the Tgn1 unit (China Creek) is present at the bottom of the Red Pheasant #3 well.

Additional rock samples have been submitted to the lab for chemical analysis from the county monitoring well that was drilled in March of 2017. The well is located on Nez Perce County road right-of-way in Lapwai Valley (Figure 6). An agreement between IDWR and Nez Perce County was established to allow this well to be drilled. Also, additional rock samples have been submitted from LOID well #5 to better define contacts between units and individual members. The 2017 rock chemistry data plus additional evaluation of existing IGS rock chemistry data will be used to refine our knowledge of the stratigraphic section and the potential for recharge from the various surface water sources.

A hydrogeologic cross-section prepared by Neely (2017) shows how the rock chemistry data can be used to better understand the subsurface geology and the hydraulic interconnection of aquifers (Figures 7a and 7b). Rock chemistry data from wells LOID #5, Red Pheasant #3 and Calkins are combined with the well driller's geologic data from the Jones well in a cross section that extends from the Lapwai Valley (Calkins well) to near the Lewiston airport (LOID #5 well). This approach will be used in more areas as additional rock chemistry data become available. Figure 7a shows that the water-level elevation is lower in LOID well #5 than in Red Pheasant well #3, which in turn is lower than the Calkins well. This hydraulic gradient to the west supports the hypothesis that aquifers within area A-1 and possibly area A may receive recharge from Lapwai Creek and/or the Clearwater River. This hypothesis will be tested using rock chemistry and water-level data collected in 2017.

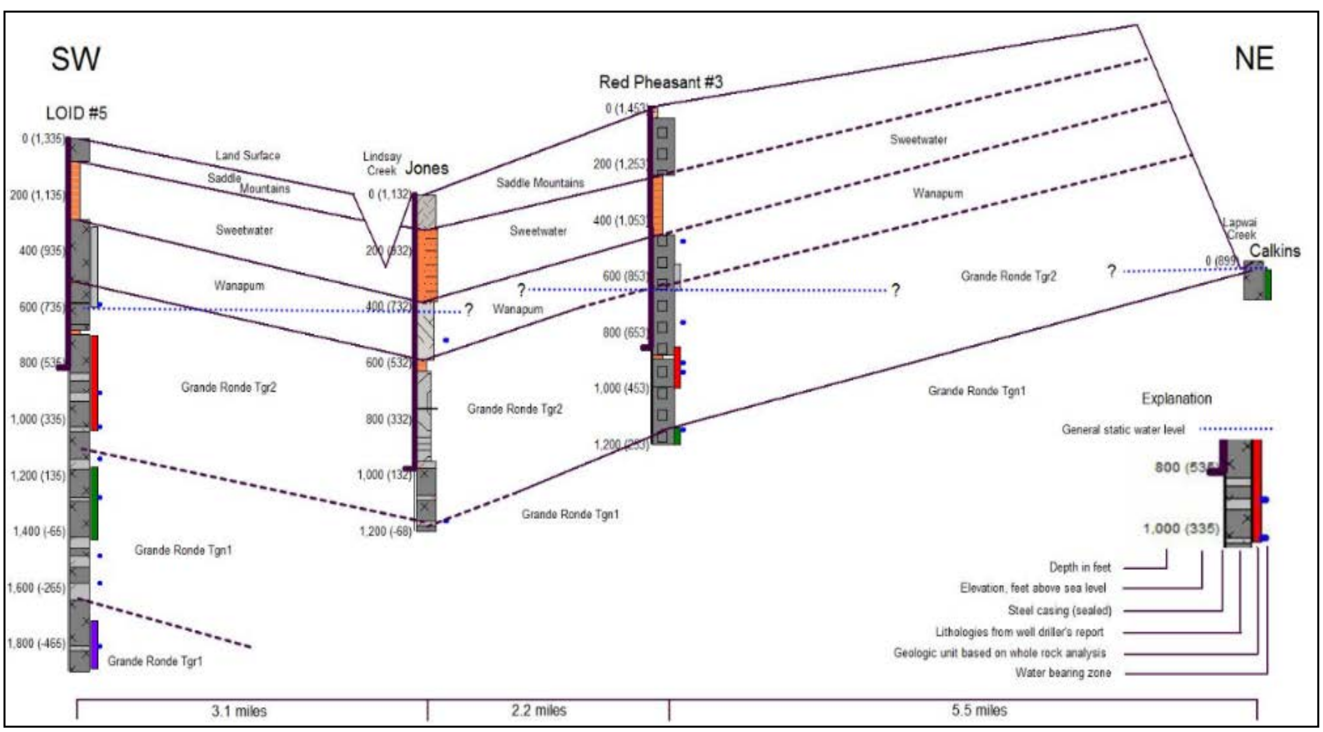

Figure 7a Hydrogeologic cross section using rock chemistry data (Neely, 2017).

