Final Remedial Investigation and Feasibility Study Report

Simplot Grower Solutions
1800 W. 1st Street
Warden, Washington 98857

September 2018

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September 2018

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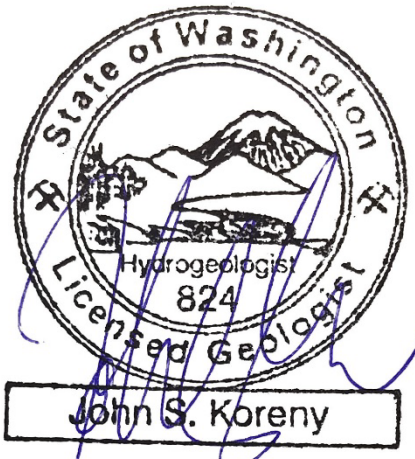

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Acronyms

ARAR	applicable or relevant and appropriate requirements
bgs	below ground surface
CLARC	Cleanup Levels and Risk Calculations
CUL	cleanup levels
DOH	Washington State Department of Health
Ecology	State of Washington, Department of Ecology
EDB	ethylene dibromide
HDR	HDR Engineering, Inc.
MCL	maximum contaminant level
MSL	mean sea level
MTCA	Model Toxics Control Act
OMM	operations, maintenance, and monitoring
OSHA	Occupational Safety and Health Administration
Pace	Pace Analytical
PGG	Pacific Groundwater Group
PID	photoionization detector
ppmv	parts per million volume
PQL	practical quantitation limit
PVC	polyvinyl chloride
QA/QC	quality assurance/quality control
RAO	remedial action objectives
RI/FS	remedial investigation/feasibility study
Simplot	J.R. Simplot Company
SVE	soil vapor extraction
TEE	terrestrial ecological evaluation
µg/Kg	microgram per kilogram
µg/L	microgram per liter
USEPA	U.S. Environmental Protection Agency
UST	underground storage tank
WAC	Washington Administrative Code

1 Remedial Investigation

Site Name	Simplot Growers Solutions Warden, Washington Site (in Agreed Order Ecology refers to site as Warden City Wells site)
Ecology Facility/sites ID	2802409
Agreed Order	No. 8421
Cleanup Site ID (CSID)	No. 1618 (Warden City Water Supply Wells 4&5)
Address	1800 West 1st Street Warden, WA 98857
Location:	GPS: 46.97025 46° 58' 13" North and -119.060309 -119° 3' 37" West UTM: Zone 11 N; 343279.18, 5203918.33 Legal: SW T17N R30E S9 Parcel: 060697000 County: Grant Washington
Ecology Site Manager	Christer Loftenius, LG, LHG State of Washington Department of Ecology Toxics Cleanup Program, Eastern Region 4601 N Monroe Street Spokane, Washington 99205-1295 clof461@ecywa.gov 509.329.3400
Potentially Liable Person (PLP)	J.R. Simplot Company P.O. Box 27 Boise, Idaho 83707
PLP Contact	Karl Schultz, CSP J.R. Simplot Company P.O. Box 27 Boise, Idaho 83707 Karl.schultz@simplot.com 208.780.7368
Site Owner	Same as PLP
RI/FS Preparer	HDR Engineering Michael Murray, Ph.D. 412 East Park Center Boulevard, Suite 100 Boise, Idaho 83706 mike.murray@hdrinc.com 208.387.7033

1.1 Background Information

The J.R. Simplot Company (Simplot) entered into an agreed order (Agreed Order 8241) with the State of Washington, Department of Ecology (Ecology) on May 27, 2011, to address the presence of ethylene dibromide (EDB), a fumigant, in soil and groundwater at Simplot's facility at 1800 W. 1st Street, Warden, Washington (**Figure 1** and **Figure 2**). Specifically, the agreed order requires Simplot to complete a remedial investigation/feasibility study (RI/FS). A RI/FS work plan was submitted to

Ecology in November 2011 that outlines the study approach (HDR 2011). Simplot conducted RI/FS activities from November 2011 through October 2013 and submitted a draft RI/FS to Ecology in June 2014. Ecology provided comments to the draft RI/FS in September 2017 and Simplot conducted groundwater monitoring in December 2017 to update the draft RI/FS (presented herein).

The objective of this RI/FS is to meet the requirements of the agreed order in accordance with the Model Toxics Control Act (MTCA) Cleanup Regulation (Washington Administrative Code [WAC] 173-340). The RI is designed to characterize site conditions in order to complete a FS and select a cleanup action as described in WACs 173-340-360 through 173-340-390.

The MTCA cleanup regulation sets forth the requirements and procedures to develop soil and groundwater cleanup standards. Cleanup levels must be based on the reasonable maximum exposure expected to occur under both current and future site conditions. Cleanup criteria are further described in Section 1.5.

1.1.1 Current Site Use

Simplot uses the site to store agricultural products (e.g., packaged fertilizers) in warehouses. The property consists of two warehouse buildings, an unpaved parking area, and several storage bins. In addition, the property hosts six groundwater monitoring wells.

Figure 1 and **Figure 2** are aerial photographs of the site and surrounding area that provide an indication of current land use. The parcel and surrounding parcels are listed by Grant County as "trade-general merchandise." Land use within 1 mile of the property includes commercial and light industry, open space (undeveloped), and agricultural. Simplot anticipates continuing to use the property to store agricultural products for the near future and has not identified any long-term changes to property use.

1.1.2 Site Vicinity

The area immediately around the Simplot Growers Solutions property is industrial (agricultural), with irrigated agricultural areas on the north and west sides of the East Low Canal and residential areas to the southeast (**Figure 2** and **Figure 3**). The property is bordered by a railroad spur to the north and west, industrial buildings to the east, 1st Street to the south, and industrial facilities to the west. The Washington Potato Company is located to the west of the Simplot property and Pure Line Seeds, Columbia Seeds, Greater Pacific Cold Storage, and ConAgra Lamb Weston (formerly Ochoa Ag Unlimited Foods and Basin Frozen Foods) are to the east of the Simplot property. To the southeast, is an auto wrecking lot, to the south is Pacific Coast Canola, and to the southwest is Skone Irrigation, CHS Sun Basin Growers, and the Warden Airport. The East Low Canal is located approximately 250 feet to the north of the facility (**Figure 3**).

1.1.3 Site History

The site is a former Simplot Grower Solutions (also known as Simplot Soilbuilders) facility. Simplot Grower Solutions are retail outlets for agri-chemicals (fertilizers, pesticides, soil amendments) that offer customized fertilizer blending, application services, and consulting.

Environmental Data Resources (EDR) conducted a chain-of-title search and reported the following for the 1800 W. 1st Street facility (2011):

- 1940 to 1971: site owned by Burlington Northern, Inc. (formally Northern Pacific Railroad Company)
- 1971 to current: J.R. Simplot Company

Simplot actively operated the Soilbuilders facility from 1971 through 1992, where they stored, blended, and transported agri-chemicals, including EDB. Most of the Simplot workers familiar with the site are retired (many no longer living). Little information is available about the storage and use of EDB and if there were any spills.

EDB was used in the past as a pesticide for potato crops and as an additive for leaded gasoline fuel. Potato crops are grown in the Warden area, and there is potato processing in the industrial section of the city. Although the chemical was banned for use as a soil fumigant in 1984, elevated levels of EDB were found in City of Warden wells (City Wells #4 and #5), which led to multiple investigations to find the source of the EDB and to protect groundwater.

1.1.4 Site Setting

A description of site geology and hydrogeology is primarily taken from the *Preliminary Investigation of Ethylene Dibromide Contamination* (PGG 2007), *Phase II Preliminary Investigation Report* (Ecology 2009), and RI/FS activities conducted by HDR Engineering, Inc. (HDR).

The City of Warden is located within the Columbia Plateau, which is dominated by the Columbia River Basalt Group (thick sequence of basalt flows). Unconsolidated sediment overlies basalt in the Warden area and is comprised of sand and silt deposited by outburst floods from Glacial Lake Missoula and Palouse Formation loess (windblown silt and fine sand). Lithology of the monitoring wells associated with the site is described as unconsolidated soil of very silty to slightly silty to silty fine sand 17 to 64 feet thick. In addition, an on-site geologist observed layers of caliche (hardened soil cause by crystalized salts) while overseeing drilling in the upper 25 feet of boreholes. For the Simplot site, caliche is interbedded with sand from 4 to 20 feet below ground surface (bgs). Beneath the unconsolidated soil, 4.5 to 14 feet of weathered basalt is encountered. Beneath the weathered basalt is competent basalt that, in the vicinity of the monitoring wells, slope to the west-northwest. A summary of lithology for monitoring well MW-5, which was constructed at the Simplot facility, is as follows (PGG 2007):

Depth below ground surface	Description
0 to 4 feet	Fill material
4 to 18.5 feet	Fine sand with caliche interbeds
18.5 to 43 feet	Fine sand and silty sand
43 to 49 feet	Weathered basalt
49 to >55 feet	Hard basalt
55 feet	Boring bottom

The site and surrounding area lies in the Odessa groundwater management subarea, a segment of the Columbia Basin groundwater system, which is characterized by declining basalt aquifer water levels and high amounts of recharge to the shallow aquifer due to irrigated agricultural activities in

the region. The surficial geologic deposits are outwash deposits and wind-blown aeolian deposits (loess). Below these surficial deposits, three aquifers are identified in the City of Warden area:

- Shallow aquifer - comprised of unconsolidated deposits (includes weathered basalt, gravels, sand, silt, and clay); regionally, this aquifer flows toward the west (George 2006). Monitoring wells associated with this RI/FS are constructed in the shallow aquifer.
- Wanapum aquifer – part of the Wanapum Basalt formation of the Columbia River Basalt Group; this formation extends to a depth of approximately 600 feet bgs and regionally groundwater flows southwest (Hansen et al. 1994).
- Grande Ronde aquifer – a deeper basalt aquifer found beneath the Wanapum formation; regionally flows toward the south and southwest (Hansen et al. 1994).

Well log information for the Wanapum and Grande Ronde aquifers indicates that the groundwater potentiometric elevations decline with depth. Based on searches through Ecology's well database (updated February 2018), there are nine extraction wells within a 1-mile radius of the site. (Per WAC 173-160-010, an extraction well includes wells that withdraw groundwater for drinking, feedlots, irrigation, dewatering and drainage, infiltration, industrial processes, washing and rinsing, heating and cooling.) For several of the identified wells, there is no information about what kind of wells they are except that they are water wells.

Table 1 lists the extraction well information and **Figure 3** shows the relative location of extraction wells in relation to the site. Locations of these wells is approximate as some of the location information is based on quarter-quarter legal descriptions and not specific global positioning system (GPS) coordinates. The deep extraction wells are finished in the Wanapum aquifer (deep aquifer), which lies below the unconsolidated material and caliche in the Wanapum Basalt formation of the Columbia River Basalt Group.

Resource protection wells within a 1-mile radius of the site are associated with the RI/FS (currently there are 11 monitoring wells that are further described in Section 1.2.3). Per WAC 173-160-410 (13), resource protection wells are defined as "a cased boring intended or used to collect subsurface information or to determine the existence or migration of pollutants within an underground formation". The resource protection wells between the site and City Wells #4 and #5 are MW-10S and MW-4 (decommissioned) (further described in Section 1.2.3 and 1.2.5).

Depth to water (shallow aquifer) in the project area is approximately 11 to 30 feet bgs and varies seasonally, where groundwater elevation rises during the irrigation season and declines during the non-irrigation season. Shallow groundwater is influenced by the East Low Canal, where the canal acts as a losing stream (creates a hydraulic mound) during the irrigation season. The shallow aquifer system consists of the outwash deposits, loess, and other unconsolidated materials above the basalt of the Wanapum Basalt formation of the Columbia River Basalt Group. The city wells are finished in the Wanapum aquifer (deep aquifer), which lies below the unconsolidated material and caliche in the Wanapum Basalt formation of the Columbia River Basalt Group. All monitoring wells are developed in the shallow aquifer. Monitoring wells designated with a "D" refer to wells screened at the bottom of the shallow aquifer (above the competent basalt) whereas monitoring wells with no designation or with an "S" designation are screened in the upper portion of the shallow aquifer.

The topography of the area is generally flat with a few gently sloping hills. Elevation of the site is approximately 1,252 feet above sea level. The geomorphologic setting of the area is characterized

by outwash deposits and wind-blown aeolian deposits (loess). The nearest major natural surface water body is Warden Lake to the west. The nearest man-made surface water body is the East Low Canal. The nearest undeveloped natural land is approximately 3 miles west/southwest of the site, part of which is the Columbia National Wildlife Refuge. Other areas around Warden are residential or agriculturally developed land (**Figure 2** and **Figure 3**).

1.1.5 Previous Studies

Table 2 lists the EDB investigation history, starting in 2004 with an Ecology early notice letter to Warden through Simplot's RI/FS activities, which include monitoring and sampling events from 2011 to October 2013, and then a groundwater sampling event in December 2017. This list represents the actions and studies that helped guide the location and type of data collection activities undertaken, and the steps taken to prepare this RI/FS report.

1.1.5.1 CITY OF WARDEN WELLS

The City of Warden's drinking water system is comprised of a series of wells that are distributed throughout town (**Figure 4**). The system serves about 1,500 customers. Well construction information is provided in **Table 3** and copies of the well logs are provided in Appendix A. The status of each city well is as follows:

Well	Status
Well #1	Decommissioned (constructed in 1910) (location uncertain)
Well #2	Converted to monitoring well
Well #3	Used to monitor drawdown in Well 6
Well #4	Decommissioned (December 2010)
Well #5	Emergency use only for potable use; well currently pumped and used with food processing wastewater for land application during growing season.
Well #6	Active
Well #7	Active
Well #8	Active
Well #9	Active

EDB was discovered in City Well #4, with a concentration exceeding the maximum contaminant level (MCL) of 0.05 micrograms per liter (µg/L) in March 1989. EDB was detected in groundwater collected from City Well #5 in February 1990. Several follow-up samples were collected as shown in **Table 4**. Of the samples collected in City Well #4, EDB concentrations above the MCL were detected in 60 percent of the samples between 1989 and 2007. For City Well #5, EDB concentrations above the MCL were detected in 72 percent of the samples between 1990 and 2013. EDB has not been detected in the other city wells (only wells #4 and #5).

City Well #4 was located between two potato-processing facilities owned by the Washington Potato Company. In August 2004, video logging of the City Well #4 was conducted to assess the competency of the well, and to assess water-bearing zones (Gray and Osborne 2004). City Well #4 was drilled in 1957 to a depth of 319 bgs and completed open hole below 80 feet. The well was

permanently decommissioned by the City of Warden in December 2010. The well was abandoned because of the presence of EDB and also because of concerns by the Washington State Department of Health (DOH) that the well's shallow casing depth and its proximity to Washington Potato's operations and Burlington Northern Railroad lines could pose a risk to wellhead protection (industrial activities take place within the well's 100-foot sanitary control area). .

City Well #5 is located approximately 800 feet west-southwest of Simplot's site (**Figure 5**). The City of Warden installed a packer in this well in 2004 to isolate the lower portion of the well for water production and to prevent shallow EDB-impacted water (if present) from entering the well. The city periodically pumps the well for irrigation use at a wastewater land application site. City Well #5 was completed in the Wanapum aquifer. It pre-dates state regulations and was not constructed in a manner to effectively seal the shallow aquifer from the Wanapum aquifer. Water level elevations in City Wells #4, #5, and #6 range from 1,180 to 1,207 feet above mean sea level (MSL). City Well #7 was completed in the Grande Ronde aquifer and its water surface elevation is 977 feet MSL.

1.1.5.2 PRELIMINARY INVESTIGATION OF ETHYLENE DIBROMIDE CONTAMINATION (PGG 2007)

Pacific Groundwater Group's (PGG) *Preliminary Investigation of Ethylene Dibromide Contamination* (2007) describes a preliminary investigation of the City of Warden's well field in response to the discovery of EDB in two wells (City Well #4 and City Well #5). Under contract with Ecology, PGG's activities included drilling and constructing five groundwater monitoring wells (MW-1 through MW-5D; see **Figure 6**, well logs are provided in Appendix B), measuring water levels, surveying wells, sampling soil and groundwater, sampling food industry process water, sampling canal sediment, and researching historic land ownership. PGG conducted field activities in August and late October 2006. The following summarizes PGG's activities and findings from the investigation:

- PGG encountered shallow groundwater during investigation activities in unconsolidated sediment 11 to 20 feet bgs. PGG advanced borings until reaching competent bedrock (basalt), confirmed by drilling 2 to 5 feet of open hole into the basalt. They constructed monitoring wells of 2-inch diameter, schedule 40 polyvinyl chloride (PVC) riser pipe, and 10-slot PVC screens, 10 feet long. In general, they set the 10-foot screens in the weathered basalt and hard basalt. The weathered basalt is considered part of the shallow aquifer (hydraulically connected). Unconsolidated sediment thicknesses ranged from 43 to 64 feet in these wells.
- PGG measured static groundwater levels in August (water in the canal) and late October/early November (no water in the canal) 2006. During the August water level survey, the East Low Canal was losing water to groundwater and groundwater flowed away from the canal to the north and south. In the October/November sampling event, the elevation of the canal bottom was lower than groundwater levels in the monitoring wells and a component of the groundwater flowed toward the canal.
- PGG collected soil samples during drilling activities for each boring at depths of 10, 30, and 60 feet bgs. EDB was non-detected in any of the soil samples except for the MW-5 (note Ecology's well MW-5 is referred to as MW-5D for this report) boring at 10 feet bgs at the Simplot facility. The concentration at 10 feet was 6.22 micrograms per kilogram (µg/Kg); EDB was non-detected in soil samples from the same boring at 30 and 40 feet bgs. The 10-foot sample was within the caliche interlayer.

- In a single sampling event in October/November 2006, PGG collected groundwater samples from the monitoring well network, City Well #5, and City Well #6 (City Well #4 was not sampled). EDB was non-detected in groundwater samples.
- At the Washington Potato facility (facility to the west of the Simplot site), PGG collected two process water samples: the first sample from the potato wash water in the receiving bays and the other sample from the process wastewater in the final clarifying tank. EDB was not detected in the wash water sample, but was detected in the final clarifying tank sample at 0.015 µg/L.
- PGG collected three water samples from the City of Warden's wastewater treatment ponds. They collected the first sample from the input point to the system, the second sample from wastewater pond 5A, and the third sample from wastewater pond 8. EDB was not detected in the wastewater treatment plant samples.
- As a follow up to the 2007 PGG investigation, Ecology sampled the monitoring wells every other month starting in November 2006 through February 2009. EDB was non-detected in wells, except for MW-5D, where EDB concentrations ranged from 0.1 µg/L to 132 µg/L. For the last six sampling events (March 2008 through February 2009), the average EDB concentration was 2.5 µg/L.

1.1.5.3 PHASE II PRELIMINARY INVESTIGATION. WARDEN CITY WATER SUPPLY WELLS SITE, WARDEN, WA, APRIL 2009 (ECOLOGY 2009)

The 2009 *Phase II Preliminary Investigation* (Ecology 2009) summarizes Ecology's Phase II investigation activities in November and December 2008, which focused on the Simplot facility and the north adjacent property. The purpose of the Phase II investigation was to gather information about potential sources of the EDB found in groundwater. The following summarizes Ecology's activities and findings from the Phase II investigation:

- During Phase I activities, one soil sample from MW-5D boring had a detectable level of EDB at 10 feet bgs within caliche interbeds at the Simplot facility. Ecology focused on additional sampling in the soil caliche during Phase II, because the caliche is hard and has a high potential for trapping volatile chemicals like EDB. The investigation focused on the area around MW-5D, since this was the only well that had detectable levels of EDB in the shallow aquifer from the five monitoring wells installed as part of Phase I activities.
- Using a hydraulic push probe unit to collect soil samples, Ecology advanced a total of 22 borings (**Figure 7**), ranging in depth from 9 to 24 feet bgs. These depths varied because the push probe had difficulty penetrating into the caliche layer at some locations. Ecology collected one soil sample from each of the 22 borings for EDB analysis.
- Assessment of soil borings revealed that there was a caliche layer throughout the sampling area; however, the caliche was thinner and not well-defined in the center of the property, south of the railroad spur. Appendix B contains copies of Ecology's boring logs.
- EDB was detected in 2 of 22 borings at concentrations of 8.4 and 3.2 µg/Kg for SB-5 and SB-12, respectively. Both borings were located in the open lot area of the Simplot facility (**Figure 7**).
- The report summarized groundwater elevations and EDB concentrations for MW-5D from October 2006 through February 2009. Depth to groundwater ranged from 19 feet bgs in early

October (end of irrigation season) to 33 feet bgs in late March (end of non-growing season). EDB concentration ranged from non-detect in November 2006 to a high of 132 µg/L in March 2007. For the last six sampling events (March 2008 through February 2009), the average EDB concentration was 2.5 µg/L.

- The report provided additional information on process water samples collected from Washington Potato and Ochoa Foods. Ecology concluded, "Results from both Washington Potato and Ochoa Foods indicate occasional detections of EDB in various processing streams. However, the concurrent sampling of the city water supply as it entered the plants shows that EDB is present prior to any processing. EDB presence is likely due to its presence in the city water supply."

1.2 Nature and Extent of Contamination – Remedial Investigation Activities

This section describes HDR's RI activities conducted from 2011 through 2013 (updated with groundwater sampling in December 2017), which includes installing 7 additional monitoring wells (12 monitoring wells total as illustrated in **Figure 7**) and sampling on-site soil. Monitoring well logs are provided in Appendix B. HDR conducted activities in accordance with the *Final Remedial Investigation and Feasibility Study Work Plan* (HDR 2011) and the Phase II *Work Plan to Support Remedial Investigation and Feasibility Study* (HDR 2013a). The two documents are referred to here as the RI/FS work plan.

1.2.1 Geophysical Investigation

On November 17 and 18, 2011, subcontractor Northwest Geophysical Associates conducted a geophysical survey of the project area. The objective of the survey was to locate potential underground storage tanks (USTs), pipes, or other infrastructure remaining on the site from previous operations. The geophysical investigation included the following:

- A magnetic survey using a Geometrics G858G magnetometer.
- An electromagnetic survey using the Geonics EM-31 ground conductivity meter.
- A ground penetrating radar survey using a Geophysical Survey Systems Inc. SIR3000 control unit with a 400-megahertz (MHz) antenna.

A report on the geophysical survey is included in the *2012 Monitoring Well and Geoprobe Sampling Report* (HDR 2012). In summary, while the survey detected some subsurface anomalies, there was no strong indication of a buried tank or piping suggesting a former UST or other underground utility that may be attributed to past chemical storage and/or use.

1.2.2 Soil/Vadose Zone Investigations

In February 2012, HDR oversaw the advancement of seven GeoProbe™ (GP) borings for soil sampling, per the RI/FS work plan, to further define the extent of EDB-impacted soil at the facility. Boring locations were based on "filling in the gaps" in areas not sampled during Ecology's investigation (see Section 1.1.5.3). Refusal in each boring occurred in the caliche interbed layer (the actual depth penetrated varied with location and is further described below). Only boring GP-7 encountered EDB-impacted soil. This boring was near MW-5D and MW-5S, where EDB was found

in soil and groundwater. **Figure 7** illustrates GeoProbe™ locations conducted as part of the RI. **Table 5** summarizes the February 2012 soil sample results. GeoProbe™ boring logs are in Appendix B.

For GP-7, HDR sampled soil at 13.0 and 15.5 feet bgs with EDB levels at 11.8 and 11.6 µg/Kg, respectively. This boring is in the same general area as the Ecology study boring SB-12, where EDB was detected at 3.2 µg/Kg at 17 feet bgs.

The boring logs for the 2009 Ecology study and the 2012 RI study (Appendix B) revealed the top of the caliche interbeds at the site ranged from 4 to 16 feet bgs. **Figure 8** illustrates a post plot of first encountered caliche depths based on the soil borings investigations. A caliche surface trough occurs in the area of SB-11, SB-1, and SB-8.

HDR also collected soil samples during the drilling of RI/FS monitoring wells (**Table 6**). EDB was detected in boring MW-5S at the 20- to 22-foot-depth at 218 µg/Kg, but not at other sampled depths for this well. The 20- to 22-foot interval was within the zone described as caliche interbeds and near the saturated zone interface.

Figure 9 is a post plot showing the locations of borings that had EDB detected in soil samples. As described previously, EDB was detected in soil in the western portion of the site near MW-5D, MW-5S, GP-7, and SB-11 (SB-5 had detectable EDB, but the adjacent probes had non-detected levels). **Table 7** summarizes boring lithology (including monitoring wells) from west to east. The table includes soil sample intervals and results, depth and thickness of caliche, and depth and thickness of the silt and sand layers (unconsolidated sediment). In some cases, the basalt layer is also shown (MW-9S and MW-6S) but, in general, the illustration in **Table 7** is limited to the unconsolidated layer.

The following summarizes HDR's 2012 findings related to lithology and occurrence of EDB in soil (see **Table 7** and **Figure 9** for reference):

- The penetration of the GeoProbe™ borings (boring IDs starting with "SB" and "GP") into the caliche varied from 1 foot for SB-21 to 8 feet for SB-7 and GP-6. Furthermore, several GeoProbe™ borings fully penetrated through the caliche and into the unconsolidated sediment beneath (e.g., SB-6). The borings for eight monitoring wells provided lithologic information on the caliche layer and the sediment beneath. Appendix B contains driller logs for the GeoProbe™ and well drilling activities.
- The yellow and red colored cells in **Table 7** illustrate sample depths, where the yellow is non-detected for EDB and the red indicates a detected concentration of EDB. For example, MW-5S shows the following:
    - EDB non-detected in soil sample near surface (1 to 3 feet bgs) (sand/silt)
    - EDB non-detected in soil sample at 10 to 12 foot depth interval (sand/silt interface with caliche)
    - EDB detected in soil sample at 20 to 22 foot interval at 218 µg/Kg (caliche/interbed)
    - EDB non-detected in soil sample at 30 to 32 foot interval (sand/silt)
    - EDB non-detected in soil sample at 37 to 39 foot interval (sand/silt) (not illustrated in **Table 7** due to scale limitation)

- As illustrated in **Table 7** and in **Figure 9**, two areas have soil impacted by EDB: the area around SB-5; and a larger area between MW-5D and SB-12. For SB-5, EDB was detected in a soil sample 2 feet into the caliche at a concentration of 8.4 µg/Kg. Five borings surrounding SB-5 (SB-4, GP-6, SB-7, SB-6, GP-5, and SB-21) had no EDB in samples collected from the same elevation and deeper within the caliche interbeds. On the west side of the site, four borings had soil samples with detectable EDB; SB-12, MW-5D, GP-7, and MW-5S. SB-12 had EDB in soil collected from about 1 to 2 feet into the caliche interbeds, at a concentration of 3.19 µg/Kg. Borings SB-3, SB-11 and SB-9 had no EDB detected in the soil samples.

1.2.3 Groundwater Monitoring Wells

Between December 2011 and July 2013, to support the RI, HDR oversaw the installation of six additional groundwater monitoring wells completed within the shallowest portion of the water table and one well, MW-7D, within the deeper portion (all within the shallow aquifer):

- MW-5S – December 2011
- MW-6S – December 2011
- MW-7S – December 2011
- MW-7D – December 2011
- MW-8S – December 2012
- MW-9S – July 2013
- MW-10S – July 2013

Figure 5 shows the locations of the wells, including the Ecology-installed wells (total of 12 monitoring wells). Monitoring well MW-4 was decommissioned in 2015 at the request of the land owner (this was an off-site well installed by Ecology). The wells were constructed to provide information on groundwater flow direction, seasonal variations in flow and gradient, and an indication of groundwater quality upgradient and downgradient of the Simplot facility. Groundwater samples were analyzed for EDB using U.S. Environmental Protection Agency (USEPA) Method 8011.

Table 8 summarizes monitoring well construction and survey information. Shallow wells (MW-5S, MW-6S, MW-7S, MW- 8S, MW-9S, and MW-10S) were screened in the upper portion of the shallow aquifer to monitor water at the groundwater/vadose zone interface. Well MW-7D and Ecology wells MW-1, MW-2, MW-3, MW-4, and MW-5D were screened in the unconsolidated to weathered basalt interface (ranging from 55 to 75 feet bgs). The “shallow” and “deep” wells provide information as to potential groundwater gradient differences between the shallow and deep zones, as well as any differences in EDB levels. Both shallow and deep wells are within the shallow unconfined aquifer. In general, the deep well depths ranged from 75 feet bgs in MW-2 to 52 feet bgs in MW-7D. Well MW-6D was planned but not drilled, because basalt was encountered at a depth of approximately 26 feet, so only MW-6S was installed. MW-9S, drilled off site to the south of the facility, encountered basalt at 16 feet bgs. Furthermore, the borehole was dry at the time of drilling in July 2013 and the well was dry in October 2013 and December 2017. The well was screened from 7 to 17 feet bgs. The following summarizes the subsurface findings based on monitoring well boring observations:

- Lithology beneath the site is described as unconsolidated soil of very silty to slightly silty to silty fine sand 17 to 64 feet thick. Layers of caliche were documented in the upper 30 feet of boreholes (see **Figure 8** for post plot of depth to caliche based on GeoProbe™ borings). For the Simplot site, caliche is interbedded with silty sand from 4 to 30 feet bgs. Beneath the

unconsolidated soil, weathered basalt is encountered. Beneath the weathered basalt is competent basalt.

- The surface of the basalt slopes to the northwest (**Figure 10**). The slope is steepest just south of the Simplot facility. The average depth to basalt within the on-site deep wells ranged from about 45 feet to the northwest to 25 feet in the southeast. The Washington Interactive Geologic Map (DNR 2012) shows the basalt near or at ground surface about ½-mile south of the facility.
- The interbedded caliche unit is approximately 4 feet bgs in the original MW-5D boring, but at 10 feet bgs in MW-5S, at 10 feet bgs in MW-6S, at 8 feet bgs in both MW-7D and 7S, and at 12 feet bgs in MW-8S (see well logs in Appendix B). When combined with the wells and soil borings from previous investigations, the top of the caliche is high at the western and eastern portions of the property, sloping down to a low north to south axis in the area just east of MW-5S. Under the Simplot facility, the caliche interbedded unit thickness varies from 20 feet thick in MW-5S to 5 feet thick in MW-9S.

1.2.4 Groundwater Monitoring

HDR sampled groundwater at the site following the sampling and analysis plan that was included in Appendix C of the RI/FS work plan (HDR 2011). For each sampling event, the sampling team measured depth to groundwater in each monitoring well (**Table 9)**. **Figure 11** presents a time series plot of groundwater elevation over time for each well for 2012 through 2013. Groundwater elevation shows seasonal trends with elevations rising during the irrigation season in response to the canal (losing stream) and area-wide irrigated agricultural activities. Elevations are lowest during the non-growing season. Paired wells, MW-5S and MW-5D and MW-7S and MW-7D show similar trends and similar elevation values, suggesting that they are in the same aquifer (shallow aquifer) and that there is no (or minimal) vertical gradient.

Groundwater contours from the sampling events, including December 2017, are presented in Appendix C. **Figure 12** and **Figure 13** illustrate groundwater elevation contours for the July 2012 monitoring event using the shallow wells and the deep wells, respectively. Groundwater gradient based on the shallow wells (**Figure 12**) shows a southerly/southwesterly flow direction. Groundwater flow for the deeper wells is split where groundwater north of the canal flows northerly, and groundwater south of the canal flows in a southerly direction (**Figure 13**). This split is a result of groundwater mounding caused by the canal (losing stream).

During winter months, the East Low Canal is dry so it does not exert groundwater mounding on the shallow aquifer system. **Figure 14** and **Figure 15** illustrate groundwater elevation contours for the January 2013 sampling event**.** Groundwater flow direction was to the south/southwest for the shallow wells (**Figure 14**). The gradient is primarily westerly for the deeper wells (wells screened at the unconsolidated/bedrock interface) (**Figure 15**) (see Appendix C for other contour maps, including December 2017, overall groundwater flow is consistent with previous monitoring events).

Following static water measurements, the sampling team collected groundwater samples from each well. Wells were surged and pumped with a low-flow sampler in accordance to the RI/FS work plan. The sampling team recorded field pH, conductivity, dissolved oxygen, temperature, redox, and turbidity measurements during purging, and took samples once field parameters were stable as

outlined in the work plan. Sample bottles were preserved according to USEPA Method 8011 for EDB. All field sampling and chain-of-custody forms are in Appendix D.

Groundwater samples for the RI activities were forwarded to Pace Analytical (Pace) in Seattle, Washington. Pace is certified in the State of Washington for analysis of air, drinking water, Resource Conservation and Recovery Act (RCRA), USTs, and wastewater (Certificate #C1915). Samples were preserved with hydrochloric acid (HCl) and analyzed for EDB as per Method USEPA 8011. **Table 10** summarizes the quality assurance/quality control (QA/QC) field samples that were collected for each quarterly groundwater sampling event. Pace followed appropriate laboratory QA/QC procedures as dictated by the USEPA method and the laboratory's standard operating procedures (SOPs). All data met data quality objectives.

Table 11 presents groundwater sampling results. EDB was detected in all eight sampling events in shallow well MW-5S. Concentrations ranged from a high of 234 µg/L in January 2012 to a low of 5.7 µg/L in July 2013. Well MW-6S had detection of EDB in seven of the eight sampling events. EDB in MW-6S ranged from a high of 26.8 µg/L in July 2012 to non-detected levels in October 2013. Deep well MW-5D had a detection 0.27 µg/L EDB in January 2012 and 0.01 µg/L in April 2012 and October 2013. Wells MW-7D and MW-7S had EDB detections of 0.01 µg/L in April 2012 but EDB was non-detected for the other seven sampling events. The EDB concentrations in wells MW-5D, MW-7D, and MW-7S were at the detection limits for the analytical laboratory.

EDB has not been detected in any off-site groundwater monitoring well (MW-1, MW-2, MW-3, MW-4, MW-9S, and MW-10S) (this includes the multiple samplings by Ecology of wells MW-1 through MW-4 between October 2006 and February 2009).

1.2.5 Groundwater Pump Test City Well #5

On August 14, 2013, HDR oversaw a pump test in City Well #5, which following procedures outlined in the *Phase II Work Plan to Support Remedial Investigation and Feasibility Study* (HDR 2013a). The pump test report, including raw data, is provided in the report *City of Warden Well 5 Pump Test* (HDR 2013b). The general approach was to pump the well for a set duration, 8 to 16 hours, and collect groundwater elevation data from selected monitoring wells (observation wells) to assess potential water level drawdown in the shallow aquifer. Automated water level loggers (transducers) were used in observation wells for measuring elevation changes, as well as in City Well #5.

Prior to initiating pumping in City Well #5, transducers were placed in monitoring wells MW-3, MW-4, MW-5, MW-5S, MW-6S, MW-10S, and City Well #5 (**Figure 16**). The monitoring wells were chosen based on proximity to City Well #5 and by well depth/screened interval. Prior to the test, and then at about 2-hour intervals, water levels were checked manually using an electronic water level indicator in these wells and also in the other (remaining) six monitoring wells.

The City of Warden installed a packer in City Well #5 in 2004 that is set at 200 feet bgs. The purpose of the packer was to isolate the shallow aquifer from the lower basalt aquifer. After consultation with the City of Warden, the packer was left in place during the pump test. Thus, the pump test results reflect potential shallow aquifer drawdown with the packer in place.

City Well #5 was pumped at an average rate of 1,500 gallons per minute (gpm), which is the normal pumping rate for this well. No drawdown was detected in any of the observation wells, including City Well #5, after 8 hours of continuous pumping, so the test was extended to 16 hours. Again there was

no detected drawdown. After 16 hours, the pump test was halted. The depth to groundwater, as recorded by the transducers and water level indicator, showed no drawdown in any of the observation wells. Water generated during the pump test was discharged into the City of Warden lagoons.

HDR collected groundwater samples prior to pumping and then every 2 hours during pumping from a sampling port on the discharge line of City Well #5. These samples were placed on ice in a cooler and shipped to Pace Analytical Laboratory and analyzed for EDB. The results ranged from 0.07 µg/L prior to pumping to 0.12 µg/L at 2 hours into the test, with a final concentration of 0.098 µg/L near the end of the test. No detectable trends in concentration values over time were determined as shown in **Table 12**.

The test results reveal that the city's current use of Well #5 does is not hydraulically connected to the Simplot facility and shallow aquifer in the site area, as no drawdown was detected in monitoring wells (monitoring wells are all constructed in the shallow aquifer). The test condition is based on the packer in Well #5; thus, this test does not reflect past conditions when no packer was in place. However, the test demonstrates no hydrogeologic connectivity between the shallow and deep Wanapum aquifer in the area when only the deep aquifer is pumped.

1.3 Conceptual Site Model

An important objective of the RI/FS is to develop a better understanding of EDB potential sources (primary and secondary), release mechanisms, and exposure pathways, so that a conceptual model can be developed.

1.3.1 Type and Source of Contaminants

EDB is a volatile organic compound (see Appendix E for risk assessment description of this compound). **Table 13** lists select chemical and physical properties.

EDB volatilizes or evaporates upon exposure to the air and dissolves in groundwater to some extent. It is moderately persistent in the soil environment, with a representative half-life of 100 days. Generally, EDB degrades readily near the surface and becomes more persistent with depth. In the atmosphere, EDB will degrade by reaction with photochemically produced hydroxyl radicals (half-life 32 days).

1.3.2 Transport and/or Migration Pathways

Transport and/or migration pathways define those mechanisms by which humans are exposed to a chemical released from a site. A pathway is comprised of four elements:

- A source and mechanism for release of a chemical into the environment
- A transport medium (e.g., soil, air, and water)
- A point of potential human contact (exposure point)
- A human exposure route (ingestion, inhalation, dermal contact)

A conceptual site model for the Simplot facility is presented in **Table 14** and summarizes the environmental pathways to exposed individuals, and routes of entry into the body for each medium of exposure. The media of concern are soil and groundwater. The media and exposure pathways are described in the following sections.

1.3.2.1 SOIL PATHWAYS

EDB has been quantified in soil at the Simplot site (see Section 1.2.2). The extent of impacted soil appears to be limited to the area of MW-5D, MW-5S, GP-7, and SB-12 (**Figure 9**). The exception is boring SB-5, which had EDB at 8.4 µg/Kg, though the soil samples from borings surrounding SB-5 had non-detected levels of EDB. Impacted soil is within the caliche interbeds (**Table 7**). The maximum EDB concentration detected was 218 µg/Kg at a depth of 20 to 22 feet bgs in boring MW-5S. This sample was in the caliche interbeds and at the vadose zone/groundwater interface. EDB was 12 µg/Kg at the 13- to 16-foot-depth for GeoProbe™ sample GP-7. It is possible that EDB-impacted soil continue to act as a secondary source for EDB leaching to groundwater. However, the caliche interbeds retard the percolation of water and thus the movement of EDB, as the hydraulic conductivity through this material is low. Because of the volatile nature of EDB, it is postulated that the primary and much of the secondary source of this material dissipates over time and what remains on site is the remnant of an old release. The location of the EDB-impacted soil correlates with the lowest elevation (trough) of the caliche on site (**Figure 8**). Thus, the conceptual model assumes that EDB was released on the surface or subsurface and infiltrated and/or leached in a dissolved state to the top of the caliche and then moved by gravity to the low lying caliche layer near MW-5. This EDB then slowly infiltrated into the caliche in this low lying area. It is possible that the EDB traveled beneath the caliche through either areas with no caliche or areas where the caliche layer was compromised or removed; however, analysis of soil samples collected beneath the caliche layer have been non-detected for EDB (**Table 7**).

Section 2.2.2 provides further discussion of EDB in soil and an estimated of volume of impacted soil.

1.3.2.2 GROUNDWATER PATHWAYS

EDB has been found in the shallow aquifer (water table aquifer) in the area of MW-5S and MW-6S beneath the Simplot facility (**Table 11**). EDB has not been detected in off-site monitoring wells MW-1, MW-2, MW-3, and MW-4, MW 9S, or MW-10S (**Table 11**). All monitoring wells are constructed in the shallow aquifer. Based on groundwater contour mapping, wells MW-2, MW-4 (decommissioned), and MW10S are downgradient of the site at least part of the year. In addition, these wells are between the site and City Well #5, where EDB has been detected. If migration of EDB from the Simplot site to City Well #5 is occurring via the shallow aquifer, then EDB would be detectable in MW-4, MW-10S, and MW-8S).

As described previously, EDB was detected in City Well #4 and the well was permanently decommissioned in 2011. Shallow groundwater flow characterization indicates flow direction from the Simplot site is either away or cross-gradient from this well. Thus migration of EDB through the shallow aquifer under transient flow conditions is unlikely. However, the hydraulic capture zone of City Well #4 during pumping is unknown. City Well #4 was drilled in 1957 to a depth of 319 feet bgs and completed open hole below 80 feet.

Several hypotheses could explain EDB in City Wells #4 and #5:

1. The design of City Well #4 created a conduit between the shallow aquifer and the deeper Wanapum aquifer (commingled). As a result, if contamination was present in the shallow aquifer, pumping the well would draw in contamination within its capture zone and impact the lower aquifer through intra-well transfer.

2. City Well #5 is located within 600 feet of City Well #4. Data collected by Gray and Osborne indicates that there is hydraulic communication between these wells (e.g., pumping of City Well #5 resulting in drawdown of the water column in City Well #4). EDB contamination introduced into the Wanapum aquifer through City Well #4 could then migrate to City Well #5 within the Wanapum aquifer.
3. The construction of City Well #5 is similar to City Well #4 in that it does not have adequate hydraulic separation between the shallow aquifer and the deeper aquifer. Thus, it too could act like a conduit. The pumping of this well could draw in contamination from the shallow aquifer within its capture zone and impact the lower aquifer through inter and intra-well transfer.
4. Combinations of 1, 2, and 3 above.

The results of the 2013 pump test of City Well #5, conducted with the packer in place, revealed no groundwater elevation drawdown in the shallow aquifer. Thus, with the packer in place, there is no measurable connection between the shallow aquifer and the Wanapum aquifer to cause drawdown. This result and off-site groundwater monitoring, suggest that the EDB detected in groundwater at the Simplot site does not present a current-day risk to the deeper aquifer. However, it is unclear if there is a hydraulic connection between City Well #5 pumping and the shallow aquifer without a packer.

In summary, there are two potential exposure pathways for groundwater:

- EDB in the shallow aquifer beneath the Simplot site. Currently, conditions show EDB remaining on site and associated with saturated conditions in the caliche interbeds, though a future pathway for off-site shallow groundwater EDB migration is considered.
- EDB in the deep aquifer (Wanapum aquifer), in the area of City Well #5. This EDB is postulated to be a remnant of a past release(s) (see hypotheses above for potential explanations).

1.3.2.3 ATMOSPHERIC RELEASES

EDB volatilization from soil and groundwater into buildings is a potential future exposure pathway. EDB in soil and groundwater is limited to the western end of the site (**Table 7**) and is deep (generally between 11 and 23 feet). Thus, vapor intrusion is not expected to be an important exposure pathway.

1.3.2.4 SURFACE WATER AND SEDIMENT

The closest surface water is the East Low Canal, which is a losing stream through the project area. Thus, the EDB in groundwater entering surface water is not a completed pathway.

1.3.2.5 IDENTIFICATION OF EXPOSURE SCENARIOS

The development of exposure scenarios is based on the conceptual site model, information obtained during the RI, and on State of Washington risk assessment guidance. Potential exposure scenarios include residential, industrial, utility worker, and agricultural. **Table 14** summarizes current and future potential exposure scenarios for the Simplot site. No current exposure of EDB to humans has been identified as completed pathways associated with the site. While there is potential EDB exposure with City Well #5, under current conditions (packer in place in Well #5 and based on groundwater monitoring results), there is not a completed migration pathway from the on-site EDB and Well #5.

This does not exclude past migration pathways, when the packer was not in place and Well #4 was operational. Future exposure scenarios include on-site industrial exposure to impacted soil and groundwater. Because there is a detectable level of EDB in groundwater beneath the site, a future scenario includes the potential for off-site migration and groundwater exposures via ingestion, inhalation, and dermal contact.

A “primary” source of EDB in a risk assessment context is the original source such as a leaking 55-gallon drum. No primary sources remain at the site. A “secondary” source is a contaminated medium that releases the contaminant to another medium (e.g., impacted soil can be a secondary source for EDB, where this compound could leach to groundwater or volatilize into a building). Three secondary EDB sources are identified: soil at the site; groundwater at the site, and the deeper Wanapum aquifer in the area of City Well #5. It is unknown how the deeper aquifer became a secondary source based on RI results; however, the hypotheses in Section 1.3.2.2 give some ideas as to how this may have occurred.

1.4 Applicable, Relevant, and Appropriate Requirements (ARARs) Analysis

Applicable or relevant and appropriate requirements (ARARs) are any federal or state statutes that pertain to the protection of human life and the environment in addressing specific conditions or use of a particular cleanup technology at a site. "Applicable" requirements are those cleanup standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance. "Relevant and appropriate" requirements are those cleanup standards, while not "applicable," address problems or situations sufficiently similar to those encountered that their use is well-suited to the particular site. ARARs may be divided into three categories:

- Chemical-specific (e.g., PCB level in soil less than 50 milligrams per kilogram [mg/Kg])
- Action-specific (e.g., if on-site contaminant is proposed, landfills standards must be met)
- Location-specific (e.g., prohibition of land disposal in a floodplain)

1.4.1 Potential Chemical Specific ARARS

Chemical-specific ARARs are addressed in the MTCA regulations. As mentioned in Section 1.1, the objective of this RI/FS is to meet the requirements of Agreed Order 8241 in accordance with the MTCA Cleanup Regulation (WAC 173-340). The RI is designed to characterize site conditions in order to complete a FS and select a cleanup action as described in WAC 173-340-360 through 173-340-390.

The MTCA Cleanup Regulation sets forth the requirements and procedures to develop soil and groundwater cleanup standards. Cleanup levels must be based on the reasonable maximum exposure expected to occur under both current and future site conditions. MTCA provides methods A, B, and C for establishing cleanup levels.

Method A provides cleanup levels that are protective of human health for the most common hazardous substances found in soil and groundwater. It is designed for cleanups that are relatively straightforward or involve only a few hazardous substances. Method B is the most common method

for setting cleanup levels when sites are contaminated with substances not listed under Method A. Sites that are remediated to Method B cleanup levels generally do not require future use restrictions on the property due to the small amount of residual contamination typically left on the property. Method C has specific uses for both soil and groundwater. For soil, Method C can be used for sites where industrial land use represents the reasonable maximum exposure (see WAC 173-340-200 and 173-340-745(1)(a)(i) to determine site eligibility). For groundwater, Method C is available for sites where it can be demonstrated that constituent concentration levels comply with applicable state and federal laws, that all practicable methods of treatment have been used, that institutional controls are in place, and where one or more of the following conditions exist: Method A or B levels are below technically possible concentrations; Method A or B are below area background concentrations; or, the attainment of Method A or B levels would potentially create a significantly greater overall threat to human health or the environment.

1.4.1.1 POTENTIAL ACTION SPECIFIC ARARS

Potential action-specific ARARs will depend upon the proposed remediation alternative. For example, if the soil is removed from the site and sent to a solid waste landfill facility, the ARARs related to the removal, transport, and treatment must be met.

1.4.1.2 POTENTIAL LOCATION SPECIFIC ARARS

Potential location-specific ARARs will depend upon the proposed remediation alternative and the physical characteristics of the site. Examples of potential location-specific ARARs are archaeological areas, endangered species habitat, and floodplains.

1.5 Cleanup Levels/Risk Assessment Analysis

The risk characterization integrates information from the exposure and effects assessment to estimate the risk of adverse effects to exposed populations and communities in an ecosystem. For an adverse effect to occur, two conditions must be met:

- The contaminant must be present in the environment at concentrations sufficient to exert an adverse effect.
- In this case, humans must come in contact (exposure) with the contaminant.

For MTCA cleanup standards, there are two primary components: cleanup levels (CULs) and points of compliance. CULs determine at what level a particular hazardous substance does not threaten human health or the environment. Points of compliance designate the location on the site where the CULs must be met. The cleanup actions are those methods that could be used to clean up a site. Cleanup actions must also comply with applicable laws, protect human health and the environment, provide for compliance monitoring to ensure effectiveness, provide for permanent cleanup to the maximum extent practicable, provide for a reasonable restoration time frame, and considers public concerns.

1.5.1 Cleanup Levels

The MTCA has three options to establish CULs. Method A provides tables of levels that are protective of human health for 25 to 30 of the most common hazardous substances found in soil and groundwater. Method A is designed for cleanups that are relatively straight forward or involve only a few hazardous substances. Method A cleanup levels for EDB in soil are the same for both

unrestricted land uses and industrial land at 5.0 µg/Kg. The Method A cleanup level for groundwater is 0.01 µg/L.

Method B is used on sites that are contaminated with substances not listed under Method A. sites that are cleaned up to Method B levels generally do not need future restrictions on property use. Method C CUL is used to set soil and air CUL at industrial sites. Method C may be used when Method A or B CUL are lower than technically possible.

Table 15 provides calculated CULs for EDB for each method. The Cleanup Levels and Risk Calculations (CLARC) database and spreadsheets were used to calculate CULs. CLARC is a searchable database with technical information regarding the establishment of CULs under the MTCA cleanup regulation, Chapter 173-340 WAC. The technical information helps the user establish site-specific CULs. The CLARC summary for EDB is shown in Appendix F. These were used to calculate preliminary potable water and soil CULs. The *Workbook Tools - MTCASGL11* program was used for soil. The calculation sheets are in Appendix F.

The calculated soil concentration for EDB that is protective of groundwater is 0.27 µg/Kg. For this site, the soil EDB CUL is set at 0.27 µg/Kg. Test America Denver (Washington accredited laboratory) indicated that the labs practical quantitation limit (PQL) is 0.1 µg/Kg in soils using USEPA Method 8019-94.

For groundwater, the CUL is set based on the DOH's ARAR and the federal MCL of 0.05 µg/L. The PQL for EDB in water is 0.01 µg/L (this is also DOH's minimum reporting level).

1.5.2 Terrestrial Ecological Evaluation

Per WAC 173-340-7490, a terrestrial ecological evaluation (TEE) is used to determine "whether a release of hazardous substances to soil presents a threat to the terrestrial environment," to characterize "existing or potential threats to terrestrial plants or animals exposed to hazardous substances in soil," and aid in establishing "site-specific cleanup standards for the protection of terrestrial plants and animals." A TEE must be conducted at all sites where a release of a hazardous substance to soil has occurred. As EDB has been released to the soil, this regulation applies to the site, and an exclusion, a simplified TEE, or a site-specific TEE is required.

The Simplot site is excluded from conducting a TEE because it meets the following exclusion (a site needs only meet one exclusion criterion, but this site meets two):

- Exclusion 1: Will all soil contamination be located at least 6 feet beneath the ground surface (conditional point of compliance)? If yes, the site qualifies for exclusion with institutional controls.
- Exclusion 3: Is there less than 1.5 acres of contiguous undeveloped land on the site, or within 500 feet of any area of the site affected by hazardous substances other than those listed in WAC 173-340-7491(1)(c)(ii)? AND Is there less than 0.25 acres of contiguous undeveloped land on or within 500 feet of any area of the site affected by hazardous substances listed in WAC 173-340-7491(1)(c)(ii)?

For this Simplot site, the answer is yes to both questions; therefore, the site qualifies for an exclusion. The site is developed and maintained for weed control as are the surrounding properties.

Furthermore, EDB is greater than 6 feet deep, and institutional controls are proposed. Thus, there is no chance of wildlife exposure to EDB at this site.

A completed TEE form in included in Appendix F. In summary, the land use at the site and the areas around it make substantial wildlife exposure unlikely. The nearest undeveloped land area is approximately 3 miles west/southwest of the site and is thousands of acres in size. Part of this area includes the Columbia National Wildlife Refuge.

