Walla Walla Basin Watershed Council

Water Year 2016

Oregon Walla Walla Basin Aquifer Recharge Report

FINAL REPORT

February 2017

Water Year 2016

Oregon Walla Walla Basin Aquifer Recharge Report

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Walla Walla Basin Watershed Council

In Cooperation with Hudson Bay District Improvement Company

2017

EXECUTIVE SUMMARY

This report summarizes Water Year (WY) 2016 aquifer recharge operations at the Anspach, Barrett, Johnson, NW Umapine and Trumbull sites and supporting groundwater level and surface water and groundwater quality monitoring data. The five aquifer recharge sites were operated under Limited License 1433 (LL-1433) issued by Oregon Water Resources Department. This report was prepared per Condition 11 of LL-1433 requiring annual reporting of aquifer recharge site operations and data collected in fulfillment of the water level and water quality monitoring plan.

Source water for all five aquifer recharge sites was diverted from the Walla Walla River at the Little Walla Walla Diversion in Milton-Freewater, OR. The water was delivered through the Hudson Bay District Improvement Company's irrigation system to each site's turnout. The WY 2016 recharge season started November 21st, 2015 and ended May 12th, 2016. The WY 2016 recharge season had 116 days of active recharge operations. The recharge season was interrupted by low river flows during November, December, and May and by a short period of freezing temperatures. Annual cleaning of the fish screens at the Little Walla Walla Diversion prevented recharge operations during the month of February and early March. The total amount of water diverted under LL-1433 for the WY 2016 recharge season was 6,229.54 acre-feet.

Water level and water quality data were collected in accordance with the approved monitoring plan for LL-1433. Down-gradient groundwater monitoring wells in the vicinity of the recharge sites responded to recharge activities, with groundwater elevations increasing and decreasing as recharge operations began and ended. After recharge operations ended on May 12th 2016, water levels at some monitoring wells remained static or increased in response to increased seepage through the fully charged ditches/canals and percolation from irrigation.

Groundwater and surface water quality data collected during aquifer recharge activities do not indicate that AR activities are degrading groundwater quality. Source water quality being delivered to the aquifer recharge sites was of good quality.

Groundwater levels saw significant declines during WY 2015 due to drought conditions, however declines were reversed during the WY 2016 recharge season and is likely due in part to aquifer recharge operations. The WY2015 and WY2016 recharge seasons provide insight into how both the groundwater system and the aquifer recharge program can be influenced by drought conditions and then recover the following year under more typically climate conditions. WY2015 and WY2016 also provide insight into how the alluvial aquifer can be managed to allow greater utilization during drought conditions if accompanied by a managed aquifer recharge program.

Continued operation of the five current sites and the addition of thirteen new aquifer recharges sites under LL-1621 is expected in WY 2017.

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INTRODUCTION

This report describes groundwater level monitoring data, surface and groundwater quality sampling data and aquifer recharge (AR) operations during water year (WY) 2016 (October 1, 2015 – September 30, 2016) performed by the Walla Walla Basin Watershed Council (WWBWC) in cooperation with the Hudson Bay District Improvement Company (HBDIC). The Walla Walla Basin AR program has been in existence since 2004. The first pilot project, the Johnson site, was started in Oregon in the spring of 2004. The program expanded in 2006 with the addition of the Hall-Wentland site just south of the Oregon-Washington state line. The first AR site in the Walla Walla watershed within Washington (Locher Road) was put into operation in 2007. For a more in-depth background on the AR program and the Walla Walla basin's hydrology and geology, please see the Walla Walla Basin Aquifer Recharge Strategic Plan (available at www.wwbwc.org/projects/recharge.html).

In contrast to many other AR projects being implemented nationally and internationally, the Walla Walla Basin AR program is not currently being implemented to store water that can later be recovered for beneficial use. Although some use of the stored water is likely occurring at existing water supply wells located hydraulically down-gradient of the current AR sites, the primary purpose of AR in the Walla Walla Basin is to restore the watershed by enhancing groundwater contributions to instream flow for public and regional benefits. Increases in groundwater levels will not only enhance stream and river baseflow during periods of seasonally low flow, but will also result in multiple benefits including those for aquatic life and additional water for recreational, domestic, and irrigation uses.

During WY 2016 the aquifer recharge program comprised five sites: Anspach, Barrett, Johnson, NW Umapine and Trumbull. The recharge sites were operated under Limited License 1433 (LL-1433) (Appendix A) issued by Oregon Water Resources Department (OWRD) on March 11, 2013. Source water for aquifer recharge was diverted from the Walla Walla River at the Little Walla Walla Diversion in Milton-Freewater, Oregon at a maximum rate of up to 45 cubic feet per second (cfs) between November 21st, 2015 and May 12th, 2016. The WY 2016 recharge season had 116 days of active recharge operations. The recharge season was interrupted by low river flows during November, December, and May and by a short period of freezing temperatures. Annual cleaning of the fish screens at the Little Walla Walla Diversion prevented recharge operations during the month of February and early March. The water diverted for recharge was delivered through the Hudson Bay District Improvement Company's irrigation system to each AR site's turnout. The total amount of water diverted under LL-1433 from November 21st, 2015 through May 12th, 2016 was 6,229.54 acre-feet.

Per Condition 11 of LL-1433, the WWBWC is required to submit an annual report that provides a detailed description of AR operations and source and groundwater observations during the aquifer recharge period. The annual report's main goals are to: 1) provide data to evaluate how AR operations are influencing groundwater quality and groundwater levels and 2) provide recommendations for modifications to the monitoring program and AR operations based on site operations and interpretation of the data. To this end, diverted surface water volumes, AR volumes and application rates, groundwater elevations, source water quality and groundwater quality data were collected in accordance with the approved monitoring plan for LL-1433 (Appendix B).

Presentation of the WY 2016 AR program operations and monitoring results are organized in this report as follows:

- Introduction
- Hydrologic Setting
- Aquifer Recharge Sites Design and Construction
- WY 2016 AR System Operation and Monitoring
    - Source water diversion
    - Anspach Recharge Site
    - Barrett Recharge Site
    - Johnson Recharge Site
    - NW Umapine Recharge Site
    - Trumbull Recharge Site
- Water Quality Monitoring
    - Source Water Quality
    - Groundwater Quality
- Recommendations for WY 2017

Appendices are provided at the end of the report as well as a compact disc with water level data in the OWRD requested format.

HYDROLOGIC SETTING

The Walla Walla River (River) system is a bi-state watershed located in northeast Oregon and southeast Washington (Figure 1). The River's headwaters are located in the Blue Mountains, the crest of which defines the eastern extent of the watershed. The mainstem Walla Walla River and its primary tributaries, Mill Creek and the Touchet River, are the three primary surface water channels of the system. They coalesce within the Walla Walla Valley from which the Walla Walla River then flows draining to the Columbia River (Figure 2). This report focuses on the portion of the River system that comprises the Walla Walla River mainstem and the distributary network, especially where they flow onto and across the area referred to in the balance of this report as the Walla Walla Valley.

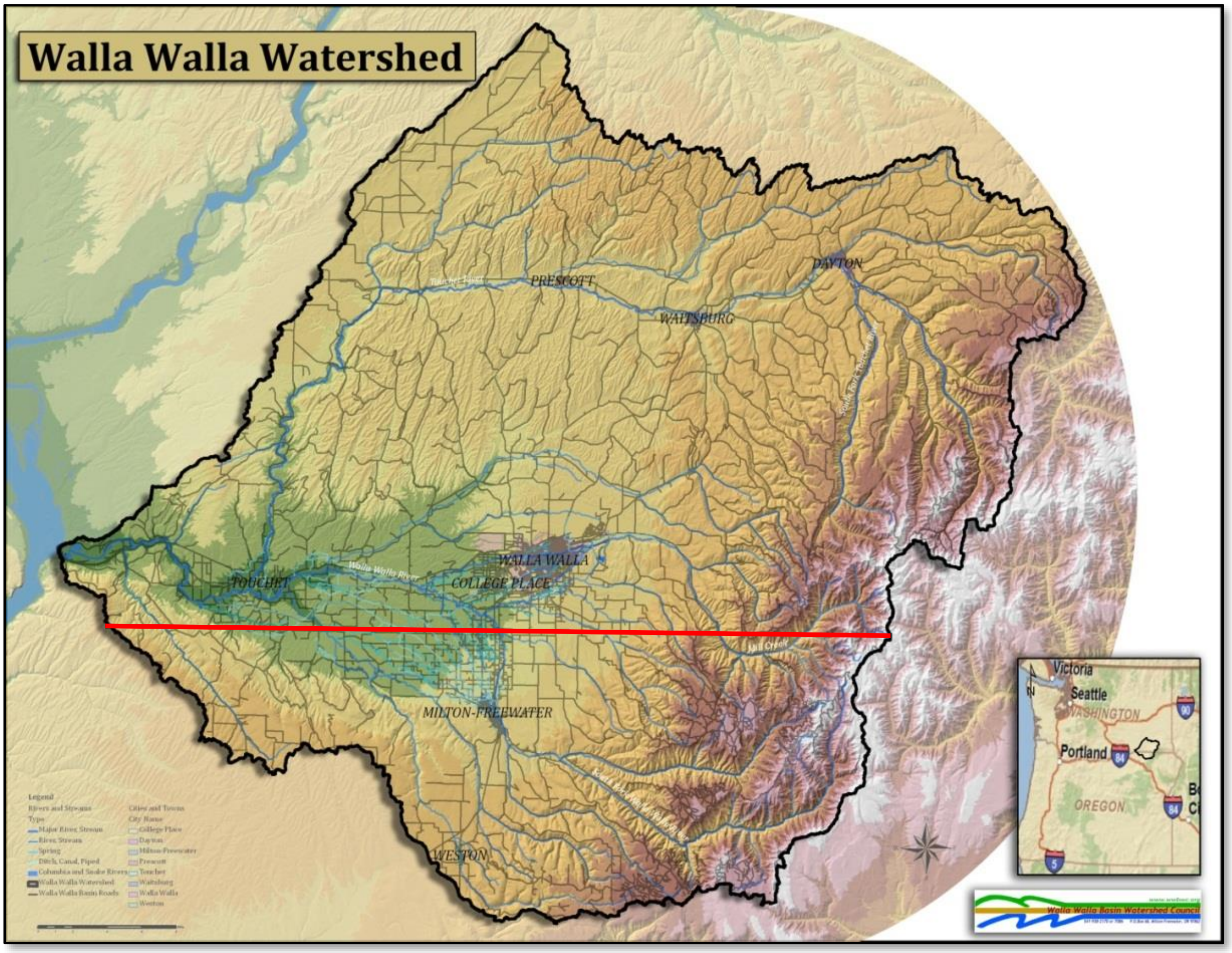

Figure 1 - The Walla Walla Watershed in Northeast Oregon and Southeast Washington. The stateline is indicated by the red line.

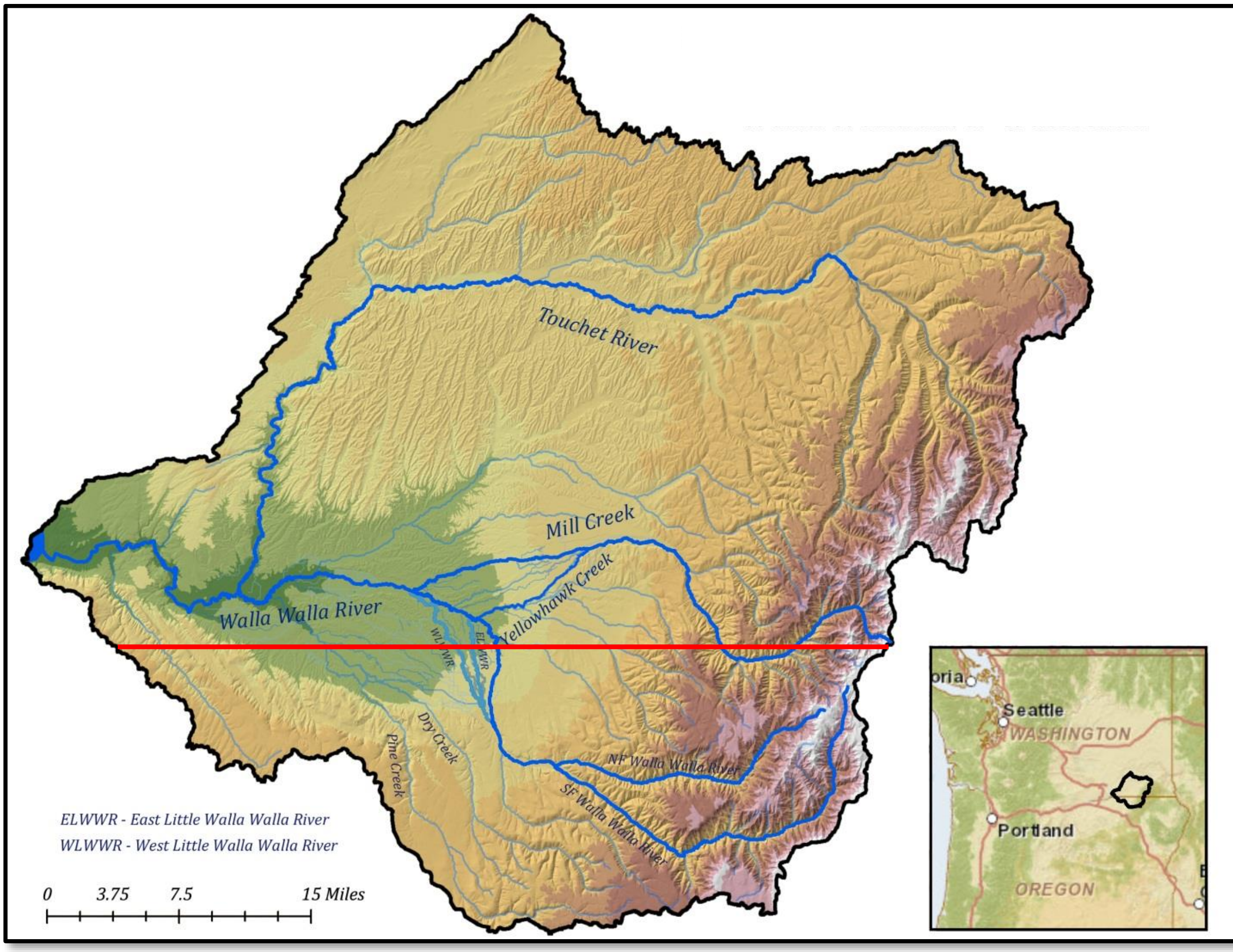

Figure 2 - The Walla Walla River and its major tributaries and distributaries. The stateline is indicated by the red line.

Walla Walla Basin hydrology is largely defined by a distributary river system and an underlying alluvial aquifer system hosted by the sediments overlying basalt. Surface waters entering the Walla Walla Valley effectively change regime from steep sided canyons in the headwaters portion of the watershed to a system of distributary and coalescing streams on the central valley floor. With this, shallow groundwater systems see a regime change from localized, saturated valley deposits and confined basalt aquifers controlled by the geologic structure of the Columbia River basalt typical of the highland areas to the more widespread, thick alluvial aquifer system immediately underlying the valley floor. Depth to basalt beneath the base of the canyon floors in the highland areas upstream of the cities of Walla Walla and Milton-Freewater is typically less than 60 feet, with 30 feet more commonly observed. Beneath the central valley floor the top of basalt often is hundreds of feet deep below overlying alluvial sediments.

Groundwater in the Walla Walla Basin occurs in two principal aquifer systems: (1) the unconfined to confined suprabasalt sediment (alluvial) aquifer system and (2) the underlying confined basalt aquifer system (Newcomb, 1965). The basalt aquifer system is regional in character, having limited hydraulic connection to the Walla Walla River, primarily in the canyons of the Blue Mountains. The alluvial aquifer system is the focus of the aquifer recharge program because of its high degree of hydraulic connection with streams on the valley floor.

The alluvial aquifer system, or alluvial aquifer, is found within a sequence of continental clastic sediments overlying the top of basalt (the Mio-Pliocene strata (upper coarse, fine and lower coarse units) and the Quaternary coarse unit). Beneath the Walla Walla Valley floor these sediments, and the alluvial aquifer system, is up to 800 feet thick. The majority of the productive portions of the alluvial aquifer system are hosted by the Mio-Pliocene coarse unit although, at least locally, it is hosted in the overlying Quaternary coarse unit. The alluvial aquifer is generally characterized as unconfined, but it does, at least locally, display evidence of confined conditions. Preferential groundwater flow within the alluvial aquifer is inferred to largely reflect the distribution of coarse sedimentary strata. General groundwater flow direction is from east to west based on contoured groundwater elevations in the alluvial aquifer (Figure 3).

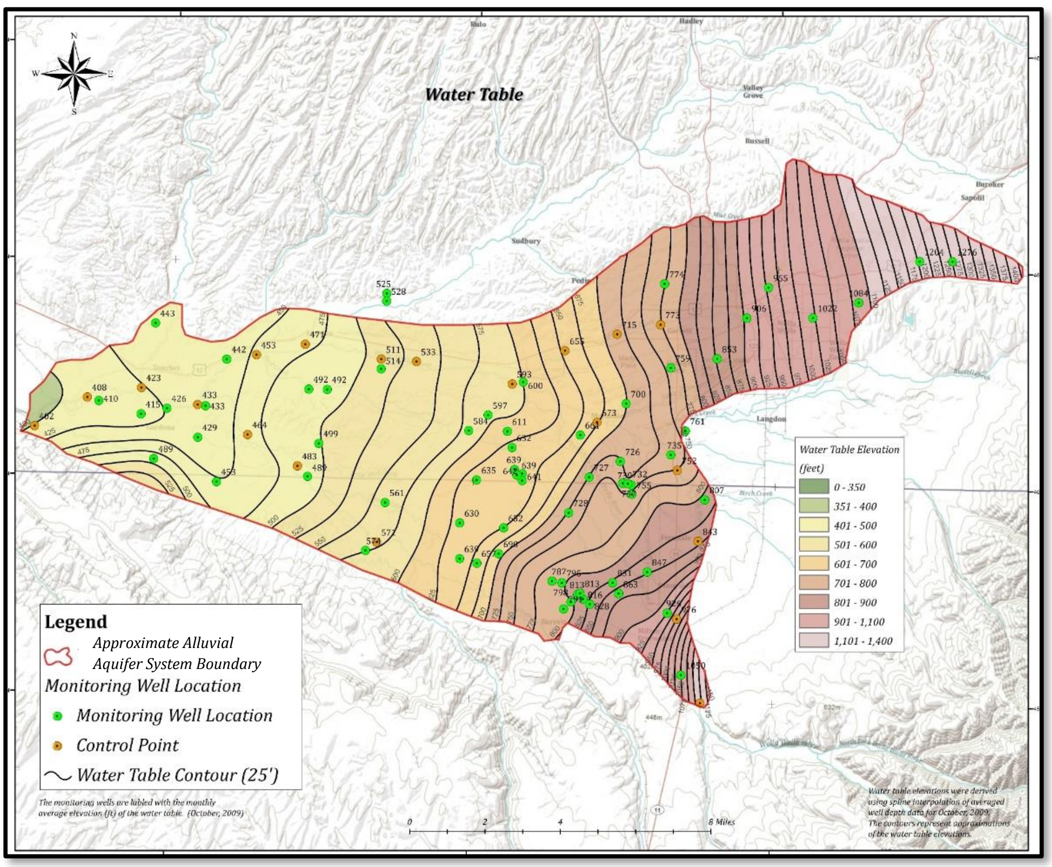

Figure 3 - Water table elevation contours for the alluvial aquifer system in October 2009.

The surficial hydrology of the Walla Walla Basin generally is defined by streams confined to steep-walled canyons in the foothills surrounding the valley, a distributary stream system as these streams exit the highlands and flow out onto the valley floor, and then, as the streams flow west, they coalesce into the main Walla Walla River channel. The distributary system formed as streams leaving the highlands entered the valley, went from higher to lower gradient and, as a consequence, deposited coarse sediment loads and formed a series of low angle, coalescing alluvial fans. Upon the alluvial fans in and around the cities of Walla Walla and Milton-Freewater these natural distributary channels still exist in part or in whole to this day. These channels are known today as the East Little Walla Walla River, West Little Walla Walla River, Mud Creek, Yellowhawk Creek, and Garrison Creek. Prior to the development of water resources in the valley, these distributary channels, with other (un-named) channels, served as high water channels that conveyed large amounts of energy and water across the alluvial fan and away from the mainstem Walla Walla River and Mill Creek. The channels run for several miles, accumulating spring flow, before returning back to the River further down the valley (Figure 4).

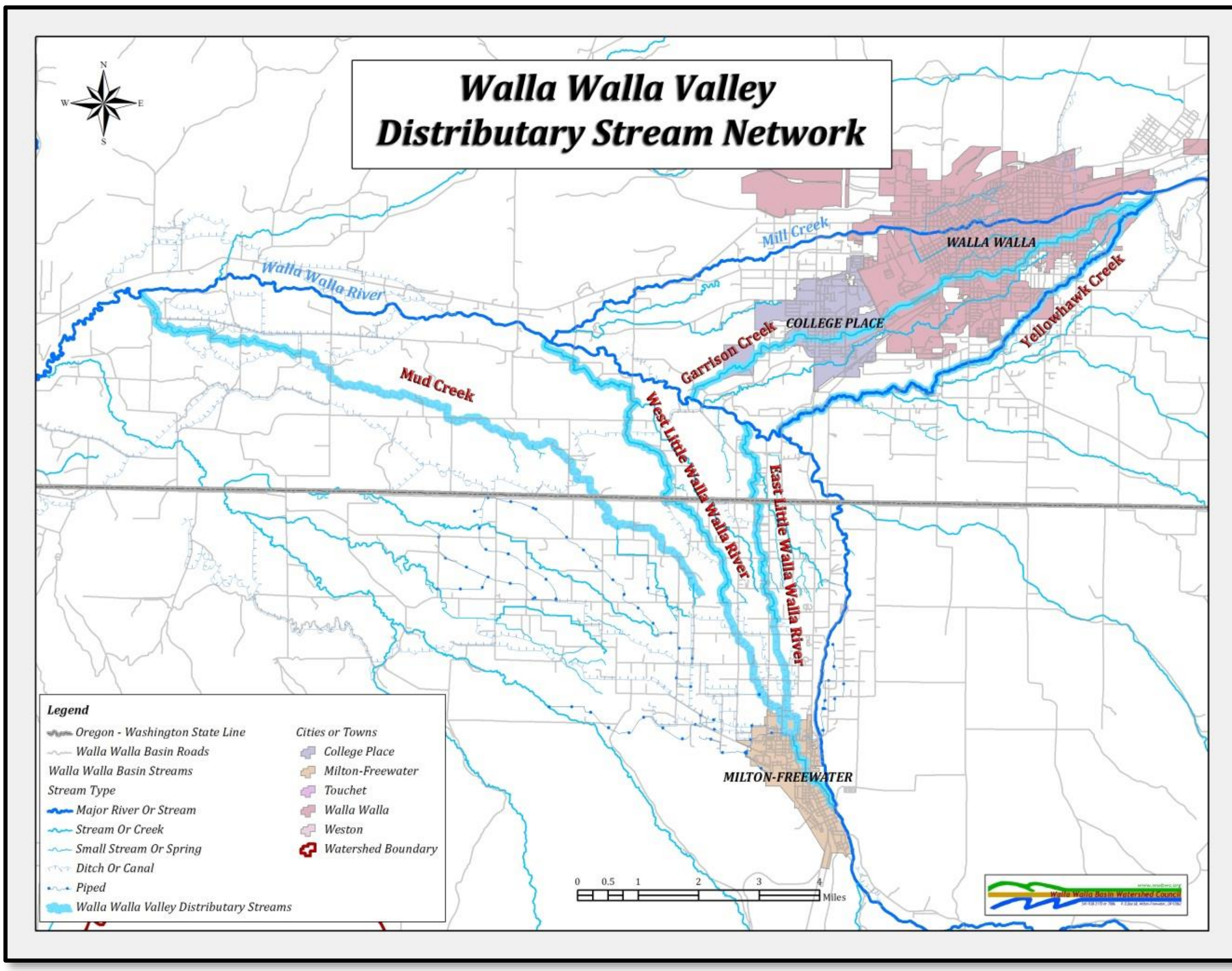

Figure 4 - Map of the distributary stream networks of the Walla Walla River and Mill Creek. Historically these stream networks conveyed winter and spring high flows across the valley's alluvial fans allowing for reduced flood pressure on the mainstem rivers, provided off-channel habitat and provided recharge to the alluvial aquifer system.

Generally, the 'spreading out' of water across the alluvial fans via distributary channels and adjacent floodplains, coupled with the high hydraulic conductivity of the underlying coarse sediment, functions as a primary groundwater recharge mechanism for the entire alluvial aquifer.

This seasonally recharged aquifer system in-turn feeds the valley's springs, spring creeks and larger streams. This cycling of surface water to groundwater recharge, followed by later discharge in springs and as stream baseflow creates a delay in discharge of these waters from the valley. Depending on local conditions, this delay can range from days to months, and even years (Jiménez, 2012). Additionally, the distributary channels provided off-channel habitat for aquatic species.

The management and development of surface water resources in the basin has led to installation of flow control devices (i.e. irrigation head gates) at the heads of the distributary channels. Over time, management of the flow within the distributary network has resulted in a less natural distribution of floodwaters during periods of high flow. Peak stream flows that would generally occur during the winter and spring no longer have free access to the distributary network and the adjacent floodplains that would provide recharge to the underlying alluvial aquifer. The current management of peak flows, the channelization of the valley's rivers and creeks and development of the alluvial aquifer as a groundwater resource has contributed substantially to declining groundwater levels in the alluvial aquifer.

The decline in alluvial aquifer water levels, coupled with the high hydraulic connectivity between surface water and alluvial groundwater, has created losing reaches along the streams and/or rivers where high seepage loss occurs and instream flow is decreased as significant volumes of surface water drain to the underlying alluvial aquifer (Figure 5).

In recent years, the listing of steelhead and bull trout as threatened under the Endangered Species Act and the reintroduction of spring chinook salmon within the Walla Walla watershed, has led to out-of-court agreements between irrigators and Federal fishery agencies to enhance instream flows. As a result of these agreements, local irrigators are leaving a portion of their legal water rights instream as bypass water year round. For example, per civil agreement, HBDIC and Walla Walla River Irrigation District irrigators leave 25-27 cfs instream (bypass) throughout the year. However, depending on the water-year and a number of other factors, it is not unusual to have a significant portion (40-50%) of the bypass water seep into the underlying alluvial aquifer before it reaches the WA/OR border (WWBWC, 2014)

Creeks across the valley are sourced by springs discharging from the alluvial aquifer and have also seen declines in flow since the earliest hydrogeologic studies were conducted by Piper (acting on behalf of the US Supreme Court) in the 1930s, Newcomb in the 1960s and Barker and MacNish in the 1970s (Piper, 1933; Newcomb, 1965; Barker and MacMish, 1976). Water level declines in the alluvial aquifer since the 1930s and 1940s (Figures 6 & 7) are consistent with the general decline in discharge from the related springs (Figure 8). These trends lead one to conclude that over the past several decades there has been a general decrease in groundwater contributions to baseflow of the Walla Walla River and other surface bodies during critical low-flow periods. This loss of cooler groundwater baseflow to streams affects not only the amount of flow in the river but also leads to increased surface water temperature during the low-flow periods, affecting aquatic species and the stream ecosystem.

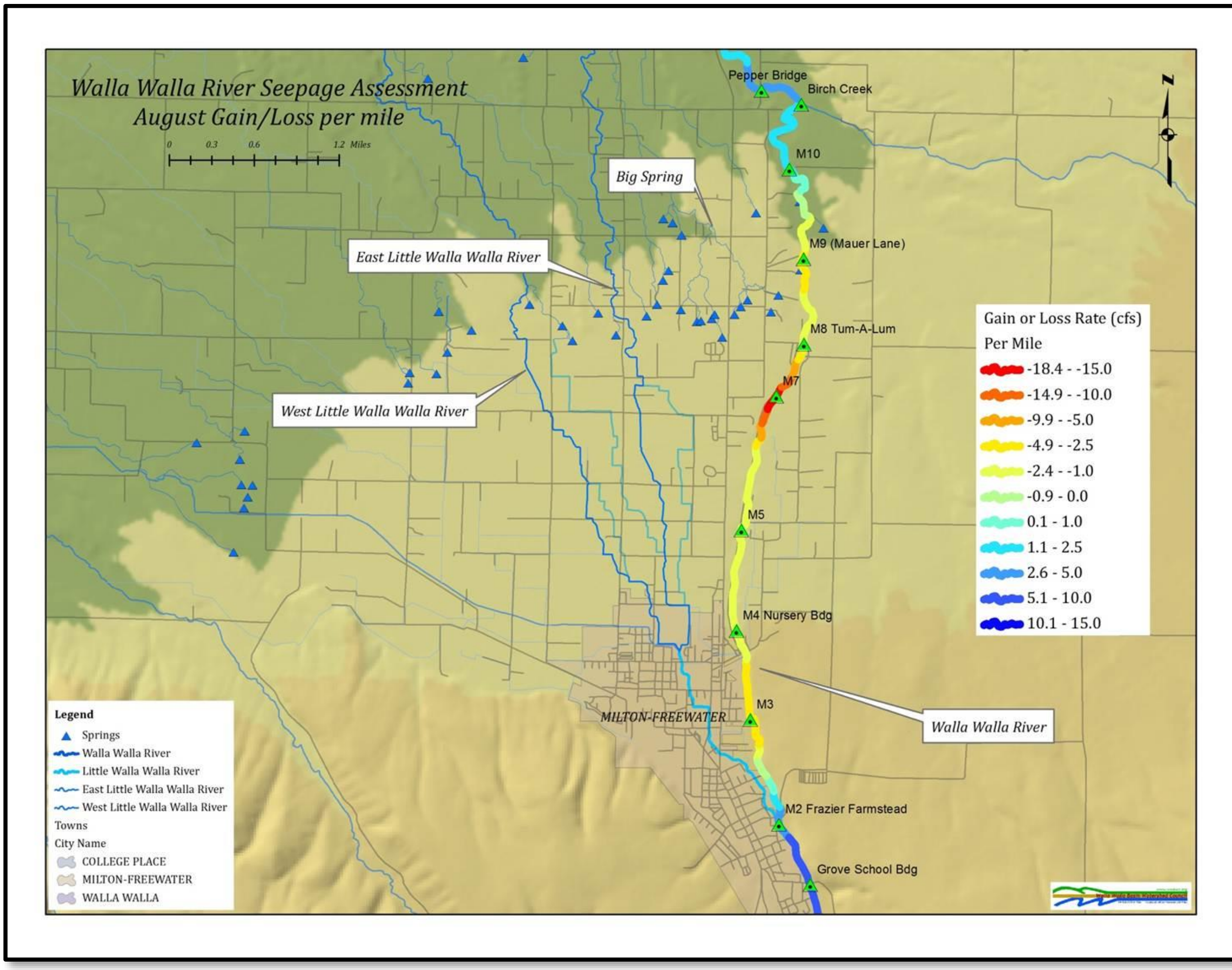

Figure 5 - Results from the water budget analysis of the Walla Walla River in August 2009. Color indicates a given reach as either gaining or losing. Gains (positive values) indicate groundwater discharging to the river and losses (negative values) indicate surface water seeping into the ground (see WWBWC, 2014 for details).

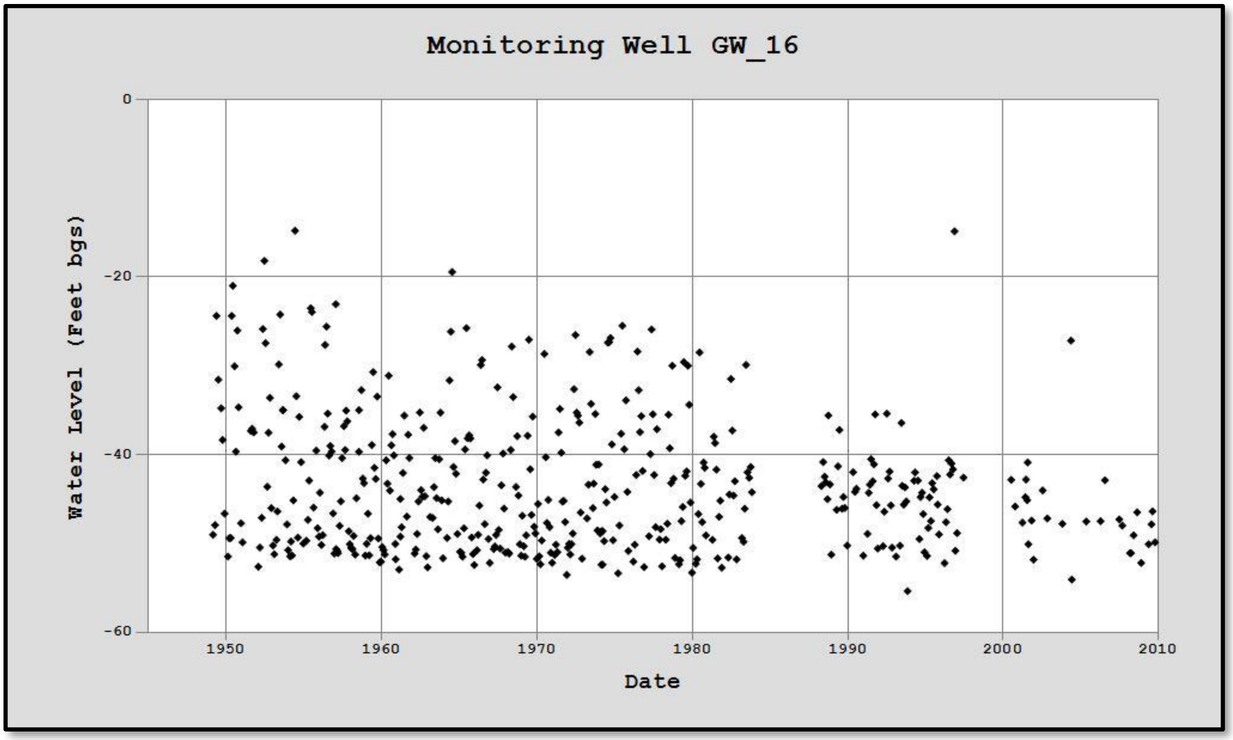

Figure 6 - Hydrograph for Monitoring Well GW_16 showing the long-term groundwater level decline in the alluvial aquifer system in the Walla Walla basin.

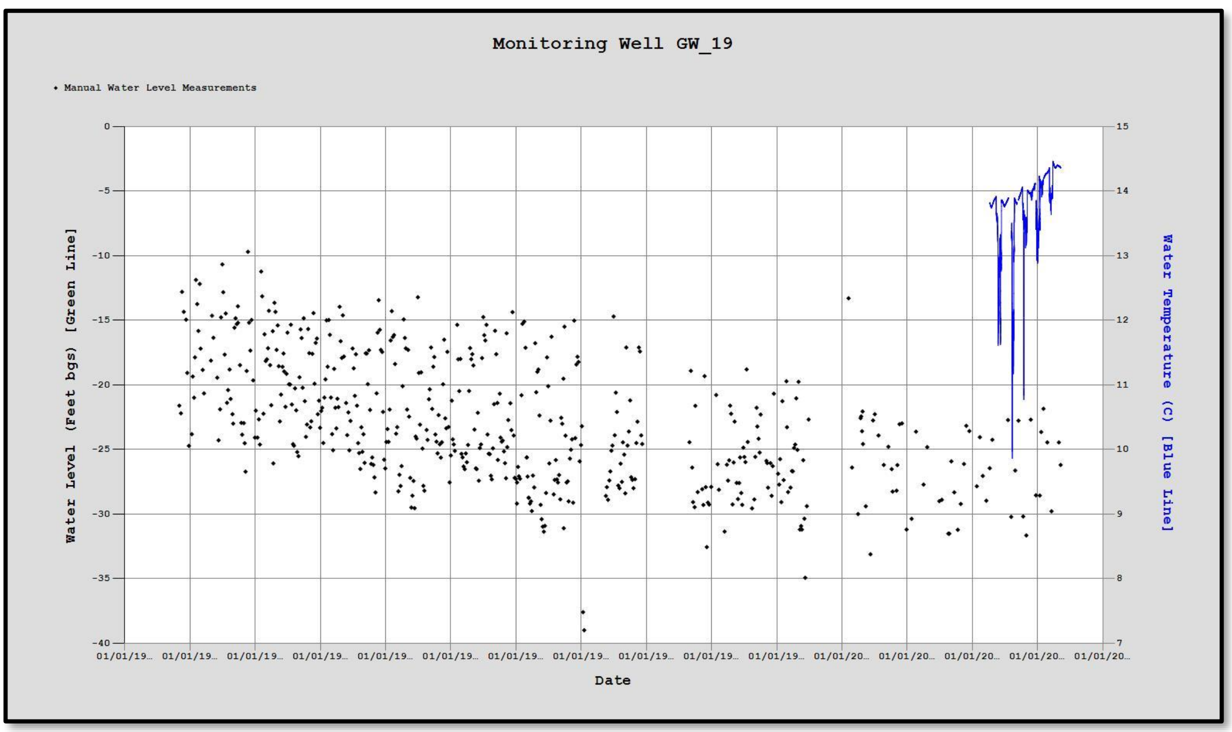

Figure 7 - Hydrograph for Monitoring Well GW_19 showing the long-term groundwater level decline in the alluvial aquifer system in the Walla Walla basin.

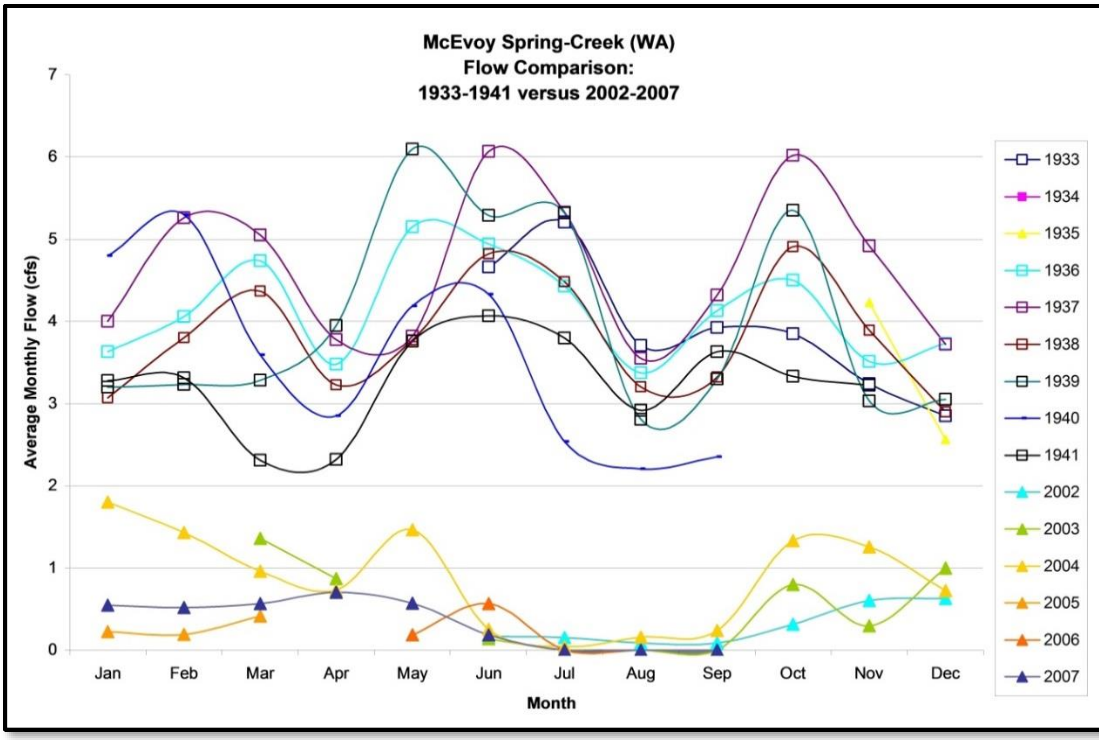

Figure 8 - Hydrograph for McEvoy Spring Creek located just north of the WA-OR state line. Hydrograph shows the decline in spring flows over the last 80 years.

Aquifer Recharge Site Infrastructure Design and Operation

The Anspach, Barrett, Johnson, NW Umapine and Trumbull AR sites were in operation during WY2016 as part of the Walla Walla Basin AR program (Figure 9). Each site's design, construction and operational capacity is provided in the following sections. Design drawings for each site are included as Appendix C.

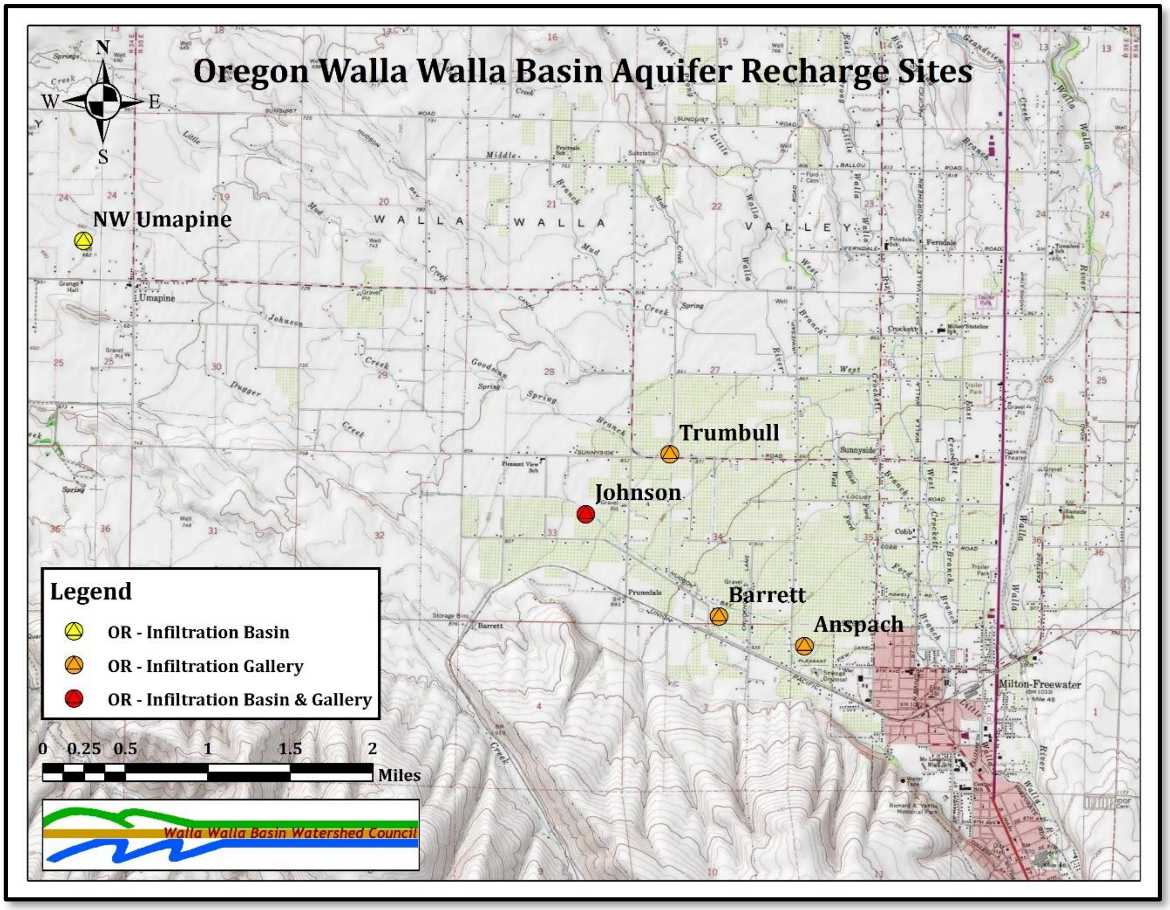

Figure 9 - Active aquifer recharge sites in the Oregon portion of the Walla Walla Basin during WY2016.

Anspach Aquifer Recharge Site

The Anspach AR site (Anspach site) was constructed in October 2012 using a combination of Bonneville Power Administration (BPA) and Oregon Watershed Enhancement Board (OWEB) funding and expanded in the fall/winter of 2015. The site consists of a single turnout structure installed in the HBDIC canal that delivers water to a new pipeline that serves both infiltration galleries. Each infiltration gallery is independently controlled via valves and turnout pipes. The pipe manifolds into ten 4-inch diameter perforated drain field pipes buried 6 to7 feet below ground surface (bgs) and extends approximately 200 feet from the source water manifold (Figure 10). The perforated pipes sit on top of approximately 1 to 2 feet of clean gravel and are overlaid with approximately 0.5 to 1 foot of clean gravel (See Appendix C for designs).

Water for this site is delivered down the HBDIC's White Ditch and diverted into a private pipeline/ditch. The site was designed to operate at a recharge rate of approximately 1 cfs. In the fall/winter of 2015, the Anspach site was expanded to include a second infiltration gallery and a new turnout and supply pipeline (Figure 11). The second infiltration gallery is similar in design to the original gallery. The expanded site now operates at approximately 1,500 gallons per minute which is 5 to 10 times what the site previously operated at. During the WY2016 recharge season, the site operated around 1,500 gallons per minute (~3.5 cfs).

Figure 10 - The Anspach Aquifer Recharge site during construction in October 2012. This recharge site utilizes ten 4-inch perforated pipes that run approximately 200 feet. See Appendix C for designs.

Figure 11 - New intake structure and pipeline for the Anspach AR site built in the fall/winter of 2015.

Barrett Aquifer Recharge Site

The Barrett AR site (Barrett site) was constructed in the winter of 2014 using OWEB funding. The site consists of seven 4-inch diameter perforated drain field pipes buried 4 to 5 feet bgs and extending approximately 600 feet from the source water manifold (Figure 12). The perforated pipes sit on top of approximately 1 to 2 foot of clean gravel and are overlaid with approximately 0.5 to 1 foot of clean gravel (See Appendix C for designs). Water for this site is delivered down the HBDIC's White Ditch and diverted into the Barrett pipeline. The Barrett site's turnout and valve are situated along the pipeline. The site was designed to operate at a recharge rate of approximately 2-3 cfs. During the WY2016 recharge season, the site operated at 1-4 cfs. The greater than expected recharge rate was likely due to head pressure in the pipeline, the sediments being more hydraulically conductive than anticipated and large depth to groundwater. Variations in recharge rate were primarily due to variable pipeline flowrates in response to clogging of the debris screen at the head of the pipeline and down-pipe irrigation demand during the spring. When the pipeline debris screen is clear of debris the site can run at over 3 cfs and when clogged with debris the site can run at 1-2 cfs.

Figure 12 - Turn out structure, valve, flow meter and pipe manifold for the Barrett Aquifer Recharge site. See Appendix C for design details.

JOHNSON AQUIFER RECHARGE SITE

The Johnson site, formerly known as the Hudson Bay site and/or the Hulette Johnson site, has been operating since 2004. The Johnson site has been developed in three phases since pilot testing operations began in 2004 (Figure 13). The initial two phases are described extensively in the final report for the sites first limited license (WWBWC, 2010). The site currently has the capacity for approximately 16 to 17 cfs of infiltration into approximately 3 acres of infiltration basins (spreading basins) and three infiltration galleries (Figure 13). During the WY2016 season the site had an average inflow rate of just over 17 cfs. Johnson site construction is summarized below. For additional details on the Johnson site please see WWBWC (2010; 2013; 2014b).

SPREADING BASINS

The Johnson site was originally constructed with three spreading basins (Figure 13). The three original basins were constructed in the winter/spring of 2004. These basins were increased in size during 2005 to almost triple their original area. Phase II included the addition of a hydraulically up-gradient spreading basin in 2006 and four infiltration galleries in the winter of 2009. Water for the new up-gradient basin was fed through the original diversion with water being "pushed" into it from the first basin. Phase III included the addition of four additional basins on the lower end of the property, a new out-flow measurement weir, a new pipeline that feeds water to each individual basin, a telemetry system to remotely monitor site operation and an alternate method to deliver water to the up-gradient basin. During the Phase III construction of the down-gradient spreading basins, the largest basin described in the preliminary design was modified because subsurface material beneath the southern half of the planned basin consisted of finer-grained sand/silt while the northern half consisted of coarser gravel/cobbles. On the basis of the encountered heterogeneous conditions, it was decided to divide the down-gradient basin into two basins based upon the sediment types (Figure 13 and 14).

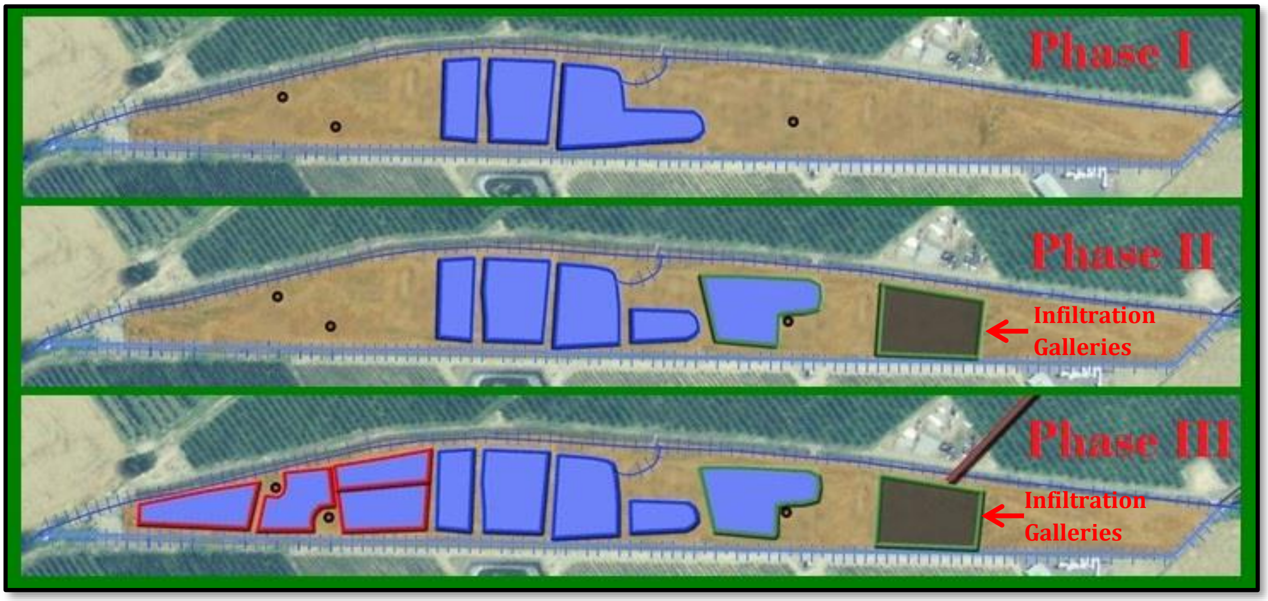

Figure 13 - The Johnson site's spreading basins showing the three phases of construction. Phase I was conducted in 2004-2005, Phase II in 2006-2009 and Phase III in 2010-2011. See Appendix C for as built designs.

Figure 14 - Aerial photo of the Johnson site from 2013 showing the current configuration of the site with 10 spreading basins and 3 active infiltration galleries (between the spreading basins and the pile of fill material).

INFILTRATION GALLERIES

During Phase II, four different infiltration gallery (IG) designs were installed at the Johnson site to evaluate each design's performance, longevity, and cost-benefit. IG #1 was constructed of four corrugated 4-inch perforated pipe, IG #2 was constructed of twenty 4-inch drain field pipe, IG #3 was four 4-inch drain field pipe inside Stormtech stormwater chambers and IG #4 was a single 4-inch drain field pipe inside Atlantis stormwater devices (Figures 15-17). During the first season of testing IG #1 clogged up and has not been utilized since. IG #2, IG #3 and IG #4 have all continued to function and have been operated during each recharge season.

Figure 15 - Photograph of infiltration gallery #2 (IG2) being installed at the Johnson Aquifer Recharge site. IG2 is 4-inch perforated drain field pipe installed over washed gravel and buried in ~1 foot of washed gravel with geo-textile fabric on top of the gravel. See Appendix C for designs.

Figure 16 - Photograph of infiltration gallery #3 (IG3) at the Johnson Aquifer Recharge site. IG3 is 4-inch perforated drain field pipe installed within Stormtech stormwater chambers (yellow covers) over washed gravel and buried in ~2 foot of washed gravel with geo-textile fabric on top of the gravel. See Appendix C for designs.

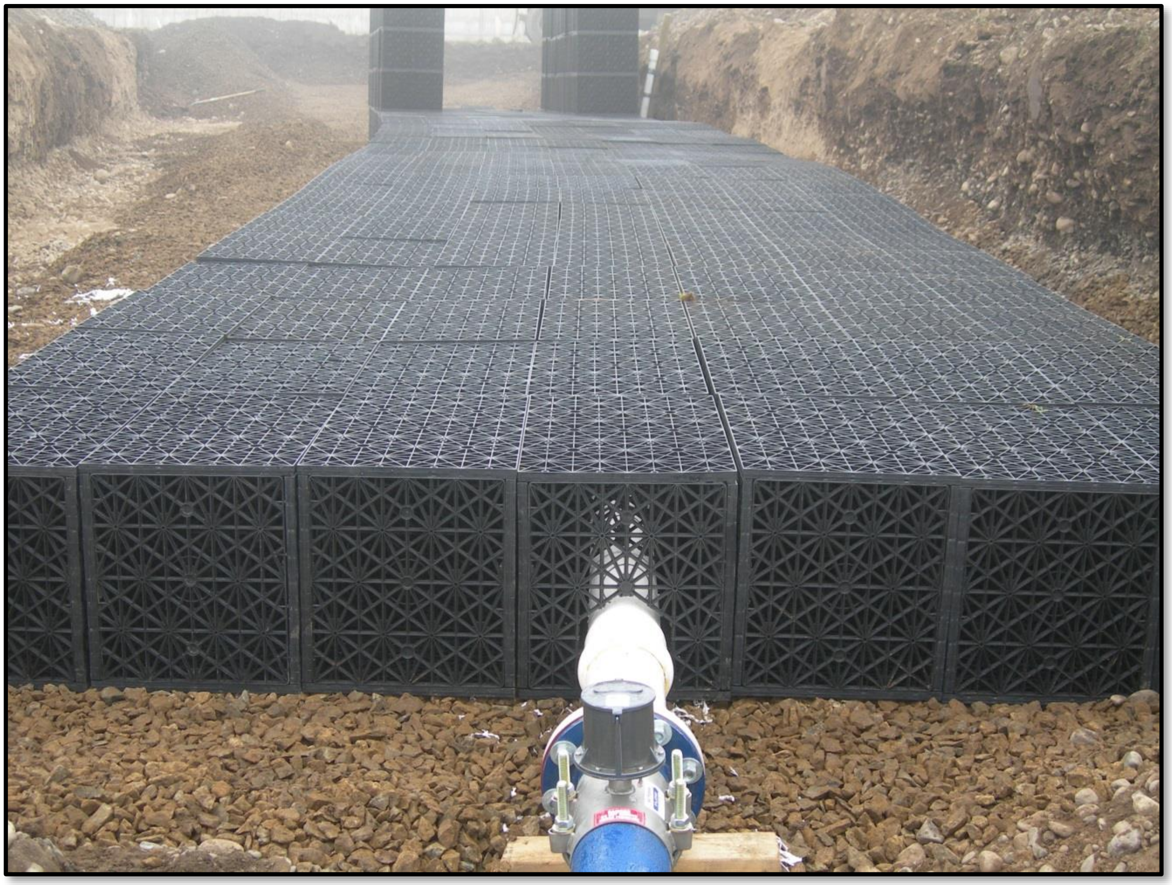

Figure 17 - Photograph of infiltration gallery #4 (IG4) at the Johnson AR site. IG4 is a single 4-inch perforated drain field pipe installed within Atlantis stormwater devices (black milk crates) over washed gravel and buried in ~2 foot of washed gravel with geo-textile fabric on top of the gravel. See Appendix C for designs.

NW Umapine Aquifer Recharge Site

The NW Umapine AR site (NW Umapine site) was constructed in the fall of 2013 using OWEB funding. The site consists of a single infiltration basin approximately 0.46 acres in size (Figures 18 and 19). The site is supplied by an approximately 1,000-ft long lateral pipeline installed off of HBDIC's Richartz's pipeline. The site was designed to operate at a recharge rate of 2-3 cfs. During the WY2016 recharge season the site averaged 1-2 cfs. Down-pipe irrigation demand reduced site water delivery during April and May.

Figure 18 - NW Umapine Aquifer Recharge site during excavation and shaping of the infiltration basin. See Appendix C for design details.

Figure 19 - NW Umapine Aquifer Recharge site operating during the WY2014 recharge season.

TRUMBULL AQUIFER RECHARGE SITE

The Trumbull AR site (Trumbull site) was constructed in October 2012 using a combination of BPA and OWEB funding. The site consists of three 8-inch perforated pipes buried 6 feet bgs and extending approximately 300 feet in length from the source water discharge and inline flow meter (Figure 20). The perforated pipes sit on top of approximately 1-2 foot of clean gravel and are overlaid with approximately 0.5-1 feet of clean gravel (See Appendix C for designs). Recharge water is delivered through the HBDIC system. The Trumbull site's water source is at the structure that splits the HBDIC canal into the Hyline pipeline and the Richardz ditch. The site has its own turnout and valve so it can operate independent of the ditch or pipeline. The site was designed to operate at a recharge rate of 2 to 3 cfs. The site was operated during the WY2016 recharge season at an average rate of 1.5 cfs. The Trumbull site recharge rate variation is hypothesized to be due to down-gradient control by springs and groundwater mounding as well as limited head pressure in the diversion structure at times during the recharge season.

Figure 20 - The Trumbull Aquifer Recharge site under construction in October 2012. The site is approximately 300 feet long with three 8-inch pipes running the entire length. See Appendix C for design details.

WY 2016 Recharge System Monitoring

This section describes diversion system monitoring results, individual site AR operations and groundwater level monitoring, and source and groundwater quality monitoring results. Laboratory water quality testing results are provided in Appendix D. Well logs for groundwater monitoring wells are included in Appendix E.

Diversion System

LL-1433 allows for up to 45 cfs to be diverted from the Walla Walla River for the purpose of testing artificial recharge. Per the conditions of LL-1433, a minimum instream flow amount is required to remain in the Tum a Lum reach of the Walla Walla River depending on the time of year (Table 1). WWBWC coordinated with HBDIC and the OWRD District 5 watermaster to ensure that this condition of LL-1433 was met during recharge operations in WY 2016.

Table 1. – Minimum instream flow values, measured below Milton-Freewater, OR that must be met before water can be diverted for OR aquifer recharge sites under Limited License LL-1433.

Minimum Instream Flow Values for Limited License LL-1433		
Nov 1st thru Nov 30th	***Dec 1st thru Jan 31st***	***Feb 1st thru May 15th***
64 cfs	***95 cfs***	***150 cfs***

On the basis of observations during WY 2016 recharge operations, not all of the water diverted from the Walla Walla River at the HBDIC diversion reaches the aquifer recharge sites due to seepage through unlined portions of the HBDIC canal system and/or evaporative losses. Because recharge operations occur during winter and spring months, evaporative losses are assumed to be negligible. To estimate ditch seepage losses during diversion, total water volumes at the Little Walla Walla Diversion stream gage (during periods when only recharge water was being diverted from the Walla Walla River) were compared to measured water volumes delivered to the recharge sites. Ditch seepage was estimated by subtracting the water delivered to the recharge sites from the water diverted from the Walla Walla River, with the difference assumed to be the amount of ditch seepage.

The total amount of water diverted at the Little Walla Walla Diversion stream gage during the WY 2016 recharge season (November 21st, 2015 to May 12th, 2016) was 6,229.54 acre-feet. A total of 5,208.74 acre-feet were applied at the five recharge sites over the same time period. The resulting calculated ditch seepage from November 21st, 2015 to May 12th, 2016 is 1,020.8 acre-feet, or approximately 8.8 acre-feet/day based on a 116 day recharge period in WY 2016.

Diversions for AR were terminated for the season on May 12th, 2016 due to low instream flows.

ANSPACH RECHARGE SITE

OVERVIEW

The Anspach AR site was constructed during the fall of 2012. This site operated under LL-1433 that was issued on March 11th, 2013. The Anspach site was operated for 77 days during the WY2016 recharge season. Operations were interrupted by cold weather and limited instream flows. The site was turned off for the season on May 12th, 2016 because of low instream flows. During the WY2016 season the site received a total of 532.38 acre-feet (6.91 acre-feet/day) of water (Figure 21).

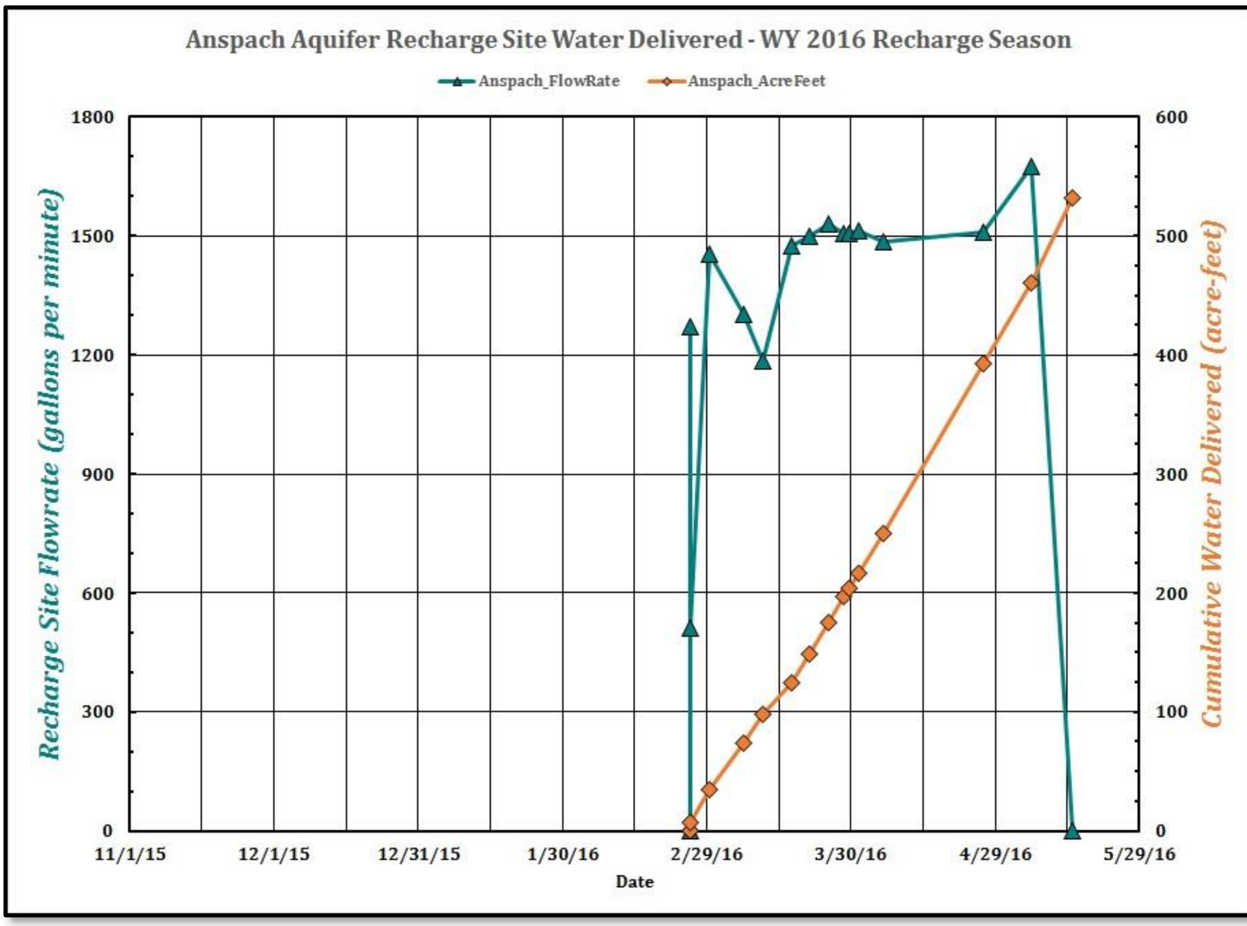

Figure 21 - Hydrograph for the Anspach Aquifer Recharge site during WY 2016 showing inflow rates and cumulative water delivered.

ALLUVIAL AQUIFER RESPONSE

The site has two up-gradient wells (GW_135 and GW_141; Figures 22-24). GW_135 is monitored quarterly, however these data correspond well with the other up-gradient well, GW_141, with a slight delay in groundwater level response at the beginning of operations (Figure 24). Groundwater levels increased in monitoring well GW_141 in response to recharge activities starting in late-February. Water levels decreased in mid-May when recharge operations were suspended for the season. Groundwater levels fall throughout the summer and early fall months with a rise in water levels when the HBDIC system was reactivated in mid-September. Quarterly static water levels were also measured in the cross-gradient monitoring well GW_23 (Figure 25). The GW_23 quarterly measurements show a similar trend to those observed in GW_141, namely lower groundwater levels before recharge is started for the season and higher levels during recharge and after recharge operations were suspended. The 2013-2016 hydrograph for GW_141 is also included to show longer term groundwater conditions at the Anspach site (Figure 26).

Groundwater levels at the Anspach site indicate that groundwater level conditions are improving (Figure 26). Operating the expanded site for additional years will help determine if this represents a long-term trend.