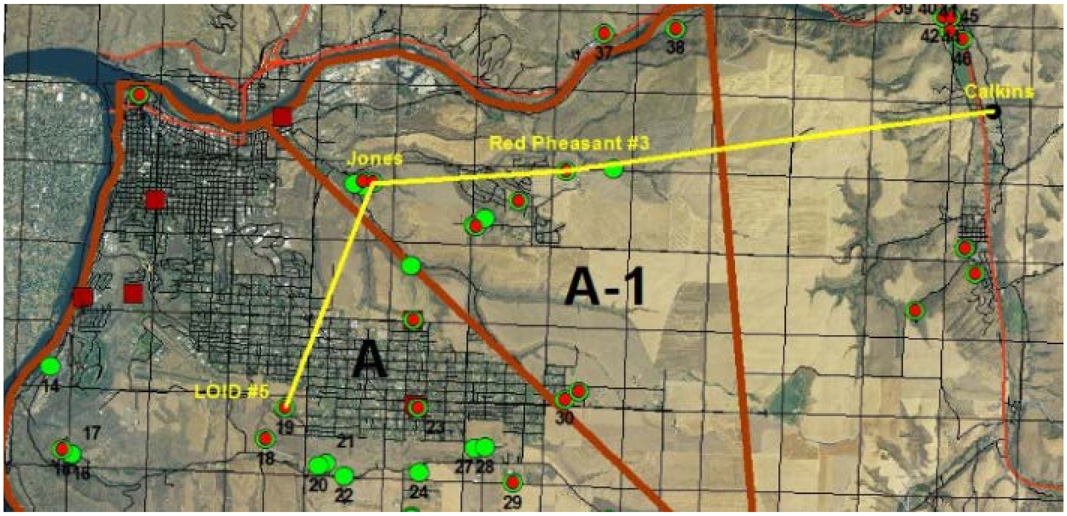

Figure 7b Location map for hydrogeologic cross section (Neely, 2017).

Potential recharge to aquifers in area A-1 from the Clearwater River

The entire thickness of the Grande Ronde Formation outcrops along the Clearwater River valley in the reach from about the confluence with Potlatch Creek (east of Lapwai Creek) to about the location of the Casino east of Lewiston. Figure 8 shows the outcrop areas of the three units of the Grande Ronde Formation along this portion of the Clearwater River. The arrows on Figure 8 show the approximate reaches of the river that might overlie each of the units of the Grande Ronde Formation.   The lowest unit outcrops upstream and the highest unit outcrops downstream because of the plunge of the Lewiston syncline to the west.

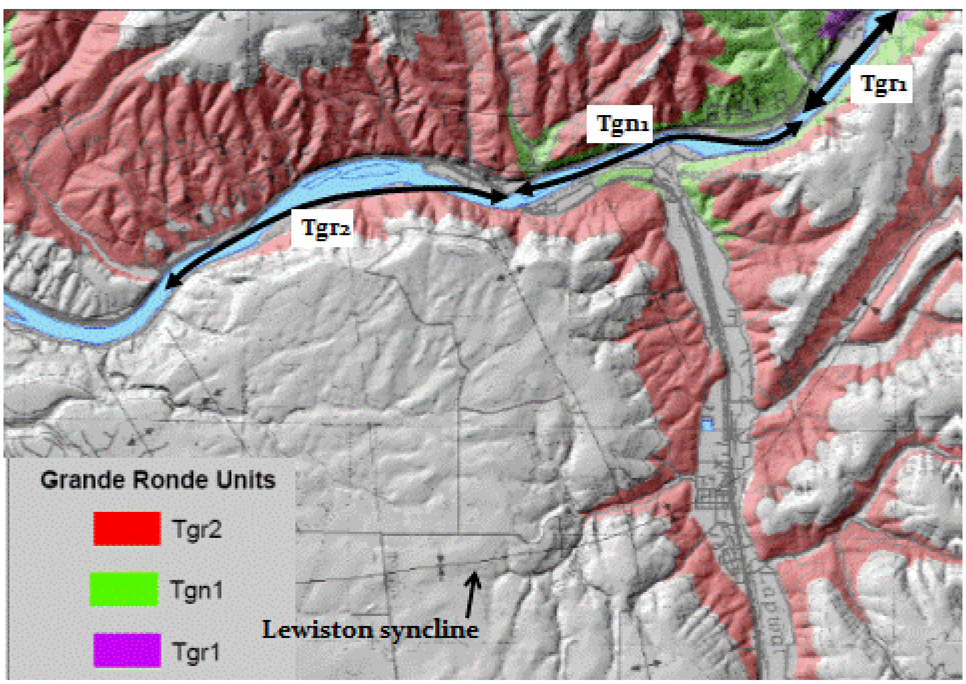

Figure 8 Map showing outcrop areas of Grande Ronde Formation units along the Clearwater River (Garwood, 2014).

The structural setting of the Grande Ronde formation along the Clearwater River is more complex than in any of the other portions of the study area. Two structural features control the orientation of the basalt flows under and near the Clearwater River. The Lewiston syncline is located south of the Clearwater River, trends approximately east-west and plunges to the west (Figure 9). Thus, the rocks along the south side of the Clearwater River valley dip to southwest. The second structural feature is an east-west trending, westerly plunging small anticline that is located approximately parallel to and mostly north of the river (Figure 9). The anticline apparently is located under the river for more than a mile starting slightly upstream of the confluence with Lapwai Creek. Dean Garwood (personal communication, 2016) described the anticline as having steep slopes near the axis and then flatter away from the axis. Additional geologic mapping and rock chemistry analysis is planned in the second year of the project to gain a better understanding of the structural setting of each of the rock units and members along this reach of the Clearwater River. This reach of the river is important relative to recharge to aquifers within the all three units of the Grande Ronde Formation.