1.6 Discussion and Recommendations

The following discussion describes soil and groundwater conditions at the site:

- EDB has been quantified in soil at the Simplot site with the extent of impacted soil limited to the area of MW-5, MW-5S, GP-7, and SB-12 (**Figure 9** and **Table 7**). Impacted soil is within the caliche hardpan and caliche interbeds. The maximum EDB concentration detected was 218 µg/Kg at a depth of 20 to 22 feet bgs in boring MW-5S. This sample was at the vadose zone/groundwater interface. GeoProbe™ sample GP-7 detected EDB at 12 µg/Kg at the 13- to 16-foot depth range. Because of the volatile nature of EDB, it is postulated that the primary and much of the secondary sources of this material have dissipated and what remains on site is the last remaining remnant of an old release. The location of the EDB-impacted soil correlates with the lowest elevation (trough) of the caliche on site (**Figure 8**). Thus, the conceptual model assumes that EDB was released on the surface or subsurface and infiltrated and/or leached in a dissolved state to the top of the caliche and then moved by gravity to the low lying caliche layer near MW-5. Section 2.2.2 provides further discussion of EDB in soil and an estimated of volume of impacted soil.
- EDB has been found in groundwater beneath the site associated with shallow well MW-5S, which is screened through the vadose zone/groundwater interface. Shallow well MW-6S has also had some detections of EDB but was non-detect in October 2013 and 0.35 µg/L in December 2017. Monitoring well MW-5D (paired well to MW-5S), which is screened at the unconsolidated groundwater/basalt interface, has been non-detect (or at trace amounts of EDB) during the RI monitoring period. EDB has not been detected in off-site monitoring wells, including wells that are downgradient (at least part of the year) from the Simplot facility. Groundwater samples collected and analyzed in December 2017 (3 years from the previous monitoring) were consistent with previous findings. Monitoring well MW-5S is screened in the caliche zone and based on soil sampling from this well, it is postulated that the detection of EDB in this well is from the slow dissolution of EDB held in this confining layer. The fact that EDB has not been detected in downgradient wells (e.g., MW-8S, MW-10S, MW-4, MW-3), suggest that the presence is localized and there is no established plume.
- Section 1.1.5 describes EDB concentrations in City Well #4 and City Well #5 and sample results are summarized in **Table 4**. City Well #4 was drilled in 1957 to a depth of 319 bgs and completed open hole below 80 feet. The City of Warden permanently decommissioned the well in December 2010. The well was abandoned because of the presence of EDB and also because of concerns by DOH that the well's shallow casing depth and its proximity to Washington Potato's operations and Burlington Northern railroad lines could pose risk to wellhead protection (industrial activities take place within the well's 100-foot sanitary control area). While the City of Warden informed HDR that the well has been closed, HDR did not

find a well log documenting the well abandonment. The City of Warden installed a packer in City Well #5 in 2004 to isolate the lower portion of the well for water production and to prevent shallow EDB-impacted water (if present) from entering the well. The City of Warden periodically pumps the well for irrigation use at a wastewater land application site. City Well #5 was completed in the Wanapum aquifer. It pre-dates state regulations and was not constructed in a manner to effectively seal the shallow aquifer from the Wanapum aquifer.

- The CUL for EDB is soil is set at 0.27 µg/Kg, which is in accordance with MTCA Method B (the CLARC is 0.27 µg/Kg for protection of groundwater). For groundwater, the CUL is set at the state drinking water MCL of 0.05 µg/L.
- Shallow groundwater flow characterization indicates flow direction from the Simplot site is either away or cross-gradient from former City Well #4. Thus migration of EDB through the shallow aquifer under transient flow conditions is unlikely. However, the hydraulic capture zone of City Well #4 during past pumping is unknown. City Well #5 is located approximately 800 feet west-southwest of Simplot's site. The packer installed in this well in 2004 is 200 feet bgs and isolates the lower portion of the well for water production. The City of Warden periodically pumps the well for irrigation use at a wastewater land application site. City Well #5 was drilled in 1968 to a depth of 368 feet bgs and completed open hole below 54 feet. Well #5 has had detection of EDB. The results of the 2013 pump test and off-site groundwater monitoring suggest that the EDB detected in groundwater at the Simplot site does not present a current risk to the deeper aquifer in the study area with the pumping of City Well #5 (with packer in place). However, the hydraulic connection between this deep well and the shallow aquifer without the packer was not determined.
- The nature of high density EDB with a potential ability to migrate through clay, still indicates a risk to the basalt aquifers from a spill at the site; however, current levels of EDB in the soil and groundwater on site are not indicative of an on-going non-aqueous phase liquid (DNAPL) type condition.
- No primary sources (e.g., original EDB tank) remain on site. Three secondary sources (contaminated media) are identified as soil at the site, groundwater at the site, and the deeper Wanapum aquifer in the area of City Well #5. It is unknown how the deeper aquifer became a secondary source; however, the hypotheses in Section 1.3.2.2 provide possible explanations. No current exposure of EDB to humans has been identified as completed pathways associated with the site. While there is potential EDB exposure with City Well #5, under current conditions (packer in place in Well #5 and based on groundwater monitoring results), there is not a completed migration pathway from the on-site EDB to Well #5. This does not exclude past migration pathways, when the packer was not in place in Well #5 and Well #4 was operational. Future exposure scenarios include both on-site industrial exposure to impacted soil and groundwater. Furthermore, because there is a detectable level of EDB in groundwater beneath the site, a future scenario includes the potential for off-site migration and groundwater exposures via ingestion, inhalation, and dermal contact.

2 Feasibility Study

2.1 Identification of Contamination to be Remediated

The chemical of concern is EDB.

2.2 Identification and Initial Screening of Remedial Alternatives

2.2.1 Development of Cleanup Levels and Remedial Action Objectives

Table 15 summarizes CUL for EDB in soil, groundwater, and air for the site. The CULs are as follows:

- 0.27 µg/Kg EDB in soil for protection of groundwater (based on MTCA Method B and with a CLARC is 0.5 µg/Kg).
- 0.05 µg/L EDB in groundwater based on state and federal MCL

The potential exposure pathways are provided in **Table 14**. No "complete" exposure pathways for EDB in soil and groundwater at the Simplot site are identified for current conditions. Potential future exposure pathways are identified in **Table 14** and include:

- Trenching (construction) – inhalation, ingestion, and dermal contact exposure routes. These exposure pathways to workers are considered under potential future activities, because EDB has been detected in subsurface soil (see **Figure 9** and **Table 7** for location of EDB in soil).
- Groundwater – ingestion, inhalation, and dermal contact exposure routes. These exposure pathways are considered because it is possible that a shallow well could be installed on site in the future and used for a drinking water supply. Furthermore, a possible future scenario is the migration of EDB in the shallow aquifer off site.
- Volatile emission – inhalation exposure route of EDB vapor intrusion in future buildings placed on site. This pathway is considered unlikely to be complete in that EDB in soil is deep (greater than 10 feet), limited in area, and is bound with the caliche layer. Inhalation during construction activities (e.g., on-site remediation) is a potential exposure pathway.

The remedial action objectives (RAOs) are developed to prevent unacceptable risk to current and future receptors.

The RAO for soil is as follows:

- For protection of human health, prevent EDB exposure to future on-site receptors through trenching activities (dermal contact and ingestion through direct soil contact). The Method B, unrestricted land use, CUL is 500 µg/Kg, which exceeds the highest detected soil value of 218 µg/Kg. Thus, the current EDB soil concentrations are below the risk based standards and this scenario is not further considered.
- For protection of human health, reduce EDB concentrations in soil to protect groundwater, where the soil CUL for protection of groundwater is 0.27 µg/Kg EDB.

The RAO for groundwater is as follows:

- For protection of human health, prevent ingestion of groundwater, both on site and off site with EDB in excess of the federal and state MCL of 0.05 µg/L.

2.2.1.1 MAXIMUM EXPOSURE DURING ON-SITE REMEDIATION

Prior to on-site remediation activities (both drilling and excavation), a health and safety plan will be developed that includes air monitoring for using a photoionization detector (PID). The Occupational Safety and Health Administration (OSHA) permissible exposure limit for an 8-hour time weighted average (TWA) is 20 parts per million volume (ppmv). The PID correction factor using isobutylene calibration is 1.7, which results in a PID reading of 34 ppmv. The reading would be the trigger concentration for on-site remediation workers needing to done an air purifying respirator (full-face respirator with organic vapor cartridges). The actual trigger concentration would likely be lower than 34 ppmv and will be determined in the site health and safety plan. The immediately-dangerous-to-life-or-health (IDLH) condition is 100ppmv (or 170 ppmv with the PID calibrated to isobutylene).

2.2.1.2 CITY WELL #5

Through groundwater monitoring and a pump test, the RI determined no current direct link (conveyance through groundwater) between the Simplot site and City Well #5 based on site and area-wide conditions and because a packer is in place in the well. A hydraulic connection between the well and the shallow aquifer without the packer in place has not been determined. Hypotheses of how the EDB may have migrated to this deeper aquifer are described in Section 1.3.2.2. Since EDB is present in the deeper Wanapum aquifer in the area of City Well #5 (possibly City Well #4 but this well was decommissioned in 2011), City Well #5 presents an exposure pathway for EDB from the Wanapum aquifer to the surface. This well is currently pumped and used with food processing wastewater for land application during growing season. This well also serves as a backup well (emergency use only) for potable use by the City of Warden. Through the use of institutional controls (restricted use of City Well #5), the groundwater-EDB ingestion exposure pathway (current and future) is not complete (no human ingestion of water).

2.2.2 Identification of Areas and Volumes of Impacts

Section 1.2.2 describes soil investigations conducted as part of the RI. A total of 27 soil borings have been advanced on site; 12 soil borings as part of the RI (includes monitoring well borings) and 15 soil borings conducted by Ecology (**Figure 6**). All borings were in the vadose zone or into the shallow aquifer to support monitoring wells. All monitoring wells are in the shallow aquifer, where the shallow aquifer is defined as unconsolidated deposits and includes weather basalt. EDB has been detected in 5 of the 27 borings. As illustrated in **Table 7** and in **Figure 9**, two areas have soil impacted by EDB: the area around SB-5; and a larger area between MW-5D and SB-12. For SB-5, EDB was detected in a soil sample 2 feet into the caliche at a concentration of 8.4 µg/Kg. Five borings surrounding SB-5 (SB-4, GP-6, SB-7, SB-6, GP-5, and SB-21) had no EDB in samples collected from the same elevation and deeper within the caliche interbeds. On the west side of the site, four borings had soil samples with detectable EDB: SB-12, MW-5D, GP-7, and MW-5S. SB-12 had EDB in soil collected from approximately 1 to 2 feet into the caliche interbeds, at a concentration of 3.19 µg/Kg. Borings SB-3, SB-11 and SB-9 had no EDB detected in the soil samples. EDB was found in the caliche at depths ranging from 10 to 22 feet bgs. Concentrations were as follows:

- SB-5 (10 feet bgs) 8.4 µg/Kg

- SB-12 (17 feet bgs) 3.2 µg/Kg
- G-7 (14 feet bgs) 11.8 µg/Kg
- G-7 (16.5 feet bgs) 11.6 µg/Kg
- MW-5S (20 feet bgs) 218 µg/Kg
- MW-5D (10 feet bgs) 6.2 µg/Kg

Maximum concentration was 218 µg/Kg and the average concentration (n=5, used average for G-7) was 49.5 µg/Kg.

Thus, the area of highest concentrations, and also the area where there is an elevation trough at the top of caliche layer, is between MW-5S, GP-7, and SB-11 (**Figure 8**). The area is defined as approximately 0.1 acres. Assuming caliche between 12 to 22 feet bgs, the volume of soil is estimated at 1,600 cubic yards of soil. The actual EDB-impacted soil is a fraction of the caliche, as illustrated in **Table 7** (Section 2.2.5 further describes estimated volumes of EDB-impacted soil). Because the near-surface soil in this area has been non-detected for EDB, this suggests that either EDB migrated into this area (e.g., migrated on top of the caliche from an upgradient source area), or that EDB was released in this area and migrated downward and that the EDB near the surface has dissipated over time. **Figure 17** illustrates the area of EDB soil impact.

In groundwater, well MW-5S is the only well to show consistent levels of EDB (**Table 11**). MW-6S has had EDB detection, but was non-detected in October 2013 and was 0.35 µg/L in December 2017. Furthermore, no EDB has been detected in off-site monitoring wells. No EDB plume has been delineated from the monitoring well network sampling.

2.2.3 Point of Compliance and Compliance Monitoring

2.2.3.1 SOIL

The point of compliance is the point or points where the soil CUL shall be obtained. Per WAC 173-340-740(6)(b), for CULs *based on protection of groundwater, the point of compliance shall be established throughout the site*. For CULs based on chronic or carcinogenic threats, the true mean soil concentration shall be used to evaluate compliance with the CUL (WAC 173-340-740(7)(c)(iv)(B)). In practice, the upper, one-sided, 95 percent confidence limit of the mean soil concentration is compared to the CUL for compliance monitoring. Also, it is appropriate to determine this compliance in the area of impact, and not for the entire site.

2.2.3.2 GROUNDWATER

The standard point of compliance for groundwater is the entire site from the uppermost level of the saturated zone extending vertically to the lower most depth, which could potentially be affected by the site (WAC 173-340-720(8)(a)). As presented in Section 1, EDB in groundwater beneath the site is identified and limited to the area of shallow well MW-5S, which is screened through the vadose zone/groundwater interface. Shallow well MW-6S has also had detections of EDB, but has been non-detect or near detection limits for the last two sampling events. Monitoring well MW-5D (paired well to MW-5S) is screened at the unconsolidated groundwater/basalt interface (still part of the upper aquifer) has been non-detect (or at trace amounts of EDB) during the RI monitoring period. Trace concentrations of EDB at MW-5D since 2012 are thought to be due to lab or site cross-contamination due to the low concentrations and due to non-detect readings at past sampling events.

EDB has not been detected in off-site monitoring wells, including wells that are downgradient (at least part of the year) from the Simplot facility. None of the deep monitoring wells (with the exception of the trace readings at MW-5D) that are finished in the fractured basalt (but still representative of the shallow aquifer) have had any detected EDB results. Monitoring well MW-5S is screened in the caliche zone and based on soil sampling from this well, it is postulated that the detection of EDB in this well is from the slow dissolution of EDB held in this confining layer. The fact that EDB has not been detected in downgradient wells (e.g., MW-8S, MW-10S, MW-4, MW-3), suggest that the presence is localized and there is no established plume.

EDB has been consistently detected in City Well #4 and City Well #5 since 1989. City Well #4 has been abandoned since December 2010. Through groundwater monitoring and a pump test, the RI has determined no current direct link (conveyance through groundwater) between the Simplot site and City Well #5 (with packer in place) based on site and area-wide conditions. However, City Well #5 was tested with a packer in place to isolate the shallow aquifer from the Wanapum aquifer. Hypotheses of how the EDB may have migrated to this deeper aquifer are described in Section 1.3.2.2. Regardless, City Well #5 presents an exposure pathway for EDB from the Wanapum aquifer to the surface.

It may not be practicable to meet the CUL for MW-5S within a reasonable restoration time frame, and Simplot requests a conditional point of compliance as the edge of property. Per WAC 173-340-720(8)(c), *where a conditional point of compliance is proposed, the person responsible for undertaking the clean up action shall demonstrate that all practicable methods of treatment are to be used in the site cleanup*, which is addressed through the remedial alternative analysis below.

2.2.4 General Response Actions and Initial Screening

General response actions for addressing EDB in soil and groundwater are grouped into the following categories:

- No action
- Institutional controls
- Cover/capping (soil only)
- Monitored natural attenuation
- In situ treatment
- Ex situ treatment
- Removal
- Containment (groundwater only)

2.2.4.1 SOIL

Brief descriptions of each general response for soil are provided below and further described in **Table 16**.

- The *no action* alternative is the basis for comparison to other alternatives and represents the most likely future scenario in absence of remedial action. This is not the same as the baseline cleanup action as defined in WAC 173-340-360(3)(e)(ii)(B), which is further addressed in Section 2.2.5.
- *Institutional controls* include actions that minimize or eliminate potential human contact with soil EDB and generally include land use restrictions. An example of an institutional control

would be a restriction preventing the placement of building in the area of detected EDB in soil.

- *Cover/capping* approach involves placing materials on the surface of the impacted soil (physical or hydraulic barrier) to minimize or prevent percolation of meteoric water and subsequent leaching of EDB.
- *Monitored natural attenuation* processes would involve allowing the soil EDB to volatilize, biodegrade, and dissolve in groundwater over time with long-term EDB groundwater monitoring. It is postulated that much of the EDB released to the environment has dissipated and what remains is the last remnants of a historic release.
- *In situ treatment* processes would reduce EDB concentrations in the soil system. Such treatment generally focuses on the soil vapor extraction to remove EDB, which is a volatile compound. This could also include in situ bioremediation (e.g., create anoxic soil conditions through addition of an organic reagent).
- *Ex situ treatment* involves excavating soil, treating the soil, and then either returning the soil to the same excavation or reuse of the soil off site (e.g., construction fill).
- *Removal* involves excavating the impacted soil and transporting the material to a solid or industrial waste landfill, or reusing the soil (e.g. as fill material for construction). For purposes of this evaluation, removal with on-site *ex situ treatment* are considered along with removal with off-site landfilling.

2.2.4.2 GROUNDWATER

A brief description of each general response for groundwater is provided below and further described in **Table 17**:

- The *no action* alternative is provided as a basis for comparison to other alternatives and represents the most likely future scenario in absence of remedial action.
- *Institutional controls* include actions that minimize or eliminate potential human ingestion of impacted groundwater. On-site institutional controls could include prohibition of potable wells. Off-site institutional controls could include future well restrictions, but they are more difficult to implement.
- *Monitored natural attenuation* processes for EDB in groundwater are advection, dispersion, sorption, biodegradation, and volatilization. Monitoring would be conducted to assess the extent of EDB impacts and the rate of natural attenuation (see discussion below in this section).
- *In situ treatment* reduces the EDB concentration in groundwater. An example of in situ treatment would be air sparging.
- *Ex situ treatment* involves extracting groundwater, treating the water, and then either re-injecting the groundwater or using it elsewhere (e.g., irrigation water source).
- *Removal* is related to soil for this site and not groundwater.
- *Groundwater containment* – technologies that prevent contaminated groundwater from coming into contact with future receptors. This could be a pump and treat system, where there is hydraulic control of impacted groundwater. Containment is similar to ex-situ

treatment, except for containment, there is more focus on hydraulic control. For purposes of this evaluation, ex-situ treatment and containment are combined.

For assessing biodegradation, monitoring could be conducted to assess if there is active biological and chemical breakdown of EDB in groundwater. This would include testing water for biological activities (for example measuring electron acceptors such as nitrate, sulfate, and presence of methane). However, the extent of EDB in groundwater is limited to one area on site (primarily MW-5S), the EDB is associated with the caliche and concentration levels are relatively low, so it questionable if accurate measurements of biological activity are achievable. Furthermore, while advection, dispersion, sorption, and volatilization mechanisms occur for EDB under site conditions, literature suggests that EDB undergoes little or no biodegradation under aerobic aquifer conditions (McKeever 2011).

2.2.4.2.1 City Well #5

Through the use of institutional controls (restricted use of City Well #5), the groundwater-EDB ingestion exposure pathway (current and future) is not complete. Furthermore, no current migration pathway exists between the site and City Well #5, as demonstrated through groundwater monitoring and the pump test. The presence of the packer in City Well #5 provides protection between the shallow aquifer and the deeper aquifer. Regarding general responses for City Well #5, besides on-going institutional controls, another action for this well that would eliminate potential exposure to receptors is the decommissioning of City Well #5. The discussion on alternatives screenings below focuses on the Simplot site only.

2.2.5 Remedial Alternatives

The MTCA cleanup regulation sets forth the requirements and procedures to develop soil and groundwater cleanup standards. CULs must be based on the reasonable maximum exposure expected to occur under both current and future site conditions.

The results of remedial technology screening presented above are used to assemble remedial alternatives. For soil, all remedial processes are carried forward into alternatives except for “excavation and landfilling.” The cost for landfilling is very high and because the site is not in use (the warehouses are used for storage but the site is mostly inactive), on-site treatment of soil and returning the soil to the excavation pit (or using for other purposes) is the most economical and environmentally sound option. For groundwater, pump and treat technologies (containment) are not advanced because current impacted groundwater associated with the Simplot site is limited to MW-5S and possibly MW-6S, both being shallow wells, and there is no evidence of a plume or current off-site migration of EDB from the site.

The following alternatives for analysis are based on the preliminary screenings described in **Table 16** and **Table 17**:

- **Alternative 1 – No action**
- **Alternative 2 – Institutional controls and monitored natural attenuation for soil and groundwater**

  This alternative includes on-site institutional controls for land use, where there would be restrictions on building locations, and the prohibition of potable wells on site. These controls would remain until the RAO are met for groundwater protection. This alternative would rely

on the monitored natural attenuation of EDB in both soil and groundwater. As described for the site conceptual model, natural attenuation processes for EDB in groundwater are advection, dispersion, sorption, biodegradation, and volatilization. In aerobic soils and groundwater, EDB undergoes minimal biodegradation (McKeever 2011); therefore, natural attenuation is mostly reliant on volatilization, advection, and dispersion. The site conceptual model is that EDB released to the environment has mostly dissipated and what remains in site soil and groundwater is the last remnant of a historic release. The fact that EDB has not been detected in downgradient wells (e.g., MW-8S, MW-10S, MW-4, MW-3), suggest that the presence is localized and there is no established plume.

Monitoring would be conducted to assess EDB in groundwater and to assess the rate of natural attenuation. See Section 2.2.6 for more detailed description of this alternative.

- **Alternative 3a – Institutional controls, targeted soil excavation including soil/groundwater interface, treatment, and return (or use elsewhere), and monitored natural attenuation of groundwater**

  The institutional controls would be the same as Alternative 2. This alternative would include the targeted excavation of EDB-impacted soil including soil at the soil/groundwater interface where EDB is detected. The goal would be to remove soil such that the remaining soil meets the CUL of 0.27 µg/Kg at the point of compliance (see Section 2.2.3.1). Confirmation sampling would be based on the upper, one-sided, 95 percent confidence limit of the mean soil concentration. EDB-impacted soil would be excavated and treated on site through ex-situ vapor extraction process (some biodegradation may occur but main mechanism is expected to be volatilization). Soil would then be returned to the excavation pit and the site re-graded. As an alternative, soil could be used for other uses such as fill material. This alternative would rely on removal of soil at the soil/groundwater interface as well as natural attenuation of EDB in groundwater similar to Alternative 2; however, unlike Alternative 2, Alternative 3a involves secondary source (e.g., EDB-impacted soil including soil at the soil/groundwater interface) removal. Caliche would be sampled using a hollow-stem auger equipped with a split-spoon sampler (California modified type) that would be driven (hammered) into the layer.

  A concern with excavation is that it may be difficult to excavate the caliche hardpan and interbedded materials and could require either ripping the layers (e.g., bulldozer with ripper) or a pneumatic hammer (e.g., equipped on a trackhoe). Soil excavation would be done in a “targeted fashion,” where first, additional soil borings would be conducted to further “pin-point” EDB location and a detailed excavation plan developed. The excavation would focus on opening up the areas of highest EDB soil levels, testing soil in place, and targeting only the soil with detectable EDB, which is primarily the area near MW-5S. This approach would reduce the risk of dislodging the EDB, but there would still be risk to groundwater through excavation activities. Excavation would go into the soil/groundwater interface since EDB has been detected in zone but would attempt to minimize digging through the caliche bottom. See Section 2.2.6 for more detailed description of this alternative.

- **Alternative 3b – Institutional controls, targeted soil excavation including soil/groundwater interface, offsite landfilling, and monitored natural attenuation of groundwater**

  This alternative is the same as Alternative 3a, except rather than on-site treatment of impacted soils the soils are transported off-site to an industrial landfill.

2.2.6 Detailed Analysis of Remedial Alternatives

2.2.6.1 MINIMAL REQUIREMENTS FOR CLEANUP ACTIONS

2.2.6.1.1 Threshold Requirements

Per WAC 173-340-360 (2)(a), the threshold criteria include overall protection of human health and the environment, compliance with ARARs, and opportunity for compliance monitoring.

- Protection of Human Health and the Environment - This criterion describes how the remedial alternative provides overall protection of human health and the environment.
- Comply with Cleanup Standards and ARARs - The assessment for this criterion determines whether each remedial alternative complies with CULs and site-specific ARARs (see Sections 1.4.1 and 1.5.1).
- Provide for Monitoring - This criterion evaluates whether implementation of compliance monitoring is possible for each remedial alternative.

2.2.6.1.2 Other Requirements and Considerations

- Permanent Cleanup - A permanent cleanup action is defined as one in which cleanup standards can be met without further action being required, other than the approved disposal of any residue from the treatment of hazardous substances (WAC 173-340-200).
- Reasonable Restoration Time Frame - The assessment for this criterion determines whether cleanup actions provide for a reasonable restoration time frame.
- Public Concerns – Ecology conducts a public participation program as part of the RI/FS decisions.
- Groundwater cleanup actions - A permanent cleanup action shall be used at the point of compliance where practicable or in public interest. When permanent cleanup action is not required, additional measures need to be addressed including source removal and treatment and implementation of groundwater containment if appropriate.
- Institutional Controls - Cleanup actions shall not rely primarily on institutional controls and monitoring where it is technically possible to implement a more permanent cleanup action
- Releases and Migration – Cleanup action shall prevent or minimize releases of hazardous substances
- Dilution and Dispersion – Cleanup actions shall not rely primarily on dilution and dispersion unless the incremental costs of any active remedial measures grossly exceed the incremental benefit
- Disproportionate Cost Analysis – A comparison of costs to benefits shall be made for alternatives. Alternatives in the FS shall be ranked from most to least permanent (based on

criteria described below). As per WAC 173-340-360(3)(e)(ii)(B), the most practical permanent solution evaluated in the FS shall be the baseline cleanup action alternative against which cleanup action alternatives are compared. For this FS, Alternative 2 is considered the baseline cleanup action in that it provides for permanence through natural attenuation (permanent removal) of EDB in soils and groundwater.

2.2.6.2 EVALUATION CRITERIA

WAC 173-340-360 provides details on the selection of cleanup actions, including evaluation criteria. The three alternatives described previously represent cleanup actions and are evaluated with respect to cleanup standards that must be met for all clean actions. Here, the terms “cleanup actions” and “remedial alternatives” are interchangeable (Ecology defines cleanup action as *any remedial action, except interim actions, taken at a site to eliminate, render less toxic, stabilize, contain, immobilize, isolate, treat, destroy, or remove* (WAC 1730-340-200)).

- Protectiveness - This criterion describes how the remedial alternative provides overall protection of human health and the environment with consideration given to the following:
    - Elimination or removal of all physical hazards
    - The degree to which existing risks are reduced
    - Time required to reduce risk at the site and attain cleanup standards
    - On-site and off-site risks resulting from implementing the remedial alternative
    - Overall improvement of environmental quality
- Permanence - A permanent cleanup action is defined as one in which cleanup standards can be met without further action being required, other than the approved disposal of any residue from the treatment of hazardous substances (WAC 173-340-200). An evaluation of permanence considers the degree to which the remedial alternative permanently reduces the toxicity, mobility, or volume of hazardous substances, including the adequacy of the remedial alternative in destroying the hazardous substances, the reduction or elimination of hazardous substance releases and sources of releases, the degree of irreversibility of waste treatment process, and the characteristics and quantity of treatment residuals generated. Per WAC 173-340-360(3)(e)(ii)(B), the most practical permanent solution evaluated in the FS shall be the baseline cleanup action alternative against which cleanup action alternatives are compared. For this FS, Alternative 2 is considered the baseline cleanup action in that it provides for permanence through natural attenuation (permanent removal) of EDB in soils and groundwater.
- Cost – This criterion evaluates estimated costs to implement each remedial alternative. Due to the preliminary nature of FS cost estimates, cost should be regarded as having a relatively large degree of uncertainty (± 30 percent). As such, they are intended for use only in the relative comparison of remedial alternatives and should not be construed as actual cost estimates for implementing the chosen alternative. The costs account for the following:
    - Construction and oversight costs that include institutional controls, permits, equipment and materials, waste management, analytical services, and labor
    - Long-term operation, maintenance, and monitoring (OMM) costs that include maintaining institutional controls and permits, replacement and repair of equipment and materials, waste management, analytical services, labor, and accounting for inflation based on estimated design life of the remedial action.

- Effectiveness Over the Long Term - Long-term effectiveness includes the degree of certainty that the remedial alternative will be successful, the reliability of the remedial alternative during the period of time hazardous substances are expected to remain on-site at concentrations that exceed CULs, the magnitude of residual risk with the remedial alternative in place, and the effectiveness of controls required to manage treatment residues or remaining wastes. The following types of cleanup action components may be used as a guide, in descending order, when assessing the relative degree of long-term effectiveness (WAC 173-340-360 (3)(f)(iv)):
    - Reuse or recycling
    - Destruction or detoxification
    - Immobilization or solidification
    - On-site or off-site disposal in an engineered, lined, and monitored facility on site;
    - Isolation or containment with attendant engineering controls
    - Institutional controls and monitoring.
- Management of Short-term Risk - The assessment for this criterion examines the effectiveness of each remedial alternative in protecting human health and the environment during the construction and implementation of the remedy until the RAOs have been met.
- Technical and Administrative Implementability – This criterion evaluates the technical and administrative feasibility of remedial alternatives with consideration given to the following (WAC 173-340-360 (3)(f)(vi)):
    - Remedial alternative is technically feasible
    - Availability of off-site services, facilities, and materials
    - Health and safety of workers during implementation
    - Scheduling, size, and complexity
    - Future OMM requirements
    - Integration with existing operations at the site and other potential remedial actions
    - site access for construction operations and monitoring
    - Administrative and regulatory requirements can be met
- Considerations of Public Concerns – This criterion reflects preferences or concerns about remedial alternatives from regulators and the public. Public acceptance of the remedial alternatives will be evaluated during a subsequent 30-day public comment period associated with review of this RI/FS.
- Reasonable Restoration Time Frame - The assessment for this criterion determines whether cleanup actions provide for a reasonable restoration time frame. with consideration given to the following (WAC 173-340-360(4)):
    - Potential risks posed by the site to human health and the environment
    - Practicability of achieving a shorter restoration time frame
    - Current use of the site, surrounding areas, and associated resources that are, or may be, affected by releases from the site
    - Potential future use of the site, surrounding areas, and associated resources that are, or may be, affected by release from the site

- Availability of alternative water supplies
- Likely effectiveness and reliability of institutional controls
- Ability to control and monitor migration of hazardous substances from the site
- Toxicity of the hazardous substances at the site
- Natural processes that reduce concentrations of hazardous substances and have been documented to occur at the site or under similar site conditions

2.2.6.3 ANALYSIS OF REMEDIAL ALTERNATIVES

Following are descriptions of the remedial alternatives and evaluations of each with respect to the evaluation criteria described in Section 2.2.5. A summary of the evaluation is provided in **Table 18**.

- **Alternative 1** – No action
- **Alternative 2** – Institutional controls and monitored natural attenuation for soil and groundwater
- **Alternative 3a** – Institutional controls, targeted soil excavation including soil/groundwater interface, treatment, and return (or use elsewhere), and monitored natural attenuation of groundwater
- **Alternative 3b** – same as Alternative 3a, except rather than on-site treatment, soils are transported to an off-site landfill for disposal.

2.2.6.3.1 Alternative 1 – No Action

Remedial Alternative 1 involves leaving all concentrations of EDB in on-site soil and groundwater in place with no further action. It is included as a baseline to which other remedial alternatives can be compared.

2.2.6.3.1.1 Evaluation

- *Protectiveness* – RI indicates no current completed pathways for human exposure to EDB (also no ecological exposure); therefore, current conditions are protective of human health and the environment. There is potential for future exposure related to soil and groundwater pathways and potential for off-site migration. Monitoring well MW-5S is screened in the caliche zone and based on soil sampling from this well, it is postulated that the detection of EDB in this well is from the slow dissolution of EDB held in this confining layer. The fact that EDB has not been detected in downgradient wells (e.g., MW-8S, MW-10S, MW-4, MW-3) suggests that the presence is localized and there is no established plume. Thus, it is possible that this alternative would remain protection in the future, as it is currently. This alternative does not include monitoring or institutional controls; thus, without monitoring and controls in place, it would be uncertain if future exposure exists.
- *Permanence* – Not considered permanent cleanup (though it is possible with no action, there would be no future exposure, but without monitoring this cannot be determined.
- *Cost* – No costs associated with Alternative 1, though it could result in long-term liability to the site owner.

- *Effectiveness Over the Long Term* – Might be effective long-term based on RI results; however, this alternative includes no monitoring or institutional control. Therefore, it fails effectiveness evaluation criteria.
- *Management of Short-term Risk* – No remedial actions involved.
- *Technical and Administrative Implementability* – No action; therefore, nothing to implement.
- *Considerations of Public and Agency Concerns* – Without monitoring, institutional controls, and other remedial actions, this alternative would not be acceptable to Ecology or the public.
- *Reasonable Restoration Time Frame* – No remedial action would occur. It is possible that EDB would continue to dissipate over time, as evident from the RI; however, this alternative includes no monitoring.
- *Comply with Cleanup Standards and ARARs* – Would not comply with CULs for soil or groundwater.
- *Provide for Monitoring* – Alternative 1 does not include monitoring.

2.2.6.3.2 Alternative 2 – Institutional Controls and Monitored Natural Attenuation for Soil and Groundwater

As described under Alternative 1, the EDB-impacted soil and groundwater is primarily limited to the area of monitoring well MW-5S (**Figure 17**). It is postulated that the detection of EDB in MW-5S is from the slow dissolution of EDB held in the confining caliche layer. The fact that EDB has not been detected in downgradient wells (e.g., MW-8S, MW-10S, MW-4, MW-3) suggests that the presence is localized and there is no established plume. This alternative is the implementation of institutional controls with long-term monitoring and with EDB concentrations dissipating over time. If monitoring results show a change in EDB (e.g., groundwater concentration increase or it is detected in downgradient wells), then additional actions would be required.

Institutional controls are defined as measures undertaken to limit or prohibit activities that may interfere with the integrity of an interim action or cleanup action or that may result in exposure of hazardous substances at a site (WAC 173-340-444). Controls may include physical barriers (e.g., fences), land use restrictions, maintenance requirements of engineered controls (e.g., repair of monitoring wells), educational programs (e.g., signs posted around site warning public), and financial assurances.

For Alternative 2, the following institutional controls would be implemented:

- Restrictive covenant – Under monitored natural attenuation, the CULs in soil and groundwater would take time to be achieved. As described in Section 2.2.3, the conditional point of compliance for groundwater is the property boundary, which currently meets the CUL for EDB. Well MW-5S does not meet the CUL, and based on its location, may take a long period of time to reach the CUL. A restrictive covenant would include the following:
    - A restriction on installing drinking water wells in the shallow aquifer on site until the CUL is met for groundwater throughout the site.
    - A restriction on construction or relocation of buildings that would prevent a building in the area of the identified EDB-impacted soil (shaded area in **Figure 17**) until the CULs in soil and groundwater are met.

The covenant would follow the Washington Uniform Environmental Covenants Act.

Another institutional control to be implemented would be the requirement to maintain monitoring wells. It is assumed that this would be covered under the Cleanup Action Plan and would be part of the agreed order between Ecology and Simplot.

Monitored natural attenuation refers to the natural physical, chemical, and/or biological processes that reduce the mass, toxicity, or mobility of EDB in the subsurface over time. Monitored natural attenuation involves sampling and analysis to verify that attenuation of EDB is occurring. Processes involved in natural attenuation of EDB are volatilization, biodegradation, dispersion, and sorption. As presented in Section 1, current site conditions show that EDB is in groundwater above the CUL of 0.05 µg/L for MW-5S, but does not exceed the CUL for other on-site wells (based on last sampling event for MW-6S). Furthermore, the CUL is met for the conditional point of compliance and there is no detection of EDB in off-site groundwater monitoring wells. It is also postulated that the EDB remaining in soil and groundwater on site represent the last remaining remnants of a historic spill/release. Thus, the existing EDB levels in soil and groundwater are representative of natural attenuation mechanisms and it is expected that continued dissipation of this compound will continue. As described for the site conceptual model, natural attenuation processes for EDB in groundwater are advection, dispersion, sorption, biodegradation, and volatilization. In aerobic soils and groundwater, EDB undergoes minimal biodegradation (McKeever 2011); therefore, natural attenuation is mostly reliant on volatilization, advection, and dispersion.

Monitoring would involve continued collection of groundwater samples from the existing monitoring well network on a semi-annual basis (twice per year). One new monitoring well would be included with this alternative (MW-11S) and would be located along the western edge of the Simplot property directly west of MW-5D. This well would serve as a conditional point of compliance well, along with MW-8S, for the downgradient property boundary. In addition, soil samples would be collected annually to assess if EDB in soils meet the soil CUL.

For evaluation purposes, a monitoring period of 10 years is assumed to achieve CUL for soil and groundwater.

2.2.6.3.2.1 Evaluation

- *Protectiveness* – There are no current completed on-site or off-site exposure pathways. The identified exposure pathways are for potential future activities that would include installation of an on-site, potable well, or if EDB in on-site soil and groundwater were to migrate off site. The installation of an on-site well would be prohibited with the implementation of institutional controls described above. EDB soil levels are below risk-based levels for exposure to workers through trenching (dermal and inhalation pathways). While the time required reaching the CUL for soil and groundwater (primarily area of MW-5S) may be long (assumes 10 years), Alternative 2 – Institutional Controls and Monitored Natural Attenuation for Soil and Groundwater, partially meets this criterion. Monitoring provides a means of assessing site conditions long term and a contingency plan for reacting to site changes would be necessary.
- *Permanence* – Monitoring natural attenuation would ultimately result in the permanent reduction of EDB in soil and groundwater to below CULs. Therefore, Alternative 2 meets this criterion, but not to the extent (confidence) that Alternatives 3a and 3b would in that

Alternative 3a and 3b involves physical removal and treatment of EDB from soil and at the soil/groundwater interface.

- *Costs –* The estimated life-cycle cost of this remedial alternative is approximately $475,560 as shown in **Table 18** and detailed in Appendix G. The cost is based on the following:
    - 10 years of semi-annual monitoring of the 11 groundwater monitoring wells and annual soil sampling. The assumption is that it will take 10 years to achieve the CULs.
    - Installation of one well (MW-11S) for compliance monitoring.
    - A one-time, up-front cost to restrain a restrictive covenant.
    - Inflation of 3 percent per year.
    - Operation and maintenance assumes replacement of two wells over the 10-year period.
    - 15 percent contingency on total cost to account for uncertainty.
- *Effectiveness over the Long Term* – Although monitored natural attenuation would reduce the mass of EDB in on-site groundwater and soil to some extent, there is a lower degree of certainty compared to Alternative 3a and 3b that it would effectively reduce soil EDB concentrations to below CULs. Therefore, Alternative 2 only partially meets this criterion.
- *Management of Short-term Risk* – There are no current, completed on-site or off-site exposure pathways (**Table 14**, see footnote in **Table 14** regarding City Well #5). Human health and the environment are anticipated to remain protected during implementation of Alternative 2.
- *Technical and Administrative Implementability* – The implementation of monitored natural attenuation is essentially the same as current site activities (groundwater monitoring) with the addition of one new monitoring well (MW-11S). The institutional controls described above can be readily implemented and would have to be administered by Ecology under the Washington Uniform Environmental Covenants Act. Thus, Alternative 2 is implementable.
- *Consideration of Public and Agency* – WAC 173-340-370 outlines Ecology's expectations for cleanup action. Specifically, WAC 173-340-370 (7) states that Ecology expects that natural attenuation of hazardous substances may be appropriate at sites where
    a) Source control (including removal and/or treatment of hazardous substances) has been conducted to the maximum extent practicable.
    b) Leaving contaminant on site during the restoration time frame does not pose and unacceptable threat to human health or the environment.
    c) There is evidence that natural biodegradation or chemical degradation is occurring and will continue to occur at a reasonable rate at the site.
    d) Appropriate monitoring requirements are conducted to ensure the natural attenuation process is taking place.

  For Alternative 2, requirements b and d are or can be met. However, this alternative does not include source control (requirement a); and degradation is not likely occurring with EDB or to

a small extent, the likely reduction in EDB overtime will be through dissolution and volatilization. Therefore, this alternative may not be considered acceptable to Ecology.

Community acceptance of the remedial alternatives will be evaluated during a subsequent 30-day public comment period.

- *Reasonable Restoration Time Frame* – **Table 11** summarizes EDB concentrations in well MW-5S. Interpretation of a trend warrants caution in that the actual physical installation of the well might have created dissolved EDB that has cleaned up over time with continued well purging. Without quantification of a trend, it is difficult to estimate expected time frame for EDB in well MW-5S to reach the CUL of 0.05 µg/L under natural attenuation alone (10 years is assumed for costing and evaluation purposes). Additional monitoring is warranted to assess trends. Compared to the Alternative 3, which includes remedial action for soil, this alternative would have a longer time frame for achieving the CUL in soil and groundwater.
- *Comply with Cleanup Standards and ARARs* – This alternative meets this criterion in the long term in that concentration can be expected to decline overtime to ultimately meet CULs; however, the timeframe is uncertain.
- *Provide for Monitoring* – This alternative allows the opportunity for compliance monitoring through the existing monitoring well network with the additional of one new well (MW-11S), and therefore, meets this criterion.

2.2.6.3.3 Alternative 3a – Institutional Controls, Targeted Soil Excavation, Treatment, and Return (or use elsewhere), and Monitored Natural Attenuation of Groundwater

For Alternative 3a, the following institutional controls would be implemented:

- Restrictive covenant – Under soil excavation and monitored natural attenuation for groundwater, the CUL for groundwater would take time to be achieved even with source removal. As described in Section 2.2.3, the conditional point of compliance for groundwater is the property boundary, which meets the CUL for EDB. A restrictive covenant would include the following:
    - A restriction on installing drinking water wells in the shallow aquifer on site until the CUL is met for groundwater throughout the site.
    - It is assumed that after soil excavation, the remaining soil would meet the CUL for soil (5 µg/Kg) and no restriction on construction or relocation of buildings would be required.

The covenant would follow the Washington Uniform Environmental Covenants Act.

Another institutional control to be implemented would be the requirement to maintain monitoring wells. The excavation would likely result in the removal of MW-5S and MW-5D, which would then have to be replaced. In addition, one new well is proposed, MW-11S, which would be located along the western edge of the Simplot property directly west of MW-5D. It is assumed that this would be covered under the Cleanup Action Plan and would be part of the agreed order between Ecology and Simplot.

For Alternative 3a, the following soil and soil/groundwater interface excavation activities would occur:

- Wells MW-5S and MW-5D would be decommissioned and wells MW-11S and MW-12S would be constructed to the west and northwest along the property boundary, respectively (see **Figure 17**). This new wells along with MW-8S would be monitored before and after excavation activities. Wells MW-5S and MW-5D would not be replaced following excavation.
- A hollow-stem auger rig equipped with a California split-spoon sampler would be used to advance up to six borings in the area between MW-5S, SP-7, and SB-12 to further assess for the presence of EDB and to further define lithology. The goal of the drilling is to further quantify EDB in the caliche layer to further define the areas of elevated EDB concentrations, including updating **Table 7**. From this information, the presence of EDB greater than 0.27 µg/Kg would be mapped and an excavation plan developed. Also based on this updated information, potential EDB concentrations would be assessed and the need any need for vapor controls measured determined for the excavated soils.
- Using the updated information from the new borings along with the information presented in **Table 7**, soil in the area of MW-5S, MW-5D, and GP-7 (see **Figure 17**) would be excavated down to the caliche zone (approximately a depth of 10 feet in the area of MW-5S). The excavated soil above the caliche is expected to be non-detect for EDB concentrations based on RI results (**Table 7**). The soil, which would be tested for EDB to confirm that it is below the CUL, would be stockpiled on-site for use as fill material following soil excavation activities. Soils would be stockpiled on plastic until laboratory results are obtain and the fate of soils determined.
- Excavation activities would occur during the winter months to take advantage of a lower water table, which allows greater access to soil at the soil/groundwater interface. It is the soil/groundwater interface that serves as the secondary source of EDB in groundwater detected in MW-5S. Starting in the area of MW-5S, the caliche zone would be penetrated using equipment designed to infiltrate this hard layer (e.g., bulldozer with ripper) or a hydraulic hammer (e.g., equipped on a trackhoe). At approximately 3-foot lifts, the soil would be sampled and tested for EDB using an off-site laboratory. (HDR has not identified an on-site screening method for EDB given the low soil concentrations; a PID can be used for screening, but at these low concentrations, is not sensitive enough to verify EDB presence.) If soil is deemed clean, then the soil would be stockpiled for use as fill. If soil has EDB in excess of 0.27 µg/Kg (the CUL), the soil would be placed in a separate stockpile for on-site treatment. Excavated soils would be placed on plastic and also covered in plastic to minimize vapor emissions. A health and safety plan would be in place that included atmospheric monitoring to ensure worker safety from breathing EDB vapors above health based (OSHA) standards (see Section 2.2.1.1). Because of the depth, soil would be laid back (sloped) to ensure safe entry of equipment and personnel including an access ramp OSHA standards would be followed). In addition, stormwater measures would be implemented to ensure stormwater runoff remains on site and stockpiled soil is protected. Excavation would continue until the zones of EDB are reached and excavated to the extent practicable. Excavation would enter the soil/groundwater interface (by excavating during winter months, the groundwater elevation are at their lowest, allowing for greater removal of the interface zone). Excavation would penetrate no more than 1 foot of saturated soils (top of aquifer).

- The soil remaining in the ground after excavation would be tested for EDB and the upper, one-sided, 95-percent confidence limit of the mean soil concentration would be compared to the CUL for compliance monitoring. If soil remains above the CUL, additional excavation would occur to the extent practicable. Once the CUL for soil was met, the excavation pit would be backfilled and compacted.
- The excavated soil identified as having EDB in excess of 0.27 µg/Kg would be separately stockpiled (placed on and covered in plastic) and stored during the winter months. Composite stockpiled soil samples would be collected to assess mean EDB concentrations and also to assess potential air emissions so that proper vapor capture and permitting can be determined. The soil with EDB exceeding 0.27 µg/Kg would be treated by ex-situ vapor extraction (SVE) during the warmer months (late spring or early summer), where the soil would be placed over a network of aboveground piping to which a vacuum would be applied to enhance and capture the EDB vapor. The piles would be on top of plastic (HDPE) and also covered with plastic. The goal would be to treat soils by ex-situ SVE until EDB vapor levels drop to near or below detection limits and then soils tested. Captured vapor treatment would be treated by passing through activated carbon (the final vapor treatment technology, carbon versus thermal oxidation will be based on estimated quantity of EDB following excavation). The treatment of vapors and its emission would follow Washington air quality standards. Treated soils would be tested for EDB and treatment continued until soil EDB levels were less than 0.27 µg/Kg based on composite sampling. Once soil reached the CUL, the soil would either be placed back into the excavation pit (an area would be kept open for additional fill), or the soil would be used for fill material elsewhere. If the fill were to be moved off site, permission would be sought from Ecology for approval of final use.
- The preliminary estimated volumes for the excavation, accounting for side slopes of 2:1, are as follows:
    - Surface area identified as containing EDB in soil above 0.27 mg/Kg is illustrated in **Figure 17** is approximately 4,000 square feet
    - Total excavation area at ground surface accounting for side slopes: 18,000 square feet
    - Total volume soil excavated: 13,000 cubic yards
    - Total volume of EDB-impacted soil greater than 0.27 µg/Kg isolated for treatment 1,180 cubic yards (estimated from **Table 7** and **Figure 17**).

Thus, an estimated 1,180 cubic yards of soil would require treatment by ex-situ SVE. The conceptual SVE design would be 100 feet by 50 feet with perforated piping network laying on top of plastic, soil on top of piping, and then a second set of piping on top of the soil. The assumption is that the excavation process has broken up the caliche to allow for greater surface area and thus greater effectiveness for SVE vapor removal. Assuming the SVE system treats 3 feet of soil (100 X 50 X 3), this results in treating approximately 550 cubic yards of soil. Thus, soils would be treated in two batches (each 550 cubic yards). It is anticipated that the SVE treatment would remove vapors within 1 month (per batch) to reach cleanup goals.

As presented in Section 1, current site conditions show that EDB in groundwater above the CUL of 0.05 µg/L for MW-5S, but does not exceed the CUL for other on-site wells (based on last sampling

event for MW-6S). Furthermore, the CUL is currently met for the conditional point of compliance and there is no detection of EDB in off-site groundwater monitoring wells. The EDB remaining in groundwater on site represents the last remaining remnants of a historic spill/release. The goal of the soil sampling is to remove EDB in the caliche and at the soil/groundwater interface. The physical removal at the interface should result in the reduction of dissolved EDB in groundwater. Any remaining EDB in groundwater would be monitored and is expected to dissipate over time. It is assumed that CUL for groundwater can be achieved in 2 to 5 years, compared to 10 years for Alternative 2.

Monitoring would involve collection of groundwater samples from the monitoring well network on a semi-annual basis (twice per year). As described previously, two new monitoring wells would be included with this alternative: new wells MW-11S and MW-12S (these proposed wells are illustrated in **Figure 17**). This wells would serve as a conditional point of compliance well, along with MW-8S, for the downgradient property boundary.

2.2.6.3.3.1 Evaluation

- *Protectiveness* – There are no current, completed on-site or off-site exposure pathways (**Table 14,** see footnote in **Table 14** regarding City Well #5). The identified exposure pathways are for potential future activities that would include installation of an on-site potable well or if EDB in on-site soil and groundwater were to migrate off site. The installation of an on-site potable well would be prohibited with the implementation of institutional controls described above. The removal of soil exceeding the CUL for EDB serves as source removal and would expedite the time for natural attenuation of EDB in groundwater.

  The potential risk of excavation is compromising the integrity of the caliche layers, which serve to retain EDB and act as a protective barrier to groundwater. This alternative includes targeted excavation with the separation of clean soil from EDB-impacted soil conducted in 3-foot lifts. It is possible that EDB could be dislodged from the caliche and enter the groundwater system. Downgradient wells would be monitored and any detection of EDB would be considered temporary since these alternative results in the removal of EDB-impacted soil including the soil/groundwater interface. With targeted excavation, institutional controls, and monitored natural attenuation, this alternative meets this criterion.

- *Permanence* – The targeted removal of soil and soil/groundwater interface and natural attenuation for groundwater would ultimately result in the permanent reduction of EDB in soil and groundwater to below CULs. Therefore, Alternative 3a meets this criterion and to a greater extent than Alternative 2.

- *Costs* - The estimated life-cycle cost of this remedial alternative is approximately $461,212 The cost is based on the following:

  - 5 years of semi-annual groundwater monitoring of the 11 monitoring wells. It is assumed with removal of soils, that CUL for groundwater can be achieved in 3 to 5 years compared to 10 years for Alternative 2.
  - Installation of two monitoring wells (MW-11S and MW-12S, compliance wells) and decommissioning of MW-5S and MW-5D.
  - A one-time, up-front cost to obtain a restrictive covenant.

- Excavation of 13,000 cubic yards of soil, on-site treatment of 1,180 cubic yards using ex-situ SVE with carbon treatment, and placement of fill back into excavation pit.
- Inflation of 3 percent per year.
- 15 percent contingency on total cost to account for uncertainty.

- *Effectiveness over the Long Term* – The removal of EDB in soil results in overall effectiveness. Per WAS 173-340-360 (3)(f)(iv), the removal and treatment of soil provides for a higher degree of long-term effectiveness compared to containment and institutional controls and monitoring.
- *Management of Short-Term Risk* – There are no current, completed on-site or off-site exposure pathways (**Table 14**, see footnote in **Table 14** regarding City Well #5). The excavation of soil does present some short-term risk in dislodging EDB from the caliche layers into groundwater. The targeted excavation approach described above minimizes this risk and meets this criterion.
- *Technical and Administrative Implementability* – The implementation of institutional controls, targeted soil excavation, treatment of excavated soils with EDB above the 0.27 µg/Kg, and monitored natural attenuation is technically and administratively feasible.
- *Consideration of Public and Regulatory Acceptance* – WAC 173-340-370 outlines Ecology's expectations for cleanup action. Specifically, WAS 173-340-370 (7) states that Ecology expects that natural attenuation of hazardous substances may be appropriate at sites where

  a) Source control (including removal and/or treatment of hazardous substances) has been conducted to the maximum extent practicable.

  b) Leaving contaminant on site during the restoration time frame does not pose an unacceptable threat to human health or the environment.

  c) There is evidence that natural biodegradation or chemical degradation is occurring and will continue to occur at a reasonable rate at this site.

  d) Appropriate monitoring requirements are conducted to ensure the natural attenuation process is taking place.

  Alternative 3a meets these requirements. Because this alternative includes source control and long-term monitoring it is expected that this alternative would have acceptance from Ecology.

  Community acceptance of the remedial alternatives will be evaluated during a subsequent 30-day public comment period.

- *Reasonable Restoration Time Frame* – The alternative provides for a shorter restoration time frame compared to Alternative 2. The removal of EDB in soil including the soil/groundwater interface provides source control. Two new compliance wells (MW-11S and MW-12 S) will be installed. The time frame for EDB to reach 0.05 µg/L in groundwater at points of compliance is uncertain but for purposes of this FS, 3 to 5 years is assumed compared to 10 years for Alternative 2. Thus, Alternative 3a partially meets this criterion, where the time frame for restoration is improved compared to Alternative 2 due to source removal measures.
- *Comply with Cleanup Standards and ARARs* – This alternative meets this criterion.

- *Provide for Monitoring* – This alternative allows the opportunity for compliance monitoring through a monitoring well network, replacement of two wells (MW-5S and MW-5D, which will be decommissioned prior to excavation), and the addition of one new well (MW-11S). Alternative 3a meets this criterion.