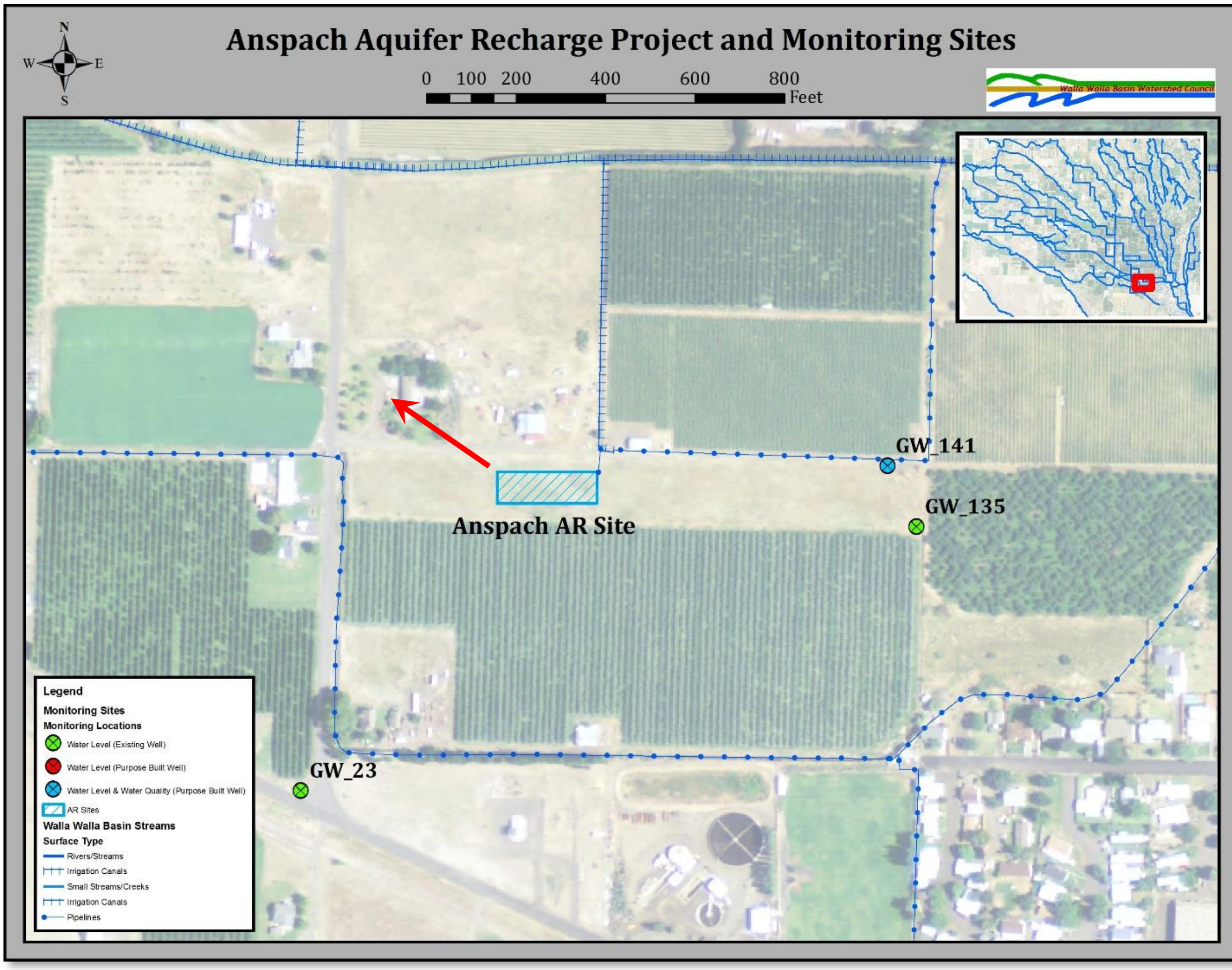

Figure 22 - Monitoring well locations for the Anspach Aquifer Recharge site. Red arrow indicates generalized groundwater flow direction.

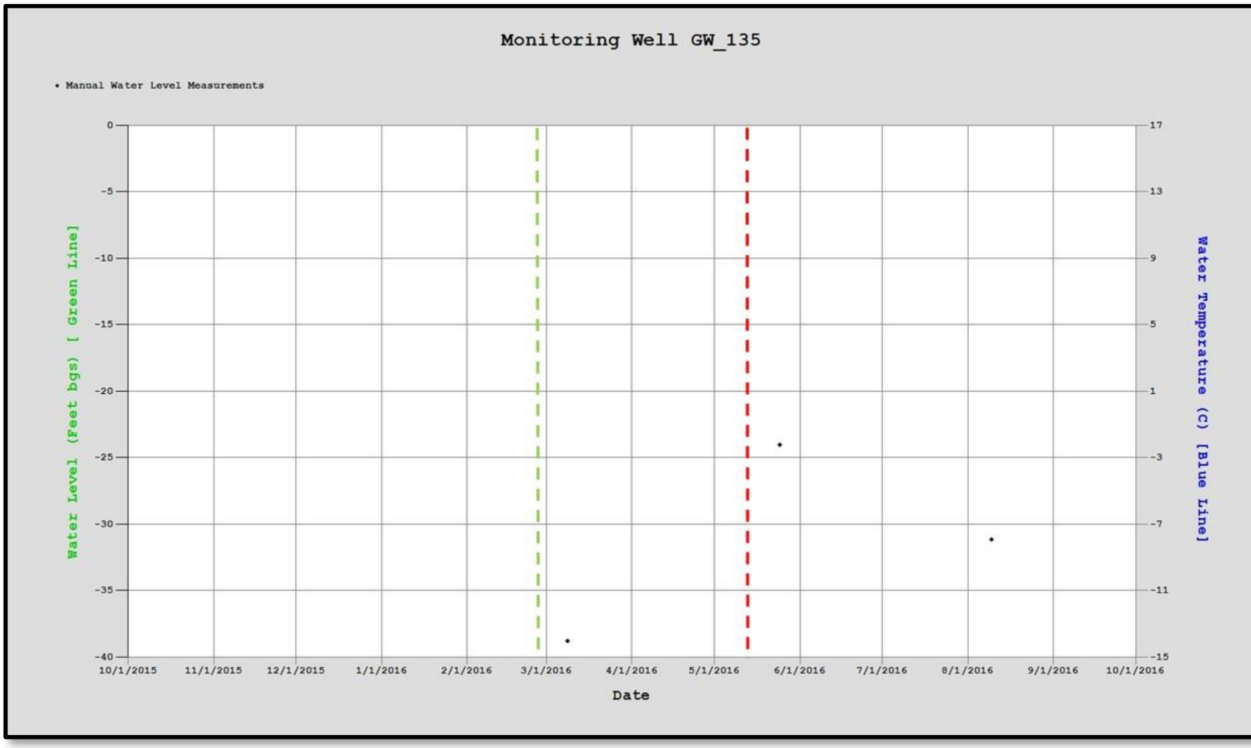

Figure 23 - Hydrograph for monitoring well GW_135. Green dashed lines indicate start of recharge operations and red dashed lines indicate end of recharge operations.

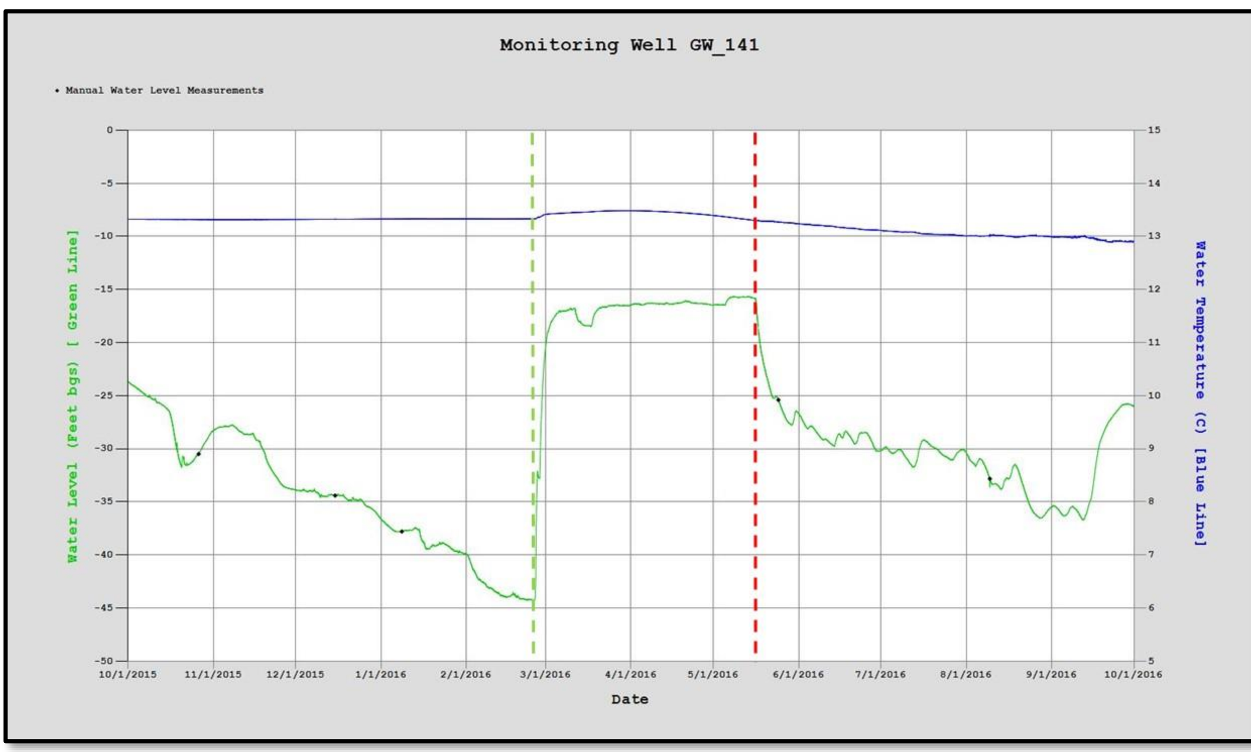

Figure 24 - Hydrograph for monitoring well GW_141. Green dashed lines indicate start of recharge operations and red dashed lines indicate end of recharge operations.

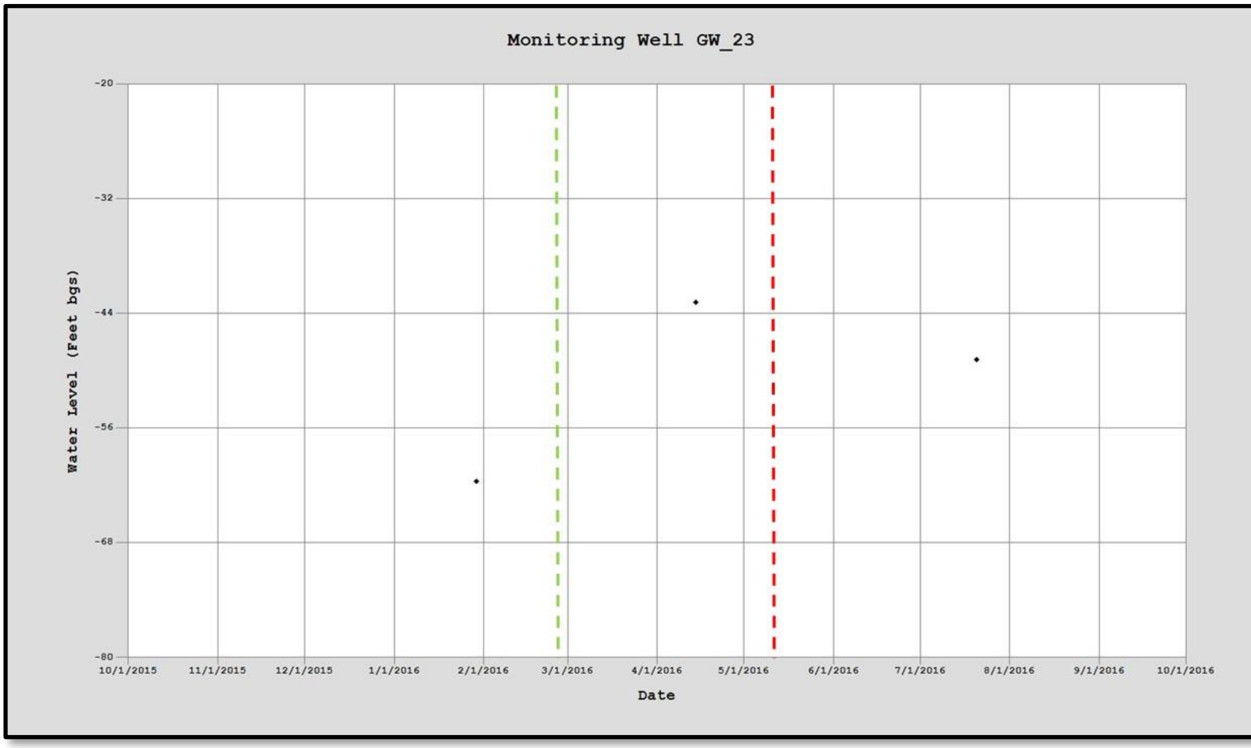

Figure 25 - Hydrograph for monitoring well GW_23. Green dashed lines indicate start of recharge operations and red dashed lines indicate end of recharge operations.

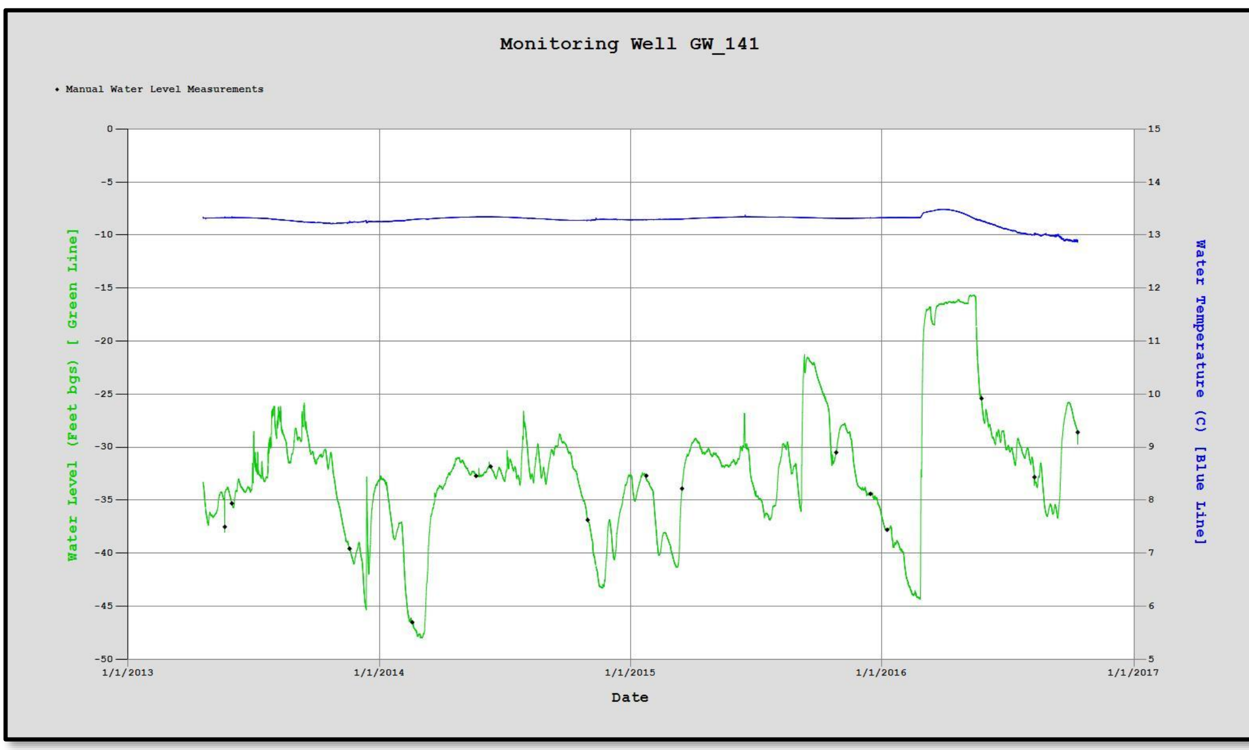

Figure 26 - 2013-2016 hydrograph for GW_141.

BARRETT RECHARGE SITE

The Barrett AR site was constructed during the winter of 2014. This site operates under LL-1433 that was issued on March 11th, 2013. During the WY2016 recharge season the site operated for 90 days from mid-December until May 12th, 2016 because of low instream flows. The site received a total of 285.52 acre-feet of water at an average rate of 3.17 acre-feet per day (Figure 27).

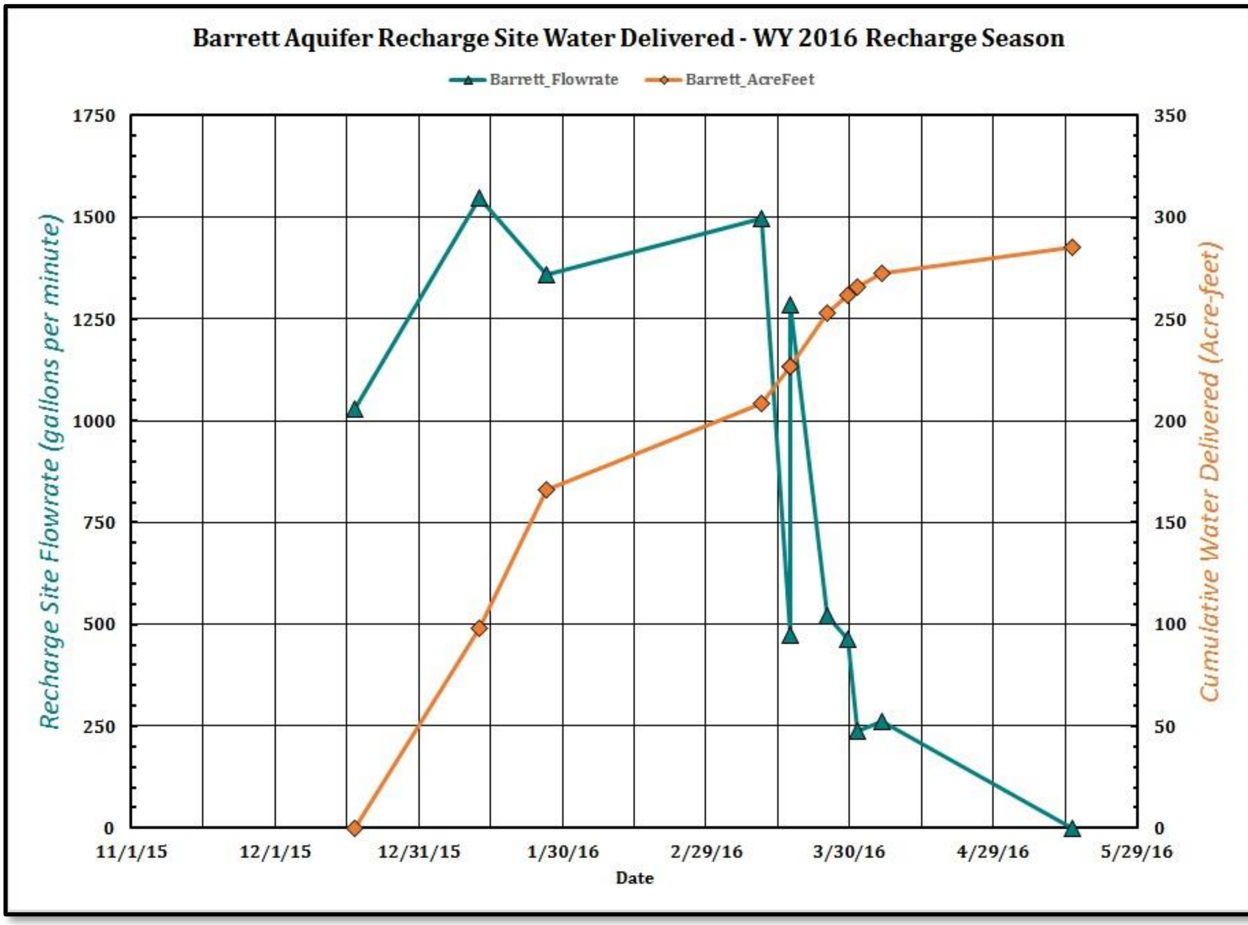

Figure 27 - Hydrograph for the Barrett Aquifer Recharge site showing inflow rates and cumulative water delivered.

ALLUVIAL AQUIFER RESPONSE

Response to recharge operations at the Barrett site were observed at the up-gradient groundwater monitoring well, GW_62 (Figure 28-30). Groundwater levels in the monitoring well increased during recharge operations and decreased when recharge operations stopped (Figure 29). An approximately one-week delay was observed between the start of recharge operations and increasing groundwater levels. Water levels measured at GW_62 are greater during the late spring and early summer months relative to water levels prior to operation of the Barrett site. The 2005-2016 hydrograph for GW_62 is included for longer term groundwater levels at the Barrett site (Figure 30).

Groundwater levels at the Barrett site have shown direct responses to aquifer recharge operations (Figure 30). Groundwater levels in GW_62 show improving groundwater levels over the last 2-3 years, especially during late-spring and summer months.

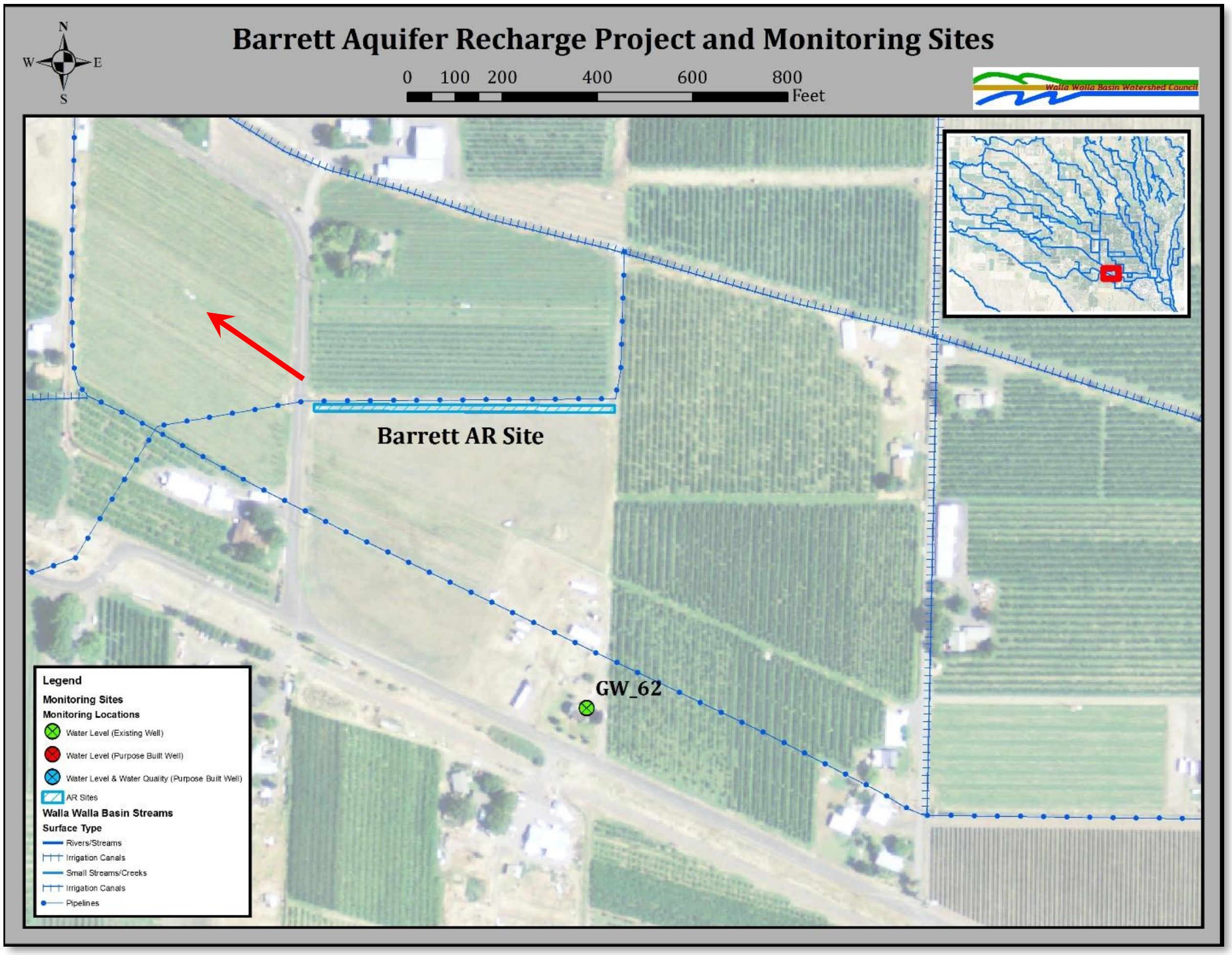

Figure 28 - Monitoring well locations for the Barrett Aquifer Recharge site. Red arrow indicates generalized groundwater flow direction.

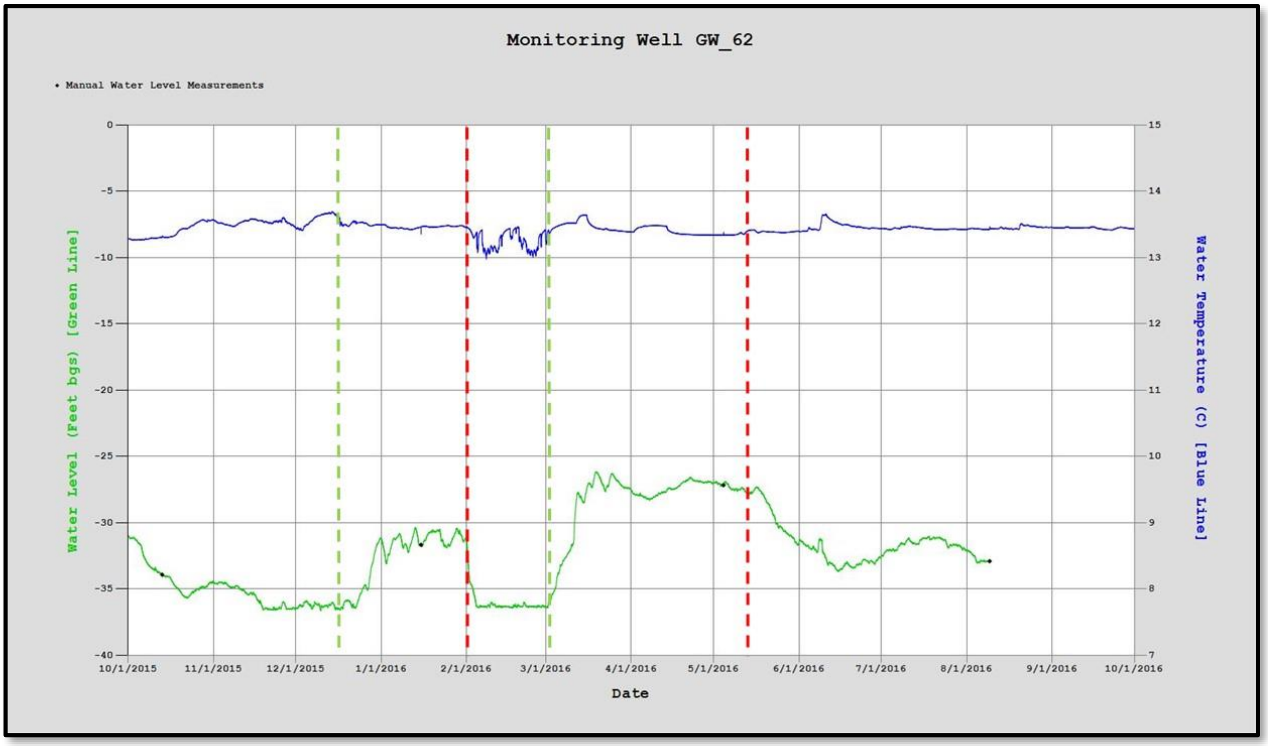

Figure 29 - Hydrograph for monitoring well GW_62. Green dashed lines indicate start of recharge operations and red dashed lines indicate end of recharge operations.

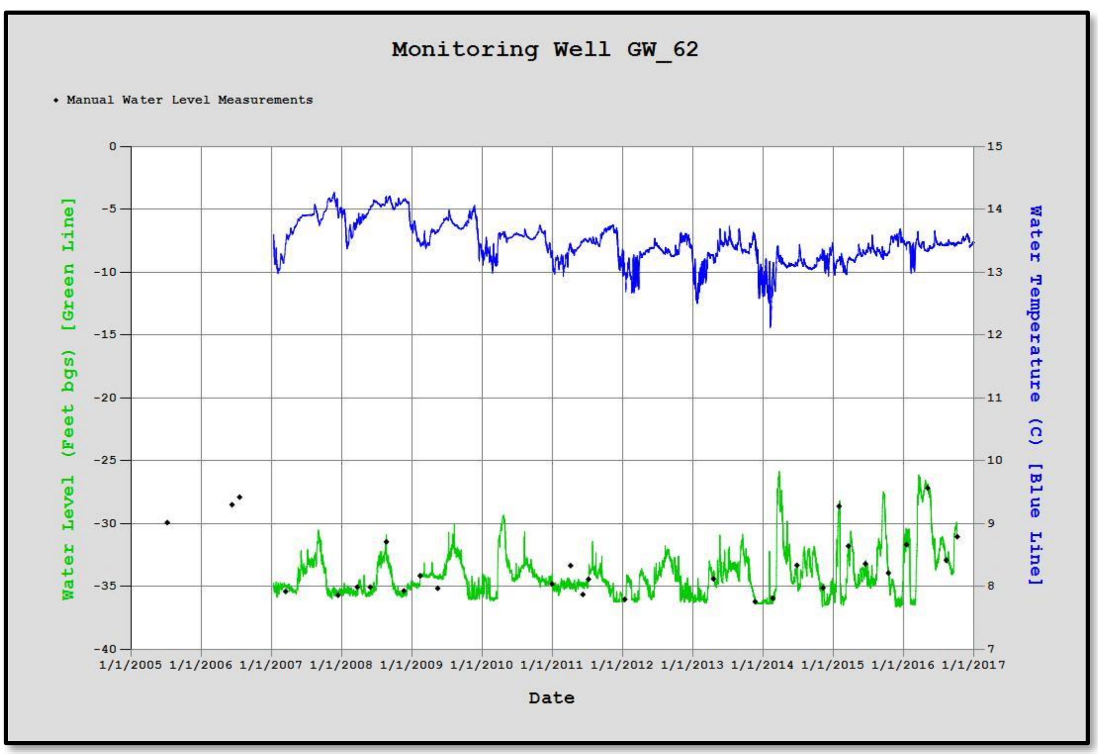

Figure 30 - 2005-2016 hydrograph for GW_62.

JOHNSON RECHARGE SITE

The Johnson site operates under LL-1433 that was issued on March 11th, 2013. The Johnson site ran for 116 days during the WY 2016 recharge season. The site ran from late-November through the end of January and from March until mid-May. The site was turned off for the season on May 12th, 2016 due to low instream flows. The Johnson site received a total of 3,958.85 acre-feet of water for recharge at an average rate of 34.1 acre-feet per day (Figures 31-34). The total measured volume of water received by the ten spreading basins was 3,474.90 acre-feet and received by the three active infiltration galleries was 483.95 acre-feet.

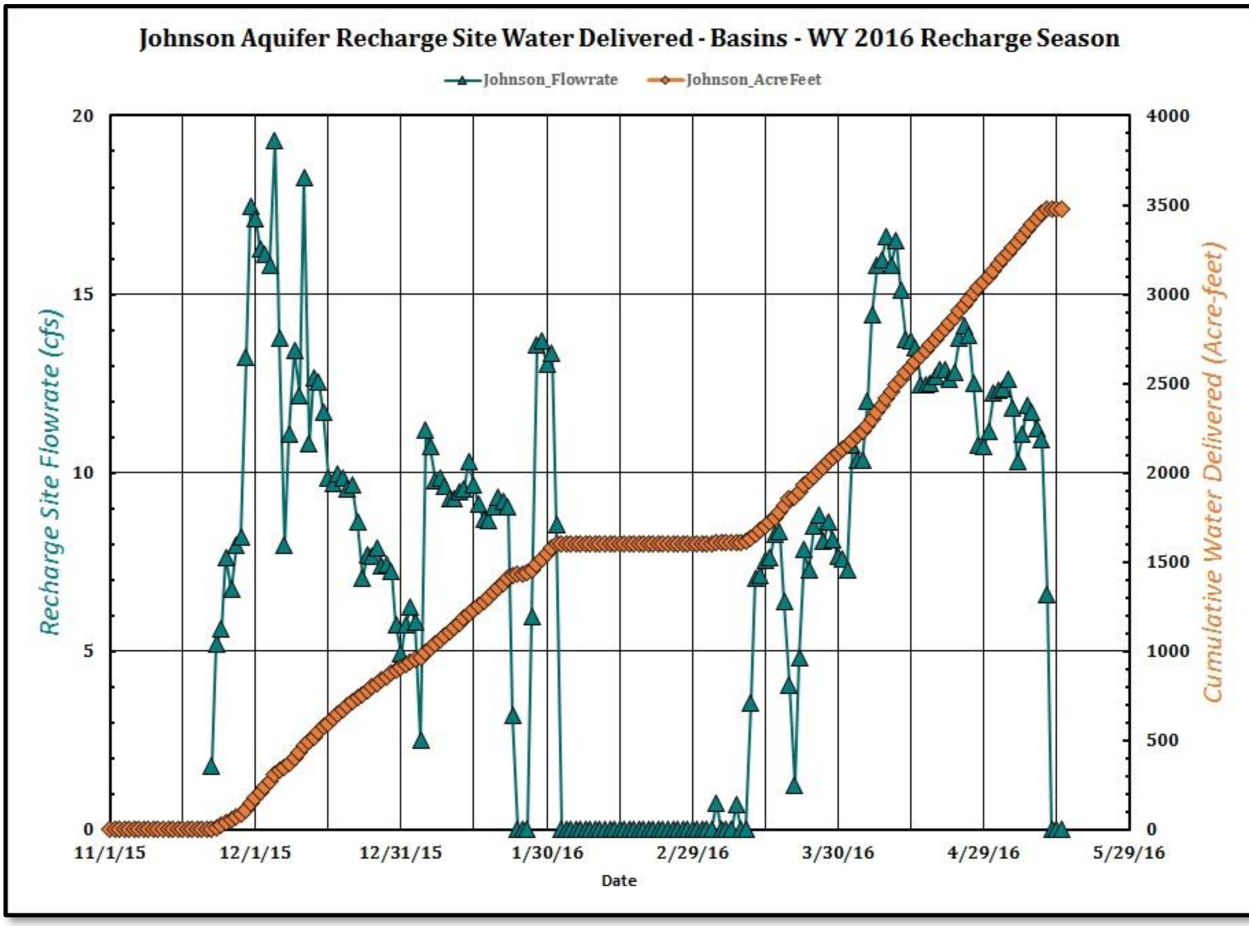

Figure 31 - Hydrograph for the Johnson site showing inflow rates and cumulative water delivered to the site's spreading basins.

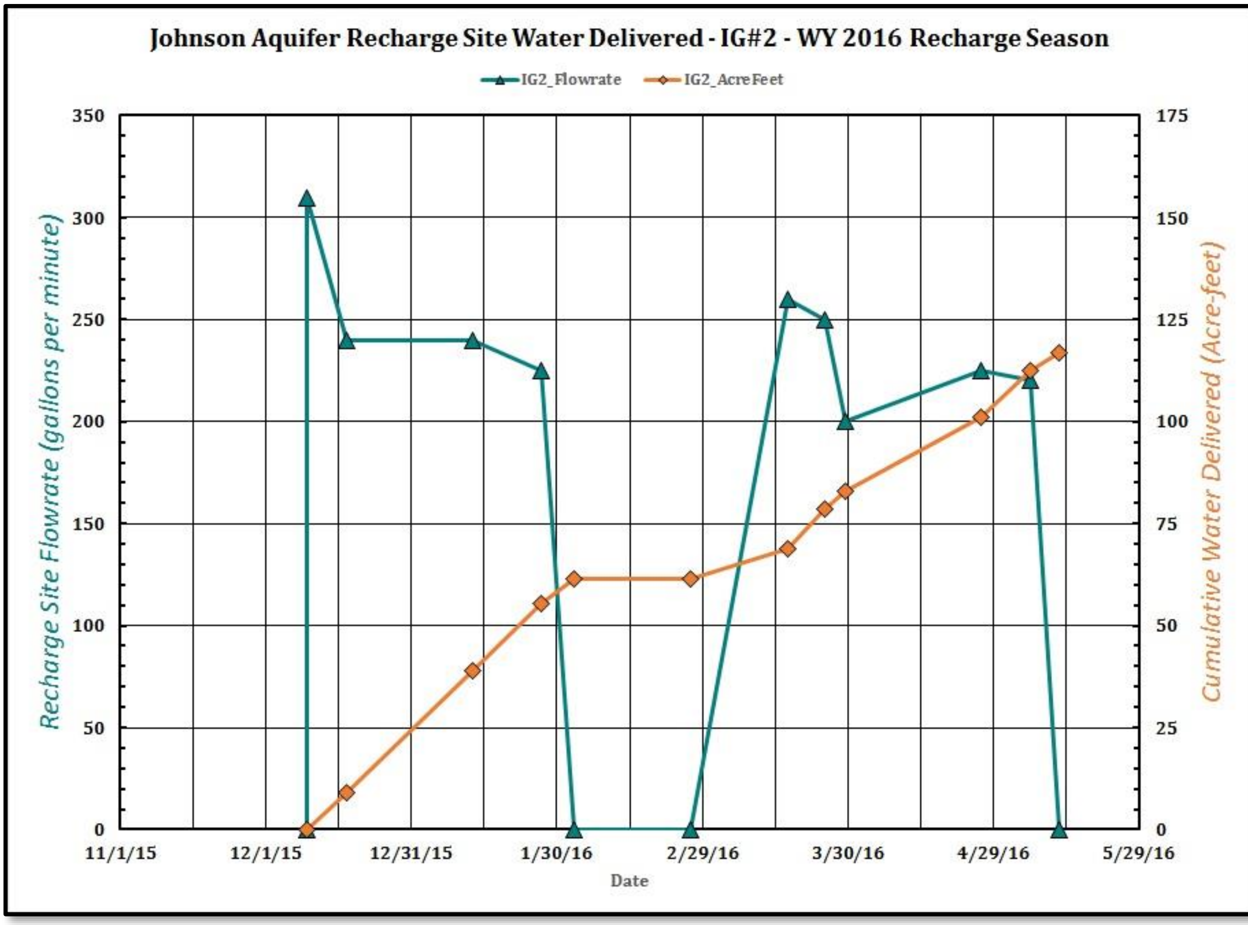

Figure 32 - Hydrograph for the Johnson site showing inflow rates and cumulative water delivered to infiltration gallery #2.

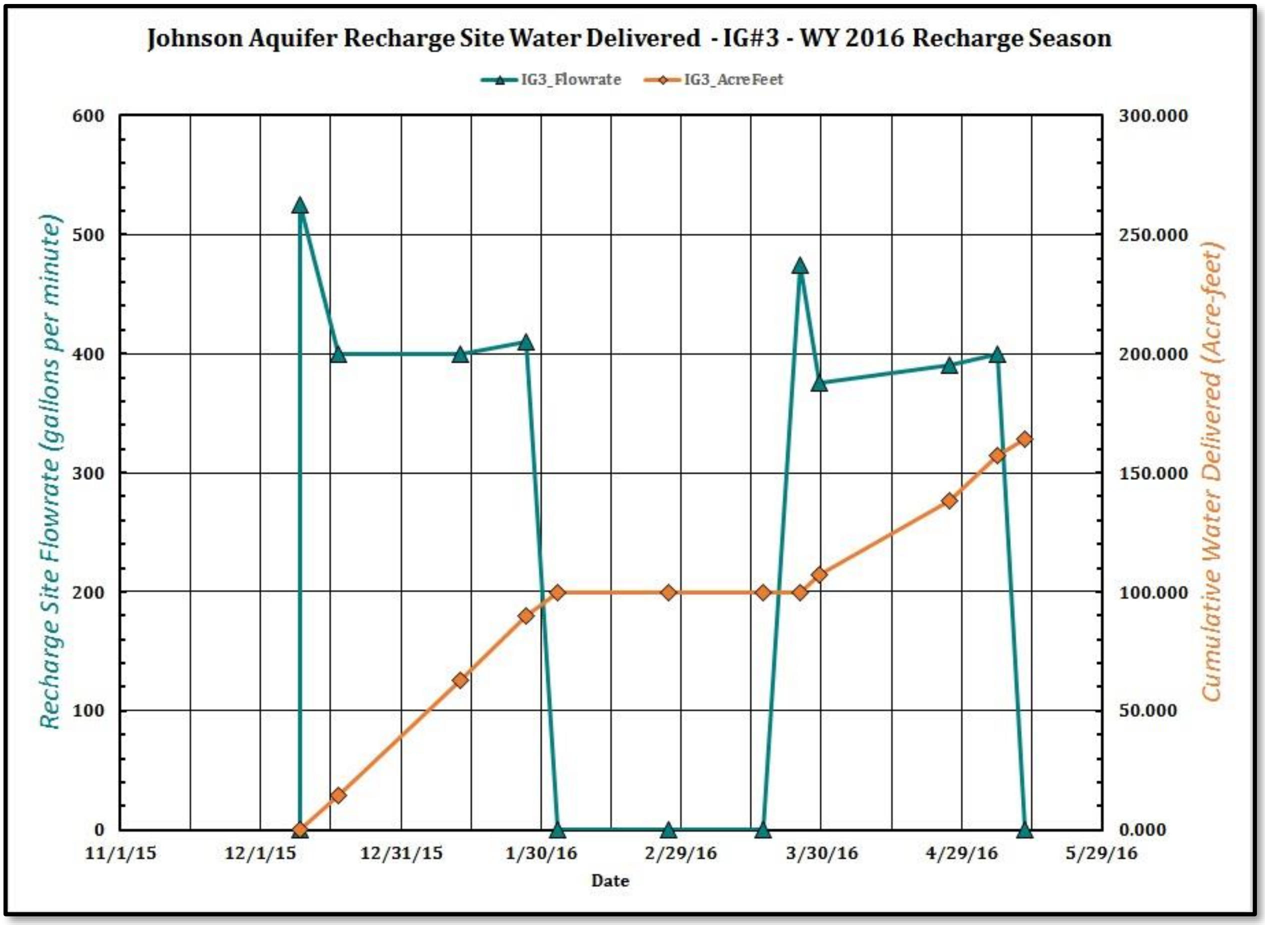

Figure 33 - Hydrograph for the Johnson site showing inflow rates and cumulative water delivered to infiltration gallery #3.

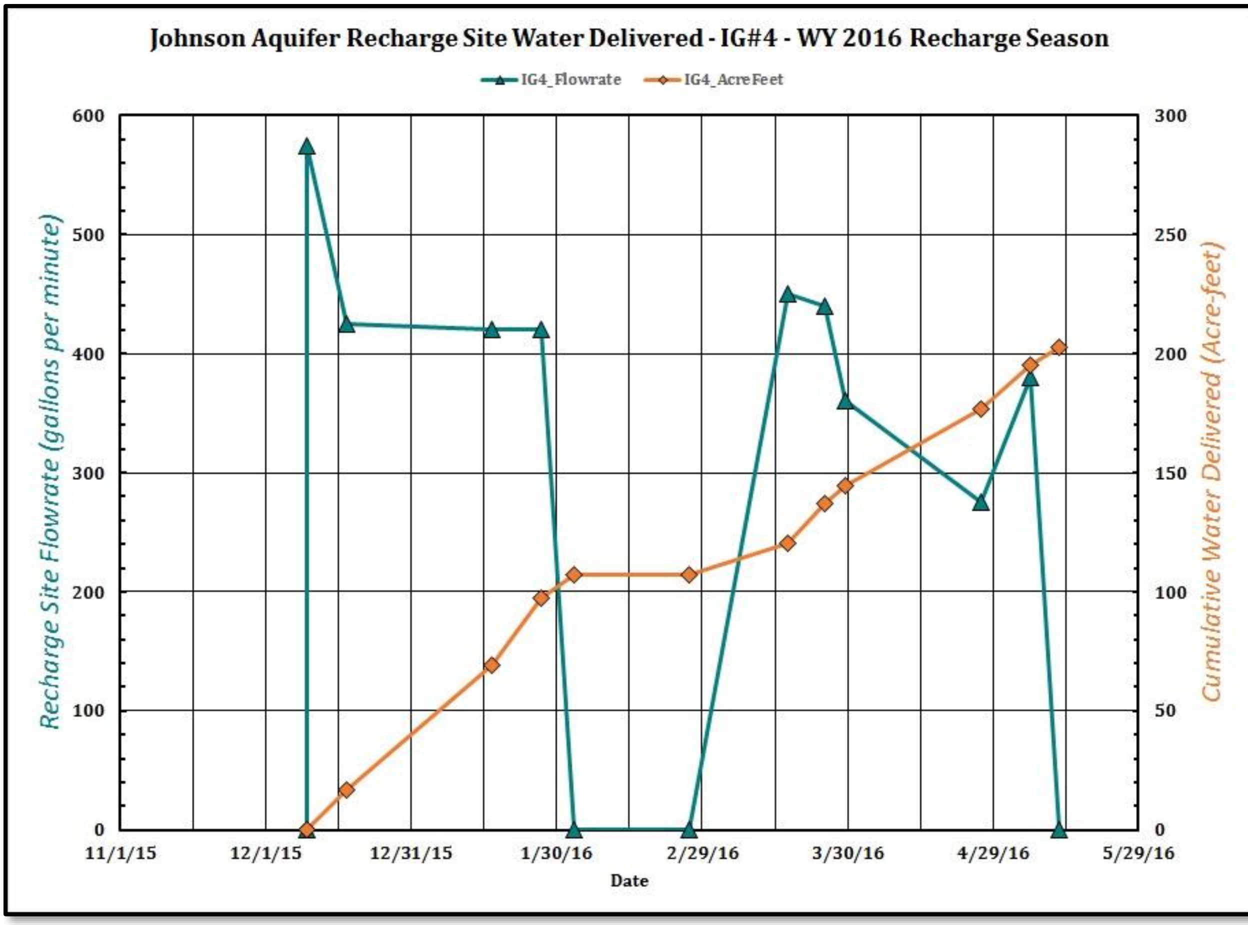

Figure 34 - Hydrograph for the Johnson Aquifer Recharge site showing inflow rates and cumulative water delivered to infiltration gallery #4.

ALLUVIAL AQUIFER RESPONSE

Groundwater monitoring wells (Figures 35-42) near the Johnson site were all observed to have a distinct increase in water levels shortly after operations began at the site. As would be expected, monitoring wells closer to the spreading basins and infiltration galleries (e.g. GW_45-48) responded more rapidly and with greater magnitude increases and decreases in water levels than those located farther down-gradient (e.g. GW_118). Up-gradient monitoring well GW_40 also showed a strong response to recharge operations with water levels increasing rapidly during recharge operations and decreasing after recharge operations were suspended. The up-gradient well also shows a direct response to White Ditch flows during the fall.

Water levels in GW_45, GW_46 and GW_47 were observed to decrease approximately 35-40 feet between approximately February 1 to March 9, 2016, when recharge operations were interrupted, and again at the end of recharge season. However, water levels after the end of recharge season do not decline as far, likely due to continued White Ditch operations and active irrigation in the area. The rate of water level decrease was slow relative to the water level increase response at the beginning of recharge operations, suggesting that groundwater mounding was occurring beneath the site, which is consistent with the observed hydraulic response in the alluvial monitoring well network. WY 2016 seasonal groundwater fluctuation at the site were typically 30 to 40 feet, with the lowest groundwater levels occurring in early March and September/October. The influence of the adjacent irrigation ditch operation and irrigation activities are apparent in the small increases and decreases in groundwater levels at the Johnson site monitoring wells during non-recharge months.

Water levels in GW_118 show a year to year positive (i.e. increasing) trend in alluvial aquifer water levels from WY 2010 through WY 2014 (Figure 42) indicating increased long-term water storage within the alluvial aquifer, potentially due to aquifer recharge activities. This trend was not continued in WY 2015, presumed to be due to decreased recharge in WY 2015 (relative to previous years) and drought conditions which resulted in increased groundwater pumping to compensate for limited surface water, especially within the Hudson Bay district. Water levels in WY 2016 returned to the trend seen before WY 2015, with a positive gain in groundwater levels. Continued recharge operations and monitoring are needed to establish a strong correlation between AR and observed long-term aquifer storage and to observe the long-term effects, if any, of the 2015 drought on groundwater conditions.

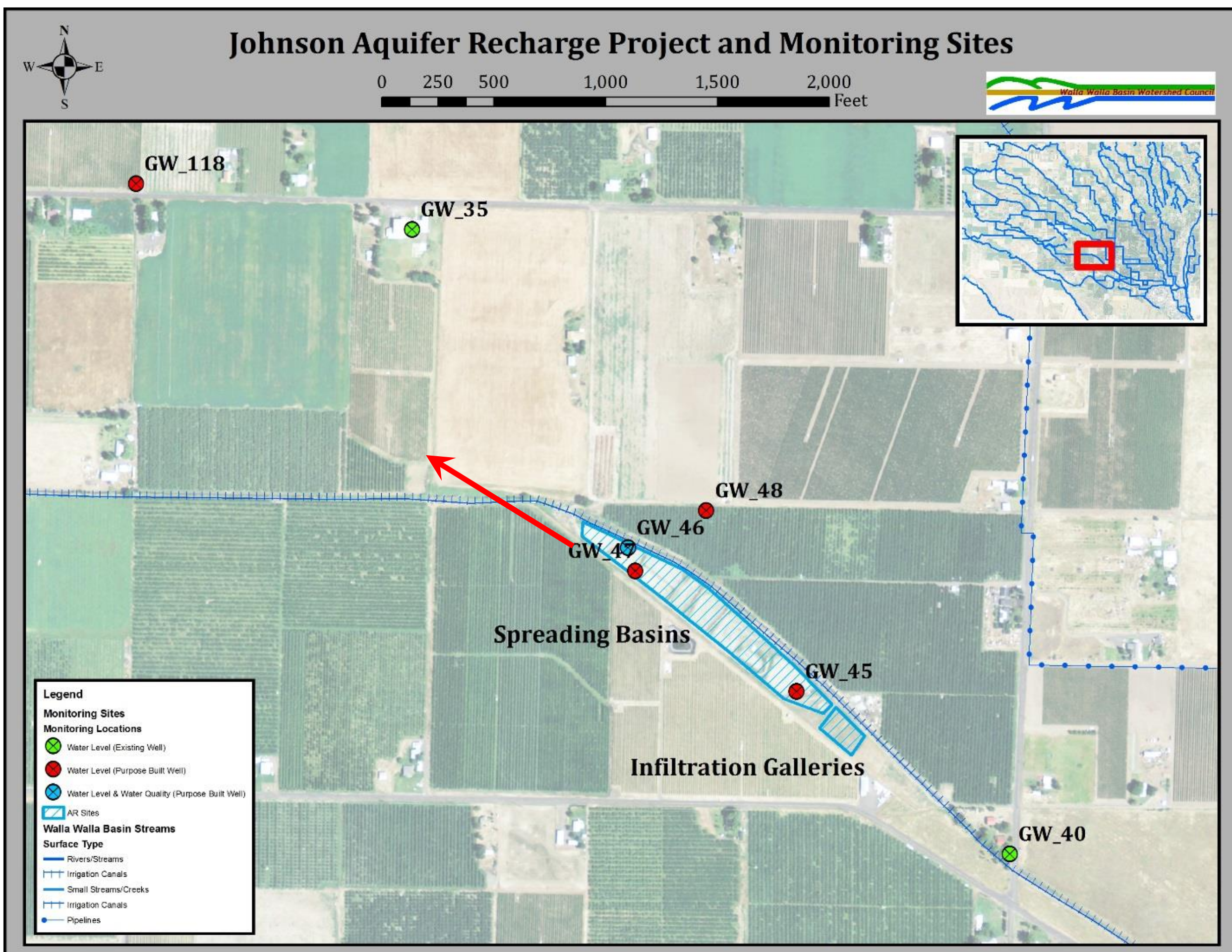

Figure 35 - Monitoring well locations for the Johnson Aquifer Recharge site. Red arrow indicates generalized groundwater flow direction.

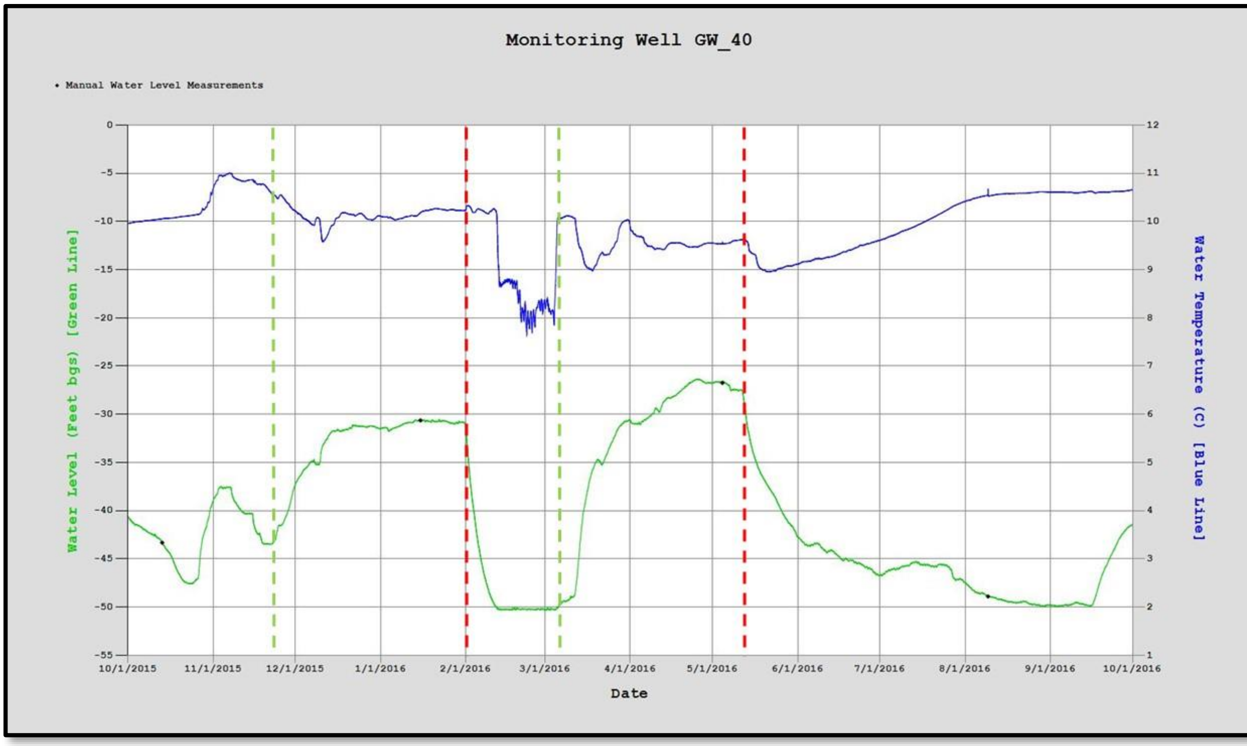

Figure 36 - Hydrograph for monitoring well GW_40. Green dashed lines indicate start of recharge operations and red dashed lines indicate end of recharge operations.

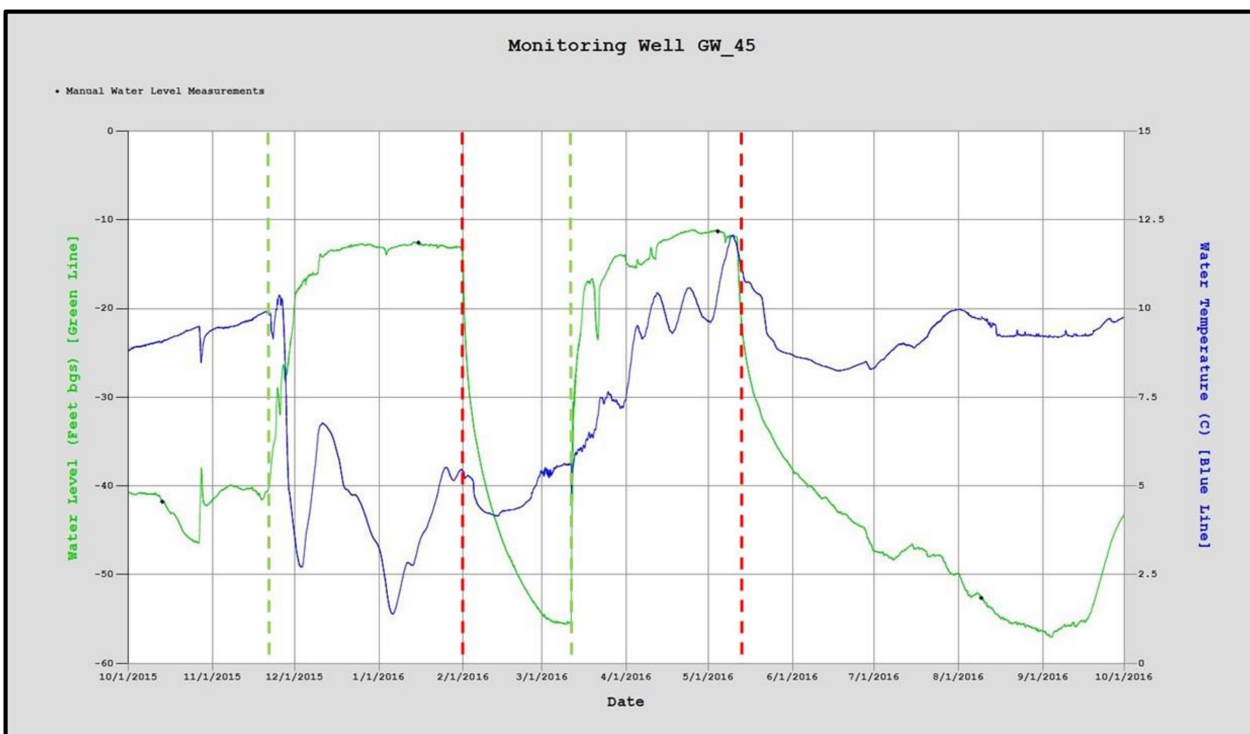

Figure 37 - Hydrograph for monitoring well GW_45. Green dashed lines indicate start of recharge operations and red dashed lines indicate end of recharge operations.

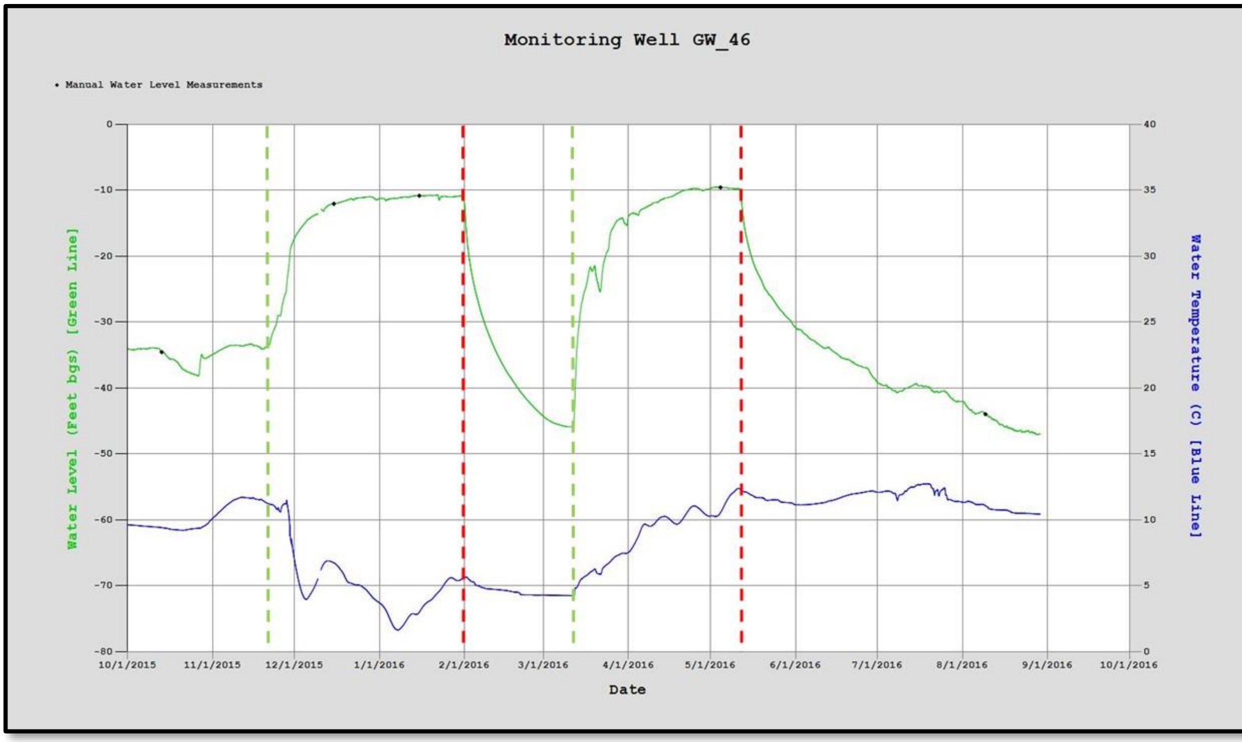

Figure 38 - Hydrograph for monitoring well GW_46. Green dashed lines indicate start of recharge operations and red dashed lines indicate end of recharge operations.

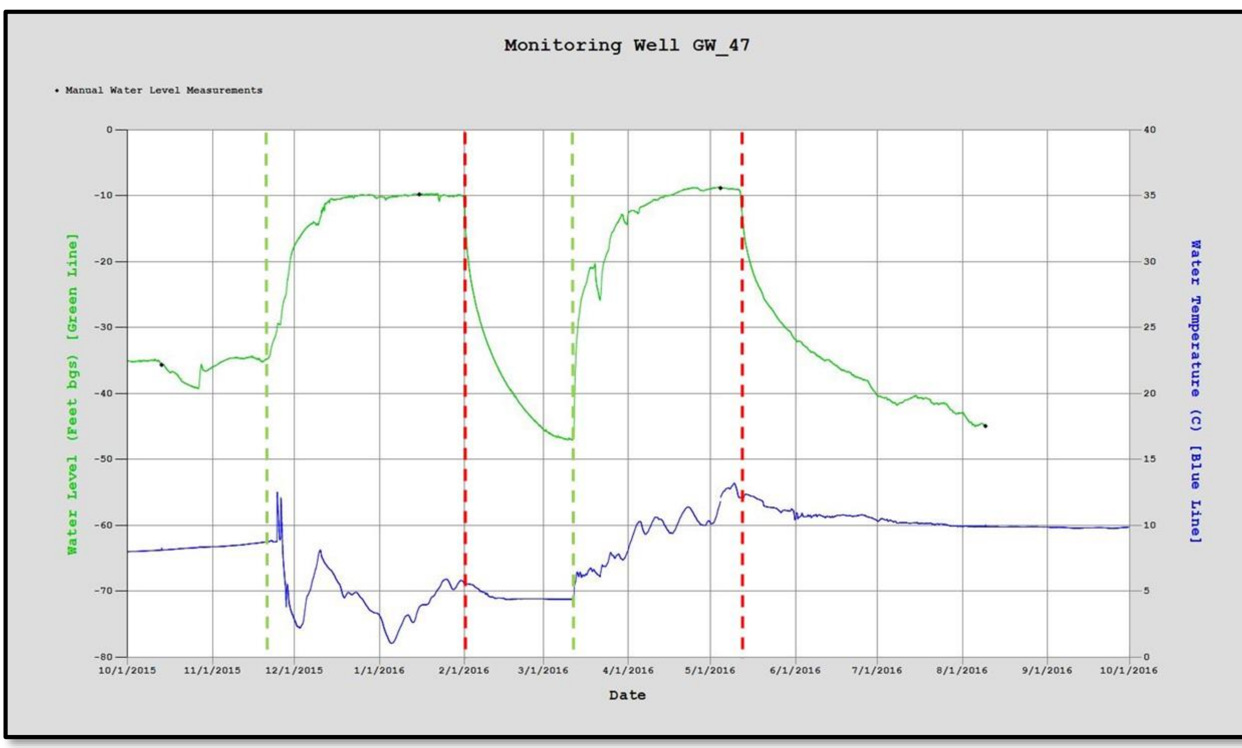

Figure 39 - Hydrograph for monitoring well GW_47. Green dashed lines indicate start of recharge operations and red dashed lines indicate end of recharge operations.

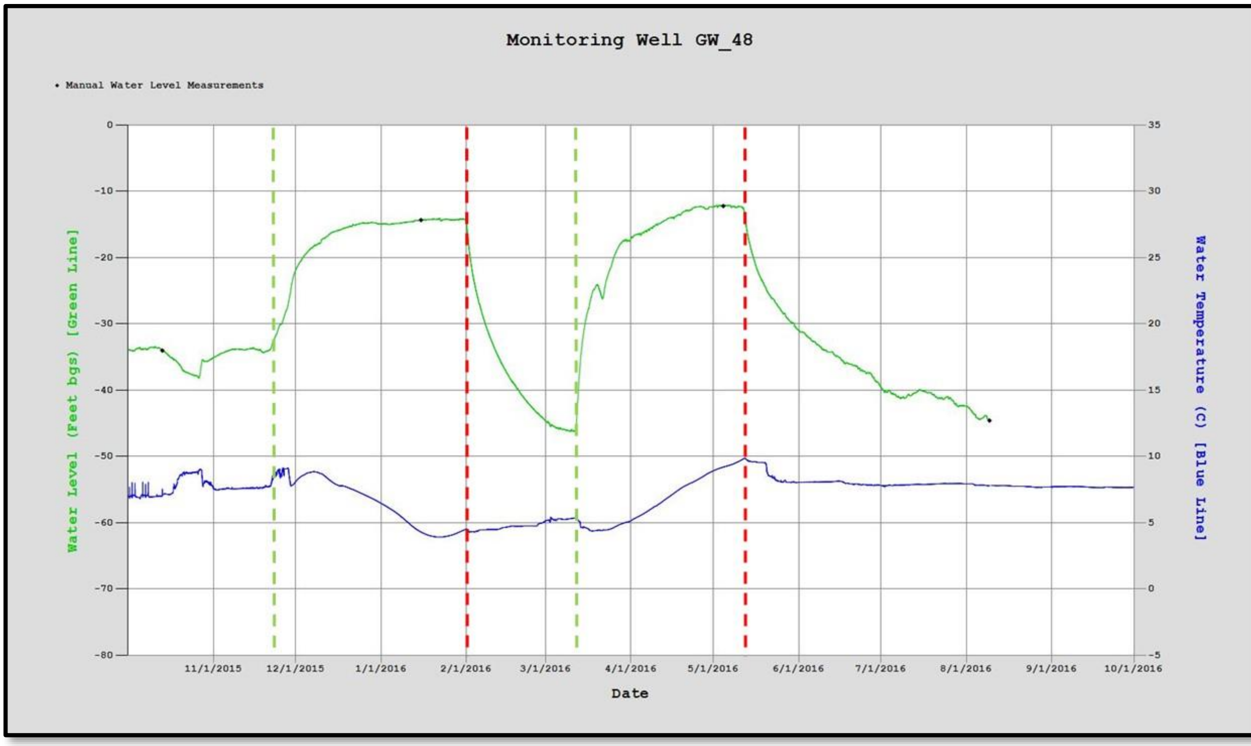

Figure 40 - Hydrograph for monitoring well GW_48. Green dashed lines indicate start of recharge operations and red dashed lines indicate end of recharge operations.