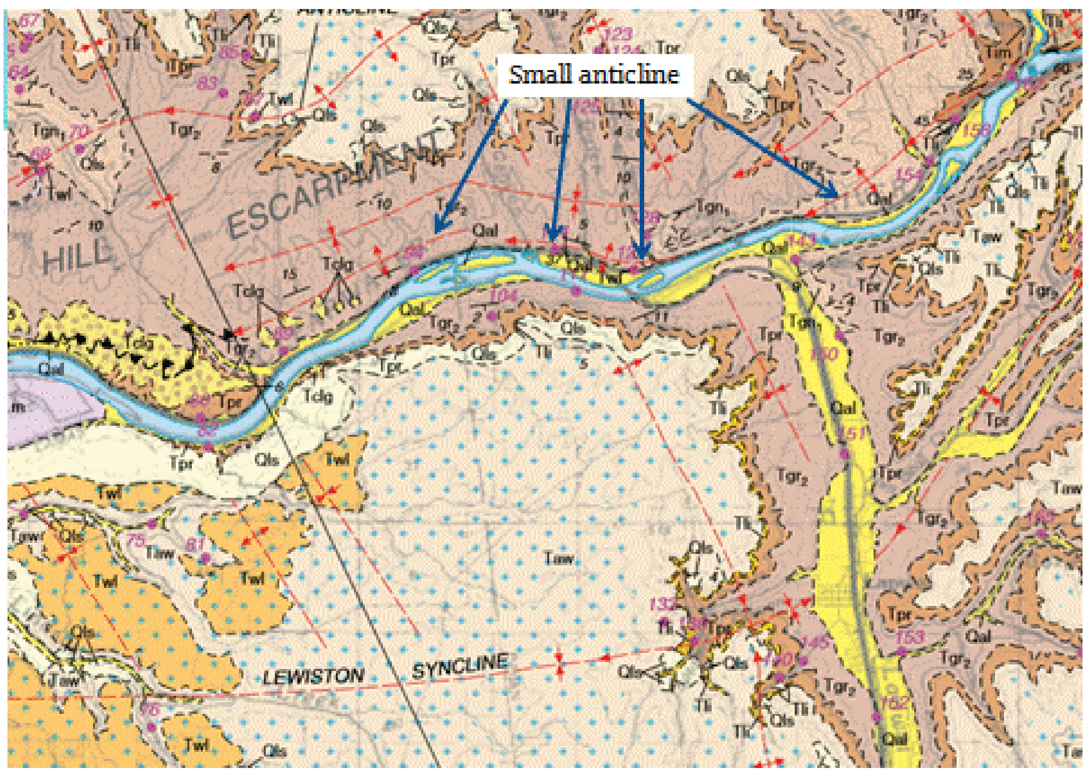

Figure 9 Geologic map of the area along the Clearwater River (Kauffman and others, 2009).

Water-level data from two wells adjacent to the Clearwater River are compared to 2016 river discharge data as a preliminary step to the project-wide analysis of water-level data from all of the wells after the 2017 runoff event. A data logger was installed in Fisheries well #2, which is located near the northern end of Lapwai Valley, prior to the start of the project and the 2016 runoff event. In addition, water-level data are available for a well located at the Clearwater Casino during the 2016 runoff event. Figure 10 shows the locations of these wells and also the U.S. Geological Survey stream gaging station on the Clearwater River.

Fisheries monitoring well #2 is located about 3,600 feet from the south shore of the Clearwater River (Figure 10). This well was constructed in 1988-89 as a test well prior to drilling a production well for a Nez Perce tribal fisheries facility (Ralston and Sprenke, 1998). The well was drilled to a depth of 520 feet and is completed with 4-inch diameter PVC casing with perforations in the depth interval of 436 to 516 feet. A sand pack was installed around the casing to a depth of 364 feet and bentonite grout was used to fill the annular space from 364 feet to land surface. The well, as presently completed, monitors basalt flow contact zones in the depth interval of 436 feet to 516 feet. The Fisheries well #2 at a depth of 520 feet penetrates alluvium underlain by basalt, likely the Tgn_1 member of the Grande Ronde formation. The well may be deep enough to penetrate into the underlying Tgr_1 unit. No drilling chip samples are available for this well. Ralston and Sprenke (1998) used a southerly dip of 5 degrees to correlate basalt units from Fisheries well #2 to the other two other test wells on the site. The dip accounts for this rock unit outcropping under the river.

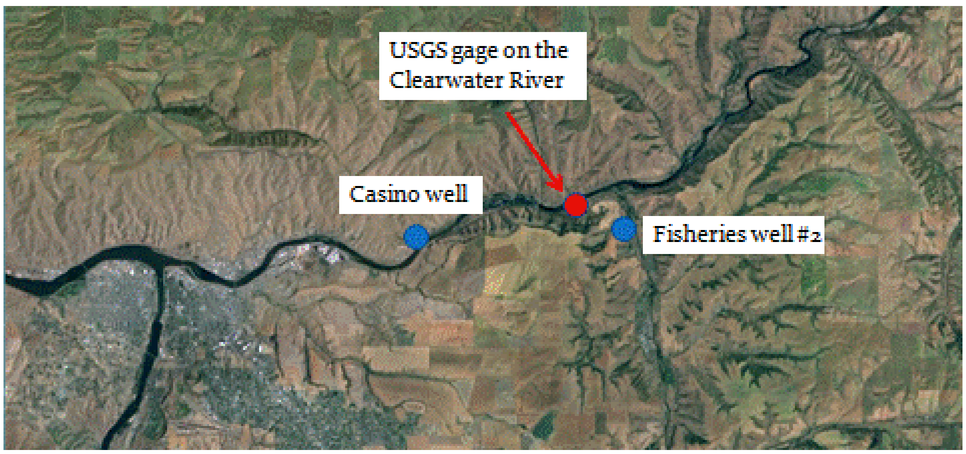

Figure 10 Map showing locations of wells with water-level data during the 2016 runoff season and the USGS stream gaging station on the Clearwater River.