2.2.6.3.4 Alternative 3b – Institutional controls, targeted soil excavation including soil/groundwater interface, offsite landfilling, and monitored natural attenuation of groundwater

Alternative 3b is the same approach as Alternative 3a, except that excavated impacted soils are transported off-site for landfill disposal rather than treating soils on-site. Excavated soils that exceed the CUL would be isolated, stored on-site, sampled, and profiled for landfill acceptance. For FS analysis, soils are summed to be acceptable as Waste Management's Greater Wenatchee facility for non-hazardous waste daily cover. As described for Alternative 3a, 1,180 cubic yards are assumed to exceed the CUL and it is this quantity that would be transported off-site and landfilled.

2.2.6.3.4.1 Evaluation

- *Protectiveness* – Same as Alternative 3a.
- *Permanence* – Same as Alternative 3a.
- *Costs* - The estimated life-cycle cost of this remedial alternative is approximately $579,846 The cost is based on the following:
    - 5 years of semi-annual groundwater monitoring of the 11 monitoring wells. It is assumed with removal of soils, that CUL for groundwater can be achieved in 3 to 5 years compared to 10 years for Alternative 2.
    - Installation of two monitoring wells (MW-11S and MW-12S, compliance wells) and decommissioning of MW-5S and MW-5D.
    - A one-time, up-front cost to obtain a restrictive covenant.
    - Excavation of 13,000 cubic yards of soil, hauling off of 1,180 cubic yards landfilling. Activity includes placement of soils into dump trucks and pups, transporting to landfill, and then landfill using soils as daily cover.
    - Inflation of 3 percent per year.
    - 15 percent contingency on total cost to account for uncertainty.
- *Effectiveness over the Long Term* – Same as Alternative 3a.
- *Management of Short-Term Risk* – Same as Alternative 3a.
- *Technical and Administrative Implementability* – Same as Alternative 3a.
- *Consideration of Public and Regulatory Acceptance* – Same as Alternative 3a.
- *Reasonable Restoration Time Frame* – Same as Alternative 3a.
- *Comply with Cleanup Standards and ARARs* – This alternative meets this criterion.
- *Provide for Monitoring* – Same as Alternative 3a

2.2.7 Disproportionate Cost Analysis

The most to least permanent alternatives are Alternatives 3a and 3b > Alternative 2 > Alternative 1. The most practical permanent solution alternative is Alternative 3a since EDB is removed from the soil and is destroyed (treated). For Alternative 3b, EDB is removed from the site and landfilled, but is not destroyed. Both Alternatives 3a and 3b provide for greater assurance of permanent cleanup (faster time frame and results in physical removal of source) and do not present disproportionate costs compared to Alternative 2 (**Table 14**). Alternative 3a provides for a lower cost than Alternative 3b; therefore, it is more desirable.

2.3 Recommended Remedial Alternative

Based on the evaluation of remedial alternatives and in consideration of the requirements of WAC 173-340, the following is recommended:

- *Alternative 3a – Institutional controls, targeted soil excavation including soil/groundwater interface, treatment, and return (or used elsewhere), and monitored natural attenuation of groundwater*

This alternative provides for a shorter cleanup time period compared to Alternative 2 and is lower costs than Alternative 3b (landfilling), and provides secondary source removal in soils through targeted excavation.

2.4 Cleanup Action Plan and Schedule

Ecology is responsible for selecting the remedial action and for developing the cleanup action plan.

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4 Tables

Table 1. Extraction Wells within 1-mile of the Site

Ecology ID number	Owner	City Well	Date Completed	Well Type	Well Diameter (in)	Well Depth (ft bgs)	SWL (ft bgs)	Distance and Direction from Site (ft)	Notes
Extraction wells									
0150559	Chicago, Milwaukee, S. P. Pac. R.R	N/A[3]	1912	Water supply	10	448	250	5,400 ENE	--
0152267	Edward Jeske	N/A	12/31/1909	Water supply	6	415	NA	4,500 SE	--
0157166	Odessa Pump Irr.	N/A	unknown (1978?)	Water supply	8	525	NA	5,100 SW	--
0161115	Ron Zirker	N/A	2/24/1994	Domestic	6	105	60	3,600 WNW	--
0293221	City of Warden	Well #5	5/21/1968	Municipal	16	368	42	1,500 SW	--
0329055	Steve Connors	N/A	3/11/2002	Domestic	6	220	100	4,500 NNW	--
799557	City of Warden	Well #6	4/4/1979	Municipal	15	830	278	6,000 E	reconditioned on 4/17/2012; original Ecology ID 0159741;
954458	City of Warden	Well #8	10/16/2014	Municipal/ irrigation	20	507	82	3,000 SSW	Reconditioned
954484	City of Warden	Well #9	10/16/2014	Municipal	20	505	52.7	2,100 SSW	--

[1]No Ecology ID number was found

[2]No owner was found, however, it was assumed that it belongs to Simplot

[3]N/A=not applicable;

in = inches; ft bgs = feet below ground surface; SWL = static water level; ENE = east northeast; SE = southeast; SW = southwest; WNW = west northwest; NNW = north northwest; E = east; SSW = south southwest

Table 2. EDB Investigation History

Date	Type	Description/Trigger
March 1989	Water Quality Report.	EDB in City Wells #4 and #5.
May 18, 2004	DOE Early Notice Letter to Warden.	Informing city of EDB contamination in wells #4 and #5 and City of Warden's obligation to investigate.
August 2004	EDB Mitigation Project Report, Gray and Osborne, Inc. for Warden.	Options for dealing with EDB in City of Warden water supply. Project funding needed: $2.3M.
September 2005	Site Hazard Assessment, Department of Health.	Ranking of 3.
July 1, 2005	Remedial Action Grant Agreement Ecology and City of Warden	Drill city well 7 and reconstruct well #5 and well 6: $2M grant.
September 19, 2005	WA Dept. of Health – Public Health Evaluation.	
January 24, 2006	Dave George to John Roland, Ethylene Dibromide Groundwater contamination site Investigation and Data Collection Summary.	Ecology memo summarizing groundwater conditions.
April 20, 2007	Preliminary Investigation of Ethylene Dibromide Contamination.	Pacific Groundwater Group (PGG), prepared for Ecology. Installed Monitoring Wells #1 through #5, and numerous soil borings.
April 2009	Phase II Preliminary Investigation, Ecology.	Additional groundwater sampling and soil borings were drilled on Simplot site.
April 6, 2010	Notice of Potential Liability under MTCA for Release of Hazardous Substances. Ecology to Simplot.	Letter of finding of liability. Request Simplot enter into an Agreed Order.
May 27, 2011	Final Agreed Order 8421	Between Ecology and Simplot.
October 2011	Final RI/FS Project Plan submitted to Ecology.	HDR prepared for Simplot.
2011, 2012, and 2013	RI/FS activities - additional monitoring well installation on site, geophysical survey, soil sampling, City Well #5 pump test, and site investigation reports and groundwater sampling results.	As part of the R/IFS Work Plan.
June 2014	Revised draft RI/FS submitted to Ecology	HDR prepared for Simplot
May 2015	Well MW-4 decommissioned at request of site owner (off-site well)	HDR prepared well closure memo and submitted to Ecology May 27,2 015
September 2017	Ecology response letter to 2014 draft RI/FS	
December 2017	Groundwater Sampling	Update to groundwater quality to support RI/FS

Table 3. Description of City of Warden Wells

General	City Well #2	City Well #3	City Well #4	City Well #5 (packer in place)	City Well #6	City Well #7	City Well #8	City Well #9
Ecology Unique ID	No log	N/A	N/A	N/A	N/A	AAS 175	BHT 112	BHT 111
Installation Dates	No log	8/5/1953	8/1957	5/21/1968	4/4/1979	2/9/2006	10/16/2014	10/16/2014
Northing	597576.92[2]	600235.34	600343.95	599948.76	600188.3	598773.03	N/A	N/A
Easting	2004931.55	2005711.68	1999401.58	1998850.28	2005670.21	2008196.28	N/A	N/A
Measuring Point (PVC) Elevation, feet	1361.57	1285.63	1243.79	1244.71	1283.83	1283.58	N/A	N/A
Top of Screen Elevation, feet	No log	N/A[3]	N/A	N/A	N/A	N/A	N/A	N/A
Bottom of Screen Elevation, feet	No log	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Top of Screen, feet bgs[1]	No log	N/A	N/A	N/A	N/A	N/A	110	120, 315[4]
Bottom of Screen, feet bgs	No log	N/A	N/A	N/A	N/A	N/A	210	220, 355
Bottom of Well Casing, feet bgs	No log	89.6	80	54	386	770	210	355
Depth of Borehole, feet bgs	No log	685	319	368	830	857	507	505
Depth to Water, feet bgs (8/2006)	Not measured	Refusal at 100	64.18	53.87	76.37	306.96	N/A	N/A
Water Level Elevation, feet (8/2006)	N/A	N/A	1179.61	1190.84	1207.46	976.62	N/A	N/A
Depth to Water, feet bgs (10&11/2006)	Not measured	Not measured	51.47	Not measured	75.87	Not measured	N/A	N/A
Water Level Elevation, feet (10&11/2006)	N/A	N/A	1192.32	N/A	1207.96	N/A	N/A	N/A
Depth to Water, feet bTOC (9&10/2014)	N/A	N/A	N/A	N/A	N/A	N/A	82	52.67

Reference: This table is taken from Table 1 of *City of Warden Preliminary Investigation of Ethylene Dibromide Contamination* (PGG 2007). Information for City Wells 8 and 9 comes from well logs.

[1]bgs = below ground surface

[2]Horizontal datum: NAD 83, Washington State South Zone, based on the published coordinate values of WSDOT monument "Warden"
Vertical datum: NAVD 88 based on the published elevation value of WSDOT monument "Warden"

[3]N/A = not applicable or available

[4]City Well #9 has two screened intervals, one from 120-220, the other from 315-355 feet bgs

Available driller well logs are in Appendix A

Table 4. Summary of EDB Sampling Results for City Wells #4 and #5

City Well #4[a]		City Well #5	
Sample Month	**(µg/L)**	**Sample Month**	**(µg/L)**
3/89	3.0	3/89	0.02
5/89	0.02	5/89	0.02
12/89	0.8	12/89	0.09
2/90	0.29	2/90	0.33
4/90	0.1	4/90	0.10
6/90	0.02	6/90	0.02
11/90	0.05	11/90	0.08
5/91	0.02	5/91	0.02
10/91	0.02	10/91	0.02
4/92	0.05	4/92	0.02
12/96	0.02	11/96	0.02
6/01	0.02	6/01	0.02
6/03	0.09	6/03	0.09
8/03	0.04	8/03	0.06
11/03	0.46	9/03	0.06
12/03	0.36	11/03	0.09
3/04	1.62	1/04	0.33
10/04	0.02	2/04	0.38
11/04	0.04	3/04	0.40
2/05	0.72	4/04	0.50
6/05	0.06	5/04	0.17
1/07	1.28	10/04	0.05
		11/04	0.06
		1/05	0.15
		2/05	0.15
		4/05	0.15
		5/05	0.06
		6/05	0.04
		7/05	0.05
		8/05	0.05
		10/05	0.05
		11/05	0.03
		10/06	0.01
		11/06	<0.010
		1/07	0.12
		3/07	1.29
		5/07	0.09
		8/07	0.15
		10/07	0.01
		12/07	0.08
		4/11	0.19
			0.15
		6/11	0.11
		7/12	0.086
		9/12	0.099
		9/12	0.83
		8/13	0.10[b]

[a] This table represents a compilation of results from several sources and has not been substantiated through review of laboratory reports by HDR.
[b] Samples collected by HDR to support pump test (HDR 2013b)
µg/L = micrograms per liter

Table 5. GeoProbe™ Sample Results (February 2012)

Sample ID	Depth (feet)	EDB (µg/Kg)
GeoProbe™ Boring (GP#)		
GP1-S-1.0	0-1.0	ND[1]
GP1-S-5.5	4.5-5.5	ND
GP2-S-1.0	0-1.0	ND
GP2-S-5.0	4.0-5.0	ND
GP2-7.0	6.0-7.0	ND
GP3-S-1.0	0-1.0	ND
GP3-S-5.0	4.0-5.0	ND
GP3-S-8.5	8.0-8.5	ND
GP4-S-1.0	0-1.0	ND
GP4-S-7.0	6.0-7.0	ND
GP4-S-8.8	8.0-8.8	ND
GP5-S-1.0	0-1.0	ND
GP5-S-2.0 (duplicate)	0-1.0	ND
GP5-S-8.5	7.5-8.5	ND
GP5-S-9.5	8.5-9.5	ND
GP6-S-1.0	0-1.0	ND
GP6-S-12.0	11.0-12.0	ND
GP6-S-18.0	17.0-18.0	ND
GP7-S-1.0	0-1.0	ND
GP7-S-14.0	13.0-14.0	11.8
GP7-S-16.5	15.5-16.5	11.6

[1] Laboratory reporting limits (practical quantitation limits) ranged between 3 and 5 micrograms per kilogram (µg/Kg) for soil.
ND = non-detected

Table 6. Monitoring Well Soil Sample Results

Sample ID	Depth (feet)	EDB (µg/Kg)
MW-5S (December 2011)		
MW-5S-1	1-3	ND[2]
MW-5S-10	10-12	ND
MW-5S-20	20-22	218
MW-5S-30	30-32	ND
MW-5S-37	37-39	ND
MW-6S (December 2011)		
MW-6S-1	1-3	ND
MW-6S-10	10-12	ND
MW-6S-20	20-22	ND
MW-7S[1] (December 2011)		
MW-7S-1	1-3	ND
MW-7S-8	8-10	ND
MW-7S-10	10-12	ND
MW-7S-20	20-22	ND
MW-7S-30	30-32	ND
MW-7S-37	37-39	ND
MW-8S (December 2012)		
MW-8S-10	10-11.5	ND
MW-8S-20	20-21.5	ND
MW-8S-30	30-31.5	ND
MW-9S (July 2013)		
MW-9S-0.0	0-1	ND
MW-9S-10	10-11	ND
MW-10S (July 2013)		
MW-10S-1.0	1-3	ND
MW-10S-10	10-12	ND
MW-10S-20	20-22	ND
MW-10S-30	30-32	ND
MW-10S-35	35-37	ND

[1] No soil samples were collected from MW-7D.

[2] Laboratory reporting limits (practical quantitation limits) ranged between 3 to 6 micrograms per kilogram (µg/Kg) for soil.

ND = non-detected

Table 7. Combined Results Showing Caliche Layer and EDB Soil Samples
(borings from east to west across site)

Well	MW-4	MW-10S	MW-8S	SB-3	SB-12	SB-22	MW-5	MW-5S	GP-7	SB-11	SB-1	SB-2	SB-9	SB-8	SB-7	GP-6	MW-9S	MW-6S	SB-10	SB-4	SB-5	SB-6	GP-5	SB-21	GP-4	MW-7	MW-7S	GP-3	GP-2	GP-1
@Grade Elevation ft.	1244.22	1242.8	1244.5	1247	1246	1245.5	1245.05	1245	1245	1245	1245	1245	1246.5	1246	1246.5	1247	1244.8	1245.4	1247	1248	1248	1248	1249	1249.5	1250	1248.5	1248.4	1251	1253	1253
1250																														
																													ND	
																											ND	ND	ND	
																									ND					
			ND					ND									ND											ND		
		ND																						ND						
1240																							ND				ND			
																				ND	8.4		ND		ND					
																											ND			
							6.22									ND			ND											
	ND		ND					ND									ND	ND							ND					
		ND				ND		ND														ND								
															ND															
				ND					11.8					ND																
1230																ND														
					3.19				11.6				ND																	
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							ND				ND	ND						ND												
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Caliche Interbeds
Silt/Sand
Basalt
Refusal - Total Thickness Unknown
ND Soil Sample - Non Detect
EDB Detected in Soil Sample (micrograms per kilogram)

Table 8. Monitoring Well Construction Summary

	MW-1	MW-2	MW-3	MW-4[2]	MW-5D	MW-5S	MW-6S	MW-7D	MW-7S	MW-8S	MW-9S	MW-10S
Ecology Unique ID	APK 353	APK 354	APK 355	APK 356	APK 357	BCE 296	BCE 297	BCE 298	BCE 299	BHP-139	BHP-507	BHP-508
Installation Dates	8/14/06	8/15/06	8/15/06	8/16/06	8/16/06	12/5/11	12/5/11	12/7/11	12/6/11	1/16/13	7/8/13	7/8/13
Measuring Point Coordinates[1]												
Northing	600643.42	600712.43	600077.54	599989.55	600190.13	600180.56	600118.69	600334.17	600331.8	600089.61	599967.53	600091.31
Easting	1999635.94	1998885.78	1998600.99	1999197.52	1999618.84	1999634.23	1999804.74	1999994.82	1999981.87	1999542.40	1999765.18	1999354.01
Elevations[1]												
Ground Surface Elevation, feet	1243.22	1244.49	1240.88	1244.72	1245.14	1245.06	1245.36	1248.51	1248.36	1244.52	1244.77	1242.82
Measuring Point (PVC) Elevation, feet	1245.62	1247.09	1240.88	1244.72	1247.54	1247.66	1247.86	1251.01	1250.86	1248.84	1247.27	1245.32
Top of Screen Elevation, feet	1197.22	1179.99	1191.38	1195.22	1201.14	1228.56	1235.36	1206.51	1231.36	1230.52	1237.77	1227.82
Bottom of Screen Elevation, feet	1187.22	1169.99	1181.38	1185.22	1191.14	1208.56	1215.36	1196.51	1211.36	1210.52	1227.77	1207.82
Depths (bgs)												
Top of Screen, feet bgs	46	64.5	49.5	49.5	44	16.5	10	42	17	16	7	15
Bottom of Screen, feet bgs	56	74.5	59.5	59.5	54	36.5	30	52	37	36	17	35
Bottom of Well Casing, feet bgs	N/A	N/A	N/A	N/A	N/A	37	30.4	52.4	37.4	36.5	17.5	35.5
Depth of Borehole, feet bgs	60	75	60	60	55	39.5	37	52.5	38.5	36.5	17.5	35.5

[1] Survey conducted by Permit Surveying, Inc.
[2] MW-4 decommissioned April 2015 at land owners request

Table 9. 2012 to 2017 Groundwater Elevation Measurements

Well	Ref. Elev.	1/19/2012		4/10/2012		7/10/2012		10/23/2012		1/22/2013		7/22/2013		10/28/2013		12/4/2017	
		Depth	Elev.	Depth	Elev.	Depth	Elev.	Depth	Elev.	Depth	Elev.	Depth	Elev.	Depth	Elev.	Depth	Elev.
		Feet															
MW-1	1245.62	24.38	1,221.24	20.55	1,225.07	14.28	1,231.34	14.53	1,231.09	25	1,220.62	13.86	1,231.76	18.31	1,227.31	22.64	1,222.98
MW-2	1247.09	27.94	1,219.15	23.25	1,223.84	16.98	1,230.11	17.89	1,229.20	28.46	1,218.63	16.91	1,230.18	21.79	1,225.30	25.24	1,221.85
MW-3	1240.88	21.37	1,219.51	21.86	1,219.02	14.31	1,226.57	11.9	1,228.98	21.58	1,219.30	13.05	1,227.83	13.22	1,227.66	18.81	1,222.07
MW-4	1244.72	24.65	1,220.07	Not sampled		20.7	1,224.02	17.44	1,227.28	25.16	1,219.56	18.94	1,225.78	18.15	1,226.57	Decommissioned	
MW-5D	1247.54	27.12	1,220.42	28.89	1,218.65	22.6	1,224.94	22.13	1,225.41	27.6	1,219.94	21.02	1,226.52	20.74	1,226.80	25.84	1,221.70
MW-5S	1247.66	26.98	1,220.68	28.66	1,219.00	22.37	1,225.29	22.32	1,225.34	27.45	1,220.21	20.78	1,226.88	20.6	1,227.06	25.62	1,222.04
MW-6S	1247.86	27.2	1,220.66	29.14	1,218.72	23.43	1,224.43	20.27	1,227.59	27.98	1,219.88	21.82	1,226.04	20.99	1,226.87	26.19	1,221.67
MW-7D	1251.01	30.03	1,220.98	30.76	1,220.25	24.74	1,226.27	19.72	1,231.29	30.65	1,220.36	23.32	1,227.69	24.04	1,226.97	28.79	1,222.22
MW-7S	1250.86	29.89	1,220.97	30.6	1,220.26	24.49	1,226.37	19.52	1,231.34	30.49	1,220.37	23.07	1,227.79	23.88	1,226.98	25.58	1,225.28
MW-8S	1248.84									28.93	1219.91	22.68	1,226.16	22.08	1226.76	27.16	1,221.68
MW-9S	1247.27													Dry		Dry	
MW-10S	1245.32											18.95	1,226.37	18.38	1226.94	23.61	1,221.71

[1] N/A = data not available

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Table 10. Quality Assurance and Quality Control Field Samples

QA/QC Type	Number of Samples	Description
Duplicate	1 groundwater sample per event	Duplicate is collected using the same sampling technique as the original sample.
Trip Blank	1 trip blank per event	Water sample in sample bottle provided by laboratory and accompanies sample bottles.

Table 11. Summary of EDB Detected in Groundwater

Well	Jan 12	Apr 12	Jul 12	Oct 12	Jan 13	Jul 13	Oct 13	Dec 17
	EDB (µg/L)							
MW-1	ND[1]	ND	ND	ND	ND	ND	ND	ND
MW-2	ND	ND	ND	ND	ND	ND	ND	ND
MW-3	ND	ND	ND	ND	ND	ND	ND	ND
MW-4	ND	ND	ND	ND	ND	ND	ND	No Well[3]
MW-5D	0.27	0.01[2]	ND	ND	ND	ND	0.01[2]	ND
MW-5S	234	16.1	9.1	22.3	14.5	5.7	63	151
MW-6S	10.9	8.7	26.8	15.4	4.2	2.0	ND	0.35
MW-7D	ND	0.01[2]	ND	ND	ND	ND	ND	ND
MW-7S	ND	0.01[2]	ND	ND	ND	ND	ND	ND
MW-8S					ND	ND	ND	ND
MW-9S							Dry	Dry
MW-10S							ND	ND

[1]ND = non-detected. Laboratory reporting limit (practical quantitation limit) is 0.01 micrograms per liter (µg/L).

[2] Laboratory or site cross-contamination suspected given the low detection and that the wells were ND for all other sampling events.

[3]Well MW-4 was permanently decommissioned in April 2015 with Ecology approval

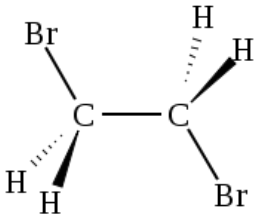
Table 12. EDB Concentration in City Well #5 During Pump Test

Time	EDB (µg/L)
1000 (prior to startup)	0.070
1200	0.120
1400	0.110
1600	0.095
1800	0.094
2000	0.093
2200	0.096
2400	0.100
0200	0.093
0400	0.098
Trip Blank	ND[1,2]

[1]ND = non-detected; laboratory reporting limit is 0.0095 micrograms per liter (µg/L)

[2] Test conducted August 13, 2013.

Table 13. Selected Properties of Ethylene Dibromide

	**Solubility in Water**	4,300 mg/L
	Vapor Pressure	11 mm Hg
	Specific Gravity	2.17
	Log Kow	1.6-2.0
Trade names	Bromofume; Dowfume W85; Dowfume EDB; Dowfume 40, W-10, W-40; Dowfume MC-2; Iscobrome D; ENT 15; 349; Netis; Pestmaster EDB-85; Santryum;unifume; EDB-85; Fumogas; Icopfume soilbrom-85; soilfume	
Synonyms	Ethylene dibromide; 1,2- dibromoethane; dibromoethane; ethylene bromide; ethane,1,2-dibromo; α-, β-dibromoethane; sym-dibromoethane	

ASTM 2006, Standard Guide for Soil Gas Monitoring In The Vadose Zone: ASTM D5314-92, 36 P.
mg/L = milligrams per liter; mm Hg = millimeters of mercury

Table 14. Conceptual site Model for Simplot site

Primary Source	Primary Release Mechanism	Secondary Source	Secondary Source Release Mechanism	Pathway	Potential Exposure Routes	On-site Exposure Pathway Complete?		Off-site Exposure Pathway Complete?	
						Current	Future	Current	Future
Fumigant (tank?)	Unknown (spill?)	Soil	Infiltration/ leaching	Groundwater	Ingestion	No	Yes	No[1]	Yes
					Inhalation	No	Yes	No	Yes
					Dermal Contact	No	Yes	No	Yes
			Trenching (construction)	Inhalation/ Ingestion	Ingestion	No	Yes	No	No
					Inhalation	No	Yes	No	No
					Dermal Contact	No	Yes	No	No
			Volatile emission	Volatilization/ vapor intrusion	Inhalation	No	Yes	No	No

[1] City Well #5 is currently operated for irrigation and has detectable amounts of EDB. This public well has been approved by Ecology for agricultural use and is also registered as an emergency water supply for the City of Warden. City Well #5 represents a potential exposure point to humans for EDB. See section 1.3.2.2 for further discussion of City Wells #4 and #5 and potential relationship with the Simplot site.

Table 15. Calculated Cleanup Levels for EDB

	Method		
	A (lookup table)	**B Unrestricted Land Use**	**C Industrial Land Use**
	EDB Target Soil CUL (µg/Kg)		
Soil Direct Contact, Ingestion and Dermal Risk 1E-6 or 1E-5	5	500	65,600
Protection of Potable Groundwater		0.27 PQL[1] = 0.1	
	EDB Target Groundwater (µg/L)		
Groundwater Protection, (carcinogen calculation)	0.01[2]	0.02	0.22

[1] PQL = Practical Quantitation Limit, laboratory reporting limit for EDB in soil (Test America Denver, USEPA Method 8011-94).
[2] Federal and State MCL is 0.05 µg/L. The PQL using USEPA 8011 is 0.01 µg/L (Pace Analytical).
µg/Kg = micrograms per kilogram; µg/L = micrograms per liter

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Table 16. Initial Remedial Technologies for EDB in Soil

Remedial Process	Description	Screening Comments
1. No Action		
None	No action	Provides as a basis for comparison to other alternatives and represents the most likely future scenario in absence of remedial action.
2. Institutional Controls		
Land use restrictions	Restriction of land use on site to limit potential exposure to impacted soil. Also, could have land use restriction to ensure integrity of cap or cover if soil is left in place.	Technically feasible and potentially applicable, generally included with other remedial alternatives.
3. Cover or Cap		
Asphalt or concrete parking area or conventional landfill cover	Barrier that would minimize or restrict meteoric water entering soil and leaching EDB to groundwater.	EDB remains in deep soil within the caliche and caliche interbed layers in a limited area at the site. The site, while unpaved, is highly compacted and percolation of meteoric water is not considered to be an important current pathway for EDB migration. While technically feasible, this technology is not considered further because the leaching is not considered a principal migration pathway.
4. Monitored Natural Attenuation		
Monitored Natural Attenuation	Current conditions would continue in that EDB would continue to dissipate through dissolving in groundwater, biodegradation, and volatilization. Because the primary EDB source is gone, EDB in soil and groundwater are expected to decline over time. Long-term groundwater monitoring would be required.	Site currently meets conditional point of compliance for EDB in groundwater (see Section 2.2.3.2). Therefore, natural attenuation is occurring at the site and meets the CUL for groundwater for the conditional point of compliance. Natural attenuation generally requires source control, which may require addressing soil EDB remedial action. Groundwater would be monitored and institutional controls put in place to ensure protection of downgradient groundwater.
5. In Situ Treatment		
Soil Washing	Percolation of fresh water (or water with a surfactant) through the soil column to wash EDB into the groundwater. Would likely have to conduct washing multiple times to remove EDB. Would likely require capturing of EDB in groundwater to protect off-site sources.	May require hydraulic controls to control EDB levels in groundwater. Dense, low hydraulic conductivity caliche layers in soil makes this technology not technically feasible.
Soil vapor extraction (SVE)	SVE involves the movement of negative pressure air (vacuum) through the soil pores to remove volatile organic compounds. EDB is readily volatile and SVE is a proven technology in soil. May require treatment of soil vapors prior to discharge to atmosphere.	SVE is suitable for porous (course textured) soil. The site is comprised of sand/silt textured surface soil down to a caliche hardpan layer and interlayers of caliche between silty sand textured soils. The hard pan is very dense and not suitable for SVE. The technology would provide good air extraction flows above the caliche but would provide minimal extraction within the caliche. Since the EDB is tied up in the caliche, this technology would not be effective in removing EDB. As a result, this technology is not considered technically feasible. An analysis would be needed to determine if treatment of vapors was needed prior to discharge.
6. Removal (includes ex situ treatment)		
Excavation and disposal	Excavation of impacted soil with fill replacement. Excavated soil would be landfilled. There would be no treatment of soil.	Caliche is very dense and difficult to excavate. Thus, this would likely require hammering or ripping to remove soil. Some risk of releasing EDB from the soil matrix if present in pure phase (though no evidence of this based on sampling results). Technically feasible and potentially applicable.
Excavation, treatment, and return	Soil would be excavated to expose the EDB to air to allow volatilization and biodegradation of the material. The soil could be treated on site in windrows. Once EDB was below CUL, the soil would be returned to the excavation or could be used for other purposes such as fill for construction	See comment from above, this approach leaves the material on site for treatment. May require air permit. Technically feasible and potentially applicable.

Table 17. Initial Remedial Technologies for EDB in Groundwater

Remedial Process	Description	Screening Comments
1. No Action		
None	No action	Provides as a basis for comparison to other alternatives and represents the most likely future scenario in absence of remedial action.
2. Institutional Controls		
Land use restrictions	On-site drilling of wells would be restricted and, if allowed, would require special design considerations to ensure no hydraulic connection between the shallow and lower aquifers. Current Washington well regulations ensure that deeper wells are drilled with suitable sanitary seal between the shallow and lower aquifers.	Technically feasible and potentially applicable. No evidence of off-site migration of EDB from the Simplot site.
3. Monitored Natural Attenuation		
Monitored Natural Attenuation	EDB in groundwater is primarily limited to the area of MW-5S and this well reflects water in the caliche interbeds. No discernible plume has been quantified based on the monitoring well network. Given the primary source is gone, and the secondary source (soil) is limited in aerial extent, EDB in groundwater can be expected to dissipate over time through natural attenuation mechanisms. The conditional point of compliance for groundwater meets the CUL (see Section 2.2.3.2).	Technically feasible and potentially applicable.
5. In Situ Treatment		
Air Sparging	Air sparging injects air into the aquifer that strips volatile organic compounds that are dissolved in the water. The resulting vapors enter into the vadose zone where they are removed through SVE.	Air sparging requires that the aquifer material be porous (course textured) and conducive to air flow. Furthermore, the vadose zone soil needs to be suitable for SVE. The presence caliche hardpan and interlayers in the shallow groundwater and in the vadose zone limits the use and effectiveness of this technology. Not considered technically feasible.
Air sparging trench	As an alternative to direct air sparging through wells, a barrier wall could be developed downgradient of the source area to treat EDB as it migrates downgradient. A trench wall would be filled with gravel and as EDB passes through the gravel it would be sparged and extracted to the atmosphere (or to a treatment system prior to atmospheric emission). Most suitable for shallow groundwater, generally less than 15 feet bgs.	No current plume from the Simplot site has been identified; rather EDB is present in one or two shallow wells but not in off-site wells. Furthermore groundwater flow direction changes seasonally and would require a large trench area to capture flows. This technology would not be effective because there is no evidence of EDB migration under current on-site conditions. Not considered technically feasible.
Permeable Reactive Barrier Methods	Physical placement of a barrier or series of wells, consisting of reactive material (either trenched or injected) to create a permeable barrier. Example would be use of oxidants to degrade EDB in groundwater (peroxide, ozone, or permanganate).	Emerging technology, but has the same on-site limitations as the air sparging barrier wall described above. Not considered technically feasible.
6. Ex Situ Treatment (Containment)		
Pump and Treat with beneficial use	Extract groundwater such that there is hydraulic control of water leaving the site, treat contaminated groundwater above ground (either air stripping or carbon treatment) and use the water for irrigation or other uses.	EDB in groundwater is limited in aerial extent to MW-5S and possibly MW-6S and no evidence of current off-site migration. Pumping of well may be limited due to interbedded caliche (anticipate low pump rates). This technology is applicable if there was a plume and that plume was migrating off site (serve as a containment technology). While technically feasible, it is not applicable to the site under current conditions.
Pump and Treat with re-injection	Same approach as described above except that the treated groundwater would be re-injected into the groundwater rather than reused.	See screening comment in column above.

Table 18. Remedial Alternative Evaluation Summary

Evaluation Criteria[1]	Remedial Alternative 1 - No Action	Remedial Alternative 2 – Institutional Controls and Monitored Natural Attenuation of Soil and Groundwater	Remedial Alternative 3a – Institutional Controls, Targeted Soil Excavation, and Monitored Natural Attenuation of Groundwater
Protectiveness	Partially meets criterion	Partially meets criterion	Meets criterion
Permanence	Not applicable	Meets criterion	Meets criterion
Costs	Not applicable	$475,560	$461,212[2]
Effectiveness Over Long-Term	Not applicable	Partially meets criterion	Meets criterion
Management of Short-Term Risk	Not applicable	Meets criterion	Meets criterion
Technical and Administrative Implementability	Not applicable	Meets criterion	Meets criterion
Consideration of Public Concerns	Likely not acceptable	Likely not acceptable	Likely acceptable
Agency Acceptance	Not acceptable	Likely not acceptable	Likely acceptable
Reasonable Restoration Time frame	Not applicable	Partially meets criterion	Partially meets criterion (improved over Alternative 2)
Comply with Cleanup Standards and ARARs	Fails Criterion	Meets criterion	Meets criterion
Provide for Monitoring	Fails Criterion	Meets criterion	Meets criterion

[1] See Section 2.2.6 for descriptions of criteria
[2] Alternative 3b is the same as Alternative 3a, except that soils exceeding CUL are landfilled offsite, rather than treated on-site through ex-situ SVE. The estimated total cost for Alternative 3b is $579,846 (see Appendix G).

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5 Figures

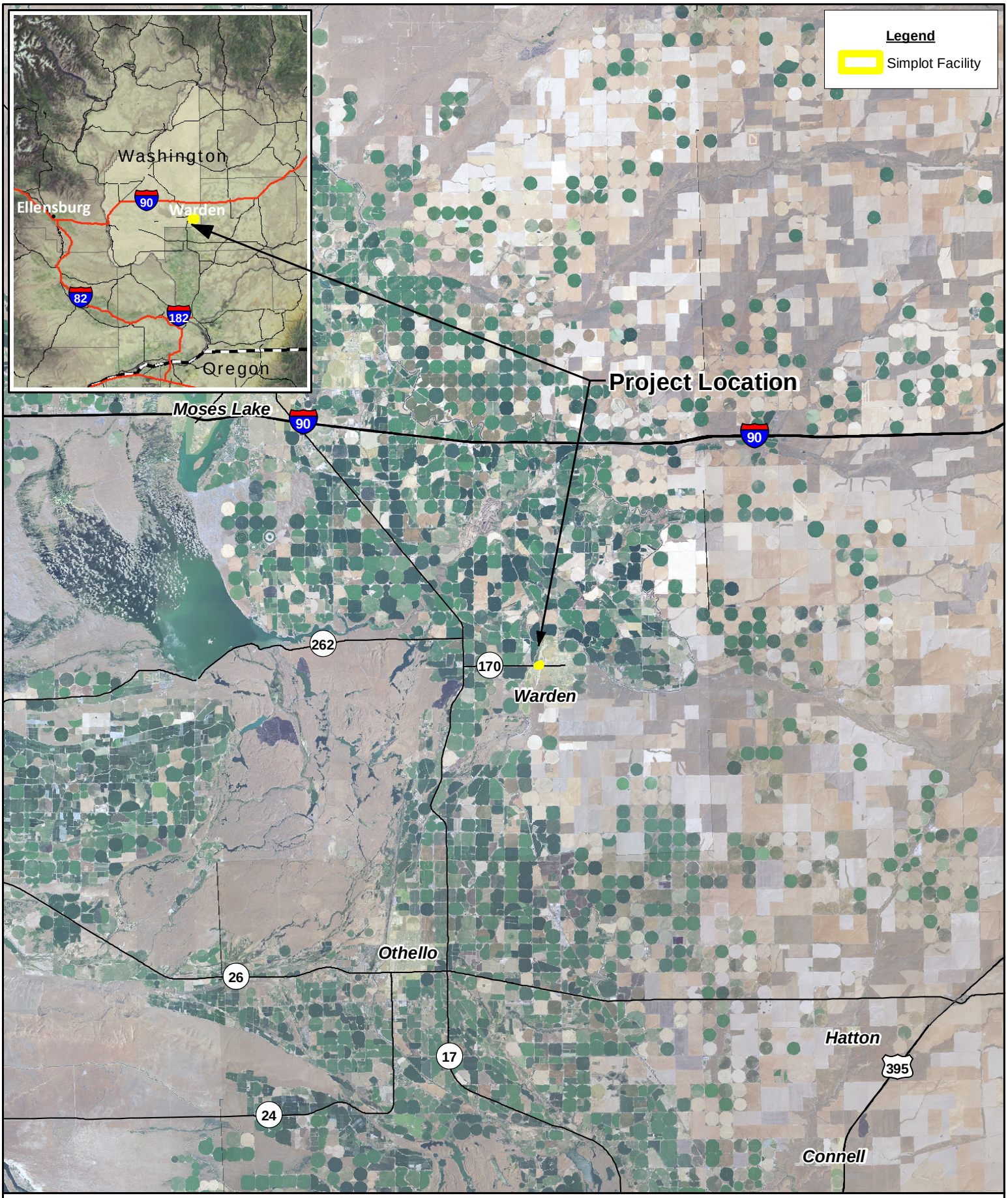


Figure 1. Vicinity Map
Simplot Grower Solutions,
1800 W 1st St., Warden, WA 98857

Imagery: 2017 NAIP 1 meter resoltion
Source: NRCS/USDA Digital Gateway
Other Data Sources: US Census Bureau; Washington Department of Transporation; Washington Department of Revenue

Map Date: 3/14/2018
Document: Q:\Simplot\CityofWarden\map_docs\Vicinity2017.mxd

HDR

Imagery: 2016 ESRI World Imagery
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics,
CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Other Data Sources: US Census Bureau; Washington Department of Transporation;
Washington Department of Revenue; Washington Department of Ecology (WDOE)

Figure 2. Project Site

Simplot Grower Solutions,
1800 W 1st St., Warden, WA 98857

0 200 400
Feet

Map Date: 3/14/2018
Document: Q:\Simplot\CityofWarden\map_docs\Site_2017.mxd

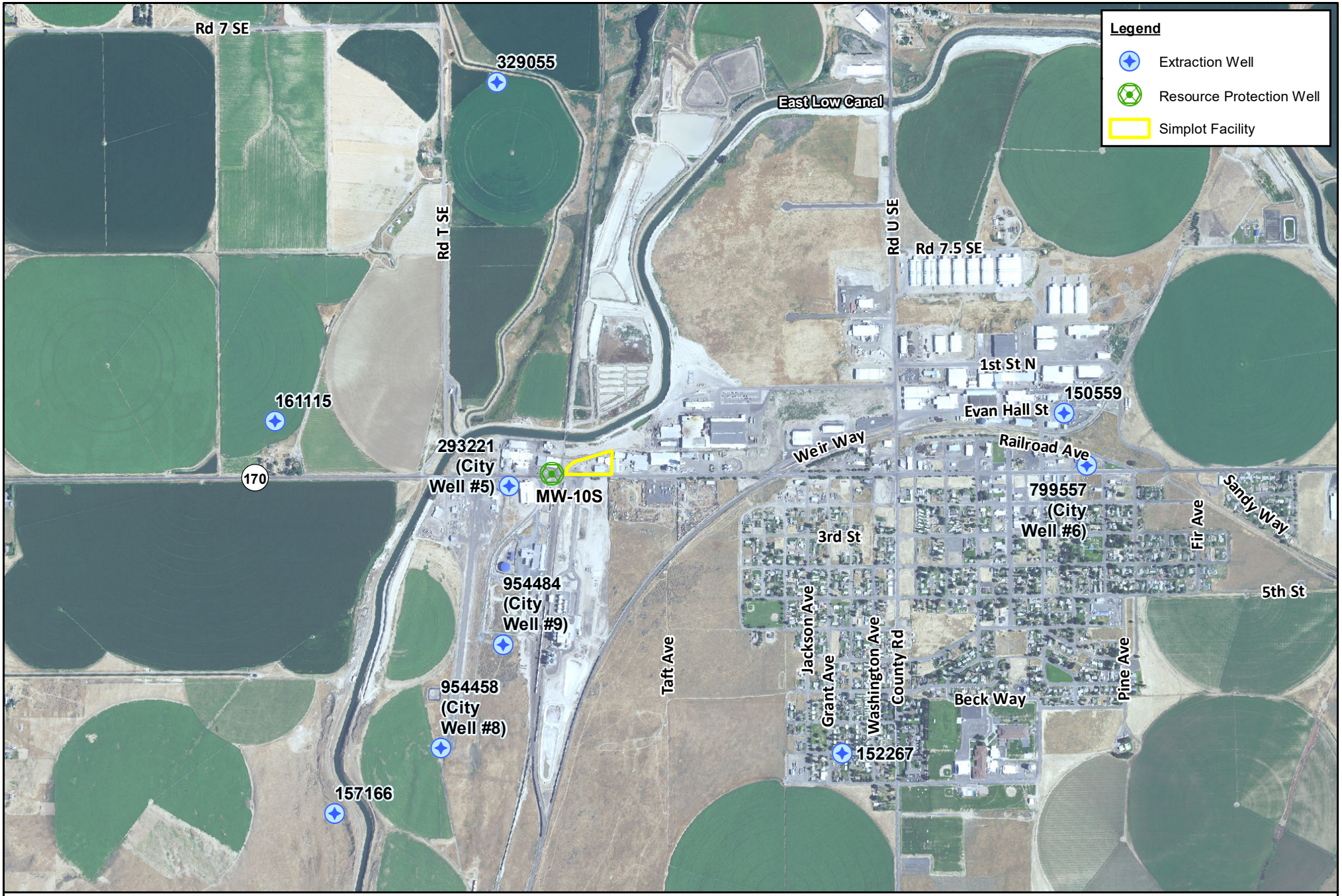


Figure 3. Extraction Wells Within 1-Mile

Simplot Grower Solutions, City of Warden, WA

Imagery: 2016 ESRI World Imagery
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics,
CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Other Data Sources: US Census Bureau; Washington Department of Transporation;
Washington Department of Revenue; Washington Department of Ecology (WDOE)

0 1,500 3,000
Feet

Map Date: 5/16/2018
Document: Q:\Simplot\CityofWarden\map_docs\Site_2017.mxd

Figure 4. City Well Locations

Simplot Grower Solutions, City of Warden, WA

Imagery: 2017 NAIP 1 meter resoltion
Source: NRCS/USDA Digital Gateway
Other Data Sources: US Census Bureau; Washington Department of Transporation; Washington Department of Revenue; Washington Department of Ecology (WDOE)

Map Date: 3/30/2018
Document: Q:\Simplot\CityofWarden\map_docs\Site_2017.mxd

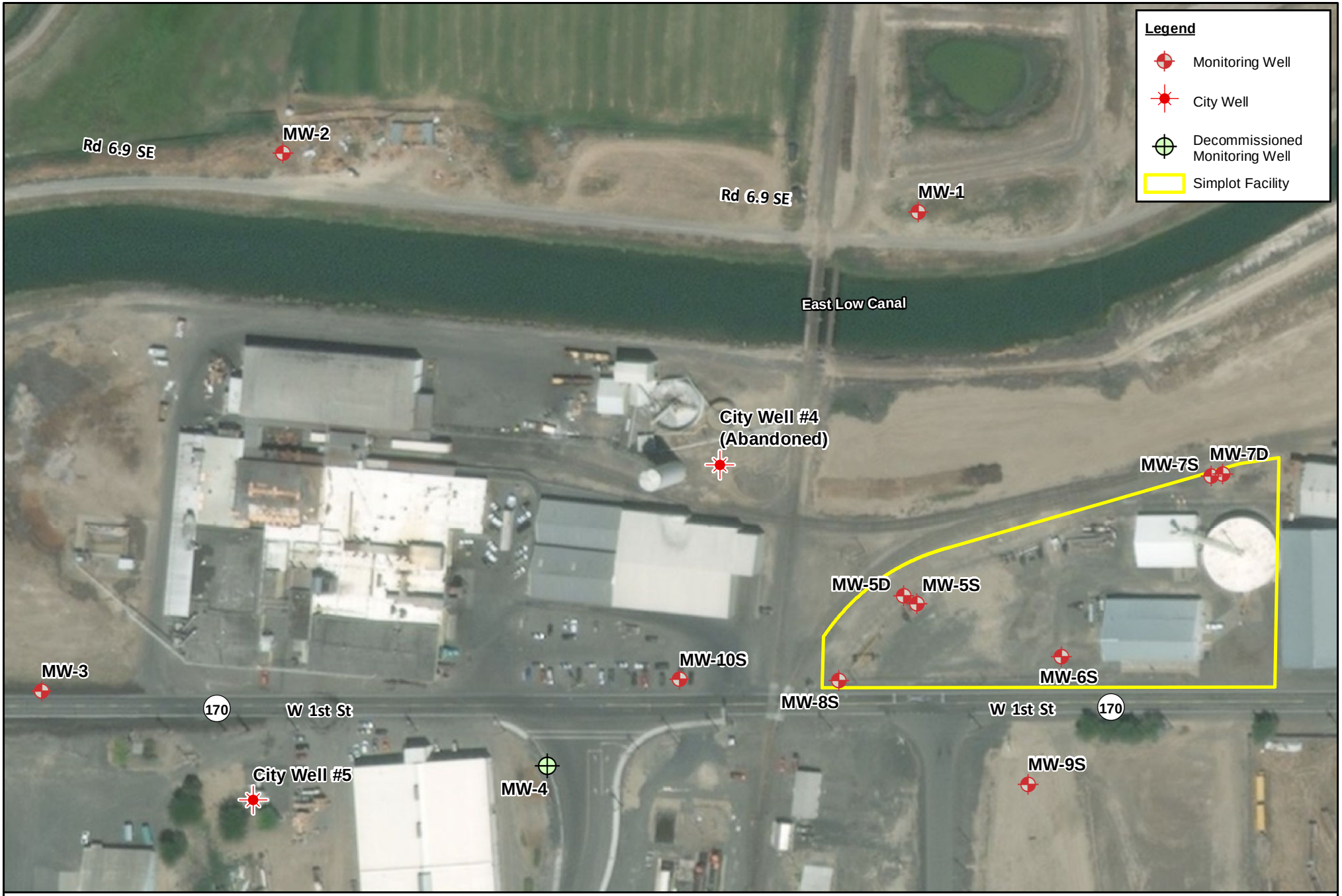


Figure 5. Monitoring Well Network

Simplot Grower Solutions,
1800 W 1st St., Warden, WA 98857

0 150 300
Feet

Imagery: 2016 ESRI World Imagery
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Other Data Sources: US Census Bureau; Washington Department of Transporation; Washington Department of Revenue; Washington Department of Ecology (WDOE)

Map Date: 3/14/2018
Document: Q:\Simplot\CityofWarden\map_docs\Site_2017.mxd

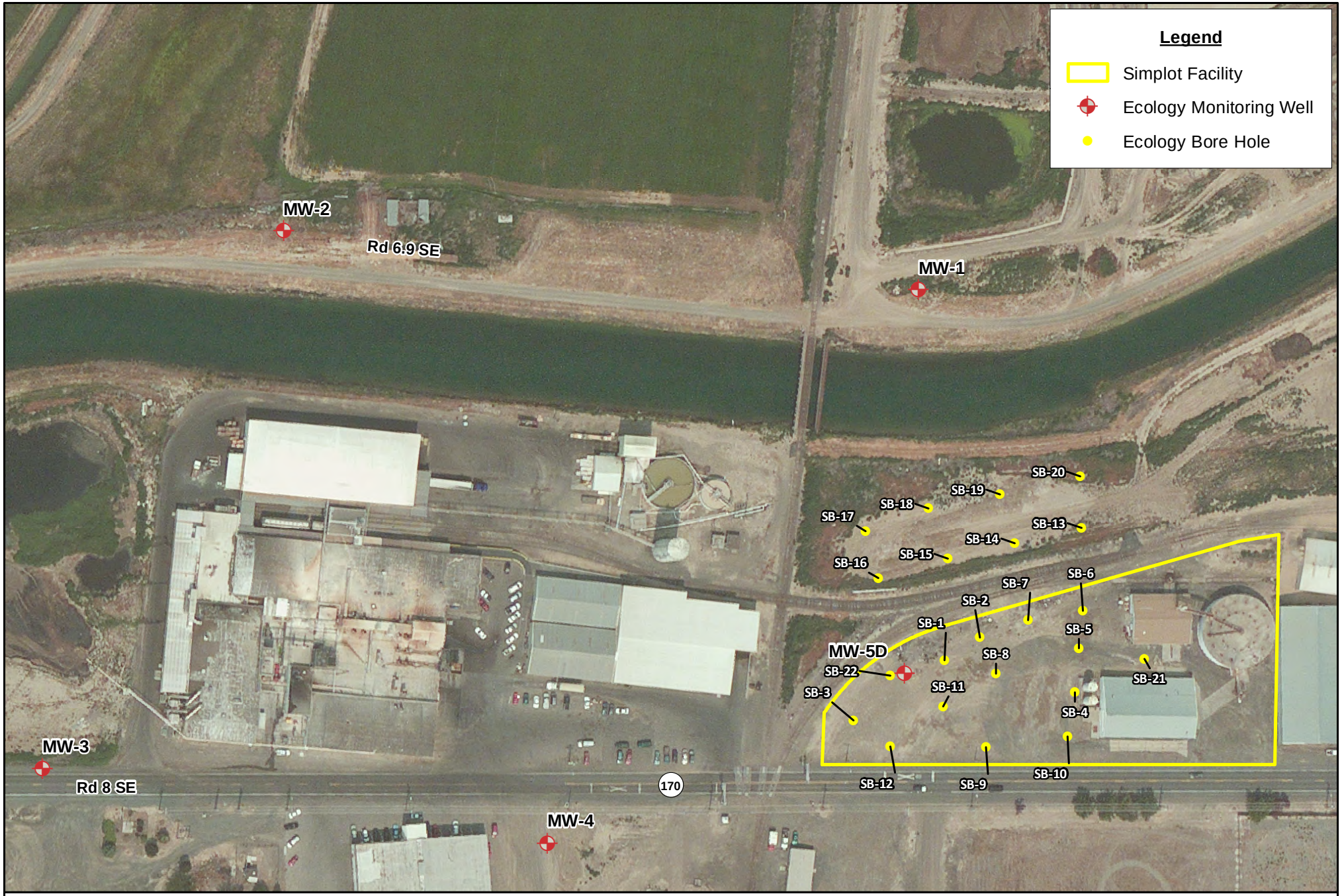


Figure 6. Phase II Preliminary Investigation by Ecology, Soil Boring Locations (2009)

Simplot Grower Solutions, City of Warden, WA

Imagery: Bing Aerial Imagery (DigitalGlobe)
Source: (c) 2012 Microsoft Corporation and its data suppliers
Other Data Sources: US Census Bureau; Washington Department of Transporation; Washington Department of Revenue; Washington Department of Ecology (WDOE)