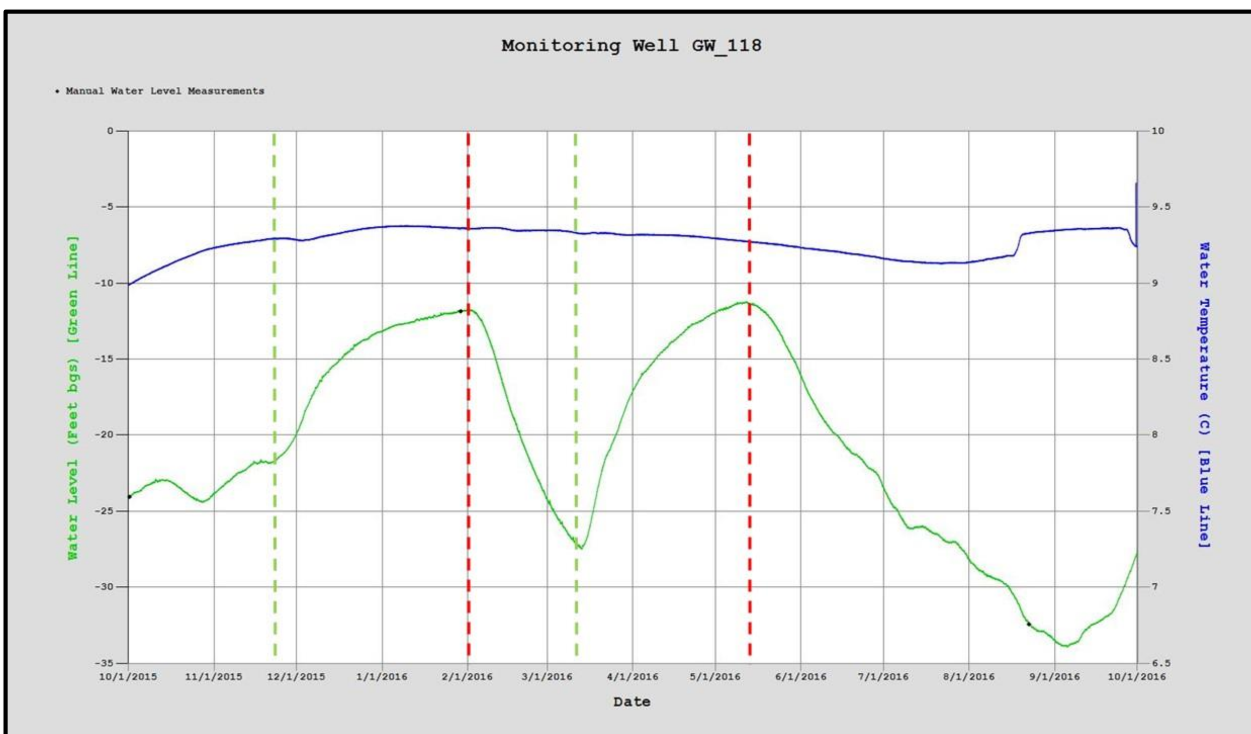

Figure 41 - Hydrograph for monitoring well GW_118. Green dashed lines indicate start of recharge operations and red dashed lines indicate end of recharge operations.

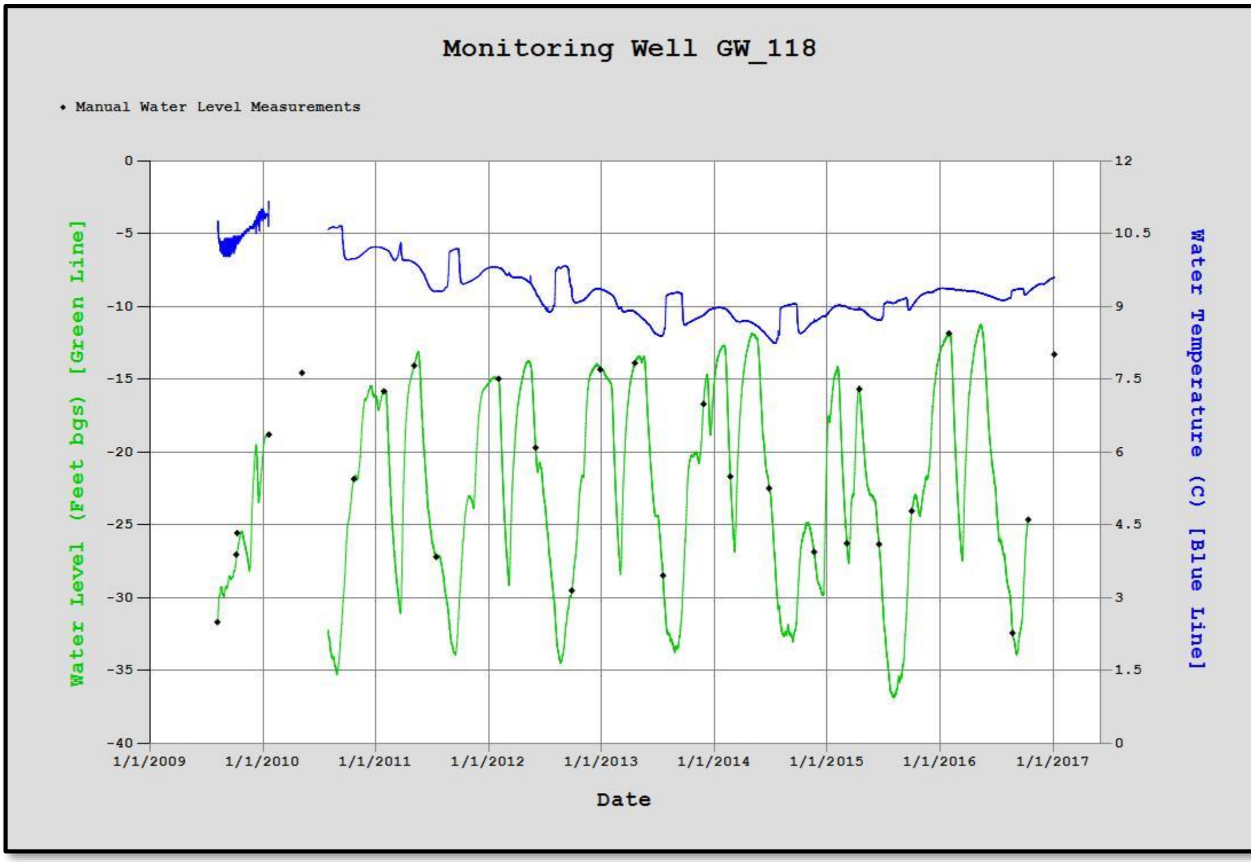

Figure 42 – 2009–2016 hydrograph for GW_118.

NW UMAPINE SITE

The NW Umapine site was constructed in the fall of 2013 and operates under LL-1433 that was issued on March 11th, 2013. The NW Umapine site ran for 90 days during the WY 2016 recharge season. The site received recharge water in mid-January through early February and from March through mid-May. Recharge operations were terminated May 12th, 2016 because of low instream flows. The NW Umapine site received a total of 169.53 acre-feet of recharge water at an average rate of 1.88 acre-feet per day (Figures 43).

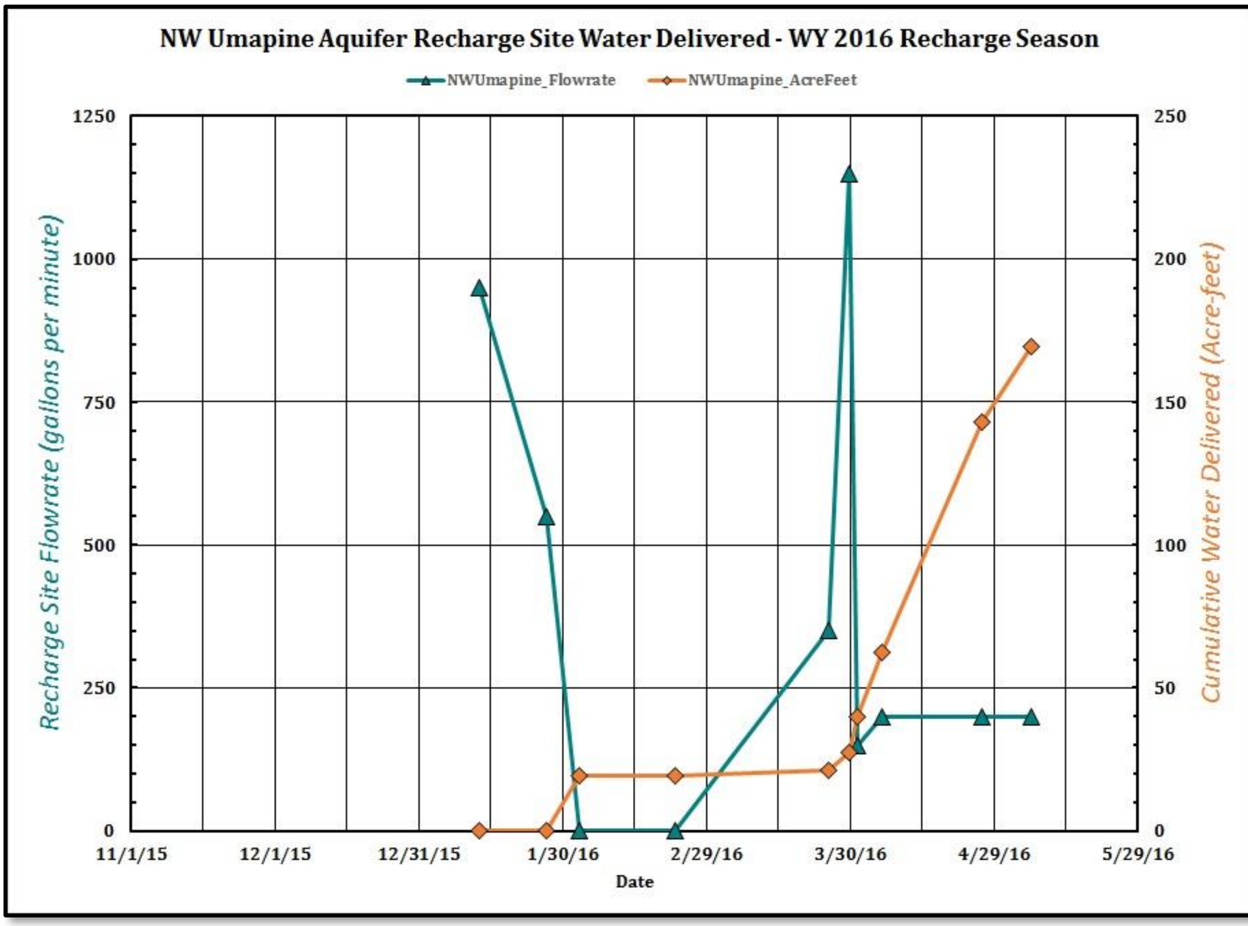

Figure 43 – NW Umapine Aquifer Recharge site inflow rates and cumulative water delivered.

ALLUVIAL AQUIFER RESPONSE

The two groundwater monitoring wells located down-gradient from the NW Umapine site (GW_34 and GW_144) show muted responses to recharge operations (Figures 44-46), with small groundwater elevation increase and decrease in response to recharge operations. A larger impact from recharge operations is seen in the temperature signal, which decreases with the onset of recharge operations and increases when recharge operations are terminated. The muted groundwater elevation response and prominent temperature response indicates that recharged water is rapidly moving away from the recharge site. Early fall water level increases observed at monitoring wells GW-34 and GW_144 may be due to increased recharge from the start of fall irrigation and/or reduction of groundwater pumping in the fall. Likewise, observed summer water level decreases are likely due to increased groundwater pumping in the area.

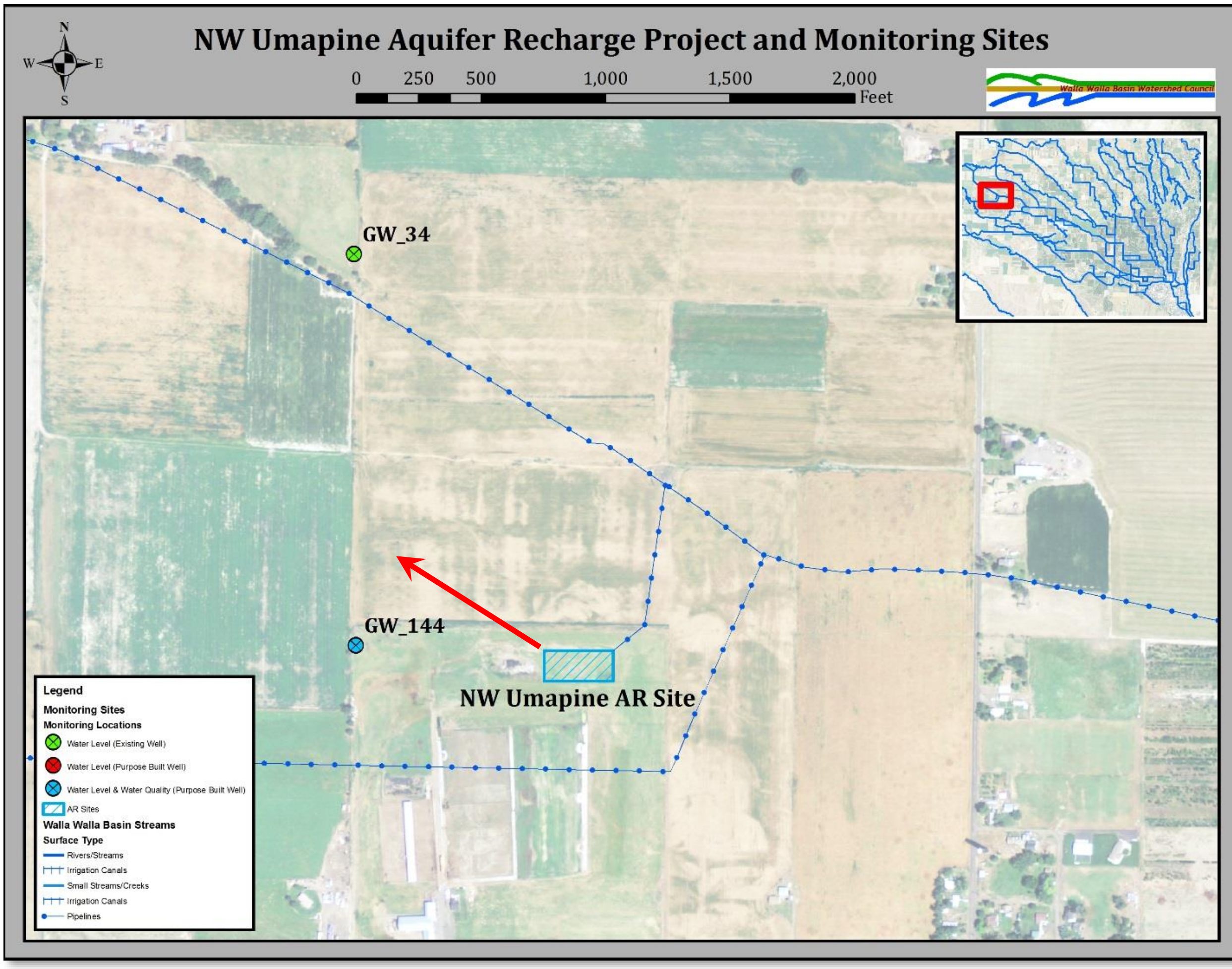

Figure 44 - Monitoring well locations for the NW Umapine Aquifer Recharge site. Red arrow indicates generalized groundwater flow direction.

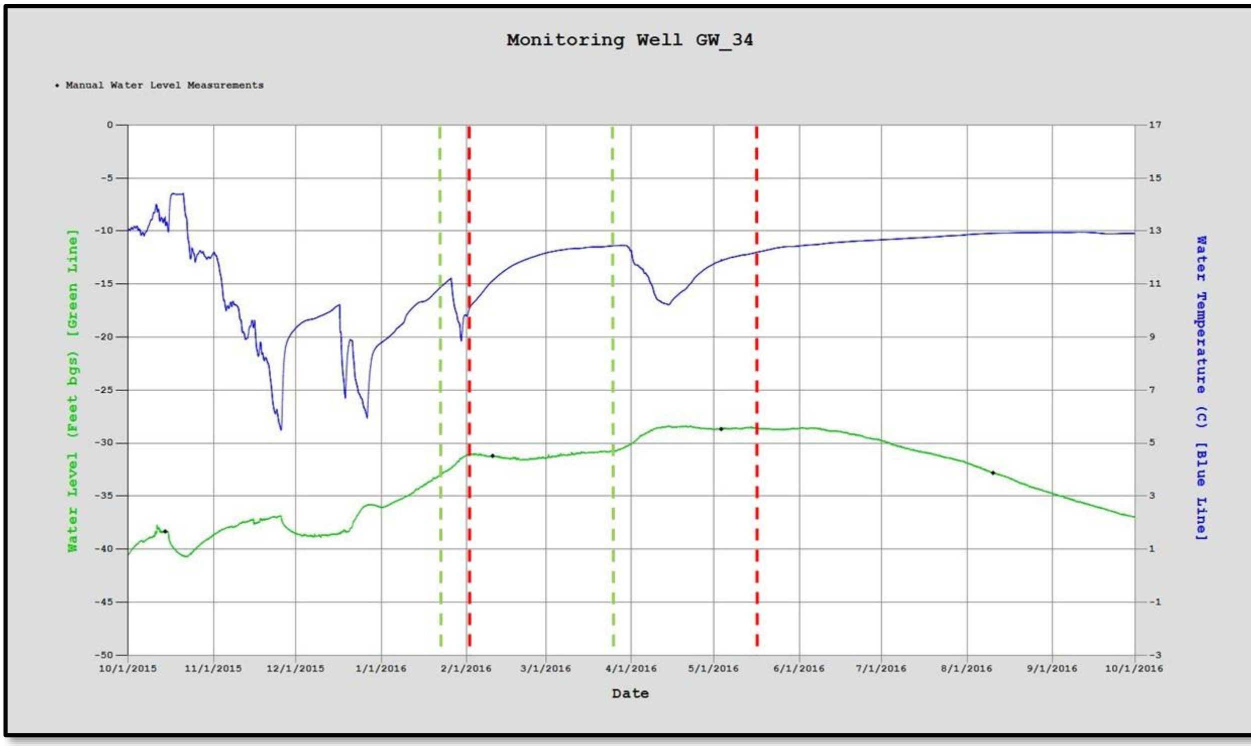

Figure 45 - Hydrograph for monitoring well GW_34. Green dashed lines indicate start of recharge operations and red dashed lines indicate end of recharge operations.

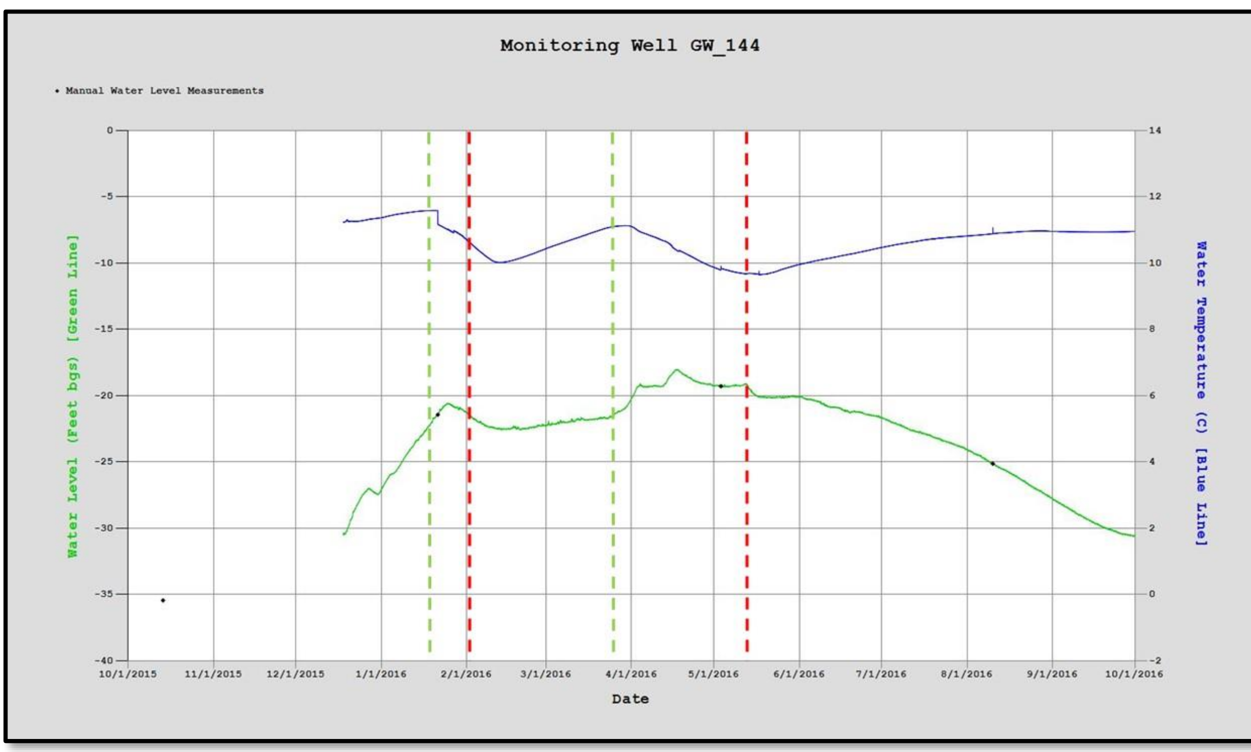

Figure 46 - Hydrograph for monitoring well GW_144. Green dashed lines indicate start of recharge operations and red dashed lines indicate end of recharge operations.

Trumbull Site

The Trumbull site was constructed during the fall of 2012 and operates under LL-1433 that was issued on March 11th, 2013. The site operated for 91 days from mid-December through January and mid-March through late-April. Overall, 262.46 acre-feet of water (2.88 acre-feet/day) was delivered to the site in WY 2016 (Figure 47).

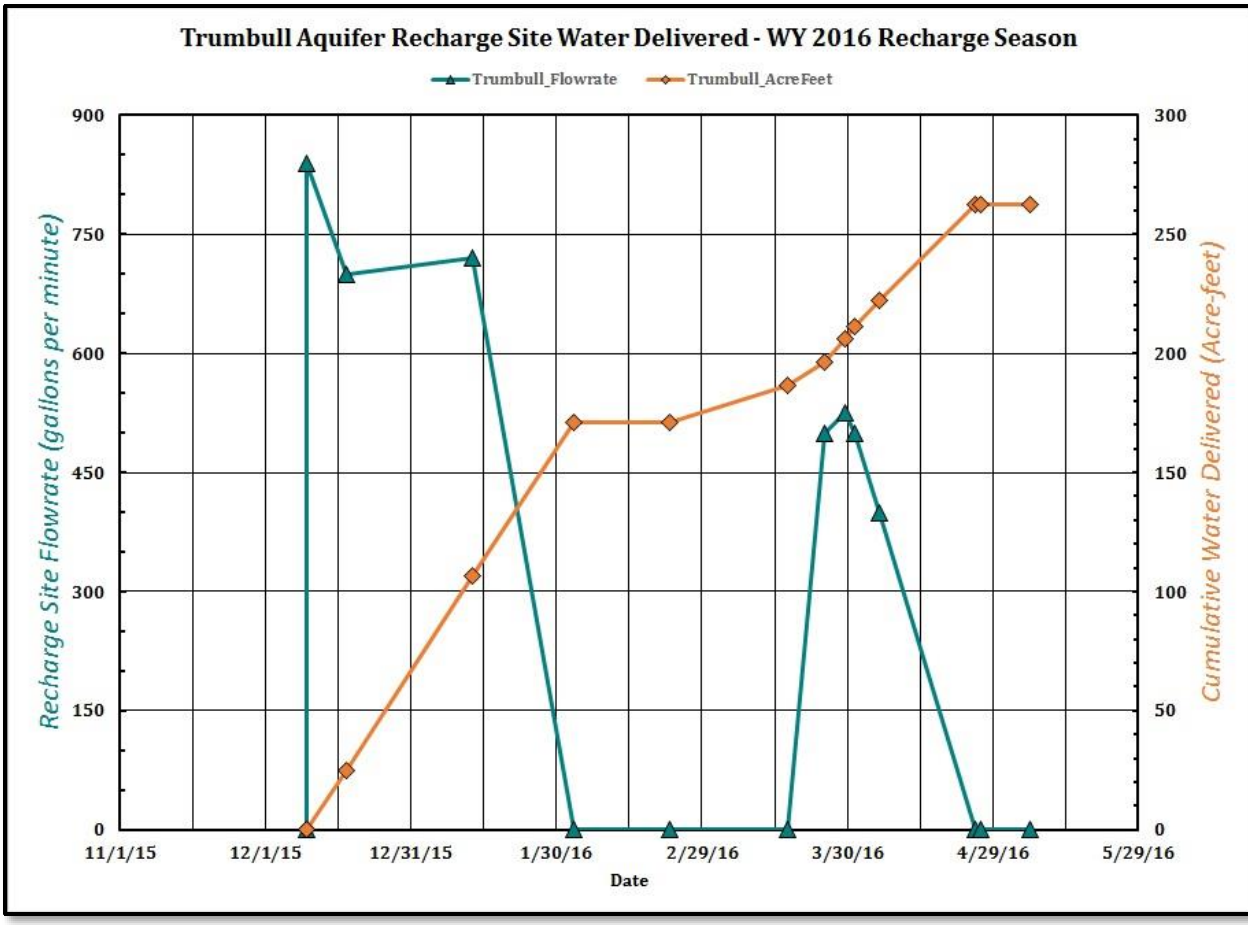

Figure 47 - Trumbull Aquifer Recharge site inflow rates and cumulative water delivered.

Alluvial Aquifer Response

Monitoring well GW_117, located up-gradient from the Trumbull site, exhibited a muted response to aquifer recharge operations (Figures 48 and 49). Groundwater levels decreased at monitoring well GW_117 from the start of recharge in mid-December through January. Groundwater levels dropped more dramatically in February after recharge operations were terminated and the entire ditch system was turned off for fish screen maintenance. Groundwater levels increased after the ditch and recharge operations resumed in mid-March. Outside of the period of recharge operations, groundwater levels coincide with water conveyance in nearby irrigation ditches. For example, groundwater levels at GW_117 remain greater than February and early March groundwater levels due to seepage loss from the nearby water filled ditch. Furthermore, a greater increase in groundwater levels in April and May coincide with the start of irrigation season. These trends indicate groundwater level response at GW_117 is due mostly to ditch seepage and irrigation water percolating to the aquifer.

Increased and decreased water levels in the down-gradient monitoring well (GW_142) are interpreted to be a direct response to aquifer recharge operations at the Trumbull site (Figures 48-52). Water levels in monitoring well GW_142 increased in the mid-December when recharge at the site started and declined in February and late spring and summer after recharge operations were terminated for the year. The water level in monitoring well GW_142 dropped below the screened portion of the well during parts of March, August, and September.

Groundwater levels near the Trumbull AR site indicate the groundwater system is responding to aquifer recharge operations since the project started in late-spring 2013. GW_117 (Figure 51), an up-gradient well, shows a change in groundwater levels, especially during the lowest groundwater levels each year (typically in the winter), starting in 2014 (first full year of operations). GW_142 (Figure 52), a down-gradient well, also shows direct response to aquifer recharge operations. This monitoring well goes dry for periods of the year, so absolute groundwater low levels cannot be determined, however the length of time the well is dry decreased during 2016 compared to recent years, especially during summer months.

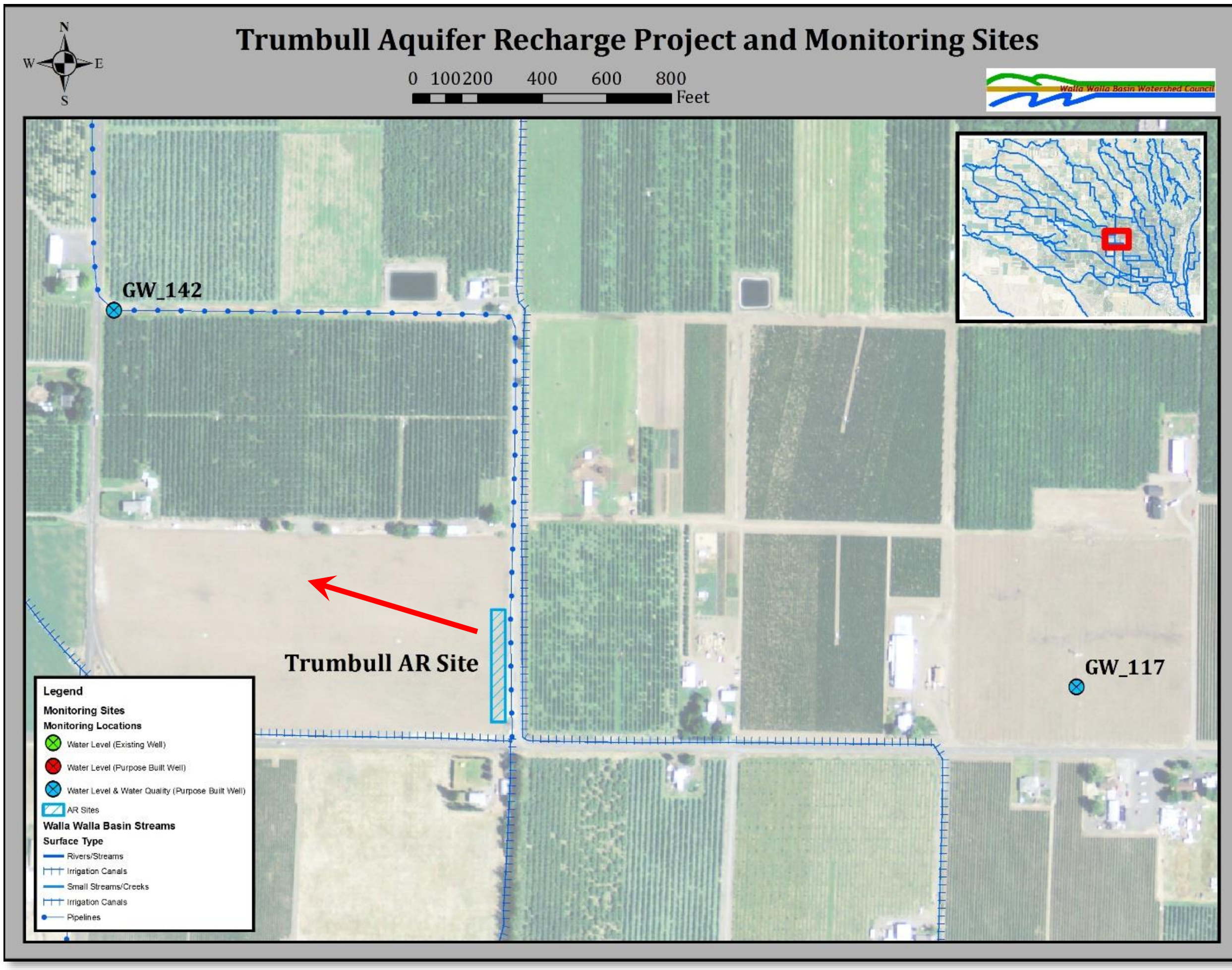

Figure 48 - Monitoring well locations for the Trumbull Aquifer Recharge site. Red arrow indicates generalized groundwater flow direction.

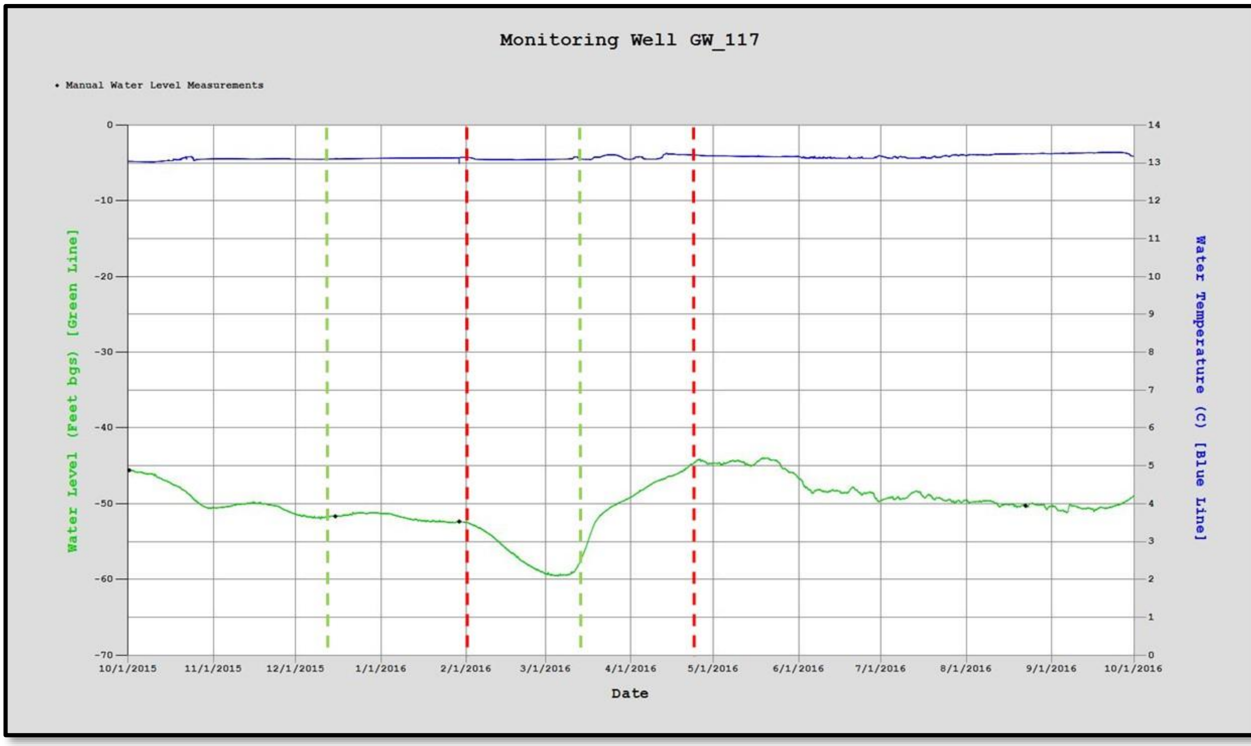

Figure 49 - Hydrograph for monitoring well GW_117. Green dashed lines indicate start of recharge operations and red dashed lines indicate end of recharge operations.

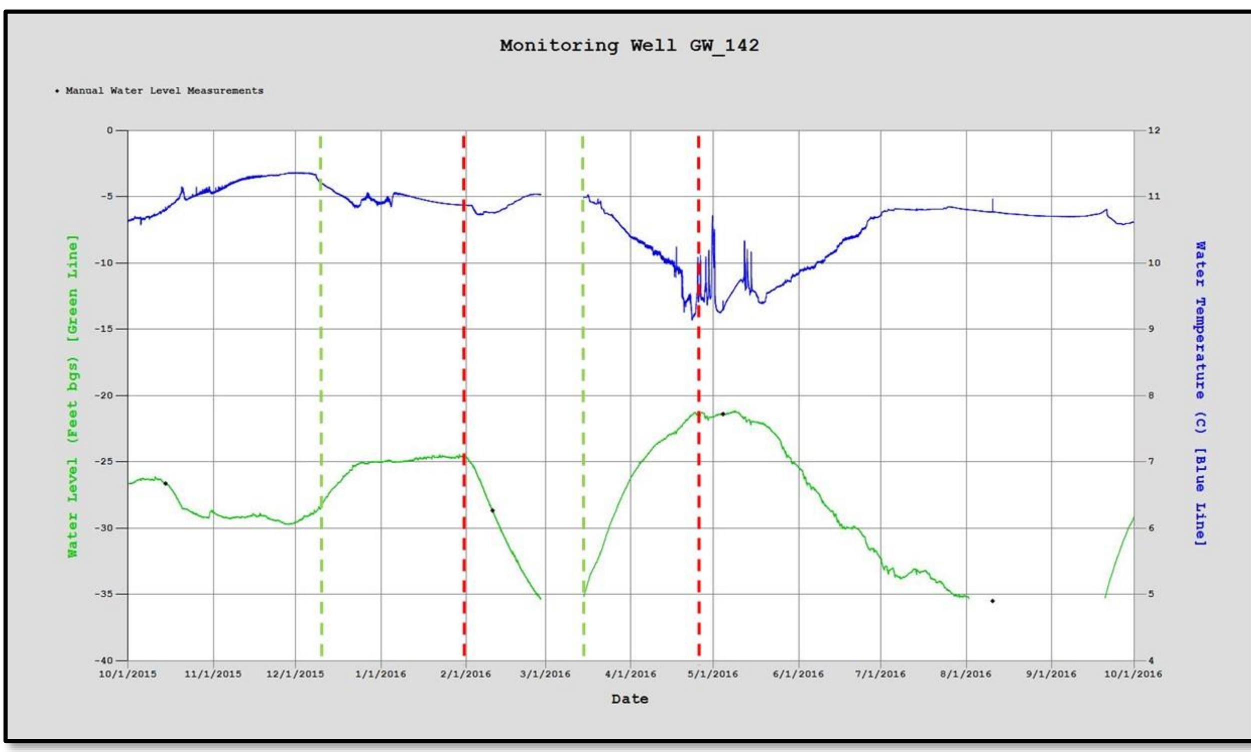

Figure 50 - Hydrograph for monitoring well GW_142. Green dashed lines indicate start of recharge operations and red dashed lines indicate end of recharge operations.

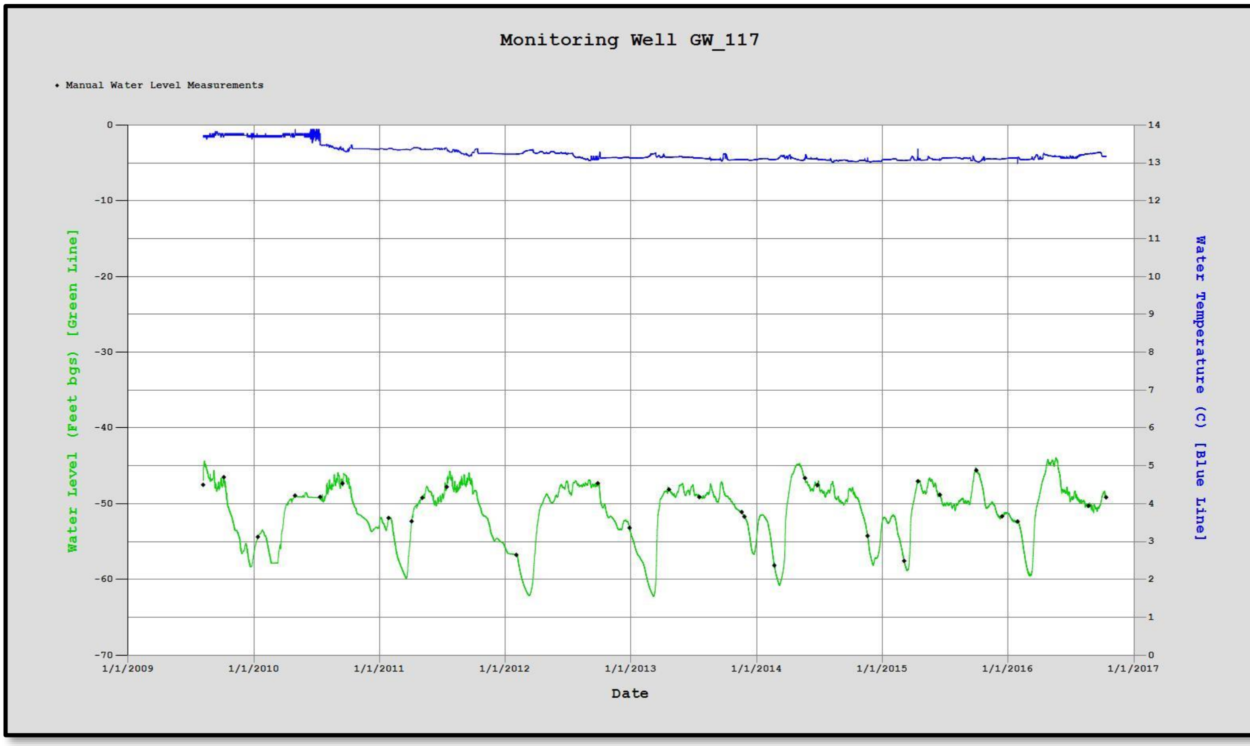

Figure 51 - 2009-2016 hydrograph for GW_117.

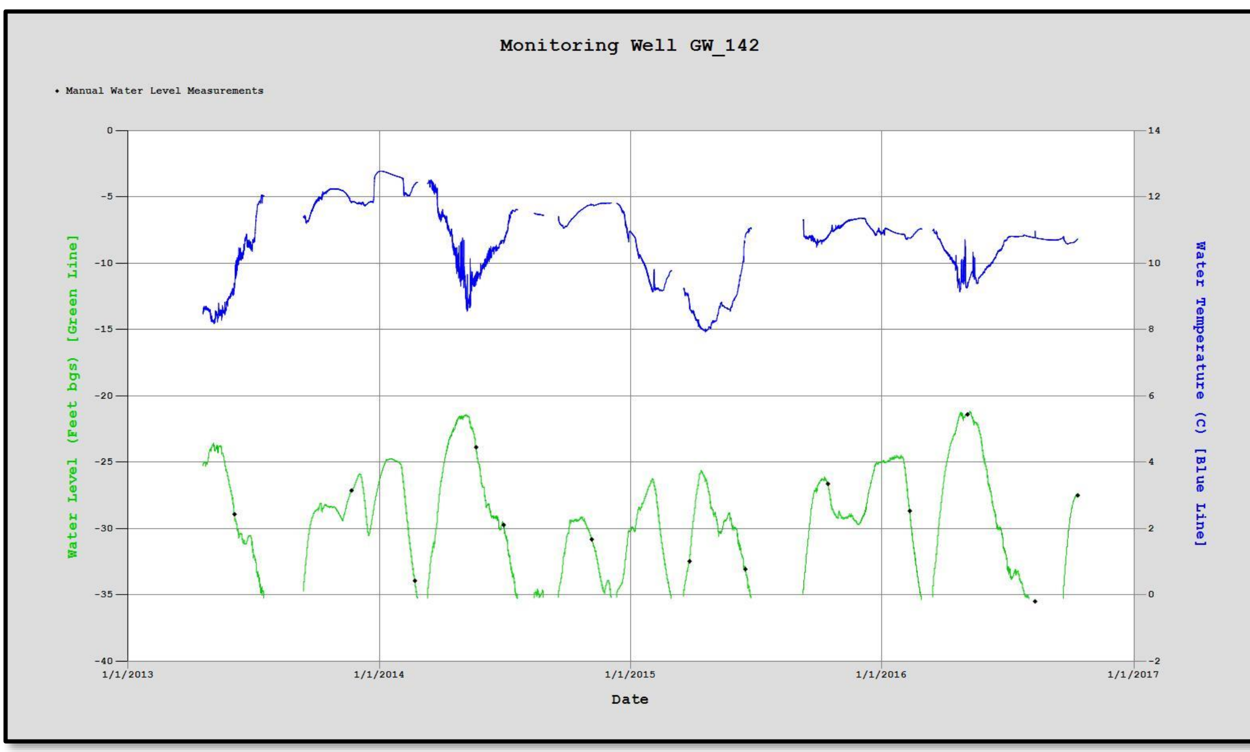

Figure 52 - 2013-2016 hydrograph for GW_142.

WATER QUALITY MONITORING

Water samples and field parameter measurements were collected in accordance with the approved monitoring plan for LL-1433 (Appendix B). Two water quality sampling events occurred during the WY 2016 recharge season. A summary of the results can be found in Tables 2-11 and graphically in Figures 51-59 below. Analytical laboratory reports are included in Appendix D. Source water quality and groundwater quality at each site are discussed below.

SOURCE WATER QUALITY DURING WY 2016

Source water samples were collected at three locations on 12/15/2015 and again on 05/17/2016:

- Source Water #1 – Zerba Weir
- Source Water #2 – Duff Weir
- Source Water #3 – Huffman/Richartz Split

In general, water quality appears to be good at all three source water locations with nutrient contents being below the reporting limit (Total Kjeldhal Nitrogen [TKN]) or extremely low concentrations present (i.e. orthophosphate) and only a single sample with elevated nitrate levels (Source Water #3 on 12/15/2015), though below drinking water maximum contaminant levels. The source water has low concentrations of major cations (sodium, potassium, calcium and magnesium), major anions (sulfate and chloride), and low alkalinity (Tables 2-4 and Figures 53-55).

TABLE 2. SOURCE WATER #1 – ZERBA WEIR

Sample Parameter	12/15/2015	05/17/2016
Total Organic Carbon (mg/L)	2.28	1.34
Nitrate-N(mg/L)	0.00	0.00
Total Kjeldahl Nitrogen (mg/L)	ND	ND
Sulfate (mg/L)	1.2	0.9
Chloride (mg/L)	0.0	0.0
Alkalinity (mg/L)	33.2	26.6
Calcium (mg/L)	5.6	3.7
Orthophosphate (mg/L)	0.030	0.025
Sodium (mg/L)	3.4	2.9
Potassium (mg/L)	1.9	2.6
Magnesium (mg/L)	2.5	2.0
Aluminum (mg/L)	0.222	0.159
Iron (mg/L)	0.207	0.030
Manganese (mg/L)	ND	ND

ND = no detection

TABLE 3. SOURCE WATER #2 – JOHNSON INTAKE/DUFF WEIR

Sample Parameter	12/15/2015	05/17/2016
Total Organic Carbon (mg/L)	2.28	1.35
Nitrate-N(mg/L)	0.00	0.20
Total Kjeldahl Nitrogen (mg/L)	ND	ND
Sulfate (mg/L)	1.2	0.8
Chloride (mg/L)	0.0	0.0
Alkalinity (mg/L)	33.4	25.9
Calcium (mg/L)	5.4	3.7
Orthophosphate (mg/L)	0.003	0.026
Sodium (mg/L)	3.4	2.9
Potassium (mg/L)	1.8	2.5
Magnesium (mg/L)	2.6	1.9
Aluminum (mg/L)	0.195	0.177
Iron (mg/L)	0.183	0.031
Manganese (mg/L)	ND	ND

ND = no detection

TABLE 4. SOURCE WATER #3 – HUFFMAN-RICHARTZ SPLIT

Sample Parameter	12/15/2015	05/17/2016
Total Organic Carbon (mg/L)	2.21	1.48
Nitrate-N(mg/L)	6.20	0.40
Total Kjeldahl Nitrogen (mg/L)	ND	ND
Sulfate (mg/L)	2.3	2.0
Chloride (mg/L)	0.0	0.0
Alkalinity (mg/L)	40.0	35.4
Calcium (mg/L)	8.1	5.9
Orthophosphate (mg/L)	0.042	0.040
Sodium (mg/L)	4.2	3.6
Potassium (mg/L)	2.2	2.7
Magnesium (mg/L)	3.5	3.0
Aluminum (mg/L)	0.207	0.216
Iron (mg/L)	0.187	0.023
Manganese (mg/L)	ND	ND

ND = no detection

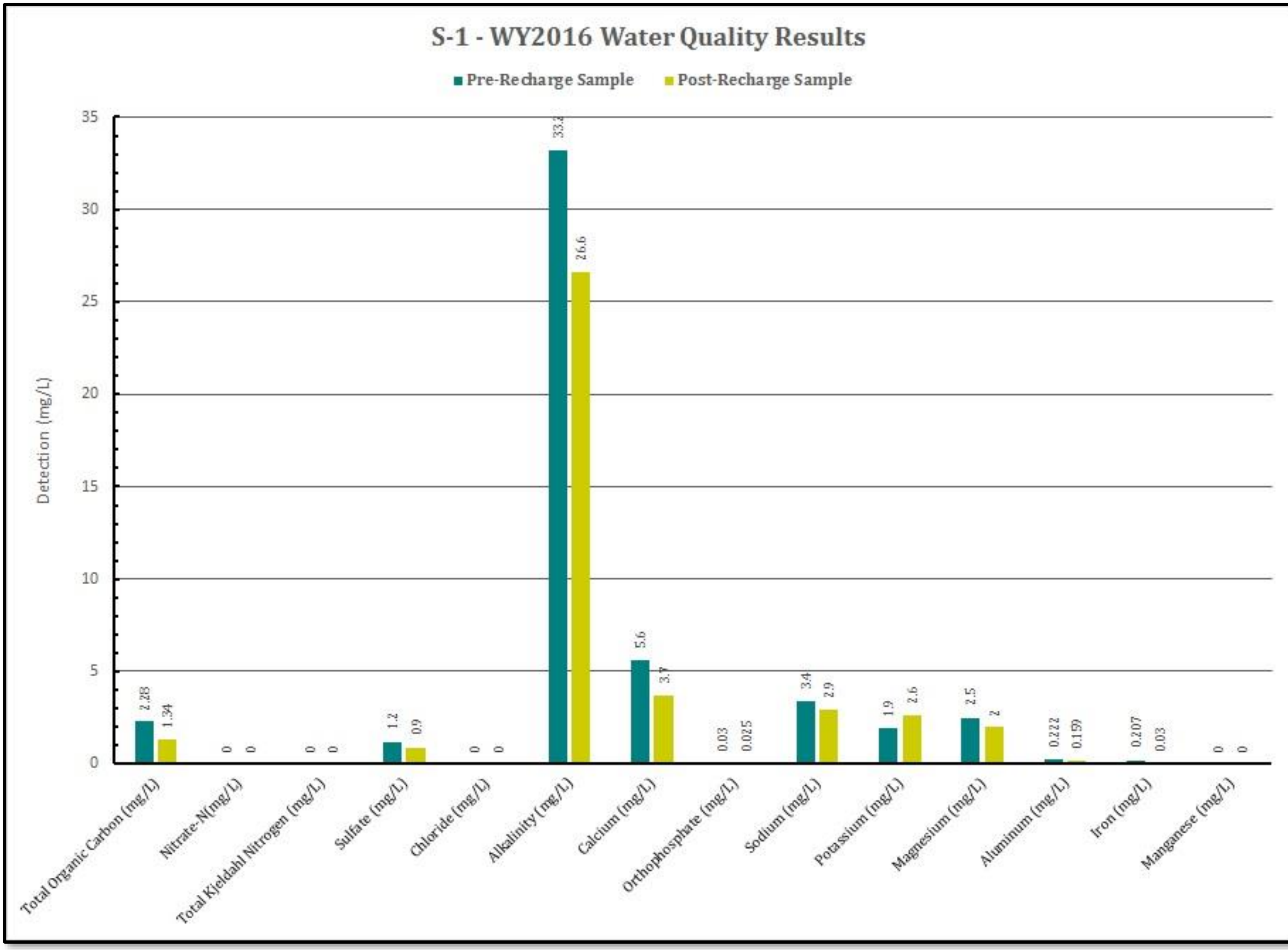

Figure 53 - Water quality results source water at S-1 for the WY2016 Aquifer Recharge Season. Lab results can be found in Appendix D.

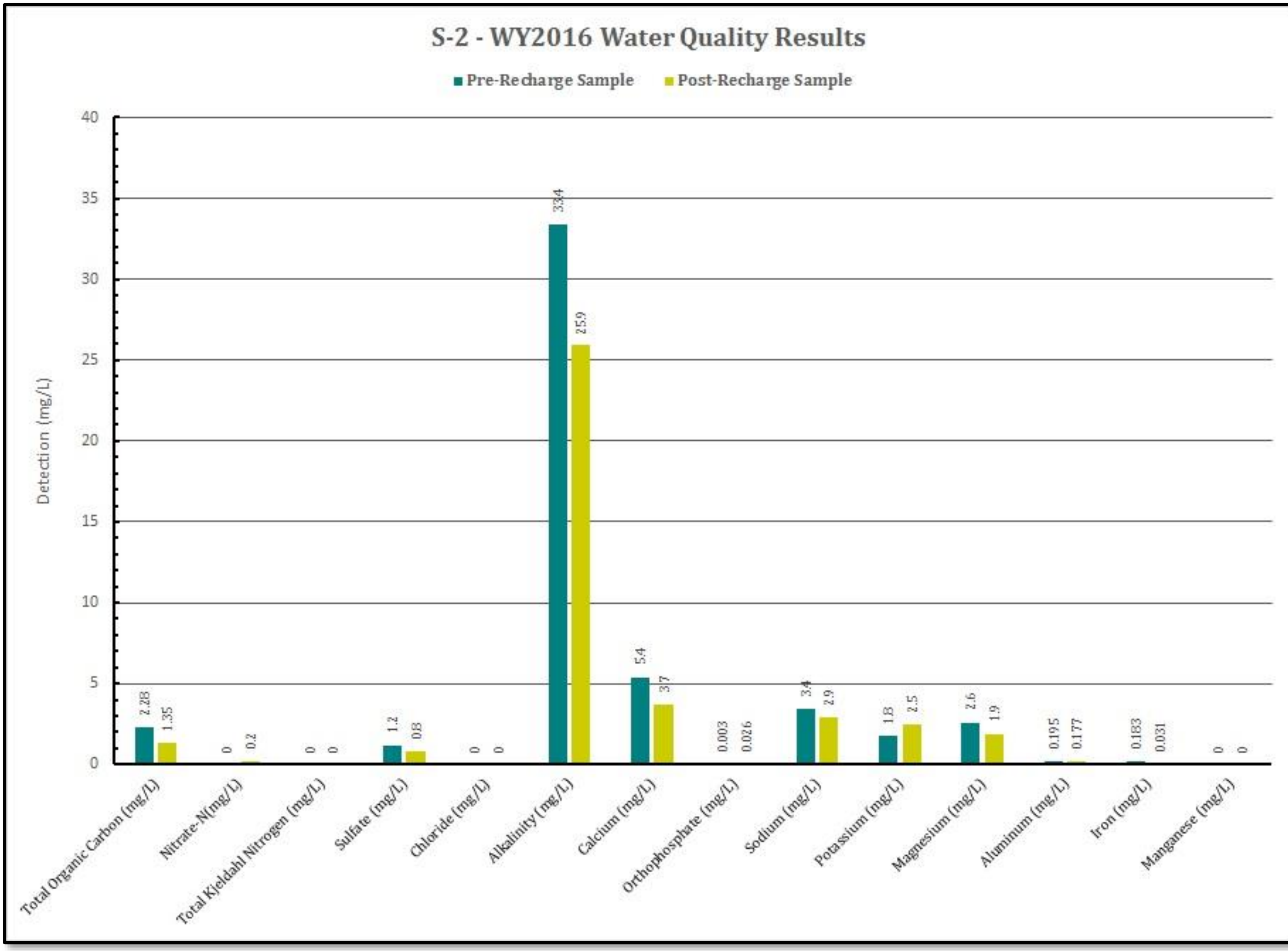

Figure 54 - Water quality results source water at S-2 for the WY2016 Aquifer Recharge Season. Lab results can be found in Appendix D.

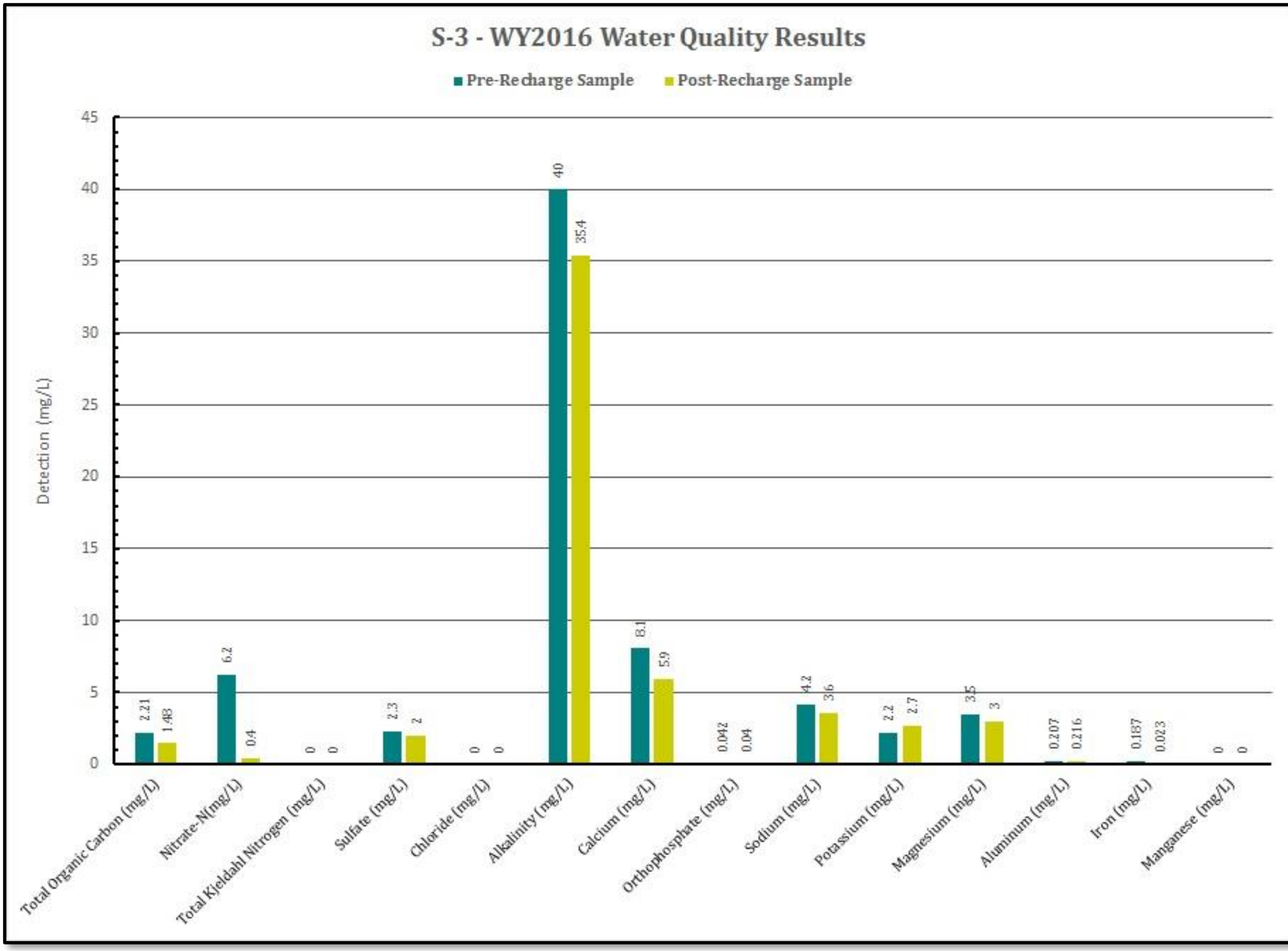

Figure 55 - Water quality results source water at S-3 for the WY2016 Aquifer Recharge Season. Lab results can be found in Appendix D.

GROUNDWATER QUALITY MONITORING

Groundwater quality samples and field parameter data were collected at six locations (GW_46, GW_117, GW_119, GW_141, GW_142, and GW_144) near the five AR sites. The general rationale for each sampling location are listed below.

- GW_141 (previously PNW2): provides up-gradient monitoring for the entire project and specifically for the Anspach and proposed Barrett sites.
- GW46: provides down-gradient monitoring for the Johnson site.
- GW117: provides water quality information for the central region of the AR program, and up-gradient monitoring for the Trumbull site.
- GW_142 (previously PNW3): provides down-gradient coverage for the Trumbull site.
- GW119: provides up-gradient coverage for both the NW Umapine site and provides a programmatic monitoring location further down-gradient than the aforementioned wells do.
- GW_144 (previously PMW5): provides down-gradient monitoring for the NW Umapine site and provides the furthest down-gradient monitoring point in the entire program.

The six wells were sampled on December 15th, 2015 and May 17th, 2016 and analyzed for the water quality parameters listed in Table 5 (Tables 6-12 and Figures 56-61). The groundwater sample collected at well GW_144 on May 17th, 2016 was also analyzed for the approved targeted list of herbicides and pesticides (see Appendix B). Analytical laboratory reports are included in Appendix D.

Table 5. Analyte list, analytical methods, and method reporting limits for WY 2016 Water Quality Monitoring Program.

Analyte	Analytical method	Method reporting limit (mg/L)
Dissolved oxygen (mg/L)	-	-
Total organic carbon	SM 5310B	0.5
Nitrate-N (mg/L)	EPA 300.0	0.1
TKN (mg/L)	SM 4500 N B	0.1
Sulfate (mg/L)	EPA 300.0	0.1
Chloride (mg/L)	EPA 300.0	0.1
Alkalinity (mg/L)	SM232OB	5
Calcium (mg/L)	EPA 200.7	0.1
Ortho-phosphate (mg/L)	EPA 300.0	0.1
Sodium (mg/L)	SPA 200.7	0.1
Potassium (mg/L)	EPA 200.7	0.1
Magnesium (mg/L)	EPA 200.7	0.1
Aluminum (mg/L)	EPA 200.7	0.01
Iron (dissolved) (mg/L)	EPA 200.7	0.01
Manganese (dissolved) (mg/L)	EPA 200.7	0.05

TABLE 6. GW_141 (PMW-2 IN THE MONITORING PLAN)

Sample Parameter	12/15/2015	05/17/2016
Total Organic Carbon (mg/L)	0.97	0.47
Nitrate-N(mg/L)	13.30	0.10
Total Kjeldahl Nitrogen (mg/L)	0.95	0.65
Sulfate (mg/L)	15.9	3.6
Chloride (mg/L)	4.8	3.2
Alkalinity (mg/L)	106.5	37.9
Calcium (mg/L)	25.2	5.6
Orthophosphate (mg/L)	00.46	0.027
Sodium (mg/L)	10.9	6.4
Potassium (mg/L)	5.3	3.7
Magnesium (mg/L)	11.2	3.1
Aluminum (mg/L)	ND	ND
Iron (mg/L)	0.395	0.116
Manganese (mg/L)	0.005	0.002

ND = no detection

TABLE 7. GW_46

Sample Parameter	12/15/2015	05/17/2016
Total Organic Carbon (mg/L)	2.28	0.84
Nitrate-N(mg/L)	0.90	0.40
Total Kjeldahl Nitrogen (mg/L)	ND	ND
Sulfate (mg/L)	1.2	0.8
Chloride (mg/L)	0.0	0.0
Alkalinity (mg/L)	35.7	26.4
Calcium (mg/L)	6.6	3.5
Orthophosphate (mg/L)	0.041	0.054
Sodium (mg/L)	3.3	3.2
Potassium (mg/L)	18	3.1
Magnesium (mg/L)	2.9	2.0
Aluminum (mg/L)	0.102	0.087
Iron (mg/L)	0.095	0.043
Manganese (mg/L)	ND	ND

ND = no detection

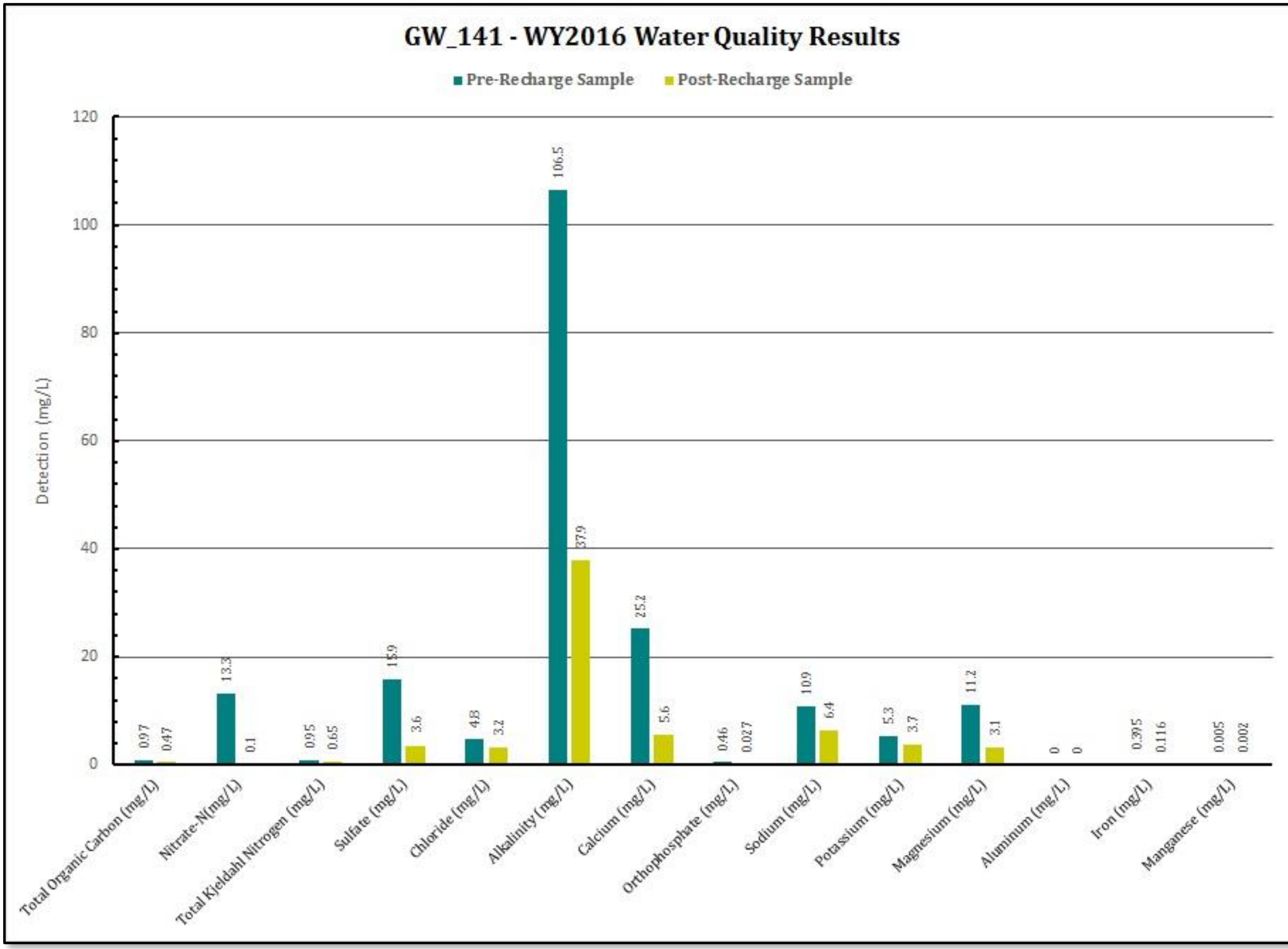

Figure 56 - Water quality results for groundwater at GW_141 for the WY2016 Aquifer Recharge Season. Lab results can be found in Appendix D.