A comparison of the hydrograph for water-level elevations in Fisheries well #2 and the discharge of the Clearwater River at the Spalding gage is presented in Figure 11. The hydrographs show a correlation between water levels in fisheries well #2 and the flow of the Clearwater River as measured at the Spalding gage. The peak flow in the river correlates with the peak water-level elevation in the well with a lag time of about one week. Smaller changes in river discharge, such as the flow peak in February, are also shown in the well hydrograph. The ground-water levels do not appear to drop off in May and June as fast as the decrease in flow in the river.

The range in water-level elevations in Fisheries well #2 can be compared to the elevation of the Clearwater River at various locations to assess whether the geologic interpretation for the well fits the associated reach of the river. Figure 12 presents river water-level elevations based on GPS elevations taken on August 25, 2016 plus data from the USGS gaging station at Spalding. There was about a 9-foot range in elevation of the river during the spring 2016 runoff event. As an approximation, the same 9-foot range in elevation can be applied to the river sites shown on Figure 12 since the late August elevation readings likely represent low flow conditions. The Fisheries well #2 range in water-level elevation of 793 to 796 feet generally fits with recharge from the Clearwater River perhaps a mile or so upstream from the confluence with Lapwai Creek (upstream portion of the Tgn_1 reach or the downstream portion of the Tgr_1 reach).

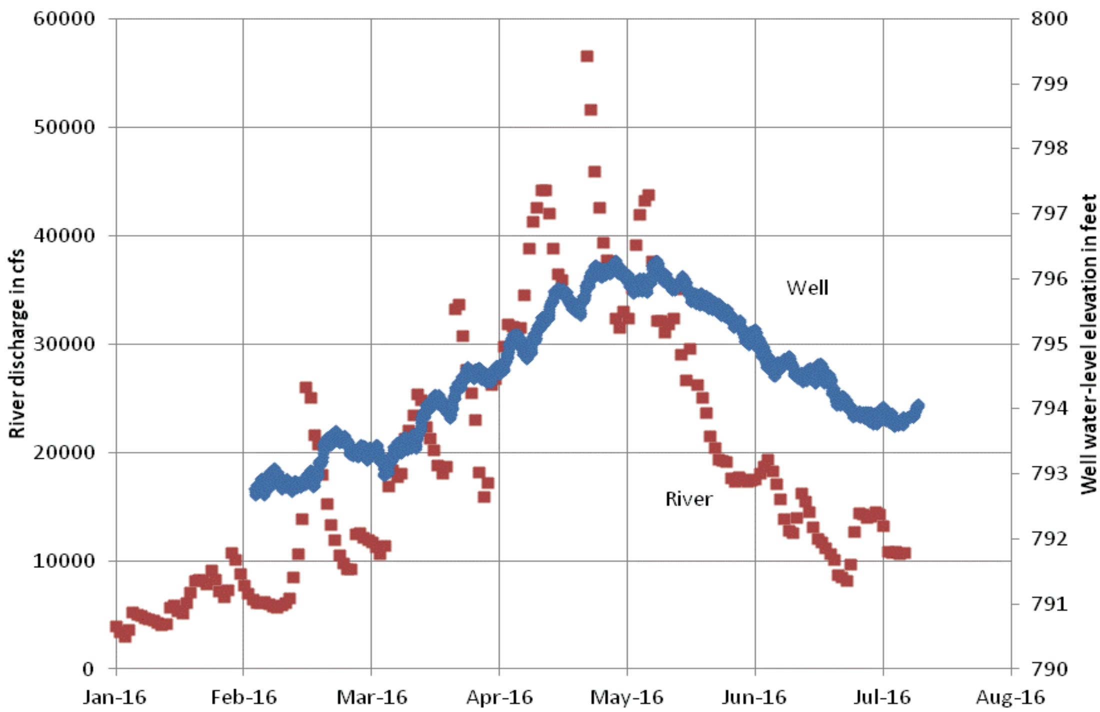

Figure 11 Hydrographs for Fisheries well #2 and the Clearwater River at Spalding.