Map Date: 11/15/2013
Document: Q:\Simplot\CityofWarden\map_docs\Site.mxd

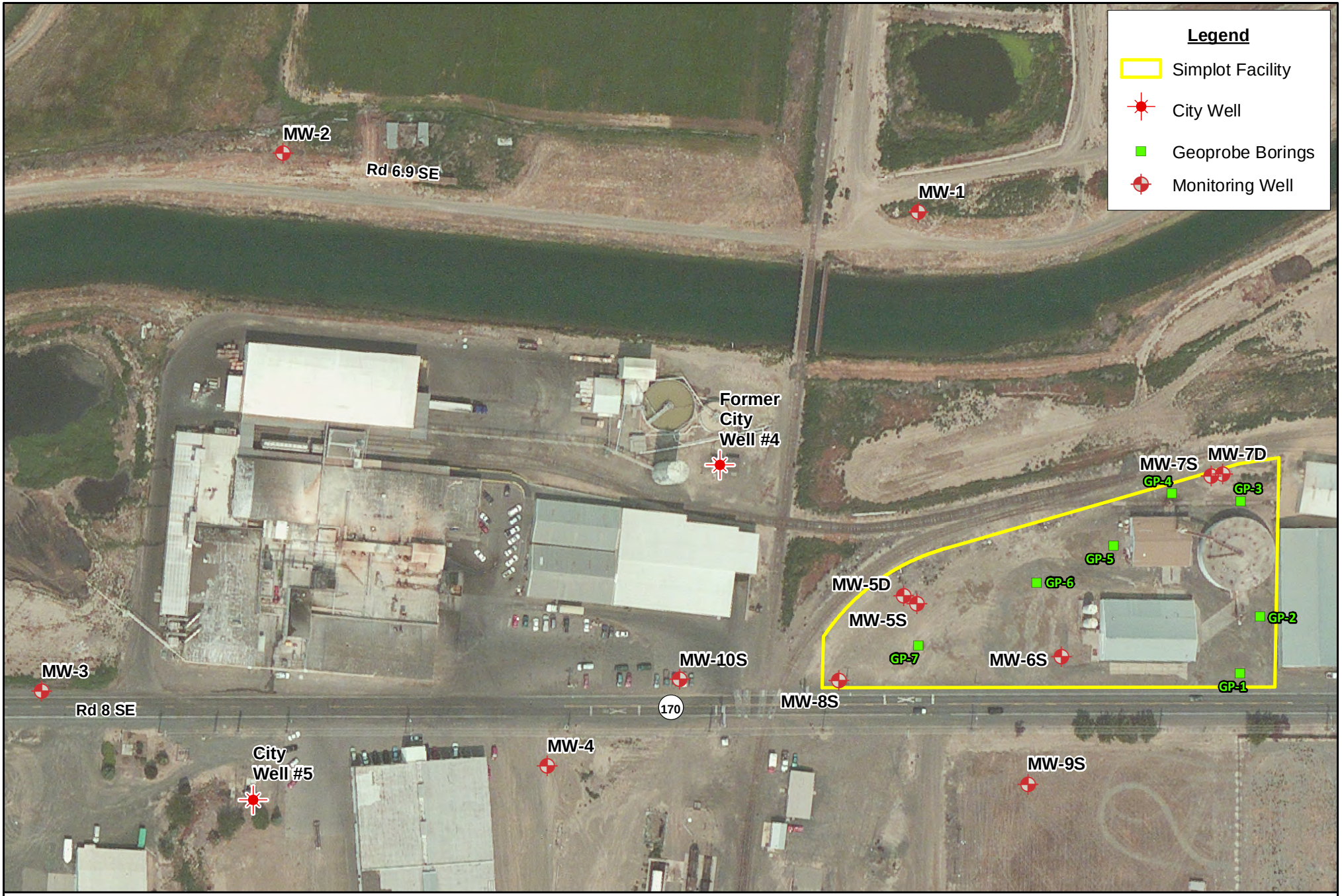


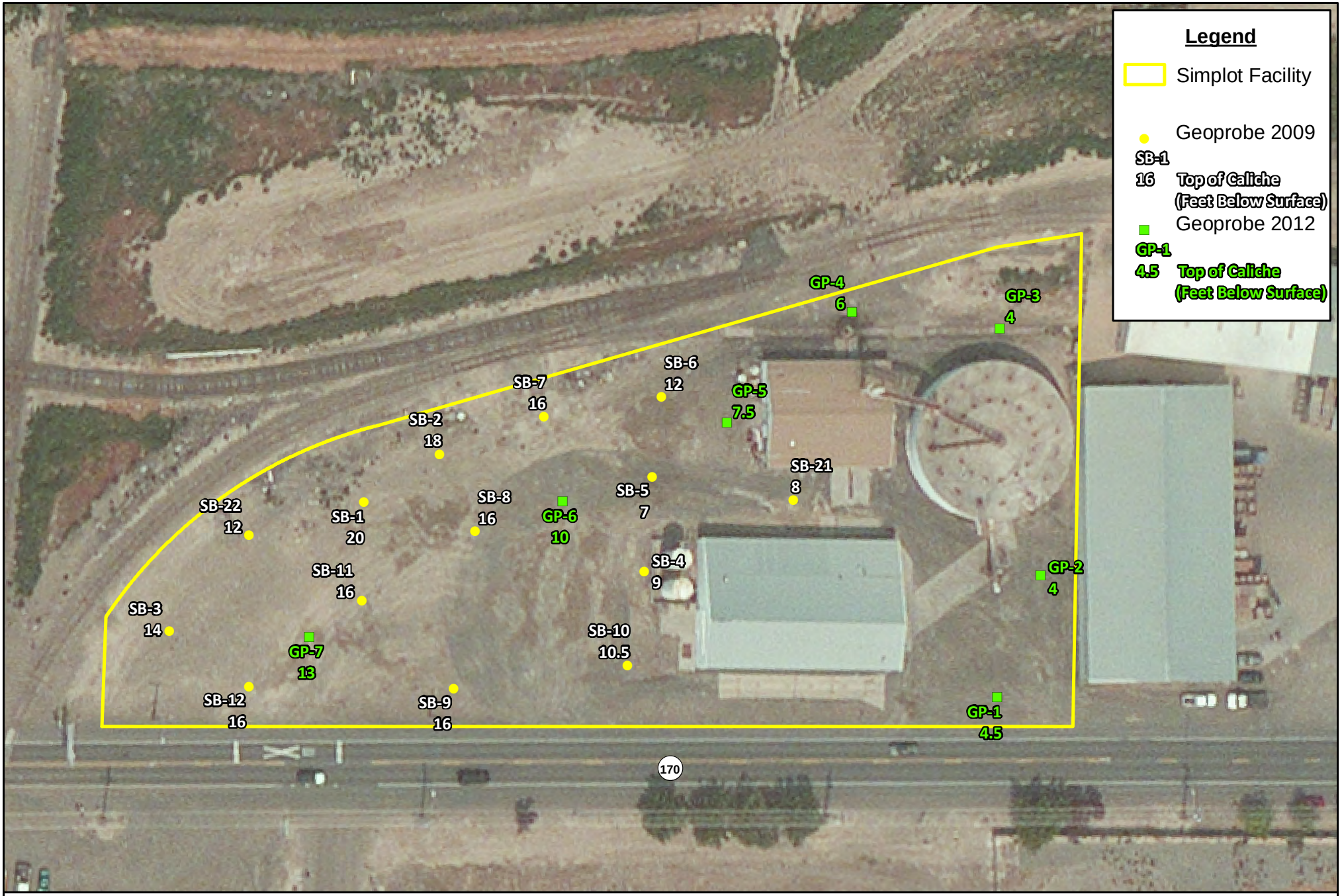
Figure 7. Geoprobe Locations (February 2012)

Simplot Grower Solutions, City of Warden, WA

Imagery: Bing Aerial Imagery (DigitalGlobe)
Source: (c) 2012 Microsoft Corporation and its data suppliers
Other Data Sources: US Census Bureau; Washington Department of Transporation; Washington Department of Revenue; Washington Department of Ecology (WDOE)

0 150 300
Feet

Map Date: 11/12/2013
Document: Q:\Simplot\CityofWarden\map_docs\Site_2012_nograph.mxd



HDR

Figure 8. Top of Caliche

Simplot Grower Solutions, City of Warden, WA

Imagery: Bing Aerial Imagery (DigitalGlobe)
Source: (c) 2012 Microsoft Corporation and its data suppliers
Other Data Sources: US Census Bureau; Washington Department of Transporation; Washington Department of Revenue; Washington Department of Ecology (WDOE)

0 70 140
Feet

Map Date: 11/22/2013
Document: Q:\Simplot\CityofWarden\map_docs\Site_2012_nograph.mxd

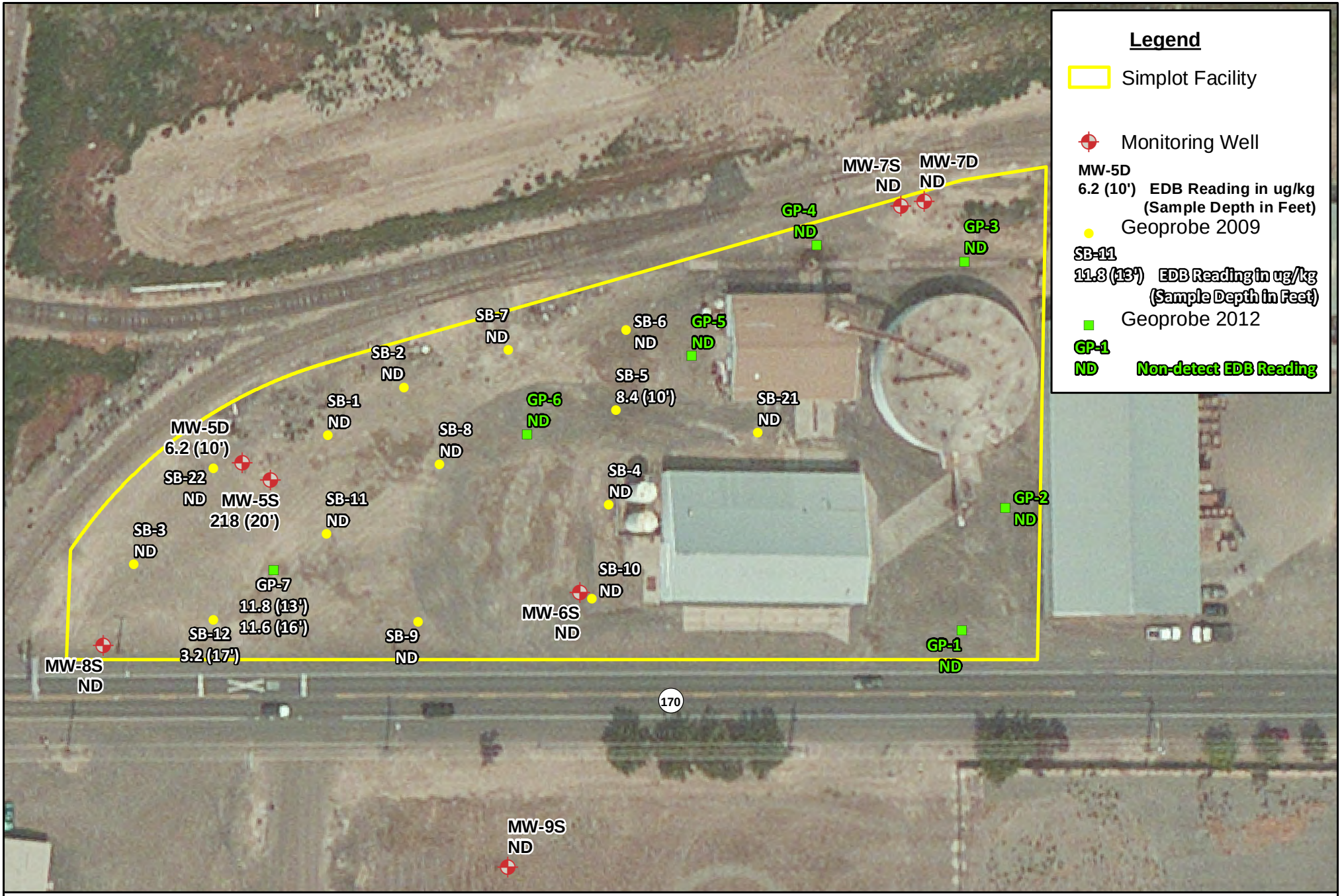


Figure 9. Post Plot of EDB in Soil, (ug/kg)

Simplot Grower Solutions, City of Warden, WA

Imagery: Bing Aerial Imagery (DigitalGlobe)
Source: (c) 2012 Microsoft Corporation and its data suppliers
Other Data Sources: US Census Bureau; Washington Department of Transporation; Washington Department of Revenue; Washington Department of Ecology (WDOE)

0 70 140
Feet

Map Date: 6/5/2014
Document: Q:\Simplot\CityofWarden\map_docs\Site_2012_nograph.mxd

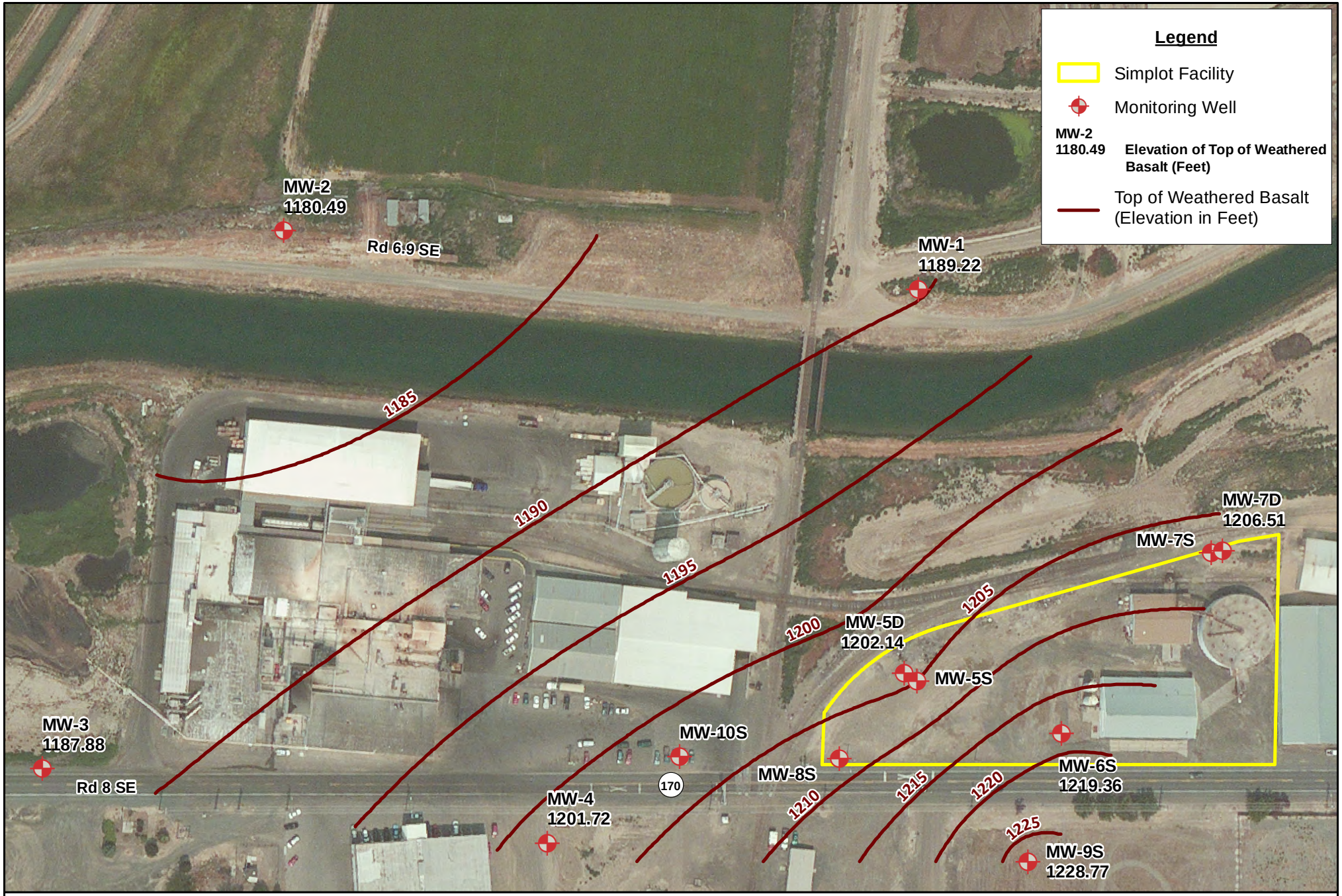


Figure 10. Top of Weathered Basalt Elevation
Simplot Grower Solutions, City of Warden, WA

Imagery: Bing Aerial Imagery (DigitalGlobe)
Source: (c) 2012 Microsoft Corporation and its data suppliers
Other Data Sources: US Census Bureau; Washington Department of Transporation; Washington Department of Revenue; Washington Department of Ecology (WDOE)

Map Date: 11/18/2013
Document: Q:\Simplot\CityofWarden\map_docs\Site.mxd

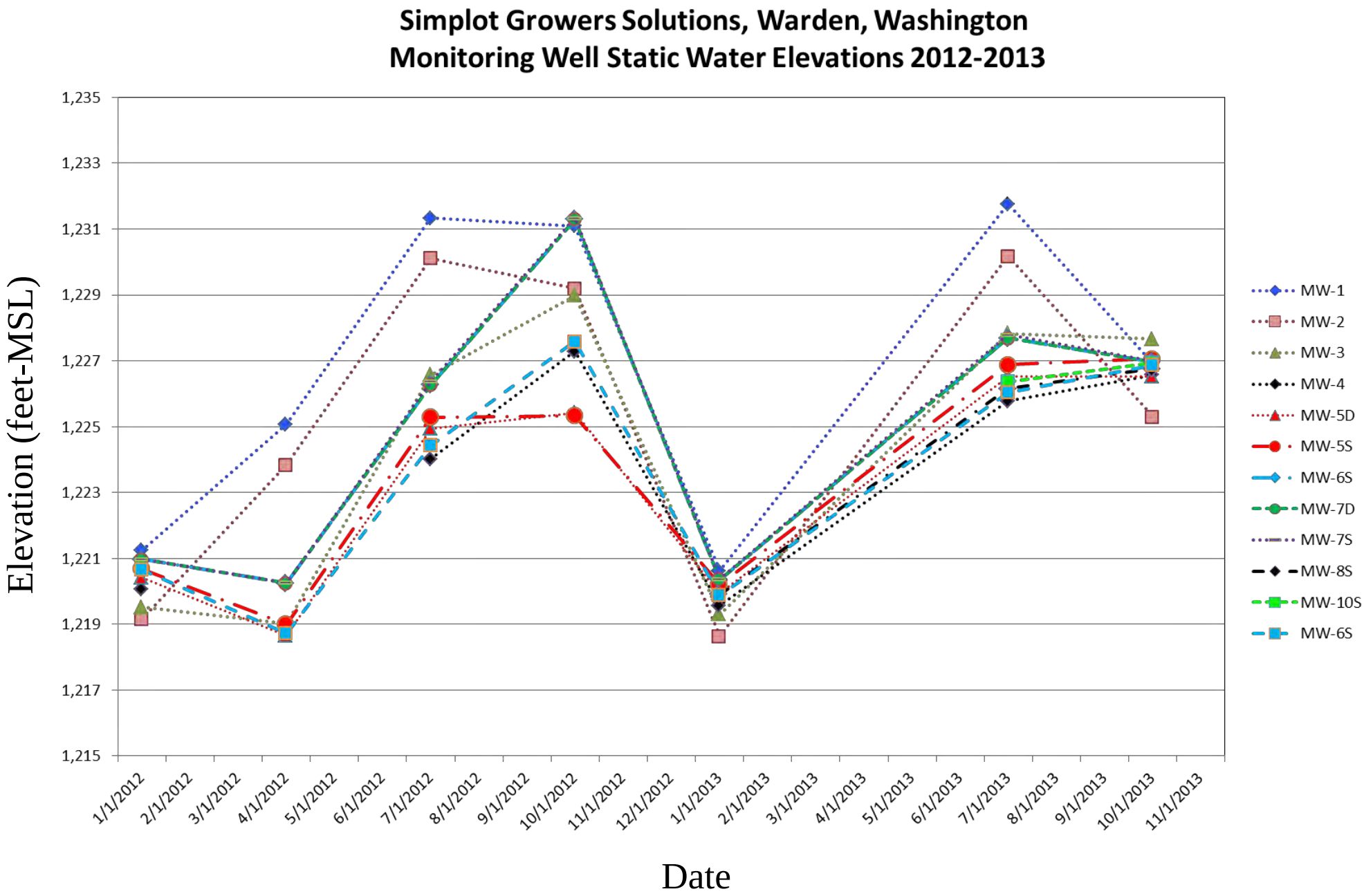


FIGURE 11. Time Series Plot of Groundwater Elevations (2012-2013)

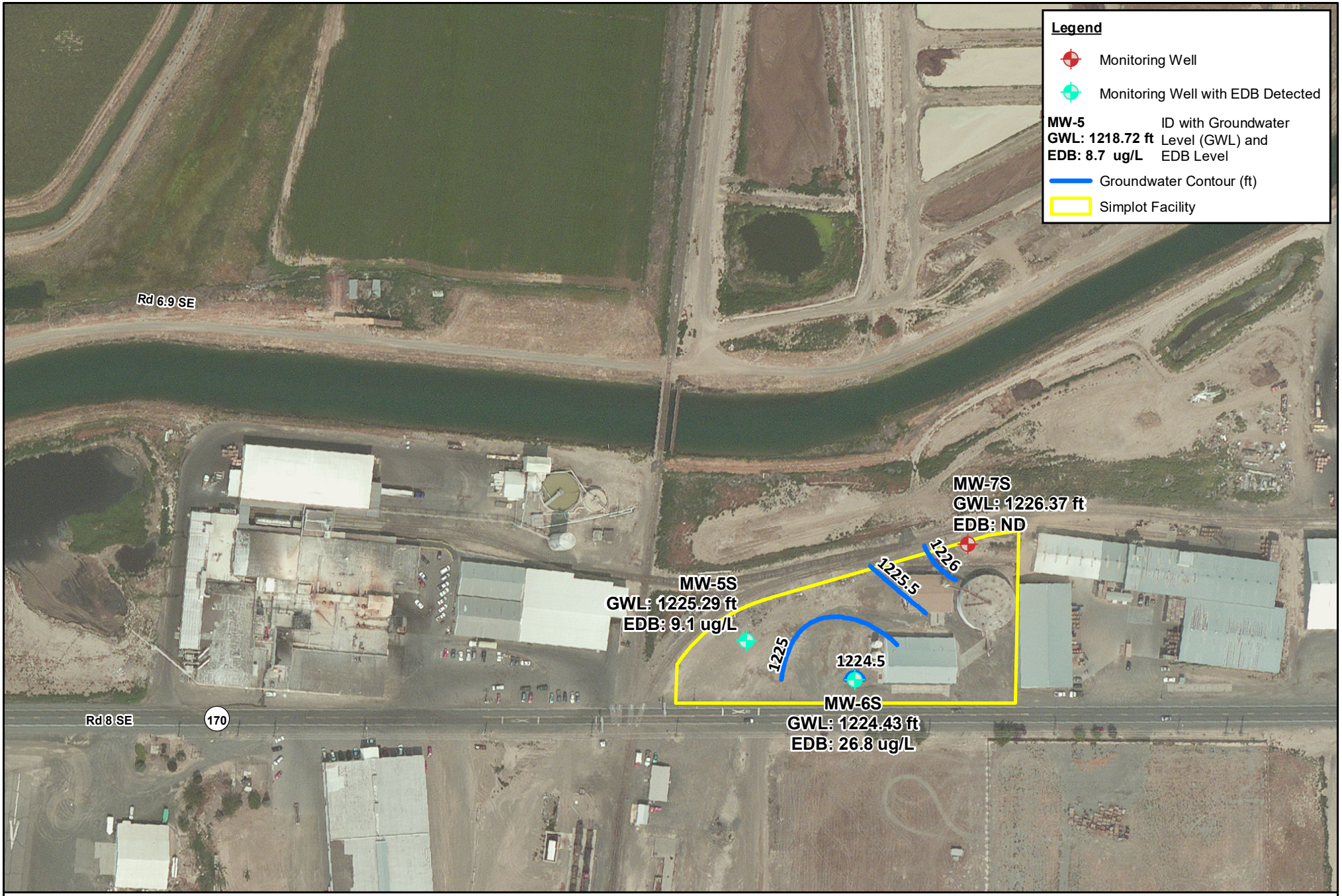


Figure 12. July 2012 Groundwater Contour Map, Shallow Wells and EDB Levels

Simplot Grower Solutions, City of Warden, WA

Imagery: Bing Aerial Imagery (DigitalGlobe)
Source: (c) 2012 Microsoft Corporation and its data suppliers
Other Data Sources: US Census Bureau; Washington Department of Transporation; Washington Department of Revenue; Washington Department of Ecology (WDOE)

0 200 400
Feet

Map Date: 5/16/2018
Document: Q:\Simplot\CityofWarden\map_docs\Site_2013.mxd

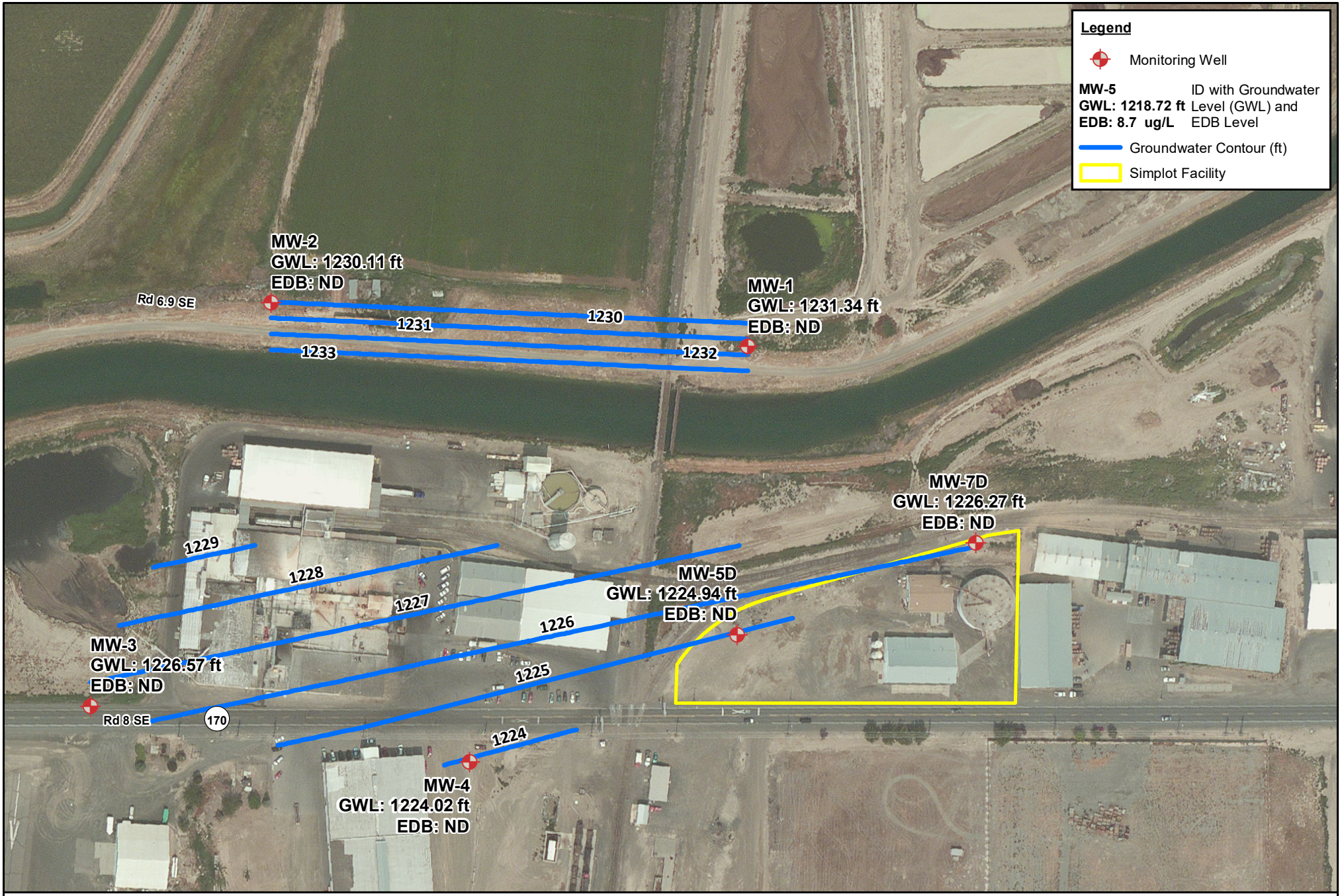


Figure 13. July 2012 Groundwater Contour Map, Deep Wells and EDB Levels
Simplot Grower Solutions, City of Warden, WA

Imagery: Bing Aerial Imagery (DigitalGlobe)
Source: (c) 2012 Microsoft Corporation and its data suppliers
Other Data Sources: US Census Bureau; Washington Department of Transporation; Washington Department of Revenue; Washington Department of Ecology (WDOE)

0 200 400
Feet

Map Date: 5/16/2018
Document: Q:\Simplot\CityofWarden\map_docs\Site_2013.mxd

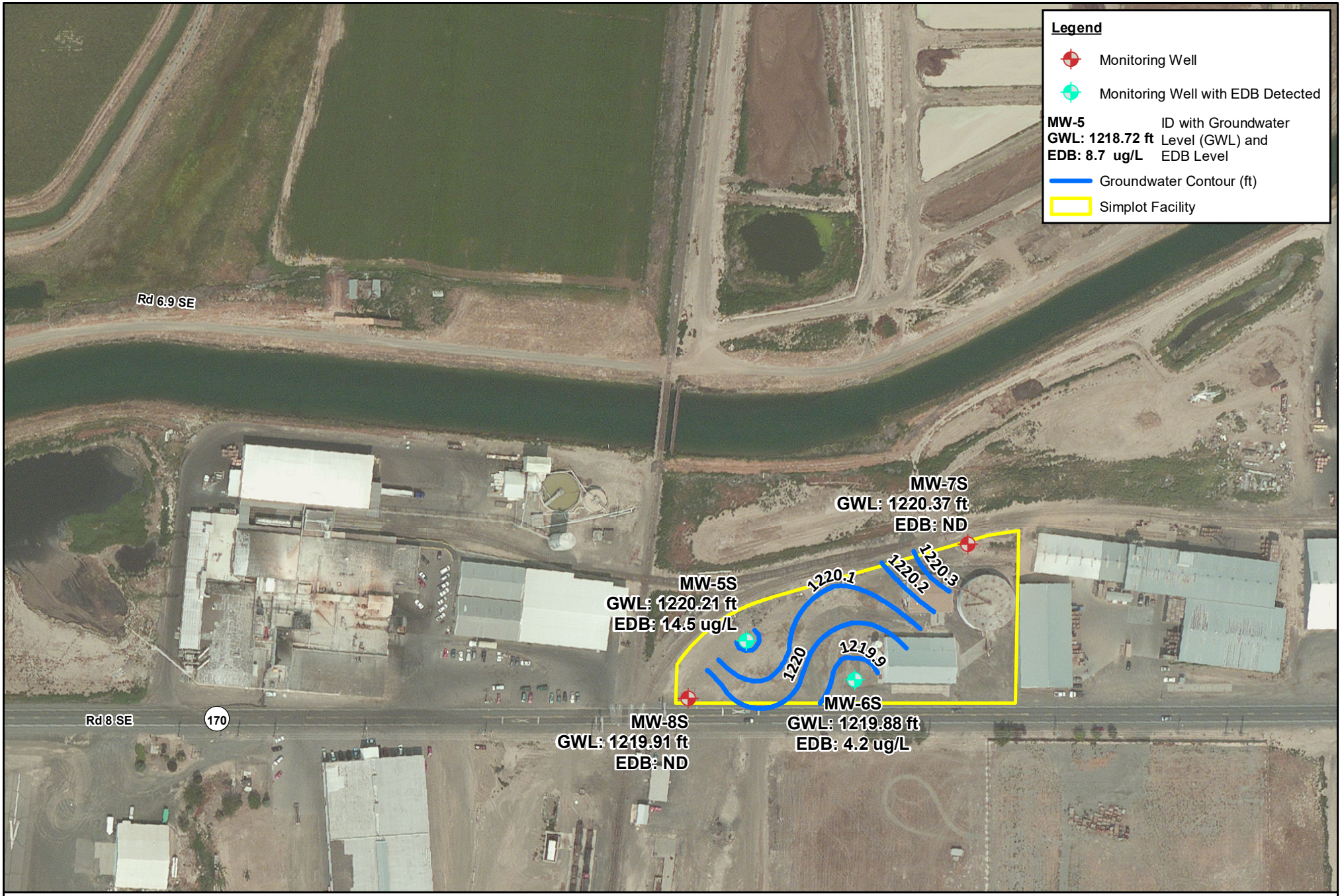


Figure 14. January 2013 Groundwater Contour Map, Shallow Wells and EDB Levels

Simplot Grower Solutions, City of Warden, WA

Imagery: Bing Aerial Imagery (DigitalGlobe)
Source: (c) 2012 Microsoft Corporation and its data suppliers
Other Data Sources: US Census Bureau; Washington Department of Transporation; Washington Department of Revenue; Washington Department of Ecology (WDOE)

0 200 400
Feet

Map Date: 5/16/2018
Document: Q:\Simplot\CityofWarden\map_docs\Site_2013.mxd

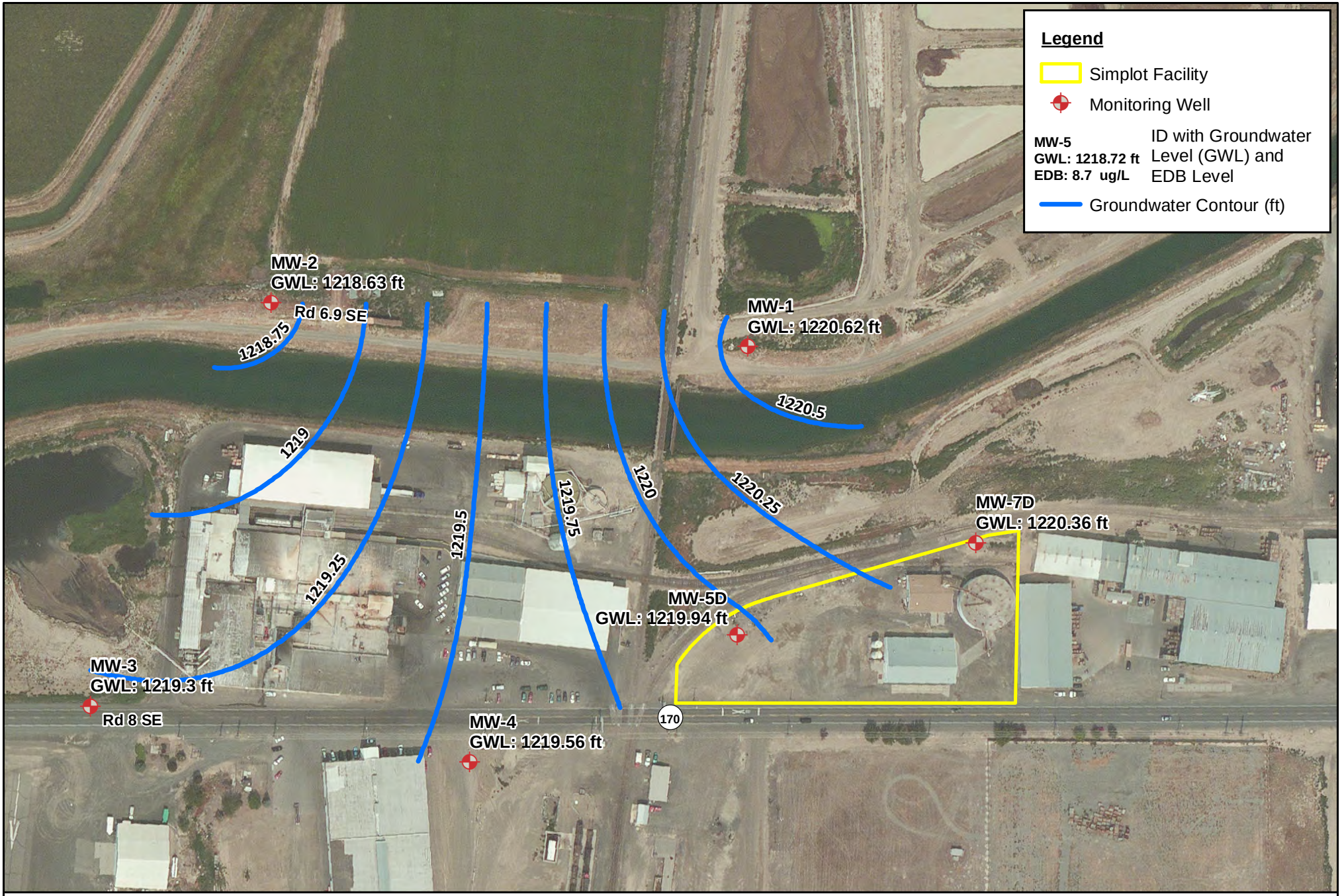


Figure 15. January 2013 Groundwater Contour Map, Deep Wells and EDB Levels

Simplot Grower Solutions, City of Warden, WA

Imagery: Bing Aerial Imagery (DigitalGlobe)
Source: (c) 2012 Microsoft Corporation and its data suppliers
Other Data Sources: US Census Bureau; Washington Department of Transporation; Washington Department of Revenue; Washington Department of Ecology (WDOE)

Note: No EDB levels were detected for these wells for this period

0 200 400
Feet

Map Date: 5/21/2014
Document: Q:\Simplot\CityofWarden\map_docs\Site_2013.mxd

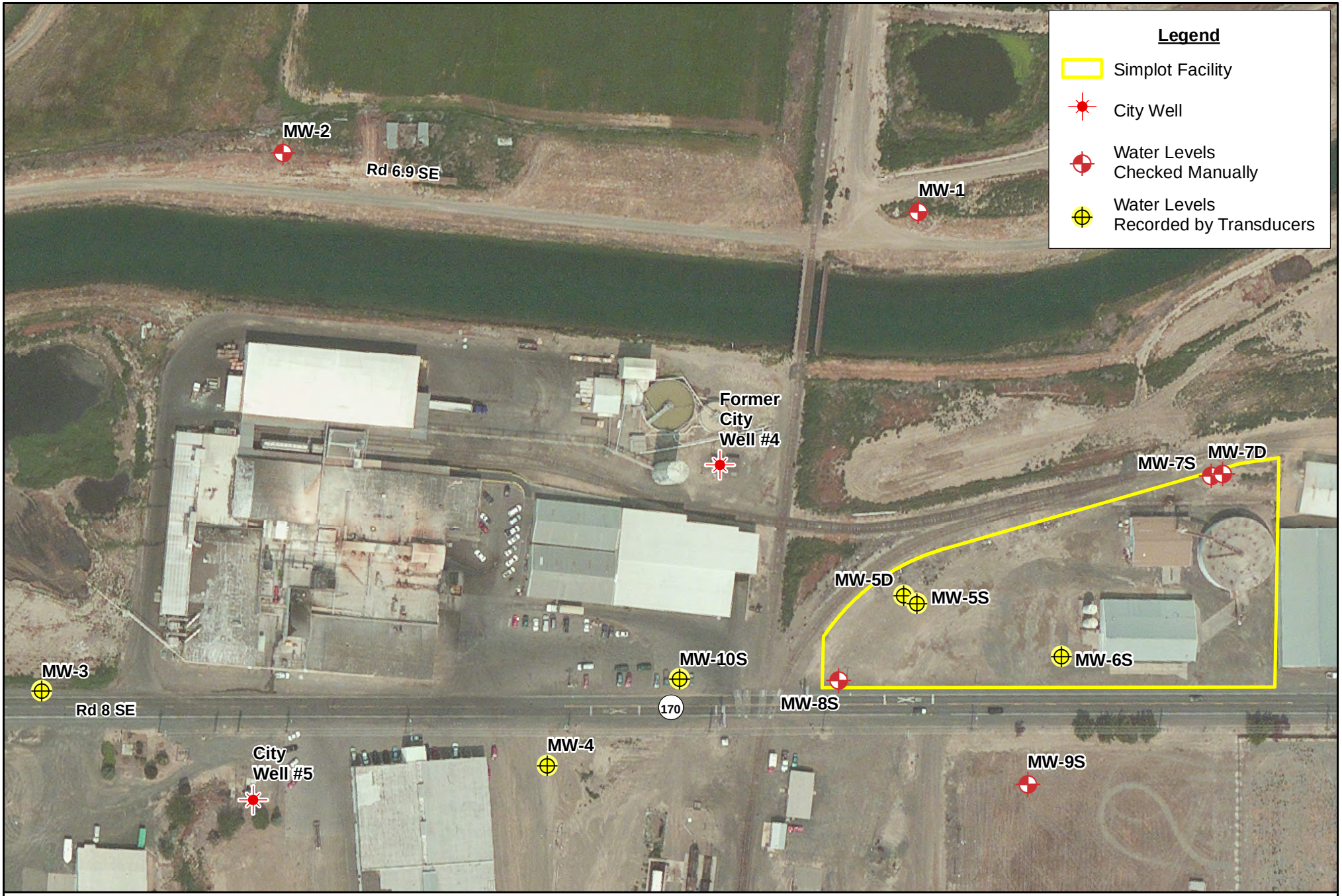


Figure 16. City Well #5 Pump Test (08-14-2013)

Simplot Grower Solutions, City of Warden, WA

Imagery: Bing Aerial Imagery (DigitalGlobe)
Source: (c) 2012 Microsoft Corporation and its data suppliers
Other Data Sources: US Census Bureau; Washington Department of Transporation; Washington Department of Revenue; Washington Department of Ecology (WDOE)

0 150 300
Feet

Map Date: 11/18/2013
Document: Q:\Simplot\CityofWarden\map_docs\Site_2012_nograph.mxd

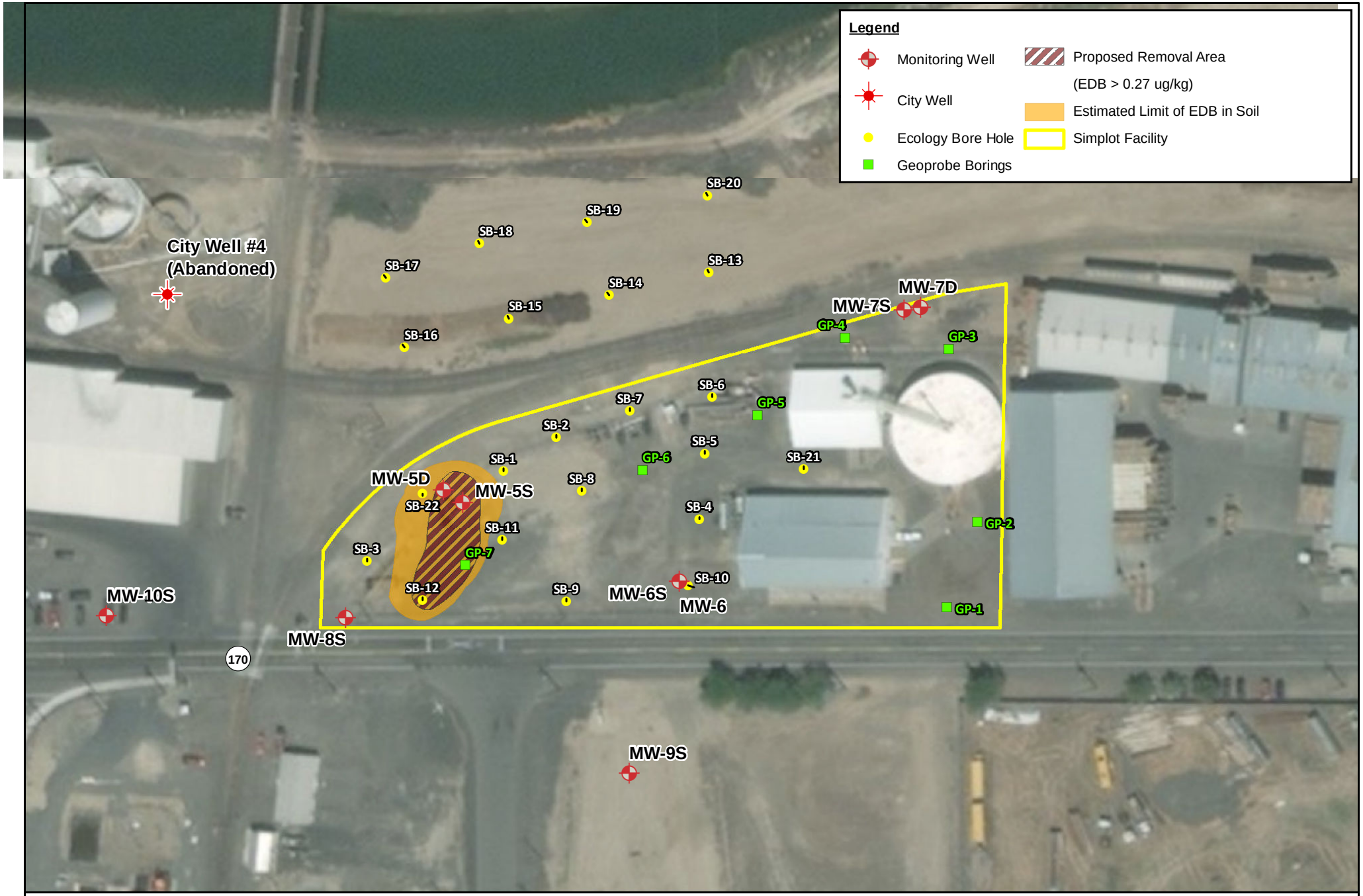


Figure 17. Estimated Limit of EDB in Soil

Simplot Grower Solutions,
1800 W 1st St., Warden, WA 98857

0 100 200
Feet

Imagery: 2016 ESRI World Imagery
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics,
CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Other Data Sources: US Census Bureau; Washington Department of Transporation;
Washington Department of Revenue; Washington Department of Ecology (WDOE)

Map Date: 3/14/2018
Document: Q:\Simplot\CityofWarden\map_docs\Site_2017.mxd

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A

City of Warden Production Well Logs

Well #1 (?)
confirmed by WRD

STATE OF WASHINGTON
DEPARTMENT OF CONSERVATION
AND DEVELOPMENT

No. Decla. #96
Cert. #890

WELL LOG

Date June 28, 1910

Record by Finlay Imbert

Source Decla. of G. W. Claim

Location: State of WASHINGTON

County Grant

Area

Map

Town of Warden NE ¼ NW ¼ sec. 15 T. 17N., R. 30 E. W.M.

DIAGRAM OF SECTION

Drilling Co.

Address

Method of Drilling drilled Date 19

Owner Town of Warden, Washington

Address

Land surface, datum 1300 ft. above / 35 below

CORRELATION	MATERIAL	THICKNESS (feet)	DEPTH (feet)
	No log		
	Pump test:		
	Dim: 375' x 6"		
	SWL: 135'		
	D.D. not known		
	Yield " Cert. issued for 50 G.P.M.		
	Casing: None		
	Perforations: None		
	Type & size of pump: Vert. turbine 4".		
	Type & size of motor: 10 hp. elec. motor.		

(Transcribe driller's terminology literally but paraphrase as necessary, in parentheses. If material water-bearing, so state and record static level if reported. Give depths in feet below land-surface datum unless otherwise indicated. Correlate with stratigraphic column, if feasible. Following log of materials, list all casings, perforations, screens, etc.)

Sheet of sheets

Turn up

Well #3 (?)

STATE OF WASHINGTON
DEPARTMENT OF CONSERVATION
AND DEVELOPMENT

WELL LOG

No. Appli. #3257
Cert. #1713-A

Date Aug. 4, 1953

Record by A. A. Durand

Source Driller's Record

Location: State of WASHINGTON

County Grant

Area

Map Lot 8, Blk. 6, Orig. Tn. of Warden
¼ ¼ sec. 10 T. 17 N., R. 30 E. W.

DIAGRAM OF SECTION

Drilling Co. A. A. Durand

Address 115 Reese Avenue; Walla Walla, Wash.

Method of Drilling Date Aug. 5 1953

Owner Town of Warden, Washington

Address

Land surface, datum 1270 ft. above / below

CORRELATION	MATERIAL	THICKNESS (feet)	DEPTH (feet)
	Surface soil, yellow, soft	3	3
	Caliche, white, soft	22	25
	Sand, yellow, soft	53	78
	Basalt, broken, black, med.	17	95
	Basalt, black, hard	11	106
	Basalt, brown, med.	14	120
	Basalt, brown, med, broken	25	145
	Basalt, balck, hard, some water	42	187
	Rock, broken, brown, med.	17	204
	Basalt, black, hard	6	210
	Basalt, black, med.	4	214
	Basalt, black, hard	9	223
	Basalt, black, med.	5	228
	Basalt, black, hard SWL 60'	22	250
	Basalt, black, med.	10	260
	Basalt, black, hard	5	265

(Transcribe driller's terminology literally but paraphrase as necessary, in parentheses. If material water-bearing, so state and record static level if reported. Give depths in feet below land-surface datum unless otherwise indicated. Correlate with stratigraphic column, if feasible. Following log of materials, list all casings, perforations, screens, etc.)

Sheet of sheets

Ce 85

WELL LOG.--Continued . No. ____/____-____

Correlation	Material	Thickness (feet)	Depth (feet)
	Depth forward	———	
	Basalt, black, med.	17	282
	Basalt, black, hard	5	287
SWL 120'	Basalt, broken, black, med.	28	315
SWL 150'	Basalt, black, hard,	5	320
	Basalt, black, med.	23	343
	Basalt, black, hard	7	350
	Basalt, black, med.	4	354
	Basalt, black, hard	16	370
	Basalt, black, med.	5	375
	Basalt, black, hard	15	390
	Basalt, black, med. SWL 200'	5	395
	Basalt, black, soft	22	417
	Basalt, black, hard	6	423
	Basalt, black, med.	3	426
	Basalt, black, hard	13	439
	Basalt, black, broken SWL 250'	9	448
	Basalt, black med. SWL 160'	48	496
	Basalt, black, broken	24	520
	Basalt, black, med.	15	535
	Basalt, black broken	31	566
	Basalt, black, med.	17	583
	Basalt, black, hard	6	589
	Basalt, black, broken SWL 160'	11	600
	Basalt, black, med.	40	640
	Basalt, black, hard	16	656
	Basalt, black, med.	7	663
	Basalt, blue, hard	13	676
	Basalt, black, med.	9	685
Pump Test:	Dim: 685' x 10"; SWL: 160';		
	Dd: 260'; Yield: 420 g.p.m.;		
	Casing: 10" dia. Std. Well Casing, 0 to 89.6		

STATE OF WASHINGTON
DEPARTMENT OF CONSERVATION
AND DEVELOPMENT

WELL LOG No. Appl. 4710

Date 8-19-57, 19

Record by well driller

Source driller's record

Location: State of WASHINGTON

County Grant

Area

Map

S½ x SW¼ sec. 9 T. 17 N., R. 30 E. xWx

Diagram of Section

Drilling Co. Barnett Plumbing & Heating

Address Lind, Wash.

Method of Drilling Date Aug. 19 57

Owner Town of Warden, Washington

Address

Land surface, datum 1230 ft above / below

Consolidation	Material	Thickness (feet)	Depth (feet)
	(Transcribe driller's terminology literally but paraphrase as necessary, in parentheses. If material water-bearing, so state and record static level if reported. Give depths in feet below land-surface datum unless otherwise indicated. Correlate with stratigraphic column, if feasible. Following log of materials, list all casings, perforations, screens, etc.)		
	Top soil	25	25
	Sand	24	49
	Broken black basalt rock	31	80
	" " " little water	22	112
	Hard gray basalt rock	47	159
	Clay & broken basalt rock	20	179
	Hard gray basalt rock	26	215
	Basalt rock (caving)	30	245
	Hard rock & broken layers of rock	33	278
	Black basalt rock	36	314
	Water rock (plenty of water)	5	319
	PUMP TEST:		
	Dim. 319'x12"		
	SWL: 62 ft.		
	DD: 166 ft.		
	Yield: 1100 g.p.m.		

Turn up (over) Sheet of sheets

WELL LOG.—Continued

No. ....../..........

Correlation	Material	Thickness (feet)	Depth (feet)
	Depth forward	———	
	Type & size of pump: Jacussi test		
	" " " " motor: 165 h.p.		
	Diesel		
	~~CASING: 12" diam. casing set at~~		
	~~80 ft. to rock from 0 to 80 ft.~~		
	~~Depth of drive shoe 80 ft.~~		
	Permitted		
	1000 gpm		
	1344 [illegible]		
	Mun		
	Meter Sparling 8" 60164		
	1/30/74 534 600 ft³		
	11/26/74 3874 840 ft³		
	12/16/75 9023490 "		
	12/1/76 1753320		

S. F. No. 7... —12-54—3M. ...168.

Well #5

STATE OF WASHINGTON
DEPARTMENT OF CONSERVATION
DIVISION OF WATER RESOURCES

Appli. 7730
Per. 7434
WELL LOG G-05055

Well #5

Record by Driller
Source Driller's Record

Location: State of WASHINGTON
County Grant
Area
Map
NW.¼ NW.¼ sec. 16 T. 17 N., R. 30 E. W.

Diagram of Section

Drilling Co. Gray & Osborne, Consulting Engineers
Address 228 S. 2nd St., Yakima, Wash.
Method of Drilling Cable Date May 21, 1968
Owner Town of Warden,
Address Warden, Washington 98857
Land surface, datum 1240 ft. above / below
SWL: 42' Date May 21, 1968 Dims. 16" x 368

Geologic Formation	Material	From (feet)	To (feet)
	(Transcribe driller's terminology literally but paraphrase as necessary, in parentheses. If material water-bearing, so state and record static level if reported. Give depths in feet below land-surface datum unless otherwise indicated. Correlate with stratigraphic columns, if feasible. Following log of materials, list all casings, perforations, screens, etc.)		
	Municipal		
	Top soil	0	12
	Caliche	12	14
	Sand, brown rock	14	37
	Sand, brown rock	37	52
	Basalt, black	52	61
	Basalt, brown (some sand, caving) water level 30'	61	155
	Basalt, black	155	210
	Basalt, black-hard	210	214
	Basalt, black	214	250
	Basalt, black-hard	250	267
	Basalt, gray-hard	267	283
	Basalt, gray	283	295
	Basalt, black-caving	295	345
	Basalt, black-hard	345	355

Turn up

Sheet ____ of ____ sheets

WELL LOG.—Continued No...../.....