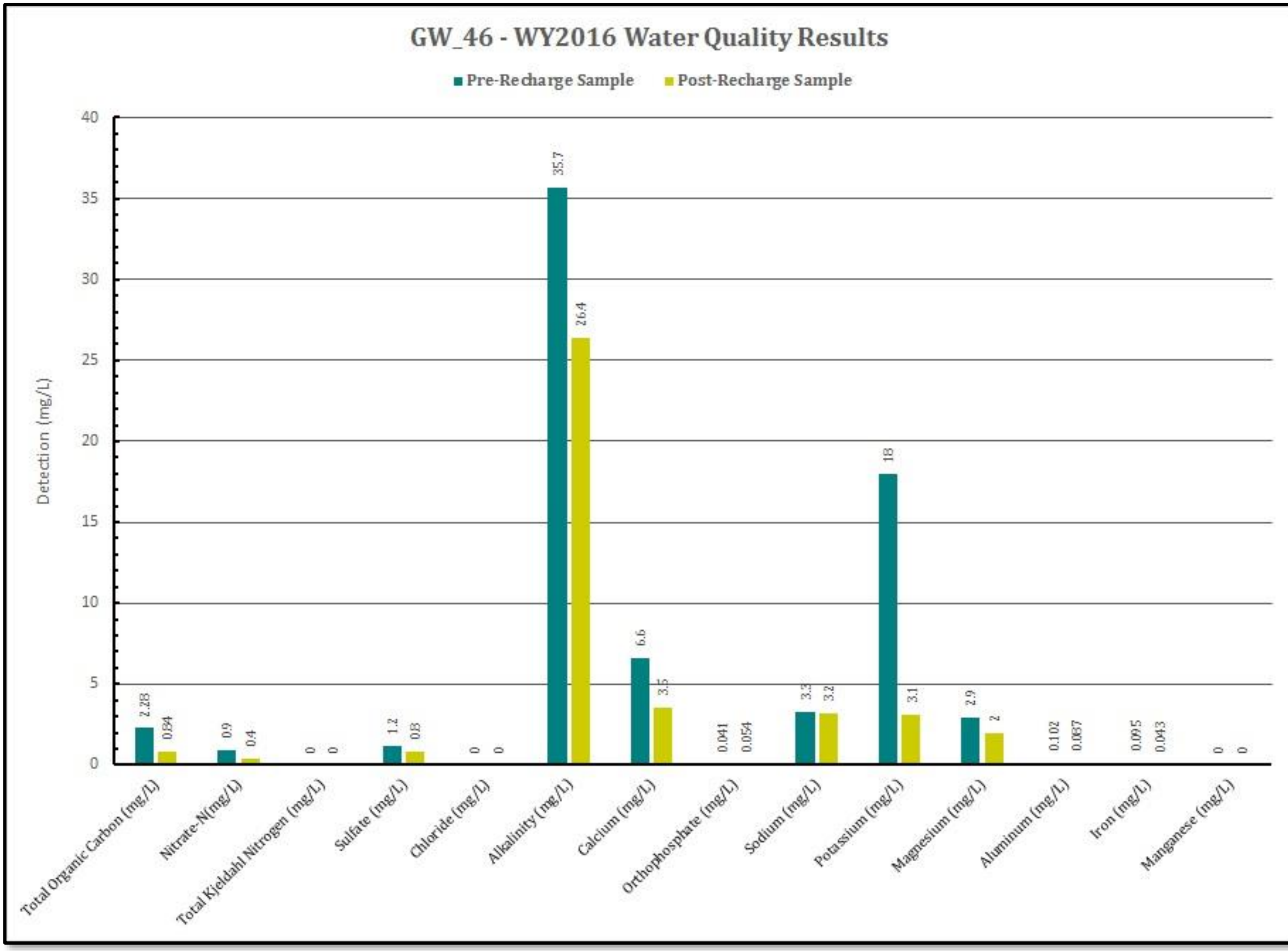

Figure 57 - Water quality results for groundwater at GW_46 for the WY2016 Aquifer Recharge Season. Lab results can be found in Appendix D.

TABLE 8. GW_117

Sample Parameter	12/15/2015	05/17/2016
Total Organic Carbon (mg/L)	0.39	0.59
Nitrate-N(mg/L)	5.30	15.00
Total Kjeldahl Nitrogen (mg/L)	< 0.3	< 0.3
Sulfate (mg/L)	8.1	13.8
Chloride (mg/L)	1.0	2.0
Alkalinity (mg/L)	80.0	78.6
Calcium (mg/L)	17.0	18.7
Orthophosphate (mg/L)	0.059	0.082
Sodium (mg/L)	6.7	7.7
Potassium (mg/L)	4.2	5.3
Magnesium (mg/L)	7.6	9.0
Aluminum (mg/L)	ND	ND
Iron (mg/L)	ND	0.012
Manganese (mg/L)	ND	ND

ND = no detection

TABLE 9. GW_142 (PWM-3 IN MONITORING PLAN)

Sample Parameter	12/15/2015	05/17/2016
Total Organic Carbon (mg/L)	0.93	0.73
Nitrate-N(mg/L)	9.30	0.00
Total Kjeldahl Nitrogen (mg/L)	0.29	0.19
Sulfate (mg/L)	5.7	4.8
Chloride (mg/L)	2.7	1.8
Alkalinity (mg/L)	62.9	45.9
Calcium (mg/L)	15.4	8.9
Orthophosphate (mg/L)	0.049	0.022
Sodium (mg/L)	5.0	4.9
Potassium (mg/L)	3.4	3.6
Magnesium (mg/L)	6.6	4.0
Aluminum (mg/L)	0.005	0.003
Iron (mg/L)	0.125	0.038
Manganese (mg/L)	ND	ND

ND = no detection

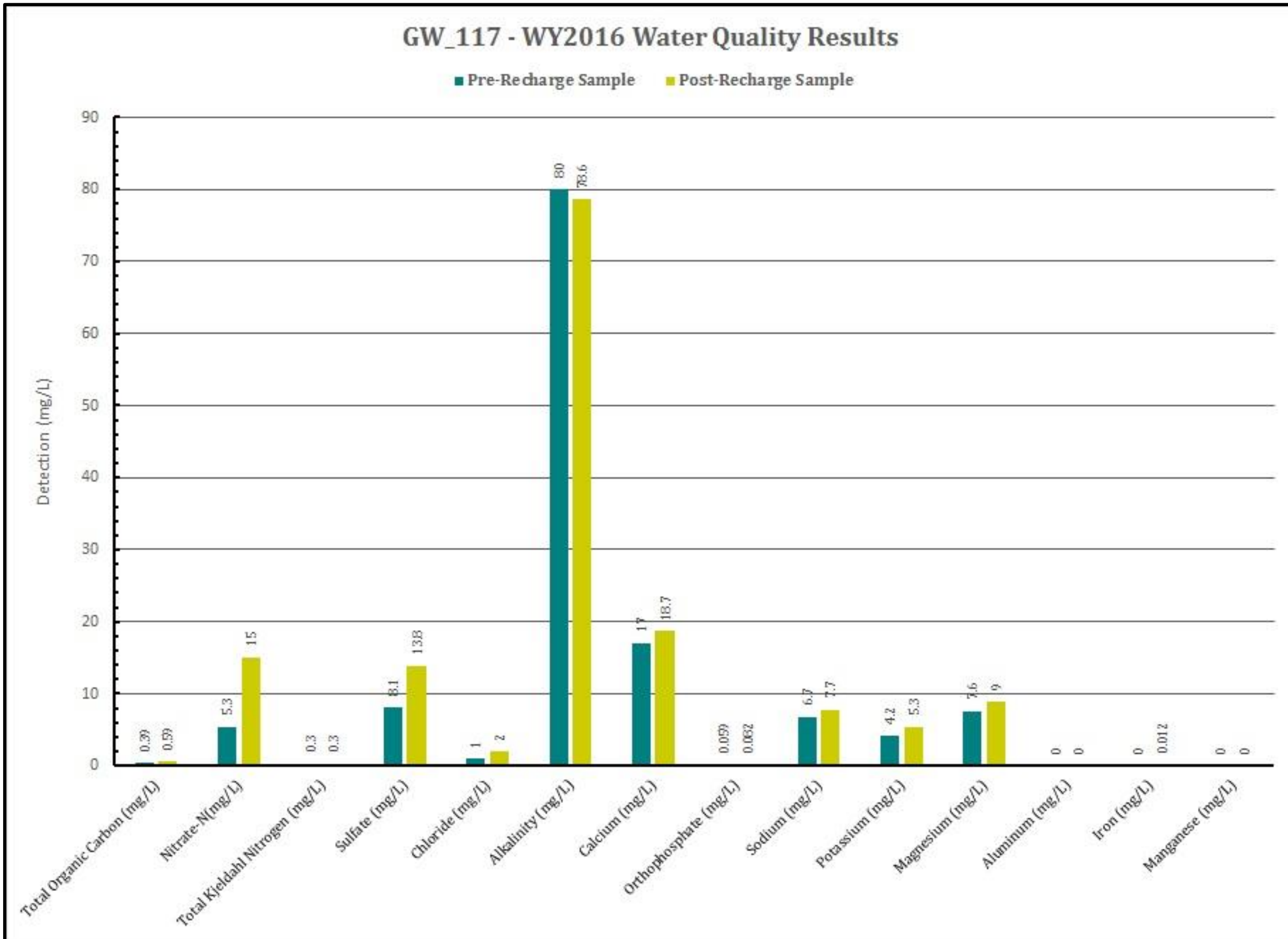

Figure 58 - Water quality results for groundwater at GW_117 for the WY2016 Aquifer Recharge Season. Lab results can be found in Appendix D.

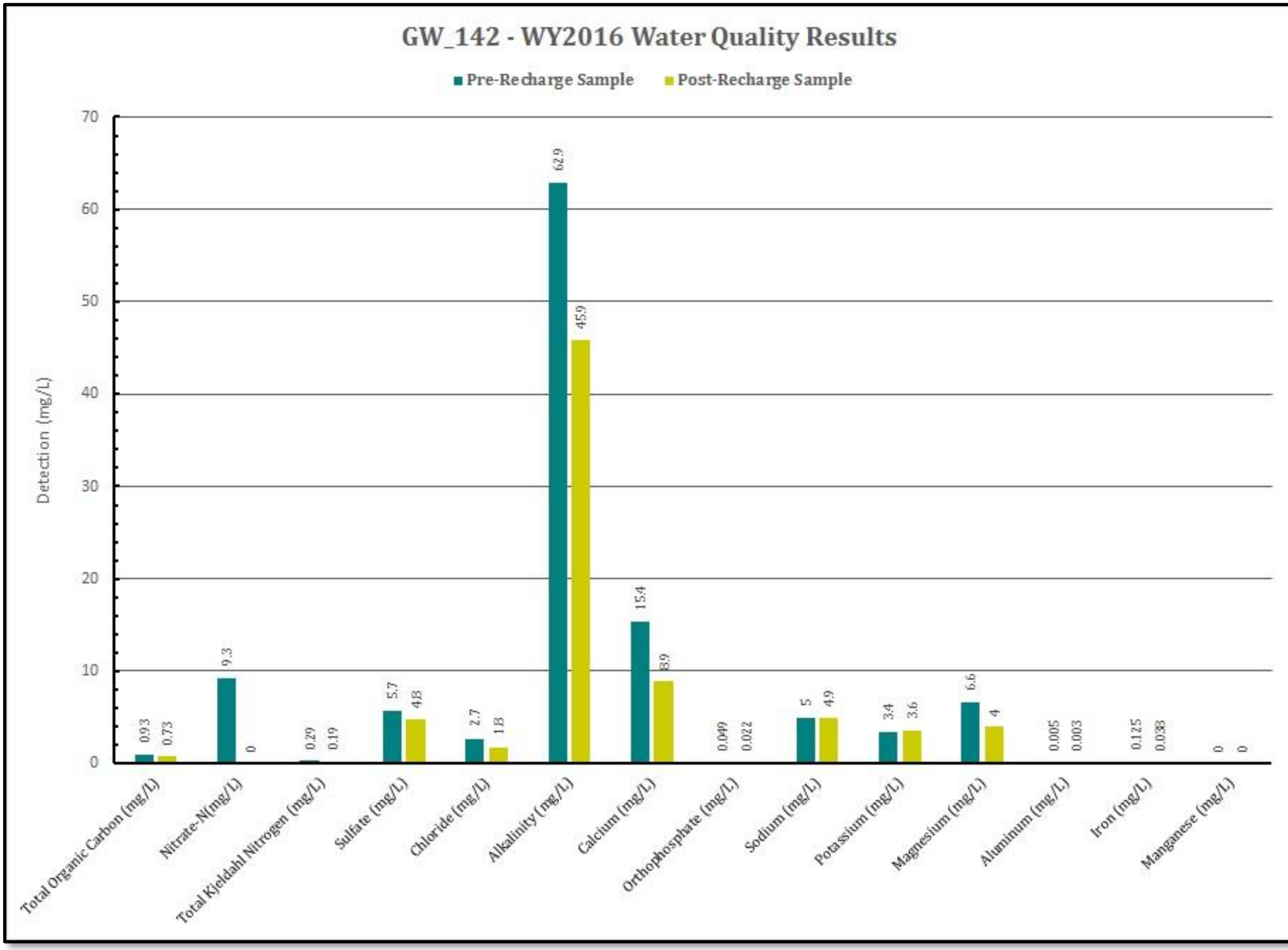

Figure 59 - Water quality results for groundwater at GW_142 for the WY2016 Aquifer Recharge Season. Lab results can be found in Appendix D.

TABLE 10. GW_119

Sample Parameter	12/15/2015	05/17/2016
Total Organic Carbon (mg/L)	0.93	1.72
Nitrate-N(mg/L)	37.20	45.20
Total Kjeldahl Nitrogen (mg/L)	1.33	1.21
Sulfate (mg/L)	19.8	26.4
Chloride (mg/L)	4.0	6.5
Alkalinity (mg/L)	160.3	106.8
Calcium (mg/L)	37.0	15.3
Orthophosphate (mg/L)	0.090	0.022
Sodium (mg/L)	20.4	26.8
Potassium (mg/L)	8.3	9.5
Magnesium (mg/L)	16.6	17.0
Aluminum (mg/L)	ND	ND
Iron (mg/L)	ND	0.012
Manganese (mg/L)	ND	ND

ND = no detection

TABLE 11. GW_144 (PMW-5 IN MONITORING PLAN)

Sample Parameter	12/15/2015	05/17/2016
Total Organic Carbon (mg/L)	0.78	2.60
Nitrate-N(mg/L)	45.60	80.60
Total Kjeldahl Nitrogen (mg/L)	3.68	3.21
Sulfate (mg/L)	13.8	19.5
Chloride (mg/L)	8.5	7.4
Alkalinity (mg/L)	122.0	75.3
Calcium (mg/L)	32.3	28.1
Orthophosphate (mg/L)	0.082	0.009
Sodium (mg/L)	17.2	20.1
Potassium (mg/L)	6.5	7.2
Magnesium (mg/L)	14.2	13.4
Aluminum (mg/L)	ND	ND
Iron (mg/L)	0.006	0.007
Manganese (mg/L)	0.082	ND

ND = no detection

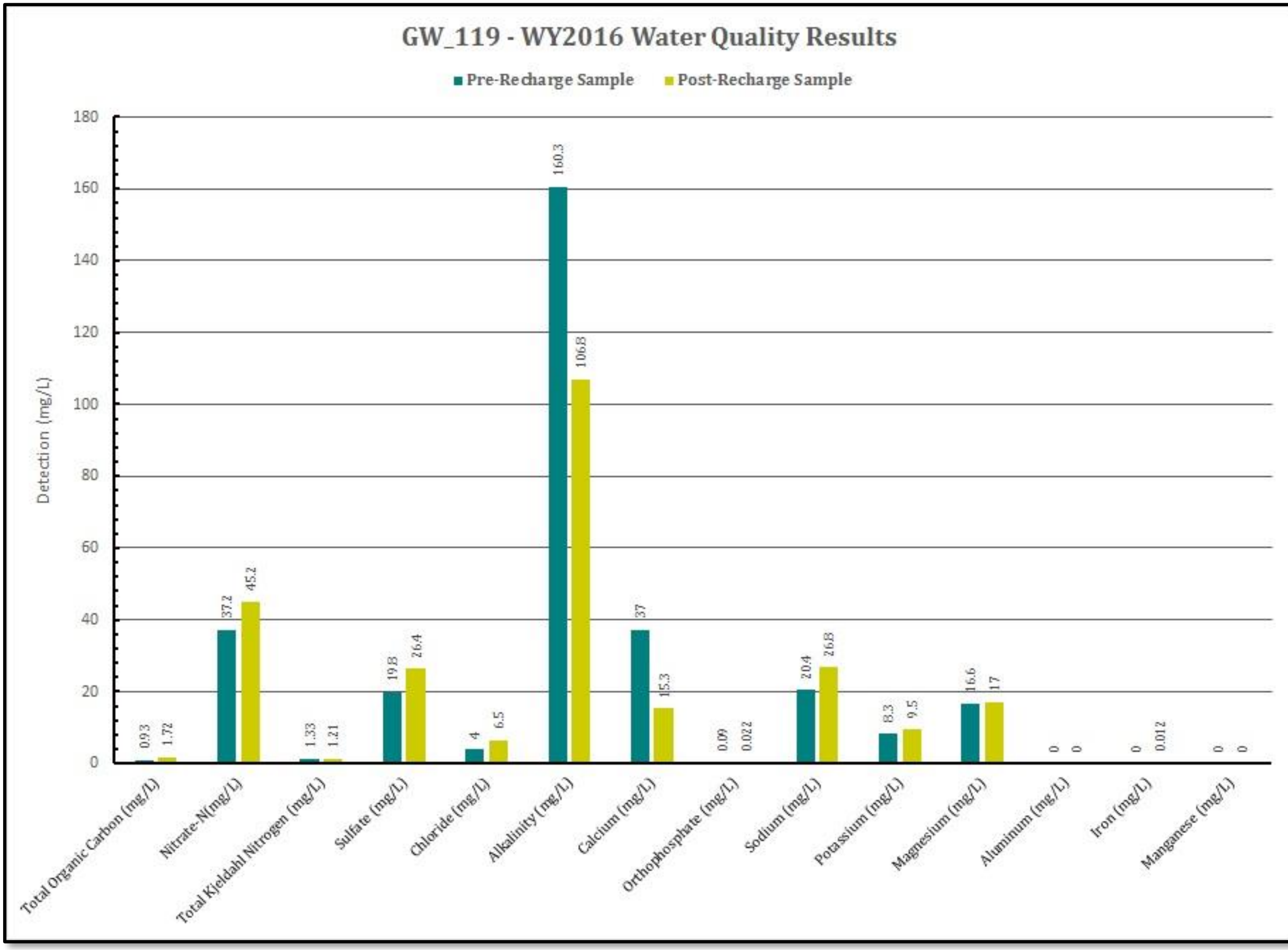

Figure 60 - Water quality results for groundwater at GW_119 for the WY2016 Aquifer Recharge Season. Lab results can be found in Appendix D.

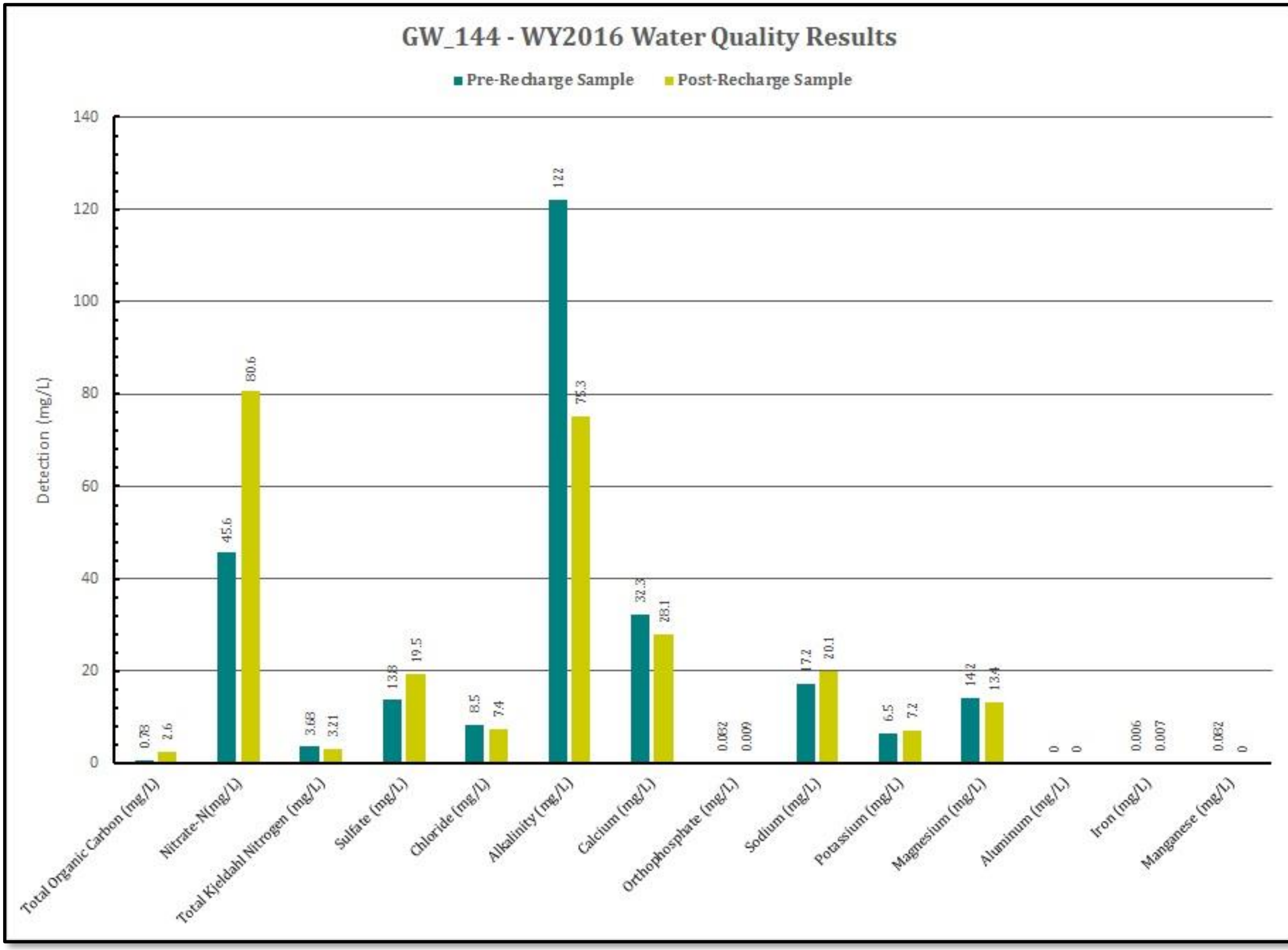

Figure 61 - Water quality results for groundwater at GW_144 for the WY2016 Aquifer Recharge Season. Lab results can be found in Appendix D.

TABLE 12. GW_144 (PMW-5 IN MONITORING PLAN) – SYNTHETIC ORGANIC COMPOUNDS (SOCS)

Sample Parameter	05/17/2016
Endrin (µg/L)	ND
Lindane (BHC – gamma) (µg/L)	ND
Methoxychlor (µg/L)	ND
Alachlor (µg/L)	ND
Atrazine (µg/L)	ND
Benzo(A)pyrene (µg/L)	ND
Di(Ethylhexyl)-Adipate (µg/L)	ND
Di(Ethylhexyl)-Phthalate (µg/L)	ND
Heptachlor (µg/L)	ND
Heptachlor Epoxide (µg/L)	ND
Hexachlorobenzene (µg/L)	ND
Hexachlorocyclo-pentadiene (µg/L)	ND
Simazine (µg/L)	ND
Pentachlorophenol (µg/L)	ND
PCBs (Total Aroclors) (µg/L)	ND
Aroclor 1221 (µg/L)	ND
Aroclor 1232 (µg/L)	ND
Aroclor 1242 (µg/L)	ND
Aroclor 1248 (µg/L)	ND
Aroclor 1254 (µg/L)	ND
Aroclor 1260 (µg/L)	ND
Aroclor 1016 (µg/L)	ND
Toxaphene (µg/L)	ND
Chlordane, Technical (µg/L)	ND
DCPA (Acid Metabolites) (µg/L)	ND
Dicamba (µg/L)	ND
2,4 DB (µg/L)	ND
2, 4, 5 T (µg/L)	ND
Bentazon (µg/L)	ND
Dichlorprop (µg/L)	ND
Acifluorfen (µg/L)	ND
3, 5 Dichlorobenzoic Acid (µg/L)	ND
2, 4 – D (µg/L)	ND
2, 4, 5 – TP (Silvex) (µg/L)	ND
Pentachlorophenol (µg/L)	ND
Dalapon (µg/L)	ND
Dinoseb (µg/L)	ND
Picloram (µg/L)	ND
Bromacil (µg/L)	ND
Fluorene (µg/L)	ND
Aldrin (µg/L)	ND
Butachlor (µg/L)	ND
Dieldrin (µg/L)	ND
Metolachlor (µg/L)	ND
Metribuzin (µg/L)	ND
Propachlor (µg/L)	ND
Aldicarb Sulfoxide (µg/L)	ND
Aldicarb Sulfone (µg/L)	ND
Methomyl (µg/L)	ND
3-Hydroxycarbofuran (µg/L)	ND
Aldicarb (µg/L)	ND
Carbaryl (µg/L)	ND
Oxamyl (µg/L)	ND
Carbofuran (µg/L)	ND

ND = no detection

Intra-well variations from the pre-recharge sampling event in November to the post-recharge sampling event in May are mostly relatively subtle. Wells closely associated with recharge sites, such as GW_46, GW_141 and GW_142, generally have lower concentrations of analytes in the post-recharge sample than the pre-recharge sample. Other, more distant or up-gradient wells showed a slight increase in most parameters from the pre-recharge sample to the post-recharge sample, such as GW_117 and GW_119. In general, wells that were clearly influenced by recharge operations (specifically GW_46) were observed to have very similar concentrations of indicator parameters that were more closely associated with source water, especially at the post-recharge sampling event (Tables 2 & 7 and Figures 62-66).

On an inter-well basis some substantial differences in groundwater quality were apparent. The program's more up-gradient wells (GW_46, 117, 141 and 142), were observed to have lower Nitrate values than down-gradient wells (GW_119 and GW_144) during WY 2016. Wells located farther down-gradient (GW_119 and GW_144) were observed to have higher concentrations of Nitrate (as Nitrogen) and Alkalinity, relative to water quality monitoring wells located up-gradient and mid-gradient within the aquifer recharge program. This trend likely reflects the influence of agricultural and livestock activities resulting in percolation of nutrients below the root zone (Figures 60 and 61).

Based on the interpretation of hydraulic response and observed leakage in the unlined canal systems in the Walla Walla basin, it would appear that groundwater quality at some of the "up-gradient" locations are influenced by surface water contributions from sources other than the recharge facilities. However, comparing up-gradient and down-gradient monitoring locations at the Trumbull (GW_117 and GW_142) and Johnson (GW_141 and GW_46) sites shows decreases in Nitrate (as Nitrogen), Alkalinity and major anion and cation concentrations at the down-gradient locations relative to the up-gradient locations and that recharge activities are improving, or at least not degrading, groundwater quality (Figures 62 and 63).

WY 2016 sampling detected high levels of Nitrate (as Nitrogen) in three of the wells, which is similar to values seen during WY 2015 sampling. The source of these nitrates is unknown, however the data suggests that recharge operations are not the source for increased nitrate values, but may be helping the problem at some locations, as indicated by:

1. The source water has very low nitrate (with the exception of the S-3 sample from 12-15-2015 – and this value is very low compared with groundwater levels).
2. Wells with high nitrate values (GW_117, 119 and 144) show similar trends with other water quality factors, such as alkalinity, sulfate, and sodium. These wells do not show a response in water quality data to recharge operations (like is seen at GW_46, 141 and 142).
3. Wells closely associated with recharge operations (GW_46, 141 and 142) all showed decreases in nitrate values over the course of the recharge season (Figure 63). Specifically, GW_141 showed high nitrate levels before the WY 2015 season. These were reduced over the season from 22.60 mg/L to 12.5 mg/L. During the WY 2016 season the values again were reduced from 13.3 mg/L to 0.1 mg/L. Similar trends in decreasing nitrate values are also measured at GW_46 and GW_142.

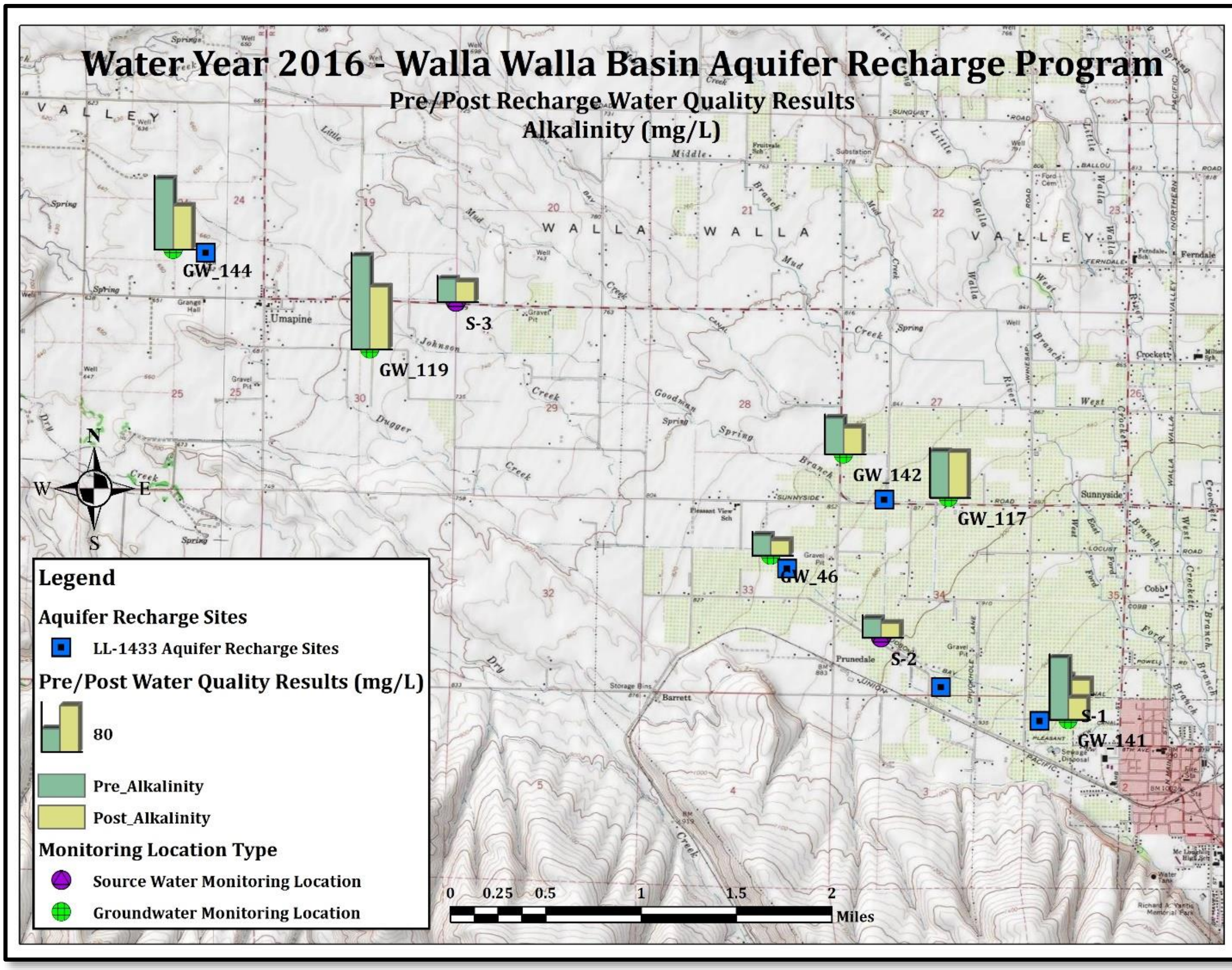

Figure 62 - Water quality results for the Walla Walla Basin Aquifer Recharge Program during WY 2016. The map shows alkalinity values (mg/L) at the various monitoring locations required by the approved monitoring plan. Green bars indicate pre-recharge values and yellow bars indicate post-recharge values. Alkalinity values are typically lower in the up-gradient portion of the program while alkalinity values are higher in the down-gradient portion of the program.

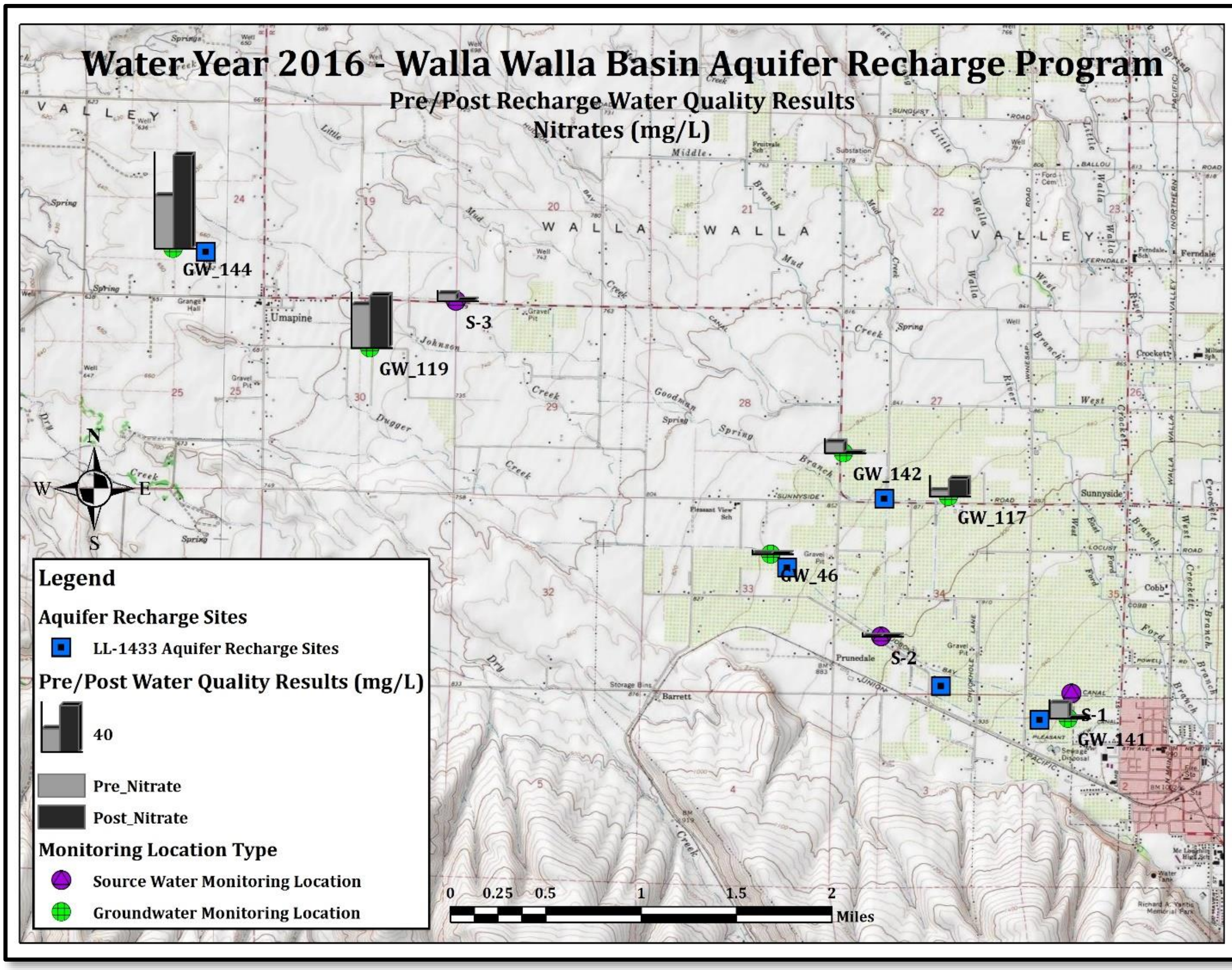

Figure 63 - Water quality results for the Walla Walla Basin Aquifer Recharge Program during WY 2016. The map shows nitrate values (mg/L) at the various monitoring locations required by the approved monitoring plan. Gray bars indicate pre-recharge values and Black bars indicate post-recharge values. Nitrate values are typically lower in the up-gradient portion of the program while alkalinity values are higher in the down-gradient portion of the program. Nitrate values at wells closely associated with recharge sites (GW_46, 141 and 142) showed a reduction in nitrate values while wells not closely associated or up-gradient of recharge sites (GW_117 and 119) showed increases in nitrate values.

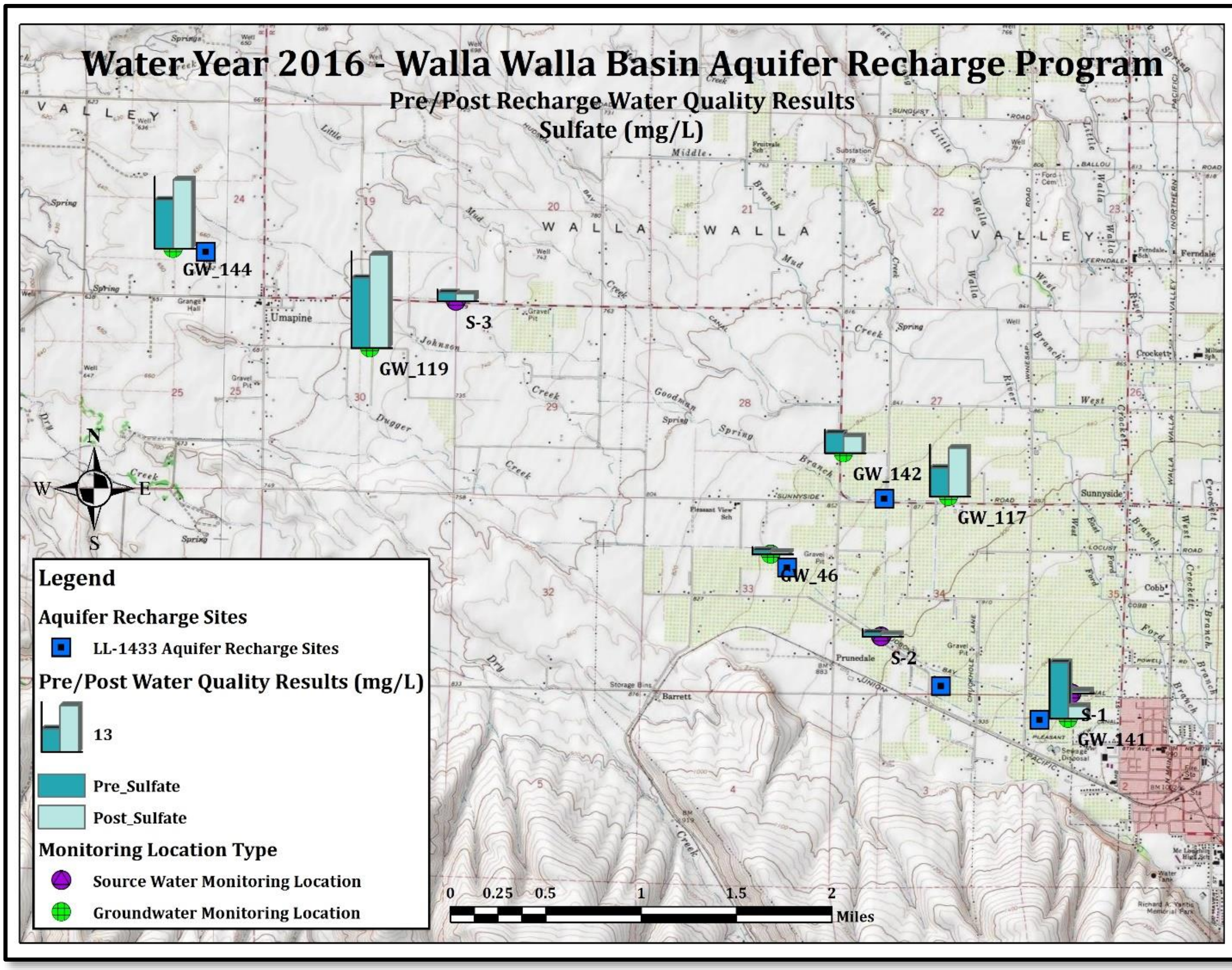

Figure 64 - Water quality results for the Walla Walla Basin Aquifer Recharge Program during WY 2016. The map shows sulfate values (mg/L) at the various monitoring locations required by the approved monitoring plan. Teal bars indicate pre-recharge values and light teal bars indicate post-recharge values. Sulfate values are typically lower in the up-gradient portion of the program while sulfate values are higher in the down-gradient portion of the program. Sulfate values at wells closely associated with recharge sites (GW_46, 141 and 142) showed a reduction in sulfate values while wells not closely associated or up-gradient of recharge sites (GW_117 and 119) showed increases in sulfate values.

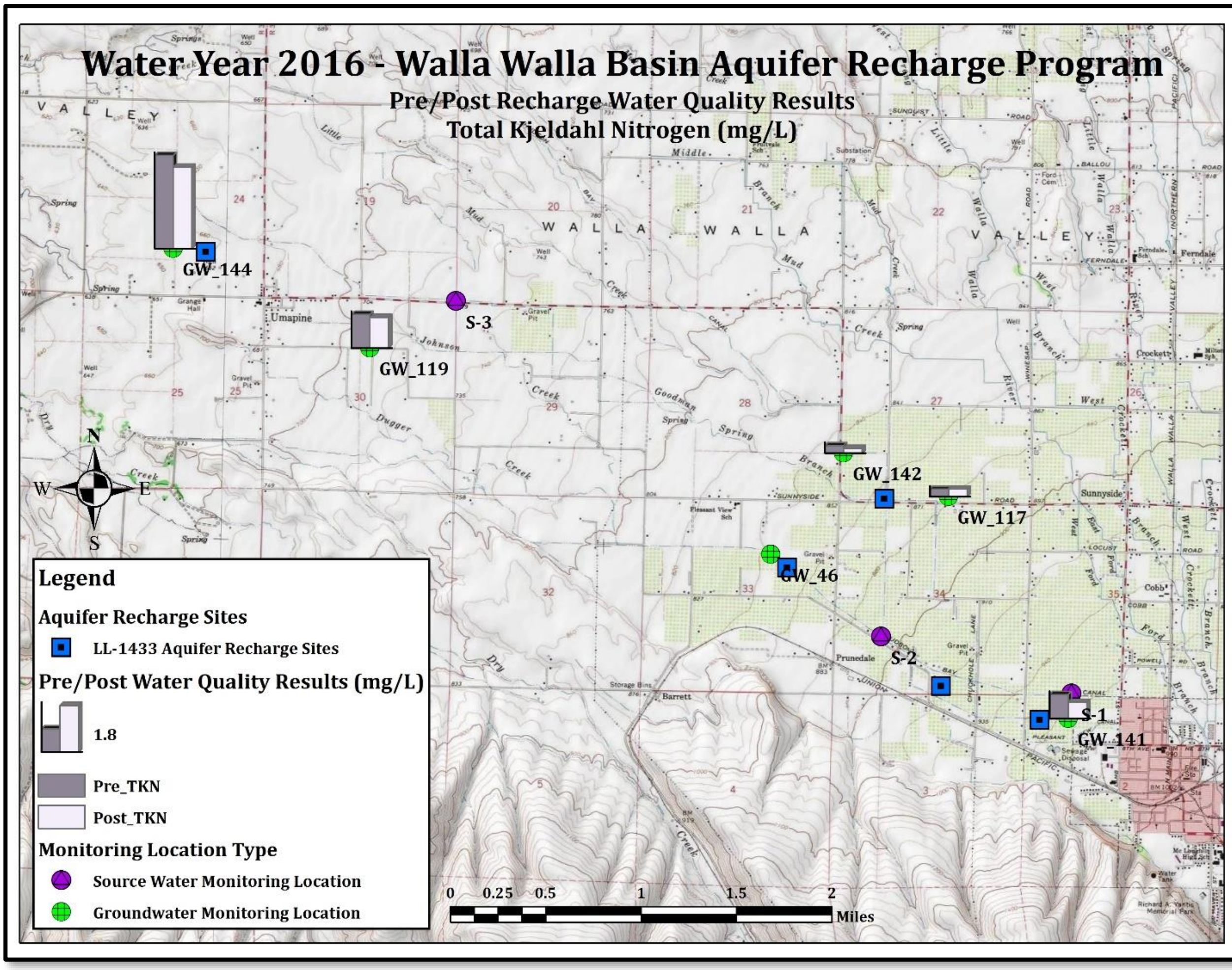

Figure 65 - Water quality results for the Walla Walla Basin Aquifer Recharge Program during WY 2016. The map shows Total Kjeldahl Nitrogen values (mg/L) at the various monitoring locations required by the approved monitoring plan. Gray bars indicate pre-recharge values and white bars indicate post-recharge values. Total Kjeldahl Nitrogen values at all monitoring locations showed a decrease in values during the recharge season.

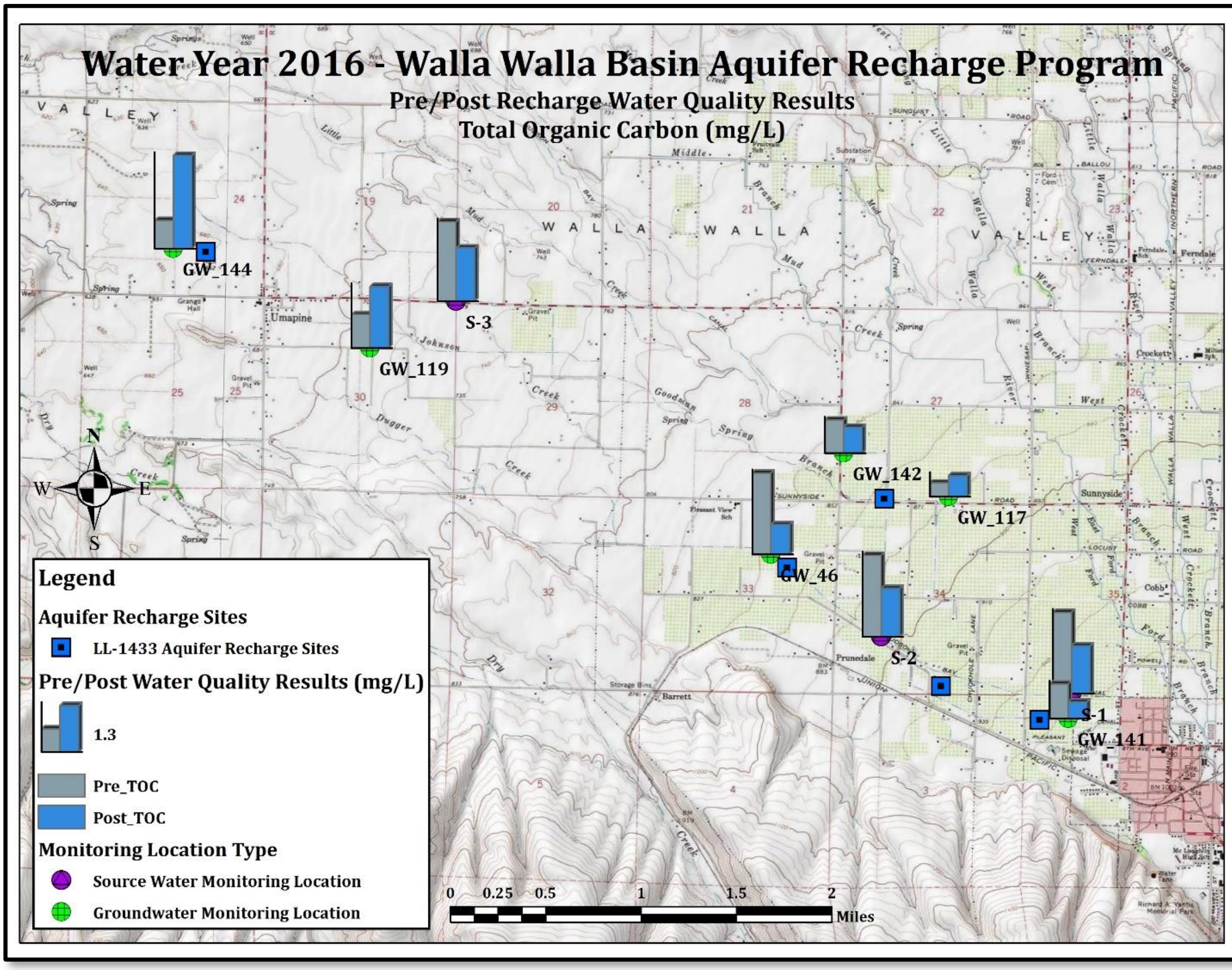

Figure 66 - Water quality results for the Walla Walla Basin Aquifer Recharge Program during WY 2016. The map shows Total Organic Carbon (TOC) values (mg/L) at the various monitoring locations required by the approved monitoring plan. Gray bars indicate pre-recharge values and gray bars indicate post-recharge values. Total Organic Carbon (TOC) values at wells closely associated with recharge sites (GW_46, 141 and 142) showed a reduction in Total Organic Carbon (TOC) values while wells not closely associated or up-gradient of recharge sites (GW_117 and 119) showed increases in Total Organic Carbon (TOC) values.

DISCUSSION OF RESULTS

During the WY 2016 recharge season 6,229.54 acre-feet (2,029,901,838 gallons) of water was diverted from the Walla Walla River and delivered to recharge basins and infiltration galleries recharging the alluvial aquifer northwest of Milton-Freewater, OR. Water levels in most down-gradient alluvial aquifer monitoring wells showed rapid response to recharge, resulting in increases in water levels in the alluvial aquifer near the sites. Wells down-gradient of the Johnson site show a year to year positive (i.e. increasing) trend in alluvial aquifer water levels suggesting that water is being stored within the alluvial aquifer, potentially due to aquifer recharge activities (Figure 42). Another site that is also showing positive groundwater gains is the Anspach site, just northwest of Milton-Freewater (Figure 26). With the exception of the drought year 2015, the site shows positive groundwater gains over the last 3 years. Other aquifer recharge sites show similar alluvial aquifer results (Trumbull and Barrett), additional years of operation and monitoring are required to evaluate trends at these other sites (Figures 30, 51 and 52). Groundwater level yearly lows and yearly highs have been on a positive trend, however limited recharge volumes and increased groundwater pumping during WY 2015 due to drought conditions decreased alluvial aquifer water level during the summer/fall of 2015 compared to previous years. Results from WY 2016 are in line with trends seen before WY 2015 and the positive trends are expected to continue assuming continued aquifer recharge operations and normal water years.

The Walla Walla Basin's AR program continues to simulate floodplain function and processes that have been lost due to irrigation development and channelization of the river and stream channels for flood control and other uses. With continued AR activities and increases in the total annual volume of water recharged, increases in alluvial aquifer water levels are anticipated, which should lead to further spring flow and/or base flow to the Walla Walla river system similar to those observed in previous pilot testing operations at the Johnson site (WWBWC, 2010, WWBWC, 2014b).

The WY2015 and WY 2016 recharge seasons provide insight into how both the groundwater system and the aquifer recharge program can be influenced by drought conditions and then recover the following year under more typically climate conditions. WY2015 and WY2016 also provide insight into how the alluvial aquifer can be managed to allow greater utilization during drought conditions if accompanied by a managed aquifer recharge program. Recharge water delivery in WY 2016 was the second highest amount since the start of the recharge program. Above average recharge water delivery volumes were achieved even with low instream flows in the Walla Walla River limiting recharge operations early in the season (November) and later in the season (mid-May). This demonstrates the increasing capacity of the Walla Walla Basin recharge program. WY2016's recharge volume (6,229.54 acre-feet) was a 223% increase over WY2015's recharge volume (2,786.05 acre-feet).

As in previous recharge seasons, groundwater and surface water quality data collected during aquifer recharge activities do not indicate that AR activities are degrading groundwater quality per Condition 5 of LL-1433. In some cases, groundwater quality parameters improved over the recharge season, while at other locations water quality remained unchanged or declined over the period of observation. Source water quality being delivered to the aquifer recharge sites continues to be of acceptable quality and would not be anticipated to degrade groundwater quality.

Proposed AR Program in WY 2017

Continued operation of the five current sites and the addition of new aquifer recharges sites under LL-1621 is expected in WY 2017. Operating sites with shorter operational history, like Barrett and NW Umapine, for a longer and more sustained duration will help to identify their influence on the alluvial aquifer via program monitoring wells. Additionally, expansion of the AR program will occur during WY 2017 with the issuance of limited license LL-1621. LL-1621 allows delivery of recharge water to a total of 17 sites. Thirteen of the 17 sites are constructed and will operate during the WY 2017 season if water is available for all sites. The remaining four sites in the limited license are in the planning phase and will likely become operational in the next 1-2 years.

In addition to new sites, WY2017 will continue the operation of near real-time water quality stations to monitoring conditions of the recharge source water. The goal of these stations is to eventually operate the aquifer recharge sites using near real-time data for the inflowing source water and to manage the sites via telemetry. An OWEB grant has been secured to expand the telemetry network to include most of the active aquifer recharge sites during WY2017. The new water quality stations will operate during the WY 2017 recharge season and data will be evaluated against grab sample water quality test results to determine the efficacy of the real-time stations and if they can be used in place of grab sample testing. A draft report and proposed monitoring plan will be developed after the WY 2017 season.

In WY 2017 monitoring will continue to be performed per the monitoring plan approved under LL-1621. A report summarizing groundwater level monitoring, water quality monitoring and AR operations performed during the WY 2017 recharge season will be submitted to OWRD by February 15, 2018.

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APPENDIX A – LIMITED LICENSE LL-1433

Oregon Water Resources Department

Final Order
Limited License Application LL-1433
Hudson Bay District Improvement Company

Appeal Rights

This is a final order in other than a contested case. This order is subject to judicial review under ORS 183.484. Any petition for judicial review must be filed within the 60-day time period specified by ORS 183.484(2). Pursuant to ORS 536.075 and OAR 137-004-0080 you may either petition for judicial review or petition the Director for reconsideration of this order. A petition for reconsideration may be granted or denied by the Director, and if no action is taken within 60 days following the date the petition was filed, the petition shall be deemed denied.

Requested Water Use

On August 31, 2012, the Water Resources Department received completed Limited License request **1433** from Hudson Bay District Improvement Company for the use of up to 45 cubic feet per second from the Walla Walla River, located in the SW ¼, NE ¼, Section 12, Township 5 North, Range 35 East, W.M., for the purpose of artificial groundwater recharge testing, for the period of November 1, 2012 through December 31, 2017.

Authorities

The Department may approve a limited license pursuant to its authority under ORS 537.143, 537.144 and OAR 690-340-0030.

ORS 537.143(2) authorizes the Director to revoke the right to use water under a limited license if it causes injury to any other water right or a minimum perennial streamflow.

A limited license will not be issued for more than five consecutive years for the same use, as directed by ORS 537.143(8).

Findings of Fact

1. The forms, fees and map have been submitted, as required by OAR 690-340-0030(1).
2. The Department provided public notice of the application, on September 11, 2012 as required by OAR 690-340-0030(2).
3. This limited license request is limited to an area within a single drainage basin as required by OAR 690-340-0030(3).
4. The Department has determined that there is water available for the requested use.

5. The Department has determined that the proposed source has not been withdrawn from further appropriation.

6. Because this use is from surface water and has the potential to impact fish, the Department finds that fish screening is required to protect the public interest.

7. Because the use requested is longer than 120 days and because the use is in an area that has sensitive, threatened or endangered fish species, the use is subject to the Department's rules under OAR 690-33. These rules aid the Department in determining whether a proposed use will impair or be detrimental to the public interest with regard to sensitive, threatened, or endangered fish species.

8. The Department has determined that the use is not subject to its rules under OAR 690-350. However, artificial groundwater recharge testing must be done in a manner that provides a test with results and supplemental information for the user's artificial groundwater recharge permit application. Consistent with this intent, the Department has added conditions pertaining to testing, monitoring, reporting and coordination with Oregon Department of Environmental Quality (ODEQ), Oregon Department of Fish and Wildlife (ODFW) and this Department.

9. The Department has received comments related to the possible issuance of the limited license from ODEQ requesting changes to the proposed monitoring plan. These changes pertained to sampling and reporting. The water quality monitoring plan was revised and approved by ODEQ on November 28, 2012. The Department has received comments from ODFW in support of this license and recommending conditions related to instream water rights and bypass flows. The Department's Groundwater Section determined the testing and water quantity monitoring plan submitted as an addendum to the application on January 3, 2013 is sufficient for artificial groundwater recharge testing. The authorization of Limited License **1433** is conditioned to satisfactorily address issues raised in those comments.

10. Pursuant to OAR 690-340-0030(4)(5), conditions have been added with regard to notice and water-use measurement.

Conclusions of Law

The proposed water use will not impair or be detrimental to the public interest pursuant to OAR 690-340-0030(2), as limited in the order below.

Order

Therefore, pursuant to ORS 537.143, ORS 537.144, and OAR 690-340-0030, application for Limited License **1433** is approved as conditioned below.

1. The period and rate of use for Limited License **1433** shall be from March 7, 2013, through December 31, 2017 for the use of up to 45 cubic feet per second from the Walla Walla River, for the purpose of artificial groundwater recharge testing. The season of use is limited to November 1 through May 15. This limited License **1433** replaces and supersedes LL-1189 which is of no further force or effect.

2. The licensee shall give notice to the Watermaster in the district where use is to occur not less than 15 days or more than 60 days in advance of using the water under this license. The notice shall include the location of the diversion, and the volume of water to be diverted and the intended use and place of use.

3. When water is diverted under this license, the use is limited to times when the following minimum streamflows are met in the Tum A Lum reach of the Walla Walla River, between the Little Walla Walla River diversion and Nursery Bridge Dam and flowing past Nursery Bridge Dam: November – 64 cfs, December and January – 95 cfs, February to May 15 – 150 cfs. Nursery Bridge Dam is located just downstream of Nursery Bridge and is downstream of the Little Walla Wall diversion. The District 5 Watermaster, based on gage and/or flow measurements, shall make the determination that the above described streamflows are flowing past Nursery Bridge Dam. Diversion under this license shall cease when said streamflows are unmet.

4. The Licensee shall follow the operation, water quality and water level monitoring plans described in the document entitled "Hydrogeologic Setting and Source Water and Groundwater Monitoring and Reporting Plan for the Hudson Bay District Improvement Company Multi-Site Alluvial Aquifer Limited License Application **LL-1433**, Umatilla County, Oregon" and dated January 3, 2013. This plan may be modified after review and approval of changes by the Department.

5. The licensee shall comply with all ODEQ water-quality requirements. If monitoring data or other information result in identification of potential water-quality concerns, ODEQ may seek modifications to the monitoring and test plan and/or require a permit of its own to address the water-quality concerns prior to resumption of artificial groundwater recharge testing.

6. Before water use may begin under this license, the licensee shall install a totalizing flow meter at each point of diversion and at the entry point to each recharge test site. The totalizing flow meters must be maintained in good working order. In addition the licensee shall maintain a record of all water use, including the total number of hours of diversion, the total volume diverted, and the categories of beneficial use to which the water is applied. During the period of the limited license, the record of use shall be available for review by the Department upon request, and shall be submitted to the Department annually and to Watermaster upon request. This record shall include the amount of water diverted from the Walla Walla River, and the amount delivered to each recharge area.

7. The Director may revoke the right to use water for any reason described in ORS 537.143(2), and OAR 690-340-0030(6). Such revocation may be prompted by field regulatory activities or by any other reason.

8. Use of water under a limited license shall not have priority over any water right exercised according to a permit or certificate, and shall be subordinate to all other authorized uses that rely upon the same source.

9. The licensee shall install, maintain and operate fish screening and by-pass devices as required by the Oregon Department of Fish and Wildlife to prevent fish from entering the proposed diversion. See copy of enclosed fish screening criteria for information.

10. In supporting this license, ODFW retains the prerogative to pursue a future instream water right for the Walla Walla River.

11. The licensee is required to provide a written annual report by February 15th of each year. This report will detail recharge testing. Reporting shall include, but is not limited to, the results of testing efforts that relate to water quality, water quantity, and operations. Water level data shall be submitted in a Department-specified digital format. The licensee shall consult with ODEQ and OWRD to identify additional specific reporting elements. The first report is due in February 2014. The annual report shall be sealed and signed by a professional(s) registered or allowed, under Oregon law, to practice geology.

NOTE: This water-use authorization is temporary. Applicants are advised that issuance of this final order does not guarantee that any permit for the authorized use will be issued in the future; any investments should be made with that in mind.

Issued March 11 2013

E. Timothy Wallin, Water Rights Program Manager, *for*
Phillip C. Ward, Director

Enclosures - limited license

cc: Tony Justus, District 5 Watermaster
Bill Duke, ODFW
Phil Richerson, ODEQ
File

If you need further assistance, please contact the Water Rights Section at the address, phone number, or fax number below. When contacting the Department, be sure to reference your limited license number for better service.

Remember, the use of water under the terms of this limited license is not a secure source of water. Water use can be revoked at any time. Such revocation may be prompted by field regulatory activities or many other reasons.

Water Rights Section
Oregon Water Resources Department
725 Summer Street NE, Suite A
Salem OR 97301-1271
Phone: (503) 986-0817 Fax: (503) 986-0901

FISH SCREENING CRITERIA FOR WATER DIVERSIONS

This summary describes ODFW fish screening criteria for all fish species.

Screen material openings for ditch (gravity) and pump screens must provide a minimum of 27% open area:

> **Perforated plate**: Openings shall not exceed 3/32 or 0.0938 inches (2.38 mm).
> **Mesh/Woven wire screen**: Square openings shall not exceed 3/32 or 0.0938 inches (2.38 mm) in the narrow direction, e.g., 3/32 inch x 3/32 inch open mesh.
> **Profile bar screen/Wedge wire**: Openings shall not exceed 0.0689 inches (1.75 mm) in the narrow direction.

Screen area must be large enough to prevent fish impact. Wetted screen area depends on the water flow rate and the approach velocity.

> **Approach velocity**: The water velocity perpendicular to and approximately three inches in front of the screen face.
> **Sweeping velocity**: The water velocity parallel to the screen face.
> **Bypass system**: Any pipe, flume, open channel or other means of conveyance that transports fish back to the body of water from which the fish were diverted.
> **Active pump screen**: Self cleaning screen that has a proven cleaning system.
> **Passive pump screen**: Screen that has no cleaning system other than periodic manual cleaning.

Screen approach velocity for ditch and active pump screens shall not exceed 0.4 fps (feet per second) or 0.12 mps (meters per second). The wetted screen area in square feet is calculated by dividing the maximum water flow rate in cubic feet per second (1 cfs = 449 gpm) by 0.4 fps.

Screen sweeping velocity for ditch screens shall exceed the approach velocity. Screens greater than 4 feet in length must be angled at 45 degrees or less relative to flow. An adequate bypass system must be provided for ditch screens to safely and rapidly collect and transport fish back to the stream.

Screen approach velocity for passive pump screens shall not exceed 0.2 fps or 0.06 mps. The wetted screen area in square feet is calculated by dividing the maximum water flow rate by 0.2 fps. Pump rate should be less than 1 cfs.

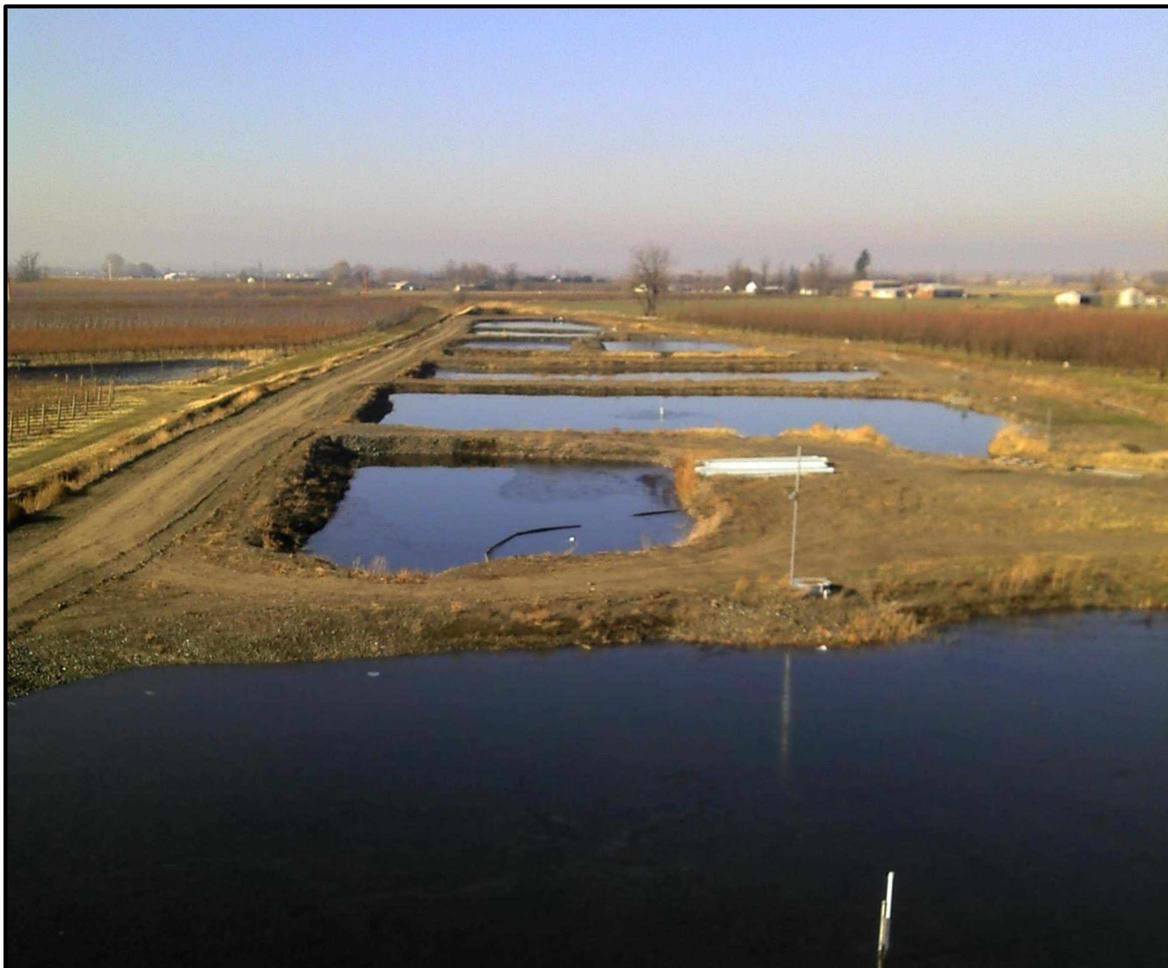
For further information please contact:

Bernie Kepshire
Oregon Department of Fish and Wildlife
7118 NE Vandenberg Avenue
Corvallis, OR 97330-9446
(541)757-4186 x255
bernard.m.kepshire@state.or.us

APPENDIX B – LL-1433 SOURCE AND GROUNDWATER MONITORING PLAN (WITHOUT FIGURES OR APPENDICES)

Click here to download complete Monitoring Plan with figures and appendices.

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



Prepared for:

Walla Walla Basin Watershed Council and Hudson Bay District Improvement Company

Prepared by:

GSI Water Solutions, Inc.

Draft Plan – January, 3rd 2013

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

Walla Walla Basin Watershed Council

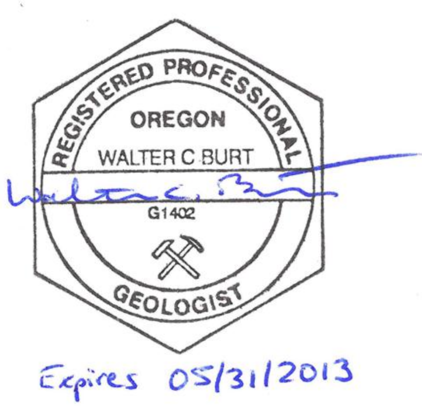
810 S. Main St., Milton-Freewater, OR 97862

And

GSI Water Solutions, Inc.