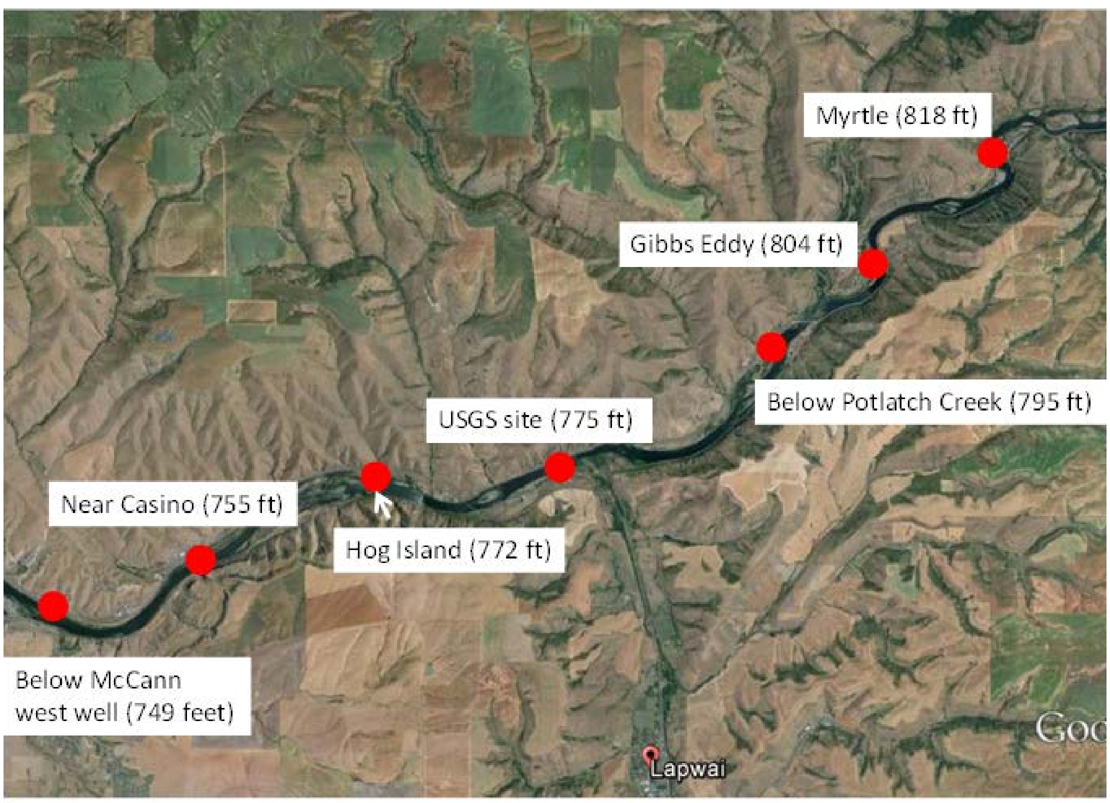

Figure 12 Elevations of the Clearwater River based on August 25, 2016 GPS readings.

The Casino well is located about 900 north of the northern bank of the Clearwater River and was drilled to a depth of 380 feet (Figure 10). Based on the driller's report, the well was completed with a grout seal around 8-inch diameter steel casing to a depth of 124 feet. Seven-inch diameter steel casing extends from 80 feet to 380 feet with perforations in the depth interval of 300 to 370 feet. The static depth to water when drilled was reported as 70 feet. The well has a pressure transducer installed with a manual readout of depth to water. The casino water system operator takes readings approximately daily during the work week.

The hydrograph for the Casino well in Figure 13(using data only when the well was not pumping) show a response to changes in flow and stage in the Clearwater River. The August ground-water level and the single elevation reading on the river in August 2016 are less than 10 feet different. The lack of water-level data starting in about June 2016 reflects the fact that the well was operating during most of the visits by the system operator. The Casino well likely is completed in the Tgr2 unit of the Grande Ronde Formation. Recharge to this unit likely occurs in the reach slightly upstream of the Casino site.

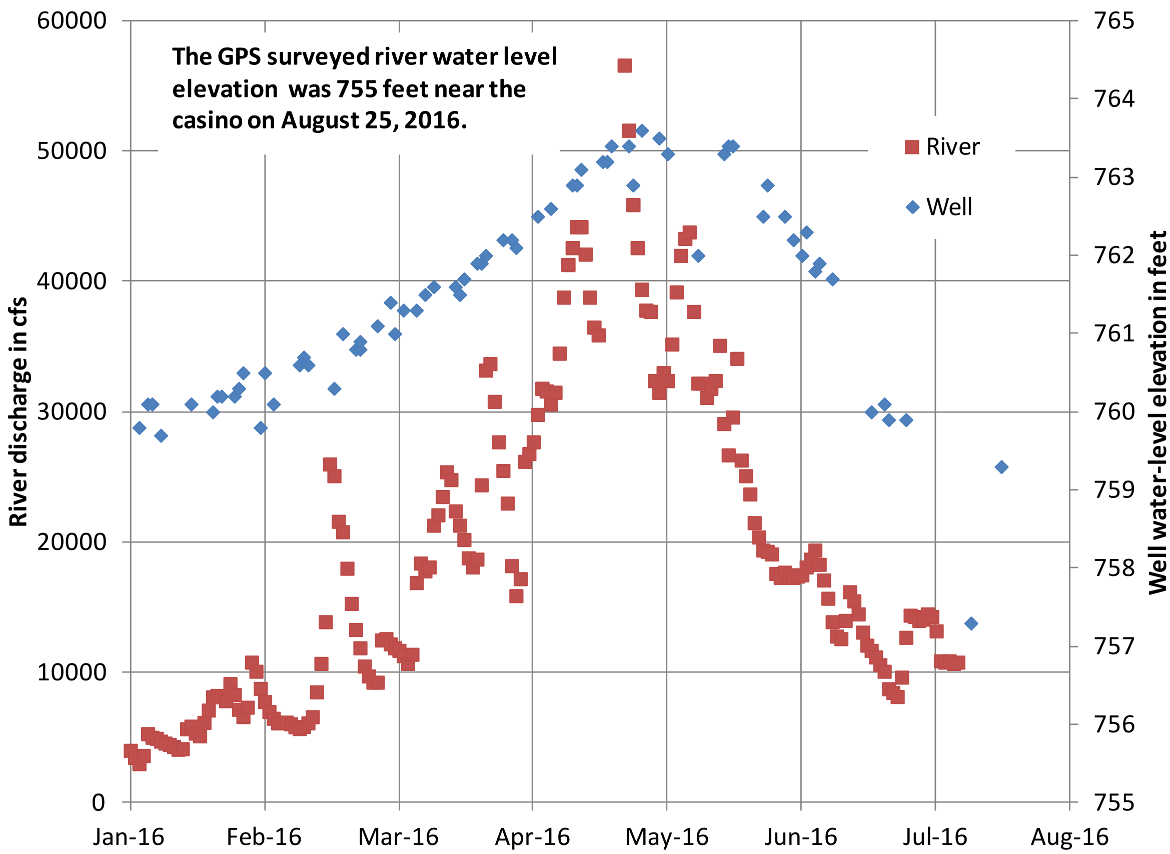

Figure 13 Hydrographs for the Casino well and the Clearwater River at Spalding.