Ownership	Material	From (feet)	To (feet)
	Depth forward	———	
	Basalt, black (water raised to 27½')	355	361
	Basalt, brown,black, caving	361	364
	Sand, brown-black	364	368
	water level dropped to 43'5"		
	Casing: 16" from 0' to 54'		
	Yield: 850 gpm with 72' DD after 2 hrs.		
	1175 gpm with 109' DD after 2 hrs.		
	1400 gpm with 163' DD after 6 hrs.		
	Recovery:		
	time: 10 sec.; water level: 50'		
	Date of test May 21, 1968		
	Temp.: 56°		
	Pump: 200 H.P., Turbine, Worthington		
	Permitted		
	1600 gpm		
	646 Sac. ft./yr		
	Mun.		
	Metal Rockwell 2"		
	10/15/74	600	
	11/26/75	709	
	12/16/75		
	12/1/76		

S. F. No. 7448—O5—12-65.

File Original and First Copy with Department of Ecology
Second Copy — Owner's Copy
Third Copy — Driller's Copy

WATER WELL REPORT
STATE OF WASHINGTON

Application No
Permit No 1713-A

(1) **OWNER:** Name Town of Warden Address Warden, Washington

LOCATION OF WELL: County Grant Original Plot of Warden ¼ ¼ Sec 16 T 17 N. R. 30 W
bearing and distance from section or subdivision corner Block 6 lot 6

(3) **PROPOSED USE:** Domestic ☐ Industrial ☐ Municipal ☒
Irrigation ☐ Test Well ☐ Other ☐

(4) **TYPE OF WORK:** Owner's number of well (if more than one) No. 6
New well ☒ Method: Dug ☐ Bored ☐
Deepened ☐ Cable ☐ Driven ☐
Reconditioned ☐ Rotary ☐ Jetted ☐

(5) **DIMENSIONS:** Diameter of well 24" to 97' 17½" to 407' 15½" to 830 inches.
Drilled 830 ft. Depth of completed well 830 ft.

(6) **CONSTRUCTION DETAILS:**
Casing installed: 20" Diam. from 0 ft. to 97 ft.
Threaded ☐ 16" Diam. from +18 ft. to 386 ft.
Welded ☒ " Diam. from ft. to ft.

Perforations: 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.

Screens: Yes ☐ No ☒
Manufacturer's Name
Type Model No.
Diam. Slot size from ft. to ft.
Diam. Slot size from ft. to ft.

Gravel packed: Yes ☐ No ☒ Size of gravel:
Gravel placed from ft. to ft.

Surface seal: Yes ☒ No ☐ To what depth? 439 ft.
Material used in seal
Did any strata contain unusable water? Yes ☒ No ☐
Type of water? Depth of strata 1150 - 400
Method of sealing strata off pressure grouted

(7) **PUMP:** Manufacturer's Name
Type: H.P.

(8) **WATER LEVELS:** Land-surface elevation above mean sea level ft.
Static level 174 ft. below top of well Date 4/19/79
Artesian pressure lbs. per square inch Date
Artesian water is controlled by (Cap, valve, etc.)

(9) **WELL TESTS:** Drawdown is amount water level is lowered below static level
Was a pump test made? Yes ☒ No ☐ If yes, by whom? Layne-Bowler
Yield: 3180 gal./min. with 86 ft. drawdown after 8 hrs.
" " " "
" " " "

Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level

Date of test 4/19/79
Bailer test gal./min. with ft. drawdown after hrs.
Artesian flow g.p.m. Date
Temperature of water 82 Was a chemical analysis made? Yes ☐ No ☐

(10) **WELL LOG:**
Formation: Describe by color, character, size of material and structure, a
show thickness of aquifers and the kind and nature of the material in ea
stratum penetrated, with at least one entry for each change of formati

MATERIAL	FROM	TO
DIAMETER: 24" to 97 ft.		
17½" to 407 ft.		
15½" to 830 ft.		
Frozen brown top soil dirt	0	2
Fine brown dirt	2	4
Tan colored calache hard	4	43
Sandy brown clay	43	62
Red soft basalt	62	70
Broken fractured basalt	70	88
Soft brown basalt	88	90
Hard black basalt	90	102
Black & Brown medium hard to medium soft fractured basalt 30 ft. hr. rat 12 rpm - 4000 lbs. on bit	102	160
Hard blackish gray basalt with some crevises 13' pr. hr. drilling rate	160	225
Medium hard gray basalt	225	229
Hard gray basalt	229	235
Medium soft brown pourous basalt small amount clay mixed	235	245
Medium hard blackish gray basalt with some fractures	245	261
Medium soft brown basalt	261	267
Medium hard black basalt	267	270
Medium soft black pourous basalt	270	281
Medium hard black fractured basalt	281	283
Hard gray crevised basalt	283	290
Soft brown basalt with blue hard clay, small amount of black basalt	290	303
Hard crevised blackish gray basalt	303	323
Medium soft black basalt	323	330
Medium black basalt	330	340
Medium soft black & gray & brown basalt with mineral dep.	340	370

Work started Jan 17, 19 79 Completed April 4, 1979

WELL DRILLER'S STATEMENT:
This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

NAME LEACH WELL DRILLING, INC.
(Person, firm, or corporation) (Type or print)
Address 1430 Hillcrest Drive, Moses Lake, Wn. 9
[Signed] Richard L. Leach
(Well Driller)
License No. 0276 Date 4/26/79, 19

File Original and First Copy with Department of Ecology
Second Copy — Owner's Copy
Third Copy — Driller's Copy

WATER WELL REPORT
STATE OF WASHINGTON

Application No.
Permit No.

(1) **OWNER:** Name Town of Warden Address

LOCATION OF WELL: County ¼ ¼ Sec. 10 T. 17 N., R. 30 W M

Bearing and distance from section or subdivision corner

(3) **PROPOSED USE:** Domestic ☐ Industrial ☐ Municipal ☐
Irrigation ☐ Test Well ☐ Other ☐

(4) **TYPE OF WORK:** Owner's number of well (if more than one)
New well ☐ Method: Dug ☐ Bored ☐
Deepened ☐ Cable ☐ Driven ☐
Reconditioned ☐ Rotary ☐ Jetted ☐

(5) **DIMENSIONS:** Diameter of well inches.
Drilled ft. Depth of completed well ft.

(6) **CONSTRUCTION DETAILS:**

Casing installed: ..." Diam. from ft. to ft.
Threaded ☐ ..." Diam. from ft. to ft.
Welded ☐ ..." Diam. from ft. to ft.

Perforations: 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.

Screens: Yes ☐ No ☐
Manufacturer's Name
Type Model No.
Diam. Slot size from ft. to ft.
Diam. Slot size from ft. to ft.

Gravel packed: Yes ☐ No ☐ Size of gravel:
Gravel placed from ft. to ft.

Surface seal: Yes ☐ No ☐ To what depth? ft.
Material used in seal
Did any strata contain unusable water? Yes ☐ No ☐
Type of water? Depth of strata
Method of sealing strata off

(7) **PUMP:** Manufacturer's Name
Type: H.P.

(8) **WATER LEVELS:** Land-surface elevation above mean sea level ft.
Static level ft. below top of well Date
Artesian pressure lbs. per square inch Date
Artesian water is controlled by (Cap, valve, etc.)

(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.
" " " "
" " " "

Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level

Date of test
Bailer test gal./min. with ft. drawdown after hrs.
Artesian flow g.p.m. Date
Temperature of water Was a chemical analysis made? Yes ☐ No ☐

(10) **WELL LOG:**

Formation: Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of formation

MATERIAL	FROM	TO
Continued from page 1		
This area caved and sluffed continually.		
Medium hard gray basalt some fractures	370	396
Medium hard gray fractured basalt with crevises	396	422
Hard gray dense basalt picking up some fractures 433'	422	455
Medium soft with hard layers, there is small amount of brown rotten basalt mixed	455	493
Hard gray fractured basalt	493	515
Medium hard gray & black basalt small amount of pourous mixed	515	540
Hard gray basalt drilling approx. 16 feet per hr.	540	598
Black pourous basalt some brown mixed	598	621
Medium hard gray black basalt	621	630
Medium soft with hard layers 6" to 8"	630	635
Medium hard gray basalt	635	666
Medium soft blackish gray basalt	666	670
Medium hard gray basalt	670	688
Hard gray basalt drilling about 16 ft. per hr. some fractures	688	730
Medium soft black with blue & brown pourous basalt H20 40 psi increase in air pressure	730	761
Medium hard fractured basalt gray color	761	765
Hard gray basalt	765	778
Medium hard gray basalt	778	780
Soft black pourous basalt H20	780	786
Hard black basalt	786	802

Work started 19 Completed 19

WELL DRILLER'S STATEMENT: Continued on page

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

NAME (Person, firm, or corporation) (Type or print)
Address
[Signed] (Well Driller)
License No. Date 19

XIII

File Original and First Copy with Department of Ecology
Second Copy — Owner's Copy
Third Copy — Driller's Copy

WATER WELL REPORT

STATE OF WASHINGTON

Application No

Permit No

(1) OWNER: Name Town of Warden Address

LOCATION OF WELL: County — ¼ ¼ Sec 16 T 17N., R 32 W M

Bearing and distance from section or subdivision corner

(3) PROPOSED USE: Domestic ☐ Industrial ☐ Municipal ☐
Irrigation ☐ Test Well ☐ Other ☐

(4) TYPE OF WORK: Owner's number of well (if more than one)
New well ☐ Method: Dug ☐ Bored ☐
Deepened ☐ Cable ☐ Driven ☐
Reconditioned ☐ Rotary ☐ Jetted ☐

(5) DIMENSIONS: Diameter of well ..... inches.
Drilled ..... ft. Depth of completed well ..... ft.

(6) CONSTRUCTION DETAILS:

Casing installed: ....." Diam. from ..... ft. to ..... ft.
Threaded ☐ ....." Diam. from ..... ft. to ..... ft.
Welded ☐ ....." Diam. from ..... ft. to ..... ft.

Perforations: 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.

Screens: Yes ☐ No ☐
Manufacturer's Name
Type ..... Model No
Diam. ..... Slot size ..... from ..... ft. to ..... ft.
Diam. ..... Slot size ..... from ..... ft. to ..... ft.

Gravel packed: Yes ☐ No ☐ Size of gravel:
Gravel placed from ..... ft. to ..... ft.

Surface seal: Yes ☐ No ☐ To what depth? ..... ft.
Material used in seal
Did any strata contain unusable water? Yes ☐ No ☐
Type of water? ..... Depth of strata
Method of sealing strata off

(7) PUMP: Manufacturer's Name
Type: ..... H.P.

(8) WATER LEVELS: Land-surface elevation above mean sea level ..... ft.
Static level ..... ft. below top of well Date
Artesian pressure ..... lbs. per square inch Date
Artesian water is controlled by (Cap, valve, etc.)

(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.
" " " "
" " " "

Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level

Date of test
Bailer test ..... gal./min. with ..... ft. drawdown after ..... hrs.
Artesian flow ..... g.p.m. Date
Temperature of water ..... Was a chemical analysis made? Yes ☐ No ☐

(10) WELL LOG:

Formation: Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of formation

MATERIAL	FROM	TO
Continued from page 2		
Soft black pourous basalt with blue mineral mixed H2O looks like theres over 3000 gpm	802	830 TWD

Work started ..... 19..... Completed ..... 19.....

WELL DRILLER'S STATEMENT:

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

NAME ..... (Person, firm, or corporation) (Type or print)

Address

[Signed] ..... (Well Driller)

License No. ..... Date ..... 19.....

Please print, sign and return to the Department of Ecology

NAU # 7

Water Well Report

Original - Ecology, 1st copy - owner, 2nd copy - driller

ECOLOGY

Construction/Decommission 190330

☑ Construction

☐ Decommission *ORIGINAL INSTALLATION Notice of Intent Number* ______

Current Notice of Intent No. W07249

Unique Ecology Well ID Tag No. AAP...

FEB 24 2006

Water Right Permit No. G3-221792

Property Owner Name City of Warden

Well Street Address NYA - NE corner of Locust Ave & ...

City Warden County Grant

Location NE 1/4-1/4 NE 1/4 Sec 15 Twn 17 R 30 EWM ☑

Lat/Long (s, t, r still REQUIRED) Lat Deg ____ Lat Min/Sec ____ Long Deg ____ Long Min/Sec ____

Tax Parcel No. 61661000

PROPOSED USE: ☐ Domestic ☐ Industrial ☑ Municipal ☐ DeWater ☐ Irrigation ☐ Test Well ☐ Other

TYPE OF WORK: Owner's number of well (if more than one) 7

☑ New well ☐ Reconditioned Method ☐ Dug ☐ Bored ☐ Driven ☐ Deepened ☐ Cable ☑ Rotary ☐ Jetted

DIMENSIONS: Diameter of well 16 inches, drilled 857 ft.

Depth of completed well 857 ft.

CONSTRUCTION DETAILS

Casing Installed: ☑ Welded 20" Diam. from +0.4 ft. to 113 ft.

☐ Liner installed 16" Diam. from +1.9 ft. to 770 ft.

☐ Threaded ___" Diam. from ___ ft. to ___ ft.

Perforations: ☐ Yes ☑ No

Type of perforator used ______

SIZE of perfs ___ in. by ___ in. and no. of perfs ___ from ___ ft. to ___ ft.

Screens: ☐ Yes ☑ No ☐ K-Pac Location ______

Manufacturer's Name ______

Type ______ Model No. ______

Diam. ___ Slot size ___ from ___ ft. to ___ ft.

Diam. ___ Slot size ___ from ___ ft. to ___ ft.

Gravel/Filter packed: ☐ Yes ☑ No ☐ Size of gravel/sand ______

Materials placed from ___ ft. to ___ ft.

Surface Seal: ☑ Yes ☐ No To what depth? 113 *see below ft.

Material used in seal cement - *16" casing also sealed from top of 20" csg to 770'

Did any strata contain unusable water? ☐ Yes ☐ No

Type of water? ______ Depth of strata ______

Method of sealing strata off ______

PUMP: Manufacturer's Name ______

Type ______ H.P. ______

WATER LEVELS: Land-surface elevation above mean sea level 1280+/- ft.

Static level 273 ft. below top of well Date 2/7/06

Artesian pressure ___ lbs. per square inch Date ___

Artesian water is controlled by ______ (cap, valve, etc.)

WELL TESTS: Drawdown is amount water level is lowered below static level

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

Yield 2100 gal./min. with 45 ft. drawdown after 1 hrs.

Yield 2100 gal./min. with 56 ft. drawdown after 8 hrs.

Yield 2100 gal./min. with 61 ft. drawdown after 24 hrs.

Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level
10	296.9	400	281.6	1000	277.1
100	288.5	600	279.5	1200	276.2
200	285.2	800	278.1	1440	275.4

Date of test began 2/12/06

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

Airtest ___ gal./min. with stem set at ___ ft. for ___ hrs.

Artesian flow ___ g.p.m. Date ___

Temperature of water ___ Was a chemical analysis made? ☑ Yes ☐ No

CONSTRUCTION OR DECOMMISSION PROCEDURE

Formation: Describe by color, character, size of material and structure, and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of information. Indicate all water encountered. (USE ADDITIONAL SHEETS IF NECESSARY.)

MATERIAL	FROM	TO
See attached formation log		
3/8" steel ring welded between 16" & 20" casings		
Liner was not installed in lower borehole at Owner's request		

Start Date 7/18/05 Completed Date 2/2006

WELL CONSTRUCTION CERTIFICATION: I constructed and/or accept responsibility for construction of this well, and its compliance with all Washington well construction standards. Materials used and the information reported above are true to my best knowledge and belief.

Driller/Engineer/Trainee Name (Print) Stephen Schneider

Driller/Engineer/Trainee Signature *[signature]*

Driller or trainee License No. 0643

IF TRAINEE, Driller's Licensed No. ______

Driller's Signature ______

Drilling Company Schneider Equipment, Inc.

Address 21881 River Road NE

City, State, Zip St. Paul, OR 97137

Contractor's Registration No. SCHNEE*226LG Date 2/21/06

Ecology is an Equal Opportunity Employer ECY 050-1-20 (Rev 2/03)

City of Warden Well No. 7

by Schneider Drilling Co.

Start Card #W07249 Label #AAS175

FM	TO	DESCRIPTION
0	11	Topsoil, brown, sandy
11	17	Caliche, hard
17	18	Sand, brown, medium-fine, silty
18	65	Sand, brown, medium-fine, silty, cemented
65	66	Stone, brown, silty, hard.
66	81	Sandy, brown, medium-fine, silty
81	86	Basalt, black & brown, broken
86	122	Basalt, black & brown, medium-hard
122	130	Basalt, gray w/brown, medium, fractured
130	137	Basalt, reddish-brown & gray, medium-soft, fractured
137	221	Basalt, gray, hard, fractured
221	244	Basalt, gray & red, medium, fractured
244	346	Basalt, gray, hard, fractured, some vesicles
346	351	Basalt, black & brown, medium, fractured, vesicular
351	386	Basalt, gray & brown, medium-soft, fractured, vesicular
386	398	Claystone, white, sandy, silty
398	445	Basalt, gray w/brown, medium, fractured, vesicular
445	466	Claystone & basalt, gray & green & brown, unstable
466	470	Basalt, gray & green, fractured
470	477	Claystone, blue-green, medium-soft, basalt, black & brown, broken, vesicular
477	482	Basalt, gray, fractured
482	488	Basalt, gray, fractured, claystone, brown
488	494	Claystone, green, fractured, basalt, black
494	499	Basalt, gray, fractured, claystone, green
499	507	Basalt, gray & brown, fractured
507	509	Basalt, redish, vesicular
509	515	Basalt, brown & gray, fractured, vesicular
515	518	Claystone, green, wood
518	520	Claystone, green, dark brown
520	521	Basalt, brown & black, medium-soft, fractured, vesicular, claystone, green
521	525	Basalt, black, medium-hard, fractured
525	527	Basalt, black, hard, fractured
527	534	Basalt, black & brown, medium-hard, fractured
534	540	Basalt, black, hard, fractured
540	545	Basalt, gray & black, hard, fractured
545	546	Basalt, brown & black, hard, fractured
546	559	Basalt, gray, hard, fractured, vesicular
559	579	Basalt, gray, hard, fractured
579	583	Basalt, gray, hard, fractured, clay, light green, fractured
583	594	Basalt, gray, very hard, fractured, clay, light green, fractured

City of Warden Well No. 7

by Schneider Drilling Co.

Start Card #W07249 Label #AAS175

FM	TO	DESCRIPTION
594	604	Basalt, black, fractured, vesicular, rock, translucent, soft
604	609	Basalt, black, medium, fractured
609	610	Basalt, brown, soft, fractured, basalt, medium-hard, vesicular
610	613	Basalt, black, medium-hard, fractured pyrite
613	616	Basalt, black, hard, fractured
616	619	Basalt, black, hard, fractured, crystal, translucent
619	623	Basalt, black, vesicular, medium-hard, basalt, brown, fractured, broken, vesicular
623	628	Basalt, black, medium-hard, broken, fractured, pyrite
628	630	Basalt, black, medium-hard, broken, crystal, translucent
630	636	Basalt, black ,fractured, hard
636	639	Basalt, black, medium-hard, fractured, basalt, brown, fractured, broken, vesicular
639	643	Basalt, brown, soft, broken, vesicular, basalt, black, fractured, broken
643	649	Basalt, black ,fractured, vesicular, brown, broken
649	651	Basalt, black, fractured, hard
651	656	Basalt, black, very hard, fractured w/ some brown, fractured
656	659	Basalt, black, hard, fractured, vesicular, pyrite
659	663	Basalt, black, fractured w/ brown fractured
663	669	Basalt, black, fractured, hard, claystone, green
669	686	Basalt, black, fractured, hard
686	690	Basalt, black, medium, very fractured, claystone, green
690	693	Basalt, black, medium-hard, fractured, claystone, green
693	701	Basalt, brown, medium-soft, fractured, black, fractured, medium, claystone, green
701	705	Basalt, dark brown & black, broken, fractured, vesicular, medium-soft
705	712	Basalt, black, fractured, vesicular, medium, pyrite
712	728	Basalt, black-gray, fractured, hard
728	738	Basalt, black & brown, soft-med, broken, vesicular
738	746	Basalt, black & grey, med-hard, fractured
746	758	Basalt, grey, hard, fractured
758	762	Basalt, grey & black, hard, some fractures
762	766	Basalt, dark grey, hard, fractured
766	775	Basalt, grey & black, very hard, some fractures
775	788	Basalt, grey, very hard, some fractures
788	808	Basalt, brown & black, soft-medium, broken, vesicular w/some claystone, brown
808	822	Basalt, dark grey, medium-hard, some fractures
822	827	Basalt, black & red, medium, fractured, vesicular
827	829	Basalt, red & brown & some black, soft, broken, vesicular
829	837	Basalt, dark grey, hard, fractured
837	840	Basalt, dark grey & some red, hard, fractured
840	857	Basalt, grey, hard, fractured

WATER WELL REPORT

Original & 1st copy – Ecology, 2nd copy – owner, 3rd copy – driller

Construction/Decommission *("x" in circle)*

☒ Construction

☐ Decommission *ORIGINAL INSTALLATION Notice of Intent Number* _____

CURRENT

Notice of Intent No. WE19115

Unique Ecology Well ID Tag No. BHT112

Water Right Permit No. 6505-A

Property Owner Name City of Warden

Well Street Address South end of Warden runway

City Warden County Grant

Location NE 1/4-1/4 NE 1/4 Sec 17 Twn 17N R 30 EWM or WWM ☑ check one

(Lat/Long (s, t, r Still **REQUIRED**) Lat Deg _____ Lat Min/Sec _____

Long Deg _____ Long Min/Sec _____

Tax Parcel No. 060659050

PROPOSED USE: ☐ Domestic ☐ Industrial ☑ Municipal ☐ DeWater ☐ Irrigation ☐ Test Well ☐ Other _____

TYPE OF WORK: Owner's number of well (if more than one) 8

☐ New well ☑ Reconditioned ☐ Deepened *Method:* ☐ Dug ☐ Bored ☐ Driven ☐ Cable ☑ Rotary ☐ Jetted

DIMENSIONS: Diameter of well 20 inches, drilled 490 ft.

Depth of completed well 507 ft.

CONSTRUCTION DETAILS

Casing Installed: ☑ Welded 20 " Diam. from +1 ft. to 100 ft.

☑ Liner installed 16 " Diam. from +1 ft. to 110 ft.

☐ Threaded _____ " Diam. from _____ ft. to _____ ft.

Perforations: ☐ Yes ☑ No

Type of perforator used _____

SIZE of perfs _____ in. by _____ in. and no. of perfs _____ from _____ ft. to _____ ft.

Screens: ☑ Yes ☐ No ☐ K-Pac Location _____

Manufacturer's Name Jonson

Type Stainless steel wire wrap Model No. _____

Diam. 16 Slot size .250 from 110 ft. to 210 ft.

Diam. _____ Slot size _____ from _____ ft. to _____ ft.

Gravel/Filter packed: ☐ Yes ☑ No ☐ Size of gravel/sand _____

Materials placed from _____ ft. to _____ ft.

Surface Seal: ☑ Yes ☐ No To what depth? 100 ft.

Material used in seal Neat cement grout

Did any strata contain unusable water? ☐ Yes ☑ No

Type of water? _____ Depth of strata _____

Method of sealing strata off _____

PUMP: Manufacturer's Name _____

Type: _____ H.P. _____

WATER LEVELS: Land-surface elevation above mean sea level _____ ft.

Static level 82 ft. below top of well Date 10/13/14

Artesian pressure _____ lbs. per square inch Date _____

Artesian water is controlled by _____ (cap, valve, etc.)

WELL TESTS: Drawdown is amount water level is lowered below static level

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

Yield: 1600 gal./min. with 74.4 ft. drawdown after 2 hrs.

Yield: 1600 gal./min. with 83 ft. drawdown after 12 hrs.

Yield: 1600 gal./min. with 89 ft. drawdown after 24 hrs.

Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level

Date of test _____

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

Airtest 2000 gal./min. with stem set at 490 ft. for 2 hrs.

Artesian flow _____ g.p.m. Date _____

Temperature of water 56 Was a chemical analysis made? ☑ Yes ☐ No

CONSTRUCTION OR DECOMMISSION PROCEDURE

Formation: Describe by color, character, size of material and structure, and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of information. (USE ADDITIONAL SHEETS IF NECESSARY.)

MATERIAL	FROM	TO
see attatched		

RECEIVED

JAN 22 2015

Department of Ecology
Eastern Regional Office

DEPT OF ECOLOGY Received JAN 16 2015 CENTRAL REGION OFFICE

Start Date 04SEP2014 Completed Date 16OCT2014

WELL CONSTRUCTION CERTIFICATION: I constructed and/or accept responsibility for construction of this well, and its compliance with all Washington well construction standards. Materials used and the information reported above are true to my best knowledge and belief.

☑ Driller ☐ Engineer ☐ Trainee Name (Print) Brendan Peck

Driller/Engineer/Trainee Signature _____

Driller or trainee License No. 3072

Drilling Company Person Pump & Well Drilling

Address 1015 E Broadway Ave

City, State, Zip Goldendale, WA 98620

If TRAINEE,

Driller's Licensed No. _____

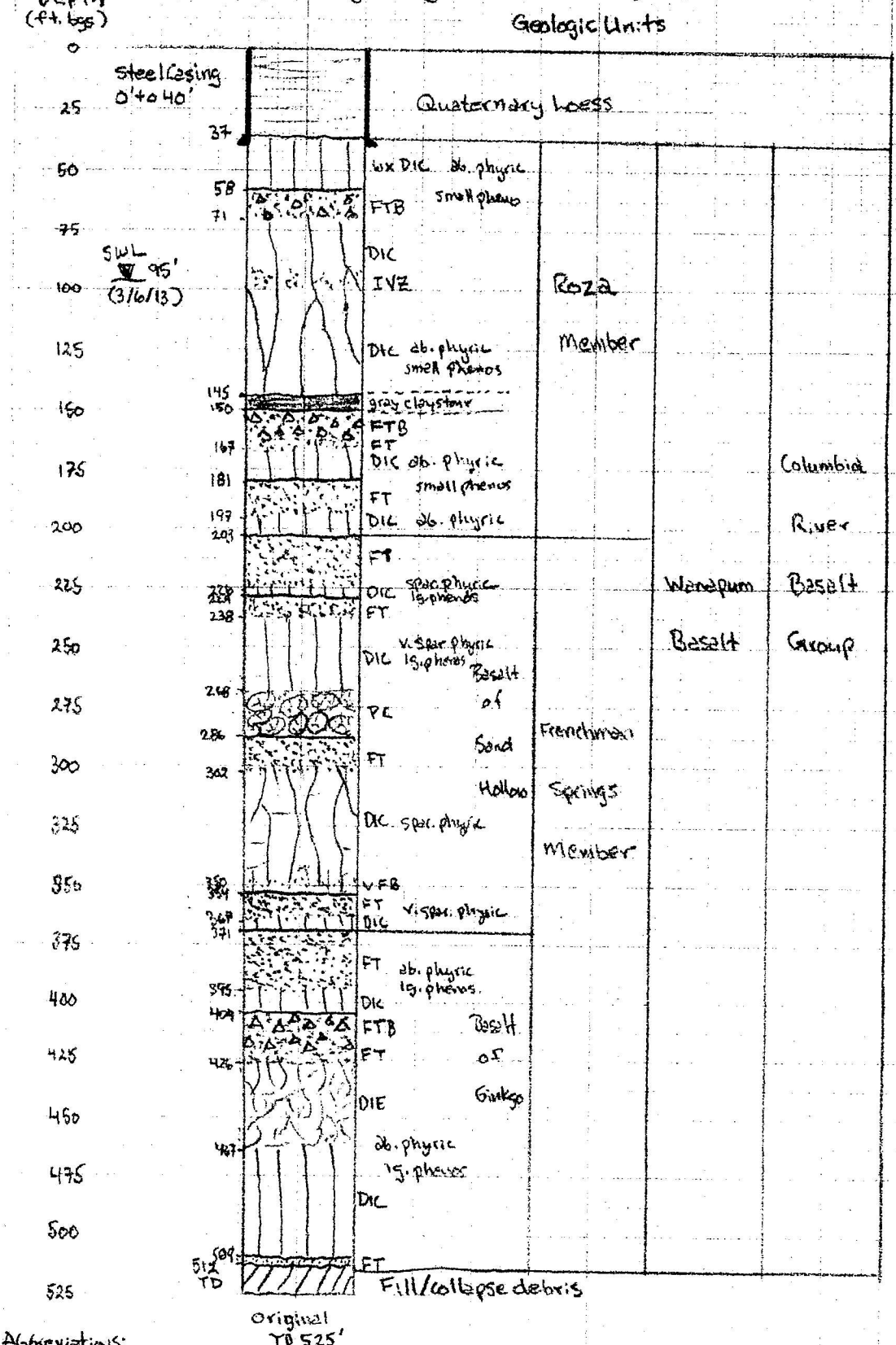
Driller's Signature _____

Contractor's Registration No. PERSOPW940PQ Date 12JAN2014

ECY 050-1-20 (Rev 3/05)

Ecology is an Equal Opportunity Employer.

Preliminary Geologic Log - Werden Irrigation Well (Sec. 7 T17N R30E)



Abbreviations:

wx = weathered
FTB = Flow Top breccia
FT = normal Flow Top
DIC = Dense interior columnar
DIE = Dense interior Entablature
IVZ = internal vesicular zone
PC = pillow complex
VFB = vesicular flow bottom
ab. = abundant
lg. = large
TD = Total Depth
SWL = static water level

State of Washington
Hydrogeologist
2170
Licensed Geologist
Terry L. Tolan
Exp. Date 08/31/2013

WATER WELL REPORT

Original & 1st copy – Ecology, 2nd copy – owner, 3rd copy – driller

Construction/Decommission *("x" in circle)*

- [x] Construction
- [ ] Decommission *ORIGINAL INSTALLATION Notice of Intent Number* _____

CURRENT
Notice of Intent No. WE18709

Unique Ecology Well ID Tag No. BHT111

Water Right Permit No. 6505-A

Property Owner Name City of Warden

Well Street Address East side of Warden runway

City Warden County Grant

Location SW 1/4-1/4 NW 1/4 Sec 16 Twn 17N R 30 EWM or WWM [x] check one

(Lat/Long (s, t, r Still **REQUIRED**) Lat Deg _____ Lat Min/Sec _____ Long Deg _____ Long Min/Sec _____

Tax Parcel No. 060704000

PROPOSED USE: [ ] Domestic [ ] Industrial [x] Municipal [ ] DeWater [ ] Irrigation [ ] Test Well [ ] Other _____

TYPE OF WORK: Owner's number of well (if more than one) 9

[x] New well [ ] Reconditioned [ ] Deepened *Method:* [ ] Dug [ ] Bored [ ] Driven [ ] Cable [x] Rotary [ ] Jetted

DIMENSIONS: Diameter of well 20 inches, drilled 505 ft.
Depth of completed well 505 ft.

CONSTRUCTION DETAILS

Casing Installed:
- [x] Welded 24" Diam. from +1 ft. to 42 ft.
- [x] Liner installed 20" Diam. from +1 ft. to 93.5 ft.
- [ ] Threaded 16" Diam. from +1 ft. to below ft.

Perforations: [ ] Yes [x] No
Type of perforator used _____
SIZE of perfs _____ in. by _____ in. and no. of perfs _____ from _____ ft. to _____ ft.

Screens: [x] Yes [ ] No [ ] K-Pac Location _____
Manufacturer's Name Johnson
Type _____ Model No. _____
Diam. 16 Slot size .250 from 120 ft. to 220 ft.
Diam. 16 Slot size .250 from 315 ft. to 355 ft.

Gravel/Filter packed: [ ] Yes [x] No [ ] Size of gravel/sand _____
Materials placed from _____ ft. to _____ ft.

Surface Seal: [x] Yes [ ] No To what depth? 93.5 ft.
Material used in seal Neat cement grout
Did any strata contain unusable water? [ ] Yes [x] No
Type of water? _____ Depth of strata _____
Method of sealing strata off _____

PUMP: Manufacturer's Name _____
Type: _____ H.P. _____

WATER LEVELS: Land-surface elevation above mean sea level _____ ft.
Static level 52' 8" ft. below top of well Date 9/29/14
Artesian pressure _____ lbs. per square inch Date _____
Artesian water is controlled by _____ (cap, valve, etc.)

WELL TESTS: Drawdown is amount water level is lowered below static level
Was a pump test made? [x] Yes [ ] No If yes, by whom? driller
Yield: 2500 gal./min. with 44 ft. drawdown after 1 hrs.
Yield: 2500 gal./min. with 51 ft. drawdown after 6 hrs.
Yield: 2500 gal./min. with 58 ft. drawdown after 24 hrs.

Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level
1min	80.2	4	81.37	15	78.01
2	82.8	5	80.88	30	75.78
3	82	10	79.17	120	70.3

Date of test 27AUG2014
Bailer test _____ gal./min. with _____ ft. drawdown after _____ hrs.
Airtest 6,000 gal./min. with stem set at 500 ft. for 4 hrs.
Artesian flow _____ g.p.m. Date _____
Temperature of water 56 Was a chemical analysis made? [x] Yes [ ] No

CONSTRUCTION OR DECOMMISSION PROCEDURE

Formation: Describe by color, character, size of material and structure, and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of information. (USE ADDITIONAL SHEETS IF NECESSARY.)

MATERIAL		FROM	TO
Ash		0	4
Caliche		4	24
Brown Sandstone		24	27
Black frac ves basalt Med		27	40
Grey black basalt Med Hard		40	119
Black and brown ves Brkn soft		119	128
Black and brown basalt Med		128	153
Brown ves rock w/ claystone interbed	WB	153	195
Hard grey basalt		195	317
Grey Brkn rock	WB	317	328
Grey basalt Hard		328	333
Brown vesicular brkn w/ brown claystone	WB	333	355
Grey basalt soft		355	365
Brown vesicular brkn w/ brown claystone	WB	365	400
Black and brown frac basalt Med		400	481
Black ves brkn basalt	WB	481	505
16" steel liner		+1	120
16" SS screen		120	220
16" steel liner		220	315
16" SS screen		315	355

DEPT OF ECOLOGY Received JAN 16 2015 CENTRAL REGIONAL OFFICE

RECEIVED JAN 22 2015 Department of Ecology Eastern Regional Office

Start Date 23JUL2014 Completed Date 16OCT2014

WELL CONSTRUCTION CERTIFICATION: I constructed and/or accept responsibility for construction of this well, and its compliance with all Washington well construction standards. Materials used and the information reported above are true to my best knowledge and belief.

[x] Driller [ ] Engineer [ ] Trainee Name (Print) Brendan Peck
Driller/Engineer/Trainee Signature _____
Driller or trainee License No. 3072

If TRAINEE,
Driller's Licensed No. _____
Driller's Signature _____

Drilling Company Person Pump & Well Drilling
Address 1015 E Broadway Ave
City, State, Zip Goldendale, WA 98620

Contractor's Registration No. PERSOPW940PQ Date 12JAN2015

B

Soil Boring Logs (from Phase II Preliminary Investigation)

GeoProbe™ Logs

Monitoring Well Logs

Name: SB-1
Project: Warden City Water Supply Wells
Driller: Cascade Drilling
Date: 11/10/2008
Latitude: N 46°58.21'
Longitude: W 119°3.66'

DEPTH	GEOLOGIC LOG	DETAILS
1	LOESS, fine, gray brown	
2		
3		
4		
5	LOESS, fine, gray brown; mixed with some basalt cobble & wood pieces	
6		
7		
8	LOESS, fine, gray brown, dense, slightly moist, very uniform	
9		
10		
11		
12		
13		
14		
15		
16		
17	LOESS, same as above but with caliche pieces	
18		
19		
20	CALICHE/LOESS mix, lt/dk gray bands SAMPLE ▶	
21	LOESS, wet, dense, gray brown, less caliche	
22		
23		
24		
25		

Name: SB-2
Project: Warden City Water Supply Wells
Driller: Cascade Drilling
Date: 11/10/2008
Latitude: N 46°58.22'
Longitude: W 119°3.64'

DEPTH	GEOLOGIC LOG	DETAILS
1	LOESS/FILL, dry, ashy, wood debris, some medium gravel	
2		
3		
4		
5	LOESS, fine, gray brown, uniform	
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17	LOESS/CALICHE, slight banding	
18		
19	CALICHE/LOESS mix, gray brown banded with light gray dense caliche	
20	SAMPLE ▶	
21	LOESS, gray brown, moist, uniform	
22		
23		
24		
25		

Name: SB-3
Project: Warden City Water Supply Wells
Driller: Cascade Drilling
Date: 11/10/2008
Latitude: N 46°58.20'
Longitude: W 119°3.68'

DEPTH	GEOLOGIC LOG	DETAILS
1	LOESS, fine, gray brown, dry	
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13	LOESS, lighter gray brown, HCl reaction indicating mix with caliche	
14		
15	CALICHE, light gray, uniform reaction w/HCl	
16		
17	SAMPLE ▶	
18	LOESS, fine, darker brown, slightly moist	
19		
20		
21		
22		
23		
24		
25		

Name: SB-4
Project: Warden City Water Supply Wells
Driller: Cascade Drilling
Date: 11/10/2008
Latitude: N 46°58.21'
Longitude: W 119°3.62'

DEPTH	GEOLOGIC LOG	DETAILS
1	LOESS, fine, gray brown, very uniform, slightly moist	
2		
3		
4		
5		
6		
7		
8		
9		
10	CALICHE, light gray, dry, dense SAMPLE ▶	
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
21		
22		
23		
24		
25		

Name: SB-5
Project: Warden City Water Supply Wells
Driller: Cascade Drilling
Date: 11/10/2008
Latitude: N 46°58.22'
Longitude: W 119°3.62'

DEPTH	GEOLOGIC LOG	DETAILS
1	LOESS, brown w/fine ash gray layers and some 1/2" gravel	
2		
3		
4		
5		
6		
7		
8	CALICHE, light gray, dense, uniform	
9		
10	SAMPLE ▶	
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
21		
22		
23		
24		
25		

Name: SB-6
Project: Warden City Water Supply Wells
Driller: Cascade Drilling
Date: 11/10/2008
Latitude: N 46°58.22'
Longitude: W 119°3.62'

DEPTH	GEOLOGIC LOG	DETAILS
1	LOESS, medium brown, slightly moist, fine	
2		
3		
4		
5		
6		
7		
8		
9		
10		
11	LOESS/CALICHE, slightly lighter brown, reaction w/ HCl	
12		
13	CALICHE, light gray, more weakly bound	
14	SAMPLE ▶	
15		
16	LOESS, medium brown	
17		
18		
19		
20		
21		
22		
23		
24		
25		

Name: SB-7
Project: Warden City Water Supply Wells
Driller: Cascade Drilling
Date: 11/10/2008
Latitude: N 46°58.22'
Longitude: W 119°3.64'

DEPTH	GEOLOGIC LOG	DETAILS
1	FILL, fine w/wood debris, gravel	
2	LOESS, medium brown, fine, uniform	
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13	LOESS/CALICHE, mostly brown loess w/thin caliche interbeds w/higher frequency at depth	
14		
15	CALICHE, slightly mixed with loess	
16	SAMPLE ▶	
17	core unrecoverable; based on recovered fragments section appears to be mostly caliche	
18		
19		
20		
21		
22		
23		
24		
25		

Name: SB-8
Project: Warden City Water Supply Wells
Driller: Cascade Drilling
Date: 11/10/2008
Latitude: N 46°58.21'
Longitude: W 119°3.64'

DEPTH	GEOLOGIC LOG	DETAILS
1	FILL mixed with dry gray loess, 1" angular gravel inclusions	
2		
3	LOESS, gray brown, dry grading to moist deeper in the section	
4		
5		
6		
7		
8		
9		
10		
11		
12		
13	LOESS, medium brown, fine, uniform, slight caliche mix based on lighter color	
14		
15		
16		
17	CALICHE, light gray, dense	
18	SAMPLE ▶	
19	LOESS, medium brown, fine	
20		
21		
22		
23		
24		
25		

Name: SB-9
Project: Warden City Water Supply Wells
Driller: Cascade Drilling
Date: 11/10/2008
Latitude: N 46°58.20'
Longitude: W 119°3.64'

DEPTH	GEOLOGIC LOG	DETAILS
1	LOESS, medium brown, fine, slightly moist	
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13	LOESS/CALICHE, lighter brown, fine, uniform	
14		
15		
16		
17	CALICHE, light gray, dense	
18		
19	SAMPLE ▶	
20	LOESS, medium brown, fine	
21		
22		
23		
24		
25		

Name: SB-10
Project: Warden City Water Supply Wells
Driller: Cascade Drilling
Date: 11/11/2008
Latitude: N 46°58.20'
Longitude: W 119°3.63'

DEPTH	GEOLOGIC LOG	DETAILS
1	LOESS, lt/med brown, fine, uniform	
2		
3		
4		
5		
6		
7		
8		
9		
10		
11	SAMPLE ▶	
12	CALICHE, light gray, dense	
13		
14		
15		
16		
17		
18		
19		
20		
21		
22		
23		
24		
25		

Name: SB-11
Project: Warden City Water Supply Wells
Driller: Cascade Drilling
Date: 11/11/2008
Latitude: N 46°58.21'
Longitude: W 119°3.66'

DEPTH	GEOLOGIC LOG	DETAILS
1	LOESS, light gray/tan, fine, with 1/2" angular gravel	
2		
3		
4		
5		
6		
7		
8		
9	LOESS, medium brown, fine, uniform	
10		
11		
12		
13		
14		
15		
16		
17	CALICHE, light gray, dense	
18	CALICHE/LOESS with prominent light gray caliche layers	
19	SAMPLE ▶	
20	LOESS, medium brown, fine	
21		
22		
23		
24		
25		

Name: SB-12
Project: Warden City Water Supply Wells
Driller: Cascade Drilling
Date: 11/11/2008
Latitude: N 46°58.20'
Longitude: W 119°3.67'

DEPTH	GEOLOGIC LOG	DETAILS
1	LOESS, light to medium brown, fine, uniform	
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13	LOESS, light brown, fine, sandier texture	
14		
15		
16		
17	CALICHE, light gray with sandier texture SAMPLE ▶	
18		
19		
20		
21		
22		
23		
24		
25		

Name: SB-13
Project: Warden City Water Supply Wells
Driller: Cascade Drilling
Date: 11/11/2008
Latitude: N 46°58.24'
Longitude: W 119°3.62'

DEPTH	GEOLOGIC LOG	DETAILS
1	LOESS, light tan, fine, some fill mixed in	
2		
3		
4		
5	LOESS, dark gray	
6		
7		
8		
9		
10		
11		
12	CALICHE, tan/gray, fine SAMPLE ▶	
13		
14		
15		
16		
17		
18		
19		
20		
21		
22		
23		
24		
25		

Name: SB-14
Project: Warden City Water Supply Wells
Driller: Cascade Drilling
Date: 11/11/2008
Latitude: N 46°58.24'
Longitude: W 119°3.64'

DEPTH	GEOLOGIC LOG	DETAILS
1	LOESS, light tan, fine	
2		
3	FILL, dark brown/black with gravel and wood debris	
4		
5	LOESS, medium brown, fine, grading to dark brown/ black with anaerobic odor	
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18	CALICHE, light gray, fine, weakly bound	
19	SAMPLE ▶	
20	LOESS, medium brown w/ loose gray caliche	
21		
22		
23		
24		
25		

Name: SB-15
Project: Warden City Water Supply Wells
Driller: Cascade Drilling
Date: 11/11/2008
Latitude: N 46°58.24'
Longitude: W 119°3.65'

DEPTH	GEOLOGIC LOG	DETAILS
1–8	LOESS, lt/med brown, fine, some 1" gravel, some organic odor	
9–13	LOESS, very dry, fine, light tan	
14–15	CALICHE, fine, dry, light gray SAMPLE ▶	
16–25		

Name: SB-16
Project: Warden City Water Supply Wells
Driller: Cascade Drilling
Date: 11/11/2008
Latitude: N 46°58.23'
Longitude: W 119°3.68'

DEPTH	GEOLOGIC LOG	DETAILS
1–13	LOESS, very dry, light to medium brown, some angular gravel	
14–15	CALICHE, dry, light gray SAMPLE ▶	
16–25		

Name: SB-17
Project: Warden City Water Supply Wells
Driller: Cascade Drilling
Date: 11/11/2008
Latitude: N 46°58.24'
Longitude: W 119°3.67'

DEPTH	GEOLOGIC LOG	DETAILS
1	LOESS, light to medium brown, dry, fine, dense	
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14	CALICHE, light gray, dry SAMPLE ▶	
15		
16		
17		
18		
19		
20		
21		
22		
23		
24		
25		

Name: SB-18
Project: Warden City Water Supply Wells
Driller: Cascade Drilling
Date: 11/11/2008
Latitude: N 46°58.24'
Longitude: W 119°3.66'

DEPTH	GEOLOGIC LOG	DETAILS
1	LOESS, light to medium brown, dry, fine, dense; strong lt/med banding throughout section	
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15	CALICHE, light gray, dry SAMPLE ▶	
16		
17		
18		
19		
20		
21		
22		
23		
24		
25		

Name: SB-19
Project: Warden City Water Supply Wells
Driller: Cascade Drilling
Date: 11/11/2008
Latitude: N 46°58.24'
Longitude: W 119°3.64'

DEPTH	GEOLOGIC LOG	DETAILS
1–5	LOESS, lt tan, very dry, dense	
6	FILL, dark brn/blk, burned wood debris & sm gravel	
7–18	LOESS, dk brn/blk with strong anaerobic odor, dense, fine, uniform	
19–20	CALICHE, light gray, fine SAMPLE ▶	
21–25		

Name: SB-20
Project: Warden City Water Supply Wells
Driller: Cascade Drilling
Date: 11/11/2008
Latitude: N 46°58.25'
Longitude: W 119°3.62'

DEPTH	GEOLOGIC LOG	DETAILS
1–11	LOESS, dk brn/blk, dense, uniform, strong anaerobic odor	
12	CALICHE, light gray, fine SAMPLE ▶	
13–25		

Name: SB-21
Project: Warden City Water Supply Wells
Driller: Cascade Drilling
Date: 11/11/2008
Latitude: N 46°58.22'
Longitude: W 119°3.60'

DEPTH	GEOLOGIC LOG	DETAILS
1	LOESS, medium brown, fine, dense	
2		
3		
4		
5		
6		
7		
8		
9	CALICHE, light gray, fine SAMPLE ▶	
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
21		
22		
23		
24		
25		

Name: SB-22
Project: Warden City Water Supply Wells
Driller: Cascade Drilling
Date: 11/11/2008
Latitude: N 46°58.21'
Longitude: W 119°3.67'

DEPTH	GEOLOGIC LOG	DETAILS
1	LOESS, medium brown, fine, some 1" gravel present	
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13	CALICHE, light gray, fine SAMPLE ▶	
14		
15		
16		
17		
18		
19		
20		
21		
22		
23		
24		
25		

HDR, Inc.	SITE: Simplot Grower Solutions	BORING NUMBER: B1	SHEET 1 of 1

GEOPROBE BORING LOG

PROJECT : Simplot Grower Solutions Warden, WA
LOCATION : Grant County WA, SE1/4, SW1/4 Sec. 9 T17N, R30E
G.S. ELEVATION : Approximately 1241 feet amsl
DRILLING CONTRACTOR : Environmental West Exploration Inc.
DRILLING METHOD USED : Geoprobe Model 5400 Truck Mounted
BOREHOLE DEPTH : 5.5
WATER LEVEL: NA
START: 2/28/2012 END: 2/28/2012
LOGGER : D. Reynolds

DEPTH BELOW SURFACE (FT)	SAMPLE DEPTH (FT)	RECOVERY	TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"	CORE DESCRIPTION: SOIL NAME, USCS SYMBOL, COLOR, MOISTURE CONTENT, CONSISTENCY OR DENSITY, SOIL STRUCTURE	COMMENTS: TIME AND MISCELLANEOUS COMMENTS
	0-1.0	100%	CC	NA	0.0 to 0.5 FILL 0.5 to 4.5 SAND/SILT brown to lt. gray, v. fine, loose, sl. moist	Sample B1-S-1.0 @ 1020
5	4.5-5.5	100%			4.5 to 5.5 CALICHE tan, hard, dry, some rocks	Sample B1-S-5.5 @ 1030
					Refusal 5.5	All cuttings contained in drum
10						
15						
20						
25						
30						
35						
40						

HDR, Inc.	SITE: Simplot Grower Solutions	BORING NUMBER: B2	SHEET 1 of 1

GEOPROBE BORING LOG

PROJECT : Simplot Grower Solutions Warden, WA
LOCATION : Grant County WA, SE1/4, SW1/4 Sec. 9 T17N, R30E
G.S. ELEVATION : Approximately 1241 feet amsl
DRILLING CONTRACTOR : Environmental West Exploration Inc.
DRILLING METHOD USED : Geoprobe Model 5400 Truck Mounted
BOREHOLE DEPTH : 7.0
WATER LEVEL: NA
START: 2/28/2012 END: 2/28/2012
LOGGER : D. Reynolds

DEPTH BELOW SURFACE (FT)	SAMPLE DEPTH (FT)	RECOVERY	TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"	CORE DESCRIPTION: SOIL NAME, USCS SYMBOL, COLOR, MOISTURE CONTENT, CONSISTENCY OR DENSITY, SOIL STRUCTURE	COMMENTS: TIME AND MISCELLANEOUS COMMENTS
	0-1.0	100%	CC	NA	0.0 to 0.5 FILL 1.0 to 4.0 SILTY SAND brown, fine, loose, sl. moist	Sample B2-S-1.0 @ 0945
	4.0-5.0	100%			4.0 to 7.0 CALICHE	Sample B2-S-5.0 @ 0950
5					tan to lt. brown, hard, some sand and rocks,	
	6.0-7.0	100%			wet 5.0 to 6.0, v. hard 6.0 to 7.0	Sample B2-S-7.0 @ 0955
					Refusal 7.0	All cuttings contained in drum
10						
15						
20						
25						
30						
35						
40						

HDR, Inc.	SITE: Simplot Grower Solutions	BORING NUMBER: B3	SHEET 1 of 1

GEOPROBE BORING LOG

PROJECT : Simplot Grower Solutions Warden, WA
LOCATION : Grant County WA, SE1/4, SW1/4 Sec. 9 T17N, R30E
G.S. ELEVATION : Approximately 1241 feet amsl
DRILLING CONTRACTOR : Environmental West Exploration Inc.
DRILLING METHOD USED : Geoprobe Model 5400 Truck Mounted
BOREHOLE DEPTH : 8.5
WATER LEVEL: NA
START: 2/28/2012
END: 2/28/2012
LOGGER : D. Reynolds

DEPTH BELOW SURFACE (FT)	SAMPLE DEPTH (FT)	RECOVERY	TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"	CORE DESCRIPTION: SOIL NAME, USCS SYMBOL, COLOR, MOISTURE CONTENT, CONSISTENCY OR DENSITY, SOIL STRUCTURE	COMMENTS: TIME AND MISCELLANEOUS COMMENTS
	0-1.0	100%	CC	NA	0 to 4.0 SILTY SAND brown to dk. brown, fine, loose, sl. moist	Sample B3-S-1.0 @ 0830
5	4.0-5.0	100%			4.0 to 8.5 CALICHE tan, hard, dry, some rocks	Sample B3-S-5.0 @ 0840
	8.0-8.5	100%				Sample B3-S-8.5 @ 0850
10					Refusal 8.5	All cuttings contained in drum
15						
20						
25						
30						
35						
40						

HDR, Inc.	SITE: Simplot Grower Solutions	BORING NUMBER: B4	SHEET 1 of 1

GEOPROBE BORING LOG

PROJECT : Simplot Grower Solutions Warden, WA — LOCATION : Grant County WA, SE1/4, SW1/4 Sec. 9 T17N, R30E

G.S. ELEVATION : Approximately 1241 feet amsl — DRILLING CONTRACTOR : Environmental West Exploration Inc.