8019 W. Quinault Ave., Suite 201

Kennewick, WA 99336



Contents

INTRODUCTION

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

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

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

The balance of this document includes the following:

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

AQUIFER RECHARGE SITES AND PROJECT GOALS

Project Goals

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

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

Hulette Johnson

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

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

Anspach

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

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

Trumbull

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

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

NW Umapine

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

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

Barrett

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

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

Dugger

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

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

ODOT

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

WALLA WALLA BASIN HYDROGEOLOGIC SETTING

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

Hydrostratigraphy

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

Quaternary Units

Quaternary Fine Unit

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

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

Quaternary Coarse Unit

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

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

Mio-Pliocene Strata

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

Mio-Pliocene Upper Coarse Unit

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

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

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

Mio-Pliocene Fine Unit

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

Mio-Pliocene Basal Coarse Unit

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

Top of Basalt

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

Alluvial Aquifer Hydrogeology

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

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

Aquifer Properties

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

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

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

Groundwater Level and Flow Direction

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

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

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

Aquifer Recharge and Discharge

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

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

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

Alluvial Aquifer Water Quality

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

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

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

RECHARGE SITE HYDROGEOLOGY

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

Hulette Johnson

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

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

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

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

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

Anspach

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

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

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

Trumbull

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

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

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

NW Umapine

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

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

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

Barrett

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

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

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

Dugger

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

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

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

ODOT

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

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

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

PROPOSED MONITORING PLAN

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

Water Quality Monitoring

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

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

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

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

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

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

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

SOC Sample Collection and Analysis

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

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

Source Water Quality Monitoring Locations

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

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

Groundwater Quality Monitoring Locations

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

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

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

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

Flow and Water Level Monitoring

Surface Flow Monitoring

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

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

Groundwater Level Monitoring

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

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

SAMPLING AND ANALYSIS PROCEDURES

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

Water Level Measurements

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

Water Sampling Equipment

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

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

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

Decontamination

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

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

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

Water Quality Sampling Procedures

Low Flow Sampling Protocol

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

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

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

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

Sample Collection

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

Sample Preservation and Holding Time

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

Resampling

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

Chain of Custody and Sample Handling

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

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

Quality Assurance and Quality Control (QA/QC)

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

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

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

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

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

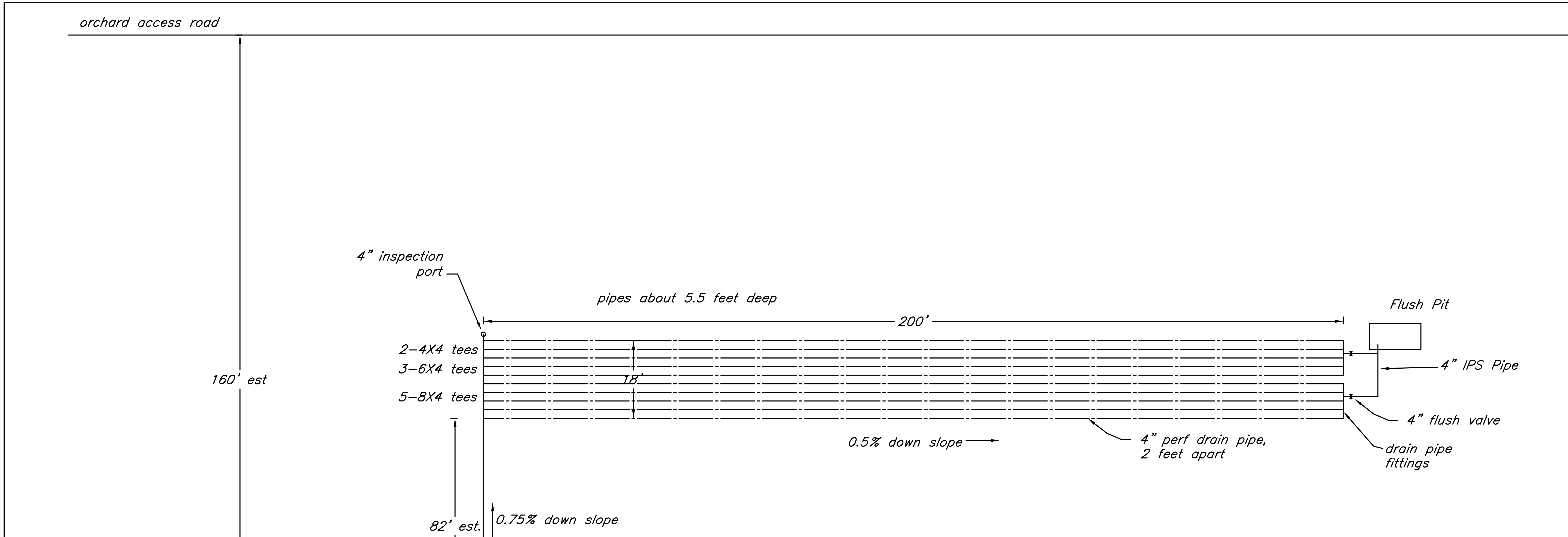
REPORTING

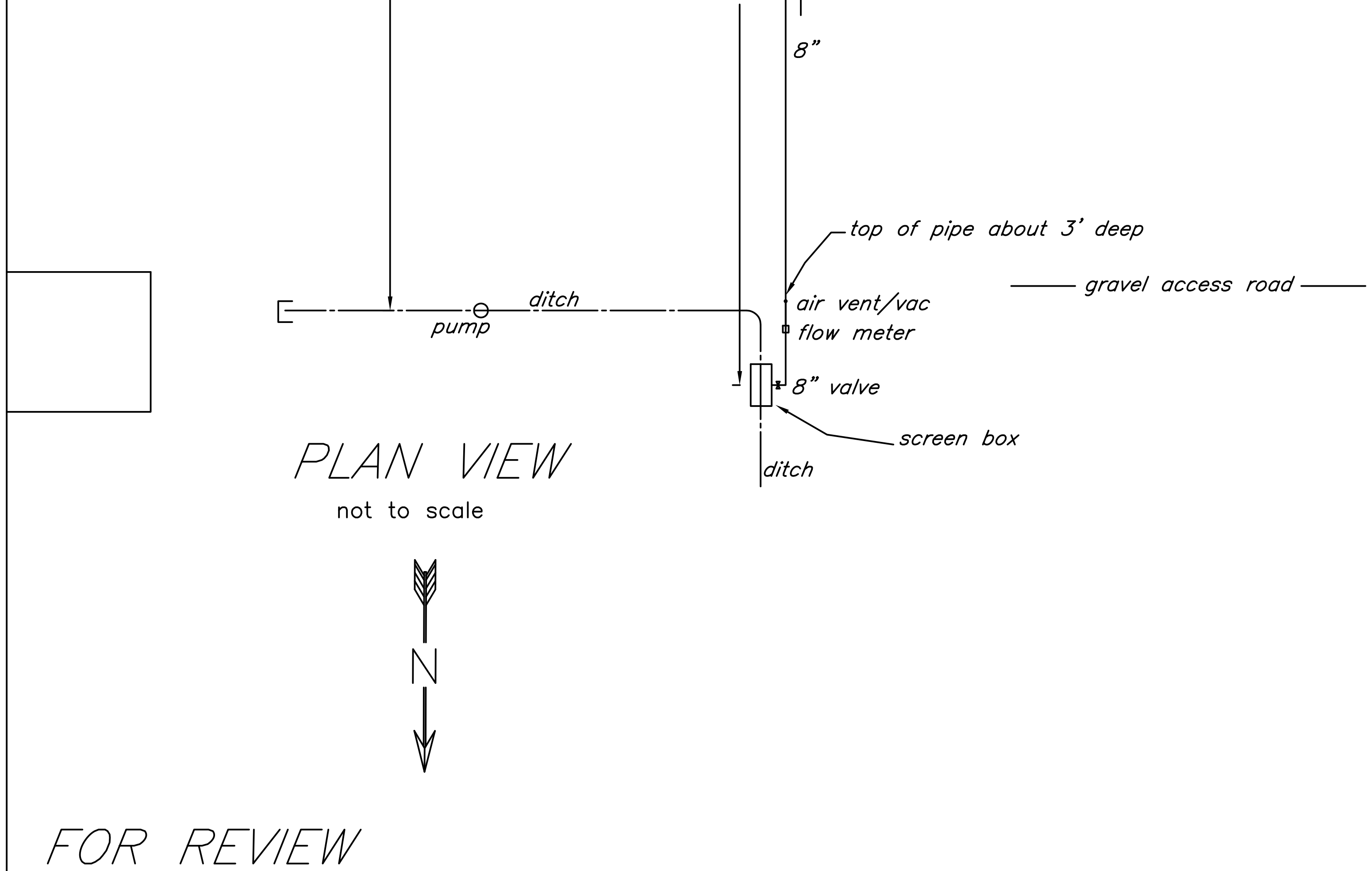
Primary reporting for this monitoring plan will focus on annual reports completed following the end of each recharge season, per OWRD requirements for the limited license and AR projects. The basic goals of the annual reports will be to: (1) analyze the data to evaluate how trends related to AR operations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

REFERENCES CITED

Barker and McNish, 1976, Digital Model of the Gravel Aquifer, Walla Walla River Basin, Washington and Oregon: Washington Department of Ecology Water Supply Bulletin 45, 47 p.

APPENDIX C – RECHARGE SITE DESIGNS





CONSTRUCTION NOTES:

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

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

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

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

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

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

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

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

File: InfGalleries.dwg

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

SITE LAYOUT
Anspach Recharge
MILTON-FREEWATER, OR

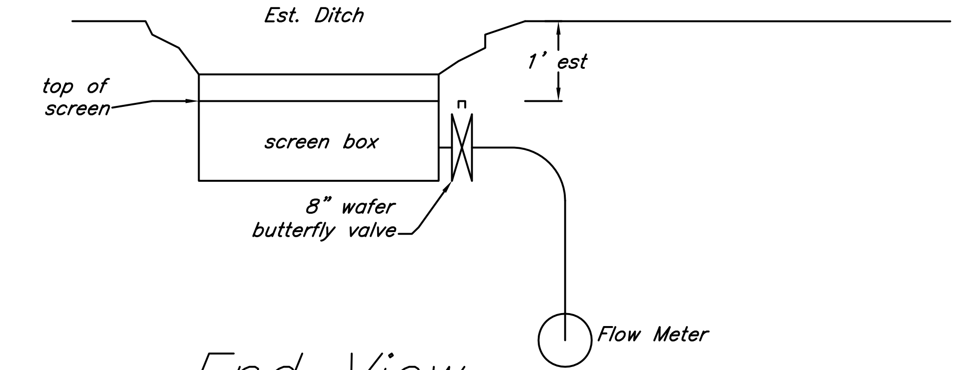
SHEET 1 OF 2

CONSTRUCTION NOTES:

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

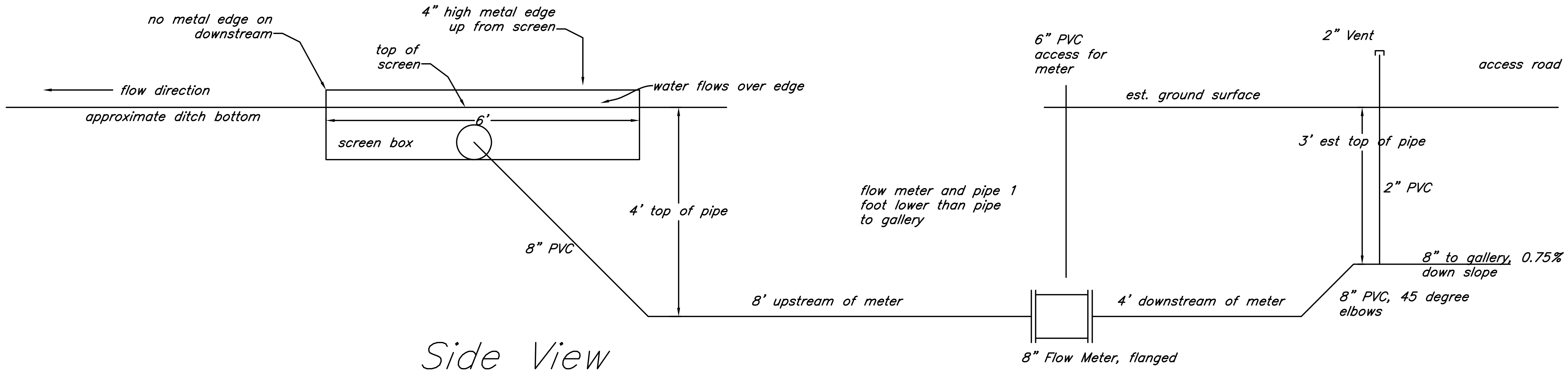
2. Proposed gravel material is 1-1/2" to 3/4" "Switch Yard", Koncrete Industries, or similar angular crushed rock with minimal fines. About 272 yards needed assuming 24' X 204' X 1.5' volume.

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

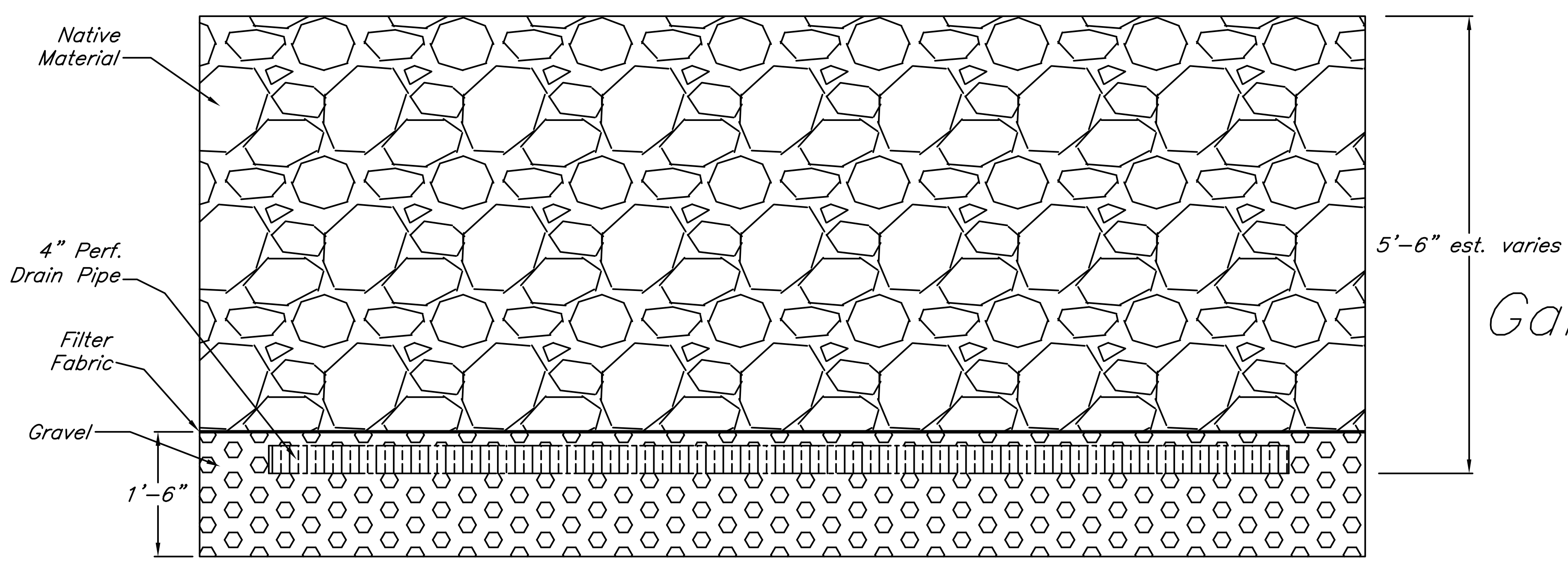


End View

Screen Box Area Details



Side View



Gallery Profile

FOR REVIEW

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

File: InfGalleries.dwg

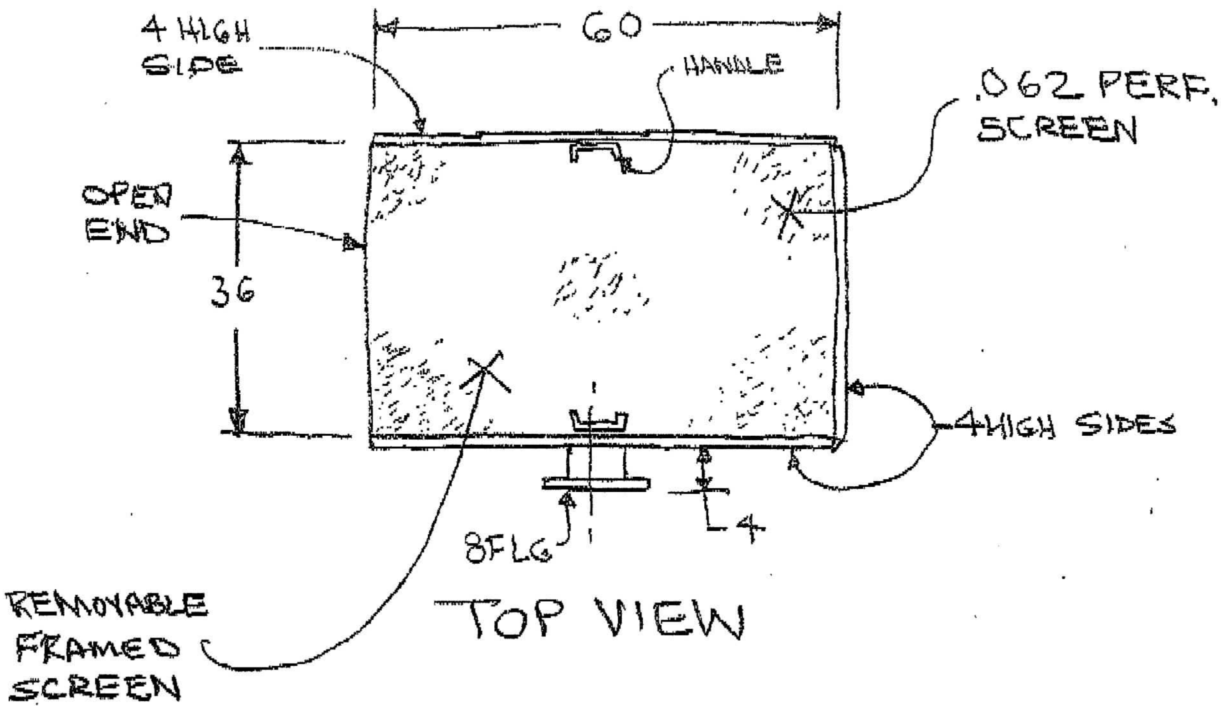
FAZIO ENGINEERING
P.O. BOX 246
MILTON-FREEWATER, OR 98762
(541) 938-6084

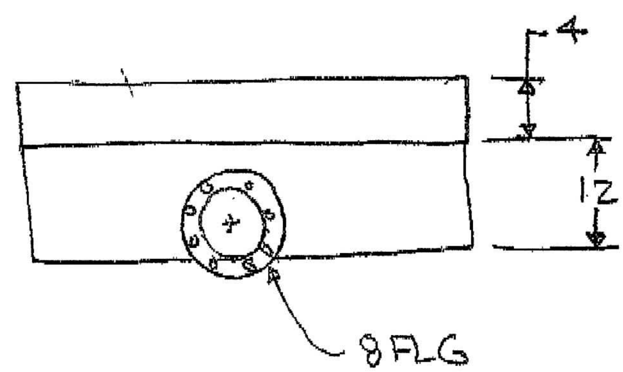
DETAILS
Anspach Recharge
MILTON-FREEWATER, OR

SHEET 2 OF 2

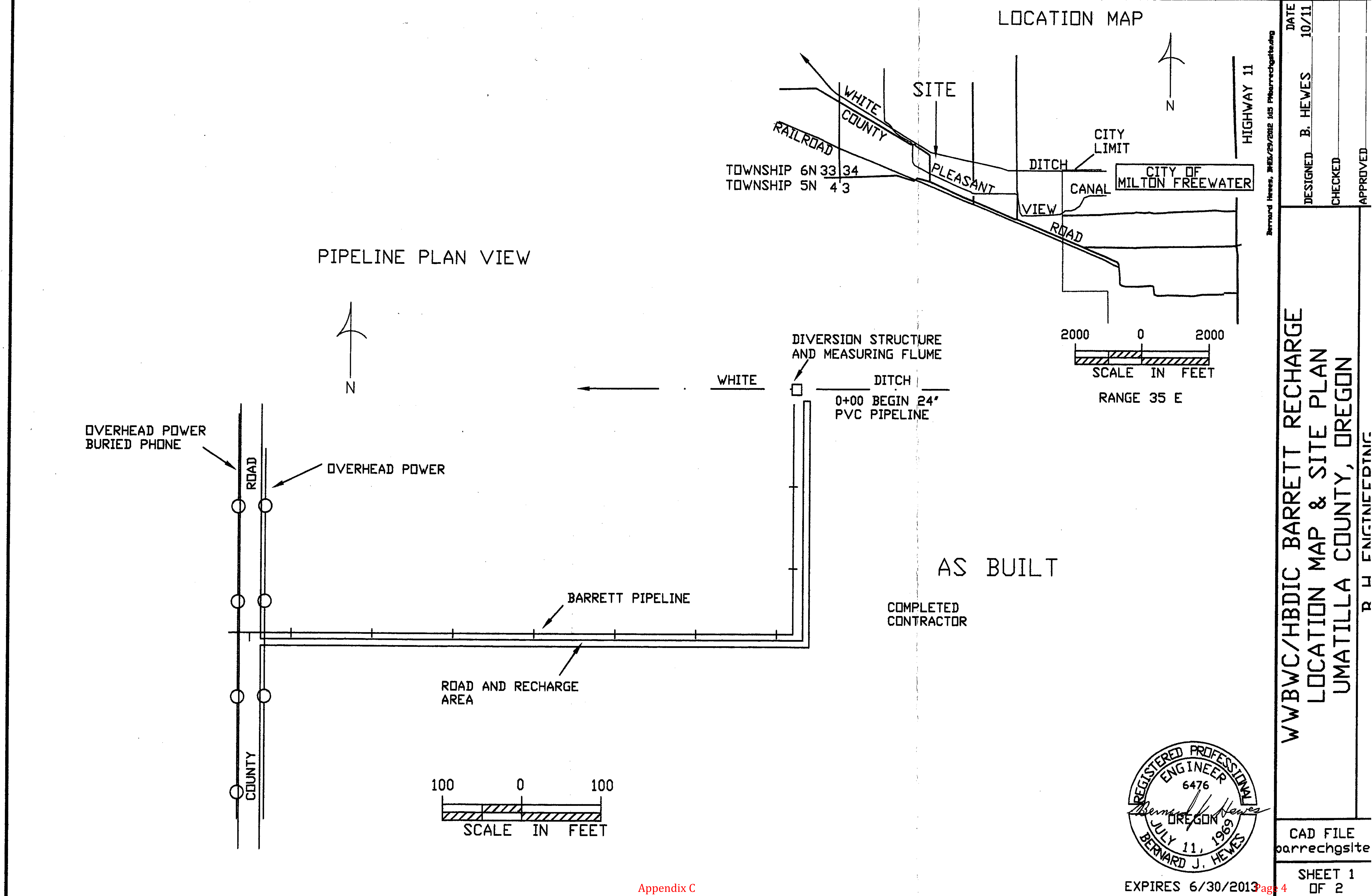
460 McLaughlin Road
Yakima, WA 98908 USA
INNOVATIVE ENGINEERING AND MANUFACTURING

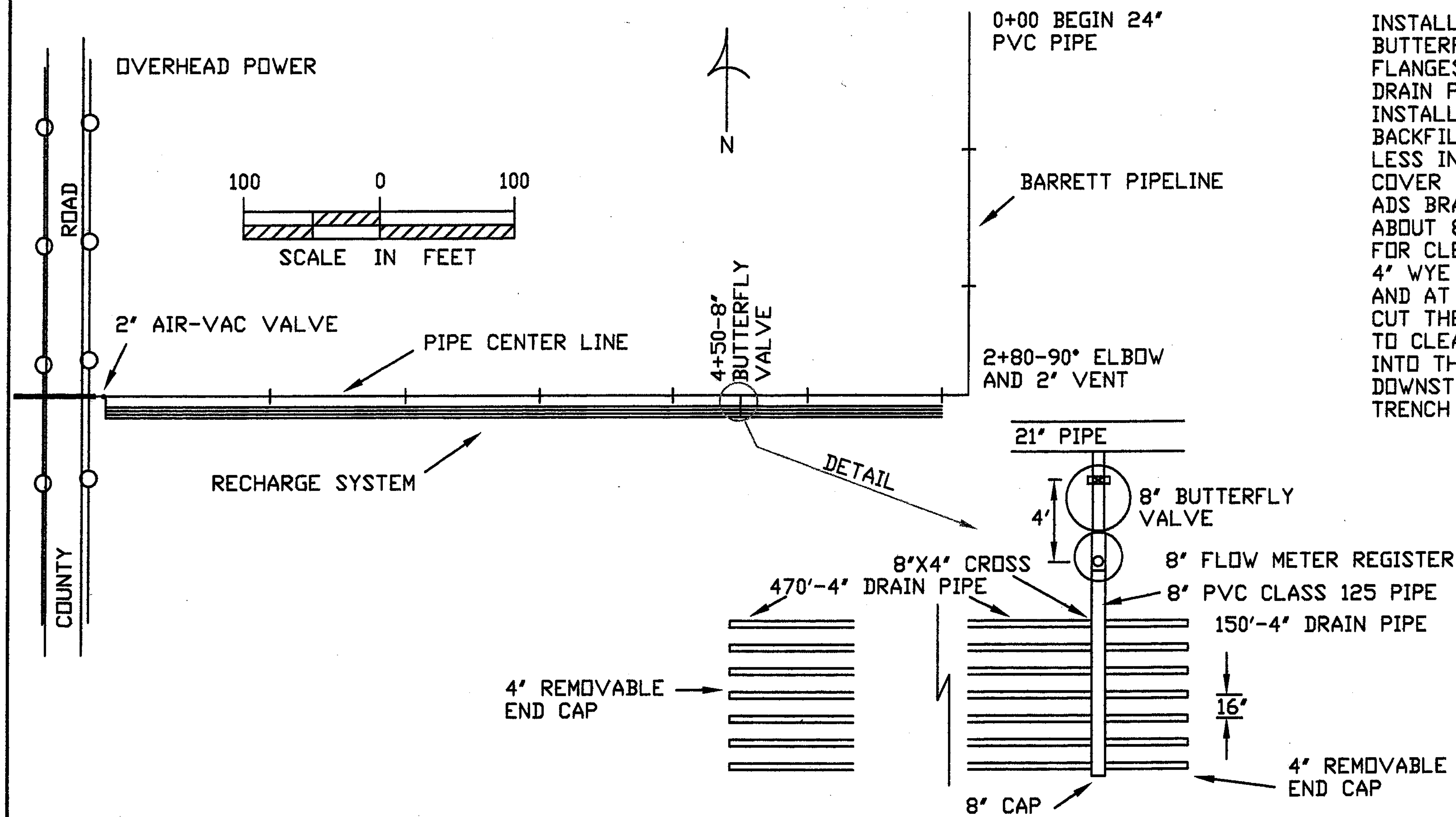
PROJECT JOHN FAZIO SHT 1 OF 1
SCREEN BOX DATE 4SEPT 12
BY BobB. JOB NO. ~





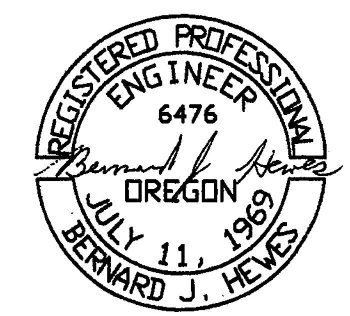
SIDE VIEW


LOCATION MAP
SITE
WHITE
COUNTY
RAILROAD
PLEASANT
VIEW
ROAD
TOWNSHIP 6N 33 34
TOWNSHIP 5N 4 3
DITCH
CITY LIMIT
CANAL
CITY OF MILTON FREEWATER
HIGHWAY 11
N
2000 0 2000
SCALE IN FEET
RANGE 35 E
PIPELINE PLAN VIEW
N
DIVERSION STRUCTURE AND MEASURING FLUME
WHITE
DITCH
0+00 BEGIN 24" PVC PIPELINE
OVERHEAD POWER BURIED PHONE
OVERHEAD POWER
ROAD
COUNTY
BARRETT PIPELINE
ROAD AND RECHARGE AREA
AS BUILT
COMPLETED CONTRACTOR
100 0 100
SCALE IN FEET
REGISTERED PROFESSIONAL ENGINEER
6476
OREGON
JULY 11, 1969
BERNARD J. HEWES
EXPIRES 6/30/2013
WWBC/HBDIC BARRETT RECHARGE
LOCATION MAP & SITE PLAN
UMATILLA COUNTY, OREGON
DESIGNED B. HEWES
DATE 10/11
CHECKED
APPROVED
CAD FILE barrechgsite
SHEET 1 OF 2

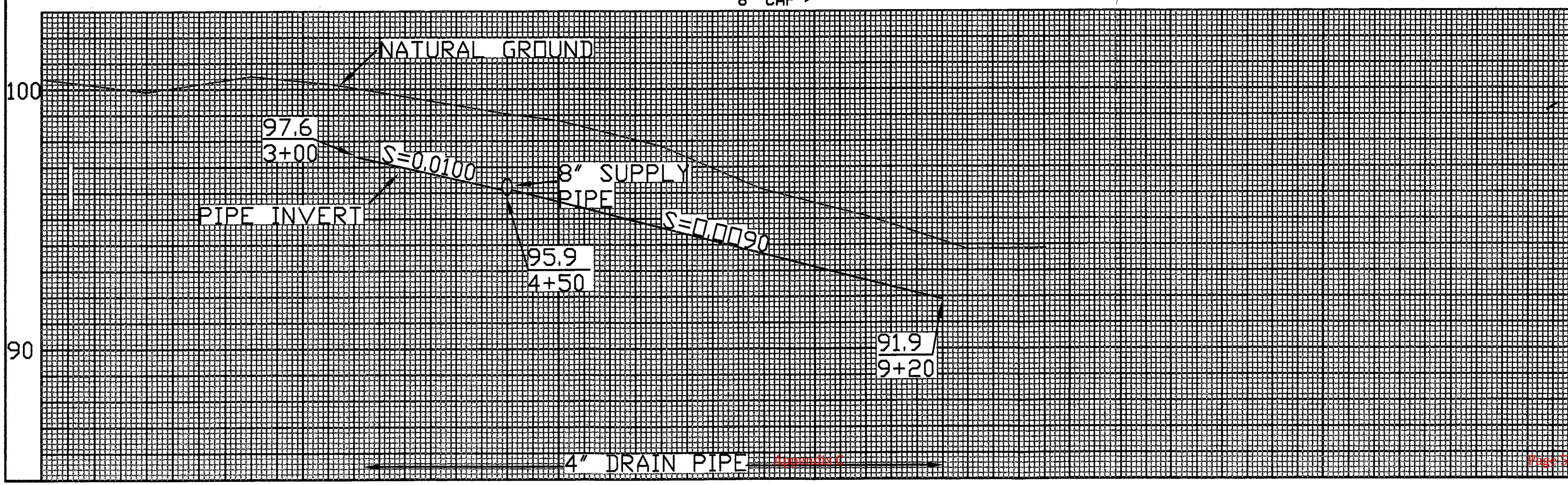


NOTES

INSTALL AN 8′ FLOW METER A MINIMUM OF 4′ FROM THE BUTTERFLY VALVE, NEED 4-8′ VAN STONE STYLE PVC FLANGES.
DRAIN PIPE TO BE PVC PERFORATED LEACH FIELD PIPE INSTALLED WITH THE SLOTS FACING DOWN.
BACKFILL THE 4′ PIPE WITH WASHED GRAVEL 2′ OR LESS IN DIAMETER, ABOUT 300 CUBIC YARDS NEEDED.
COVER THE GRAVEL BACKFILL WITH GEOTEXTILE FABRIC ADS BRAND 4000 NON-WOVEN OR EQUIVALENT. NEED ABOUT 8000 SQUARE FEET.
FOR CLEANING SEDIMENT FROM THE 4′ PIPE INSTALL A 4′ WYE AT THE UPSTREAM END OF EACH OF THE PIPES AND AT 100′ SPACING DOWNSTREAM. CAP EACH WYE AND CUT THE FILTER FABRIC TO FIT AROUND THE WYE.
TO CLEAN THE PIPE INSERT A HIGH PRESSURE HOSE INTO THE UPSTREAM WYE AND FLUSH THE SEDIMENT DOWNSTREAM. AT THE DOWNSTREAM END EXCAVATE A TRENCH TO COLLECT THE SEDIMENT.



EXPIRES 6/30/2013

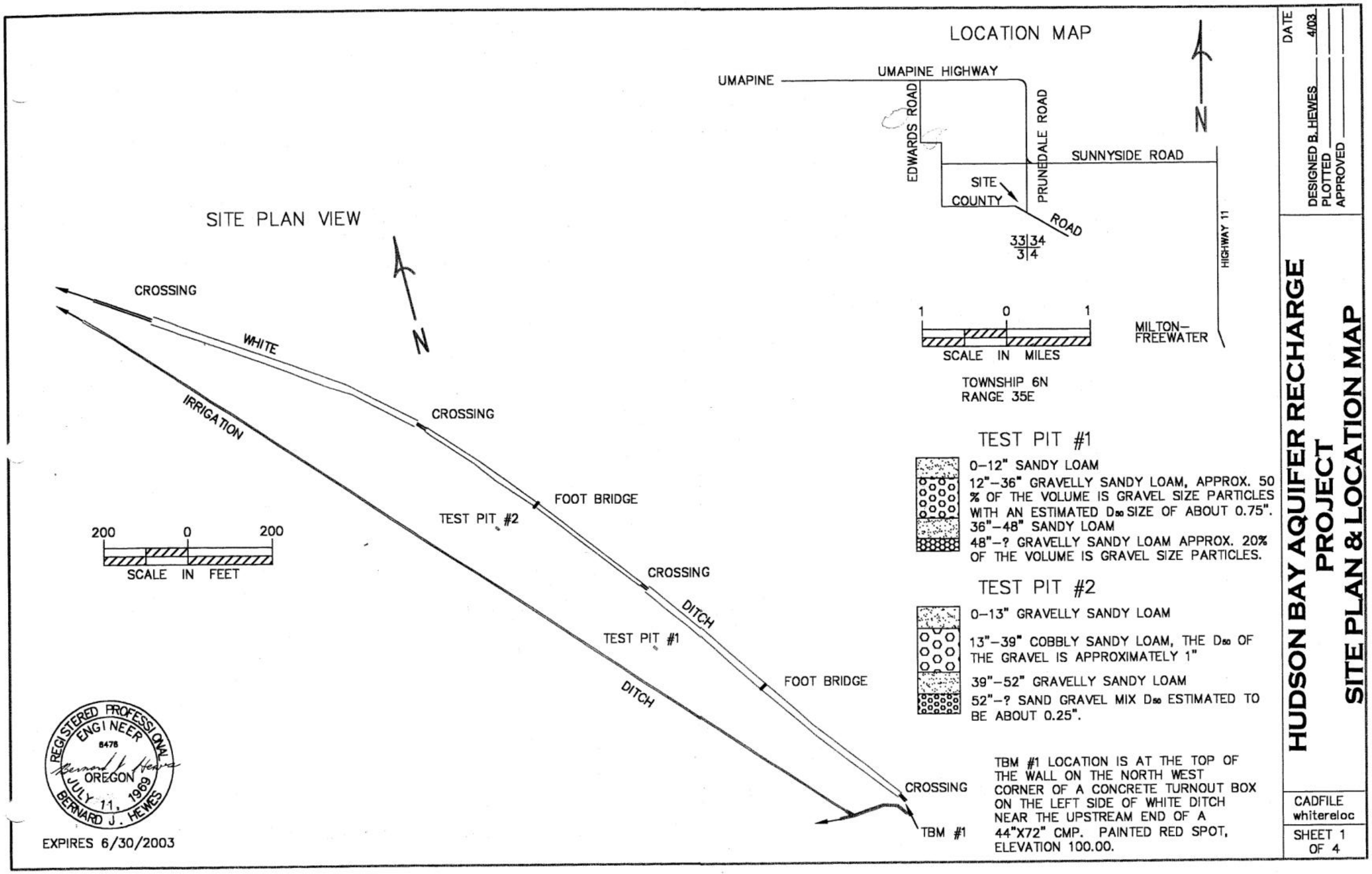


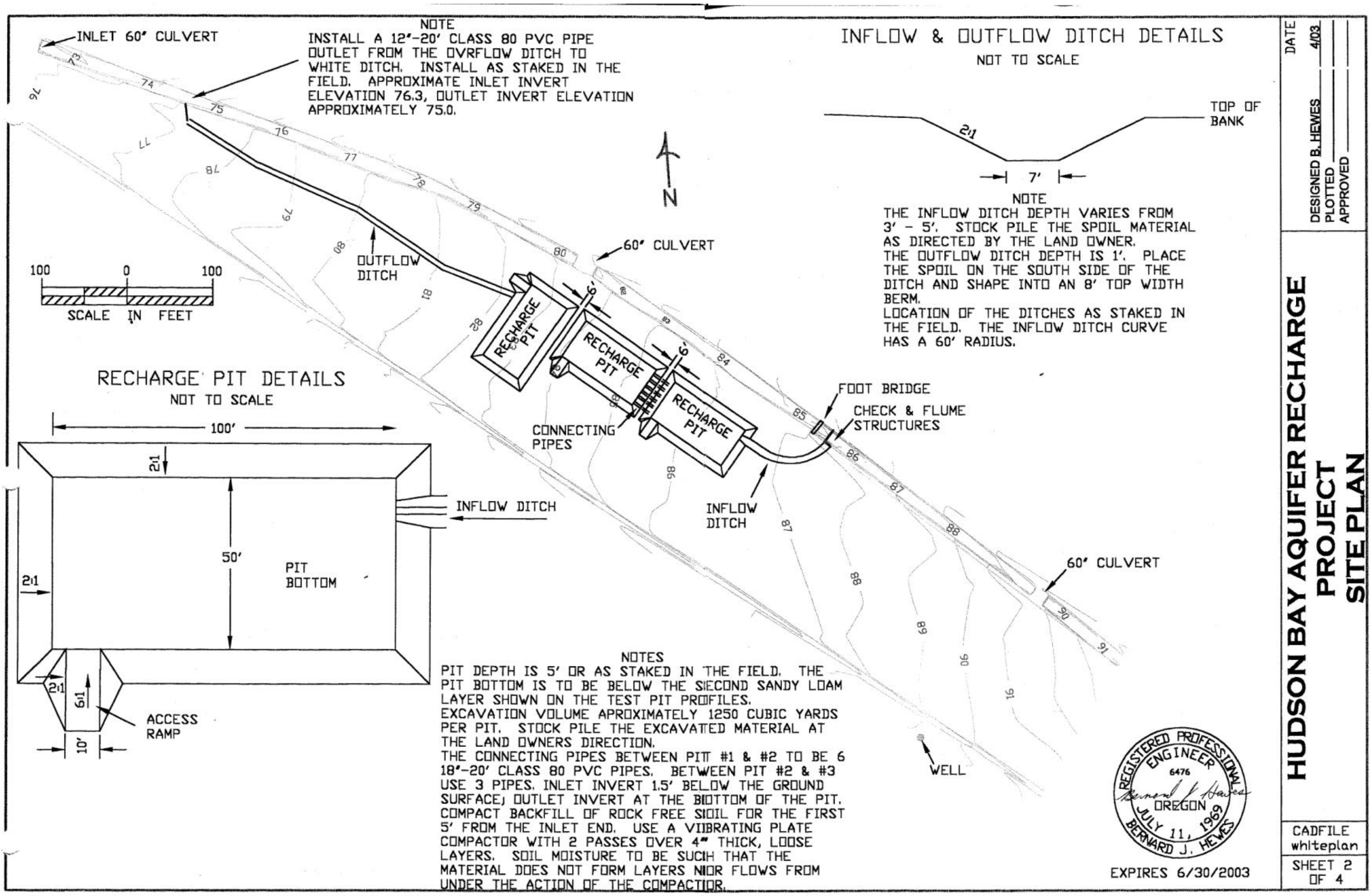
WWBWC/HBDIC BARRETT RECHARGE
PIPE PLAN & PROFILE
UMATILLA COUNTY OREGON

DATE
DESIGNED B. HEWES 10/11
PLOTTED
APPROVED

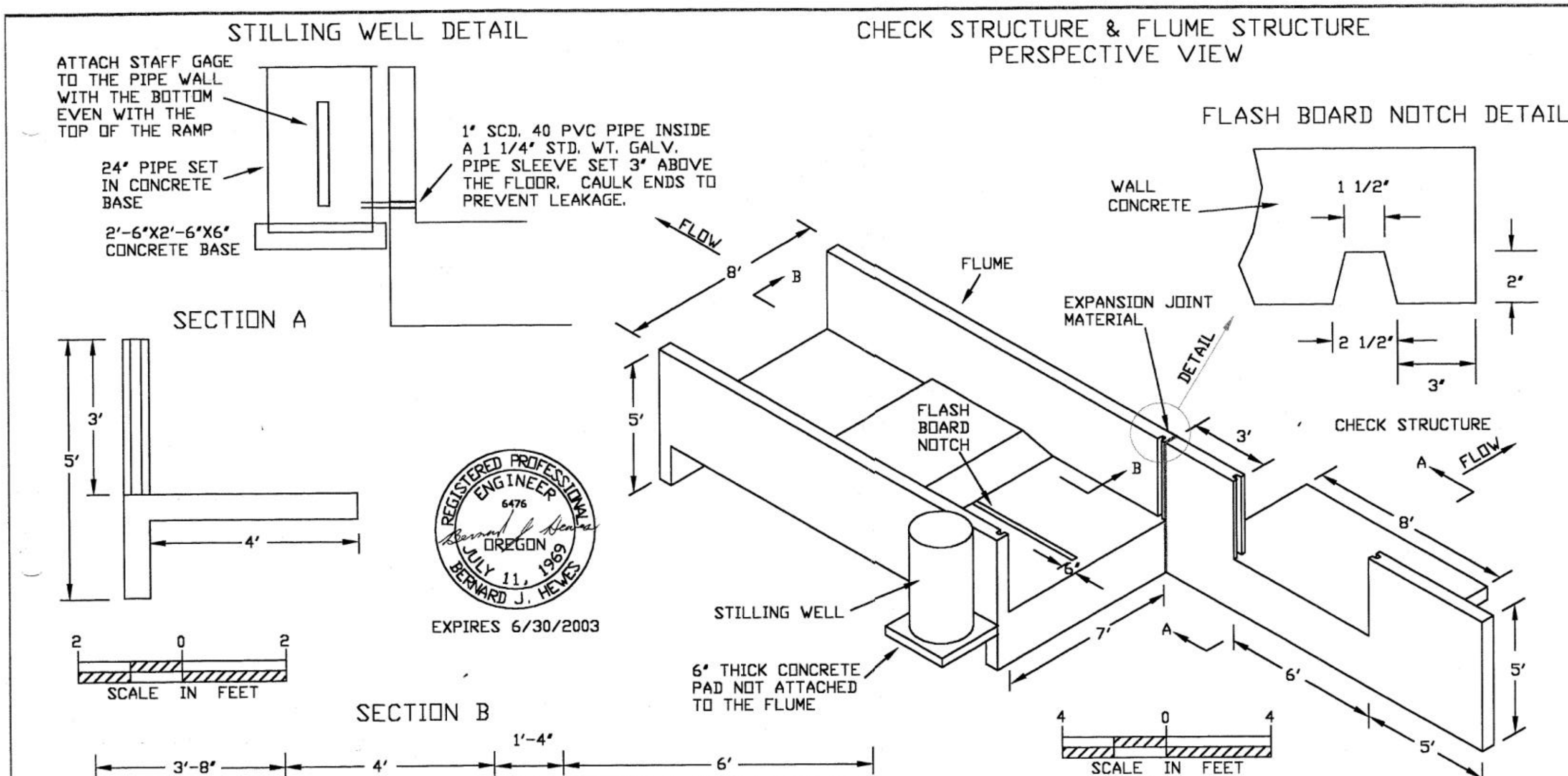
CAD FILE
barrechg

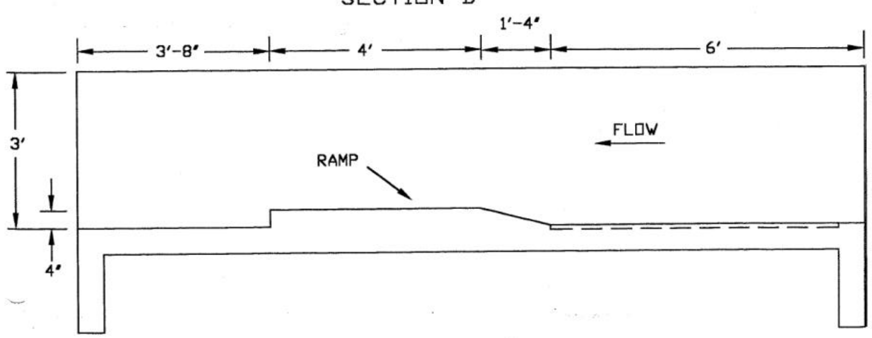
SHEET 2 OF 2


LOCATION MAP
UMAPINE
UMAPINE HIGHWAY
EDWARDS ROAD
PRUNEDALE ROAD
SUNNYSIDE ROAD
SITE
COUNTY ROAD
33|34
3|4
HIGHWAY 11
N
1 0 1
SCALE IN MILES
MILTON-FREEWATER
TOWNSHIP 6N
RANGE 35E
SITE PLAN VIEW
N
CROSSING
WHITE
CROSSING
IRRIGATION
FOOT BRIDGE
TEST PIT #2
CROSSING
DITCH
TEST PIT #1
DITCH
FOOT BRIDGE
CROSSING
TBM #1
200 0 200
SCALE IN FEET
REGISTERED PROFESSIONAL ENGINEER
8478
OREGON
JULY 11, 1969
BERNARD J. HEWES
EXPIRES 6/30/2003
TEST PIT #1
0-12" SANDY LOAM
12"-36" GRAVELLY SANDY LOAM, APPROX. 50 % OF THE VOLUME IS GRAVEL SIZE PARTICLES WITH AN ESTIMATED D50 SIZE OF ABOUT 0.75".
36"-48" SANDY LOAM
48"-? GRAVELLY SANDY LOAM APPROX. 20% OF THE VOLUME IS GRAVEL SIZE PARTICLES.
TEST PIT #2
0-13" GRAVELLY SANDY LOAM
13"-39" COBBLY SANDY LOAM, THE D50 OF THE GRAVEL IS APPROXIMATELY 1"
39"-52" GRAVELLY SANDY LOAM
52"-? SAND GRAVEL MIX D50 ESTIMATED TO BE ABOUT 0.25".
TBM #1 LOCATION IS AT THE TOP OF THE WALL ON THE NORTH WEST CORNER OF A CONCRETE TURNOUT BOX ON THE LEFT SIDE OF WHITE DITCH NEAR THE UPSTREAM END OF A 44"X72" CMP. PAINTED RED SPOT, ELEVATION 100.00.
HUDSON BAY AQUIFER RECHARGE PROJECT
SITE PLAN & LOCATION MAP
DESIGNED B. HEWES
PLOTTED
APPROVED
DATE
4/03
CADFILE
whitereloc
SHEET 1 OF 4



INLET 60" CULVERT
NOTE
INSTALL A 12"-20' CLASS 80 PVC PIPE OUTLET FROM THE OVRFLOW DITCH TO WHITE DITCH. INSTALL AS STAKED IN THE FIELD. APPROXIMATE INLET INVERT ELEVATION 76.3, OUTLET INVERT ELEVATION APPROXIMATELY 75.0.
INFLOW & OUTFLOW DITCH DETAILS
NOT TO SCALE
TOP OF BANK
2:1
7'
NOTE
THE INFLOW DITCH DEPTH VARIES FROM 3' - 5'. STOCK PILE THE SPOIL MATERIAL AS DIRECTED BY THE LAND OWNER.
THE OUTFLOW DITCH DEPTH IS 1'. PLACE THE SPOIL ON THE SOUTH SIDE OF THE DITCH AND SHAPE INTO AN 8' TOP WIDTH BERM.
LOCATION OF THE DITCHES AS STAKED IN THE FIELD. THE INFLOW DITCH CURVE HAS A 60' RADIUS.
N
OUTFLOW DITCH
60" CULVERT
100 0 100
SCALE IN FEET
RECHARGE PIT
RECHARGE PIT
RECHARGE PIT
6'
6'
FOOT BRIDGE
CHECK & FLUME STRUCTURES
CONNECTING PIPES
INFLOW DITCH
60" CULVERT
WELL
RECHARGE PIT DETAILS
NOT TO SCALE
100'
2:1
50'
PIT BOTTOM
INFLOW DITCH
2:1
2:1
6:1
ACCESS RAMP
10'
NOTES
PIT DEPTH IS 5' OR AS STAKED IN THE FIELD. THE PIT BOTTOM IS TO BE BELOW THE SECOND SANDY LOAM LAYER SHOWN ON THE TEST PIT PROFILES.
EXCAVATION VOLUME APROXIMATELY 1250 CUBIC YARDS PER PIT. STOCK PILE THE EXCAVATED MATERIAL AT THE LAND OWNERS DIRECTION.
THE CONNECTING PIPES BETWEEN PIT #1 & #2 TO BE 6 18"-20' CLASS 80 PVC PIPES. BETWEEN PIT #2 & #3 USE 3 PIPES. INLET INVERT 1.5' BELOW THE GROUND SURFACE; OUTLET INVERT AT THE BOTTOM OF THE PIT.
COMPACT BACKFILL OF ROCK FREE SOIL FOR THE FIRST 5' FROM THE INLET END. USE A VIBRATING PLATE COMPACTOR WITH 2 PASSES OVER 4" THICK, LOOSE LAYERS. SOIL MOISTURE TO BE SUCH THAT THE MATERIAL DOES NOT FORM LAYERS NOR FLOWS FROM UNDER THE ACTION OF THE COMPACTOR.
REGISTERED PROFESSIONAL ENGINEER
6476
OREGON
JULY 11, 1969
BERNARD J. HEWES
EXPIRES 6/30/2003
DATE 4/03
DESIGNED B. HEWES
PLOTTED
APPROVED
HUDSON BAY AQUIFER RECHARGE PROJECT
SITE PLAN
CADFILE whiteplan
SHEET 2 OF 4





NOTES

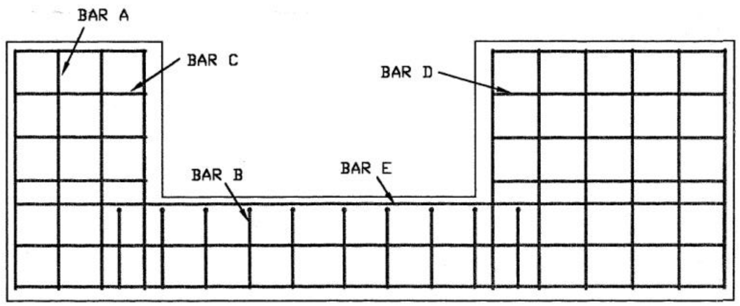
INSTALL THE CONCRETE IN ACCORDANCE WITH CONSTRUCTION SPECIFICATION 42, ATTACHED.
ALL WALLS AND FLOORS TO BE 6" THICK.
USE 4000 PSI STRENGTH CONCRETE. 1.6 CUBIC YARDS NEEDED FOR THE CHECK STRUCTURE AND 4.9 CUBIC YARDS NEEDED FOR THE FLUME.
SEPARATE THE TWO STRUCTURES USING A 6'X 1/2"X 5' STRIP OF ASPHALT EXPANSION JOINT FILLER.
THE STILLING WELL PIPE MAY BE CORRUGATED METAL OR CLASS 80, MINIMUM, PVC PIPE.
THE FLASH BOARD NOTCH IN THE BOTTOM OF THE FLUME IS TO HOLD THE BOTTOM OF A SPLITTER WALL. USE 2 PIECES OF 3/4" MARINE PLYWOOD. HOLD THE TOP AT THE DOWNSTREAM END WITH A 2"X8"X8' WITH 2-2"X4"X8" CLEATS. AT THE UPSTREAM END USE 2-2"X12"X8' WITH 2-2"X4"X24" CLEATS.

DATE 4/03
DESIGNED B. HEWES
PLOTTED
APPROVED

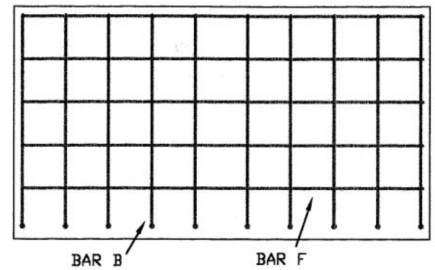
HUDSON BAY AQUIFER RECHARGE PROJECT
STRUCTURE DETAILS

CADFILE whiteck
SHEET 3 OF 4

CHECK STRUCTURE ELEVATION VIEW



APRON PLAN VIEW



REINFORCING STEEL SCHEDULE

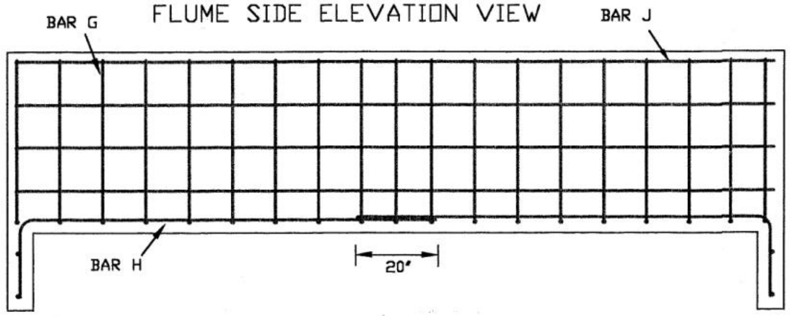
BAR	NO.	SHAPE	A	B	C
		CHECK			
A	10	STRAIGHT	4'-7"	-	-
B	10	A⌊B	1'-7"	4'-1"	-
C	4	STRAIGHT	2'-6"	-	-
D	4	STRAIGHT	4'-6"	-	-
E	3	STRAIGHT	13'-8"	-	-
F	5	STRAIGHT	7'-8"	-	-
		FLUME			
G	19	A⌊B⌋C	3'-1"	7'-6"	3'-1"
H	20	A⌊B	1'-6"	8'-1"	-
I	4	STRAIGHT	7'-6"	-	-
J	8	STRAIGHT	14'-6"	-	-

NOTES
ALL BARS TO BE NUMBER 4.
BARS TO BE PLACED IN THE CENTER OF THE WALLS AND FLOOR.
NEED 820 LINEAL FEET OF REINFORCING BARS WITHOUT ANY WASTE.

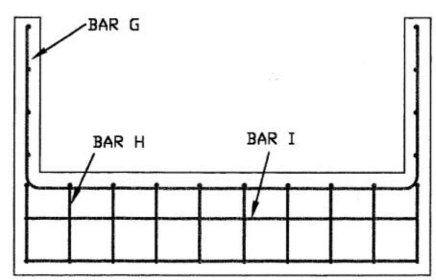
REGISTERED PROFESSIONAL ENGINEER 6476 OREGON JULY 11, 1969 BERNARD J. HEWES

EXPIRES 6/30/2003

FLUME SIDE ELEVATION VIEW



FLUME END WALL ELEVATION VIEW

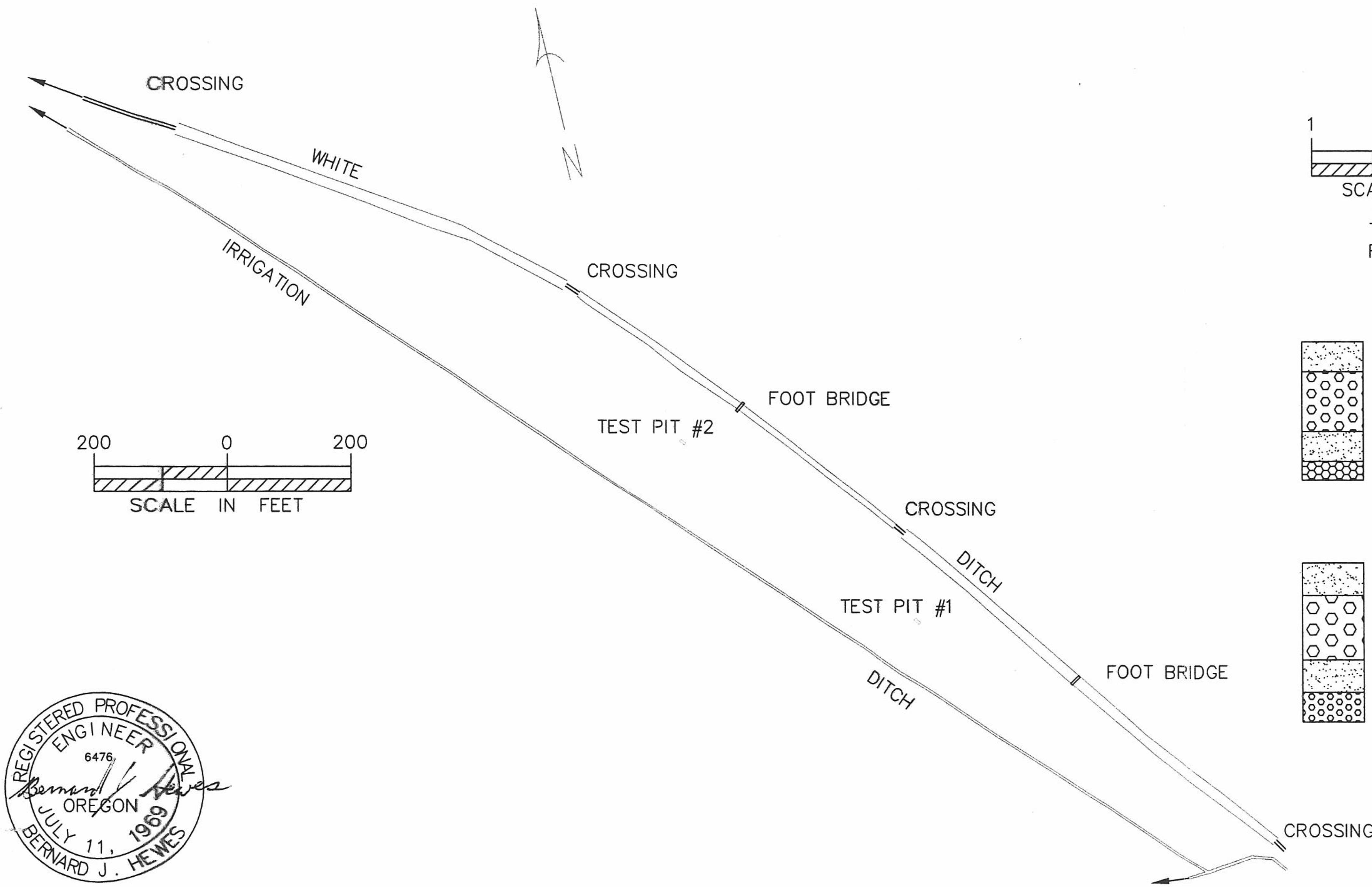


DESIGNED B. HEWES DATE 4/03
PLOTTED
APPROVED

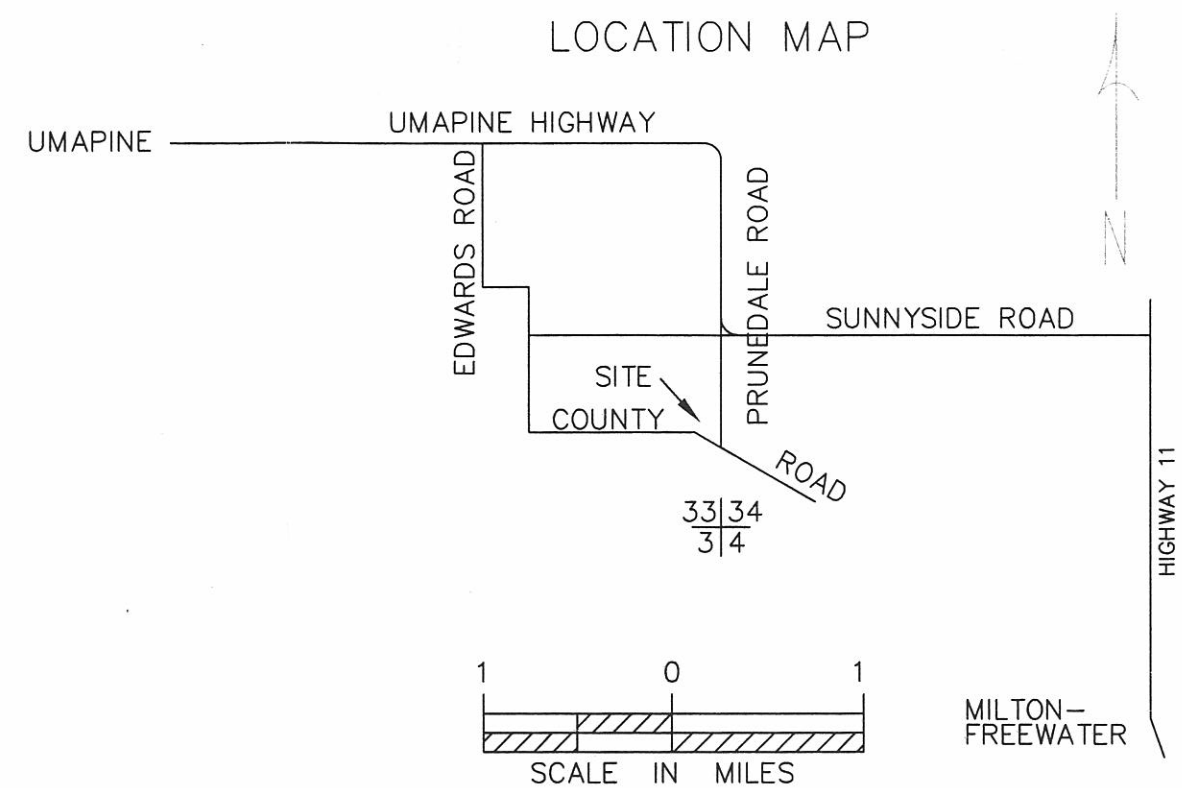
HUDSON BAY AQUIFER RECHARGE PROJECT
STRUCTURE REINFORCING STEEL

CADFILE whlteckst
SHEET 4 OF 4

SITE PLAN VIEW



LOCATION MAP



TOWNSHIP 6N
RANGE 35E

TEST PIT #1

0–12" SANDY LOAM
12"–36" GRAVELY SANDY LOAM, APPROX. 50% OF THE VOLUME IS GRAVEL SIZE PARTICLES WITH AN ESTIMATED D_{50} SIZE OF ABOUT 0.75".
36"–48" SANDY LOAM
48"–? GRAVELY SANDY LOAM APPROX. 20% OF THE VOLUME IS GRAVEL SIZE PARTICLES.

TEST PIT #2

0–13" GRAVELY SANDY LOAM
13"–39" COBBLY SANDY LOAM, THE D_{50} OF THE GRAVEL IS APPROXIMATELY 1"
39"–52" GRAVELY SANDY LOAM
52"–? SAND GRAVEL MIX D_{50} ESTIMATED TO BE ABOUT 0.25".

REGISTERED PROFESSIONAL ENGINEER
6476
OREGON
JULY 11, 1969
BERNARD J. HEWES
EXPIRES 6/30/2009

B. Hewes 1/26/2007 11:35 A\whitereloc.dwg

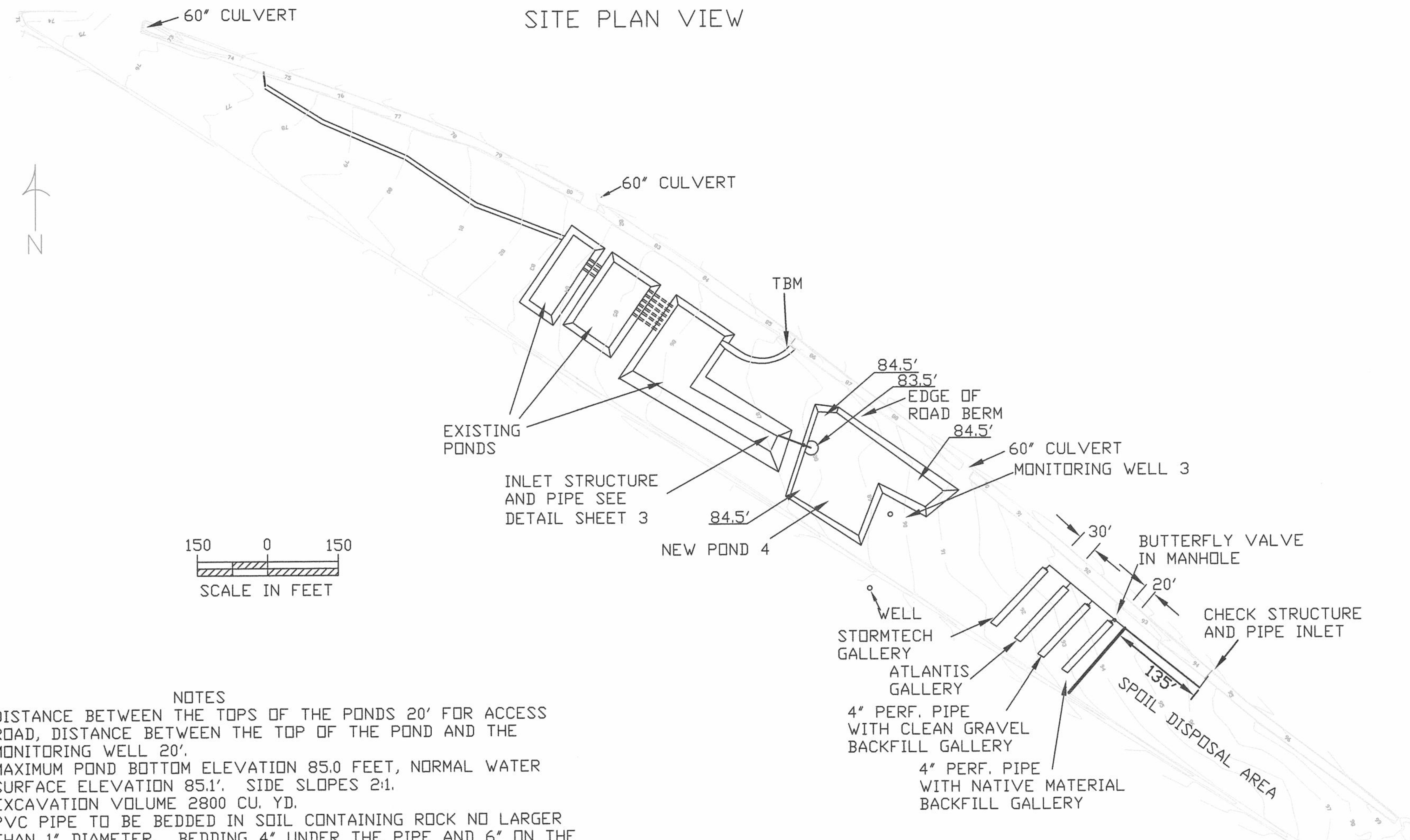
	DATE
DESIGNED B. HEWES	4/03
PLOTTED	
APPROVED	

WWBWC/HBDIC UPPER RECHARGE PROJECT
SITE PLAN & LOCATION MAP
UMATILLA COUNTY, OREGON

CADFILE
whitereloc

SHEET 1
OF 7

SITE PLAN VIEW



NOTES

DISTANCE BETWEEN THE TOPS OF THE PONDS 20' FOR ACCESS ROAD, DISTANCE BETWEEN THE TOP OF THE POND AND THE MONITORING WELL 20'.
MAXIMUM POND BOTTOM ELEVATION 85.0 FEET, NORMAL WATER SURFACE ELEVATION 85.1'. SIDE SLOPES 2:1.
EXCAVATION VOLUME 2800 CU. YD.
PVC PIPE TO BE BEDDED IN SOIL CONTAINING ROCK NO LARGER THAN 1" DIAMETER. BEDDING 4" UNDER THE PIPE AND 6" ON THE SIDES AND TOP. COMPACT THE BEDDING WITH ONE PASS OF A VIBRATING PLATE COMPACTOR OVER 6" LOOSE LIFTS.
CONSIDER FLOW METERS: AQUA MASTER MODEL 900R FROM JENNINGS INC.
McCROMETER MODEL EO300 PROPELLER STYLE METER.
CHECK FOR COMPATIBILITY WITH YOUR EXISTING RECORDING AND CONTROL EQUIPMENT.
SPACE THE DIFFERENT KIND OF GALLERIES 30'.
TBM IS AT THE TOP OF THE RIGHT SIDE WALL, DOWNSTREAM END OF THE FLUME. ELEVATION 88.7 FEET.