In summary, 2016 water-level data from two wells show that ground-water within the Grande Ronde formation is hydraulically connected to and receives recharge from the Clearwater River. The geologic setting of the river is complex. Planned project efforts in 2017 include geologic field mapping, additional rock chemistry analysis and interpretation of water level data from additional monitoring wells.

Potential recharge to area A-1 from Lapwai Creek and the Lapwai Valley

A downward hydraulic gradient in the subsurface is an indicator that recharge is occurring from the alluvium within Lapwai Valley to the underlying basalt. A well on the valley floor that is completed in the alluvium should have a higher water-level elevation than a well completed in the uppermost aquifer in the underlying basalt. Similarly, shallow wells completed in basalt should have higher water-level elevations than deeper wells completed in basalt. Water-level elevation data are available from groups of wells located at two sites within the Lapwai Valley. These data that show that there is a downward hydraulic gradient in the subsurface. The first site is at the fisheries site at the north end of the valley. The second site is within the City of Lapwai.

There are several potential approaches to determine the extent to which Lapwai Creek/Valley serves as a recharge area for aquifers within the Grande Ronde formation in area A-1 of the GWMA. One approach is to determine whether water levels in wells completed in one or more of the units of the Grande Ronde formation respond to surface water flood events. None of the data loggers in the general Lapwai area were installed prior to the 2016 runoff event. These data will be available for analysis after the 2017 runoff event. The second approach is to use streamflow data from Lapwai Creek to determine if the creek discharge increases or decreases as it flows from south to north in the valley. However, there is only one stream gaging station on Lapwai Creek within the valley so this approach cannot be taken.

The available rock chemistry data indicate that the contact between the Tgr2 unit and the underlying Tgn1 unit in the Lapwai area is in the elevation range of about 960 feet to 1,030 feet. The land elevation within the City of Lapwai ranges from about 950 feet to 990 feet. The rock chemistry results currently available suggest that the valley floor in the immediate Lapwai area is underlain by the China Creek and/or the Downey Gulch members of the Tgn1 unit of the Grande Ronde Formation.

Given the rock chemistry data, the presumption is that recharge from Lapwai Creek and/or Lapwai Valley would be to the Tgn1 unit of the Grande Ronde Formation. The top of the Tgn1 unit is at an elevation of 400 feet in the Red Pheasant #3 well and an elevation of about 200 feet in the LOID #5 well. The plateau portion of area A-1 ranges in elevation from about 1,400 feet to about 1,500 feet. This means that, depending on land elevation, a well would need to be greater than 1,000 to 1,200 feet deep to reach the Tgn1 unit.

In summary, data loggers that are in place will provide water-level data to determine the extent to which Lapwai Creek/Valley is a recharge source for aquifers penetrated by wells that penetrate the Grande Ronde Formation within area A-1 of the GWMA. Additional rock chemistry and water-level data will be provided from the county monitoring well that was constructed in March 2017 in Lapwai Valley (Figure 6).

Potential recharge to area B from Sweetwater Creek or other sources

Area B of the GWMA is located south of areas A and A-1 and is bounded by the deep canyon of the Snake River on the west and the relatively shallow canyon of Sweetwater Creek on the east (Figure 14). A deep side canyon to the Snake River is located along the southwestern boundary of area B. The Grande Ronde basalt that underlies area B generally dips to the north because the area is located on the southern side of the Lewiston syncline. The major structural feature in the area is the Waha fault, which trends northeast-southwest and is located south of area B. The dashed red lines with arrows pointing in the same direction on Figure 14 show where the dip of the basalt steepens. Most of these small structural features tend to be approximately parallel to the Waha fault.