DRILLING METHOD USED : Geoprobe Model 5400 Truck Mounted — BOREHOLE DEPTH : 8.8

WATER LEVEL: NA — START: 2/28/2012 — END: 2/28/2012 — LOGGER : D. Reynolds

DEPTH BELOW SURFACE (FT)	SAMPLE DEPTH (FT)	RECOVERY	TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"	CORE DESCRIPTION: SOIL NAME, USCS SYMBOL, COLOR, MOISTURE CONTENT, CONSISTENCY OR DENSITY, SOIL STRUCTURE	COMMENTS: TIME AND MISCELLANEOUS COMMENTS
	0-1.0	100%	CC	NA	0.0 to 0.5 FILL 0.5 to 6.0 SAND/SILT brown, fine, loose, sl. Moist	Sample B4-S-1.0 @ 0910
5	6.0-7.0	100%				Sample B4-S-7.0 @ 0920
					6.0 to 8.8 CALICHE lt. brown to lt. gray, some sand and rocks,	
	8.0-8.8	100%			tan and v. hard 8.0 to 8.8	Sample B4-S-8.8 @ 0930
10					Refusal 8.8	All cuttings contained in drum
15						
20						
25						
30						
35						
40						

HDR, Inc.	SITE: Simplot Grower Solutions	BORING NUMBER: B5	SHEET 1 of 1

GEOPROBE BORING LOG

PROJECT : Simplot Grower Solutions Warden, WA
LOCATION : Grant County WA, SE1/4, SW1/4 Sec. 9 T17N, R30E
G.S. ELEVATION : Approximately 1241 feet amsl
DRILLING CONTRACTOR : Environmental West Exploration Inc.
DRILLING METHOD USED : Geoprobe Model 5400 Truck Mounted
BOREHOLE DEPTH : 9.5
WATER LEVEL: NA
START: 2/28/2012 END: 2/28/2012
LOGGER : D. Reynolds

DEPTH BELOW SURFACE (FT)	SAMPLE DEPTH (FT)	RECOVERY	TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"	CORE DESCRIPTION: SOIL NAME, USCS SYMBOL, COLOR, MOISTURE CONTENT, CONSISTENCY OR DENSITY, SOIL STRUCTURE	COMMENTS: TIME AND MISCELLANEOUS COMMENTS
	0-1.0	100%	CC	NA	0.0 to 0.5 FILL 0.5 to 7.5 SAND/SILT brown, fine, loose, sl. moist, some gravel	Sample B5-S-1.0 @ 1050 Duplicate Sample B5-S-2.0 @1055
5						
					7.5 to 9.5 CALICHE	
	7.5-8.5	100%			tan, hard, dry, some rocks	Sample B5-S-8.5 @ 1100
	8.5-9.5	100%				Sample B5-S-9.5 @ 1110
10						
					Refusal 9.5	All cuttings contained in drum
15						
20						
25						
30						
35						
40						

HDR, Inc.	SITE: Simplot Grower Solutions	BORING NUMBER: B6	SHEET 1 of 1

GEOPROBE BORING LOG

PROJECT : Simplot Grower Solutions Warden, WA — LOCATION : Grant County WA, SE1/4, SW1/4 Sec. 9 T17N, R30E

G.S. ELEVATION : Approximately 1241 feet amsl — DRILLING CONTRACTOR : Environmental West Exploration Inc.

DRILLING METHOD USED : Geoprobe Model 5400 Truck Mounted — BOREHOLE DEPTH : 18.0

WATER LEVEL: NA — START: 2/28/2012 — END: 2/28/2012 — LOGGER : D. Reynolds

DEPTH BELOW SURFACE (FT)	SAMPLE DEPTH (FT)	RECOVERY	TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"	CORE DESCRIPTION: SOIL NAME, USCS SYMBOL, COLOR, MOISTURE CONTENT, CONSISTENCY OR DENSITY, SOIL STRUCTURE	COMMENTS: TIME AND MISCELLANEOUS COMMENTS
	0-1.0	100%	CC	NA	0.0 to 0.5 FILL 0.5 to 10.0 SAND/SILT brown, fine, loose, sl. moist, some gravel	Sample B6-S-1.0 @ 1130
10					10.0 to 18.0 CALICHE/INTERBEDS caliche is tan, hard, interbedded with dk.	
	11.0-12.0'	100%			brown, silt and sand, some gravel, caliche at 11.0 to 12.0, 13.0 to 14.0, and 17.0 to 18.0	Sample B6-S-12.0 @ 1140 Triplicate Sample for MS/MSD
	17.0-18.0'	100%				Sample B6-S-18.0 @ 1150
						All cuttings contained in drum
					Refusal 18.0	

HDR, Inc.	SITE: Simplot Grower Solutions	BORING NUMBER: B7	SHEET 1 of 1

GEOPROBE BORING LOG

PROJECT : Simplot Grower Solutions Warden, WA — LOCATION : Grant County WA, SE1/4, SW1/4 Sec. 9 T17N, R30E

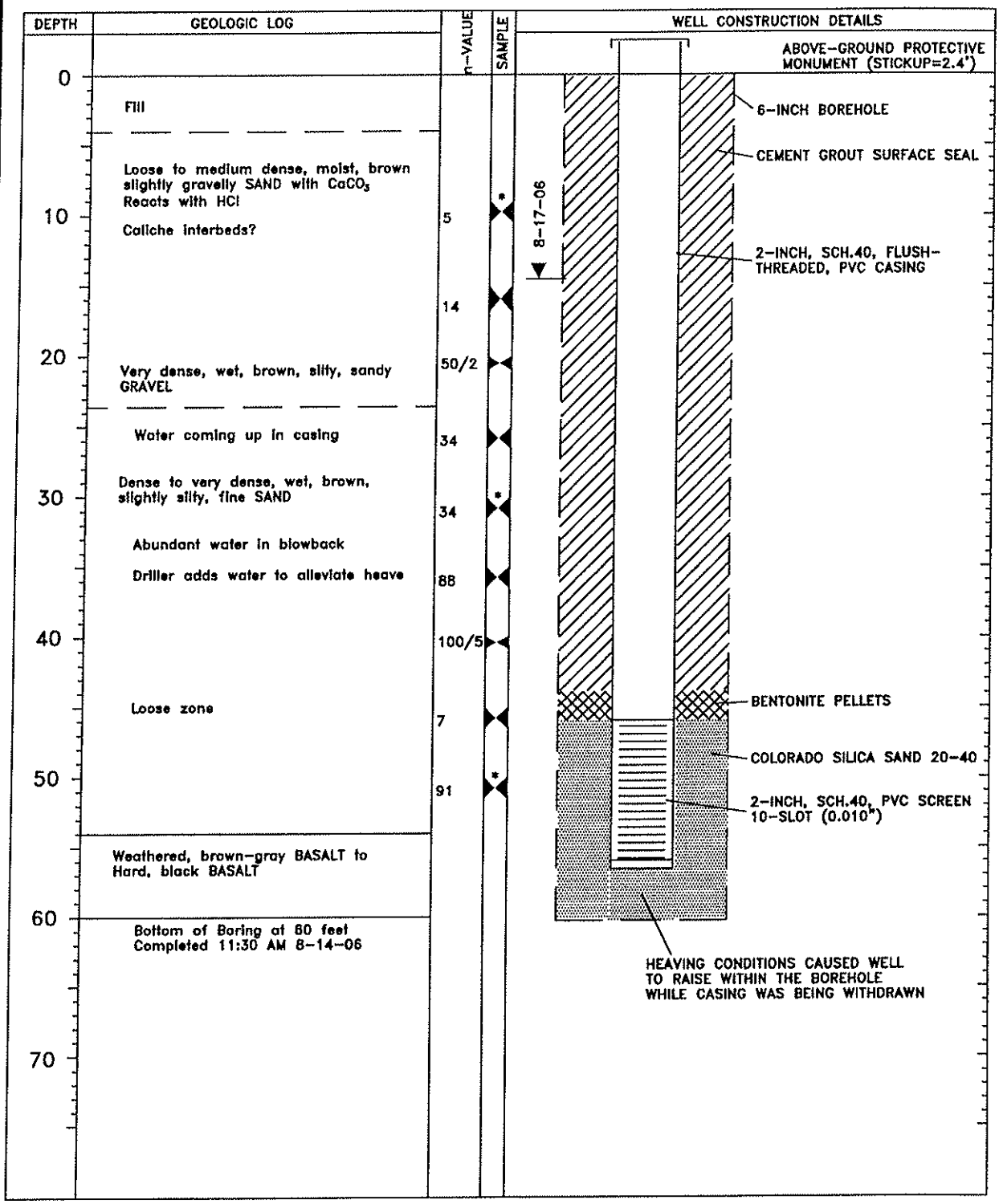
G.S. ELEVATION : Approximately 1241 feet amsl — DRILLING CONTRACTOR : Environmental West Exploration Inc.

DRILLING METHOD USED : Geoprobe Model 5400 Truck Mounted — BOREHOLE DEPTH : 16.5

WATER LEVEL: NA — START: 2/28/2012 — END: 2/28/2012 — LOGGER : D. Reynolds

DEPTH BELOW SURFACE (FT)	SAMPLE DEPTH (FT)	RECOVERY	TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"	CORE DESCRIPTION: SOIL NAME, USCS SYMBOL, COLOR, MOISTURE CONTENT, CONSISTENCY OR DENSITY, SOIL STRUCTURE	COMMENTS: TIME AND MISCELLANEOUS COMMENTS
	0-1.0	100%	CC	NA	0.0 to 0.5 FILL 0.5 to 13.0 SAND/SILT brown, fine, loose, sl. moist	Sample B7-S-1.0 @ 1215
5						
10						
	13.0-14.0'	100%			13.0 to 16.5 CALICHE/INTERBEDS caliche is tan, hard, interbedded with dk. brown, silt and sand, some gravel,	Sample B7-S-14.0 @ 1220
15	15.5-16.5'	100%			caliche at 13.0 to 14.0 and 15.5 to 16.5	Sample B7-S-16.5 @ 1225
						All cuttings contained in drum
20					Refusal 16.5	
25						
30						
35						
40						

CITY OF WARDEN - EDB INVESTIGATION
MW-1



* Sample Submitted for Laboratory Analysis

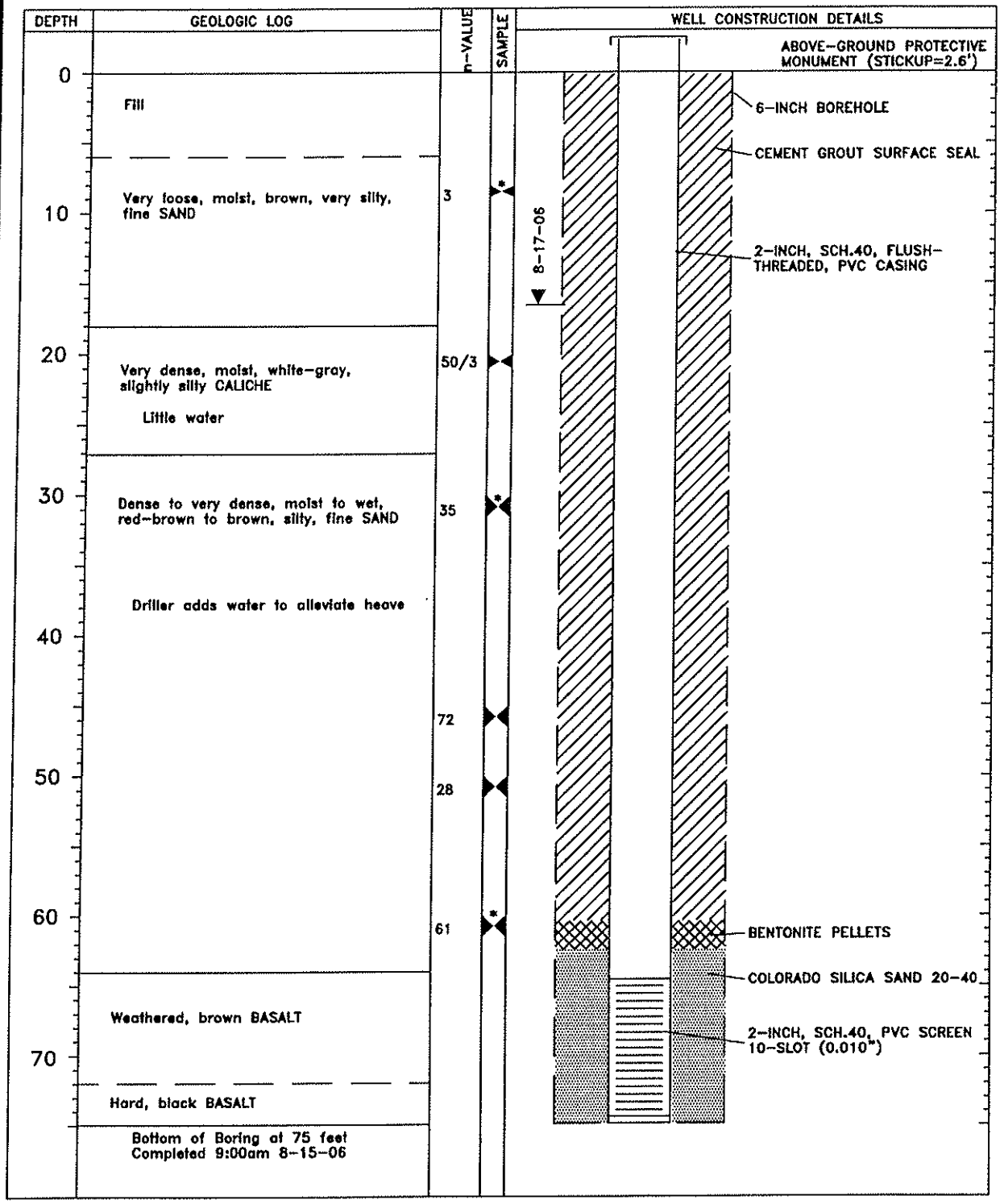
FIGURE 2

PROJECT NAME: City of Warden – EDB Investigation
WELL INDENTIFICATION NUMBER: MW-1
DRILLING METHOD: Air Rotary
DRILLER: Ron Sink
FIRM: Environmental West
CONSULTING FIRM: Pacific Groundwater Group, Inc.
REPRESENTATIVE: Erin Cunningham-Rudders

LOCATION: SE¼ SW¼ Sec. 9, T17N, R30E
UNIQUE WELL ID: APK353
DATUM: NAVD 88
WELLHEAD ELEVATION: 1245.82
INSTALLED: 8-14-06
DEVELOPED: 8-17-06

PgG

CITY OF WARDEN - EDB INVESTIGATION
MW-2



* Sample Submitted for Laboratory Analysis

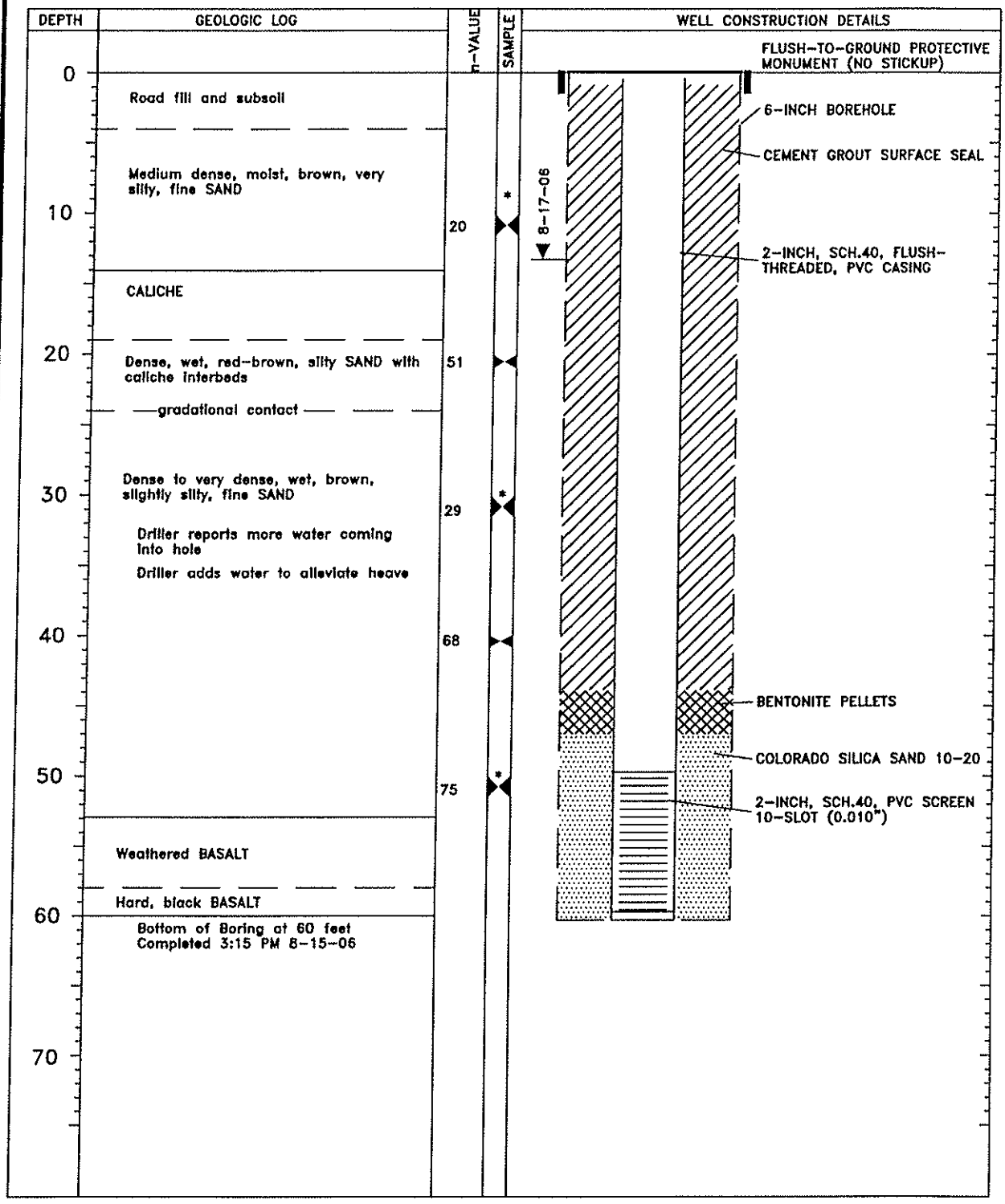
FIGURE 3

PROJECT NAME: City of Warden – EDB Investigation
WELL INDENTIFICATION NUMBER: MW-2
DRILLING METHOD: Air Rotary
DRILLER: Ron Sink
FIRM: Environmental West
CONSULTING FIRM: Pacific Groundwater Group, Inc.
REPRESENTATIVE: Erin Cunningham-Rudders

LOCATION: SW¼ SW¼ Sec. 9, T17N, R30E
UNIQUE WELL ID: APK354
DATUM: NAVD 88
WELLHEAD ELEVATION: 1247.28
INSTALLED: 8-15-06
DEVELOPED: 8-17-06

PgG

CITY OF WARDEN - EDB INVESTIGATION
MW-3



* Sample Submitted for Laboratory Analysis

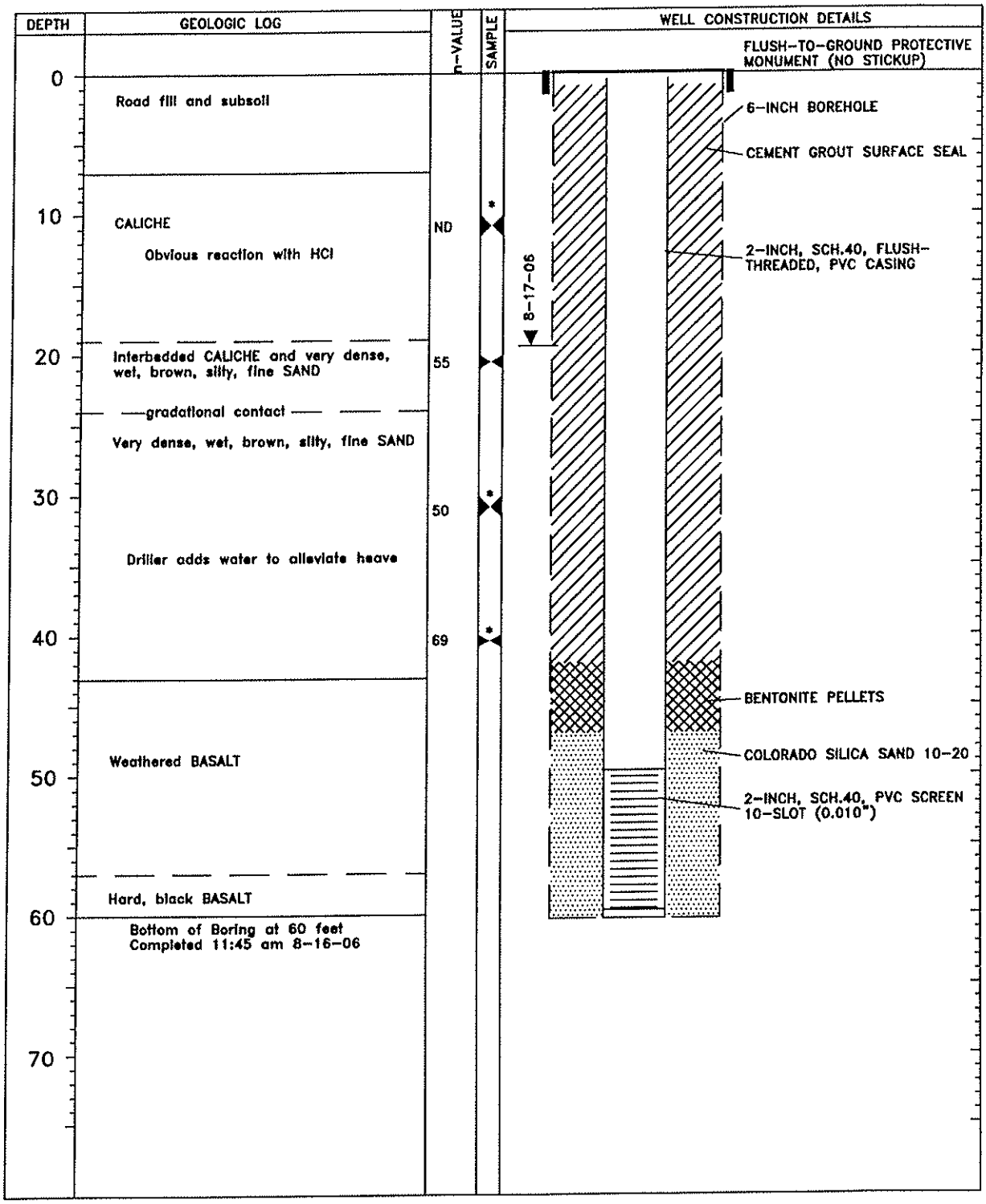
FIGURE 4

PROJECT NAME: City of Warden – EDB Investigation
WELL INDENTIFICATION NUMBER: MW-3
DRILLING METHOD: Air Rotary
DRILLER: Ron Sink
FIRM: Environmental West
CONSULTING FIRM: Pacific Groundwater Group, Inc.
REPRESENTATIVE: Erin Cunningham-Rudders

LOCATION: SW¼ SW¼ Sec. 9, T17N, R30E
UNIQUE WELL ID: APK355
DATUM: NAVD 88
WELLHEAD ELEVATION: 1241.04
INSTALLED: 8-15-06
DEVELOPED: 8-17-06

PgG

CITY OF WARDEN - EDB INVESTIGATION
MW-4



* Sample Submitted for Laboratory Analysis

FIGURE 5

PROJECT NAME: City of Warden – EDB Investigation
WELL INDENTIFICATION NUMBER: MW-4
DRILLING METHOD: Air Rotary
DRILLER: Ron Sink
FIRM: Environmental West
CONSULTING FIRM: Pacific Groundwater Group, Inc.
REPRESENTATIVE: Erin Cunningham-Rudders

LOCATION: NW¼ NW¼ Sec. 16, T17N, R30E
UNIQUE WELL ID: APK356
DATUM: NAVD 88
WELLHEAD ELEVATION: 1244.92
INSTALLED: 8-16-06
DEVELOPED: 8-17-06

PgG

CITY OF WARDEN - EDB INVESTIGATION
MW-5

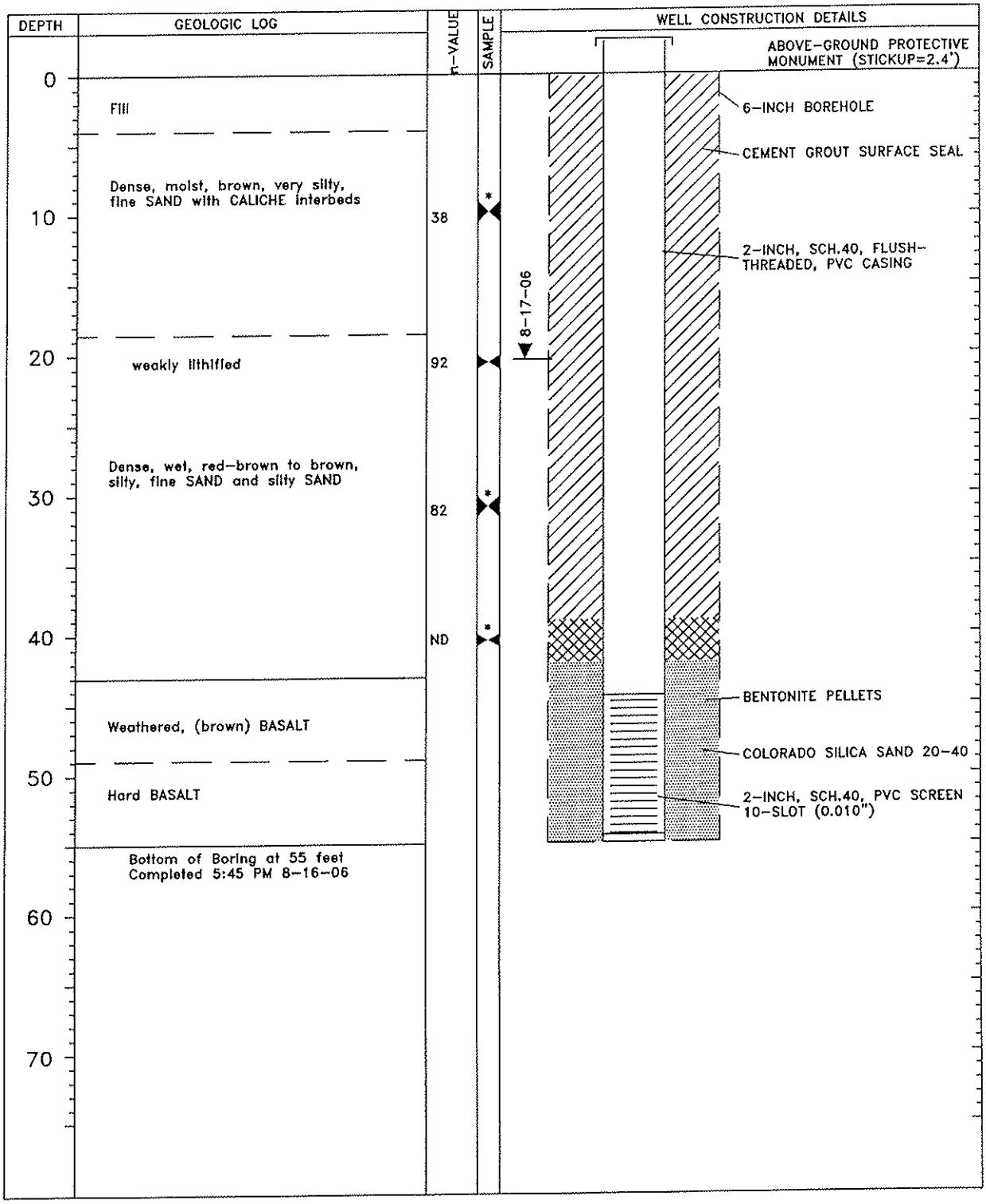


FIGURE 6

* Sample Submitted for Laboratory Analysis

PROJECT NAME: City of Warden – EDB Investigation
WELL INDENTIFICATION NUMBER: MW-5
DRILLING METHOD: Air Rotary
DRILLER: Ron Sink
FIRM: Environmental West
CONSULTING FIRM: Pacific Groundwater Group, Inc.
REPRESENTATIVE: Erin Cunningham-Rudders

LOCATION: SE¼ SW¼ Sec. 9, T17N, R30E
UNIQUE WELL ID: APK357
DATUM: NAVD 88
WELLHEAD ELEVATION: 1247.83
INSTALLED: 8-16-06
DEVELOPED: 8-17-06

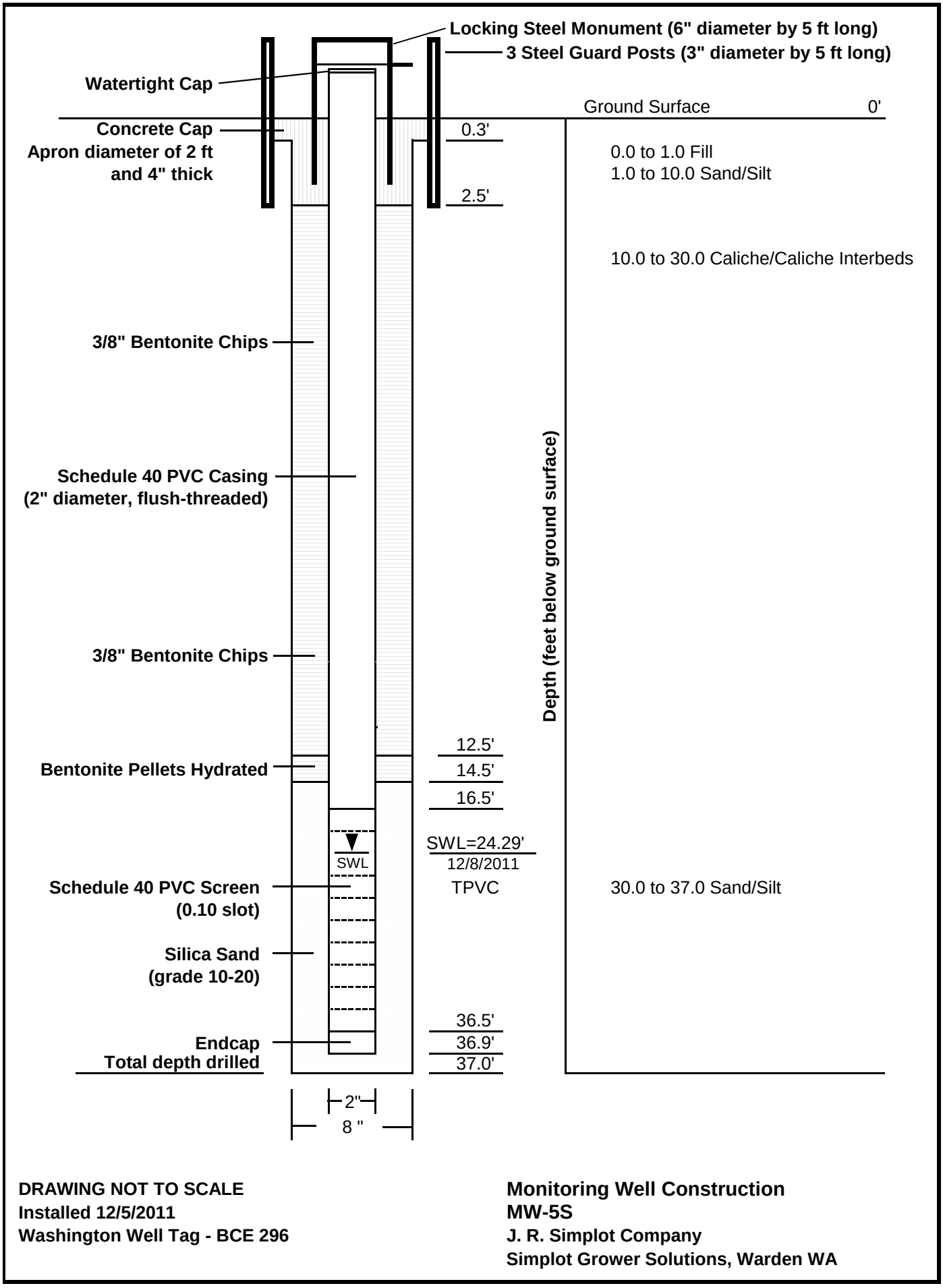
PgG

HDR, Inc.	SITE: Simplot Grower Solutions	BORING NUMBER: MW-5S	SHEET 1 of 1

SOIL BORING LOG

PROJECT : Simplot Grower Solutions Warden, WA		LOCATION : Grant County WA, SE1/4, SW1/4 Sec. 9 T17N, R30E	
G.S. ELEVATION : Approximately 1241 feet amsl		DRILLING CONTRACTOR : Environmental West Exploration Inc.	
DRILLING METHOD USED : Foremost Mobile B90 H.S.A.			BOREHOLE DEPTH : 37.0 ft
WATER LEVEL: 24.29' TPVC (12/8/2011)	START: 12/5/11	END: 12/5/11	LOGGER : D. Reynolds

DEPTH BELOW SURFACE (FT)	SAMPLE DEPTH (FT)	RECOVERY	TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"	CORE DESCRIPTION: SOIL NAME, USCS SYMBOL, COLOR, MOISTURE CONTENT, CONSISTENCY OR DENSITY, SOIL STRUCTURE	COMMENTS: TIME AND MISCELLANEOUS COMMENTS
	1	100%	SS	9-13-3	0.0 to 1.0 FILL 1.0 to 10.0 SAND/SILT brown. v. fine, loose, sl. moist	WA Well Tag No. BCE 296 Sample MW-5S-1 @ 0910 All cuttings contained in drums
5						
10	10	100%	SS	13-50/4"	10.0 to 30.0 CALICHE/INTERBEDS tan, hard, interbedded dk. brown silt and sand, wet at 20.5', more sand	Sample MW-5S-10 @ 0928
15						
20	20	100%	SS	9-23-42		Sample MW-5S-20 @ 0940
25						
30	30	100%	SS	21-48-50/2"	30.0 to 37.0 SAND/SILT brown, fine, wet	Sample MW-5S-30 @ 0955
35						
	37	100%	SS	42-5-/5"		Sample MW-5S-37 @ 1015
40					TD HSA 37.0'	



DRAWING NOT TO SCALE
Installed 12/5/2011
Washington Well Tag - BCE 296

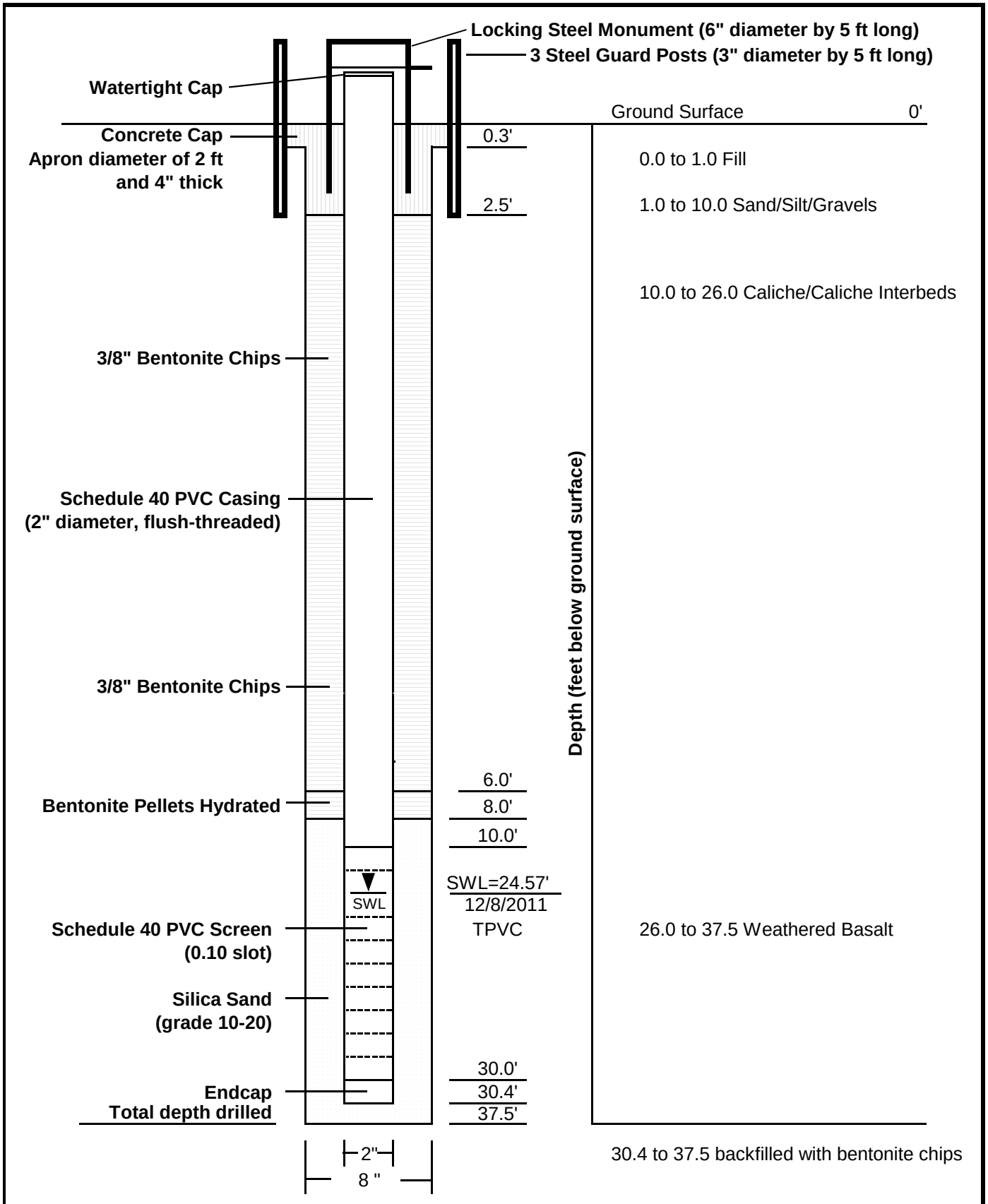
Monitoring Well Construction
MW-5S
J. R. Simplot Company
Simplot Grower Solutions, Warden WA

HDR, Inc.	SITE: Simplot Grower Solutions	BORING NUMBER: MW-6S	SHEET 1 of 1

SOIL BORING LOG

PROJECT : Simplot Grower Solutions Warden, WA		LOCATION : Grant County WA, SE1/4, SW1/4 Sec. 9 T17N, R30E	
G.S. ELEVATION : Approximately 1243 feet amsl		DRILLING CONTRACTOR : Environmental West Exploration Inc.	
DRILLING METHOD USED : Foremost Mobile B90 HSA/AR			BOREHOLE DEPTH : 37.5 ft
WATER LEVEL: 24.57' TPVC (12/8/2011)	START: 12/5/2011	END: 12/6/2011	LOGGER : D. Reynolds

DEPTH BELOW SURFACE (FT)	SAMPLE DEPTH (FT)	RECOVERY	TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"	CORE DESCRIPTION: SOIL NAME, USCS SYMBOL, COLOR, MOISTURE CONTENT, CONSISTENCY OR DENSITY, SOIL STRUCTURE	COMMENTS: TIME AND MISCELLANEOUS COMMENTS
					0.0 to 1.0 FILL	WA Well Tag No. BCE 297
	1	100%	SS	36-50/5"	1.0 to 2.5 SILTY SAND gray, fine, loose, dry to sl. moist	Sample MW-6S-1 @ 1300
5					2.5 to 4.0 SAND & GRAVEL brown, some silt, loose, sl. moist	All cuttings contained in drums
					4.0 to 10.0 SILTY SAND brown, fine, dry to sl. moist, loose	
10	10	25%	SS	48-50/2"	10.0 to 26.0 CALICHE/INTERBEDS tan, v. hard, poor recovery, interbedded dk. brown, silt and sand, wet at 22'	Sample MW-6S-10 @ 1320
15						
20	20	100%	SS	50/1"		Sample MW-6S-20 @ 1350
25					26.0 to 37.5 WEATHERED BASALT dry, dk. brown to black	
30						
35						
40					TD AR 37.5'	



DRAWING NOT TO SCALE
Installed 12/6/2011
Washington Well Tag - BCE 297

Monitoring Well Construction
MW-6S
J. R. Simplot Company
Simplot Grower Solutions, Warden WA

HDR, Inc.	SITE: Simplot Grower Solutions	BORING NUMBER: MW-7S	SHEET 1 of 1

SOIL BORING LOG

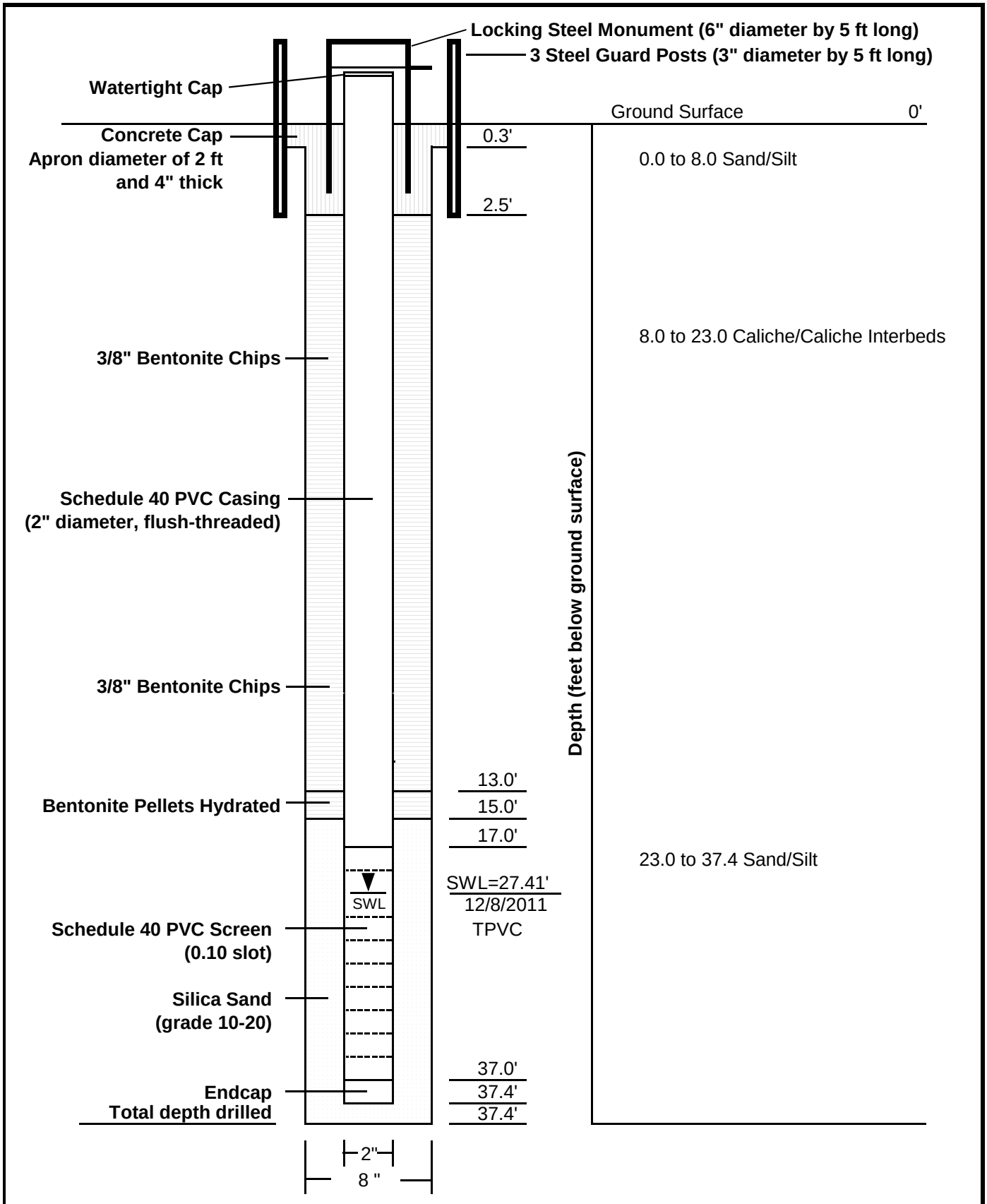
PROJECT : Simplot Grower Solutions Warden, WA | LOCATION : Grant County WA, SE1/4, SW1/4 Sec. 9 T17N, R30E

G.S. ELEVATION : Approximately 1246 feet amsl | DRILLING CONTRACTOR : Environmental West Exploration Inc.

DRILLING METHOD USED : Foremost Mobile B90 H.S.A. | BOREHOLE DEPTH : 37.4 ft

WATER LEVEL: 27.41' TPVC (12/8/2011) | START: 12/6/2011 | END: 12/7/2011 | LOGGER : D. Reynolds

DEPTH BELOW SURFACE (FT)	SAMPLE DEPTH (FT)	RECOVERY	TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"	CORE DESCRIPTION: SOIL NAME, USCS SYMBOL, COLOR, MOISTURE CONTENT, CONSISTENCY OR DENSITY, SOIL STRUCTURE	COMMENTS: TIME AND MISCELLANEOUS COMMENTS
	1	100%	SS	14-21-24	0.0 to 8.0 SAND/SILT brown, dry, loose	WA Well Tag No. BCE 299 Sample MW-7S-1 @ 1105 All cuttings contained in drums
5						
	8	100%	SS	50/5"	8.0 to 23.0 CALICHE/INTERBEDS tan, hard, interbedded dk. brown, silt and sand.	Sample MW-7S-8 @ 1120
10	10	100%	SS	50/4"		Sample MW-7S-10 @ 1130
15						
20	20	100%	SS	44-50/5"		Sample MW-7S-20 @ 1155
25					23.0 to 37.4 SAND/SILT brown, fine, wet at 25.0', flowing sand, difficult to install well	
30	30	100%	SS	21-50/5"		Sample MW-7S-30 @ 1210
35						
	37	100%	SS	11-49-50/3"		Sample MW-7S-37 @ 1230
40					TD HSA 37.4'	



DRAWING NOT TO SCALE
Installed 12/7/2011
Washington Well Tag - BCE 299

Monitoring Well Construction
MW-7S
J. R. Simplot Company
Simplot Grower Solutions, Warden WA

HDR, Inc.	SITE: Simplot Grower Solutions	BORING NUMBER: MW-7	SHEET 1 of 2

SOIL BORING LOG

PROJECT : Simplot Grower Solutions Warden, WA		LOCATION : Grant County WA, SE1/4, SW1/4 Sec. 9 T17N, R30E	
G.S. ELEVATION : Approximately 1246 feet amsl		DRILLING CONTRACTOR : Environmental West Exploration Inc.	
DRILLING METHOD USED : Foremost Mobile B90 A.R.			BOREHOLE DEPTH : 52.4 ft
WATER LEVEL: 27.61' TPVC (12/8/2011)	START: 12/7/2011	END: 12/7/2011	LOGGER : D. Reynolds

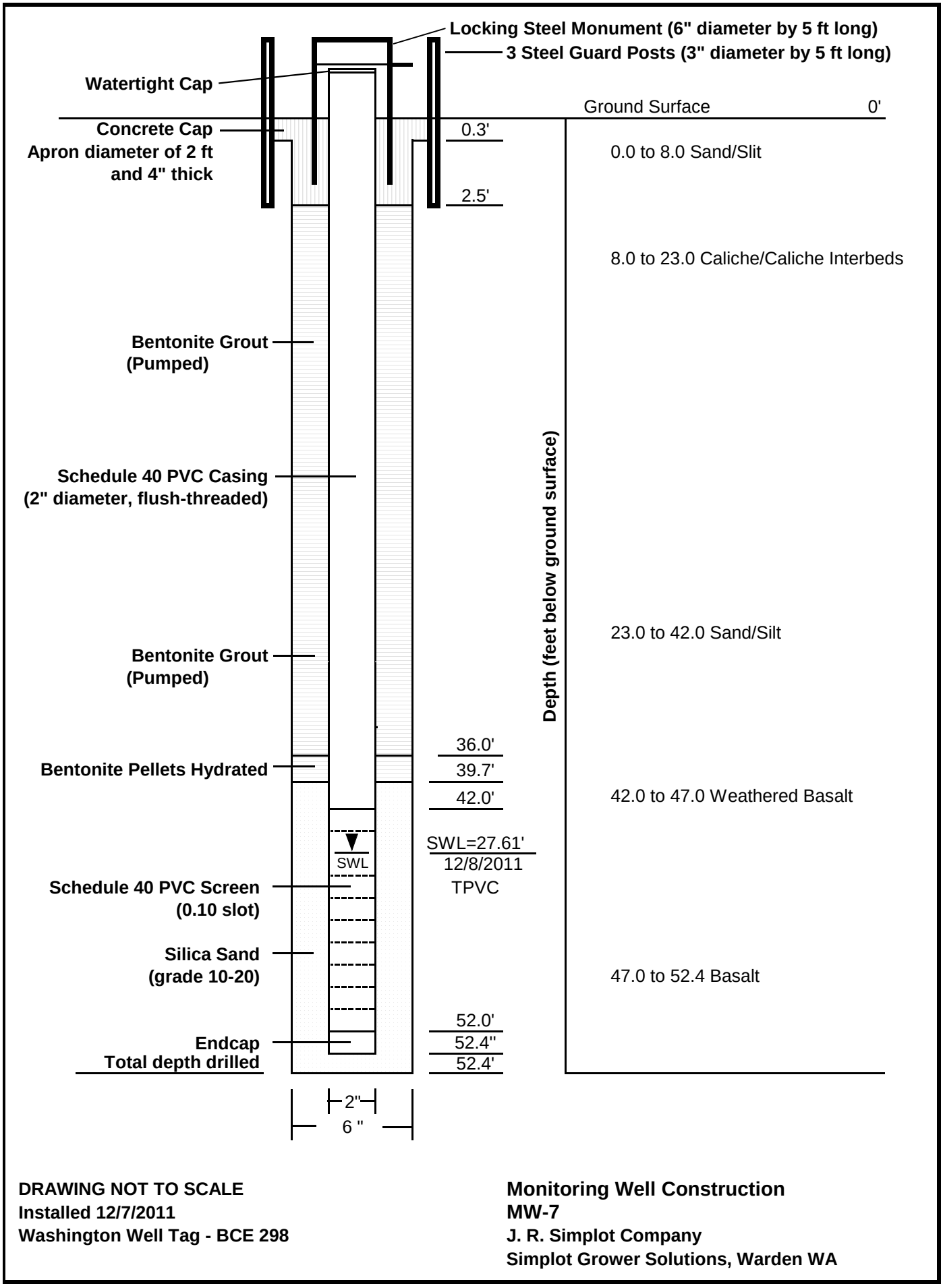
DEPTH BELOW SURFACE (FT)	SAMPLE DEPTH (FT) / RECOVERY / TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"	CORE DESCRIPTION: SOIL NAME, USCS SYMBOL, COLOR, MOISTURE CONTENT, CONSISTENCY OR DENSITY, SOIL STRUCTURE	COMMENTS: TIME AND MISCELLANEOUS COMMENTS
			0.0 to 8.0 SAND/SILT brown, dry, loose	WA Well Tag No. BCE 298
				All cuttings contained in drums
5				
			8.0 to 23.0 CALICHE/INTERBEDS tan, hard, interbedded dk. brown, silt and sand.	
10				
15				
20				
			23.0 to 42.0 SAND/SILT brown, fine, wet at 25.0',	
25				
30				
35				
40				

HDR, Inc.	SITE: Simplot Grower Solutions	BORING NUMBER: MW-7	SHEET 2 of 2

SOIL BORING LOG

PROJECT : Simplot Grower Solutions Warden, WA		LOCATION : Grant County WA, SE1/4, SW1/4 Sec. 9 T17N, R30E	
G.S. ELEVATION : Approximately 1246 feet amsl		DRILLING CONTRACTOR : Environmental West Exploration Inc.	
DRILLING METHOD USED : Foremost Mobile B90 A.R.			BOREHOLE DEPTH : 52.4 ft
WATER LEVEL: 27.61' TPVC (12/8/2011)	START: 12/7/2011	END: 12/7/2011	LOGGER : D. Reynolds

DEPTH BELOW SURFACE (FT)	SAMPLE DEPTH (FT)	RECOVERY	TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"	CORE DESCRIPTION: SOIL NAME, USCS SYMBOL, COLOR, MOISTURE CONTENT, CONSISTENCY OR DENSITY, SOIL STRUCTURE	COMMENTS: TIME AND MISCELLANEOUS COMMENTS
45					42.0 to 47.0 WEATHERED BASALT dry, dk. brown to black	
50					47.0 to 52.4 BASALT hard, competent, dry, dk. brown to black	
55					TD AR 52.4'	
60						
65						
70						
75						
80						