REGISTERED PROFESSIONAL ENGINEER
6476
OREGON
JULY 11, 1969
BERNARD J. HEWES
EXPIRES 6/30/2009

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DATE
DESIGNED B. HEWES 11/07
PLOTTED
APPROVED

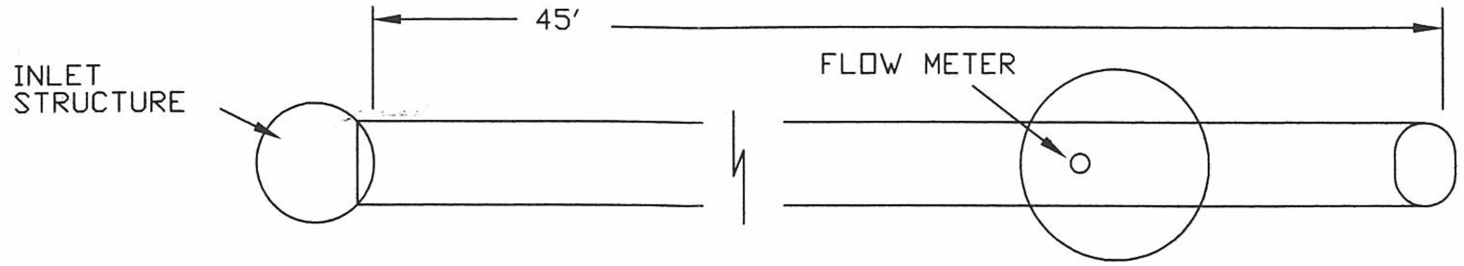
WWBWC/HBDIC UPPER RECHARGE PROJECT
SITE PLAN
UMATILLA COUNTY, OREGON

CADFILE
whitextpln2

SHEET 2 OF 7

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

SUPPLY PIPE TO POND 4 PLAN VIEW



NOTES

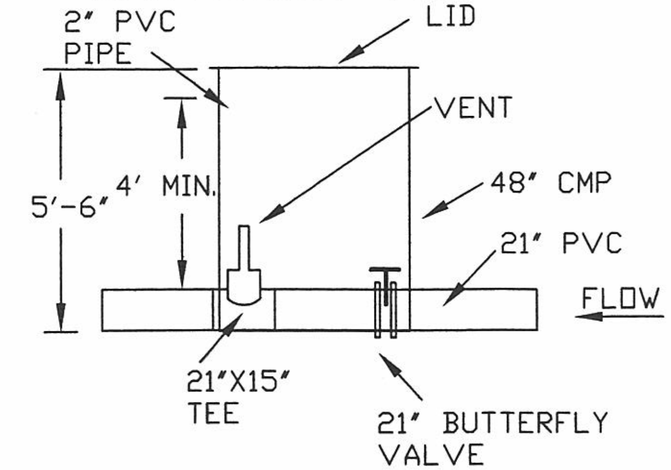
CUT THE HOLE IN THE INLET STRUCTURE TO CLOSELY FIT AROUND THE SUPPLY PIPE. FILL THE SPACE BETWEEN THE STRUCTURE AND PIPES WITH CAULKING ON BOTH SIDES.

THE BOTTOM LIP OF THE 45° ELBOW CAN BE NO LESS THAN 0.2' BELOW THE TOP OF THE 21" PIPE.

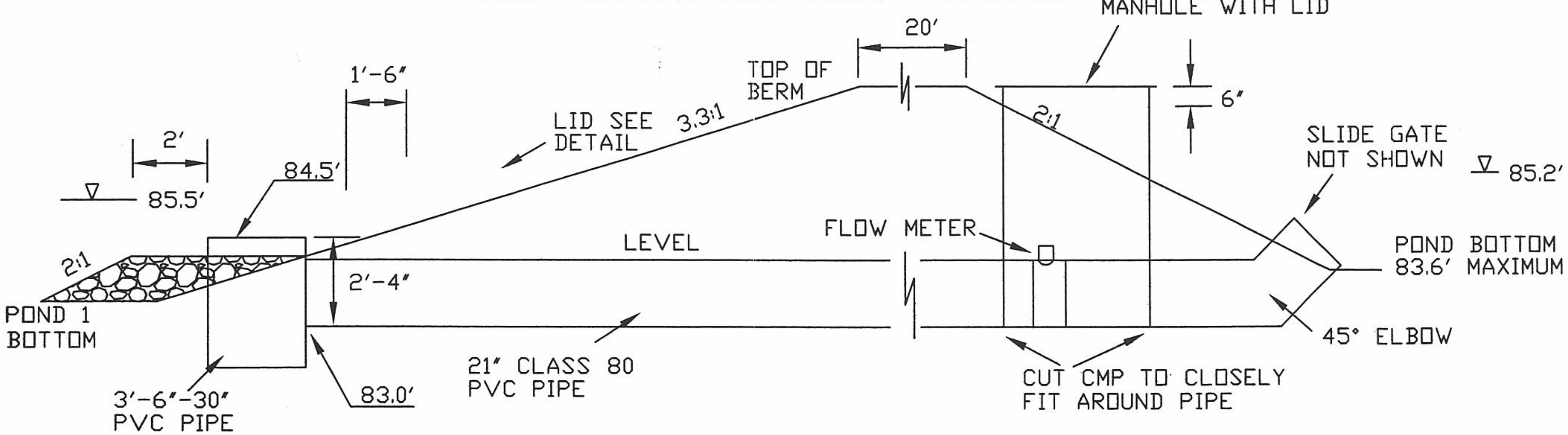
LID FOR THE CMP MANHOLE TO BE GALVANIZED 1/8" THICK STEEL.

SLIDE GATE TO BE A WATERMAN C-8-4 OR EQUIVALENT. INSTALL A CATWALK FOR ACCESS TO THE SLIDE GATE.

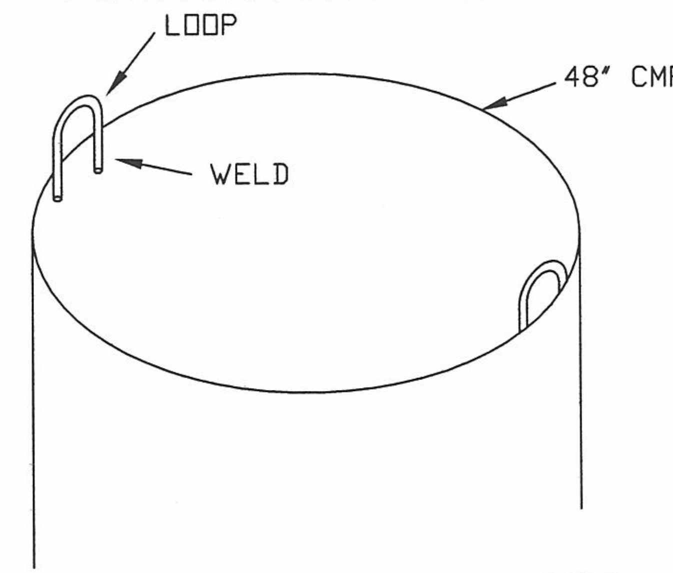
GALLERY SUPPLY PIPE VALVE DETAILS ELEVATION VIEW



SIDE ELEVATION VIEW TYPICAL

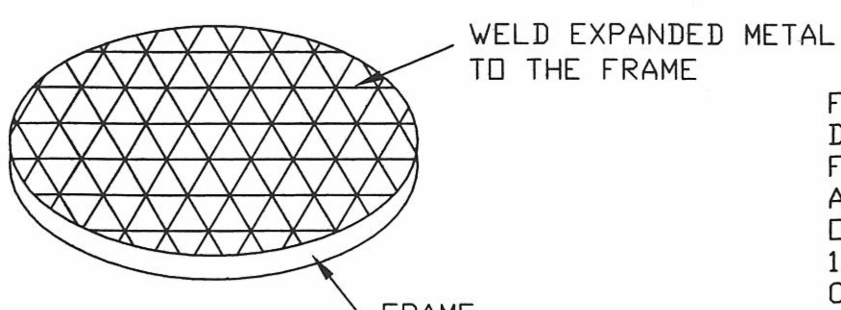


MANHOLE LID HOLD DOWN PERSPECTIVE VIEW



USE 1/2" DIAMETER ROD TO MAKE LOOPS. DIAMETER OF THE LOOP 2"

INLET STRUCTURE TRASH RACK DETAIL PERSPECTIVE VIEW



FRAME IS 1/8" X 3" STEEL, INSIDE DIAMETER 32". COVER TO BE FLATTENED EXPANDED METAL APPROXIMATELY 0.120" THICK; OPENINGS APPROXIMATELY 1/2" X 1 5/8 ".
CLEAN AND PAINT WITH 2 COATS OF HIGH ZINC COLD GALVANIZING PAINT.

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

EXPIRES 6/30/2009

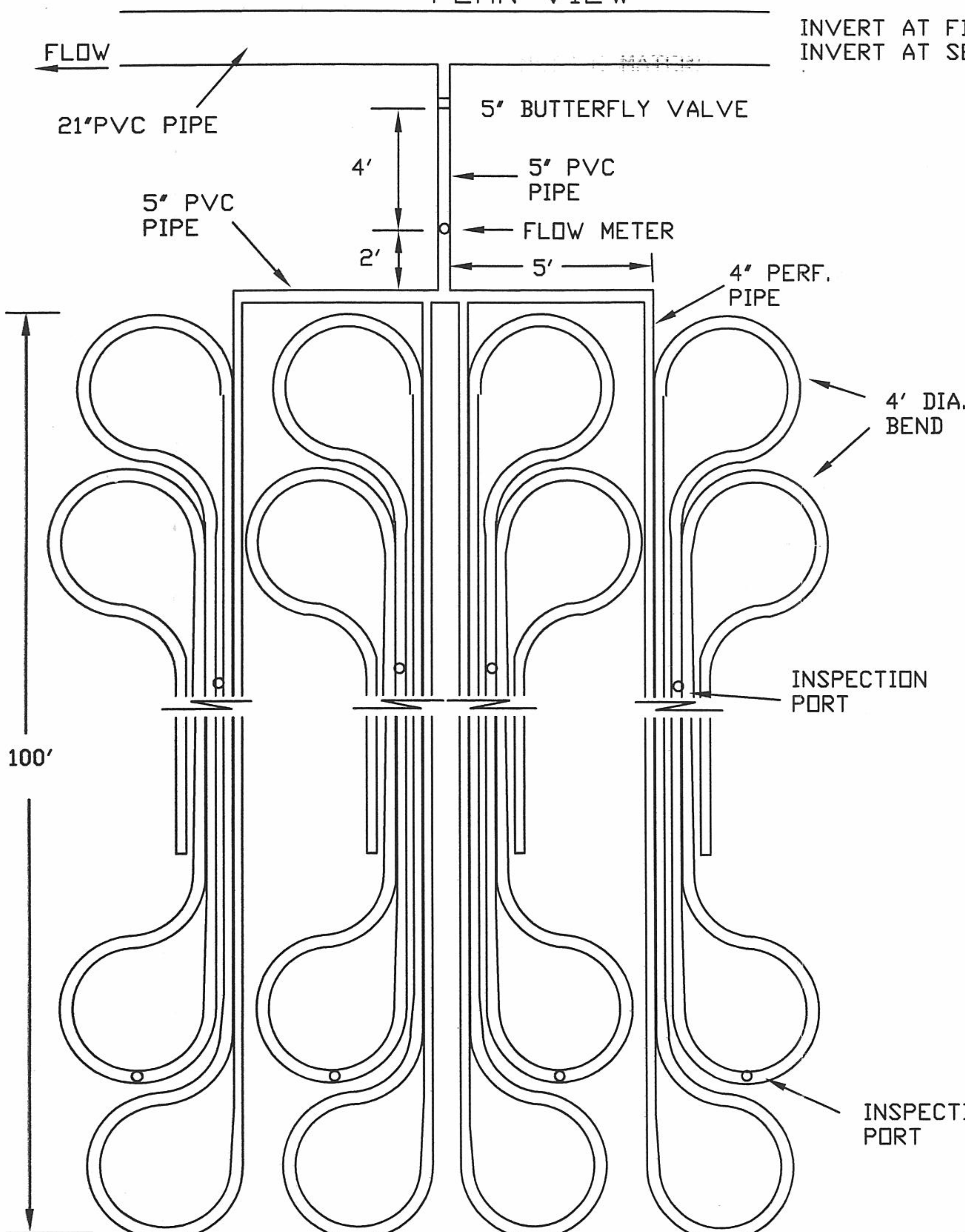
B. Hewes 12/11/2007 10:31 AM whitemisc.dwg

DATE	
DESIGNED	B. HEWES 11/07
CHECKED	
APPROVED	

CAD FILE whitemisc

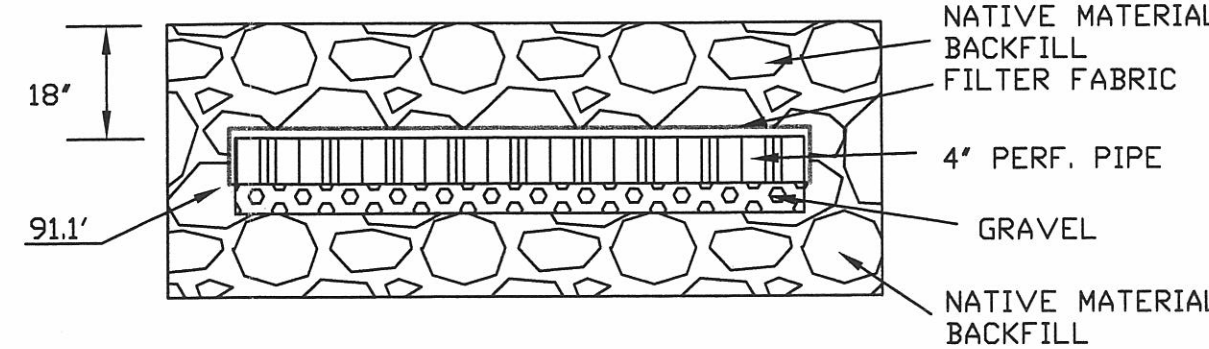
SHEET 3 OF 7

TYPICAL 4" PERFORATED PIPE GALLERY PLAN VIEW



NOTE: ON THIS SIDE THE PERF. PIPE CHANGED TO SMOOTH DRAIN FIELD PIPE WITH A TEE FOR EACH PIPE ROW, 20 ROWS.

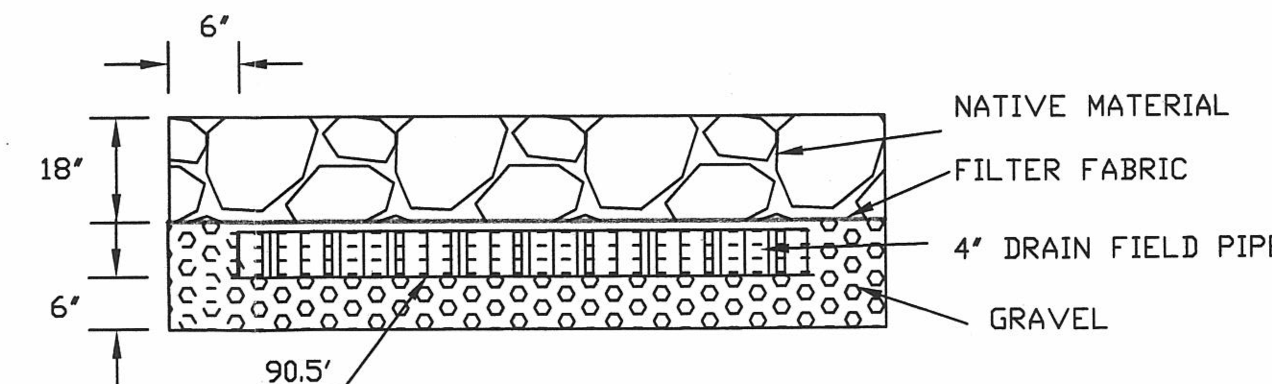
4" PERFORATED PIPE WITH NATIVE MATERIAL BACKFILL ELEVATION VIEW



NOTES

NEED 2000' OF ADS 4" SINGLE WALL, PERFORATED, CORRUGATED POLYETHYLENE PIPE OR EQUIVALENT. CONNECT THE 4" TO THE 5" PIPE USING A MAR-MAC POLYSEAL PIPE COUPLER OR EQUIVALENT.
USE ONLY ENOUGH GRAVEL BEDDING TO PROVIDE A SMOOTH SURFACE TO LAY THE PIPE ON OR REMOVE ALL ROCK GREATER THAN 2" IN DIAMETER FROM CONTACTING THE PIPE.
THE INSPECTION PORT TO BE INSTALLED WHERE THE TWO PIPE ROLLS CONNECT AND NEAR THE END AS SHOWN. CONNECT THE ROLLS WITH A 4" TEE, USE 2' OF VERTICAL 4" PERF. PIPE WRAPPED WITH FILTER FABRIC FOR AN INSPECTION PORT. INSTALL A 4" CAP ON THE END OF THE PIPE AND INSPECTION PORT.
THE FILTER FABRIC TO BE ADS 4000 NONWOVEN OR EQUIVALENT. ABOUT 75 SQ. YD. NEEDED.

4" DRAIN FIELD PIPE WITH GRAVEL BEDDING ELEVATION VIEW



NOTES

NEED 2000' OF 4" PVC DRAIN FIELD PIPE. CONNECT THE 4" TO THE 5" PIPE USING A MAR-MAC POLYSEAL PIPE COUPLER OR EQUIVALENT.
THE INSPECTION PORTS TO BE INSTALLED NEAR THE MIDDLE OF ONE OF THE ROWS AND NEAR THE END. USE 2' OF VERTICAL 4" PIPE WRAPPED WITH FILTER FABRIC FOR AN INSPECTION PORT. INSTALL A 4" CAP ON THE END OF THE PIPE AND INSPECTION PORT.
THE FILTER FABRIC TO BE ADS 4000 NONWOVEN OR EQUIVALENT. ABOUT 75 SQ. YD. NEEDED.
GRAVEL TO BE ANGULAR CRUSHED ROCK WITH THE MAJORITY BEING ¾"-2", ABOUT 60 CU. YD. NEEDED.

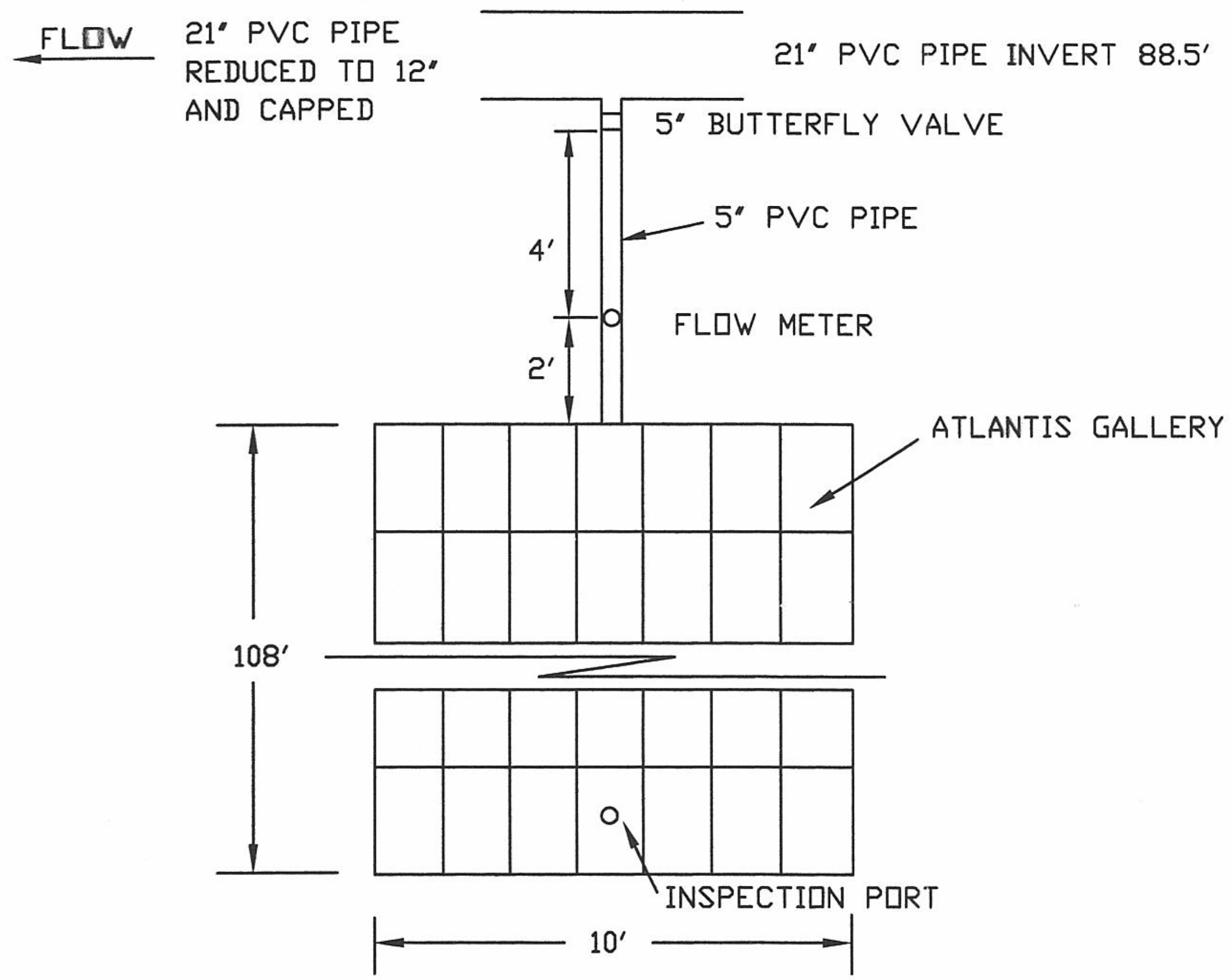
REGISTERED PROFESSIONAL ENGINEER 6476 OREGON JULY 11, 1969 BERNARD J. HEWES
EXPIRES 6/30/2009

WWBWC/HBDIC UPPER RECHARGE PROJECT
4" PERF. & DRAIN FIELD PIPE DETAILS
UMATILLA COUNTY, OREGON
B H ENGINEERING

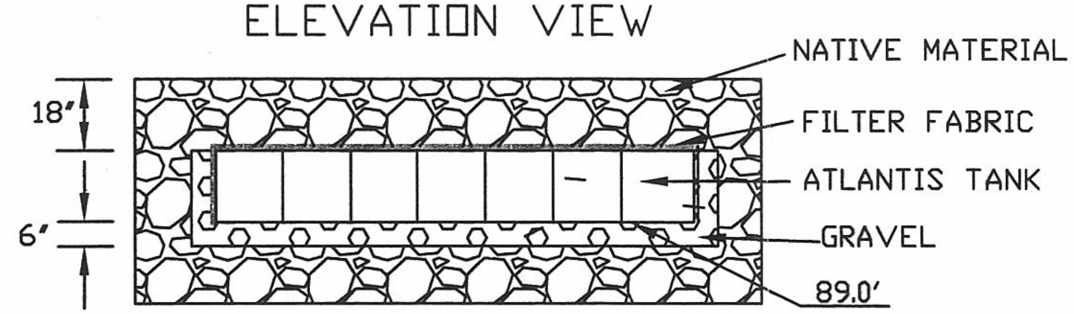
DESIGNED B. HEWES DATE 12/07
CHECKED
APPROVED

CAD FILE whiteperf
SHEET 4 OF 7

ATLANTIS RAIN TANK DETAIL
PLAN VIEW



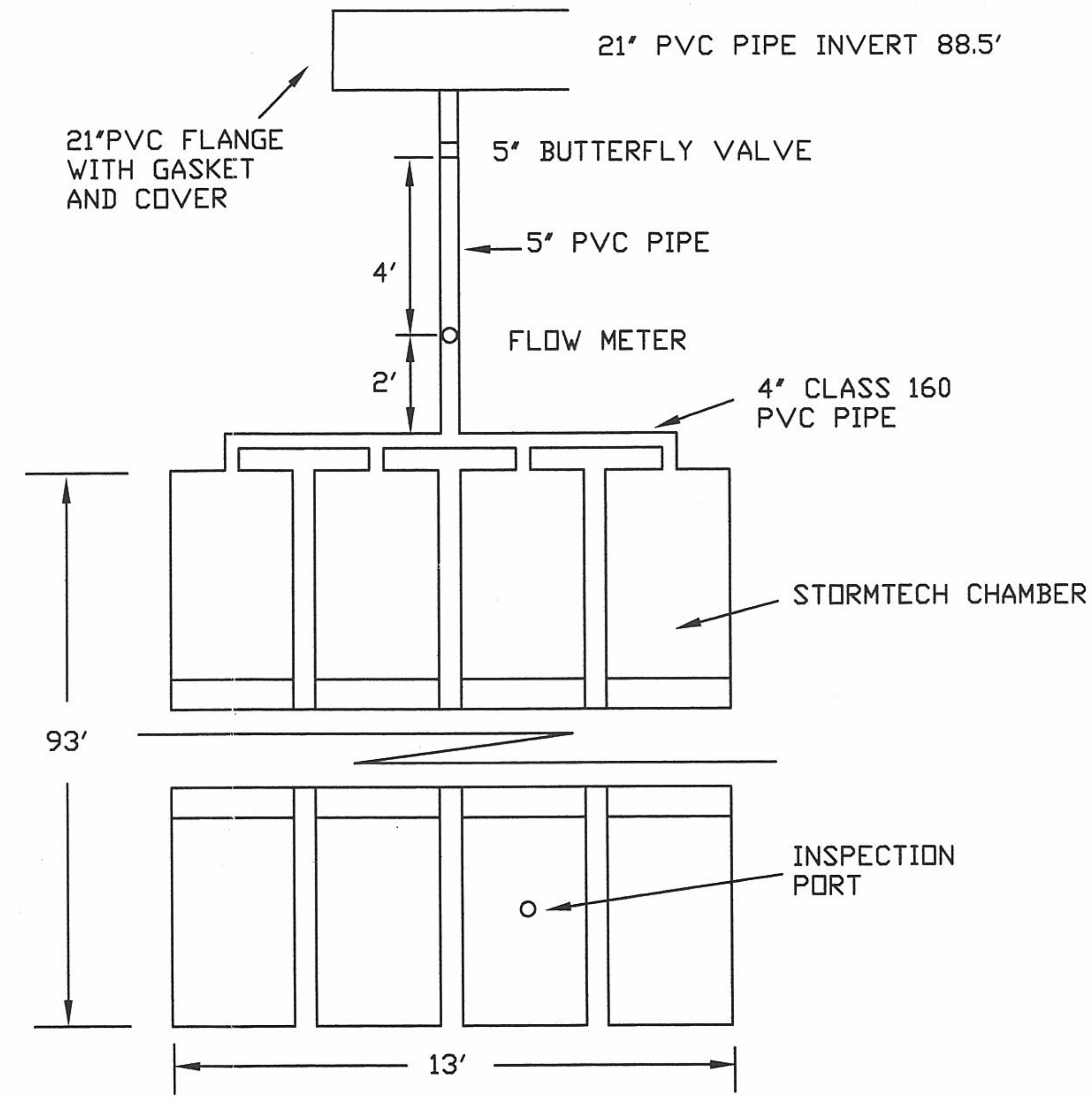
ELEVATION VIEW



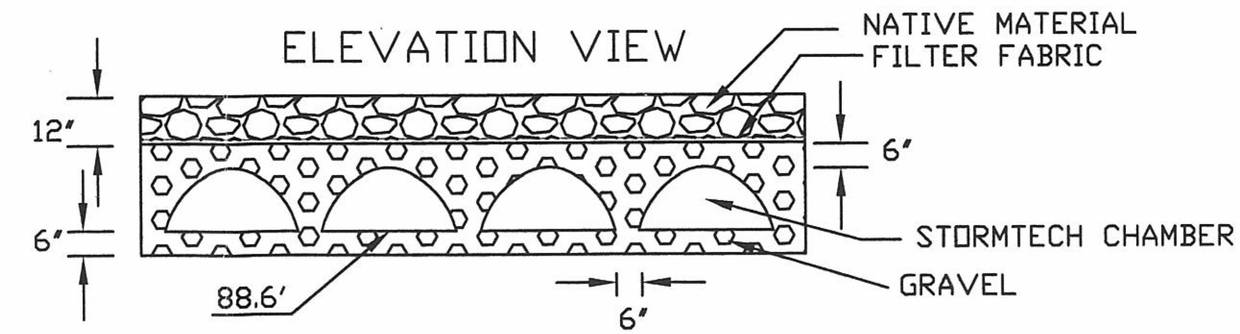
NOTES

ASSEMBLE AND INSTALL RAIN TANKS AND INSPECTION PORT AS DESCRIBED IN THE MANUFACTURERS LITERATURE. TANKS ARE 16" WIDE, 27" LONG AND 17¾" HIGH, NEED 336 TANKS FOR H-10 LOADING. USE 4" PVC PIPE FOR THE PORT, EXTEND 1' ABOVE GROUND AND PROTECT WITH A FENCE POST AND END CAP.
FILTER FABRIC TO BE ADS 4000 OR EQUIVALENT, NEED 160 SQ. YD. FOLD AND TAPE THE CORNERS AS SHOWN IN THE LITERATURE.
GRAVEL TO BE ANGULAR CRUSHED ROCK WITH THE MAJORITY OF PARTICLES BETWEEN ¾"-2", NEED ABOUT 25 CU. YD.

STORMTECH CHAMBER
PLAN VIEW



ELEVATION VIEW



NOTES

ASSEMBLE AND INSTALL CHAMBERS AND INSPECTION PORT AS SHOWN IN THE MANUFACTURERS LITERATURE. TANKS ARE 34" WIDE, 7'-2" LONG AND 16" HIGH, NEED 50 CHAMBERS. IN LIEU OF THE SUBSURFACE PORT SHOWN IN THE LITERATURE EXTEND THE PORT 1' ABOVE GROUND AND PROTECT WITH A FENCE POST AND END CAP.
FILTER FABRIC TO BE ADS 4000 OR EQUIVALENT, NEED 190 SQ. YD.
GRAVEL TO BE ANGULAR CRUSHED ROCK WITH THE MAJORITY OF PARTICLES BETWEEN ¾"-2", NEED ABOUT 115 CU. YD.

EXPIRES 6/30/2009

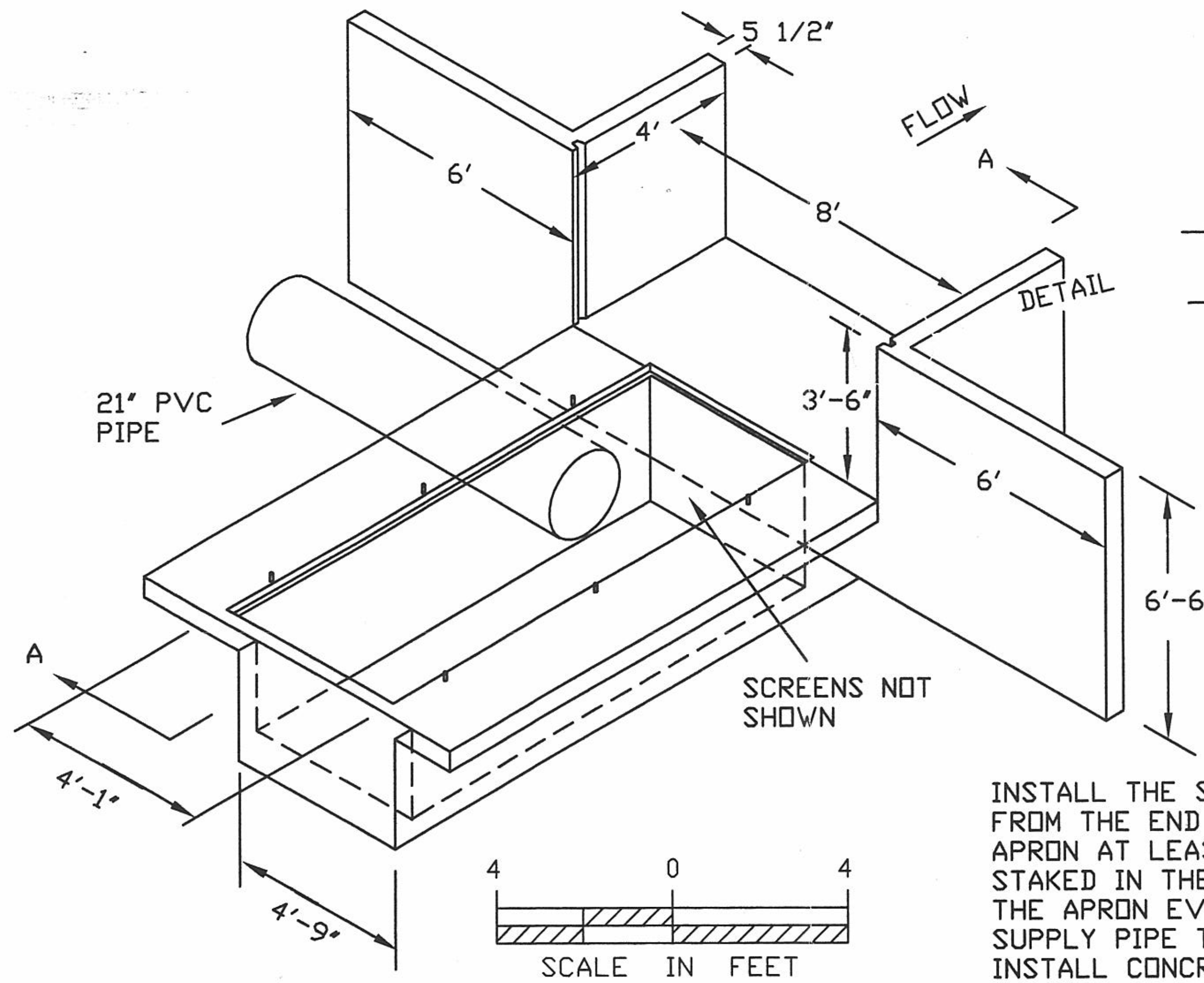
DATE 12/07
DESIGNED B. HEWES
CHECKED

WWBWC/HBDIC UPPER RECHARGE PROJECT
ATLANTIS & STORMTECH CHAMBERS DETAILS
UMATILLA COUNTY, OREGON

CAD FIL
whiteatlar

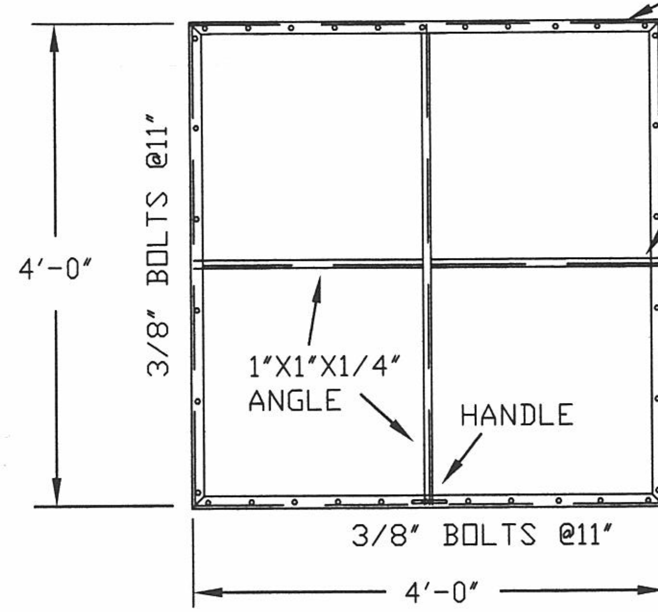
SHEET 5
OF 7

STRUCTURE PERSPECTIVE VIEW

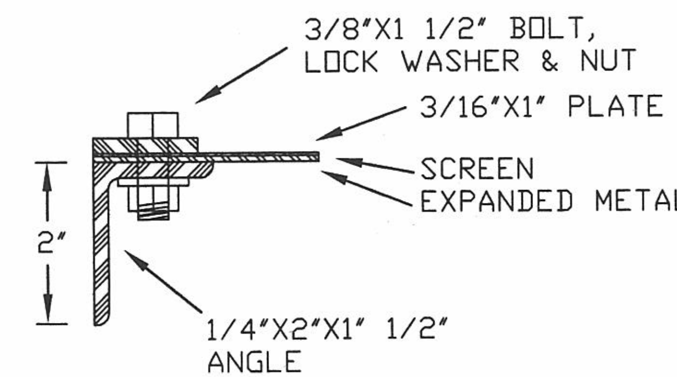


SCREEN FRAME DETAIL

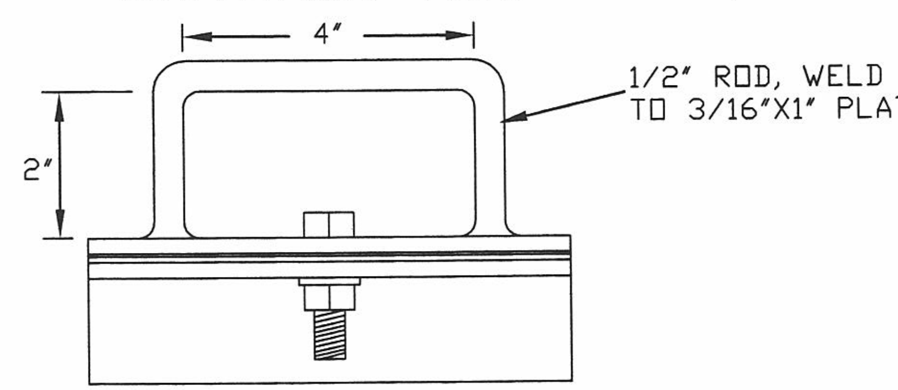
3 NEEDED



SCREEN FRAME DETAIL ELEVATION VIEW



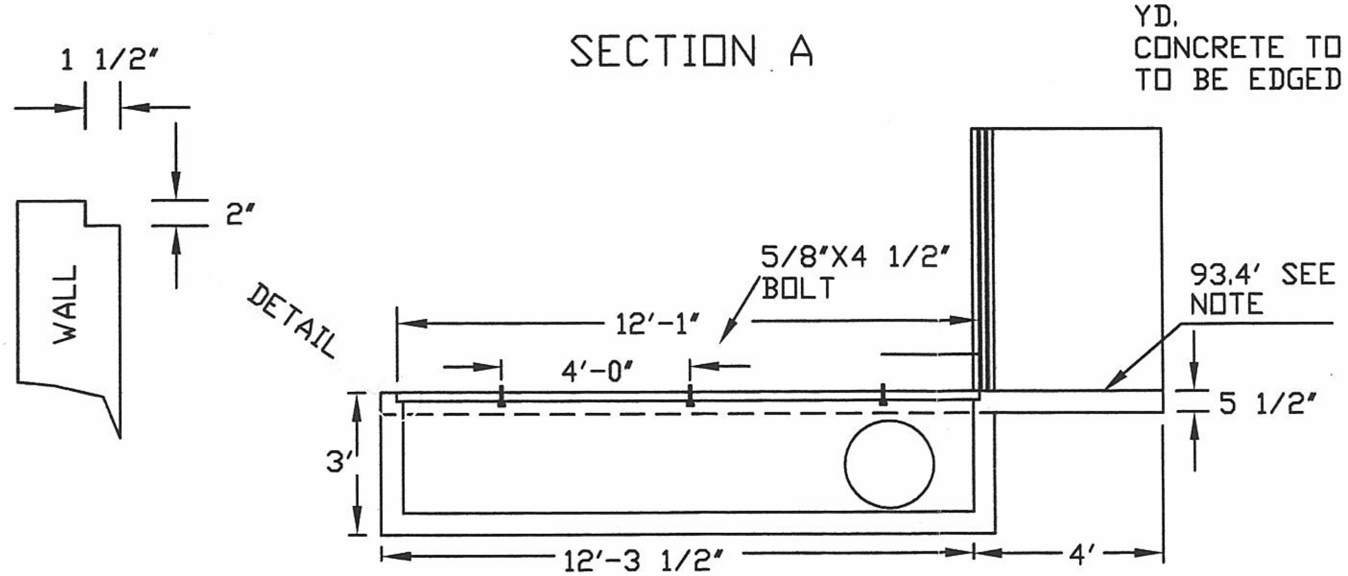
FRAME HANDLE DETAIL ELEVATION VIEW



NOTES

INSTALL THE STRUCTURE ABOUT 135' UPSTREAM FROM THE END OF THE SPOIL PILE WITH THE APRON AT LEAST AT AN ELEVATION OF 93.4' AS STAKED IN THE FIELD. SET THE ELEVATION OF THE APRON EVEN WITH THE CHANNEL BOTTOM.
SUPPLY PIPE TO BE 260'-21" CLASS 100 PVC.
INSTALL CONCRETE ACCORDING TO NATURAL RESOURCES CONSERVATION SERVICE SPECIFICATION 42, REINFORCED CONCRETE FOR MINOR STRUCTURES.
USE 4000 PSI STRENGTH CONCRETE, NEED 5.4 CU. YD.
CONCRETE TO BE VIBRATED, ALL EXPOSED EDGES TO BE EDGED WITH AN EDGING TOOL.

SECTION A



NOTE

NOTCH IS ON ALL 4 SIDES OF THE BOX.
BOLTS ARE TO HOLD DOWN THE SCREEN, USE A 1"X4"X¼"BAR WITH A 3/4" DIAMETER HOLE 1" FROM ONE END.

REGISTERED PROFESSIONAL ENGINEER
6476
OREGON
JULY 11, 1969
BERNARD J. HEWES
EXPIRES 6/30/2009

NOTES

EXPANDED METAL TO BE CARBON STEEL, FLATTENED, 13 GAGE, 3/4" SHORT OPENING WIDTH.
SCREEN TO BE TYPE 304 STAINLESS STEEL, 20 GAGE MINIMUM WITH 3/32" HOLES SPACED 5/32" STAGGERED.

B. Hewes 8/21/2009 11:20 AM whitescreen.dwg

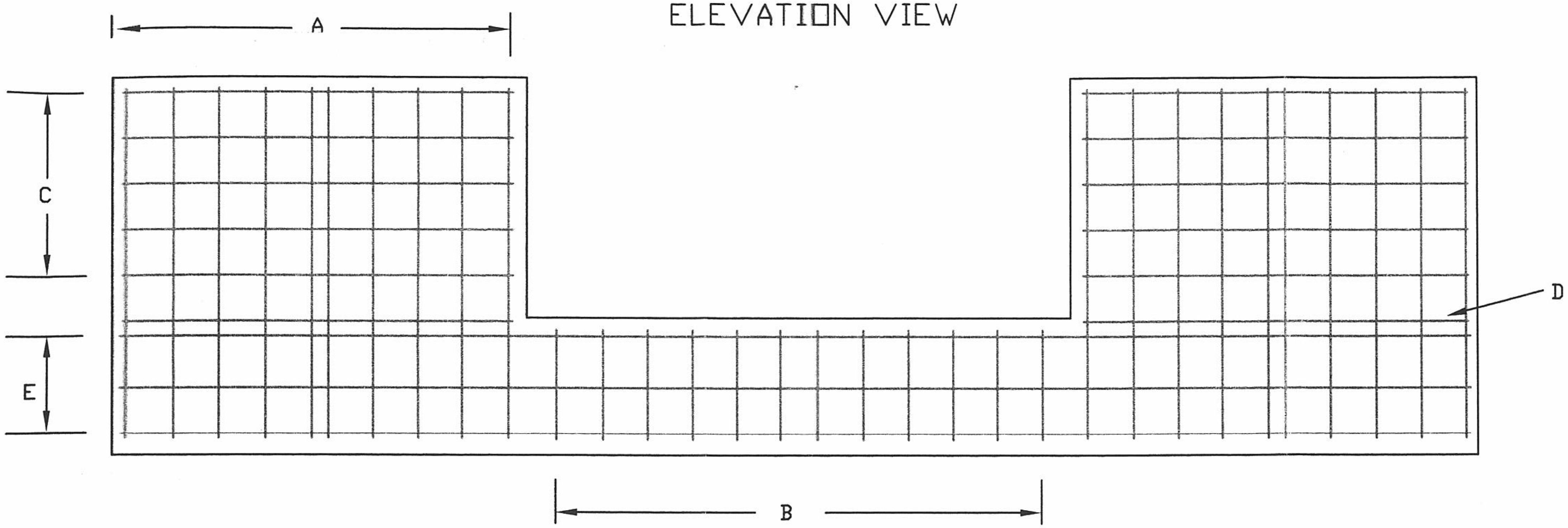
DESIGNED	B. HEWES	DATE 12/07
CHECKED		
APPROVED		

WWBWC/HBDIC UPPER RECHARGE PROJECT
CHECK & SCREEN STRUCTURE
UMATILLA COUNTY, OREGON
R H ENGINEERING

CAD FILE whitescreen

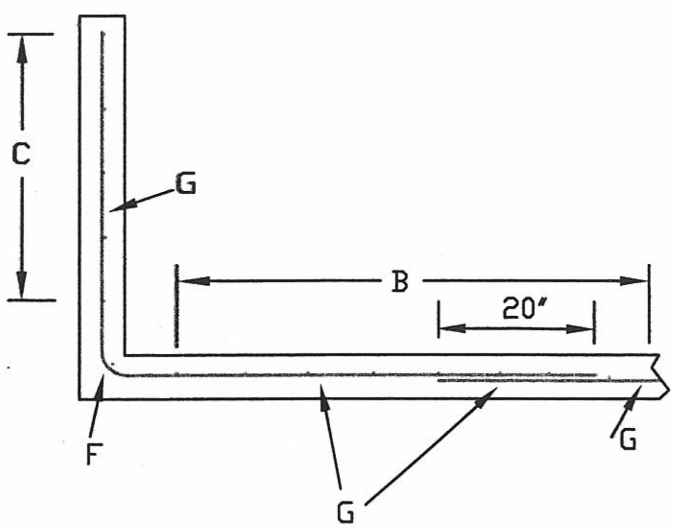
SHEET 6 OF 7

HEADWALL LOOKING DOWNSTREAM ELEVATION VIEW

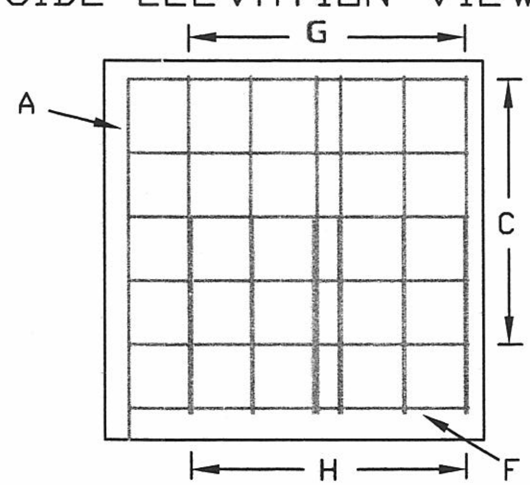


DOWNSTREAM SIDE WALL AND APRON

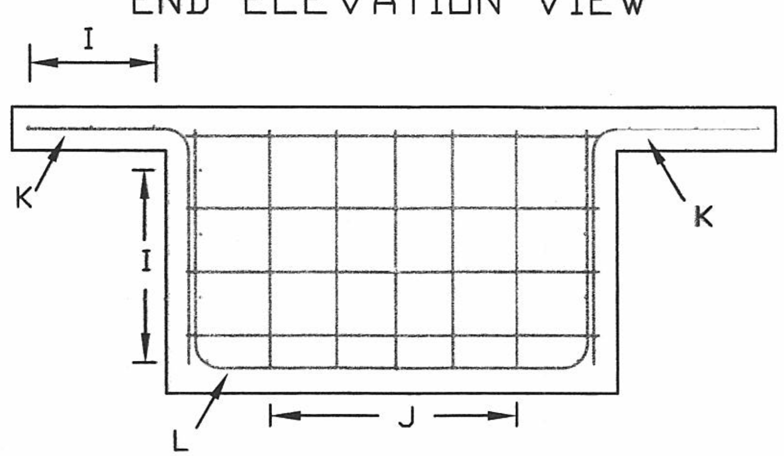
END ELEVATION VIEW



SIDE ELEVATION VIEW



SCREEN BOX END ELEVATION VIEW

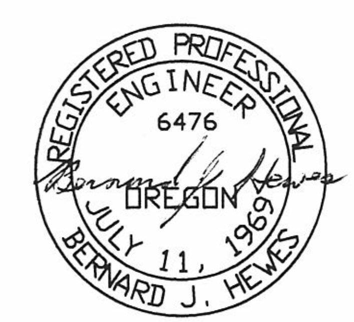


REINFORCING STEEL SCHEDULE

ALL NUMBER 4 BARS, 8" NOMINAL SPACING

BAR	NO.	SHAPE	A	B	C
A	20	STRAIGHT	6'-1"	--	--
B	12	A⌊ B	2'-7"	3'-7"	--
C	10	A⌊ B	5'-7"	3'-9"	--
D	2	STRAIGHT	5'-8"	--	--
E	3	STRAIGHT	19'-8"	--	--
F	2	STRAIGHT	3'-7"	--	--
G	12	A⌊ B	3'-7"	5'-1"	--
H	12	A⌊ B	2'-0"	2'-0"	--
I	14	STRAIGHT	12'-0"	--	--
J	5	A⌊ B	2'-6"	3'-8"	--
K	38	A⌊ B	1'-9"	2'-6"	--
L	19	A⌊ B ⌋C	2'-6"	4'-3"	2'-6"

1080 FEET NEEDED WITHOUT ANY WASTE



EXPIRES 6/30/2009

B. Hewes 8/21/2008 11:11 AM whiterebar.dwg

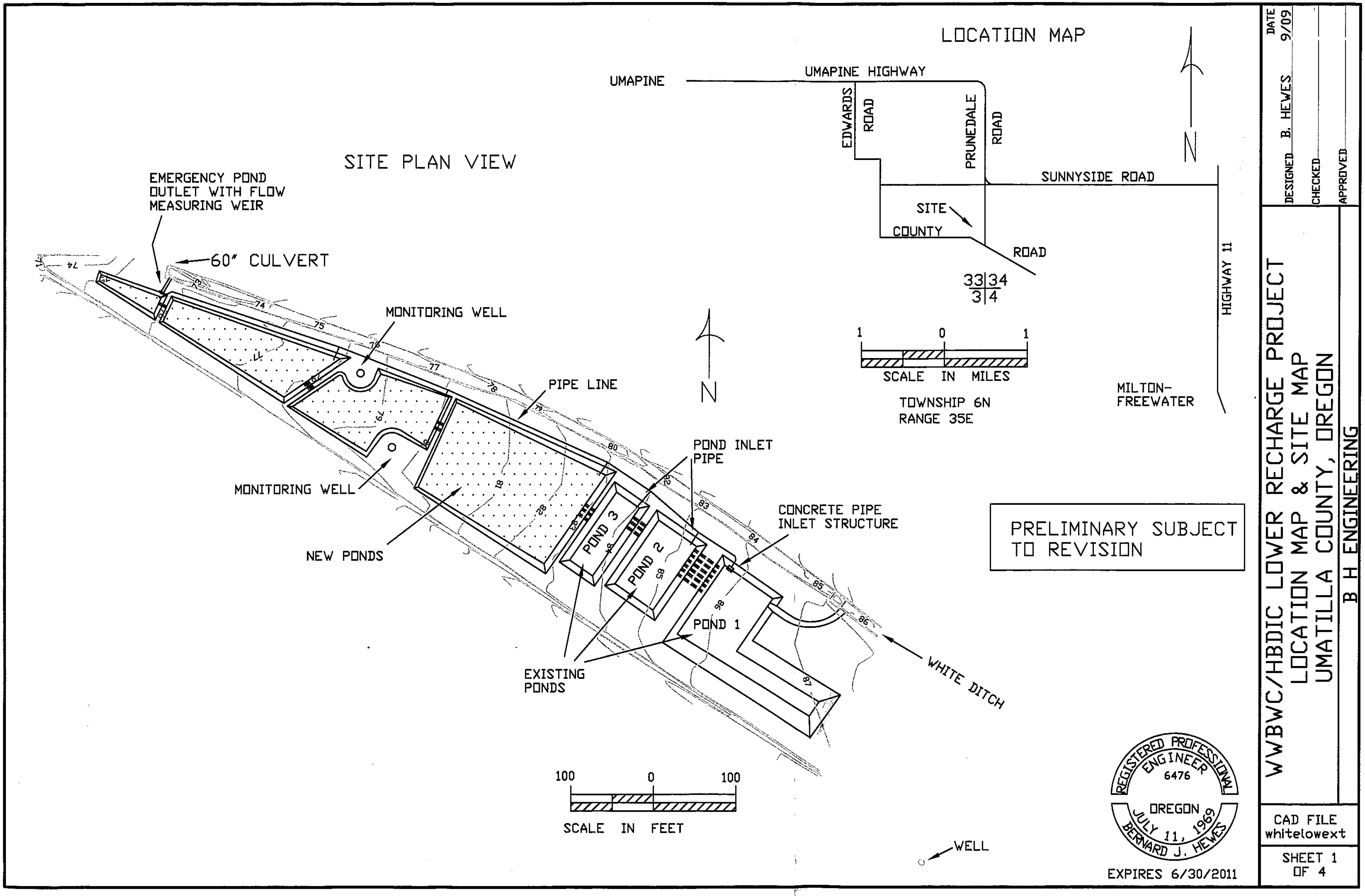
DESIGNED B. HEWES DATE 12/07
CHECKED
APPROVED

WWBWC/HBDIC UPPER RECHARGE PROJECT
REINFORCING STEEL DETAILS
UMATILLA COUNTY, OREGON

B H ENGINEERING

CAD FILE whiterebar

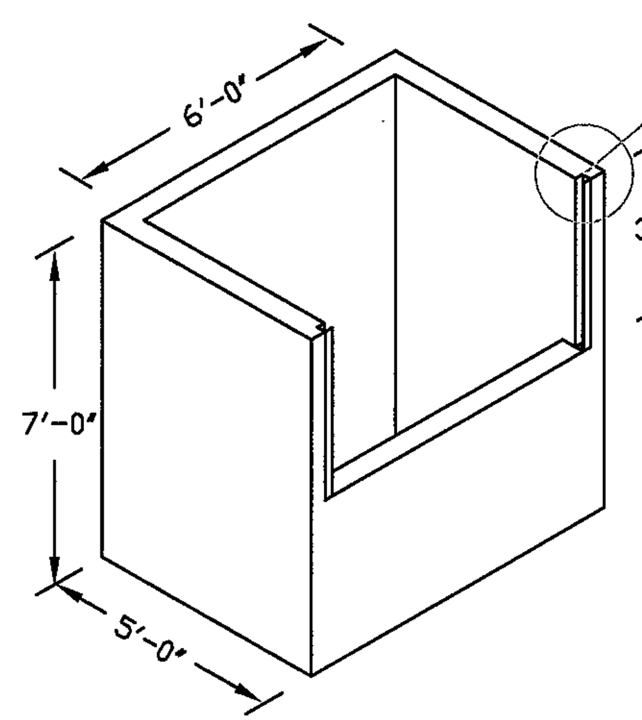
SHEET 7 OF 7

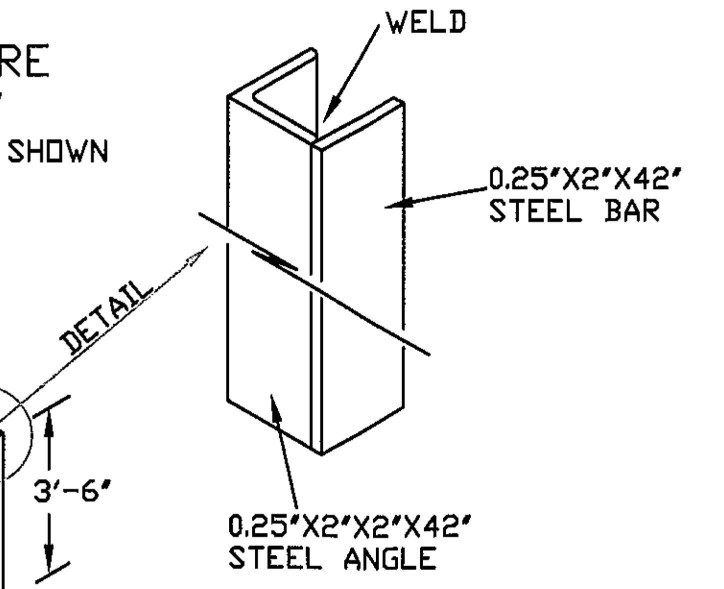


SITE PLAN VIEW
EMERGENCY POND OUTLET WITH FLOW MEASURING WEIR
60" CULVERT
MONITORING WELL
PIPE LINE
MONITORING WELL
NEW PONDS
POND INLET PIPE
CONCRETE PIPE INLET STRUCTURE
POND 3
POND 2
POND 1
EXISTING PONDS
WHITE DITCH
N
100 0 100
SCALE IN FEET
WELL
LOCATION MAP
UMAPINE
UMAPINE HIGHWAY
EDWARDS ROAD
PRUNEDALE ROAD
SUNNYSIDE ROAD
SITE
COUNTY ROAD
33|34
3|4
HIGHWAY 11
N
1 0 1
SCALE IN MILES
TOWNSHIP 6N
RANGE 35E
MILTON-FREEWATER
PRELIMINARY SUBJECT TO REVISION
REGISTERED PROFESSIONAL ENGINEER
6476
OREGON
JULY 11, 1969
BERNARD J. HEWES
EXPIRES 6/30/2011
DESIGNED B. HEWES
DATE 9/09
CHECKED
APPROVED
WWBWC/HBDIC LOWER RECHARGE PROJECT
LOCATION MAP & SITE MAP
UMATILLA COUNTY, OREGON
B H ENGINEERING
CAD FILE whitelowext
SHEET 1 OF 4

PIPE INLET STRUCTURE PERSPECTIVE VIEW

SLIDE GATE AND TRASH RACK NOT SHOWN

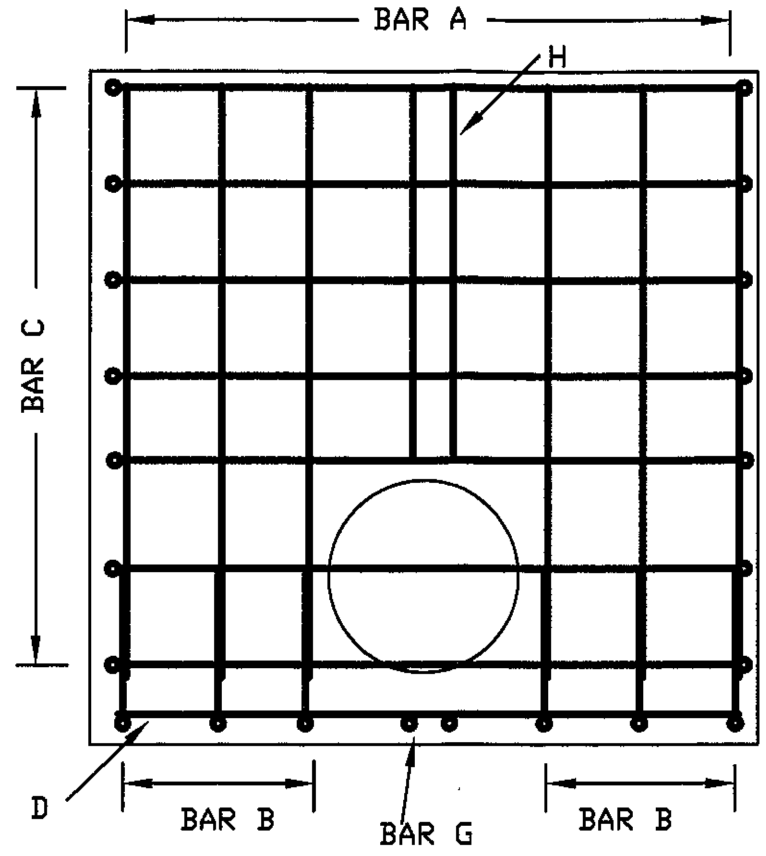




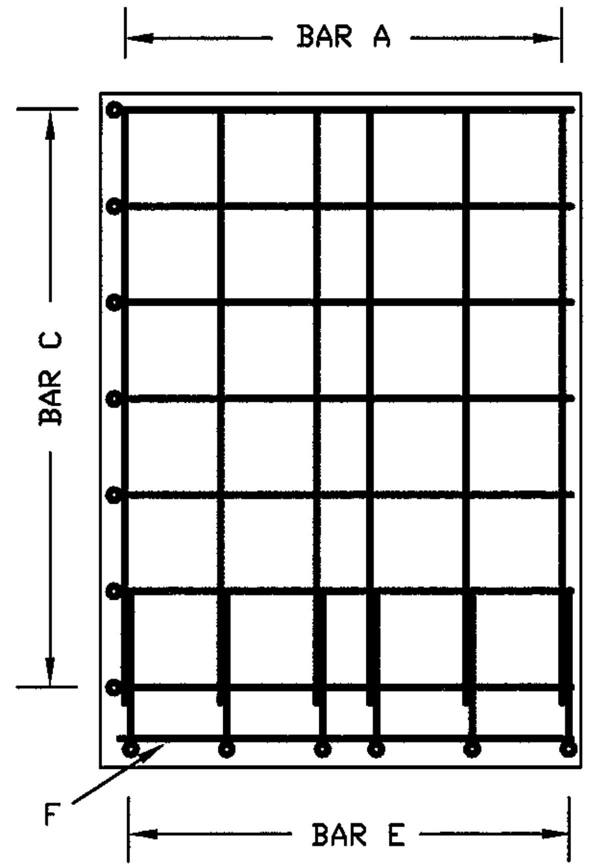
PRELIMINARY SUBJECT TO REVISION

REINFORCING STEEL DETAILS

BACK ELEVATION VIEW

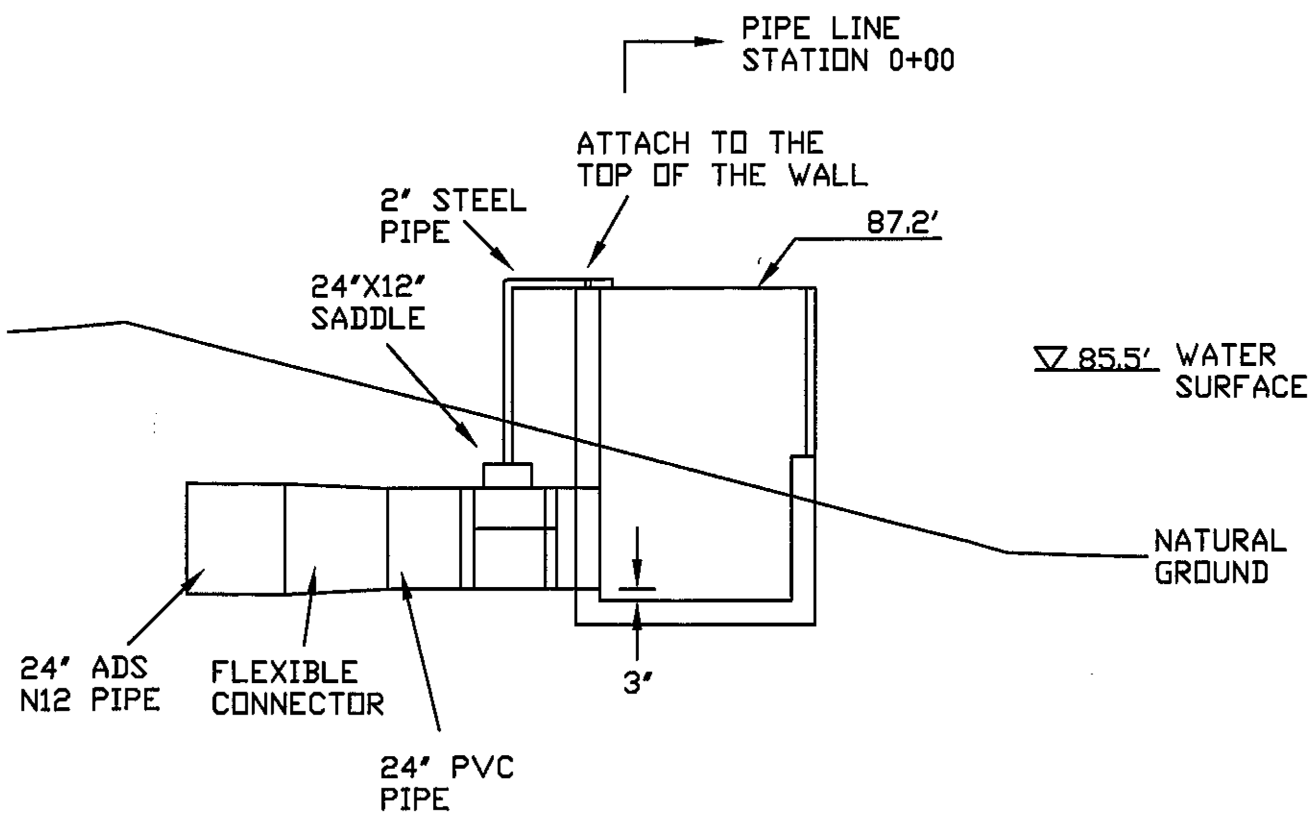


SIDE ELEVATION VIEW



CROSS SECTION VIEW

SLIDE GATE AND TRASH RACK NOT SHOWN



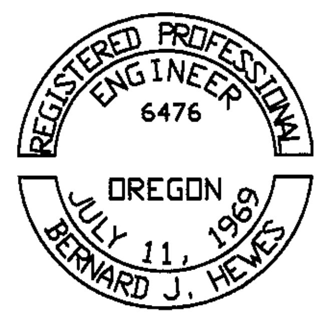
REINFORCING STEEL SCHEDULE

ALL NUMBER 4 BARS, 12" NOMINAL SPACING

BAR	NO.	SHAPE	A	B	C
A	18	straight	6'-2"	--	--
B	6	A|_B_|C	1'-7"	6'-6"	3'-1"
C	7	A|_B_|C	4'-7"	6'-6"	4'-7"
D	2	straight	6'-6"	--	--
E	6	A|_B_|C	1'-7"	6'-6"	1'-7"
F	2	straight	4'-6"	--	--
G	2	_A_|B	6'-6"	3'-1"	--
H	2	straight	3'-11"	--	--

NOTES

INSTALL THE PIPE INLET STRUCTURE ACCORDING TO CONSTRUCTION SPECIFICATION 42, REINFORCED CONCRETE FOR MINOR STRUCTURES. USE 4000 PSI STRENGTH CONCRETE. APPROXIMATELY 3.0 CU. YD. NEEDED.
REINFORCING STEEL TO BE #4 BARS, NEED 400 FEET ASSUMING NO WASTE.