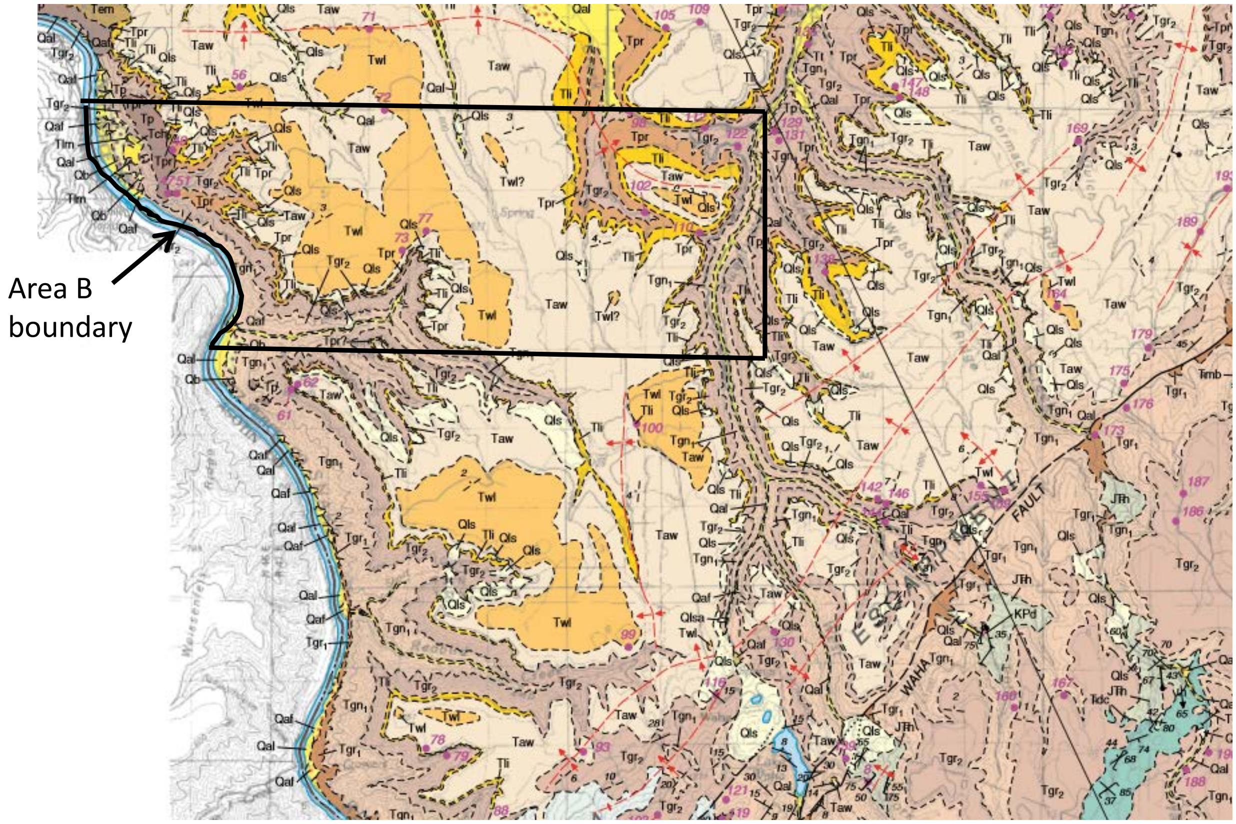

Figure 14 Geologic map of the area south of Lewiston showing the area B boundary (Kauffman and others, 2009).

Two possible pathways for water to recharge aquifers underlying area B are: 1) leakage from Sweetwater Creek and its tributaries and 2) downward movement of water along fracture pathways associated with Waha Fault and the other approximately parallel structural features. These alternatives are addressed in the following paragraphs.

The available geologic data shows that Sweetwater Creek is underlain by the same member of the Grande Ronde Formation (Tgn1) from where it discharges into Lapwai Creek to the headwaters which are located south of the southern boundary of the GWMA (Figure 14). The potential for recharge under this geologic setting is small because most, if not all, of the flow-contact aquifers likely do not outcrop under the stream. Additional interpretation of available Idaho Geological Survey rock chemistry data for sites in the area is planned to determine if this conceptual model is valid.

Analysis of streamflow data from Sweetwater Creek and Webb Creek provides insight relative to the assessment of surface water recharge to aquifers in area B of the GWMA. Sweetwater Creek and its major tributary (Webb Creek) are small enough that gain/loss studies can be useful in assessing potential recharge to ground water. Streamflow data are available for the Sweetwater Creek drainage from the U.S. Bureau of Reclamation (USBR) for sites within the Sweetwater Creek drainage because of the historic use of surface water for the operation of the

Lewiston Orchards Irrigation District (LOID) (Figure 15). The discharge of Sweetwater Creek is measured at two locations: 1) near the confluence with Lapwai Creek at and 2) below the canal diversion for the LOID system. The discharge of Webb Creek is also measured at two locations: 1) near the confluence with Sweetwater Creek and 2) below the canal diversion for the LOID system. The gain/loss in Sweetwater Creek can be calculated by subtracting the sum of the flow of Webb Creek near the mouth and the flow of Sweetwater Creek below the diversion from the flow of Sweetwater Creek at the mouth. Similarly, the gain/loss of Webb Creek can be calculated by subtracting the flow of Webb Creek below diversion from the flow of Webb Creek at the mouth.

Daily measurements of flow at the four stations described above are available from 2007 for the two Sweetwater Creek stations and the Webb Creek station at the mouth. Data for the upstream Webb Creek station is available starting in 2009. There are data gaps in the records for all four of the stations. However, sufficient data are available to allow analysis for identification of possible ground-water connections, either gains or losses.