DRAWING NOT TO SCALE
Installed 12/7/2011
Washington Well Tag - BCE 298

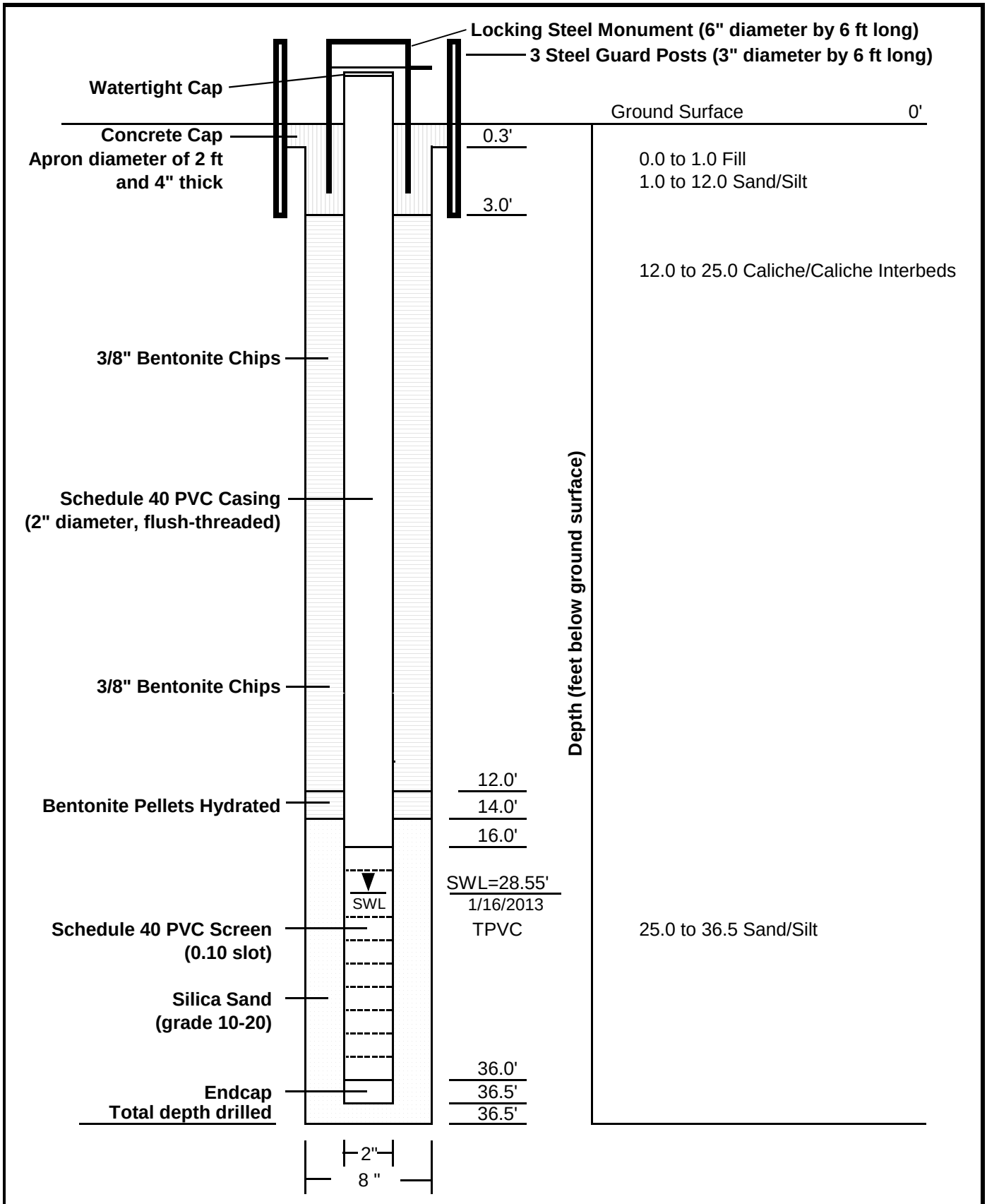
Monitoring Well Construction
MW-7
J. R. Simplot Company
Simplot Grower Solutions, Warden WA

HDR, Inc.	SITE: Simplot Grower Solutions	BORING NUMBER: MW-8S	SHEET 1 of 1

SOIL BORING LOG

PROJECT : Simplot Grower Solutions Warden, WA		LOCATION : Grant County WA, SE1/4, SW1/4 Sec. 9 T17N, R30E	
G.S. ELEVATION : 1244.52 feet amsl		DRILLING CONTRACTOR : Environmental West Exploration Inc.	
DRILLING METHOD USED : Shram T300 H.S.A.			BOREHOLE DEPTH : 36.5 ft
WATER LEVEL: 28.55' TPVC (1/16/2013)	START: 1/16/13	END: 1/16/13	LOGGER : D. Reynolds

DEPTH BELOW SURFACE (FT)	SAMPLE DEPTH (FT)	RECOVERY	TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"	CORE DESCRIPTION: SOIL NAME, USCS SYMBOL, COLOR, MOISTURE CONTENT, CONSISTENCY OR DENSITY, SOIL STRUCTURE	COMMENTS: TIME AND MISCELLANEOUS COMMENTS
	1				0.0 to 1.0 FILL 1.0 to 12.0 SAND/SILT brown. v. fine, loose, sl. moist, some dk. brown gravel at 5', some pea gravel to 12'	WA Well Tag No. BHP-139 All cuttings contained in drums
10	10	100%	SS	3-7-6	12.0 to 25.0 CALICHE/INTERBEDS tan, hard, interbeded dk. brown silt and sand, some pea gravel	Sample MW-8S-10 @ 1000
20	20	100%	SS	9-21-22		Sample MW-8S-20 @ 1030
30	30	100%	SS	4-8-11	25.0 to 36.5 SAND/SILT brown, fine, wet at 27', some pea gravel	Sample MW-8S-30 @ 1100
40	36.5				TD HSA 36.5'	



DRAWING NOT TO SCALE
Installed 1/16/2013
Washington Well Tag - BHP-139

Monitoring Well Construction
MW-8S
J. R. Simplot Company
Simplot Grower Solutions, Warden WA

HDR, Inc.	SITE: Simplot Grower Solutions	BORING NUMBER: MW-9S	SHEET 1 of 1

SOIL BORING LOG

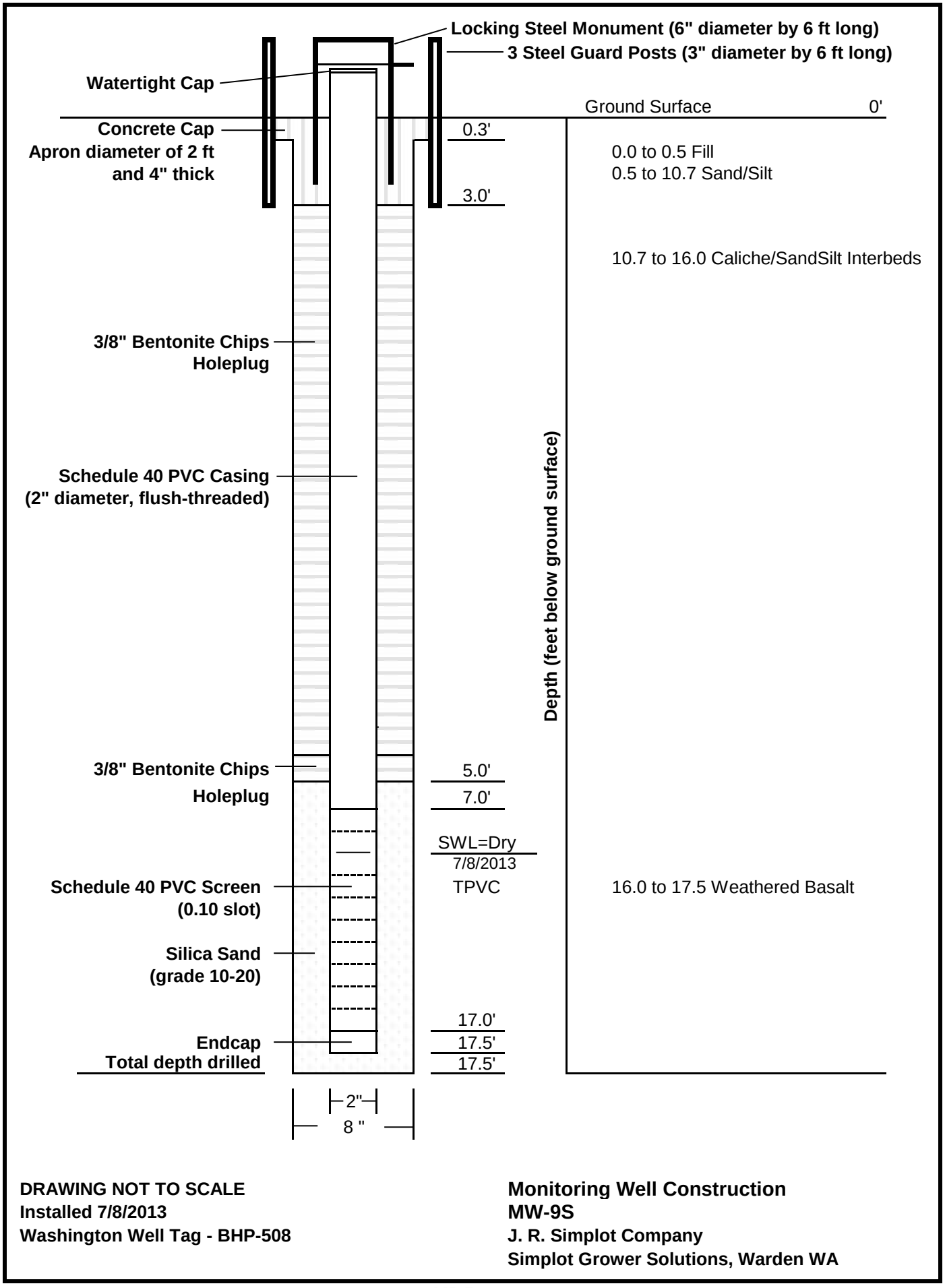
PROJECT : Simplot Grower Solutions Warden, WA — LOCATION : Grant County WA, NE1/4, NE1/4 Sec. 16 T17N, R30E

G.S. ELEVATION : Approximately 1244.39 feet amsl — DRILLING CONTRACTOR : Environmental West Exploration Inc.

DRILLING METHOD USED : Shram T300 H.S.A. — BOREHOLE DEPTH : 17.5 ft

WATER LEVEL: Dry (7/8/2013) — START: 7/8/13 — END: 7/8/13 — LOGGER : D. Reynolds

DEPTH BELOW SURFACE (FT)	SAMPLE DEPTH (FT)	RECOVERY	TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"	CORE DESCRIPTION: SOIL NAME, USCS SYMBOL, COLOR, MOISTURE CONTENT, CONSISTENCY OR DENSITY, SOIL STRUCTURE	COMMENTS: TIME AND MISCELLANEOUS COMMENTS
	0	100%	SS	7-8-10	0.0 to 0.5 FILL 0.5 to 10.7 SAND/SILT brown. v. fine, loose, dry, some pea gravel	WA Well Tag No. BHP-507 Sample MW-9S-0.0 @ 1200 (0.0 to 1.5') All cuttings contained in drums
10	10	100%	SS	6-15-37	10.7 to 16.0 CALICHE/INTERBEDS tan, hard, interbeded dk. brown silt and sand, some pea gravel	Sample MW-9S-10 @ 1215 Sample MW-9S-10 MS @ 1215 Sample MW-9S-10 MSD @ 121 (10.0 to 11.5')
15					16.0 to 17.5 Weathered Basalt	
	17.5	0%	SS	70 for 0"	Refusal at 17.5'	
20					TD HSA 17.5'	
25						
30						
35						
40						



DRAWING NOT TO SCALE
Installed 7/8/2013
Washington Well Tag - BHP-508

Monitoring Well Construction
MW-9S
J. R. Simplot Company
Simplot Grower Solutions, Warden WA

HDR, Inc.	SITE: Simplot Grower Solutions	BORING NUMBER: MW-10S	SHEET 1 of 1

SOIL BORING LOG

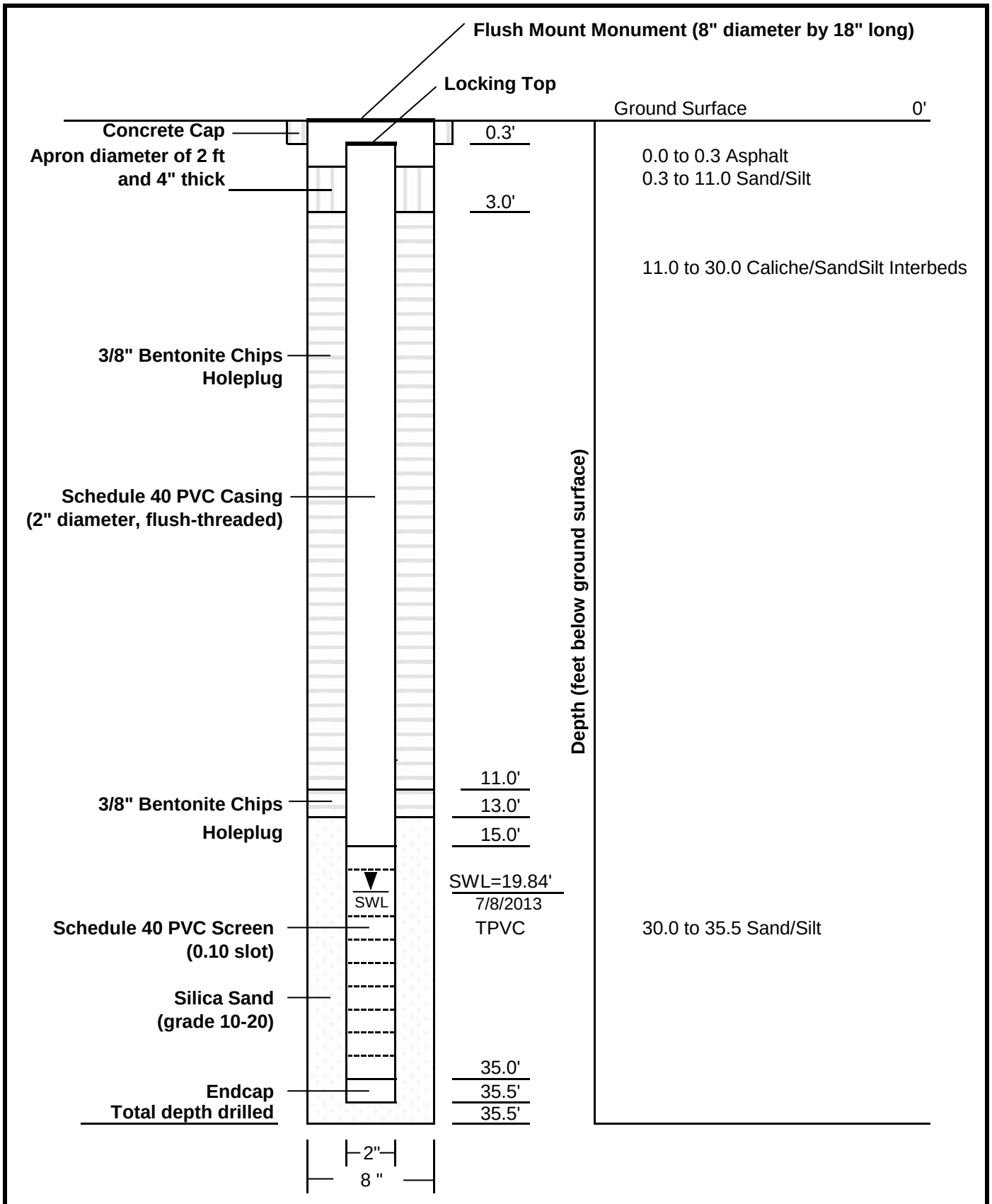
PROJECT : Simplot Grower Solutions Warden, WA — LOCATION : Grant County WA, SE1/4, SW1/4 Sec. 9 T17N, R30E

G.S. ELEVATION : Approximately 1245.68 feet amsl — DRILLING CONTRACTOR : Environmental West Exploration Inc.

DRILLING METHOD USED : Shram T300 H.S.A. — BOREHOLE DEPTH : 35.5 ft

WATER LEVEL: 19.84' TPVC (7/8/2013) — START: 7/8/13 — END: 7/8/13 — LOGGER : D. Reynolds

DEPTH BELOW SURFACE (FT)	SAMPLE DEPTH (FT)	RECOVERY	TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"	CORE DESCRIPTION: SOIL NAME, USCS SYMBOL, COLOR, MOISTURE CONTENT, CONSISTENCY OR DENSITY, SOIL STRUCTURE	COMMENTS: TIME AND MISCELLANEOUS COMMENTS
	1	100%	SS	16-13-12	0.0 to 0.3 ASPHALT 0.3 to 11.0 SAND/SILT brown. v. fine, loose, dry,	WA Well Tag No. BHP-508 Sample MW-10S-1.0 @ 0900 (1.0 to 2.5) All cuttings contained in drums Flush mount monument
5						
10	10	100%	SS	8-19-46	11.0 to 30.0 CALICHE/INTERBEDS tan, hard, interbeded dk. brown silt and sand. Water at 20'	Sample MW-10S-10.0 @ 0930 (10.0 to 11.5)
15						
20	20	100%	SS	16-24-40		Sample MW-10S-20.0 @ 0945 (20.0 to 21.5)
25						
30	30	100%	SS	4-6-9	30.0 to 35.5 SAND/SILT brown, fine, some caliche, wet	Sample MW-10S-30 @ 1000 (30.0 to 31.5)
35	35.0	100%	SS	20-50 For 4"		Sample MW-10S-35.0 @ 1030 (35.0 to 35.8)
40					TD HSA 35.5'	

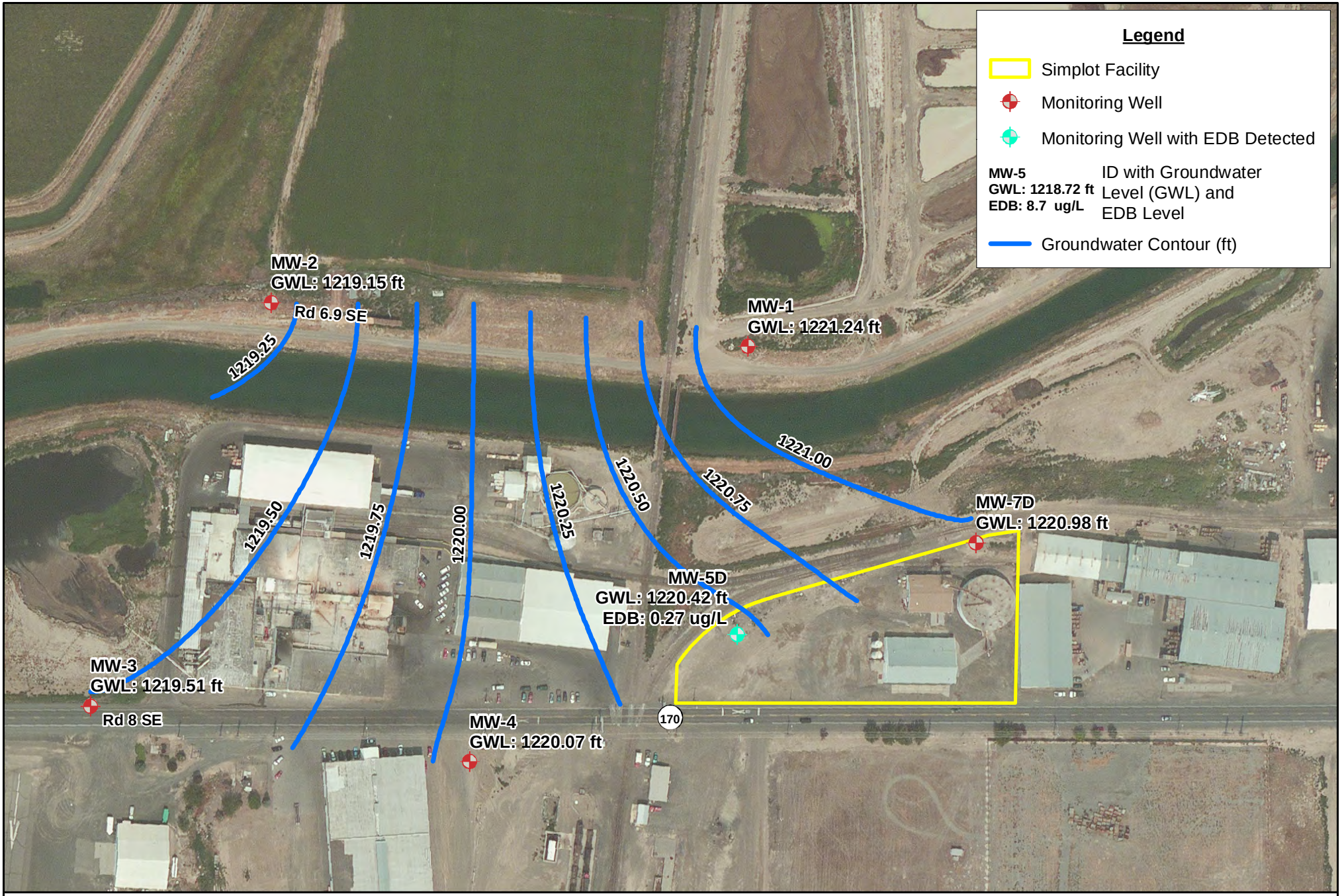


DRAWING NOT TO SCALE
Installed 7/8/2013
Washington Well Tag - BHP-507

Monitoring Well Construction
MW-10S
J. R. Simplot Company
Simplot Grower Solutions, Warden WA

C

Groundwater Contour Maps



January 2012 Groundwater Contour Map, Deep Wells and EDB Levels

Simplot Grower Solutions, City of Warden, WA

Imagery: Bing Aerial Imagery (DigitalGlobe)
Source: (c) 2012 Microsoft Corporation and its data suppliers
Other Data Sources: US Census Bureau; Washington Department of Transporation; Washington Department of Revenue; Washington Department of Ecology (WDOE)

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Feet

Map Date: 4/17/2013
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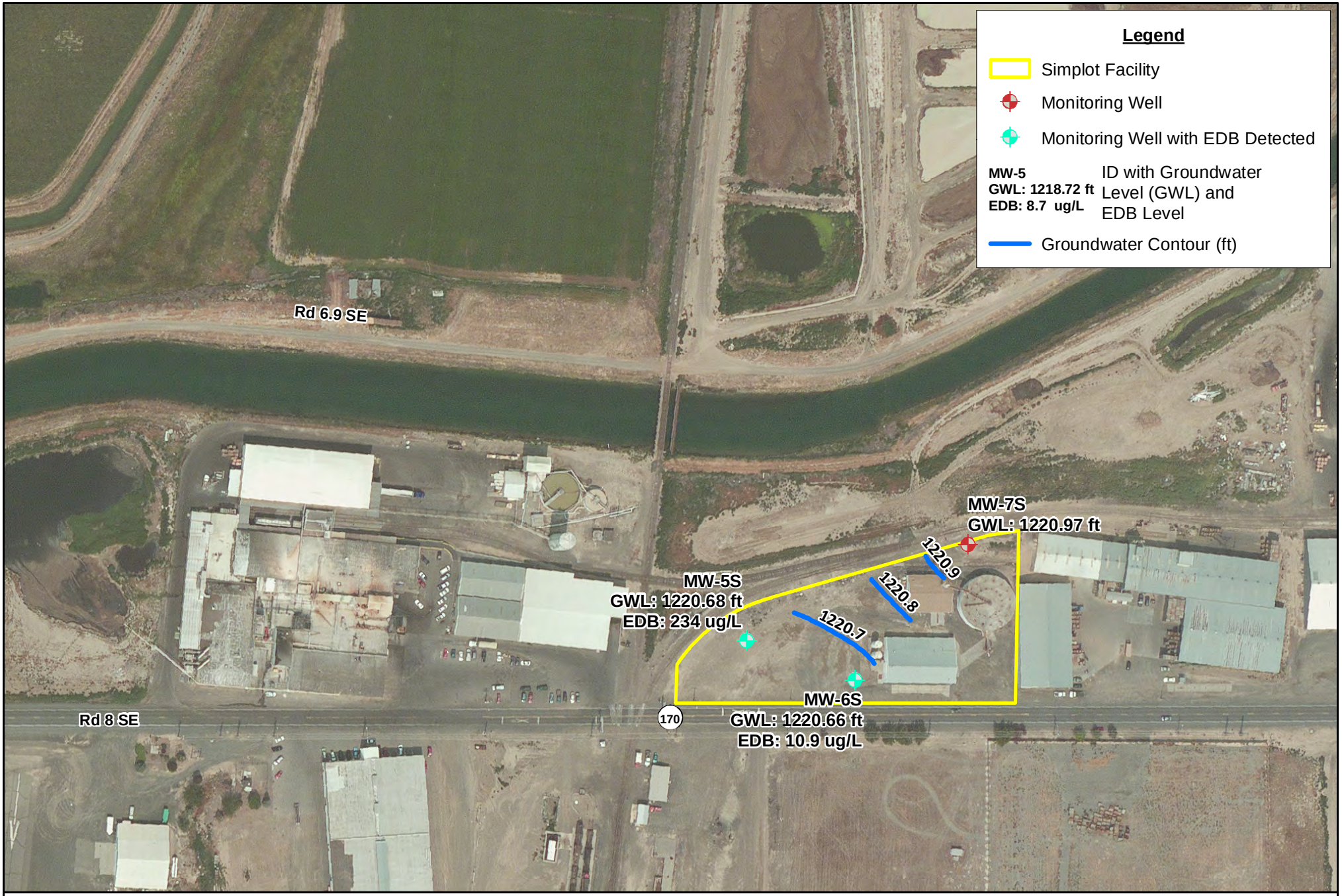

January 2012 Groundwater Contour Map, Shallow Wells and EDB Levels

Simplot Grower Solutions, City of Warden, WA

Imagery: Bing Aerial Imagery (DigitalGlobe)
Source: (c) 2012 Microsoft Corporation and its data suppliers
Other Data Sources: US Census Bureau; Washington Department of Transporation; Washington Department of Revenue; Washington Department of Ecology (WDOE)

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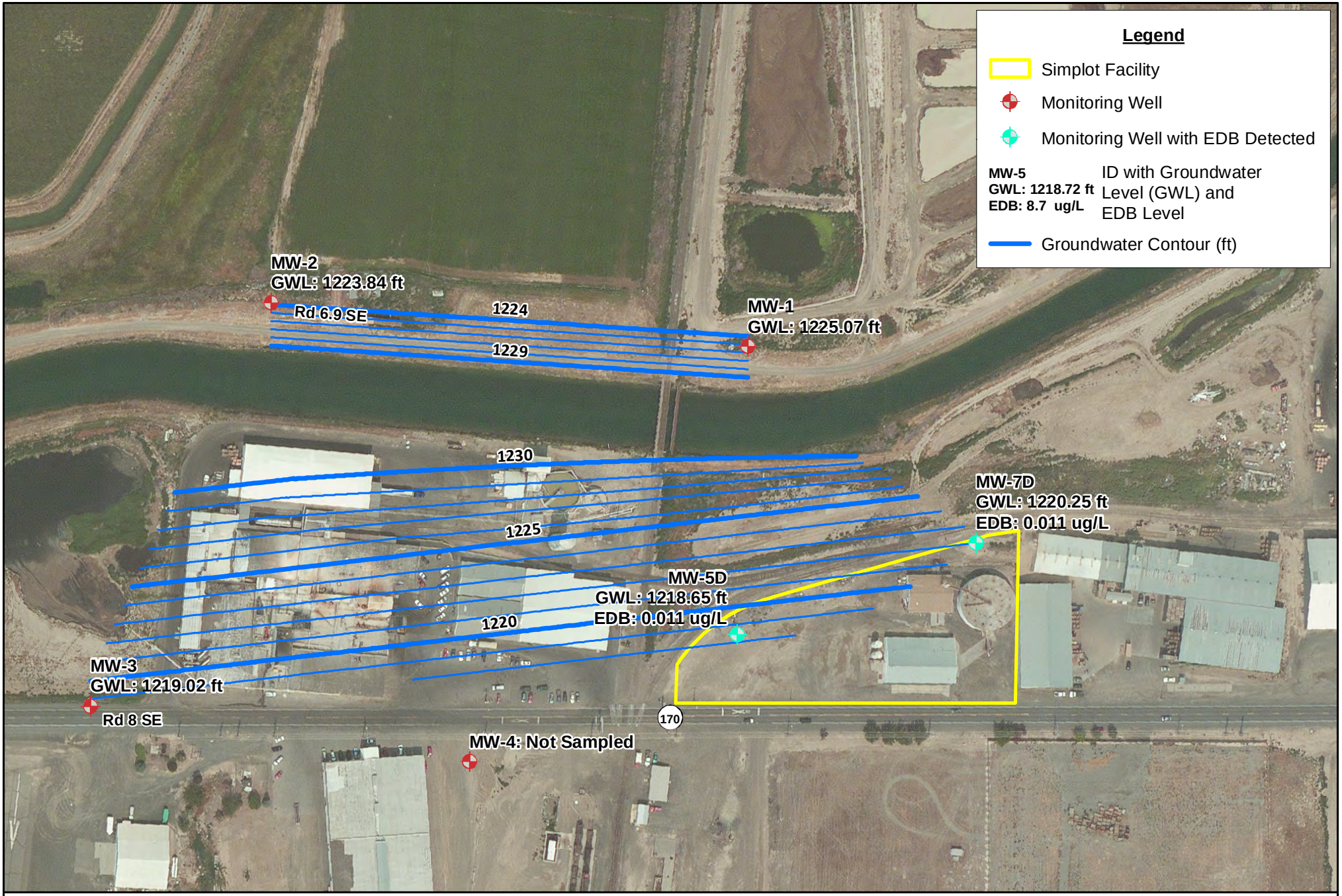

April 2012 Groundwater Contour Map, Deep Wells and EDB Levels

Simplot Grower Solutions, City of Warden, WA

Imagery: Bing Aerial Imagery (DigitalGlobe)
Source: (c) 2012 Microsoft Corporation and its data suppliers
Other Data Sources: US Census Bureau; Washington Department of Transporation; Washington Department of Revenue; Washington Department of Ecology (WDOE)

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Map Date: 4/17/2013
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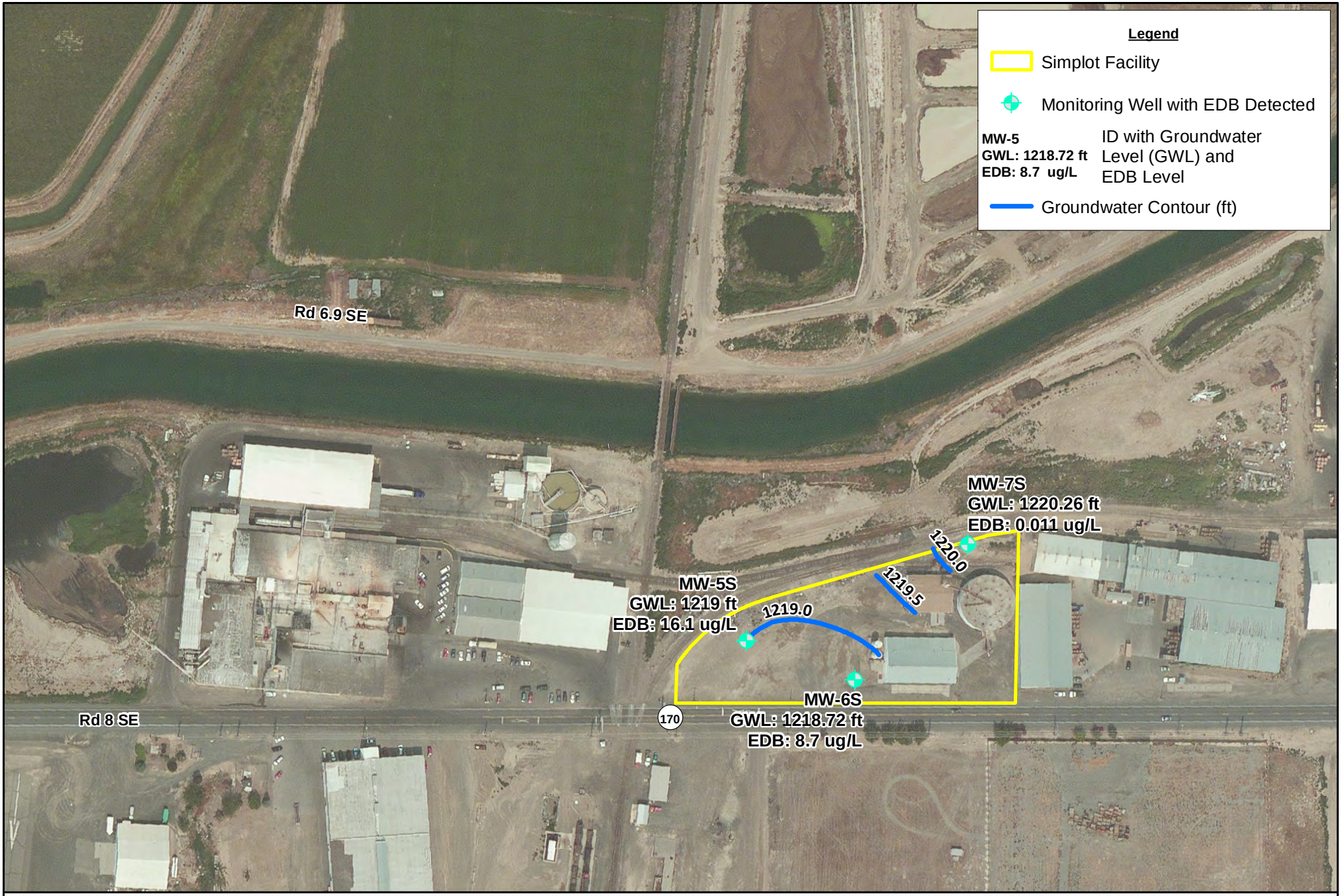

April 2012 Groundwater Contour Map, Shallow Wells and EDB Levels

Simplot Grower Solutions, City of Warden, WA

Imagery: Bing Aerial Imagery (DigitalGlobe)
Source: (c) 2012 Microsoft Corporation and its data suppliers
Other Data Sources: US Census Bureau; Washington Department of Transporation; Washington Department of Revenue; Washington Department of Ecology (WDOE)

Map Date: 1/22/2013
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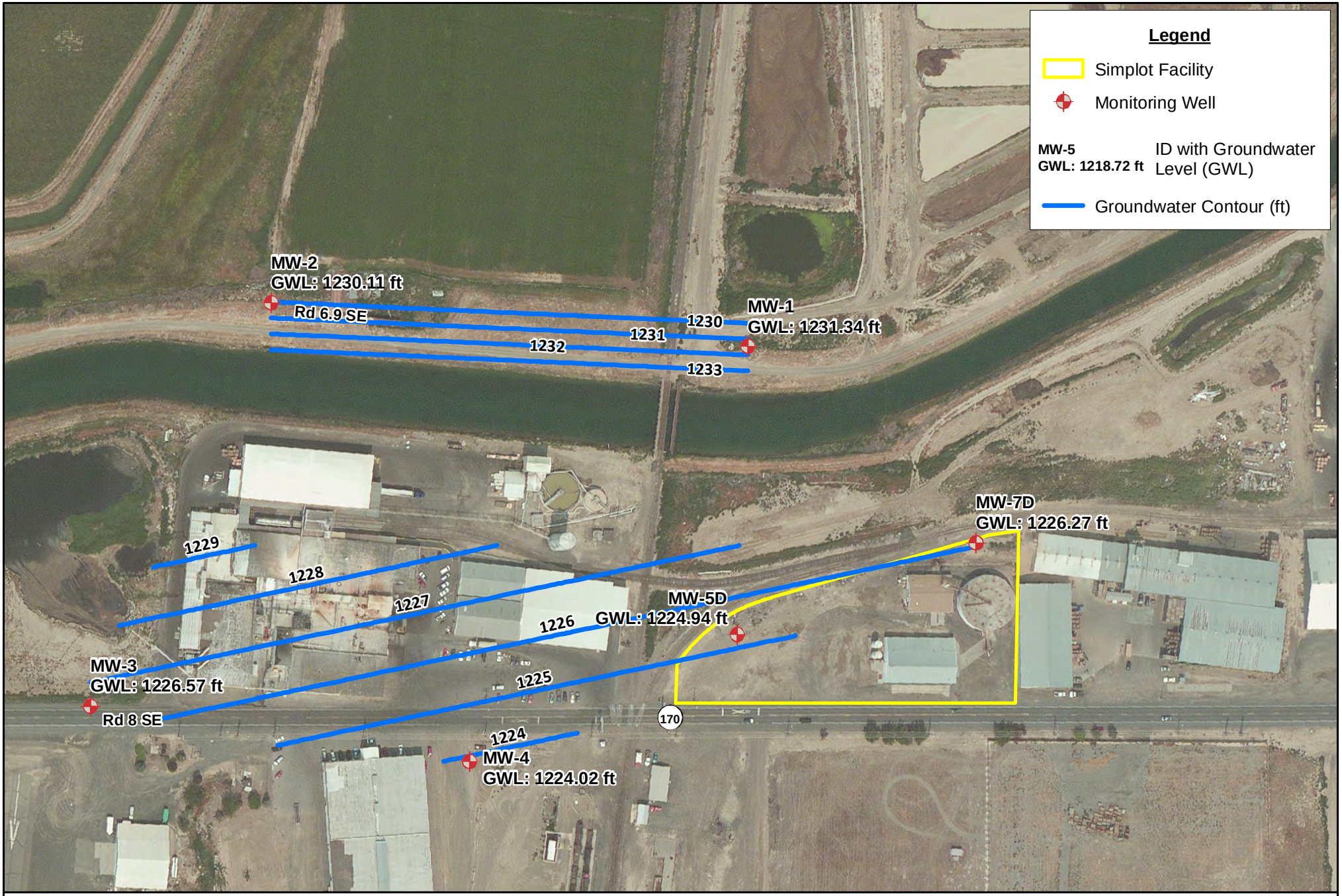

July 2012 Groundwater Contour Map, Deep Wells and EDB Levels

Simplot Grower Solutions, City of Warden, WA

Note: No EDB levels were detected for these wells for this period

Imagery: Bing Aerial Imagery (DigitalGlobe)
Source: (c) 2012 Microsoft Corporation and its data suppliers
Other Data Sources: US Census Bureau; Washington Department of Transporation; Washington Department of Revenue; Washington Department of Ecology (WDOE)

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Map Date: 4/17/2013
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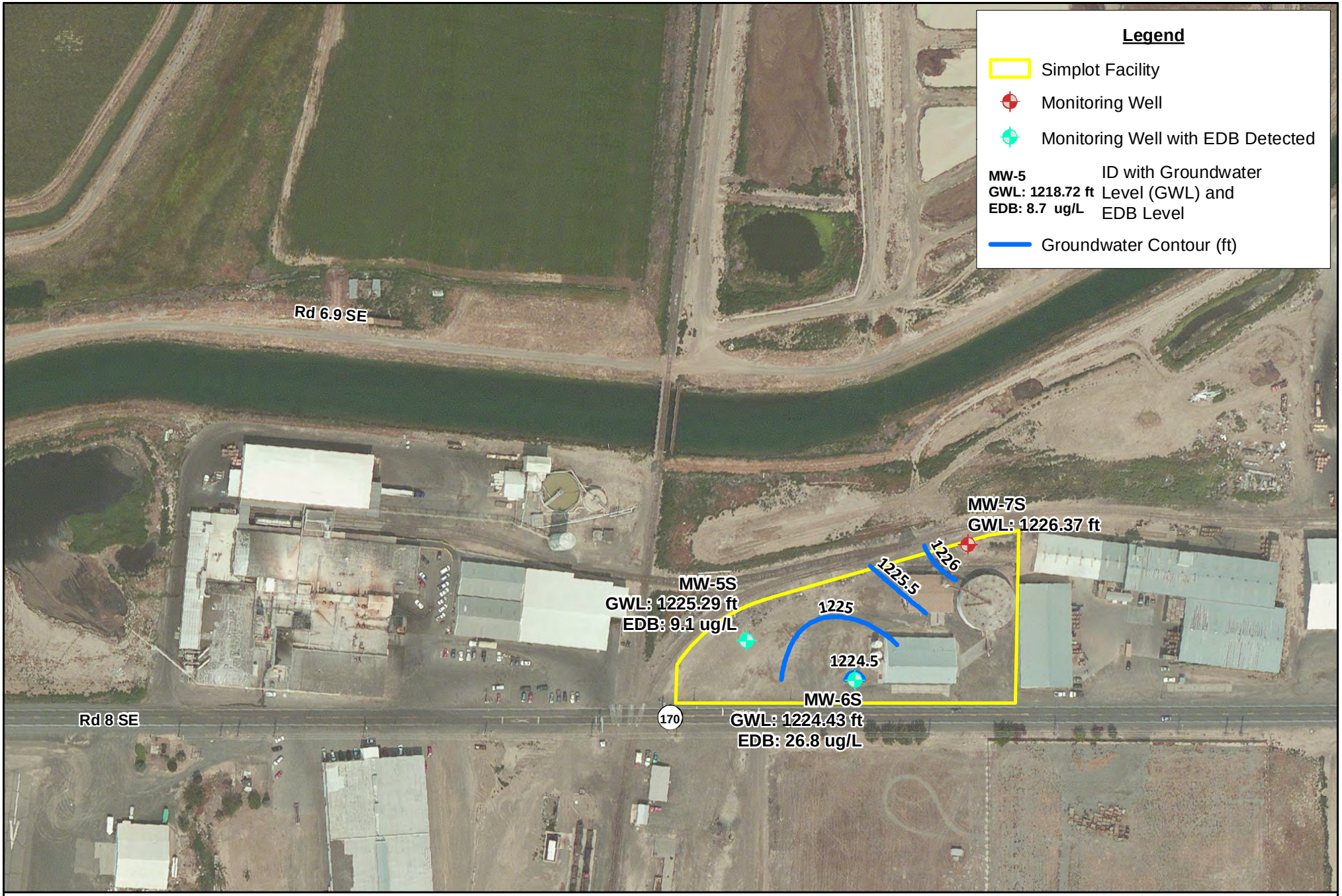

July 2012 Groundwater Contour Map, Shallow Wells and EDB Levels

Simplot Grower Solutions, City of Warden, WA

Imagery: Bing Aerial Imagery (DigitalGlobe)
Source: (c) 2012 Microsoft Corporation and its data suppliers
Other Data Sources: US Census Bureau; Washington Department of Transporation; Washington Department of Revenue; Washington Department of Ecology (WDOE)

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Map Date: 4/17/2013
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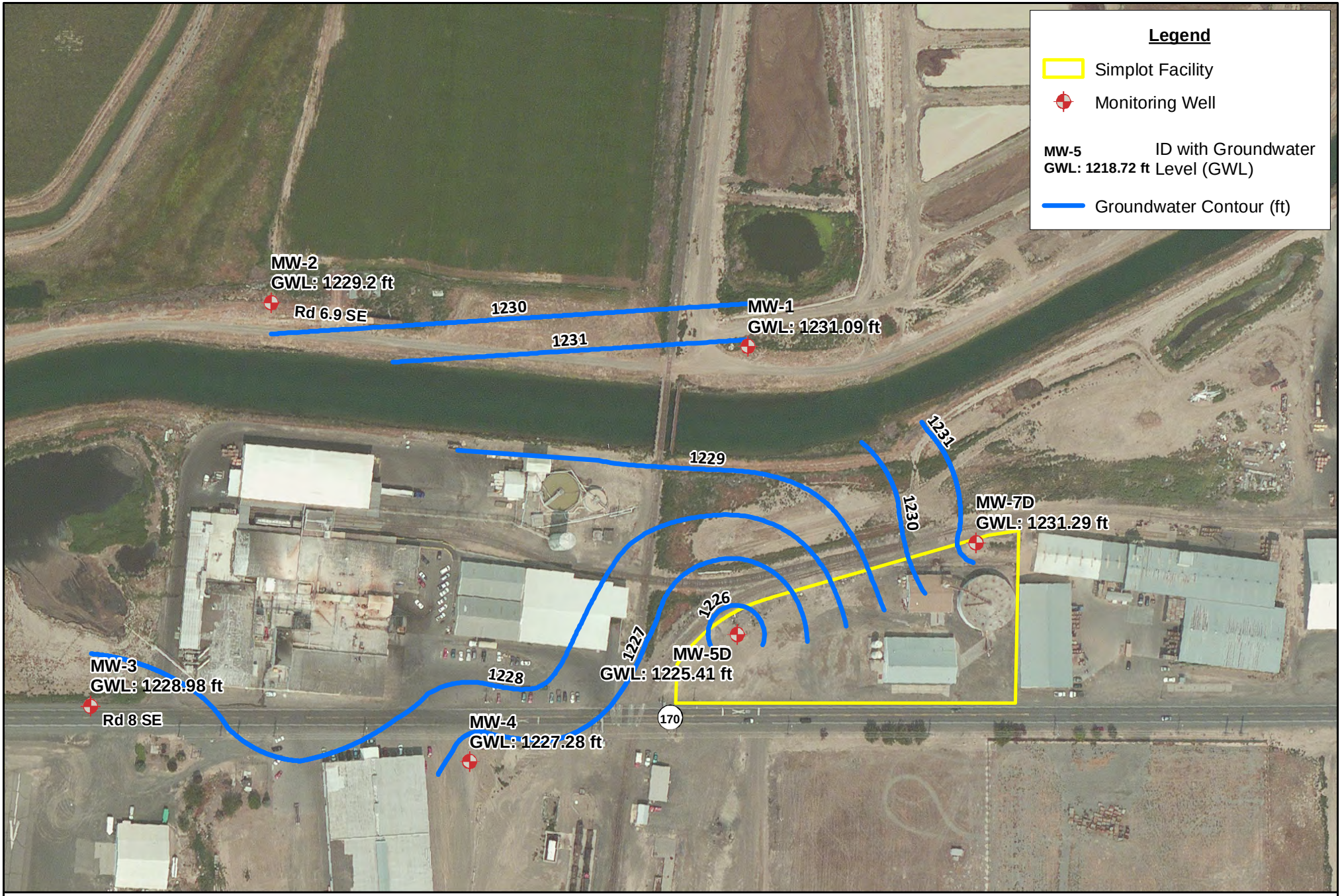


October 2012 Groundwater Contour Map, Deep Wells and EDB Levels

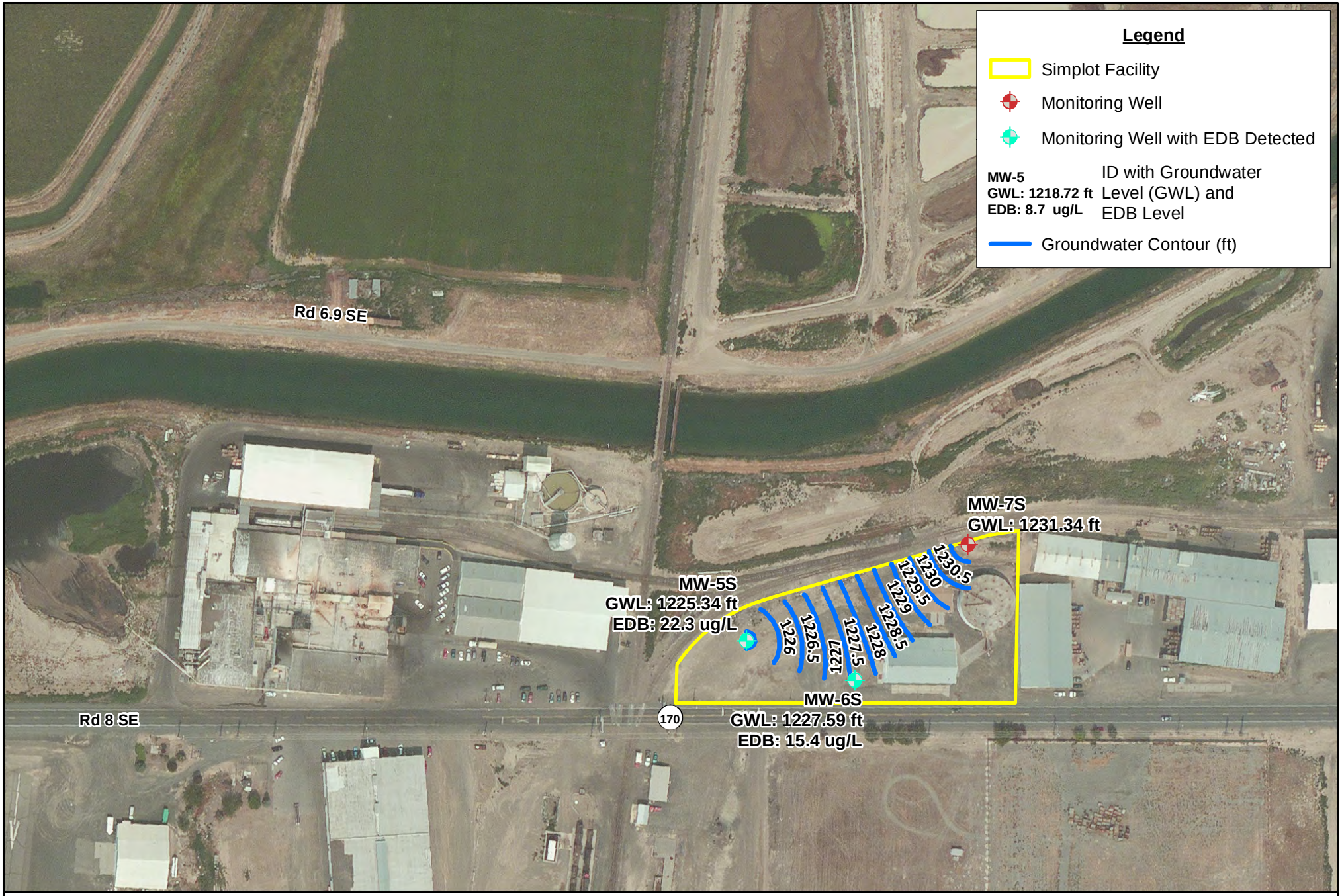
Simplot Grower Solutions, City of Warden, WA

Imagery: Bing Aerial Imagery (DigitalGlobe)
Source: (c) 2012 Microsoft Corporation and its data suppliers
Other Data Sources: US Census Bureau; Washington Department of Transporation; Washington Department of Revenue; Washington Department of Ecology (WDOE)

Note: No EDB levels were detected for these wells for this period

0 200 400
Feet

Map Date: 4/17/2013
Document: Q:\Simplot\CityofWarden\map_docs\Site_2012_nograph.mxd



October 2012 Groundwater Contour Map, Shallow Wells and EDB Levels
Simplot Grower Solutions, City of Warden, WA

Imagery: Bing Aerial Imagery (DigitalGlobe)
Source: (c) 2012 Microsoft Corporation and its data suppliers
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Map Date: 4/17/2013
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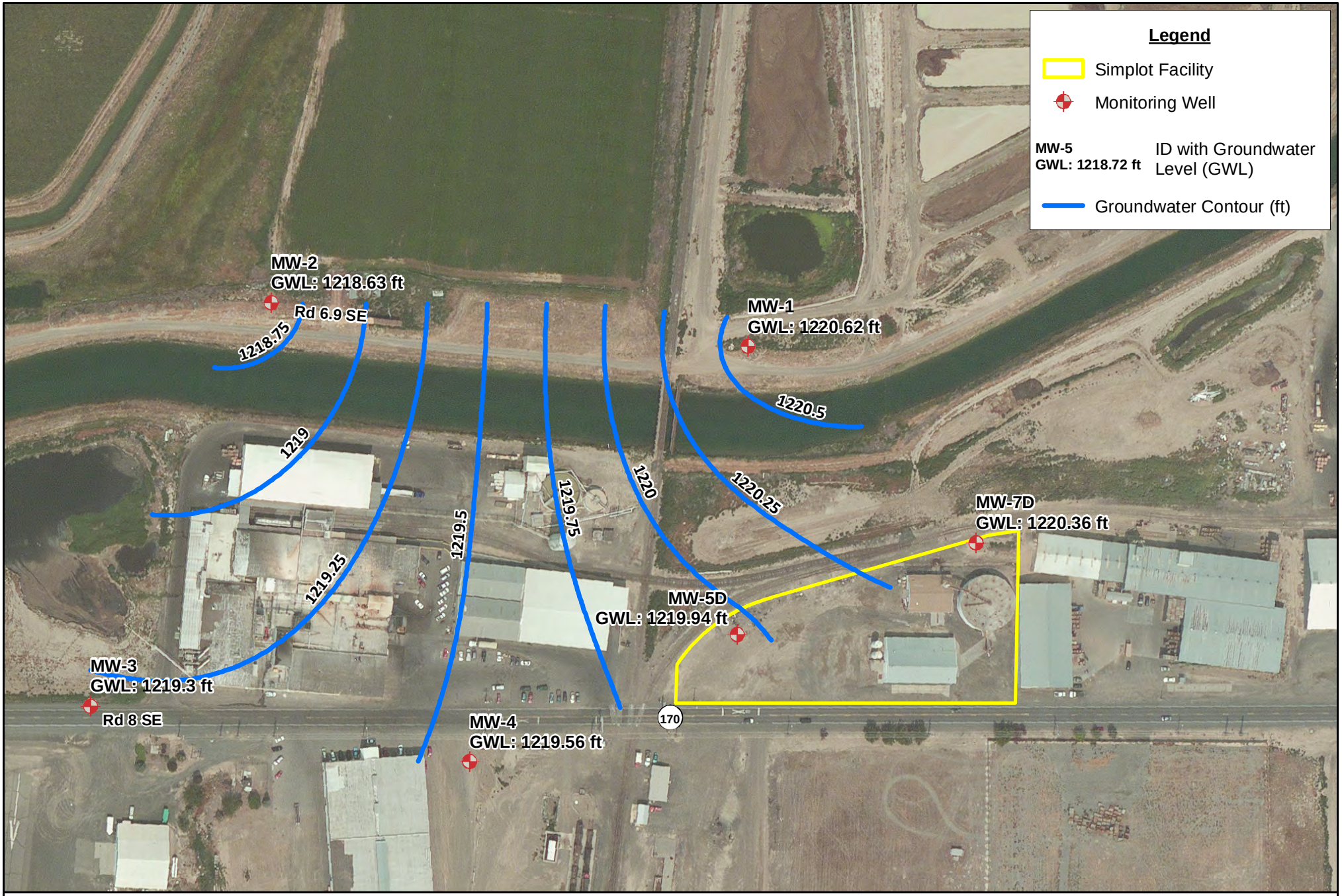