EXPIRES 6/30/2011

DATE 10/09
DESIGNED B. HEWES
CHECKED
APPROVED

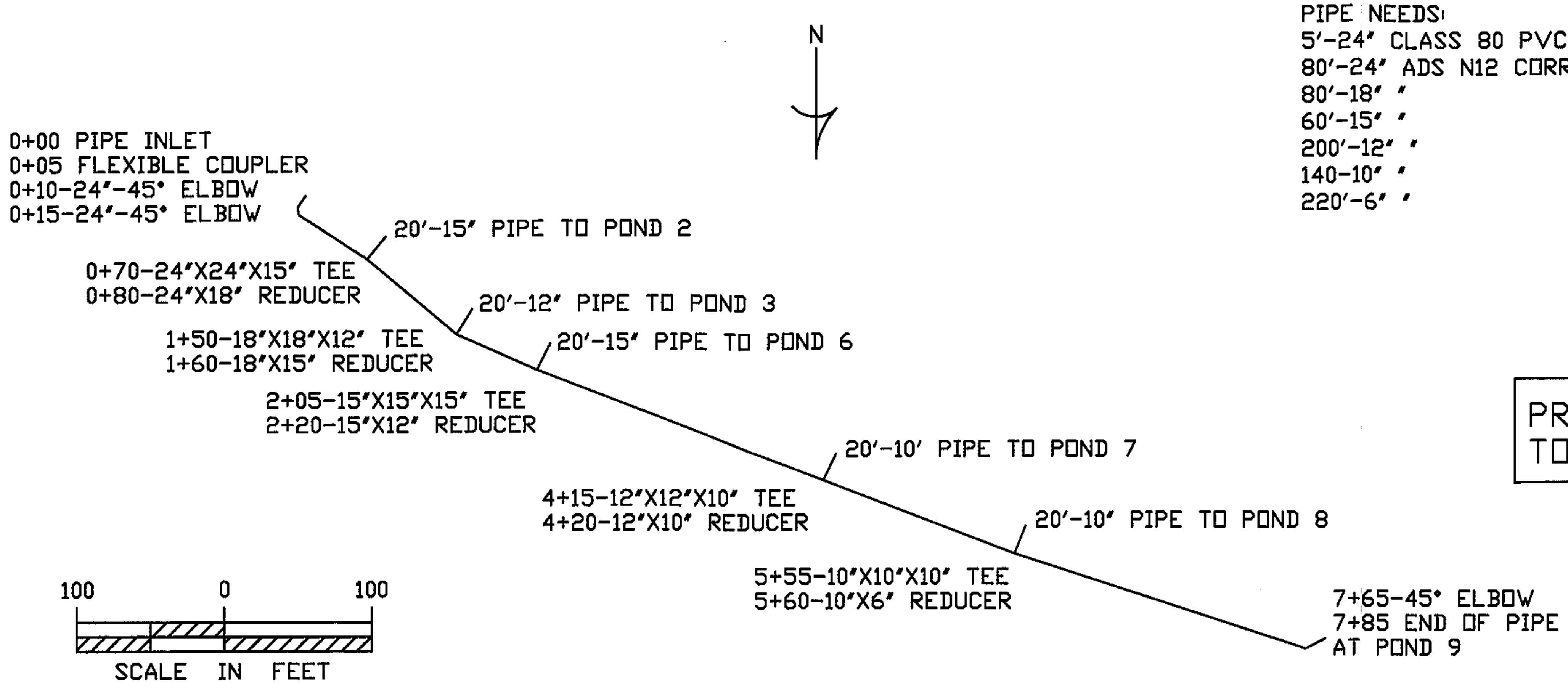
WWBWC/HBDIC LOWER RECHARGE PROJECT
PIPE INLET STRUCTURE
UMATILLA COUNTY, OREGON
B H ENGINEERING

CAD FILE
whitelowstruc

SHEET 2
OF 4

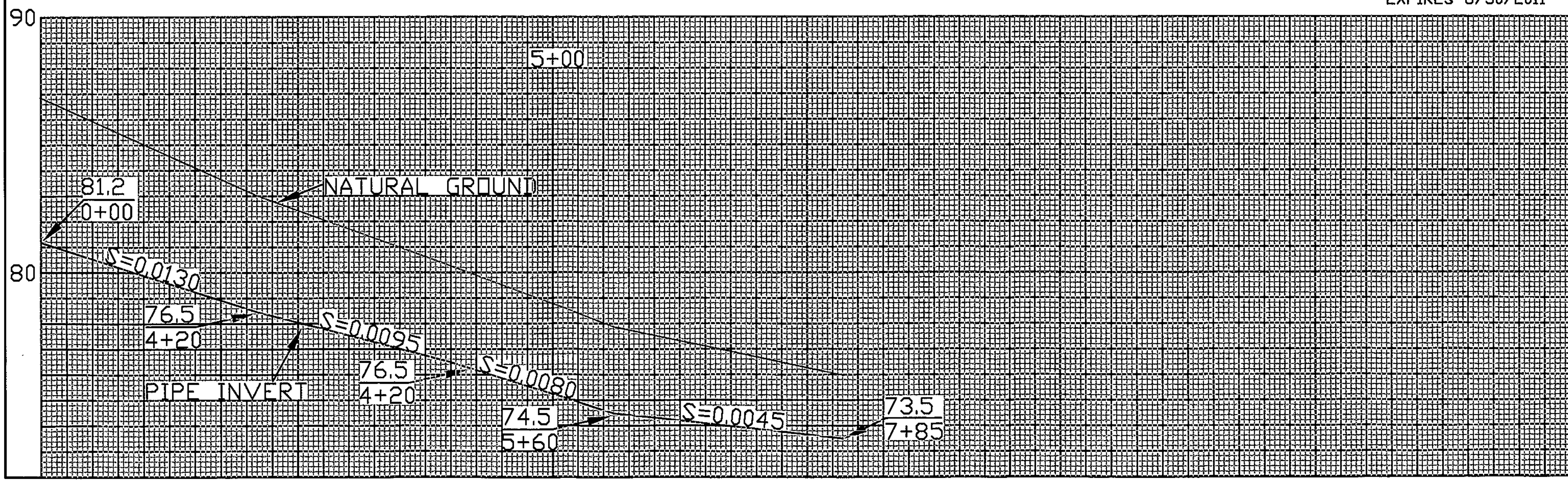
NOTES

PIPE NEEDS:
5'-24" CLASS 80 PVC PIPE
80'-24" ADS N12 CORRUGATED POLYETHYLENE PIPE
80'-18" " "
60'-15" " "
200'-12" " "
140-10" " "
220'-6" " "



PRELIMINARY SUBJECT TO REVISION

REGISTERED PROFESSIONAL ENGINEER 6476
OREGON
JULY 11, 1969
BERNARD J. HEWES
EXPIRES 6/30/2011



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

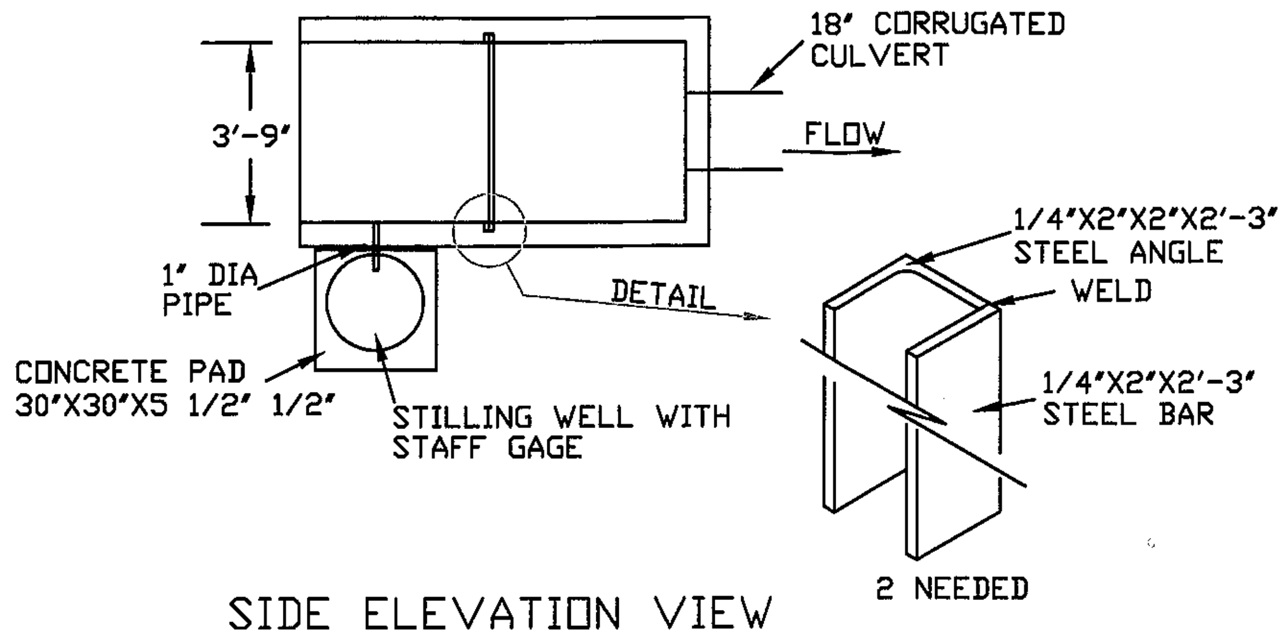
DESIGNED B. HEWES	10/09
PLOTTED	
APPROVED	

DATE

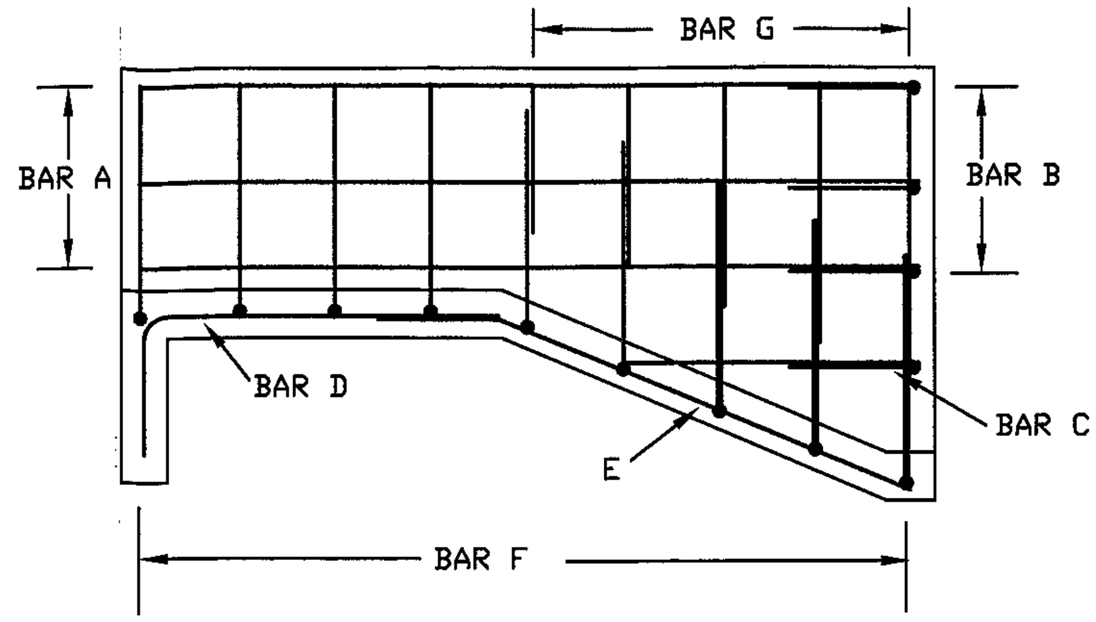
CAD FILE whitelowpipe

SHEET 3 OF 4

POND EMERGENCY OUTLET PLAN VIEW

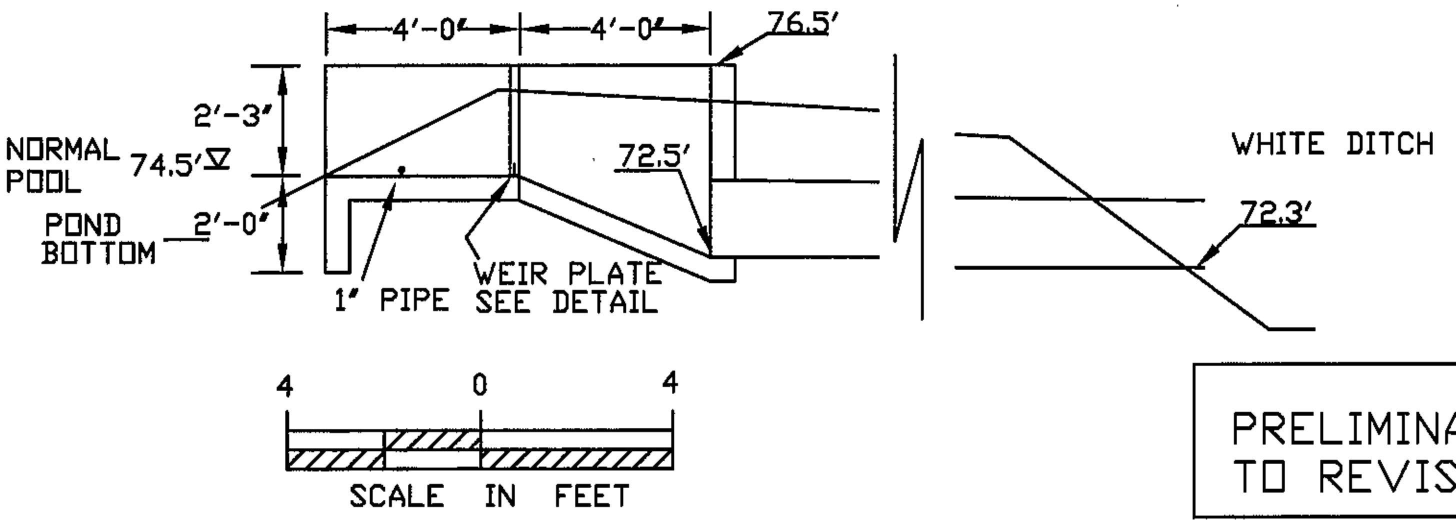


REINFORCING STEEL DETAILS SIDE ELEVATION VIEW

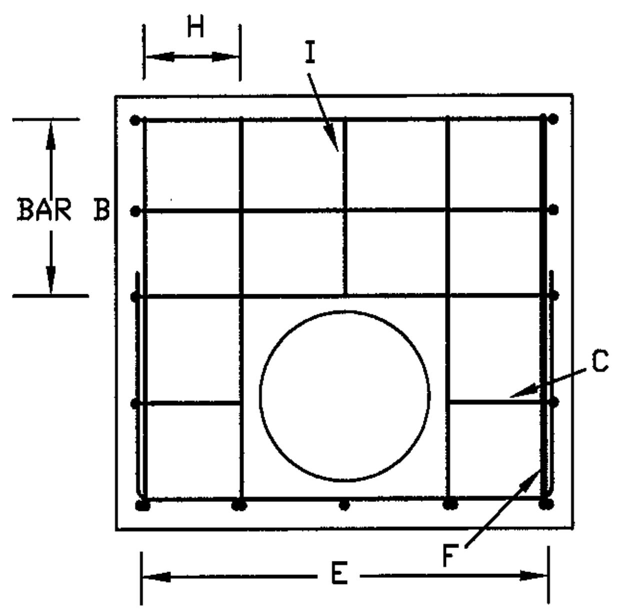


SIDE ELEVATION VIEW

STILLING WELL NOT SHOWN



PIPE INLET END ELEVATION VIEW



PRELIMINARY SUBJECT TO REVISION

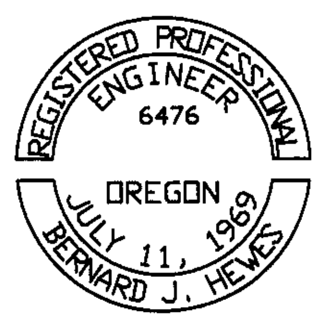
NOTES

INSTALL CONCRETE IN ACCORDANCE WITH CONSTRUCTION SPECIFICATION 42, 'REINFORCED CONCRETE FOR MINOR STRUCTURES'. USE 4000 PSI STRENGTH CONCRETE, NEED ABOUT 2.2 CU. YD.
REINFORCING STEEL ALL #4 BARS, NEED 260 FEET WITH NO WASTE.
CULVERT PIPE MAY BE STEEL OR HIGH DENSITY POLYETHYLENE.
SET THE WEIR PLATE IN A RABBET CUT INTO A 1 1/2"X1 3/4" BOARD AND SET INTO THE SOCKETS. THE WEIR PLATE TO BE STEEL 1/8"X3"X48".
SET THE STILLING WELL AT LEAST 2" INTO THE CONCRETE BASE. USE A MINIMUM PIPE DIAMETER OF 18" EITHER PVC OR STEEL.
SET THE STAFF GAGE ZERO POINT IN THE STILLING WELL LEVEL WITH THE CREST OF THE WEIR PLATE. INSTALL THE 1" PIPE TO THE STILLING WELL WITH 1" BETWEEN THE FLOOR AND PIPE.

REINFORCING STEEL SCHEDULE

ALL #4 BARS, 12" NOMINAL SPACING

BAR	NO.	SHAPE	A	B	C
A	6	straight	7'-8"	--	--
B	3	A|_B_|C	1'-3"	4'-3"	1'-3"
C	2	A|_B	1'-3"	1'-1"	--
D	5	A|_B	1'-6"	4'-0"	--
E	5	A_B	1'-3"	4'-8"	--
F	9	A|_B_|C	2'-4"	4'-3"	2'-4"
G	10	straight	varies	--	--
H	4	A|_B	1'-3"	4'-1"	--
I	1	straight	1'-10"	--	--



EXPIRES 6/30/2011

Bernard Hewes, n/a 10/15/2009 11:09 AM whitelowweir.dwg

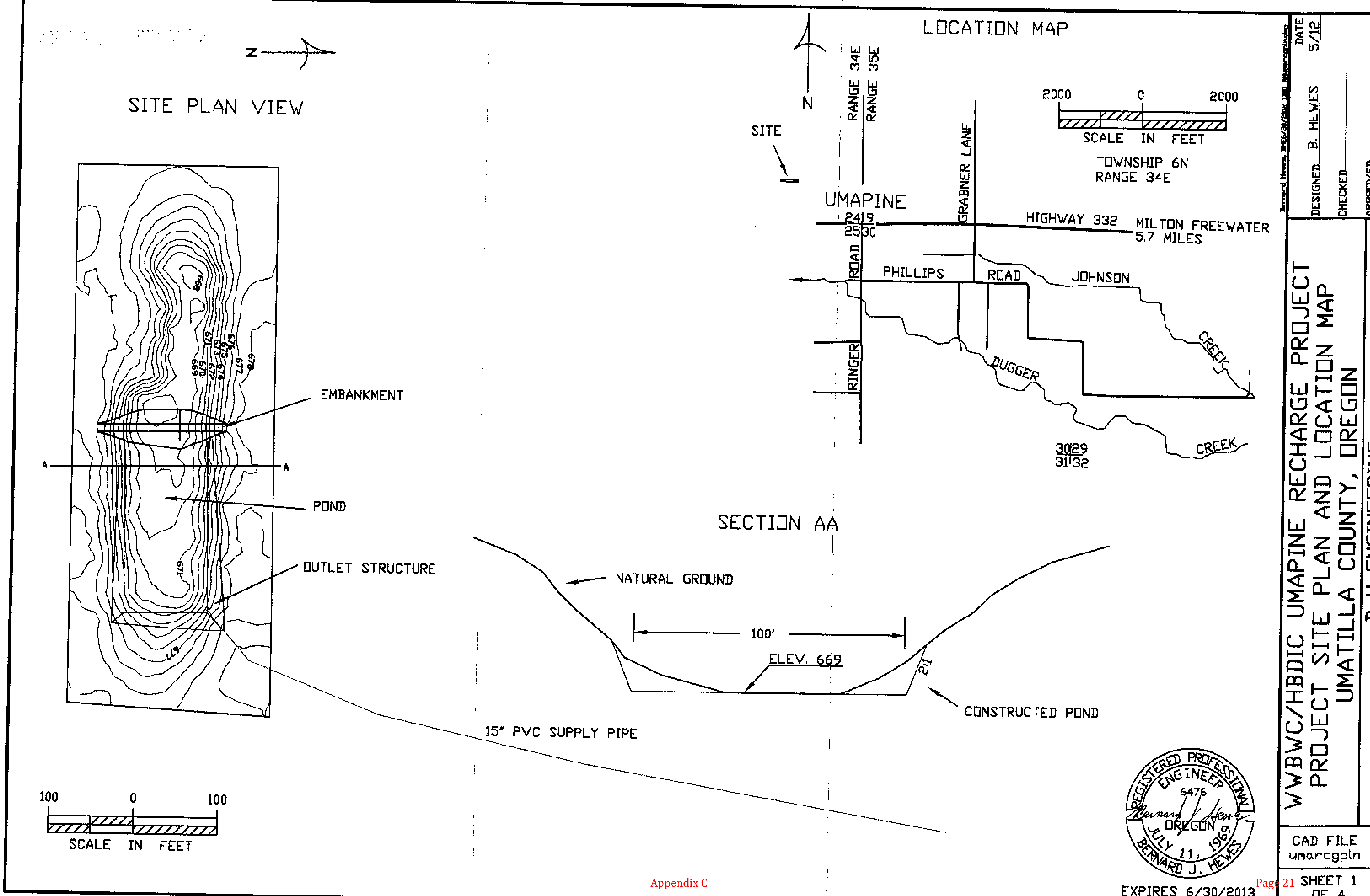
WWBWC/HBDIC LOWER RECHARGE PROJECT
EMERGENCY SPILLWAY WEIR
UMATILLA COUNTY, OREGON

B H ENGINEERING

DATE	10/09
DESIGNED	B. HEWES
CHECKED	
APPROVED	

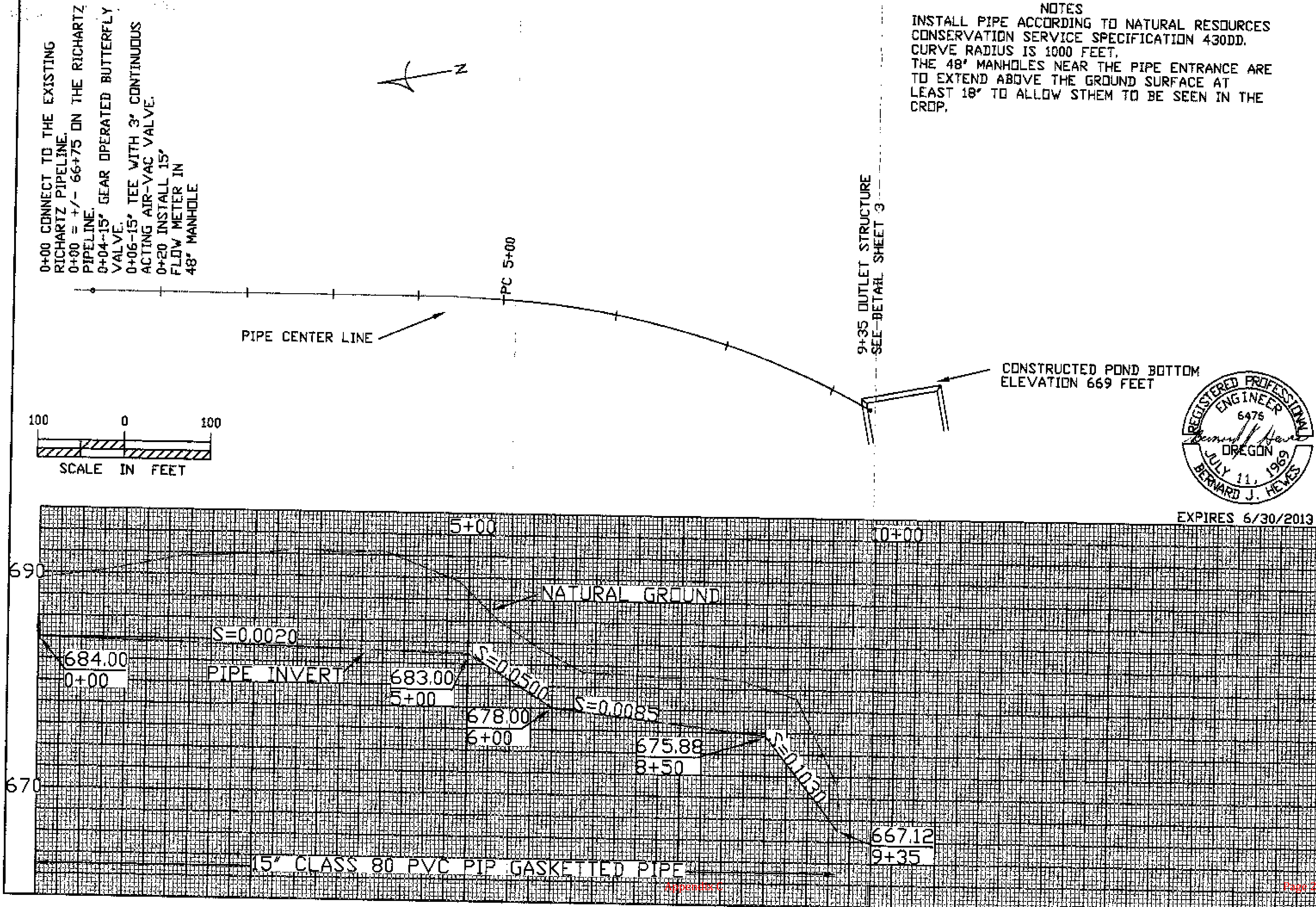
CAD FILE whitelowweir

SHEET 4 OF 4


SITE PLAN VIEW
N
EMBANKMENT
A
A
POND
OUTLET STRUCTURE
668
669
670
671
672
673
674
675
677
678
15" PVC SUPPLY PIPE
100
0
100
SCALE IN FEET
LOCATION MAP
N
SITE
RANGE 34E
RANGE 35E
2000
0
2000
SCALE IN FEET
TOWNSHIP 6N
RANGE 34E
UMAPINE
GRABNER LANE
2419
2530
HIGHWAY 332
MILTON FREEWATER
5.7 MILES
ROAD
PHILLIPS
ROAD
JOHNSON
CREEK
RINGER
DUGGER
CREEK
3029
3132
SECTION AA
NATURAL GROUND
100'
ELEV. 669
2:1
CONSTRUCTED POND
REGISTERED PROFESSIONAL ENGINEER
6476
OREGON
JULY 11, 1969
BERNARD J. HEWES
EXPIRES 6/30/2013
DATE 5/12
DESIGNED B. HEWES
CHECKED
APPROVED
WWBWC/HBDIC UMAPINE RECHARGE PROJECT
PROJECT SITE PLAN AND LOCATION MAP
UMATILLA COUNTY, OREGON
B H ENGINEERING
CAD FILE
umarcgpln
SHEET 1
OF 4

NOTES

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

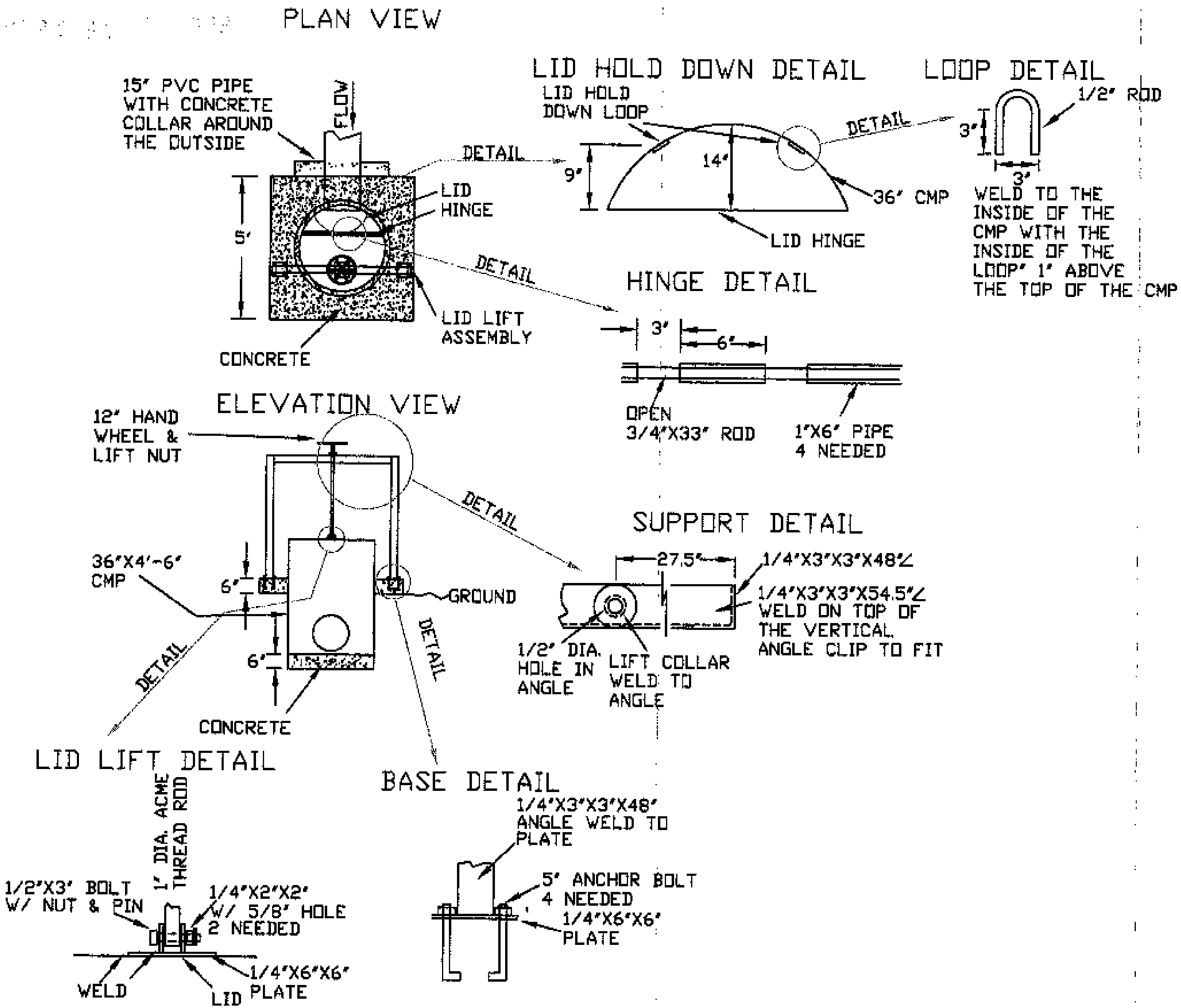


DESIGNED B. HEWES	DATE 5/12
PLOTTED	
APPROVED	

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

CAD FILE umarcgpp

SHEET 2 OF 4

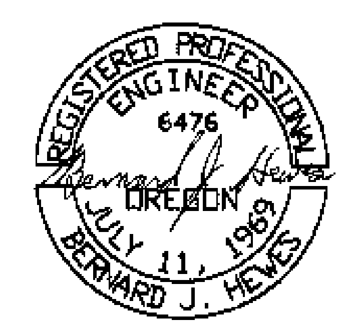


NOTES

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

DATE 5/12
DESIGNED B. HEWES
CHECKED
APPROVED

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

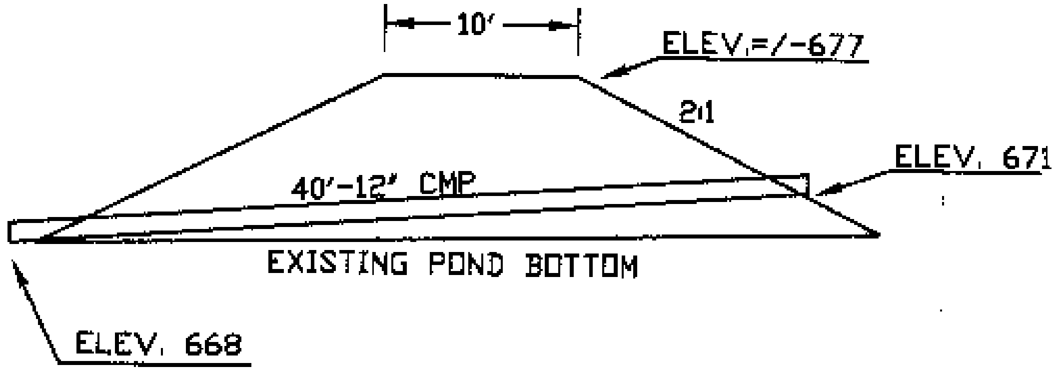


EXPIRES 6/30/2013

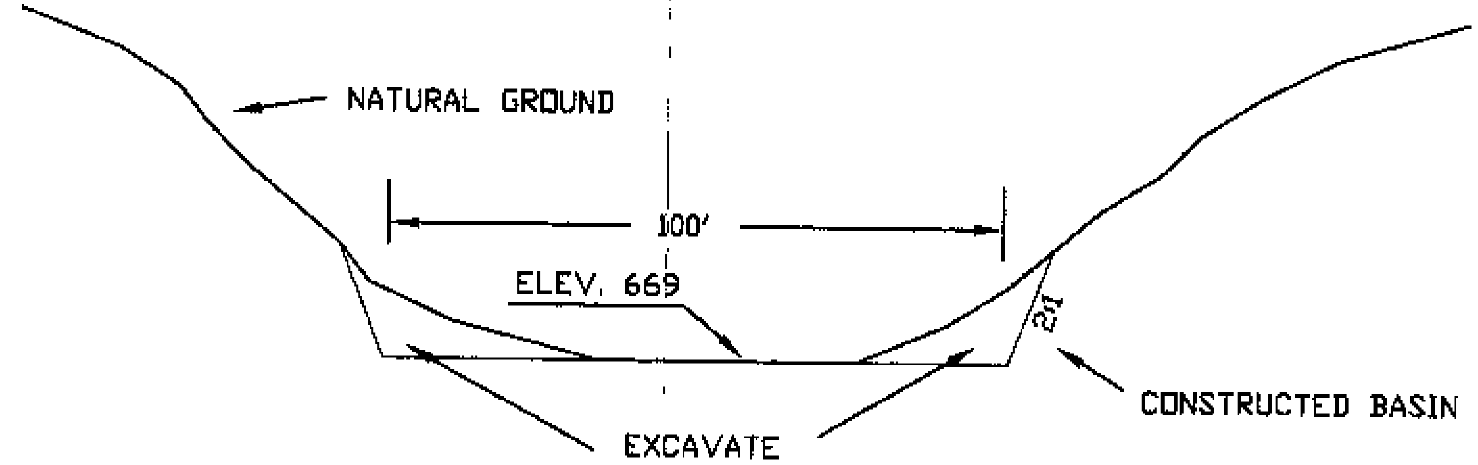
CAD FILE umarcgout

SHEET 3 OF 4

EMBANKMENT CROSS SECTION



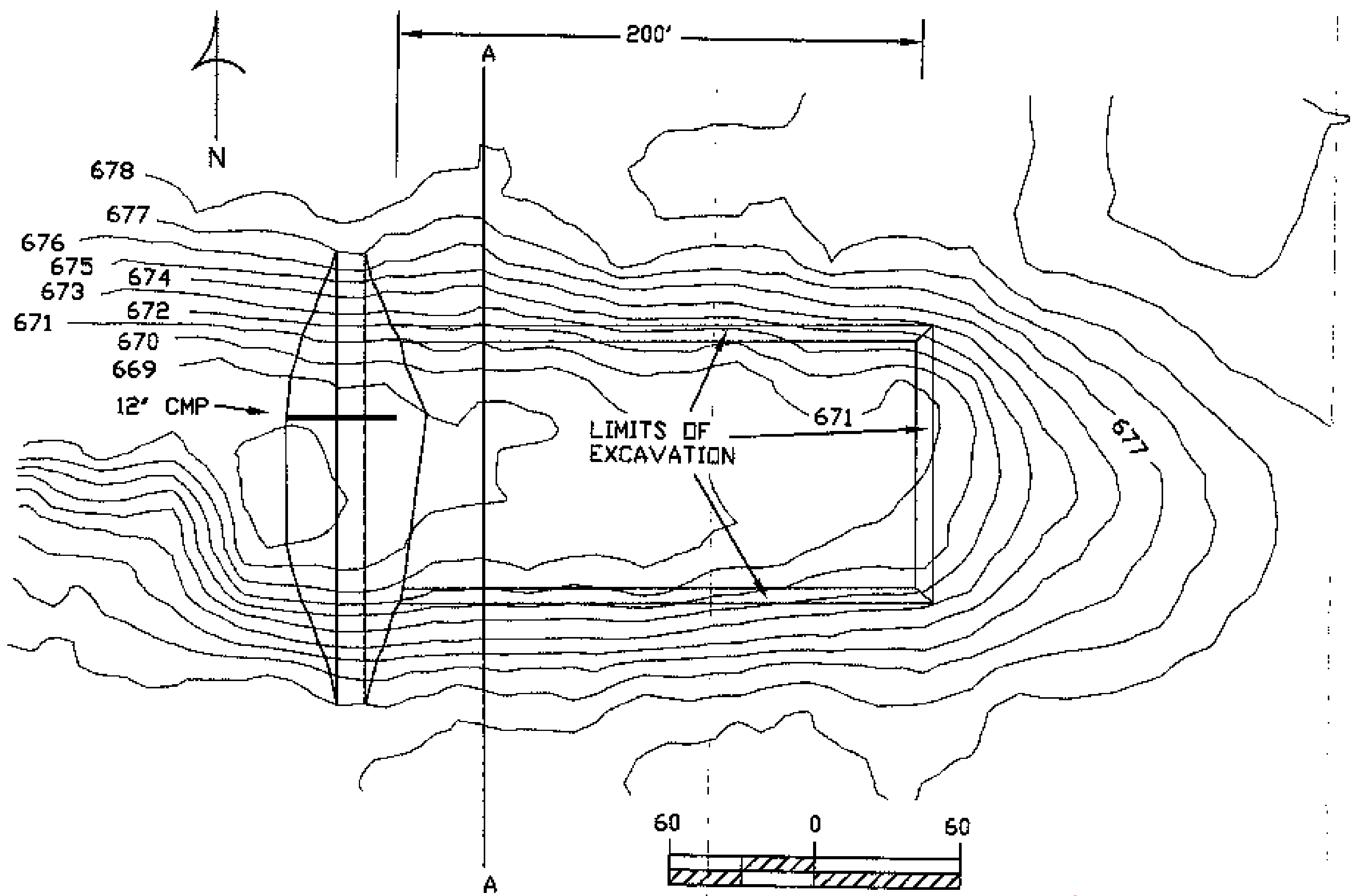
SECTION AA



NOTES

ESTIMATED EXCAVATION VOLUME ABOUT 900 CU. YD.

CONSOLIDATE THE EMBANKMENT FILL USING A VIBRATING ROLLER COMPACTOR. USE AT LEAST TWO PASSES OVER 1' THICK, LOOSE LAYERS.



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

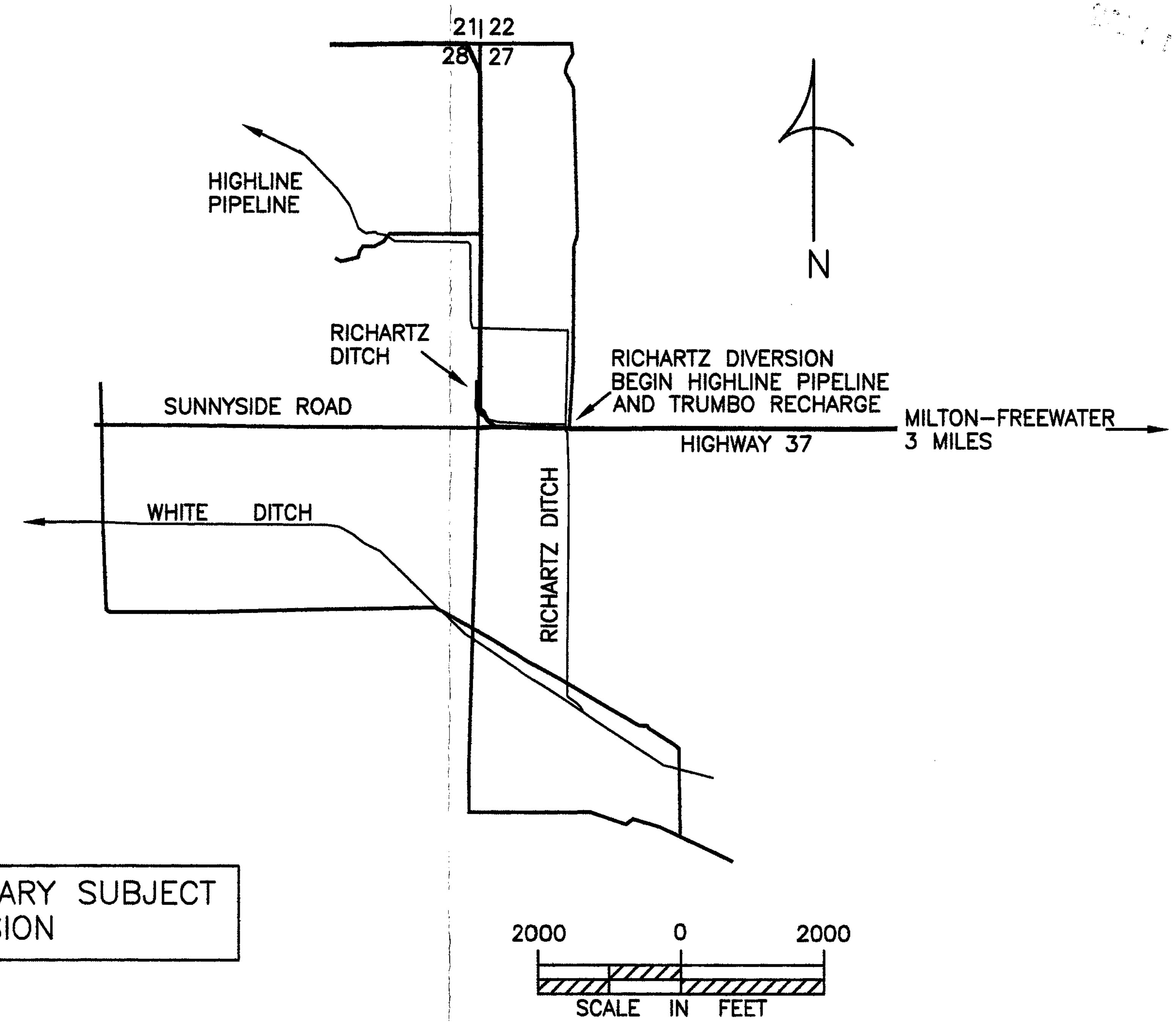
EXPIRES 6/30/2013

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

DESIGNED	B. HEWES	DATE 5/12
CHECKED		
APPROVED		

CAD FILE umarcgpond

SHEET 4 OF 4



PRELIMINARY SUBJECT TO REVISION

SECTION 27
TOWNSHIP 6N
RANGE 35E

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

EXPIRES 6/30/2013

DATE 9/12
DESIGNED B. HEWES
CHECKED
APPROVED

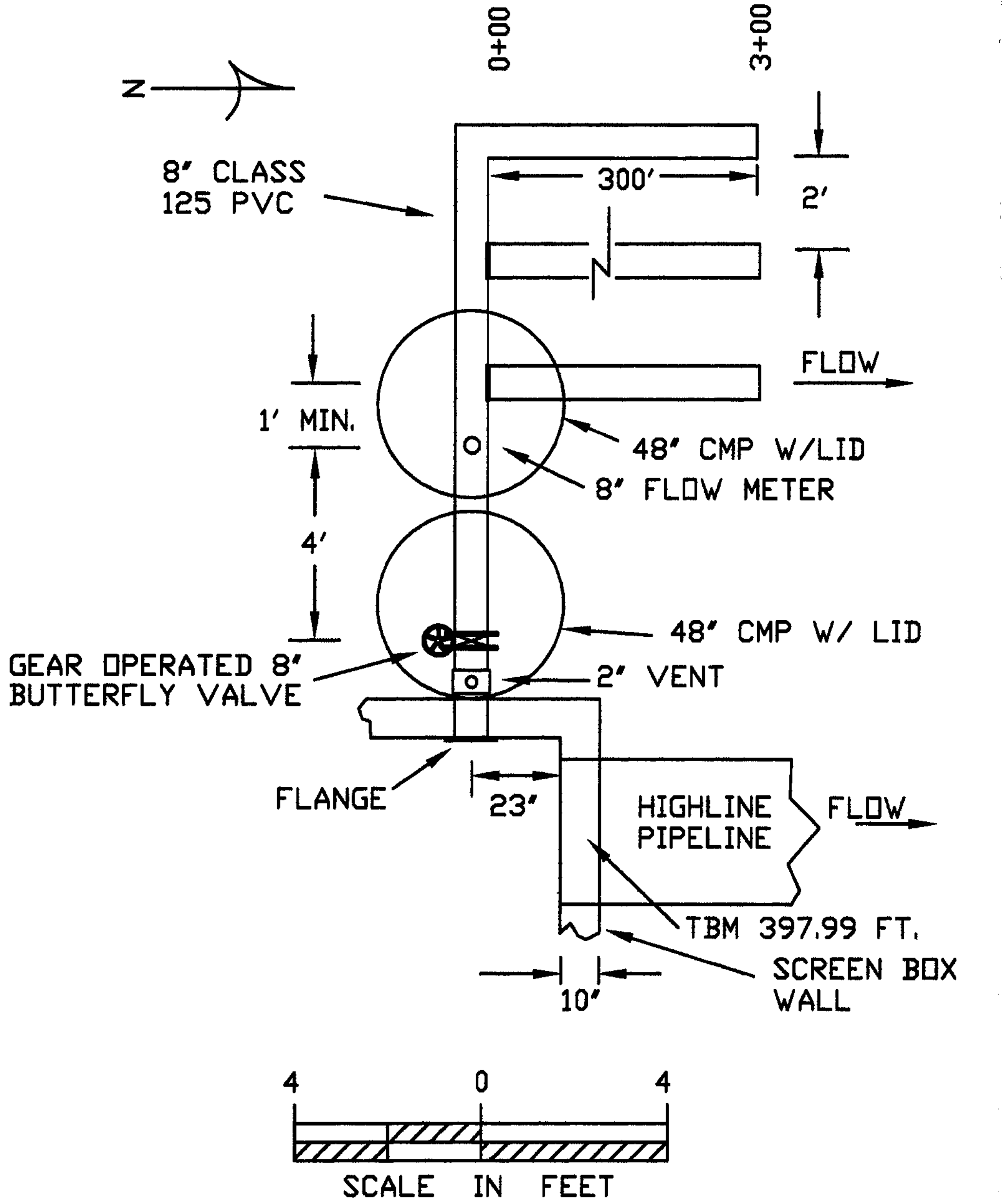
WWBWC/HBDIC TRUMBO LANE RECHARGE
LOCATION MAP
UMATILLA COUNTY, OREGON

B H ENGINEERING

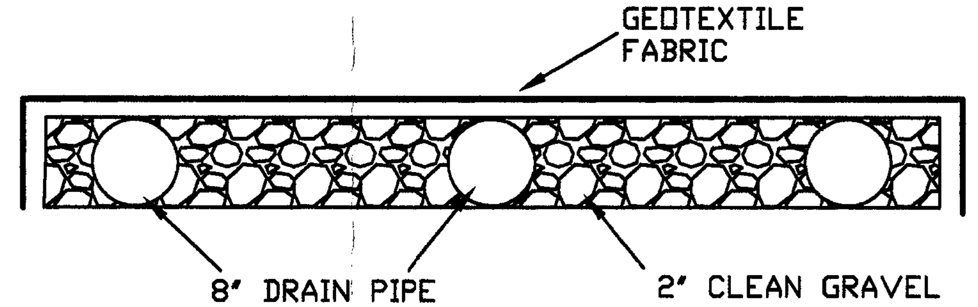
CADFILE
trumboloc

SHEET 1
OF 2

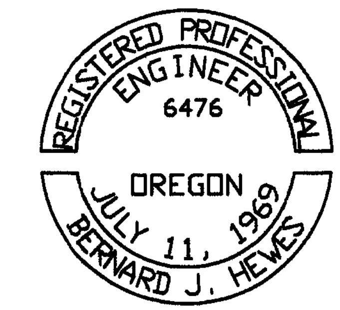
RECHARGE SYSTEM PLAN VIEW



DRAIN PIPE CROSS SECTION ELEVATION VIEW



PRELIMINARY SUBJECT TO REVISION



EXPIRES 6/30/2013

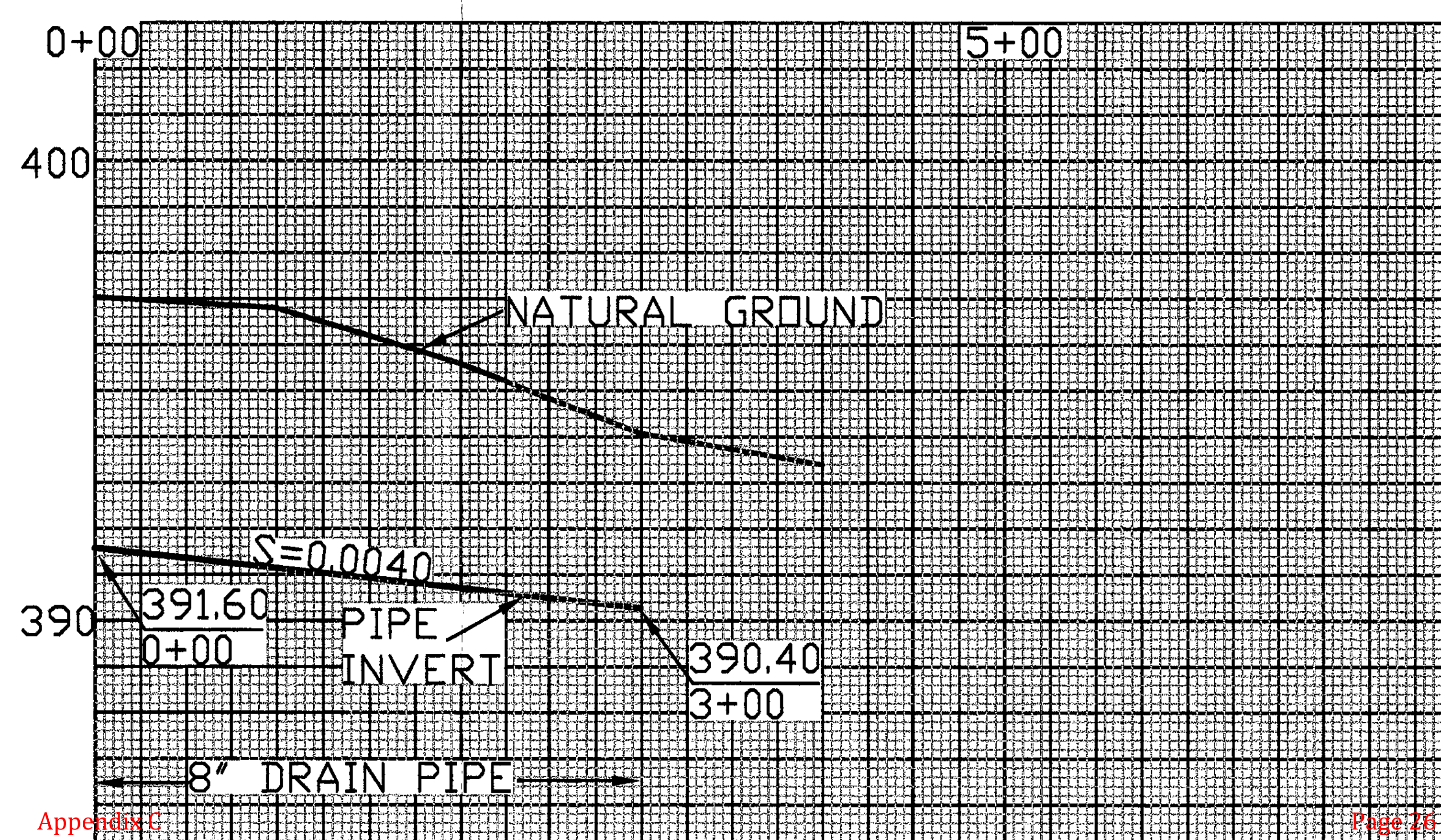
NOTES

BOTTOM OF THE HOLE FOR THE 8″ OUTLET PIPE IS 20″ ABOVE THE FLOOR AND 23″ FROM THE INSIDE OF THE NORTH WALL. MINIMUM DIAMETER OF THE HOLE IS 10″.

PLACE CAULK BETWEEN THE FLANGE AND THE WALL WHEN SETTING THE 8″ PIPE. FORCE NON-SHRINK GROUT BETWEEN THE PIPE AND HOLE WALL. AFTER THE GROUT IS SET CLEAN UP ANY VOIDS WITH CAULKING COMPOUND.

THE 8″ RECHARGE PIPE CAN BE EITHER CORRUGATED ABS PERFORATED DRAIN PIPE OR SMOOTH WALL LEACH FIELD PIPE.

INSTALL A WYE NEAR 0+00 AND 2+00 ON EACH LINE FOR A CLEAN OUT. PLACE A REMOVABLE CAP ON THE END OF EACH DRAIN LINE FOR CLEANING OUT.



DESIGNED B. HEWES 9/12
PLOTTED
APPROVED
DATE

WWBWC/HBDIC TRUMBO LANE RECHARGE
PLAN & PROFILE

CAD FILE trumboplan

SHEET 2 OF 2

APPENDIX D – WATER QUALITY RESULTS

Water Analysis Report

Walla Walla Regional Water Testing Services

714 So. College Avenue
College Place, WA 99324

Phone: 509-526-9287
Fax: 509-526-5272

Email : info@wallawatr.com

Customer Name:	Walla Walla Basin Water Shed Council	***Invoice #***	4255
Address:	811 S Main P.O.Box 68	***Date Collected:***	12/15/2015
City:	Milton Freewater	***Sampled By:***	Steve Patten
State:	OR ***Zip:*** 97862	***Report Date:***	1/20/16

Analyte	UNITS	S-1	S-2	S-3	GW-46	GW-117	GW-119	GW-141	GW-142	GW-144
Lab Number		209-09593	209-09594	209-09595	209-09596	209-09597	209-09598	209-09599	209-09600	209-09601
Total Organic Carbon	mg/L	2.28	2.28	2.21	2.28	0.39	0.93	0.97	0.93	0.78
Nitrate-N	mg/L	0.00	0.00	6.20	0.90	5.30	37.20	13.30	9.30	45.60
Total Kjeldahl Nitrogen	mg/L	ND	ND	ND	ND	< 0.3	1.33	0.95	0.29	3.68
Sulfate	mg/L	1.2	1.2	2.3	1.2	8.1	19.8	15.9	5.7	13.8
Chloride	mg/L	0.0	0.0	0.0	0.0	1.0	4.0	4.8	2.7	8.5
Alkalinity	mg/L	33.2	33.4	40.0	35.7	80.0	160.3	106.9	62.9	122.0
Calcium	mg/L	5.6	5.4	8.1	6.6	17.0	37.0	25.2	15.4	32.3
Ortho-Phosphate	mg/L	0.030	0.003	0.042	0.041	0.059	0.090	0.046	0.049	0.082
Sodium	mg/L	3.4	3.4	4.2	3.3	6.7	20.4	10.9	5.0	17.2
Potassium	mg/L	1.9	1.8	2.2	1.8	4.2	8.3	5.3	3.4	6.5
Magnesium	mg/L	2.5	2.6	3.5	2.9	7.6	16.6	11.2	6.6	14.2
Aluminum	mg/L	0.222	0.195	0.207	0.102	ND	ND	ND	0.005	ND
Iron	mg/L	0.207	0.183	0.187	0.095	0.017	ND	0.395	0.125	0.006
Manganese	mg/L	ND	ND	ND	ND	ND	ND	0.005	ND	0.082
Dissolved Oxygen	mg/L	11.65	11.58	12.26	10.48	7.97	9.91	7.53	8.38	8.31

Curtis W. Skifstad, Lab Director: [signature]

Water Analysis Report

714 So. College Avenue
College Place, WA 99324

Phone: 509-526-9287
Fax: 509-526-5272

Email : info@wallawatr.com

Customer Name: Walla Walla Basin Water Shed Council

Address: 811 S Main P.O.Box 68

City: Milton Freewater

State: OR ***Zip:*** 97862

Invoice # 4755

Date Collected: 5/17/2016

Sampled By: Steve Patten

Report Date: 7/12/16

Analyte	UNITS	S-1	S-2	S-3	GW-46	GW-117	GW-119	GW-141	GW-142	GW-144
Lab Number		209-10470	209-10471	209-10472	209-10473	209-10474	209-10475	209-10476	209-10477	209-10478
Total Organic Carbon	mg/L	1.34	1.35	1.48	0.84	0.59	1.72	0.47	0.73	2.60
Nitrate-N	mg/L	0.00	0.20	0.40	0.40	15.00	45.20	0.10	0.00	80.60
Total Kjeldahl Nitrogen	mg/L	ND	ND	ND	ND	< 0.3	1.21	0.65	0.19	3.21
Sulfate	mg/L	0.9	0.8	2.0	0.8	13.8	26.4	3.6	4.8	19.5
Chloride	mg/L	0.0	0.0	0.0	0.0	2.0	6.5	3.2	1.8	7.4
Alkalinity	mg/L	26.6	25.9	35.4	26.4	78.6	106.8	37.9	45.9	75.3
Calcium	mg/L	3.7	3.7	5.9	3.5	18.7	15.3	5.6	8.9	28.1
Ortho-Phosphate	mg/L	0.025	0.026	0.040	0.054	0.082	0.022	0.027	0.022	0.009
Sodium	mg/L	2.9	2.9	3.6	3.2	7.7	26.8	6.4	4.9	20.1
Potassium	mg/L	2.6	2.5	2.7	3.1	5.3	9.5	3.7	3.6	7.2
Magnesium	mg/L	2.0	1.9	3.0	2.0	9.0	17.0	3.1	4.0	13.4
Aluminum	mg/L	0.159	0.177	0.216	0.087	ND	ND	ND	0.003	ND
Iron	mg/L	0.030	0.031	0.023	0.043	0.012	0.012	0.116	0.038	0.007
Manganese	mg/L	ND	ND	ND	ND	ND	ND	0.002	ND	ND
Dissolved Oxygen	mg/L	10.19	10.42	10.41	9.47	8.64	9.49	9.36	8.96	8.17

Curtis W. Skifstad, Lab Director: Curtis W. Skifstad

EDGE ANALYTICAL

Burlington, WA	Corporate Laboratory (a)	1620 S Walnut St	Burlington, WA 98233	800.755.9295 • 360.757.1400
Bellingham, WA	Microbiology (b)	805 Orchard Dr Ste 4	Bellingham, WA 98225	360.715.1212
Portland, OR	Microbiology/Chemistry (c)	9150 SW Pioneer Ct Ste W	Wilsonville, OR 97070	503.682.7802
Corvallis, OR	Microbiology (d)	540 SW Third Street	Corvallis, OR 97333	541.753.4946

WSDOE Lab C567

DATA REPORT

Client Name: Walla Walla Regional Water Testing Services
714 S College Avenue
College Place, WA 99324

Reference Number: **16-11435**
Project: Recharge TOC

Lab Number: 25962
Field ID: GW_144
Sample Description: OR STITES
Matrix: Water
Sample Date: 5/17/16
Extraction Date: 5/23/16
Extraction Method: 3535

Report Date: 6/7/16
Date Analyzed: 5/23/16
Analyst: CO
Analytical Method: 508.1
Batch: 508_160523
Approved By: co,pdm,rjk

Authorized by:

Lawrence J Henderson, PhD
Director of Laboratories, Vice President

CAS	Compound	RESULT	Flag	UNITS	Lab QL	Permit QL	MDL	D.F.	Lab	COMMENT
	PCBs/Toxaphene									
1336-36-3	PCBS (Total Aroclors)	**ND**		ug/L		0.2	0.5	1.00	a	
11104-28-:	AROCLOR 1221	**ND**		ug/L		20	0.2	1.00	a	
11141-16-:	AROCLOR 1232	**ND**		ug/L		0.5	0.2	1.00	a	
53469-21-:	AROCLOR 1242	**ND**		ug/L		0.3	0.3	1.00	a	
12672-29-(	AROCLOR 1248	**ND**		ug/L		0.1	0.08	1.00	a	
11097-69-	AROCLOR 1254	**ND**		ug/L		0.1	0.05	1.00	a	
11096-82-:	AROCLOR 1260	**ND**		ug/L		0.2	0.14	1.00	a	
12674-11-:	AROCLOR 1016	**ND**		ug/L		0.08	0.08	1.00	a	
8001-35-2	TOXAPHENE	**ND**		ug/L	1	1	0.4	1.00	a	
	EPA Regulated									
57-74-9	CHLORDANE, TECHNICAL	**ND**		ug/L	0.2	0.2	0.07	1.00	a	

Notes:

Flags are data qualifiers. If there are data qualifiers on your report definitions can be found on an accompanying sheet.
ND - indicates the compound was not detected above the PQL or MDL.
Lab QL = Laboratory Quantitation Limit is the lowest level that can be achieved within specified limits of precision and accuracy during routine laboratory operating conditions.
Permit QL = Quantitation Limt required by permit (listed in Appendix A) or other regulatory requirement.
D.F. - Dilution Factor.

If you have any questions concerning this report contact us at the above phone number.
Form: c608.rpt

EDGE ANALYTICAL

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Portland, OR	Microbiology/Chemistry (c)	9150 SW Pioneer Ct Ste W	Wilsonville, OR 97070	503.682.7802
Corvallis, OR	Microbiology (d)	540 SW Third Street	Corvallis, OR 97333	541.753.4946

WSDOE Lab C567

DATA REPORT

Client Name: Walla Walla Regional Water Testing Services
714 S College Avenue
College Place, WA 99324

Reference Number: **16-11435**
Project: Recharge TOC

Lab Number: 25962
Field ID: GW_144
Sample Description: OR STITES
Matrix: Water
Sample Date: 5/17/16
Extraction Date: 5/25/16
Extraction Method: 3511

Report Date: 6/7/16
Date Analyzed: 5/27/16
Analyst: KAH
Analytical Method: 515.4
Batch: 515.4_160525
Approved By: co,pdm,rjk

Authorized by:

Lawrence J Henderson, PhD
Director of Laboratories, Vice President

CAS	Compound	RESULT	Flag	UNITS	Lab QL	Permit QL	MDL	D.F.	Lab	COMMENT
	Other									
E-14028	DCPA (ACID METABOLITES)	**ND**		ug/L	0.13	0.1	0.08	1.00	a	
1918-00-9	DICAMBA	**ND**		ug/L	0.13	0.2	0.07	1.00	a	
94-82-6	2,4 DB	**ND**		ug/L	0.5	1.0	0.13	1.00	a	
50594-66-(	ACIFLUORFEN	**ND**		ug/L	0.13	2.0	0.15	1.00	a	
51-36-5	3,5 - DICHLOROBENZOIC ACID	**ND**		ug/L	0.13	0.5	0.08	1.00	a	
	EPA Regulated									
94-75-7	2,4 - D	**ND**		ug/L	0.13	0.1	0.05	1.00	a	
93-72-1	2,4,5 - TP (SILVEX)	**ND**		ug/L	0.13	0.2	0.11	1.00	a	
87-86-5	PENTACHLOROPHENOL	**ND**		ug/L	0.04	0.04	0.05	1.00	a	
75-99-0	DALAPON	**ND**		ug/L	0.5	1	0.26	1.00	a	
88-85-7	DINOSEB	**ND**		ug/L	0.13	0.2	0.07	1.00	a	
1918-02-1	PICLORAM	**ND**		ug/L	0.13	0.1	0.08	1.00	a	

Notes:

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Permit QL = Quantitation Limt required by permit (listed in Appendix A) or other regulatory requirement.
D.F. - Dilution Factor.

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Form: c608.rpt

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Corvallis, OR	Microbiology (d)	540 SW Third Street	Corvallis, OR 97333	541.753.4946

WSDOE Lab C567

DATA REPORT

Client Name: Walla Walla Regional Water Testing Services
714 S College Avenue
College Place, WA 99324

Reference Number: **16-11435**
Project: Recharge TOC

Lab Number: 25962
Field ID: GW_144
Sample Description: OR STITES
Matrix: Water
Sample Date: 5/17/16
Extraction Date: 5/23/16
Extraction Method: 3535

Report Date: 6/7/16
Date Analyzed: 5/23/16
Analyst: CO
Analytical Method: 525.2
Batch: 525_160523
Approved By: co,pdm,rjk

Authorized by:
Lawrence J Henderson, PhD
Director of Laboratories, Vice President

CAS	Compound	RESULT	Flag	UNITS	Lab QL	Permit QL	MDL	D.F.	Lab	COMMENT
	State Unregulated - Other									
314-40-9	BROMACIL	**ND**		ug/L	0.1	0.2	0.07	1.00	a	
86-73-7	FLUORENE	**ND**		ug/L	0.1	0.2	0.04	1.00	a	
	EPA Unregulated									
309-00-2	ALDRIN	**ND**		ug/L	0.1	0.1	0.04	1.00	a	
23184-66-!	BUTACHLOR	**ND**		ug/L	0.1	0.4	0.05	1.00	a	
60-57-1	DIELDRIN	**ND**		ug/L	0.1	0.1	0.05	1.00	a	
51218-45-:	METOLACHLOR	**ND**		ug/L	0.1	1.0	0.04	1.00	a	
21087-64-!	METRIBUZIN	**ND**		ug/L	0.1	0.2	0.05	1.00	a	
1918-16-7	PROPACHLOR	**ND**		ug/L	0.1	0.1	0.03	1.00	a	
	EPA Regulated									
72-20-8	ENDRIN	**ND**		ug/L	0.01	0.01	0.02	1.00	a	
58-89-9	LINDANE (BHC - GAMMA)	**ND**		ug/L	0.01	0.02	0.04	1.00	a	
72-43-5	METHOXYCHLOR	**ND**		ug/L	0.1	0.1	0.07	1.00	a	
15972-60-:	ALACHLOR	**ND**		ug/L	0.1	0.2	0.05	1.00	a	
1912-24-9	ATRAZINE	**ND**		ug/L	0.1	0.1	0.04	1.00	a	
50-32-8	BENZO(A)PYRENE	**ND**		ug/L	0.01	0.02	0.03	1.00	a	
103-23-1	DI(ETHYLHEXYL)-ADIPATE	**ND**		ug/L	0.1	0.6	0.05	1.00	a	
117-81-7	DI(ETHYLHEXYL)-PHTHALATE	**ND**		ug/L	0.1	0.6	0.37	1.00	a	
76-44-8	HEPTACHLOR	**ND**		ug/L	0.01	0.04	0.04	1.00	a	
1024-57-3	HEPTACHLOR EPOXIDE	**ND**		ug/L	0.01	0.02	0.03	1.00	a	
118-74-1	HEXACHLOROBENZENE	**ND**		ug/L	0.1	0.1	0.02	1.00	a	
77-47-4	HEXACHLOROCYCLO-PENTADIENE	**ND**		ug/L	0.1	0.1	0.05	1.00	a	
122-34-9	SIMAZINE	**ND**		ug/L	0.05	0.07	0.03	1.00	a	

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D.F. - Dilution Factor.