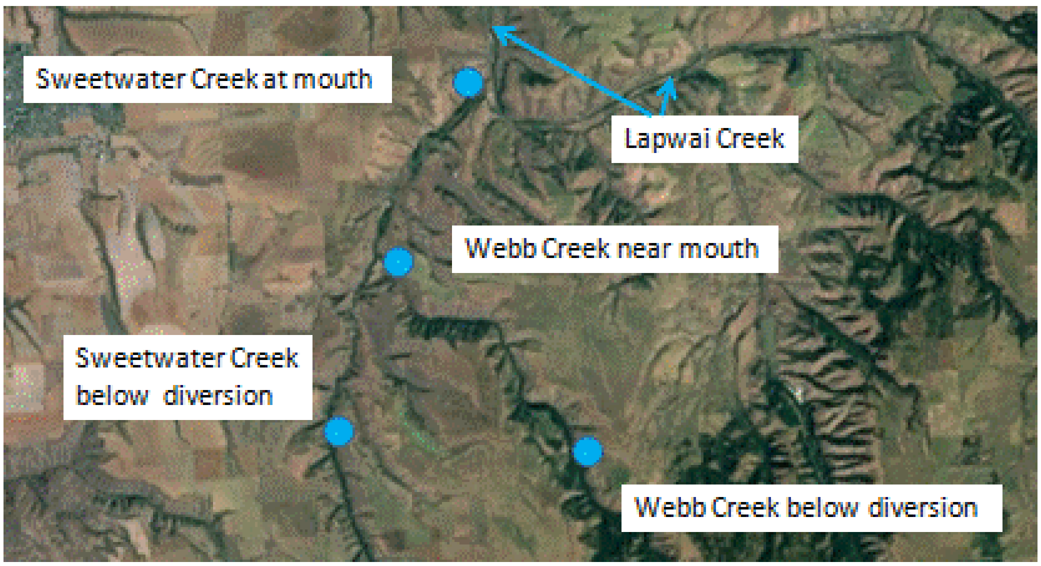

Figure 15 Location map showing stream gaging stations in the Sweetwater Creek drainage.

Analysis of daily gain/loss in both streams was calculated for the months of August and September for three selected years (2009, 2013 and 2016) to reflect different levels of summer flow conditions. The data indicate that Sweetwater Creek likely is a gaining stream in the reach from below the canal diversion to the mouth. The streamflow data indicate that Webb Creek likely is a losing stream in the reach from below the canal diversion to the mouth. The fact that Sweetwater Creek is not a losing stream during August and September make it unlikely that it is a major recharge source for aquifers under area B.

The Waha Fault and associated structural features have the potential to provide vertical pathways for water to move from land surface into the deeper basalt. The fault likely is not a single feature but rather a fault zone or a combination of faults and folds. Figure 14 shows that the Waha fault cuts across the upper drainage area of Sweetwater Creek. Intermittent flow in small valleys may infiltrate into the ground and flow downward via the fracture zones and recharge flow contact aquifers within the Grande Ronde formation. Additional geologic field work is planned during the second year of the project to better understand this recharge potential.

Most of the wells located in area B have been constructed in the Tammany View subdivision which is located near the southern boundary of the area. Information from well driller reports indicate the presence of three or more perched aquifers. The well depths fall into the following ranges: 10 wells 300 feet deep or shallower; 12 wells 301 to 600 feet deep; 3 wells 601 to 800 feet deep and 19 wells deeper than 801 feet. The deeper wells have lower ground water levels. Data loggers have been installed in two unused wells. One well is 125 feet deep and has a depth to water of about 58 feet. The second well is 1,125 feet deep and has a depth to water of about 1,023 feet. Temporal water-level data from these wells will be analyzed after the 2017 runoff period to determine the characteristics of any recharge event.

In summary, our knowledge of the hydrogeology of area B is limited by the small number of wells that are available to provide hydrogeologic data (except within the Tammany View subdivision). Cutting samples are not available for any of the wells for rock chemistry analysis. Water-level data from the two wells being monitored will provide important information on potential recharge sources. Some additional geologic reconnaissance work is planned for the area to better understand the potential for recharge to occur along the Waha structural feature.

PROPOSAL FOR SECOND YEAR

The purpose of the second year of work on the Lewiston Plateau GWMA is to complete tasks started in the first year and to conduct geologic work not anticipated in the original proposal. Data loggers, installed in a number of wells during the first year of the project, will provide important information on stream/aquifer interconnection via data collected during the high river and stream flow in the spring of 2017. The project is fortunate in that stream flows during the spring of 2017 are higher than have occurred in recent years. The hydraulic effect of the high flows on ground- water levels will be easier to identify than if the 2017 flow event would have been average or below average.

Rock chemistry data have proven to be very important in understanding the subsurface geology. However, we have utilized all of the available sources for down well cutting samples. Additional cutting samples, obtained from the county monitoring well that was drilled March 2017, have been submitted to the WSU GeoAnalytical Lab for analysis along with additional samples from LOID well #5. The potential for drilling three or four boreholes to provide rock samples for chemical analysis is being explored. These boreholes would be spaced along the south side of the Clearwater River from approximately across from the Casino to upstream of the confluence with Lapwai Creek (see Figure 10). The boreholes would be backfilled and abandoned after drilling and would not be completed as monitoring wells. Rock chemistry data from analysis of cutting samples from these boreholes would be valuable in gaining a better understanding the hydrogeology along the Clearwater River.

The project approach in the second year will be the same as the first year, except for a greater emphasis on field geology. The focus of the field geology work will be on the Clearwater River canyon with some work along the Waha fault. Data analysis will include correlation of ground-water levels from the various monitoring wells with surface water flow and stage data. An emphasis will be placed on developing more monitoring opportunities in area B. The resulting report will provide a detailed assessment of recharge to individual flow contact aquifers in areas A-1 and B within the GWMA. Recommendations will be provided for ongoing data collection programs and also for potential changes to the management program for the Lewiston GWMA.

The project will be conducted by Dr. Dale Ralston with the assistance of Dean Garwood, a geologist with considerable experience in the area. We will work closely with Ken Neely and Daniel Sturgis of IDWR, Doug Zenner of Nez Perce County and Kevin Brackney with the Nez Perce Tribe. The anticipated completion date for the project is June, 2018. The proposed Ralston Hydrologic Services budget for the second year of the project is $50,000. This proposed scope of work and budget is based on the assumption that IDWR will have funding for drilling boreholes, installing tubing in existing wells for monitoring and providing field equipment, particularly data loggers and access to a 1,500-foot electric tape. Thank you.

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