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Corvallis, OR	Microbiology (d)	540 SW Third Street	Corvallis, OR 97333	541.753.4946

WSDOE Lab C567

DATA REPORT

Client Name: Walla Walla Regional Water Testing Services
714 S College Avenue
College Place, WA 99324

Reference Number: **16-11435**
Project: Recharge TOC

Lab Number: 25962
Field ID: GW_144
Sample Description: OR STITES
Matrix: Water
Sample Date: 5/17/16
Extraction Date: 5/17/16
Extraction Method: FILTER0.2

Report Date: 6/7/16
Date Analyzed: 5/17/16
Analyst: RJK
Analytical Method: 531.2
Batch: 531_160517
Approved By: co,pdm,rjk

Authorized by:

Lawrence J Henderson, PhD
Director of Laboratories, Vice President

CAS	Compound	RESULT	Flag	UNITS	Lab QL	Permit QL	MDL	D.F.	Lab	COMMENT
	EPA Unregulated									
1646-87-3	ALDICARB SULFOXIDE	ND		ug/L	0.5	0.5	0.68	1.00	a	
1646-88-4	ALDICARB SULFONE	ND		ug/L	0.8	0.8	0.51	1.00	a	
16752-77-	METHOMYL	ND		ug/L	1.0	4.0	0.7	1.00	a	
16655-82-	3-HYDROXYCARBOFURAN	ND		ug/L	1.0	2.0	0.8	1.00	a	
116-06-3	ALDICARB	ND		ug/L	0.5	0.5	0.94	1.00	a	
63-25-2	CARBARYL	ND		ug/L	1.0	2.0	0.76	1.00	a	
	EPA Regulated									
23135-22-	OXAMYL	ND		ug/L	1.0	2.0	0.5	1.00	a	
1563-66-2	CARBOFURAN	ND		ug/L	0.9	0.9	0.55	1.00	a	

Notes:

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Form: c608.rpt

Appendix E – Well Logs for Monitoring Wells

GW_23

NOTICE TO WATER WELL CONTRACTOR
The original and first copy of this report are to be filed with the
STATE ENGINEER, SALEM, OREGON 97310 within 30 days from the date of well completion.

RECEIVED
JAN 30 1970
STATE ENGINEER
SALEM, OREGON

WATER WELL REPORT
STATE OF OREGON
(Please type or print)
(Do not write above this line)

UMAT 3941

State Well No. 5N/35-3aa
State Permit No.

(1) OWNER:
Name Richard L. Robins
Address RT #2 Box 366 Milton Freewater

(2) TYPE OF WORK (check):
New Well ☐ Deepening ☑ Reconditioning ☐ Abandon ☐
If abandonment, describe material and procedure in Item 12.

(3) TYPE OF WELL:
Rotary ☐ Driven ☐
Cable ☑ Jetted ☐
Dug ☑ Bored ☐

(4) PROPOSED USE (check):
Domestic ☑ Industrial ☐ Municipal ☐
Irrigation ☐ Test Well ☐ Other ☐

(5) CASING INSTALLED: Threaded ☐ Welded ☑
6" Diam. from 0 ft. to 46½ ft. Gage .250
" Diam. from ft. to ft. Gage
" Diam. from ft. to ft. Gage

(6) PERFORATIONS: Perforated? ☐ Yes ☑ No
Type of perforator used
Size of perforations in. by in.
perforations from ft. to ft.
perforations from ft. to ft.
perforations from ft. to ft.
perforations from ft. to ft.
perforations from ft. to ft.

(7) SCREENS: Well screen installed? ☐ Yes ☑ No
Manufacturer's Name
Type Model No.
Diam. Slot size Set from ft. to ft.
Diam. Slot size Set from ft. to ft.

(8) WATER LEVEL: Completed well.
Static level 35 ft. below land surface Date Nov 15-69
Artesian pressure lbs. per square inch Date

(9) WELL TESTS: Drawdown is amount water level is lowered below static level
Was a pump test made? ☐ Yes ☑ No If yes, by whom?
Yield: gal./min. with ft. drawdown after hrs.
Bailer test 12 gal./min. with 77 ft. drawdown after 3 hrs.
Artesian flow g.p.m. Date
Temperature of water 54 Was a chemical analysis made? ☐ Yes ☑ No

(10) CONSTRUCTION:
Well seal—Material used Bentonite
Depth of seal 34 ft.
Diameter of well bore to bottom of seal 48 in.
Were any loose strata cemented off? ☐ Yes ☑ No Depth
Was a drive shoe used? ☑ Yes ☐ No
Did any strata contain unusable water? ☐ Yes ☑ No
Type of water? depth of strata
Method of sealing strata off
Was well gravel packed? ☐ Yes ☑ No Size of gravel:
Gravel placed from ft. to ft.

(11) LOCATION OF WELL:
County Umatilla Driller's well number
NE ¼ NE ¼ Section 3 T. 5N R. 35 E W.M.
Bearing and distance from section or subdivision corner
well Located 80 ft. W. 140 ft. S of NE Corner of S.3 T.5N. R.35

(12) WELL LOG: Diameter of well below casing 6
Depth drilled 118 ft. Depth of completed well 118 ft.
Formation: Describe color, texture, grain size and structure of materials; and show thickness and nature of each stratum and aquifer penetrated, with at least one entry for each change of formation. Report each change in position of Static Water Level as drilling proceeds. Note drilling rates.

MATERIAL	From	To	SWL
Dug well To 34'			
Brown Cement Gravel	34	40	
Med. Coarse Gravel Some water	40	47	
Brown Cement Gravel	47	80	
Med. Gravel clean Some water	80	83	
Cement Gravel (Brown)	83	101	
Cleaner possibly Some water	101	102	
Cement Gravel	102	118	

Work started Nov 11 1969 Completed Nov 15 1969
Date well drilling machine moved off of well Nov 18 1969

Drilling Machine Operator's Certification:
This well was constructed under my direct supervision. Materials used and information reported above are true to my best knowledge and belief.
[Signed] Lowell W. Marlatt (Drilling Machine Operator) Date Nov 15, 1969
Drilling Machine Operator's License No. 11

Water Well Contractor's Certification:
This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.
NAME Lowell W. Marlatt (Person, firm or corporation) (Type or print)
Address RT #2 Box 111 A Milton Freewater, Ore
[Signed] Lowell W. Marlatt (Water Well Contractor)
Contractor's License No. 265 Date Nov 15, 1969

(USE ADDITIONAL SHEETS IF NECESSARY)

GW_31

NOTICE TO WATER WELL CONTRACTOR
The original and first copy of this report are to be filed with the STATE ENGINEER, SALEM, OREGON 97310 within 30 days from the date of well completion.

RECEIVED JAN 30 1970 STATE ENGINEER SALEM, OREGON

WATER WELL REPORT
STATE OF OREGON
(Please type or print)
(Do not write above this line)

UMAT 3941

State Well No. 5N/35-3aa
State Permit No.

(1) OWNER:
Name Richard L. Robins
Address RT #2 Box 366 Milton Freewater

(2) TYPE OF WORK (check):
New Well ☐ Deepening ☒ Reconditioning ☐ Abandon ☐
If abandonment, describe material and procedure in Item 12.

(3) TYPE OF WELL:
Rotary ☐ Driven ☐
Cable ☒ Jetted ☐
Dug ☒ Bored ☐

(4) PROPOSED USE (check):
Domestic ☒ Industrial ☐ Municipal ☐
Irrigation ☐ Test Well ☐ Other ☐

(5) CASING INSTALLED: Threaded ☐ Welded ☒
6 " Diam. from 0 ft. to 46½ ft. Gage .250
" Diam. from ft. to ft. Gage
" Diam. from ft. to ft. Gage

(6) PERFORATIONS: Perforated? ☐ Yes ☒ No
Type of perforator used
Size of perforations in. by in.
perforations from ft. to ft.
perforations from ft. to ft.
perforations from ft. to ft.
perforations from ft. to ft.
perforations from ft. to ft.

(7) SCREENS: Well screen installed? ☐ Yes ☒ No
Manufacturer's Name
Type Model No.
Diam. Slot size Set from ft. to ft.
Diam. Slot size Set from ft. to ft.

(8) WATER LEVEL: Completed well.
Static level 35 ft. below land surface Date Nov 15-69
Artesian pressure lbs. per square inch Date

(9) WELL TESTS: Drawdown is amount water level is lowered below static level
Was a pump test made? ☐ Yes ☒ No If yes, by whom?
Yield: gal./min. with ft. drawdown after hrs.
Bailer test 12 gal./min. with 77 ft. drawdown after 2 hrs.
Artesian flow g.p.m. Date
Temperature of water 54 Was a chemical analysis made? ☐ Yes ☒ No

(10) CONSTRUCTION:
Well seal—Material used Bentonite
Depth of seal 34 ft.
Diameter of well bore to bottom of seal 48 in.
Were any loose strata cemented off? ☐ Yes ☒ No Depth
Was a drive shoe used? ☒ Yes ☐ No
Did any strata contain unusable water? ☐ Yes ☒ No
Type of water? depth of strata
Method of sealing strata off
Was well gravel packed? ☐ Yes ☒ No Size of gravel:
Gravel placed from ft. to ft.

(11) LOCATION OF WELL:
County Umatilla Driller's well number
NE ¼ NE ¼ Section 3 T. 5N R. 35 E W.M.
Bearing and distance from section or subdivision corner
well Located 80 ft. W. 140 ft. S of NE Corner of S. 3 T. 5N R. 35

(12) WELL LOG: Diameter of well below casing 6
Depth drilled 118 ft. Depth of completed well 118 ft.

Formation: Describe color, texture, grain size and structure of materials; and show thickness and nature of each stratum and aquifer penetrated, with at least one entry for each change of formation. Report each change in position of Static Water Level as drilling proceeds. Note drilling rates.

MATERIAL	From	To	SWL
Dug well To 34'			
Brown Cement Gravel	34	40	
Med. Coarse Gravel			
Some water	40	47	
Brown Cement Gravel	47	80	
Med. Gravel clean			
Some water	80	83	
Cement Gravel (Brown)	83	101	
Cleaner possibly Some water	101	102	
Cement Gravel	102	118	

Work started Nov 11 1969 Completed Nov 15 1969
Date well drilling machine moved off of well Nov 18 1969

Drilling Machine Operator's Certification:
This well was constructed under my direct supervision. Materials used and information reported above are true to my best knowledge and belief.
[Signed] Lowell M. Marlett (Drilling Machine Operator) Date Nov 15, 1969

Drilling Machine Operator's License No. 11

Water Well Contractor's Certification:
This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.
NAME Lowell W. Marlett (Person, firm or corporation) (Type or print)
Address RT #2 Box 111 A Milton Freewater, Or
[Signed] Lowell M. Marlett (Water Well Contractor)
Contractor's License No. 265 Date Nov 15, 1969

(USE ADDITIONAL SHEETS IF NECESSARY)

GW_34

STATE ENGINEER
Salem, Oregon

UMAT 4135

UMAT 4135 **Well Record**

GR- 1099

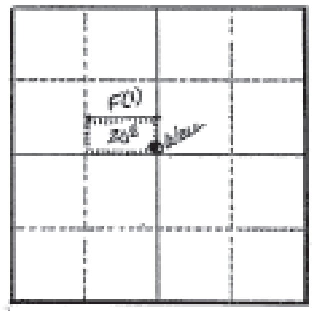
STATE WELL NO. 6N/34-24R(1)
COUNTY Umatilla
APPLICATION NO. GR-1139

OWNER: John L. Richarts
MAILING ADDRESS: Rt. 2, Box 129

LOCATION OF WELL: Owner's No. ...
CITY AND STATE: Milton-Freewater, Oregon

SE ¼ NW ¼ Sec. 24 T. 6 N., R. 34 E., W.M.

Bearing and distance from section or subdivision corner 150' N. & 7' W. from Center of Sec. 24.



Altitude at well 750 ft.

TYPE OF WELL: Drilled Date Constructed 1918

Depth drilled 50 ft. Depth cased 25 ft.

Section 24

CASING RECORD:
10 inch from 8 to 13 ft.
8 inch from 13 to 33 ft.

FINISH:

AQUIFERS:
Gravel

WATER LEVEL:
16 ft.

PUMPING EQUIPMENT: Type Sterling Cent. 3 in. H.P. 3
Capacity 350 G.P.M.

WELL TESTS:
Drawdown 22 ft. after ... hours 300 G.P.M.
Drawdown ... ft. after ... hours ... G.P.M.

USE OF WATER Irrigation Temp. ... °F. ..., 19...
SOURCE OF INFORMATION G. R. Record
DRILLER or DIGGER ...
ADDITIONAL DATA:
Log N.A. Water Level Measurements ... Chemical Analysis ... Aquifer Test ...

REMARKS:
Irrigation of 20 acres.

State Printing 48018

GW_35

No well log

GW_36

GW36

NOTICE TO WATER WELL CONTRACTOR: The original and first copy of this report are to be filed with the STATE ENGINEER, SALEM, OREGON 97310 within 30 days from the date of well completion.

RECEIVED FEB 13 1980 WATER RESOURCES DEPT SALEM, OREGON

WATER WELL REPORT
STATE OF OREGON
(Please type or print)
(Do not write above this line)

RECEIVED DEC 21 1981 WATER RESOURCES DEPT SALEM, OREGON

State Well No. 6N/35E-30acc

State Permit No.

UMAT 4822

(1) OWNER: Barbara A Kelly

Name William A Kelly

Address Rt#1 Box 214-A M.F. Ore. 97862

(2) TYPE OF WORK (check):

New Well ☑ Deepening ☐ Reconditioning ☐ Abandon ☐

If abandonment, describe material and procedure in Item 12.

(3) TYPE OF WELL:

Rotary ☐ Driven ☐
Cable ☑ Jetted ☐
Dug ☐ Bored ☐

(4) PROPOSED USE (check):

Domestic ☐ Industrial ☐ Municipal ☐
Irrigation ☑ Test Well ☐ Other ☐

(5) CASING INSTALLED: Threaded ☐ Welded ☑

10" Diam. from 0 ft. to 200-4 ft. Gage .250

" Diam. from ft. to ft. Gage

" Diam. from ft. to ft. Gage

(6) PERFORATIONS: Perforated? ☑ Yes ☐ No

Type of perforator used Acetylene

Size of perforations 3/8 in. by 8 in.

perforations from ft. to ft.

170 perforations from 25 ft. to 190 ft.

perforations from ft. to ft.

(7) SCREENS: Well screen installed? ☑ Yes ☐ No

Manufacturer's Name 125# P.V.C.

Type Liner Model No.

Diam. 8 Slot size 1/8 x 10" Set from ft. to ft.

Diam. Slot size Set from ft. to ft.

(8) WELL TESTS: Drawdown is amount water level is lowered below static level

Was a pump test made? ☑ Yes ☐ No If yes, by whom? Marlatt

Yield: gal./min. with ft. drawdown after hrs.

90 " 165 " 10 "

130 " 300 " 15 "

Bailer test gal./min. with ft. drawdown after hrs.

Artesian flow g.p.m.

Temperature of water 59 Depth artesian flow encountered ft.

(9) CONSTRUCTION:

Well seal—Material used Cement

Well sealed from land surface to 21 - Grout pump ft.

Diameter of well bore to bottom of seal 14 in.

Diameter of well bore below seal 10 in.

Number of sacks of cement used in well seal 12 sacks

Number of sacks of bentonite used in well seal sacks

Brand name of bentonite

Number of pounds of bentonite per 100 gallons of water lbs./100 gals.

Was a drive shoe used? ☑ Yes ☐ No Plugs Size: location ft.

Did any strata contain unusable water? ☐ Yes ☑ No

Type of water? depth of strata

Method of sealing strata off

Was well gravel packed? ☐ Yes ☑ No Size of gravel:

Gravel placed from ft. to ft.

(10) LOCATION OF WELL:

County Umatilla Driller's well number

SW ¼ NE ¼ Section 30 T. 6N R. 35 E W.M.

Bearing and distance from section or subdivision corner

well located center of property

(11) WATER LEVEL: Completed well.

Depth at which water was first found 55 ft.

Static level 38 ft. below land surface. Date Dec. 2-

Artesian pressure lbs. per square inch. Date

(12) WELL LOG: Diameter of well below casing

Depth drilled ft. Depth of completed well ft.

Formation: Describe color, texture, grain size and structure of materials; and show thickness and nature of each stratum and aquifer penetrated, with at least one entry for each change of formation. Report each change in position of Static Water Level and indicate principal water-bearing strata.

MATERIAL	From	To	SWL
Top soil & clay	0	11	
Cement Gravel - Brown	11	55	
Cement Gravel Brown			
Drilling water	55	86	55
Clay - Brown	86	92	
Gravel Cleaner			
Some water - 125-137	92	168	35
Clay - Brown	168	179	
Gravel - Brown Cement	179	195	
Gravel Brown - Caving	195	198	
Gravel Cement - Brown	198	348	35
Clay - Brown	348	371	
Gravel Cleaner - Med.	371	382	38
Clay - Brown	382	387	
Gravel Cement	387	394	
Clay - Brown	394	399	
Gravel Cement	399	412	

Work started Aug. 16 1979 Completed Dec. 2 1979

Date well drilling machine moved off of well Dec. 4- 1979

Drilling Machine Operator's Certification:

This well was constructed under my direct supervision. Materials used and information reported above are true to my best knowledge and belief.

[Signed] Lowell W. Marlatt (Drilling Machine Operator) Date Dec. 4, 1979

Drilling Machine Operator's License No. 11

Water Well Contractor's Certification:

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

Name Lowell W. Marlatt (Person, firm or corporation) (Type or print)

Address Rt#2 Box 140-B M. F. Ore.

[Signed] Lowell W. Marlatt (Water Well Contractor)

Contractor's License No. 265 Date Dec. 4, 1979

(USE ADDITIONAL SHEETS IF NECESSARY)

STATE ENGINEER
Salem, Oregon

UMAT 4919

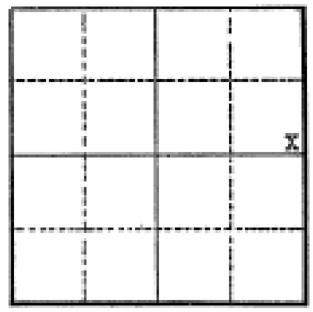
Well Record

STATE WELL NO. 6N/35-33H
COUNTY Umatilla
APPLICATION NO. GR-4228

OWNER: Wm. J. & Carolyn K. Jackson
MAILING ADDRESS: Route 2, Box 318
LOCATION OF WELL: Owner's No. ....
CITY AND STATE: Milton-Freewater, Oregon

SE ¼ NE ¼ Sec. 33 T. 6 N., R. 35 E., W.M.

Bearing and distance from section or subdivision corner 100' W. & 150' N. of E¼ Cor. Sec. 33



Section 33

Altitude at well ....

TYPE OF WELL: Dug 25' Drill 120' Date Constructed 1895

Depth drilled 120 ft. Depth cased ....

CASING RECORD:

FINISH:

AQUIFERS:

WATER LEVEL:

30 feet below surface

PUMPING EQUIPMENT: Type Peerless turbine H.P. 10
Capacity 600 G.P.M.

WELL TESTS:
Drawdown .... ft. after .... hours .... G.P.M.
Drawdown .... ft. after .... hours .... G.P.M.

USE OF WATER Irrigation Temp. ..... °F. ...., 19.....
SOURCE OF INFORMATION Well Registration Statement Cert. # GR-3767
DRILLER or DIGGER ....
ADDITIONAL DATA:
Log .... Water Level Measurements .... Chemical Analysis .... Aquifer Test ....

REMARKS:

State Printing 30018

GW_40

No well log

GW_41

No well log

GW_45

UMAT 55115

OBS 3

STATE OF OREGON
MONITORING WELL REPORT
(as required by ORS 537.765 & OAR 690-240-095)
Instructions for completing this report are on the last page of this form.

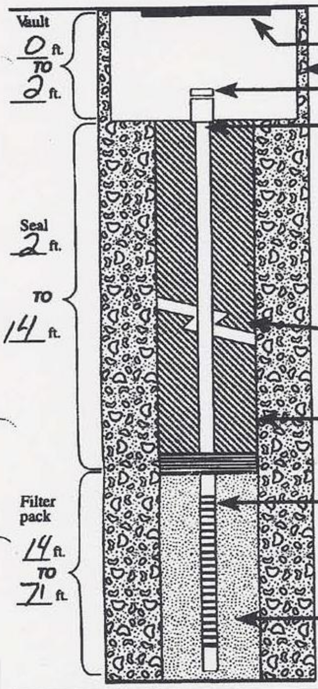
Well ID# L63871
Start Card # 163229

(1) OWNER/PROJECT WELL NO. MW-3
Name Hulette Johnson
Address 52833 Sunquist Rd.
City Milton Freewater State Or. Zip 97862

(2) TYPE OF WORK
☑ New construction ☐ Alteration (Repair/Recondition)
☐ Conversion ☐ Deepening ☐ Abandonment

(3) DRILLING METHOD
☑ Rotary Air ☐ Rotary Mud ☐ Cable
☐ Hollow Stem Auger ☐ Other

(4) BORE HOLE CONSTRUCTION:
Special Standards Yes ☑ No ☐ Depth of Completed Well 71 ft.



Land surface
Vault 0 ft. TO 2 ft.
Water-tight cover
Surface flush vault
Locking cap
Casing diameter 2 in.
material Sch 40 PVC
Welded ☐ Threaded ☑ Glued ☐
Seal 2 ft. TO 14 ft.
Liner diameter ______ in.
material ______
Welded ☐ Threaded ☐ Glued ☐
Well seal:
Material Bentonite Chips
Amount 3 bags
Grout weight ______
Borehole diameter 6 in.
Bentonite plug at least 3 ft. thick
Filter pack 14 ft. TO 71 ft.
Screen material Sch 40 PVC
interval(s):
From 16 To 71
From ______ To ______
Slot size .020 in.
Filter pack:
Material Sand
Size 10/20 in.

(5) WELL TESTS:
☐ Pump ☐ Bailer ☐ Air ☐ Flowing Artesian
Permeability ______ Yield ______ GPM
Conductivity ______ PH ______
Temperature of water 54 °C Depth artesian flow found ______ ft.
Was water analysis done? ☐ Yes ☑ No
By whom? ______
Depth of strata to be analyzed. From ______ ft. to ______ ft.
Remarks: ______

Name of supervising Geologist/Engineer Kevin Lindsey

(6) LOCATION OF WELL By legal description:
County Umatilla Latitude ______ Longitude ______
Township 6 (N or S) Range 35 (E or W) Section 33
SE 1/4 of NE 1/4 of above section.
Street address of well location Near Hudson Bay Canal Approx 500' West of Rd. bordering east edge of sec. 33 M. Freewater
Tax lot number of well location
ATTACH MAP WITH LOCATION IDENTIFIED. Map shall include approximate scale and north arrow.

(7) STATIC WATER LEVEL:
49 Ft. below land surface. Date 3/10/04
Artesian Pressure ______ lb/sq. in. Date ______

(8) WATER BEARING ZONES:
Depth at which water was first found 49

From	To	Est. Flow Rate	SWL

(9) WELL LOG:
Ground Elevation ______

Material	From	To	SWL
Sand Silt w/gravel	0	2	
Gravel w/some sand	2	22	
Silty Gravel	22	40	
Gravel w/sand	40	62	49
Silty Sand	62	71	49

RECEIVED APR 12 2004 WATER RESOURCES DEPT SALEM, OREGON

RECEIVED MAY 03 2004 WATER RESOURCES DEPT SALEM, OREGON

Date started 3/9/04 Completed 3/10/04

(unbonded) Monitor Well Constructor Certification:
I certify that the work I performed on the construction, alteration, or abandonment of this well is in compliance with Oregon water supply well construction standards. Materials used and information reported above are true to the best of my knowledge and belief.
Signed [signature] MWC Number 10430 Date 4/3/04

(bonded) Monitor Well Constructor Certification:
I accept responsibility for the construction, alteration, or abandonment work performed on this well during the construction dates reported above. All work performed during this time is in compliance with Oregon water supply well construction standards. This report is true to the best of my knowledge and belief.
Signed [signature] MWC Number 10054 Date 4/6/04

ORIGINAL COPY – WATER RESOURCES DEPARTMENT FIRST COPY – CONSTRUCTOR SECOND COPY – CUSTOMER

GW_46

UMAT 55114
UMAT 55114

OBS 1

STATE OF OREGON
MONITORING WELL REPORT
(as required by ORS 537.765 & OAR 690-240-095)
Instructions for completing this report are on the last page of this form.

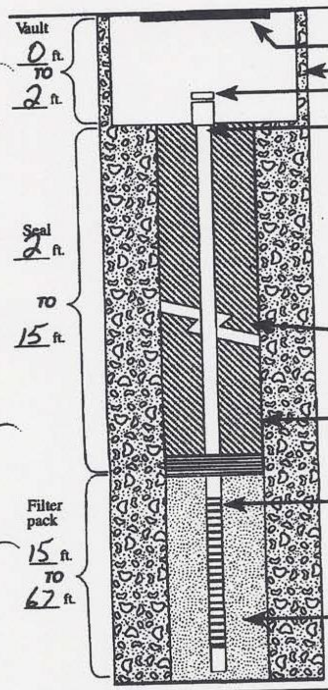
Well ID# L 63869
Start Card # 163227

(1) OWNER/PROJECT WELL NO. MW-1
Name Hulette Johnson
Address 52833 Sunquist Rd.
City Milton Freewater State Or. Zip 97862

(2) TYPE OF WORK
☒ New construction ☐ Alteration (Repair/Recondition)
☐ Conversion ☐ Deepening ☐ Abandonment

(3) DRILLING METHOD
☒ Rotary Air ☐ Rotary Mud ☐ Cable
☐ Hollow Stem Auger ☐ Other

(4) BORE HOLE CONSTRUCTION:
Special Standards Yes ☒ No ☐ Depth of Completed Well 67 ft.



Casing diameter 4 in.
material sch 40 PVC
Welded ☐ Threaded ☒ Glued ☐
Liner diameter ____ in.
material ____
Welded ☐ Threaded ☐ Glued ☐
Well seal:
Material Bentonite Chips
Amount 7 bags
Grout weight ____
Borehole diameter 8 in.
Bentonite plug at least 3 ft. thick
Screen material sch 40 PVC
interval(s):
From 17 To 67
From ____ To ____
Slot size .020 in.
Filter pack:
Material Sand
Size 10/20 in.

(5) WELL TESTS:
☐ Pump ☐ Bailer ☐ Air ☐ Flowing Artesian
Permeability ____ Yield ____ GPM
Conductivity ____ PH ____
Temperature of water 54 °F/C Depth artesian flow found ____ ft.
Was water analysis done? ☐ Yes ☒ No
By whom? ____
Depth of strata to be analyzed. From ____ ft. to ____ ft.
Remarks: ____

Name of supervising Geologist/Engineer Kevin Lindsey

(6) LOCATION OF WELL By legal description:
County Umatilla Latitude ____ Longitude ____
Township 6 (N or S) Range 35 (E or W) Section 33
SW 1/4 of NE 1/4 of above section.
Street address of well location Near Hudson Bay Canal approx 1200' West of road bordering East
Tax lot number of well location edge of Sec 33 Milton Freewater
ATTACH MAP WITH LOCATION IDENTIFIED. Map shall include approximate scale and north arrow.

(7) STATIC WATER LEVEL:
59 Ft. below land surface. Date 3/9/04
Artesian Pressure ____ lb/sq. in. Date ____

(8) WATER BEARING ZONES:
Depth at which water was first found 59'

From	To	Est. Flow Rate	SWL

(9) WELL LOG:
Ground Elevation ____

Material	From	To	SWL
Gravel w/some sand	0	24	
Silty Gravel	24	50	
Gravel w/silty sand	50	67'	59

RECEIVED APR 12 2004 WATER RESOURCES DEPT SALEM, OREGON

RECEIVED MAY 03 2004 WATER RESOURCES DEPT SALEM, OREGON

Date started 3/9/04 Completed 3/9/04

(unbonded) Monitor Well Constructor Certification:
I certify that the work I performed on the construction, alteration, or abandonment of this well is in compliance with Oregon water supply well construction standards. Materials used and information reported above are true to the best of my knowledge and belief.
MWC Number 10430
Signed [signature] Date 4/3/04

(bonded) Monitor Well Constructor Certification:
I accept responsibility for the construction, alteration, or abandonment work performed on this well during the construction dates reported above. All work performed during this time is in compliance with Oregon water supply well construction standards. This report is true to the best of my knowledge and belief.
MWC Number 10054
Signed [signature] Date 4/6/04

ORIGINAL COPY – WATER RESOURCES DEPARTMENT FIRST COPY – CONSTRUCTOR SECOND COPY – CUSTOMER

GW_47

UMAT 55116
UMAT 55116

OBS2

STATE OF OREGON
MONITORING WELL REPORT
(as required by ORS 537.765 & OAR 690-240-095)
Instructions for completing this report are on the last page of this form.

Well ID# L 63870
Start Card # 163228

(1) OWNER/PROJECT WELL NO. MW-2
Name Hulette Johnson
Address 52833 Sunquist Rd.
City Milton Freewater State Or. Zip 97862

(2) TYPE OF WORK
☑ New construction ☐ Alteration (Repair/Recondition)
☐ Conversion ☐ Deepening ☐ Abandonment

(3) DRILLING METHOD
☑ Rotary Air ☐ Rotary Mud ☐ Cable
☐ Hollow Stem Auger ☐ Other ______

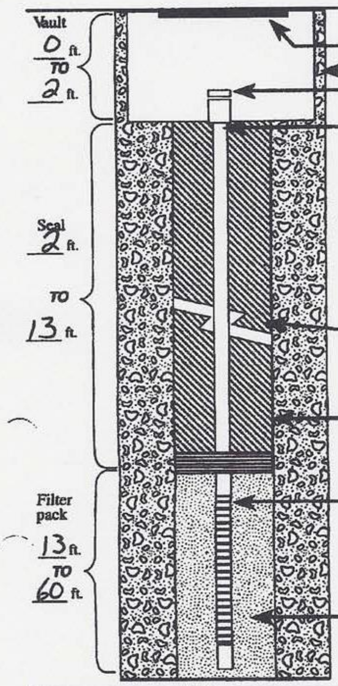
(4) BORE HOLE CONSTRUCTION:
Special Standards Yes ☑ No ☐ Depth of Completed Well 60 ft.

Land surface

Vault 0 ft. TO 2 ft.

Seal 2 ft. TO 13 ft.

Filter pack 13 ft. TO 60 ft.



Water-tight cover
Surface flush vault
Locking cap
Casing diameter 2 in.
material sch 40 PVC
Welded ☐ Threaded ☑ Glued ☐
Liner diameter ______ in.
material ______
Welded ☐ Threaded ☐ Glued ☐
Well seal:
Material Bentonite Chips
Amount 3 bags
Grout weight ______
Borehole diameter 6 in.
Bentonite plug at least 3 ft. thick
Screen
material sch 40 PVC
interval(s):
From 15 To 60
From ______ To ______
Slot size .020 in.
Filter pack:
Material Sand
Size 10/20 in.

(5) WELL TESTS:
☐ Pump ☐ Bailer ☐ Air ☐ Flowing Artesian
Permeability ______ Yield ______ GPM
Conductivity ______ PH ______
Temperature of water 54 °F/C Depth artesian flow found ______ ft.
Was water analysis done? ☐ Yes ☑ No
By whom? ______
Depth of strata to be analyzed. From ______ ft. to ______ ft.
Remarks: ______

Name of supervising Geologist/Engineer Kevin Lindsey

(6) LOCATION OF WELL By legal description:
County Umatilla Latitude ______ Longitude ______
Township 6 (N or S) Range 35 (E or W) Section 33
SW 1/4 of NE 1/4 of above section.
Street address of well location Near Hudson Bay Canal Approx. 1100' West of Rd. bordering east edge of
Tax lot number of well location section 33 Milton Freewater
ATTACH MAP WITH LOCATION IDENTIFIED. Map shall include approximate scale and north arrow.

(7) STATIC WATER LEVEL:
50 Ft. below land surface. Date 3/9/04
Artesian Pressure ______ lb/sq. in. Date ______

(8) WATER BEARING ZONES:
Depth at which water was first found 50'

From	To	Est. Flow Rate	SWL

(9) WELL LOG:
Ground Elevation ______

Material	From	To	SWL
Gravel w/some sand	0	22	
Silty Gravel	22	44	
Gravel w/sands	44	60	50

RECEIVED
APR 1 2 2004
WATER RESOURCES DEPT
SALEM, OREGON

RECEIVED
MAY 0 3 2004
WATER RESOURCES DEPT
SALEM, OREGON

Date started 3/9/04 Completed 3/9/04

(unbonded) Monitor Well Constructor Certification:
I certify that the work I performed on the construction, alteration, or abandonment of this well is in compliance with Oregon water supply well construction standards. Materials used and information reported above are true to the best of my knowledge and belief.
Signed [signature] MWC Number 10430 Date 4/3/04

(bonded) Monitor Well Constructor Certification:
I accept responsibility for the construction, alteration, or abandonment work performed on this well during the construction dates reported above. All work performed during this time is in compliance with Oregon water supply well construction standards. This report is true to the best of my knowledge and belief.
Signed [signature] MWC Number 10054 Date 4/6/04

ORIGINAL COPY – WATER RESOURCES DEPARTMENT FIRST COPY – CONSTRUCTOR SECOND COPY – CUSTOMER

GW_48

UMAT 55117
UMAT 55117

OBS4

STATE OF OREGON
MONITORING WELL REPORT
(as required by ORS 537.765 & OAR 690-240-095)
Instructions for completing this report are on the last page of this form.

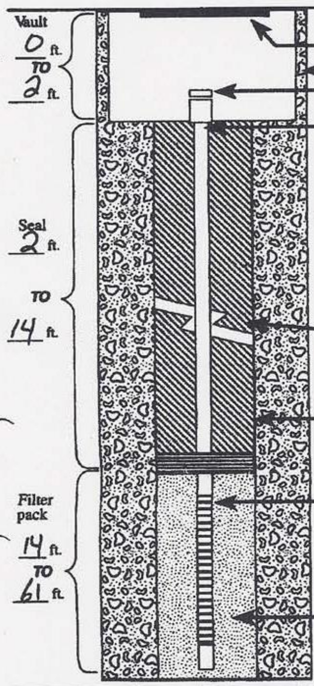
Well ID# L63872
Start Card # 163230

(1) OWNER/PROJECT WELL NO. MW-4
Name Hulette Johnson
Address 52833 Sunquist Rd.
City Milton Freewater State Or. Zip 97862

(2) TYPE OF WORK
☑ New construction ☐ Alteration (Repair/Recondition)
☐ Conversion ☐ Deepening ☐ Abandonment

(3) DRILLING METHOD
☑ Rotary Air ☐ Rotary Mud ☐ Cable
☐ Hollow Stem Auger ☐ Other

(4) BORE HOLE CONSTRUCTION:
Special Standards Yes ☑ No ☐ Depth of Completed Well 61 ft.



Vault 0 ft. TO 2 ft.
Seal 2 ft. TO 14 ft.
Filter pack 14 ft. TO 61 ft.

Casing diameter 2 in.
material sch 40 PVC
Welded ☐ Threaded ☑ Glued ☐
Liner diameter ____ in.
material ____
Welded ☐ Threaded ☐ Glued ☐
Well seal:
Material Bentonite Chips
Amount 3 bags
Grout weight ____
Borehole diameter 6 in.
Bentonite plug at least 3 ft. thick
Screen material sch 40 PVC
interval(s):
From 16 To 61
From ____ To ____
Slot size .020 in.
Filter pack:
Material Sand
Size 10/20 in.

(5) WELL TESTS:
☐ Pump ☐ Bailer ☐ Air ☐ Flowing Artesian
Permeability ____ Yield ____ GPM
Conductivity ____ PH ____
Temperature of water 54 °F/C Depth artesian flow found ____ ft.
Was water analysis done? ☐ Yes ☑ No
By whom? ____
Depth of strata to be analyzed. From ____ ft. to ____ ft.
Remarks: ____

Name of supervising Geologist/Engineer Kevin Lindsey

(6) LOCATION OF WELL By legal description:
County Umatilla Latitude ____ Longitude ____
Township 6 (N or S) Range 35 (E or W) Section 33
SW 1/4 of NE 1/4 of above section.
Street address of well location Near Hudson Bay Canal Appox. 1100' West of Rd bordering east edge of sec. 33 Milton Freewater
Tax lot number of well location ____
ATTACH MAP WITH LOCATION IDENTIFIED. Map shall include approximate scale and north arrow.

(7) STATIC WATER LEVEL:
49 Ft. below land surface. Date 3/10/04
Artesian Pressure ____ lb/sq. in. Date ____

(8) WATER BEARING ZONES:
Depth at which water was first found 49

From	To	Est. Flow Rate	SWL

(9) WELL LOG:
Ground Elevation ____

Material	From	To	SWL
Sandy Silt	0	3	
Sandy Gravel	3	18	
Silty Gravel	18	38	
Sandy Gravel	38	47	
Silty Gravel	47	61	49

RECEIVED APR 12 2004 WATER RESOURCES DEPT SALEM, OREGON

RECEIVED MAY 03 2004 WATER RESOURCES DEPT SALEM, OREGON

Date started 3/10/04 Completed 3/10/04

(unbonded) Monitor Well Constructor Certification:
I certify that the work I performed on the construction, alteration, or abandonment of this well is in compliance with Oregon water supply well construction standards. Materials used and information reported above are true to the best of my knowledge and belief.
MWC Number 10430
Signed [signature] Date 4/3/04

(bonded) Monitor Well Constructor Certification:
I accept responsibility for the construction, alteration, or abandonment work performed on this well during the construction dates reported above. All work performed during this time is in compliance with Oregon water supply well construction standards. This report is true to the best of my knowledge and belief.
MWC Number 10054
Signed [signature] Date 4/6/04

ORIGINAL COPY – WATER RESOURCES DEPARTMENT FIRST COPY – CONSTRUCTOR SECOND COPY – CUSTOMER

GW_62

No well log

GW_63

No well log

GW_117

UMAT 56444

STATE OF OREGON
MONITORING WELL REPORT
(as required by ORS 537.765 & OAR 690-240-0395)

WELL LABEL # L 97062
START CARD # 1007459

(1) LAND OWNER Owner Well I.D. MW-10
First Name Dennis Last Name Burks
Company
Address 84452 Hwy 339
City Milton-Freewater State Or. Zip 97862

(2) TYPE OF WORK ☑ New ☐ Deepening ☐ Conversion
☐ Alteration (repair/recondition) ☐ Abandonment

(3) DRILL METHOD
☑ Rotary Air ☐ Rotary Mud ☐ Cable ☐ Hollow Stem Auger ☐ Cable Mud
☐ Reverse Rotary ☐ Other

(4) CONSTRUCTION Piezometer Well ☑
Depth of Completed Well 70 ft. Special Standard ☐

MONUMENT/VAULT Below Ground
From 0 To 1.5'

BORE HOLE
Diameter 6" From 0 To 70'

CASING
Dia 2" From +.5' To 35'
Gauge sch 40 Wld Thrd
Material ○ Steel ⊘ Plastic ☐ ☑

LINER
Dia From To
Gauge N/A Wld Thrd
Material ○ Steel ○ Plastic ☐ ☐

SEAL
From 1.5' To 35'
Material Bentonite chips
Amount 6 bags Grout weight

SCREEN
(Casing) Liner Material sch 40 PVC
Diameter 2" From 35' To 70'
Slot Size .020

FILTER
From 33' To 70' Material Sand Size of pack 10/20

(5) WELL TESTS
○ Pump ○ Bailer ○ Air ○ Flowing Artesian

Yield gal/min	Drawdown	Drill stem/Pump depth	Duration (hr)

Temperature 54 °F Lab analysis ☐ Yes By
Supervising Geologist/Engineer Jon Travis
Water quality concerns? ☐ Yes (describe below)

From	To	Description	Amount	Units

(6) LOCATION OF WELL (legal description)
County Umatilla Twp 6 (N) Range 35 (E) WM
Sec 27 SW 1/4 of the SE 1/4 Tax Lot 1600
Tax Map Number Lot
Lat ° ' " or DMS or DD
Long ° ' " or DMS or DD
Street address of well ✓ Nearest address
Sunny Side Rd. Orchard

(7) STATIC WATER LEVEL

	Date	SWL(psi)	+ SWL(ft)
Existing Well / Predeepening			
Completed Well	7/17/09		39

Flowing Artesian? ☐ Dry Hole? ☐
WATER BEARING ZONES Depth water was first found 39'

SWL Date	From	To	Est Flow	SWL(psi)	+ SWL(ft)
7/17/09	39	70			39

(8) WELL LOG Ground Elevation

Material	From	To
Asphalt gravels	0	9
Silty fine sand w/gravel	9	46
gravel	46	48
Silty fine sand w/gravel	48	70

RECEIVED
SEP 2 4 2009
WATER RESOURCES DEPT
SALEM, OREGON

Date Started 7/16/09 Completed 7/17/09

(unbonded) Monitor Well Constructor Certification
I certify that the work I performed on the construction, deepening, alteration, or abandonment of this well is in compliance with Oregon monitoring well construction standards. Materials used and information reported above are true to the best of my knowledge and belief.
License Number 10430 Date 9/1/09
Password (if filing electronically)
Signed [signature]

(bonded) Monitor Well Constructor Certification
I accept responsibility for the construction, deepening, alteration, or abandonment work performed on this well during the construction dates reported above. All work performed during this time is in compliance with Oregon monitoring well construction standards. This report is true to the best of my knowledge and belief.
License Number 10054 Date 9/21/09
Password (if filing electronically)
Signed [signature]
Contact Info (optional) Environmental West Exploration

ORIGINAL - WATER RESOURCES DEPARTMENT
THIS REPORT MUST BE SUBMITTED TO THE WATER RESOURCES DEPARTMENT WITHIN 30 DAYS OF COMPLETION OF WORK
Form Version: 0.31

GW_118

UMAT 56445

STATE OF OREGON
MONITORING WELL REPORT
(as required by ORS 537.765 & OAR 690-240-0395)

WELL LABEL # L 91064
START CARD # 1007461

(1) LAND OWNER Owner Well I.D. MW-12
First Name Dave Last Name Hansen
Company McKnight Well
Address RR3 Box 210 C
City Milton-Freewater State Or. Zip 97862

(2) TYPE OF WORK ☑ New ☐ Deepening ☐ Conversion ☐ Alteration (repair/recondition) ☐ Abandonment

(3) DRILL METHOD
☑ Rotary Air ☐ Rotary Mud ☐ Cable ☐ Hollow Stem Auger ☐ Cable Mud ☐ Reverse Rotary ☐ Other

(4) CONSTRUCTION Piezometer Well ☑
Depth of Completed Well 70' ft. Special Standard ☐

MONUMENT/VAULT Above Ground
From +2.5 To -2.5'

BORE HOLE
Diameter 6" From 0 To 70'

CASING
Dia 2" From ☐ 2.5' To 30'
Gauge sch 40 Wld Thrd
Material ◯ Steel ◉ Plastic ☐ ☑

LINER
Dia From To
Gauge N/A Wld Thrd
Material ◯ Steel ◯ Plastic ☐ ☐

SEAL
From 1.5 To 28'
Material Bentonite Chips
Amount 5 bags Grout weight

SCREEN
(Casing)/Liner Material sch 40 PVC
Diameter 2" From 30' To 70'
Slot Size .020

FILTER
From 28' To 70' Material Sand Size of pack 10/20

(5) WELL TESTS
◯ Pump ◯ Bailer ◯ Air ◯ Flowing Artesian

Yield gal/min	Drawdown	Drill stem/Pump depth	Duration (hr)

Temperature 54 °F Lab analysis ☐ Yes By
Supervising Geologist/Engineer Jon Travis
Water quality concerns? ☐ Yes (describe below)

From	To	Description	Amount	Units

(6) LOCATION OF WELL (legal description)
County Umatilla Twp 6 N N/S Range 35 E E/W WM
Sec 28 SW 1/4 of the SW 1/4 Tax Lot 1801
Tax Map Number Lot
Lat ° ' " DMS or DD
Long ° ' " DMS or DD
☐ Street address of well ☑ Nearest address
Well DURD 50W #853

(7) STATIC WATER LEVEL

	Date	SWL(psi)	+	SWL(ft)
Existing Well / Predeepening	7/20/09			
Completed Well	7/20/09		-	40'

Flowing Artesian? ☐ Dry Hole? ☐
WATER BEARING ZONES Depth water was first found 40'

SWL Date	From	To	Est Flow	SWL(psi)	+	SWL(ft)
7/20/09	40'	70'			-	40

(8) WELL LOG Ground Elevation

Material	From	To
Silt	0	8
Gravely Silt	8	11
Silty Gravel	11	42
Gravely Sand	42	50
Silty fine sand w/some gravel	50	70

RECEIVED
SEP 2 4 2009
WATER RESOURCES DEPT
SALEM, OREGON

Date Started 7/20/09 Completed 7/20/09

(unbonded) Monitor Well Constructor Certification
I certify that the work I performed on the construction, deepening, alteration, or abandonment of this well is in compliance with Oregon monitoring well construction standards. Materials used and information reported above are true to the best of my knowledge and belief.
License Number 10430 Date 9/1/09
Password (if filing electronically)
Signed

(bonded) Monitor Well Constructor Certification
I accept responsibility for the construction, deepening, alteration, or abandonment work performed on this well during the construction dates reported above. All work performed during this time is in compliance with Oregon monitoring well construction standards. This report is true to the best of my knowledge and belief.
License Number 10054 Date 9/21/09
Password (if filing electronically)
Signed
Contact Info (optional) Environmental West Exploration

ORIGINAL - WATER RESOURCES DEPARTMENT
THIS REPORT MUST BE SUBMITTED TO THE WATER RESOURCES DEPARTMENT WITHIN 30 DAYS OF COMPLETION OF WORK
Form Version: 0.11

GW_119

UMAT 56447

STATE OF OREGON
MONITORING WELL REPORT
(as required by ORS 537.765 & OAR 690-240-0395)

DRAFT

WELL LABEL # L 91065
START CARD # 201096

(1) LAND OWNER Owner Well I.D. MW-13
First Name Jan Last Name Brough
Company
Address 51396 Phillips Rd
City Milton-Freewater State Or Zip 97862

(2) TYPE OF WORK ☑ New ☐ Deepening ☐ Conversion
☐ Alteration (repair/recondition) ☐ Abandonment

(3) DRILL METHOD
☑ Rotary Air ☐ Rotary Mud ☐ Cable ☐ Hollow Stem Auger ☐ Cable Mud
☐ Reverse Rotary ☐ Other

(4) CONSTRUCTION Permanent Well ☑
Depth of Completed Well 40 ft. Special Standard ☐

MONUMENT/VAULT Below Ground
From +2.5 To 2.5

BORE HOLE
Diameter 6" From 0 To 40

CASING
Dia 2" From + 2.5 To 10
Gauge sch 40 Wld Thrd
Material ◯ Steel ◯ Plastic ☐ ☑

LINER
Dia N/A From To
Gauge Wld Thrd
Material ◯ Steel ◯ Plastic ☐ ☐

SEAL
From 1.5' To 8'
Material Bentonite Chips
Amount 12 bags Grout weight

SCREEN
Casing/Liner Material sch 40 PVC
Diameter 2" From 10' To 40
Slot Size .020

FILTER
From 8' To 40 Material Sand Size of pack 10/20

(5) WELL TESTS
◯ Pump ◯ Bailer ◯ Air ◯ Flowing Artesian

Yield gal/min	Drawdown	Drill stem/Pump depth	Duration (hr)

Temperature 54 °F Lab analysis ☐ Yes By
Supervising Geologist/Engineer Jon Travis
Water quality concerns? ☐ Yes (describe below)

From	To	Description	Amount	Units

(6) LOCATION OF WELL (legal description)
County Umatilla Twp 6 N N/S Range 35 E E/W WM
Sec 30 NW 1/4 of the NE 1/4 Tax Lot 500
Tax Map Number Lot
Lat ° ' " or DMS or DD
Long ° ' " or DMS or DD
Street address of well / Nearest address
Brough Ranch - Dugger Creek

(7) STATIC WATER LEVEL

	Date	SWL(psi)	+ SWL(ft)
Existing Well / Predeepening			
Completed Well	7/29/09		- 72

Flowing Artesian? ☐ Dry Hole? ☐
WATER BEARING ZONES Depth water was first found 12'

SWL Date	From	To	Est Flow	SWL(psi)	+ SWL(ft)
7/29/09	12'	40'			- 72

(8) WELL LOG Ground Elevation

Material	From	To
Silt	0	7
Silty fine sand w/some gravel	7	30
Silty Gravel	30	40

RECEIVED
SEP 24 2009
WATER RESOURCES DEPT
SALEM, OREGON

Date Started 7/29/09 Completed 7/29/09

(unbonded) Monitor Well Constructor Certification
I certify that the work I performed on the construction, deepening, alteration, or abandonment of this well is in compliance with Oregon monitoring well construction standards. Materials used and information reported above are true to the best of my knowledge and belief.
License Number 10430 Date 9/10/09
Password (if filing electronically)
Signed

(bonded) Monitor Well Constructor Certification
I accept responsibility for the construction, deepening, alteration, or abandonment work performed on this well during the construction dates reported above. All work performed during this time is in compliance with Oregon monitoring well construction standards. This report is true to the best of my knowledge and belief.
License Number 10054 Date 9/21/09
Password (if filing electronically)
Signed
Contact Info (optional) Environmental West Exploration

ORIGINAL - WATER RESOURCES DEPARTMENT
THIS REPORT MUST BE SUBMITTED TO THE WATER RESOURCES DEPARTMENT WITHIN 30 DAYS OF COMPLETION OF WORK
Form Version: 0.31

GW_135

No well log

GW_141

UMAT 57169

UMAT 57169

STATE OF OREGON
MONITORING WELL REPORT
(as required by ORS 537.765 & OAR 690-240-095)
Instructions for completing this report are on the last page of this form.

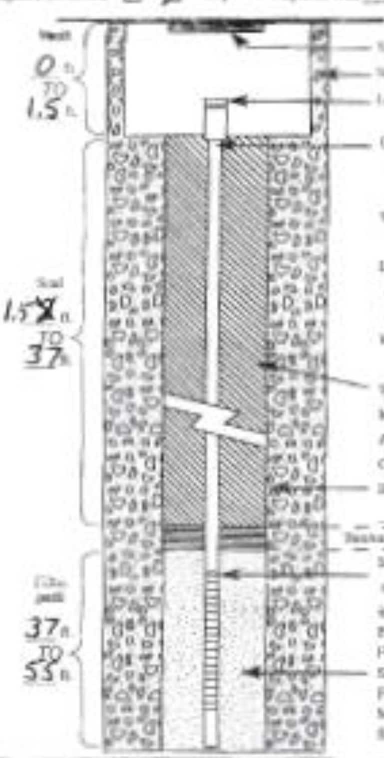
Well Label #: L 97758
Start Card #: 1019462

(1) OWNER/PROJECT: WELL NO. Russach
Name: Walla Walla Basin Watershed Council
Address: 810 S Main St
City: Milton Freewater State: OR Zip: 97862

(2) TYPE OF WORK:
☒ New construction ☐ Alteration (Repair/Recondition)
☐ Conversion ☐ Deepening ☐ Abandonment

(3) DRILLING METHOD:
☒ Rotary Air ☐ Rotary Mud ☐ Cable
☐ Hollow Stem Auger ☐ Other

(4) BORE HOLE CONSTRUCTION:
Special Standards: Yes ☐ No ☒ Depth of completed well 55 ft.



(5) WELL TEST:
Pump Bailer Air Flowing Artesian
Permeability ____ Yield ____ GPM
Conductivity ____ pH ____
Temperature of Water 54 °F Depth artesian flow found ____ ft.
Was a water analysis done? Yes No
By whom?
Depth of strata to be analyzed. From ____ ft. to ____ ft.
Remarks:
Name of supervising Geologist/Engineer: River Fritz

(6) LOCATION OF WELL By legal description
Well Location: County Umatilla
Township 5 N Range 35 E Section 2
NW ¼ of NW ¼ of above section.
Street address of well location 83757 Winesap Rd Milton Freewater, OR 97862
Tax lot number of well location 500
ATTACH MAP WITH LOCATION IDENTIFIED. Map shall include approximate scale and north arrow.

(7) STATIC WATER LEVEL:
38 Ft. below land surface Date 4/16/13
Artesian Pressure ____ lb/sq in Date ____

(8) WATER BEARING ZONES:
Depth at which water was first found 38

From	To	Est. Flow Rate	SWL
38	55		38

(9) WELL LOG: Ground elevation ____

Material	From	To	SWL
Sand gravel w/silt	0	5	
Silty Sandy gravel	5	25	
Sandy gravel w/some silt	25	55	38

RECEIVED BY OWRD
APR 2 2 2013
SALEM, OR

RECEIVED BY OWRD
JUN 1 4 2013
SALEM, OR

Date started 4/16/13 Completed 4/16/13

(unbonded) Monitor Well Constructor Certification:
I certify that the work I performed on the construction, alteration, or abandonment of this well is in compliance with Oregon well construction standards. Materials used and information reported above are true to the best knowledge and belief.
Signed [signature] MWC Number 10430 Date 4/18/13

(bonded) Monitor Well Constructor Certification:
I accept responsibility for the construction, alteration, or abandonment work performed on this well during the construction dates reported above. All work performed during this time is in compliance with Oregon well construction standards. This report is true to the best of my knowledge and belief.
Signed [signature] MWC Number 10054 Date 4-19-13

GW_142

UMAT 57171

UMAT 57171

STATE OF OREGON
MONITORING WELL REPORT
(as required by ORS 537.765 & OAR 690-240-095)
Instructions for completing this report are on the last page of this form.

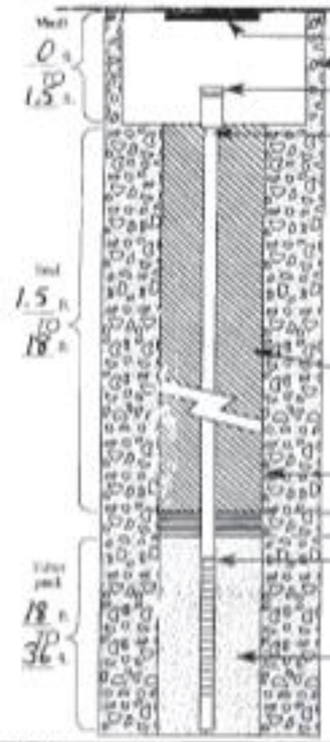
Well I.D. # L 97760
Start Card # 1019463

(1) OWNER/PROJECT: WELL NO. Trumbull
Name Walla Walla Basin Watershed Council
Address 810 S. main
City Milton Freewater State OR Zip 97862

(2) TYPE OF WORK:
☒ New construction ☐ Alteration (Repair/Recondition)
☐ Conversion ☐ Deepening ☐ Abandonment

(3) DRILLING METHOD:
☒ Rotary Air ☐ Rotary Mud ☐ Cable
☐ Hollow Stem Auger ☐ Other

(4) BORE HOLE CONSTRUCTION:
Special Standards Yes ☐ No ☒ Depth of completed well 36 ft.



Well 0 ft. to 1.5 ft.
Seal 1.5 ft. to 18 ft.
Filter pack 18 ft. to 36 ft.

Water-tight Cover
Surface Seal
Locking cap
Casing
diameter 2 in.
material sch 40 PVC
Welded Threaded Glued
☐ ☒ ☐
Liner
diameter ______ in.
material
Welded Threaded Glued
☐ ☐ ☐
Well Seal
Material Bentonite Chips
Amount 4 bags
Grout Weight
Borehole diameter
6 in.
Bentonite Plug at least 3 ft. thick
Screen
material sch 40 PVC
interval(s)
From 21 To 36
From To
Slot size .020 in.
Filter Pack
Material SAND
Size 10/20 in.

(5) WELL TEST:
Pump Bailer Air Flowing Artesian
Permeability ______ Yield ______ GPM
Conductivity ______ pH ______
Temperature of Water 54 °F Depth artesian flow found ______ ft.
Was water analysis done? Yes No
By whom?
Depth of strata to be analyzed. From ______ ft. to ______ ft.
Remarks
Name of supervising Geologist/Engineer Ryan Frelos

(6) LOCATION OF WELL By legal description
Well Location: County Umatilla
Township 6 N Range 35 E Section 27
SW ¼ of SW ¼ of above section
Street address of well location 53446 Umapine Hwy
Milton Freewater, OR 97862
Tax lot number of well location 900
ATTACH MAP WITH LOCATION IDENTIFIED. Map shall include approximate scale and north arrow.

(7) STATIC WATER LEVEL:
26 ft. below land surface Date 4/17/13
Artesian Pressure ______ lb/sq in. Date ______

(8) WATER BEARING ZONES:
Depth at which water was first found 26

From	To	Est. Flow Rate	SWL
26	36		26

(9) WELL LOG: Ground elevation ______

Material	From	To	SWL
Silty Sand	0	5	
Sand Gravel	5	12	
Silty Sandy Gravel	12	36	26

RECEIVED BY OWRD
APR 22 2013
SALEM, OR

RECEIVED BY OWRD
JUN 14 2013
SALEM, OR

Date started 4/17/13 Completed 4/17/13

(unbonded) Monitor Well Constructor Certification:
I certify that the work I performed on the construction, alteration, or abandonment of this well is in compliance with Oregon well construction standards. Materials used and information reported above are true to the best knowledge and belief.
MWC Number 10430
Signed [signature] Date 4/17/13

(bonded) Monitor Well Constructor Certification
I accept responsibility for the construction, alteration, or abandonment work performed on this well during the construction dates reported above. All work performed during this time is in compliance with Oregon well construction standards. This report is true to the best of my knowledge and belief.
MWC Number 10054
Signed [signature] Date 4-19-13

GW_143

UMAT 57170

UMAT 57170

STATE OF OREGON
MONITORING WELL REPORT
(as required by ORS 537.765 & OAR 690-240-095)
Instructions for completing this report are on the last page of this form.

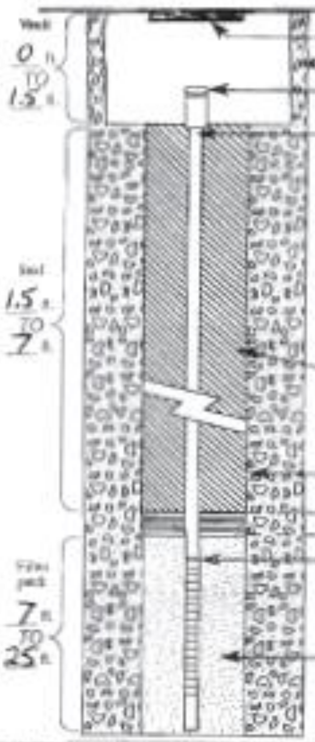
Well I.D. # L 97759
Start Card # 1019464

(1) OWNER/PROJECT: WELL NO. Mud Creek
Name Walla Walla Basin Watershed Council
Address 810 S Main
City Milton Freewater State OR Zip 97862

(2) TYPE OF WORK:
☑ New construction ☐ Alteration (Repair/Recondition)
☐ Conversion ☐ Deepening ☐ Abandonment

(3) DRILLING METHOD:
☑ Rotary Air ☐ Rotary Mud ☐ Cable
☐ Hollow Stem Auger ☐ Other

(4) BORE HOLE CONSTRUCTION:
Special Standards Yes ☐ No ☑ Depth of completed well 25 ft.



Vault 0 ft. TO 1.5 ft.
Water-tight Cover
Surface flush vault
Locking cap
Casing diameter 2 in. material Sch 40 PV
Welded ☐ Threaded ☑ Glued ☐
Liner diameter ______ in. material ______
Welded ☐ Threaded ☐ Glued ☐
Seal 1.5 ft. TO 7 ft.
Well Seal: Material Bentonite Chips Amount 1.5 bags
Grout Weight
Borehole diameter 6 in.
Bentonite Plug at least 3 ft. thick
Screen material Sch 40 PVC
Interval(s): From 10 To 25
From ______ To ______
Slot size .020 in.
Filter pack 7 ft. TO 25 ft.
Filter Pack: Material SAND Size 10/20 in.

(5) WELL TEST:
Pump ☐ Bailer ☐ Air ☐ Flowing Artesian ☐
Permeability ______ Yield ______ GPM
Conductivity ______ pH ______
Temperature of Water 54 °F Depth artesian flow found ______ ft.
Was water analysis done? Yes (No)
By whom? ______
Depth of strata to be analyzed. From ______ ft. to ______ ft.
Remarks ______
Name of supervising Geologist/Engineer Roger Fowler

(6) LOCATION OF WELL By legal description:
Well Location: County Umatilla
Township 6 N Range 35 E Section 28
SW 1/4 of NE 1/4 of above section
Street address of well location Preston Lane, Milton Freewater, OR 97862
Tax lot number of well location 1900
ATTACH MAP WITH LOCATION IDENTIFIED. Map shall include approximate scale and north arrow.

(7) STATIC WATER LEVEL:
19 ft. below land surface Date 4/16/13
Artesian Pressure ______ lb/sq. in. Date ______

(8) WATER BEARING ZONES:
Depth at which water was first found 19

From	To	Est. Flow Rate	SWL
19	25		19

(9) WELL LOG: Ground elevation ______

Material	From	To	SWL
Silty Sand	0	5	
Silt	5	10	
Sandy Silt	10	17	
Silty sand & gravel	17	25	19

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SALEM, OR
JUN 1 4 2013
SALEM, OR

Date started 4/16/13 Completed 4/16/13

(unbonded) Monitor Well Constructor Certification:
I certify that the work I performed on the construction, alteration, or abandonment of this well is in compliance with Oregon well construction standards. Materials used and information reported above are true to the best knowledge and belief.
MWC Number 10430
Signed [signature] Date 4/18/13

(bonded) Monitor Well Constructor Certification:
I accept responsibility for the construction, alteration, or abandonment work performed on this well during the construction dates reported above. All work performed during this time is in compliance with Oregon well construction standards. This report is true to the best of my knowledge and belief.
MWC Number 10054
Signed [signature] Date 4-19-13

GW_144

UMAT 57172

UMAT 57172

STATE OF OREGON
MONITORING WELL REPORT
(as required by ORS 537.765 & OAR 690-240-095)
Instructions for completing this report are on the last page of this form.

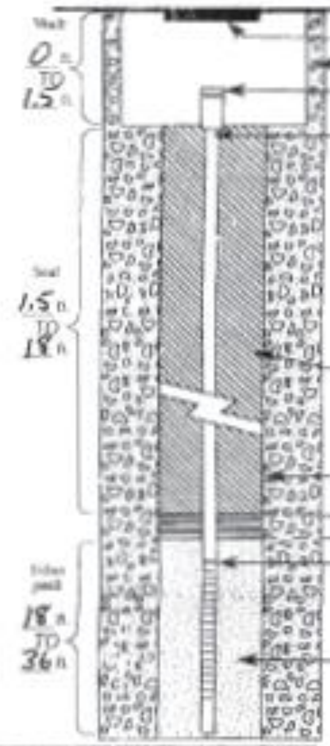
Well I.D. # L 97761
Start Card # 1019965

(1) OWNER/PROJECT: WELL NO. MW Umapine
Name Walla Walla Basin Watershed Council
Address 810 S Main
City Milton Freewater State OR Zip 97862

(2) TYPE OF WORK:
☑ New construction ☐ Alteration (Repair/Recondition)
☐ Conversion ☐ Deepening ☐ Abandonment

(3) DRILLING METHOD:
☑ Rotary Air ☐ Rotary Mud ☐ Cable
☐ Hollow Stem Auger ☐ Other

(4) BORE HOLE CONSTRUCTION:
Special Standards Yes ☐ No ☑ Depth of completed well 36 ft.



Casing
diameter 2 in.
material sch 40 PVC
Welded ☐ Threaded ☑ Glued ☐
Liner
diameter ______ in.
material ______
Welded ☐ Threaded ☐ Glued ☐
Well Seal:
Material Bentonite Chip
Amount 4 bags
Grout Weight ______
Borehole diameter
6 in.
Bentonite Plug at least 3 ft. thick
Screen
material sch 40 PVC
interval(s):
From 21 To 36
From ______ To ______
Slot size .020 in.
Filter Pack:
Material SAND
Size 10/20 in.

(5) WELL TEST:
Pump Bailer Air Flowing Artesian
Permeability ______ Yield ______ GPM
Conductivity ______ pH ______
Temperature of Water 54 °F Depth artesian flow found ______ ft.
Was water analysis done? Yes (No)
By whom? ______
Depth of strata to be analyzed. From ______ ft. to ______ ft.
Remarks ______

Name of supervising Geologist/Engineer Renee Fowler

(6) LOCATION OF WELL By legal description:
Well Location County Umatilla
Township 6 N Range 34 E Section 24
SW ¼ of SE ¼ of above section
Street address of well location 80901 Umapine Rd
Milton Freewater, OR 97862
Tax lot number of well location ______
ATTACH MAP WITH LOCATION IDENTIFIED. Map shall include approximate scale and north arrow.

(7) STATIC WATER LEVEL:
24 Ft. below land surface Date 4/17/13
Artesian Pressure ______ lb/sq. in. Date ______

(8) WATER BEARING ZONES:
Depth at which water was first found 24

From	To	Est. Flow Rate	SWL
24	36		24

(9) WELL LOG: Ground elevation ______

Material	From	To	SWL
Silty Sand	0	5	
Silty Sandy Gravel	5	36	24

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Date started 4/17/13 Completed 4/17/13

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MWC Number 10054
Signed [signature] Date 4-19-13