January 2013 Groundwater Contour Map, Deep Wells and EDB Levels

Simplot Grower Solutions, City of Warden, WA

Imagery: Bing Aerial Imagery (DigitalGlobe)
Source: (c) 2012 Microsoft Corporation and its data suppliers
Other Data Sources: US Census Bureau; Washington Department of Transporation; Washington Department of Revenue; Washington Department of Ecology (WDOE)

Note: No EDB levels were detected for these wells for this period

0 200 400
Feet

Map Date: 4/17/2013
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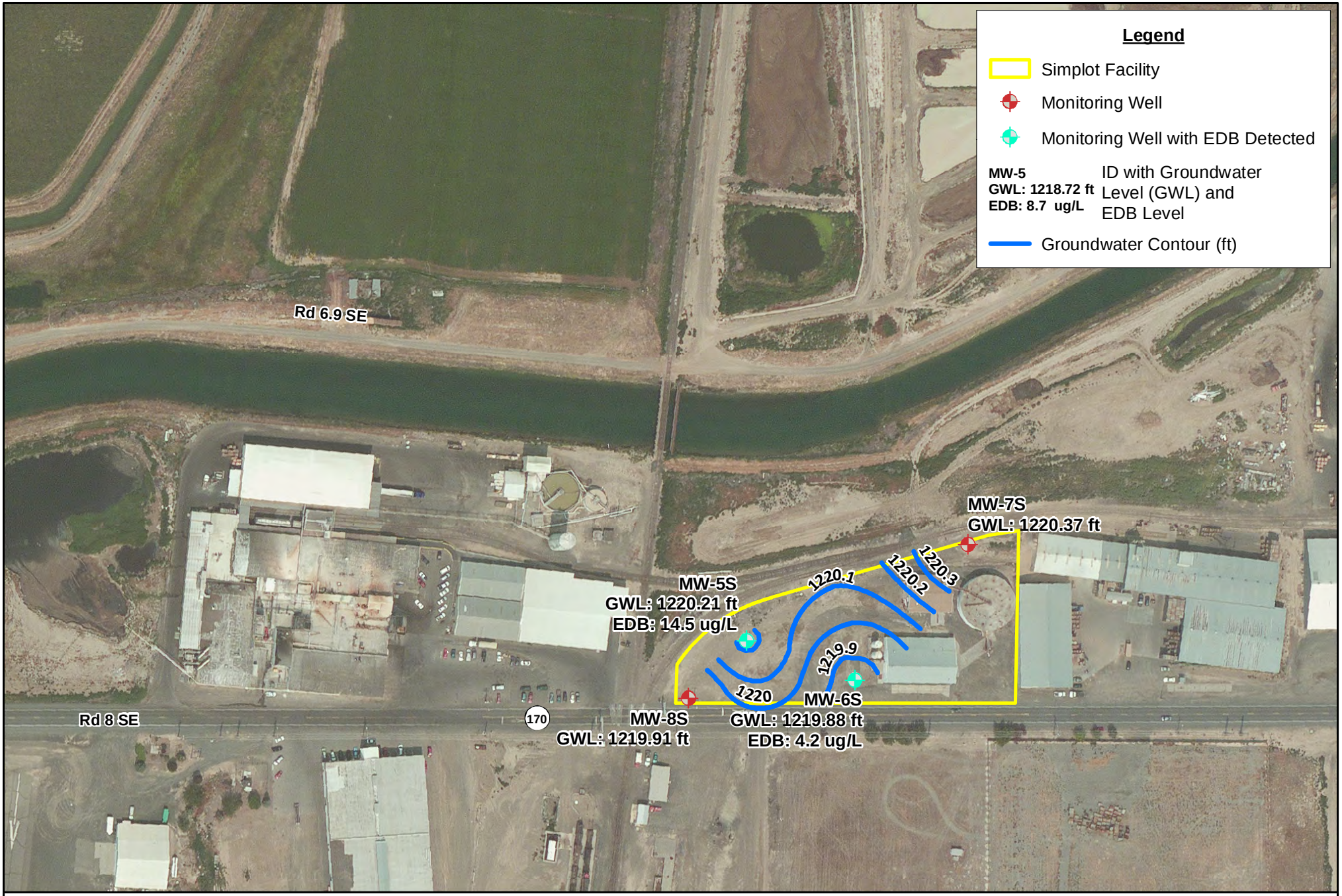

January 2013 Groundwater Contour Map, Shallow Wells and EDB Levels

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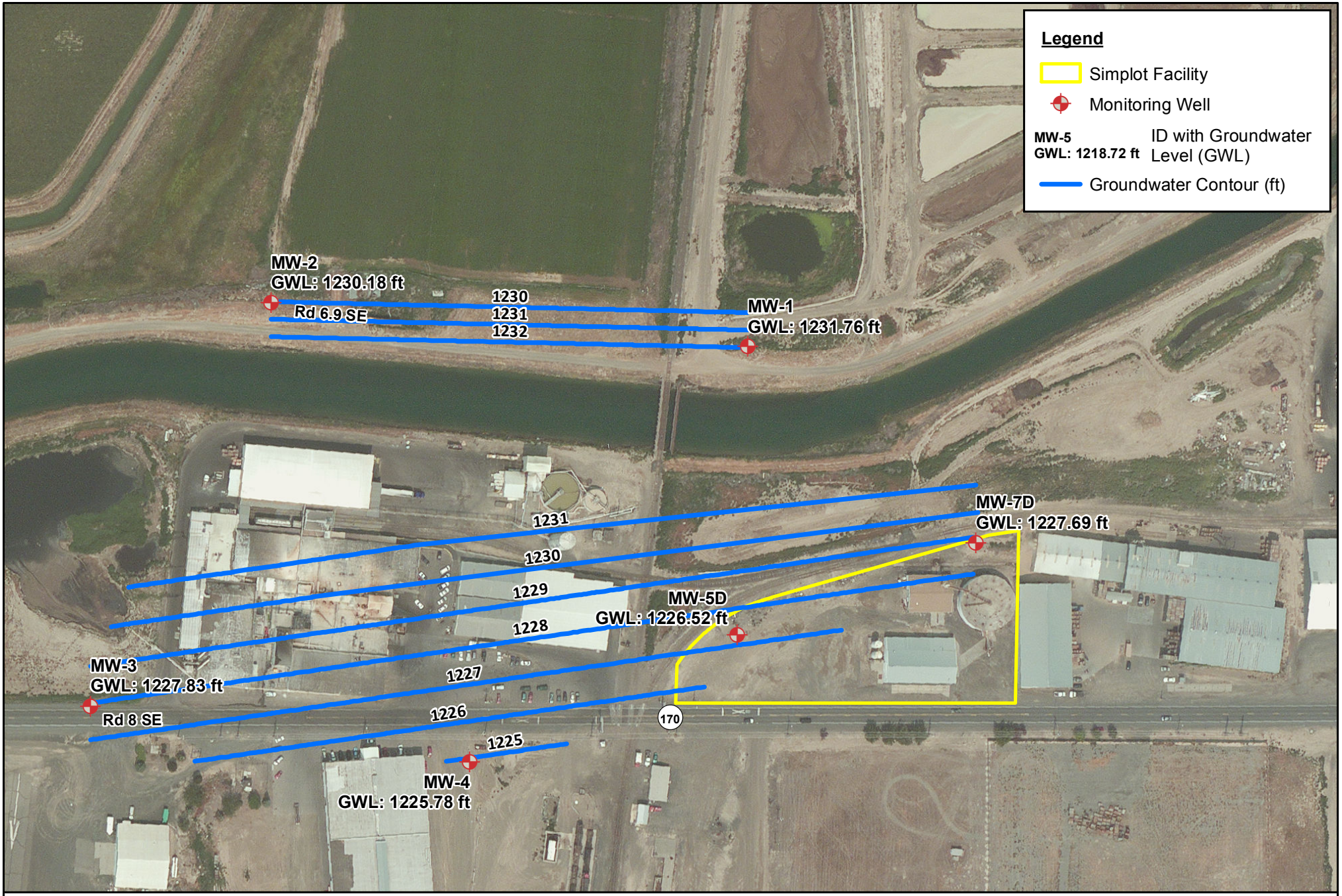

July 2013 Groundwater Contour Map, Deep Wells

Simplot Grower Solutions, City of Warden, WA

Imagery: Bing Aerial Imagery (DigitalGlobe)
Source: (c) 2012 Microsoft Corporation and its data suppliers
Other Data Sources: US Census Bureau; Washington Department of Transporation; Washington Department of Revenue; Washington Department of Ecology (WDOE)

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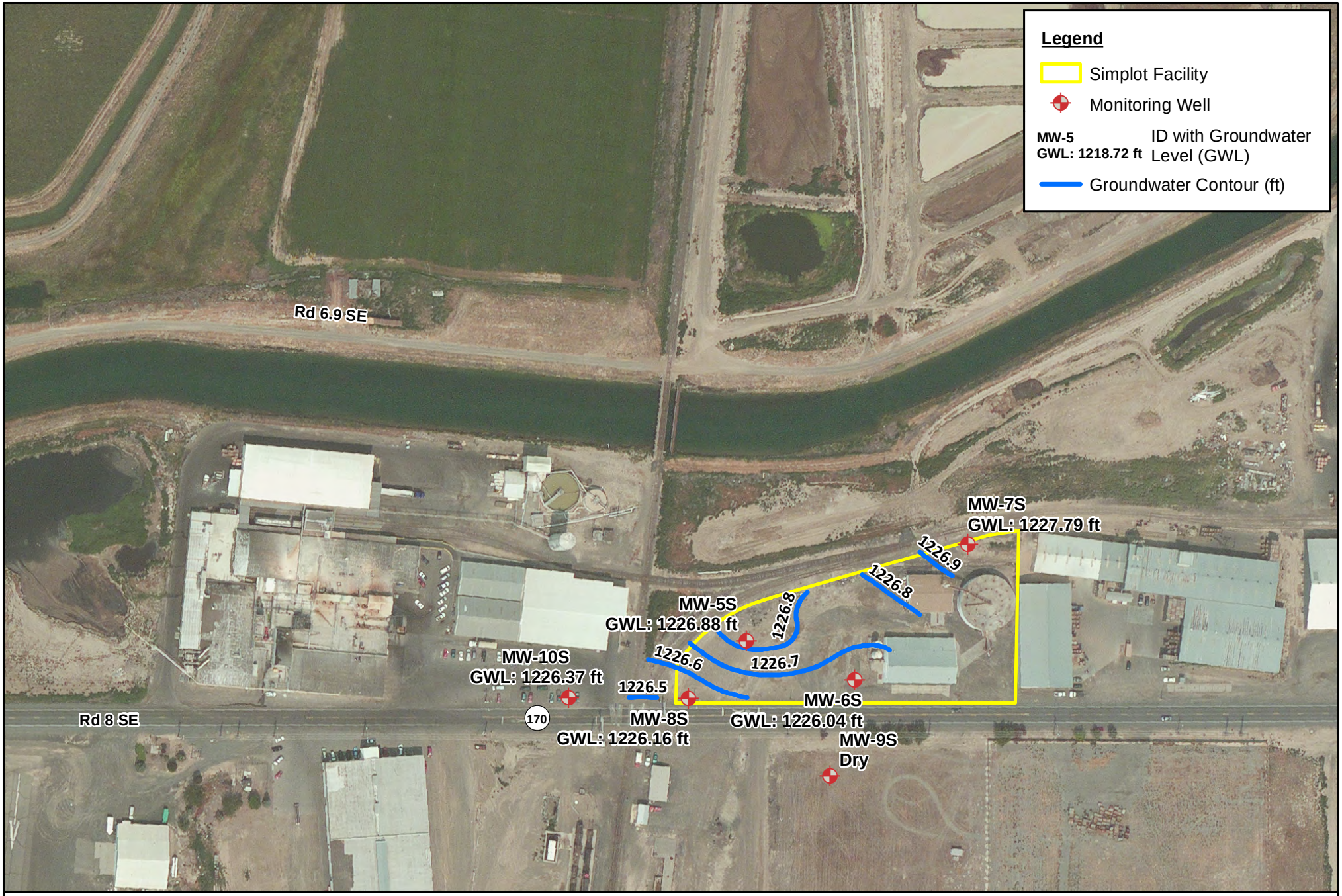

July 2013 Groundwater Contour Map, Shallow Wells

Simplot Grower Solutions, City of Warden, WA

Imagery: Bing Aerial Imagery (DigitalGlobe)
Source: (c) 2012 Microsoft Corporation and its data suppliers
Other Data Sources: US Census Bureau; Washington Department of Transporation; Washington Department of Revenue; Washington Department of Ecology (WDOE)

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Map Date: 11/22/2013
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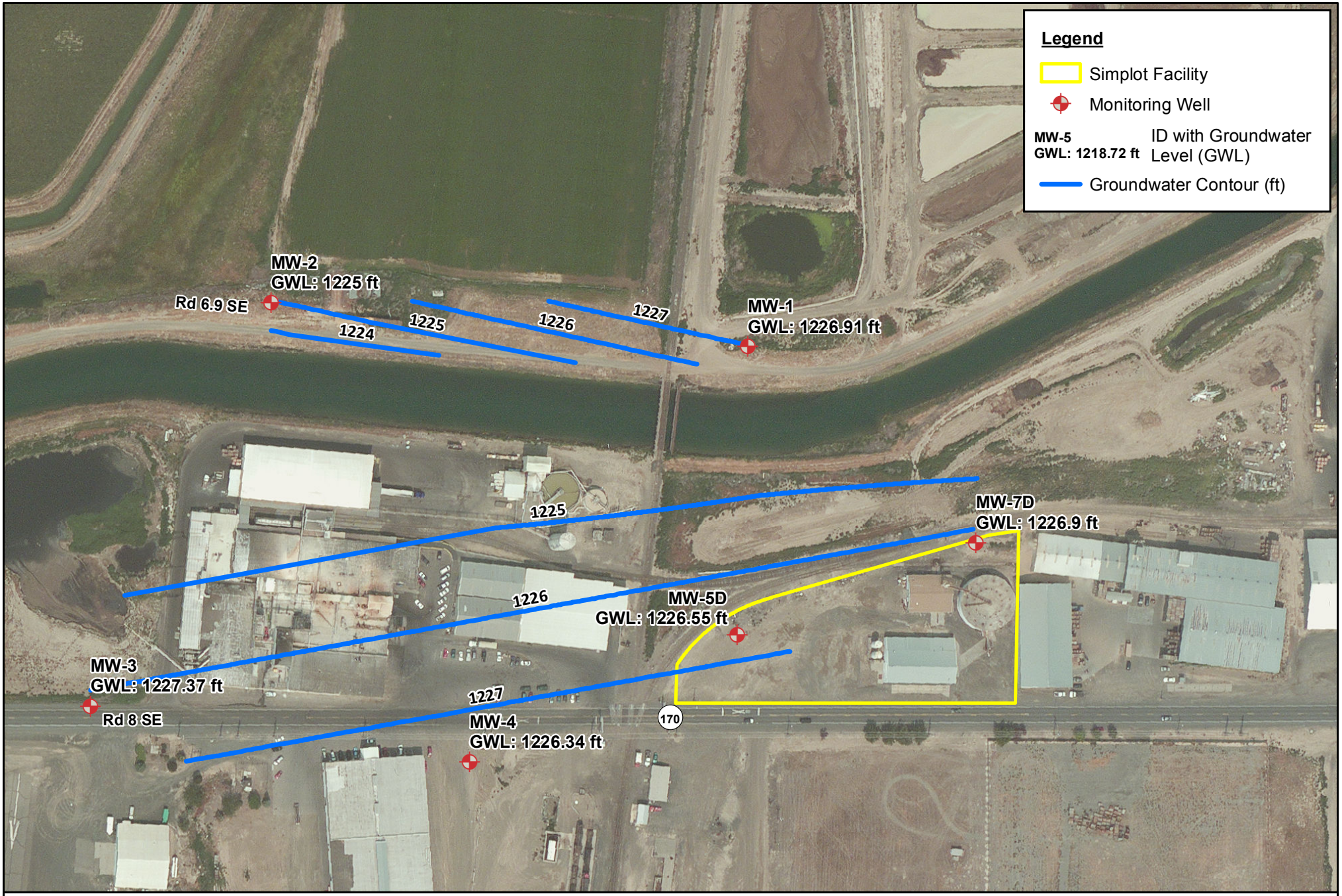

October 2013 Groundwater Contour Map, Deep Wells

Simplot Grower Solutions, City of Warden, WA

Imagery: Bing Aerial Imagery (DigitalGlobe)
Source: (c) 2012 Microsoft Corporation and its data suppliers
Other Data Sources: US Census Bureau; Washington Department of Transporation; Washington Department of Revenue; Washington Department of Ecology (WDOE)

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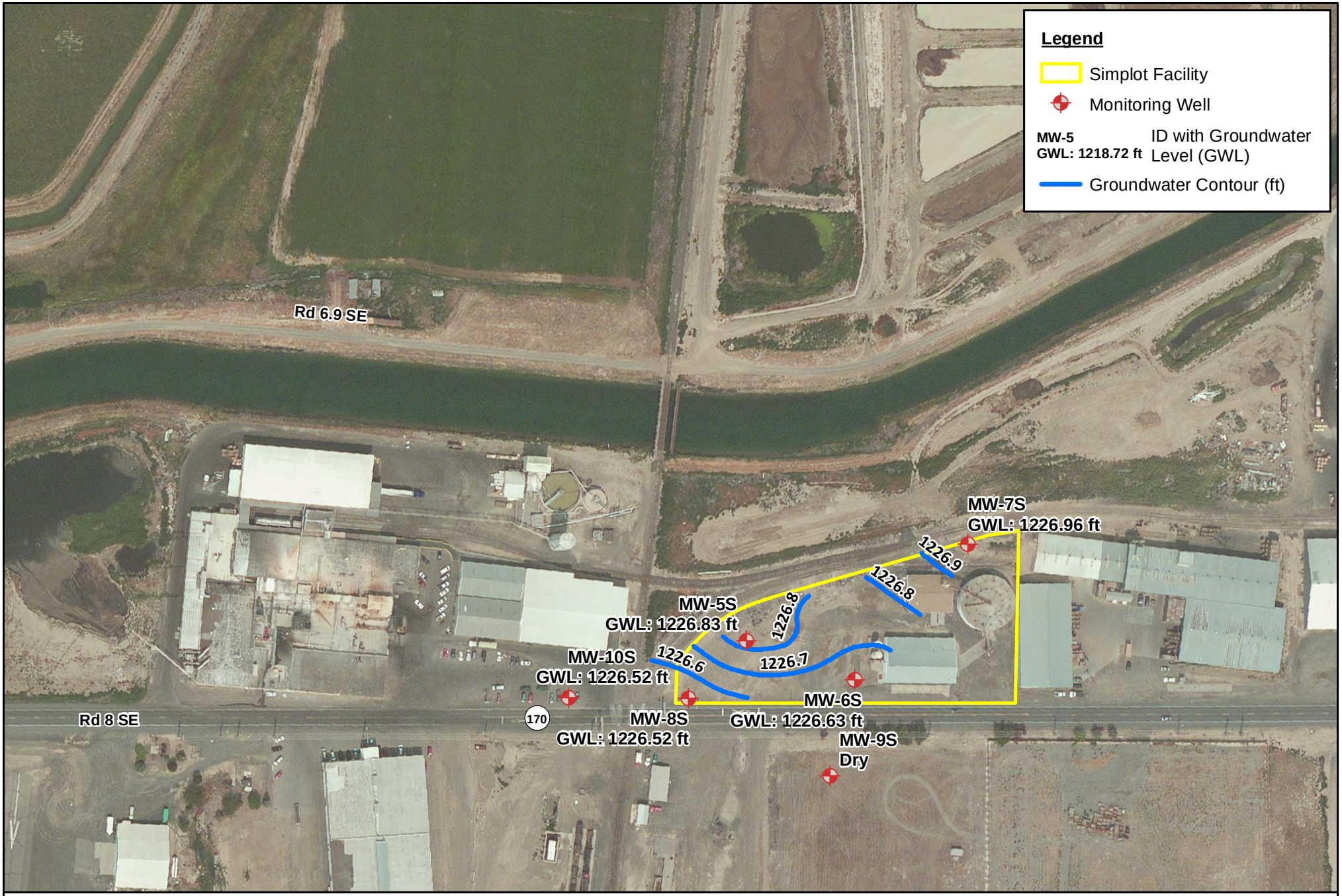

October 2013 Groundwater Contour Map, Shallow Wells
Simplot Grower Solutions, City of Warden, WA

Imagery: Bing Aerial Imagery (DigitalGlobe)
Source: (c) 2012 Microsoft Corporation and its data suppliers
Other Data Sources: US Census Bureau; Washington Department of Transporation; Washington Department of Revenue; Washington Department of Ecology (WDOE)

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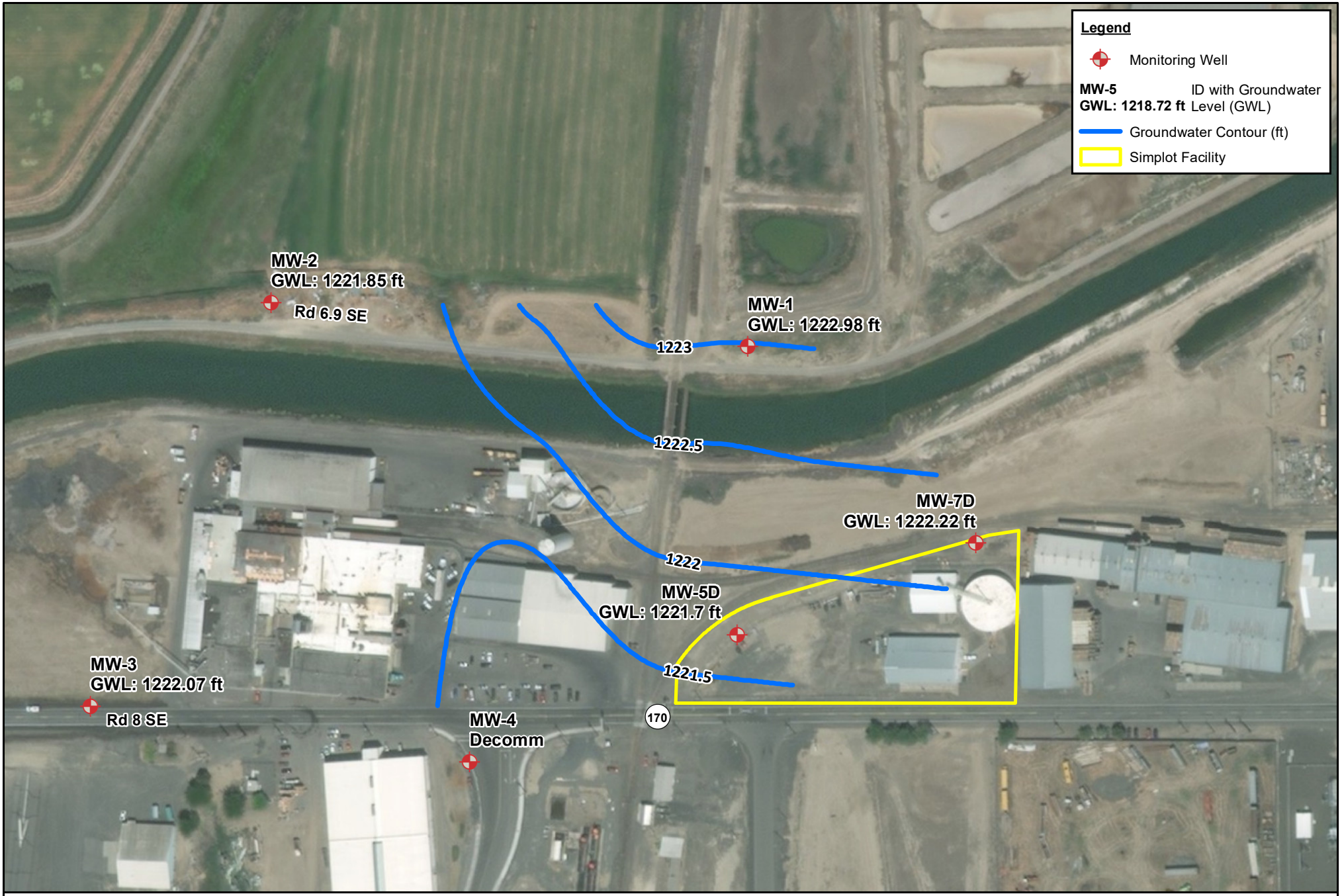

December 2017 Groundwater Contour Map, Deep Wells

Simplot Grower Solutions, City of Warden, WA

Imagery: 2016 ESRI World Imagery
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Other Data Sources: US Census Bureau; Washington Department of Transporation; Washington Department of Revenue; Washington Department of Ecology (WDOE)

0 200 400
Feet

Map Date: 1/9/2018
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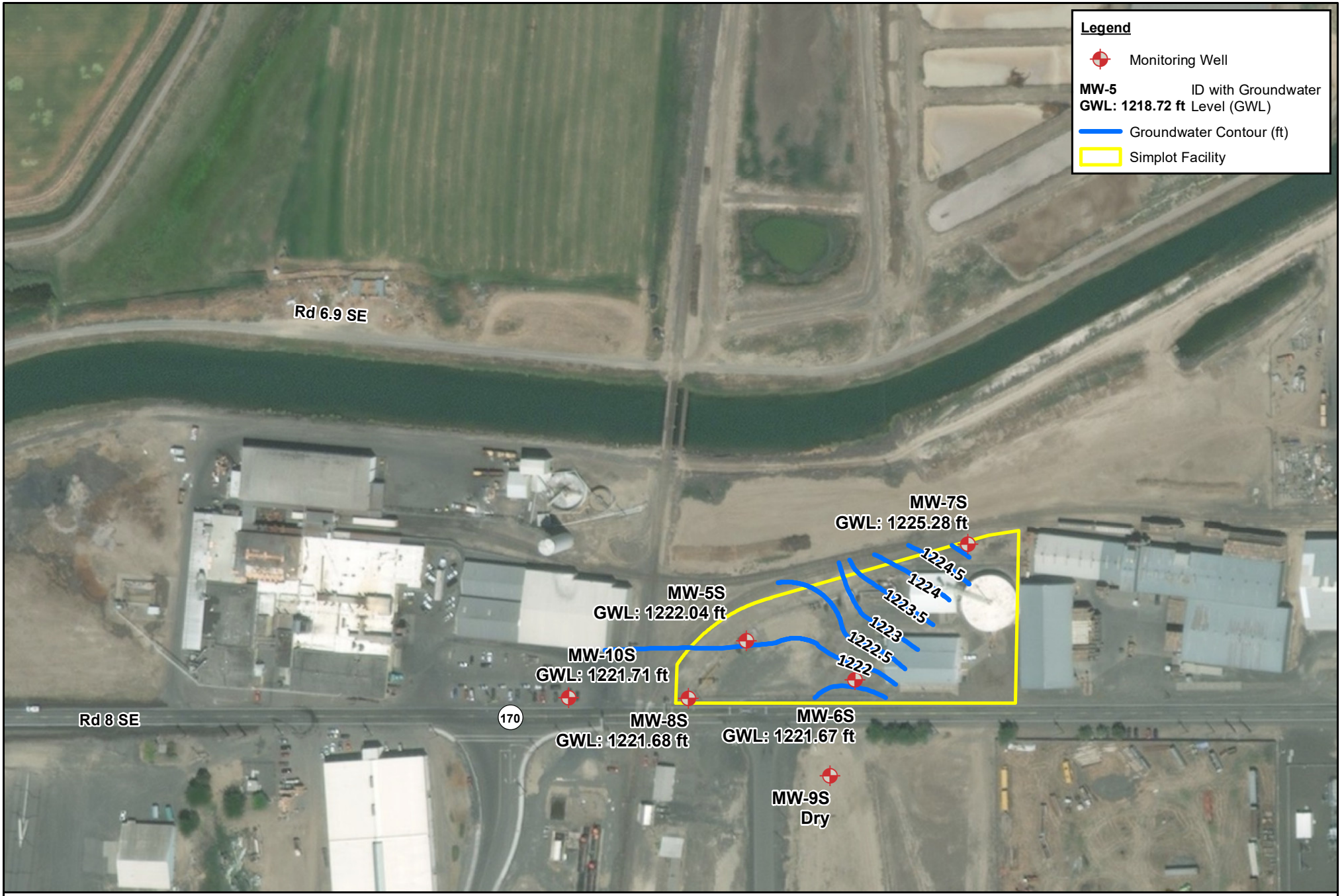

December 2017 Groundwater Contour Map, Shallow Wells

Simplot Grower Solutions, City of Warden, WA

Imagery: 2016 ESRI World Imagery
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Other Data Sources: US Census Bureau; Washington Department of Transporation; Washington Department of Revenue; Washington Department of Ecology (WDOE)

0 200 400
Feet

Map Date: 1/9/2018
Document: Q:\Simplot\CityofWarden\map_docs\Site_2017.mxd

D

Groundwater Sampling Field Forms and Laboratory Reports

(CD only)

E

2005 Health Consultation for City Well #5

STATE OF WASHINGTON
DEPARTMENT OF HEALTH
Office of Environmental Health Assessments
NewMarket Industrial Campus Building 2 • P.O. Box 47846 • Olympia, Washington 98504-7846
TDD Relay Service (800) 833-6388

September 19, 2005

Dear Recipient/Interested Party:

The Washington State Department of Health (DOH) has completed a public health evaluation of the City of Warden, EDB Drinking Water Well Contamination located at Warden, Washington. DOH conducted the evaluation to determine if people were being exposed to environmental contaminants, and whether that exposure could cause harmful health effects. The enclosed health consultation was prepared to summarize the findings of DOH's evaluation. The consultation includes several components:

(1) A background including a brief history of the site and sampling data, pages 6-9.
(2) A discussion of exposure and possible health effects, pages 9-12.
(3) Conclusions about the site's impact on public health, page 12.
(4) Recommendations to improve public health, page 13.

A reader evaluation form is also enclosed. Please take the time to complete and return it within two weeks (postage is paid). DOH relies on the input from affected communities and involved agencies to effectively address health concerns. Your knowledge about the site and surrounding community helps to improve the quality of our work and how we communicate with you.

Feel free to share this document with others who may also be concerned about the public health issues outlined in this health consultation. If you have questions or would like additional information, call me at (360) 236-3376 or toll free at 1-877-485-7316.

Sincerely,

Lenford O'Garro
Health Assessor
Site Assessment Section

Enclosures

Health Consultation

City of Warden
EDB Drinking Water Well Contamination
Warden, Grant County, Washington

September 8, 2005

Prepared by

The Washington State Department of Health
Under a Cooperative Agreement with the
Agency for Toxic Substances and Disease Registry

DOH Pub. 333-101

HEALTH CONSULTATION

CITY OF WARDEN

EDB DRINKING WATER WELL CONTAMINATION

WARDEN, GRANT COUNTY, WASHINGTON

Prepared by:

Washington State Department of Health
Under Cooperative Agreement with the
U.S. Department of Health and Human Services
Agency for Toxic Substances and Disease Registry

Forward

The Washington State Department of Health (DOH) has prepared this health consultation in cooperation with the Agency for Toxic Substances and Disease Registry (ATSDR). ATSDR is part of the U.S. Department of Health and Human Services and is the principal federal public health agency responsible for health issues related to hazardous waste. This health consultation was prepared in accordance with methodologies and guidelines developed by ATSDR.

The purpose of this health consultation is to identify and prevent harmful human health effects resulting from exposure to hazardous substances in the environment. Health consultations focus on specific health issues so that DOH can respond to requests from concerned residents or agencies for health information on hazardous substances. DOH evaluates sampling data collected from a hazardous waste site, determines whether exposures have occurred or could occur, reports any potential harmful effects, and recommends actions to protect public health. The findings in this report are relevant to conditions at the site during the time of this health consultation, and should not necessarily be relied upon if site conditions or land use changes in the future.

For additional information or questions regarding DOH or the contents of this health consultation, please call the health advisor who prepared this document:

Lenford O'Garro
Washington State Department of Health
Office of Environmental Health Assessments
P.O. Box 47846
Olympia, WA 98504-7846
(360) 236-3376
FAX (360) 236-3383
1-877-485-7316
Web site: www.doh.wa.gov/ehp/oehas/sashome.htm

For more information about ATSDR, contact the ATSDR Information Center at 1-888-422-8737 or visit the agency's Web site: www.atsdr.cdc.gov/.

Table of Contents

Glossary

Acute	Occurring over a short time [compare with **chronic**].
Agency for Toxic Substances and Disease Registry (ATSDR)	The principal federal public health agency involved with hazardous waste issues, responsible for preventing or reducing the harmful effects of exposure to hazardous substances on human health and quality of life. ATSDR is part of the U.S. Department of Health and Human Services.
Aquifer	An underground formation composed of materials such as sand, soil, or gravel that can store and/or supply groundwater to wells and springs.
Cancer Risk	A theoretical risk for developing cancer if exposed to a substance every day for 70 years (a lifetime exposure). The true risk might be lower.
Cancer Slope Factor	A number assigned to a cancer causing chemical that is used to estimate its ability to cause cancer in humans.
Carcinogen	Any substance that causes cancer.
Chronic	Occurring over a long time (more than 1 year) [compare with **acute**].
Comparison value	Calculated concentration of a substance in air, water, food, or soil that is unlikely to cause harmful (adverse) health effects in exposed people. The CV is used as a screening level during the public health assessment process. Substances found in amounts greater than their CVs might be selected for further evaluation in the public health assessment process.
Contaminant	A substance that is either present in an environment where it does not belong or is present at levels that might cause harmful (adverse) health effects.
Dermal Contact	Contact with (touching) the skin (see route of exposure).
Dose (for chemicals that are not radioactive)	The amount of a substance to which a person is exposed over some time period. Dose is a measurement of exposure. Dose is often expressed as milligram (amount) per kilogram (a measure of body weight) per day (a measure of time) when people eat or drink contaminated water, food, or soil. In general, the greater the dose, the greater the likelihood of an effect. An "exposure dose" is how much of a substance is encountered in the environment. An "absorbed dose" is the amount of a substance that actually got into the body through the eyes, skin, stomach, intestines, or lungs.

Environmental Protection Agency (EPA)	United States Environmental Protection Agency.
Epidemiology	The study of the occurrence and causes of health effects in human populations. An epidemiological study often compares two groups of people who are alike except for one factor, such as exposure to a chemical or the presence of a health effect. The investigators try to determine if any factor (i.e., age, sex, occupation, economic status) is associated with the health effect.
Exposure	Contact with a substance by swallowing, breathing, or touching the skin or eyes. Exposure may be short-term [**acute exposure**], of intermediate duration, or long-term [**chronic exposure**].
Groundwater	Water beneath the earth's surface in the spaces between soil particles and between rock surfaces [compare with surface water].
Hazardous substance	Any material that poses a threat to public health and/or the environment. Typical hazardous substances are materials that are toxic, corrosive, ignitable, explosive, or chemically reactive.
Ingestion	The act of swallowing something through eating, drinking, or mouthing objects. A hazardous substance can enter the body this way [see route of exposure].
Ingestion rate	The amount of an environmental medium that could be ingested typically on a daily basis. Units for IR are usually liter/day for water, and mg/day for soil.
Inhalation	The act of breathing. A hazardous substance can enter the body this way [see **route of exposure**].
Inorganic	Compounds composed of mineral materials, including elemental salts and metals such as iron, aluminum, mercury, and zinc.
Lowest Observed Adverse Effect Level (LOAEL)	The lowest tested dose of a substance that has been reported to cause harmful (adverse) health effects in people or animals.
Maximum Contaminant Level (MCL)	A drinking water regulation established by the federal Safe Drinking Water Act. It is the maximum permissible concentration of a contaminant in water that is delivered to the free flowing outlet of the ultimate user of a public water system. MCLs are enforceable standards.

Media	Soil, water, air, plants, animals, or any other part of the environment that can contain contaminants.
Minimal Risk Level (MRL)	An ATSDR estimate of daily human exposure to a hazardous substance at or below which that substance is unlikely to pose a measurable risk of harmful (adverse), noncancerous effects. MRLs are calculated for a route of exposure (inhalation or oral) over a specified time period (acute, intermediate, or chronic). MRLs should not be used as predictors of harmful (adverse) health effects [see **reference dose**].
No apparent public health hazard	A category used in ATSDR's public health assessments for sites where human exposure to contaminated media might be occurring, might have occurred in the past, or might occur in the future, but where the exposure is not expected to cause any harmful health effects.
No Observed Adverse Effect Level (NOAEL)	The highest tested dose of a substance that has been reported to have no harmful (adverse) health effects on people or animals.
Oral Reference Dose (RfD)	An amount of chemical ingested into the body (i.e., dose) below which health effects are not expected. RfDs are published by EPA.
Organic	Compounds composed of carbon, including materials such as solvents, oils, and pesticides that are not easily dissolved in water.
Parts per billion (ppb)/Parts per million (ppm)	Units commonly used to express low concentrations of contaminants. For example, 1 ounce of trichloroethylene (TCE) in 1 million ounces of water is 1 ppm. 1 ounce of TCE in 1 billion ounces of water is 1 ppb. If one drop of TCE is mixed in a competition size swimming pool, the water will contain about 1 ppb of TCE.
Route of exposure	The way people come into contact with a hazardous substance. Three routes of exposure are breathing [inhalation], eating or drinking [ingestion], or contact with the skin [dermal contact].
Volatile organic compound (VOC)	Organic compounds that evaporate readily into the air. VOCs include substances such as benzene, toluene, methylene chloride, and methyl chloroform.

Summary and Statement of Issues

In June 2003, the City of Warden conducted routine drinking water testing and found ethylene dibromide (EDB), also known as 1, 2-dibromoethane, at levels above the Environmental Protection Agency's (EPA) maximum contaminant level (MCL) in two of the city's three water supply wells. The City of Warden notified the Washington State Department of Health (DOH) Office of Drinking Water of the exceedance. DOH has prepared this health consultation at the request of the Grant County Health District (GCHD) and the City of Warden to evaluate the potential health hazard posed by the EDB found in the city's drinking water supply. DOH prepares public health consultations (PHCs) under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR).

Background

Public Water

City of Warden Water System

The City of Warden, hereafter referred to as the City, is located in Grant County, Washington (See Figure 1). The City's water system has three municipal wells (Well No. 4, 5 and 6) located inside of the city limits and services about 1500 customers in the area. The groundwater is drawn from the Odessa aquifer sub-basin area at a depth of approximately 360 feet for wells No. 4 (screens at about 80 feet) and 5 (screens at about 54 feet), and a depth of approximately 830 feet for well No. 6. Wells No. 5 and 6 are the two main drinking water drinking water supply wells for the City. They are both treated for bacteria via chlorination before distribution to the customers. Well No. 6 is located in the eastern section of the city, and primarily used to service the City. Well No.5 is sometimes blended with water from Well No.6 to augment the supply to the City when necessary. Well No.4 is an emergency well and has not been used in several years because of its proximity to a railroad line and a potato-processing plant. Wells 4 and 5 are located in the western section of the city and are spaced approximately 1,000 feet apart (See Figure 2).

The City also has two other wells that are not part of the City's water system (Well No. 2 and 3). Well No. 2 is a former private well located in the south of the City. In 2001, the City purchased the water rights for Well No. 2 from a local farmer. In the transfer process with Washington State Department of Ecology (Ecology), the City agreed to make it a monitoring well by drilling it an additional 200 feet. Well No. 3 is an older well that has not been in service since the mid 1970s when the shaft broke and could not be repaired. Well # 3 is located about 200 feet northeast of Well No.6.

The Safe Drinking Water Act (SDWA), enforced by DOH, requires the City to monitor organic, inorganic, and radiological components in the groundwater biannually. In April 1992, EDB contamination was detected in two wells (No. 4 and 5) [1]. DOH provided information on health-effects resulting from exposure to EDB, which the city distributed to water customers [1]. DOH initiated compliance action on the system that required increased monitoring frequency. Subsequent testing of the City water system showed wells No. 4 and 5 it to be free of the

presence of EDB until June 2003 when water samples tested positive for the presence of EDB in both wells (Table 1 and 2) at levels above the maximum contaminant level (MCL) of 0.05 parts per billion (ppb). The City notified the Washington State Department of Health Office of Drinking Water (ODW) of the EDB (MCL) exceedances.

The Public Notification (PN) Rule requires the City to notify its consumers that EDB exceeded the maximum contaminant level (MCL). According to the PN Rule, violating the EDB MCL is a "Tier 2" violation. A Tier 2 violation requires public notification within 30 days of learning that a violation of the MCL has occurred. State and federal drinking water regulations require the City to inform its customers that some people who drink water-containing EDB in excess of the MCL over many years could experience problems with their liver, stomach, reproductive system, or kidneys, and may have an increased risk of getting cancer.

In February 2004, Ecology and the GCHD collected additional water samples from several drinking water wells near Warden. These wells are not part of the City's water system but draw water from similar depth as Wells 4 and 5 are screen. Analysis of these samples failed to detect EDB.

The City consulted with ODW to determine the appropriate measures for dealing with recurring levels of EDB exceeding the MRL. ODW determined that the City must collect and analyze water samples for EDB from each of the City's three wells every three months until each source is determined to be reliably and consistently below the MCL. The City publishes a public notice in the newspaper every three months providing information on the levels of EDB and actions taken to reduce these levels (See Appendix C).

In Spring 2005, the City received a one million dollar grant from the Community Development Block Grant for the engineering and design for a new well. In addition, a one million dollar grant in the Washington State Governor's budget that will be administered by Ecology's, Toxic Cleanup Programs (July 2005) to finish the new well, reconstruction of Wells No. 5 and 6, decommission Wells No. 3 and 4, and reconstruction of Well No. 2 as a monitoring well.

Table 1. Concentration of Ethylene Dibromide detected in the City of Warden Well No.4, Warden, Grant County, Washington.

Well Number	Ethylene Dibromide (EDB)			EPA Cancer Class
	Date Sampled	Results (ppb)	MCL (ppb)	
4	2/8/05	**0.724**	0.05	B2
	11/9/04	0.04		
	10/12/04	0.02		
	3/2/04	**1.62**		
	12/9/03	**0.36**		
	11/18/03	**0.46**		
	8/20/03	0.033		
	8/20/03	0.038		
	6/24/03	**0.091**		

Bold numbers indicate levels exceed the MCL
Well 4 primarily used as emergency well. Not frequently used

Table 2. Concentration of Ethylene Dibromide detected in the City of Warden Well No.5, Warden, Grant County, Washington.

Well Number	Ethylene Dibromide (EDB)			EPA Cancer Class
	Date Sampled	Results (ppb)	MCL (ppb)	
5	4/12/05	**0.15**	0.05	B2
	2/8/05	**0.148**		
	1/10/05	**0.15**		
	11/9/04	**0.06**		
	10/12/04	**0.05**		
	5/11/04	**0.17**		
	4/6/04	**0.50**		
	3/2/04	**0.4**		
	2/9/04	**0.38**		
	2/9/04	0.04*		
	1/21/04	**0.33**		
	11/18/03	**0.09**		
	9/29/03	**0.063**		
	8/20/03	**0.061**		
	6/24/03	**0.092**		

Bold numbers indicate levels exceed the MCL
Well 5 is primarily used to service industrial/commercial processes. Sometimes used to augment residential water supply from well 6.
* Well No.5 and 6 blended

Discussion

Ethylene dibromide (EDB or 1,2-dibromoethane) was found in 2 of 3 wells used to supply water to the City. The presence of EDB alone does not necessarily indicate that adverse health effects will occur. EDB was used extensively in the past as a soil fumigant pesticide and leaded-gasoline additive. Due to an EPA ban on the use of EDB as a soil fumigant in 1984 and increased regulation of leaded gasoline, EDB use has substantially declined in the United States. The source of the EDB in the City water system is unknown. EDB is a volatile organic compound, which can be absorbed into the body during domestic use of EDB contaminated water. People can be exposed to EDB through drinking water, dermal absorption while bathing, and inhaling it after it has been released from the water while cooking and bathing. The MCL for EDB in drinking water is 0.05 ppb. MCLs are enforceable standards established by EPA and designed to be protective of human health. Levels above the MCL do not necessarily mean that adverse health effects will occur.

Exposure to EDB in water

The most obvious route of exposure to EDB in drinking water is ingestion. However, the ability of EDB to volatilize from water makes it available for inhalation from indoor air particularly during bathing and showering. Breathing EDB from indoor air and dermal absorption from water during normal household use is expected to contribute only a small fraction of the total dose (Appendix A, Table A2).

Non-cancer effects

In order to evaluate the potential for non-cancer adverse health affects that may result from exposure to EDB in water, a dose is estimated for each route of exposure (ingestion, dermal, and inhalation). These doses are calculated for situations by which residents might contact the contaminated media. The total estimated dose is compared to a health guideline. If the estimated exposure dose is below the health guideline, then the exposure is not likely to result in health effects. If the estimated dose exceeds the health guideline, then additional analysis is needed to decide if health effects are likely.

EPA's oral reference dose (RfD) for EDB was the health guideline chosen to evaluate potential exposures from well #5. RfDs are doses below which non-cancer adverse health effects are not expected to occur. These doses take into account the differences between animals and humans and difference among people. They are derived from toxic effect levels obtained from human population and laboratory animal studies. Because of uncertainty in these data, the toxic effect level is divided by "safety factors" to produce the lower and more protective RfD.

The chronic oral RfD for EDB is 0.009 mg/kg/day based on cellular necrosis in rats. Other non-cancer health effects associated with EDB exposure are problems with the liver, stomach, reproductive system, and kidneys [2]. These health effects occurred in animal studies after exposure to very high levels of EDB. Workers exposed to high levels of EDB experienced damage to sperm cells.

People who are users of water from the City's wells may be exposed through multiple routes and pathways. EDB can enter the body through ingestion of drinking water, through the skin during bathing, through inhalation of EDB in the shower or while boiling water on the stove. Exposure doses were calculated for people exposed through all pathways. Exposure equations and assumptions are provided in Appendix A, Table A2. This PHC assumes people are exposed everyday for five years to the maximum level measured in Well No. 5 (0.5 ppb). Because Well No. 4 is not currently used as a source of drinking water, only Well No. 5 contamination results will be used in the EDB evaluation. This assumption is protective of public health because Well No. 5 is primarily used to augment the City water supply when necessary. Well No. 6 primarily supplies the City, and there have been no current or historical EDB detections in this well. The highest estimated exposure dose was 3.0 E-5 mg/kg/day and is below the RfD (9.0 E-3 mg/kg/day). Therefore exposure to water from well #5 for five years would not result in any non-cancer adverse health effects.

In general, adverse health effects that have been associated with exposure to EDB have resulted from exposure to concentrations that were much higher than those detected in City water supply system. Adverse non-cancer health effects are not expected as a result of exposure to EDB from the water system.

Cancer effects

The EPA classifies EDB as a Group B2 probable human carcinogen. This means that there is sufficient evidence of carcinogenicity in animal studies, but inadequate evidence in human epidemiological studies. Cancer risk is estimated by calculating an exposure dose (Appendix A) similar to that described above and multiplying it by a cancer potency factor, also known as the cancer slope factor. Some cancer potency factors are derived from human population data. Others are derived from laboratory animal studies involving doses much higher than are encountered in the environment. Use of animal data requires extrapolation of the cancer potency obtained from these high dose studies down to real-world exposures. This process involves much uncertainty.

Cancer Risk

Cancer risk estimates do not reach zero no matter how low the level of exposure to a carcinogen. Terms used to describe this risk are defined below as the number of excess cancers expected in a lifetime:

Term		# of Excess Cancers
low	is approximately equal to	1 in 10,000
very low	is approximately equal to	1 in 100,000
slight	is approximately equal to	1 in 1,000,000
insignificant	is less than	1 in 1,000,000

Current regulatory practice assumes that there is no "safe dose" of a carcinogen and that a very small dose of a carcinogen could give a very small cancer risk. Cancer risk estimates are, therefore, not yes/no answers but measures of chance (probability). Such measures, however uncertain, are useful in determining the magnitude of a cancer risk. The validity of the "no safe dose" assumption for all cancer-causing chemicals is not clear. Some evidence suggests that certain chemicals considered carcinogenic must exceed a threshold of tolerance before initiating cancer. For such chemicals, risk estimates are not appropriate. More recent guidelines on cancer risk from EPA reflect the potential that thresholds for some carcinogenesis exist. However, EPA still assumes no threshold unless sufficient data indicate otherwise.

This document describes cancer risk that is attributable to site-related contaminants in qualitative terms like low, very low, slight and no significant increase in cancer risk. These terms can be better understood by considering the population size required for such an estimate to result in a single cancer case. For example, a low increase in cancer risk indicates an estimate in the range of one excess cancer case per ten thousand persons exposed over a lifetime. A very low estimate might result in one excess cancer case per several tens of thousands exposed over a lifetime and a slight estimate would require an exposed population of several hundreds of thousands to result in a single case. DOH considers cancer risk insignificant when the estimate results in less than one cancer per one million exposed over a lifetime. The reader should note that these estimates are for excess cancers that might result in addition to those normally expected in an unexposed

population. Cancer risks quantified in this document are an upper-bound theoretical estimate. Actual risks are likely to be much lower.

EPA has derived a cancer potency factor based on these studies so that cancer risk to humans can be quantified. Cancer risk is the likelihood, or chance, of getting cancer. In a worst-case scenario, the current highest level of EDB in drinking water (0.5 ppb) would increase a person's cancer risk by 4 in 1,000,000 (4 excess cancers in a population of 1,000,000 people exposed) (See Appendix A - Table A3) and a lifetime cancer risk of 1 in 100,000. The reader should note that these estimates are for excess cancers that might result in addition to those normally expected in an unexposed population. This estimated risk is slight to very low.

Children's Health Concerns

The unique vulnerabilities of infants and children demand special attention in communities that have contamination of their water, food, soil, or air. The potential for exposure and subsequent adverse health effects often increases for younger children compared with older children or adults. ATSDR and DOH recognize that children are susceptible to developmental toxicity that can occur even when contaminant levels are much lower than those that cause other types of toxicity. This vulnerability is a result of the following factors:

- Children are more likely to play outdoors and bring food into contaminated areas.
- Children are shorter and their breathing zone is closer to the ground, resulting in a greater likelihood to breathe dust, soil, and heavy vapors.
- Children are smaller and receive higher doses of chemical exposure per body weight.
- Children's developing body systems are more vulnerable to toxic exposures, especially during critical growth stages in which permanent damage may be incurred.

During the evaluation of the City water supply, DOH considered potential exposures to children, as well as to adults. The doses calculated for EDB is not expected to result in adverse health effects for children, or adults, based on comparison with RfD value. The assessment did find that chronic exposure to EDB over many years (for example, 30 years) does indicate a very low to slight increased cancer risk.

Conclusions

No apparent public health hazard exists for residents exposed to EDB found in drinking water wells in the City.

Exposure to EDB at levels above the MCL can pose a very low to slight increase in cancer risk over many years of exposure. This estimate of cancer risk was based on worst-case assumptions such as the entire water source coming from contaminated Well No. 5 when in reality; Warden residents tend to drink water from Well No. 6. EDB has *not* been shown to cause cancer in humans, although studies of human populations are limited.

Recommendations

Although users of the City drinking water are not expected to experience adverse non-cancer health effects, and their increased cancer risk is very low to slight, the DOH Office of Drinking Water recommends quarterly testing for EDB in the City drinking water in order for the system to comply with the rules of the SDWA.

Public Health Action Plan

Action Completed

1. In December 2003, DOH Office of Drinking Water sent a letter and Public Notification to the City (See Appendix B).

2. DOH attended a City sponsored public meeting in Warden, Washington. Staff provided educational material to community members present at the meeting: DOH questions and answers sheet (See Appendix D).

Actions Planned

1. DOH will mail this consult to the City, GCHD and concerned residents of Warden.

2. DOH will evaluate future data if EDB concentrations in the City water system increase.

Other Actions

1. Ecology provided a grant to the City for the installation of packers in the affected wells. The packers are used to isolate the upper contaminated water-bearing zone from the lower, pumping zone. A packer has been installed on Well No. 5 and is currently being evaluated for effectiveness. A determination will be made either to install a second packer on Well No. 4 or to abandon the well.

2. Ecology will be leading an investigation to identify the source of the groundwater contamination.

3. The City will drill Well No. 2 about another 200 feet to make it a monitoring well.

4. Individuals who are concerned about their water supply can minimize exposure to EDB by taking precautionary measures such as limiting shower and bathing times, reducing the temperature of the bath water, and ensuring that bathrooms are well ventilated. Another option is to install a treatment system. If residents wish to install a home treatment device (e.g., under the sink models), the EPA states that granular activated carbon (GAC) is

considered the best available technology for treatment of EDB. Anyone considering the purchase of a GAC water treatment unit should make certain the system is listed by the National Sanitation Foundation (http://www.nsf.org/) for use in drinking water treatment, and that a third-party testing data confirms the unit is effective at removing EDB.

Questions or comments regarding Ecology's present or planned actions should be directed to Dave George at Ecology, Toxics Cleanup Program. Phone: (509) 329-3520; email: cgeo461@ecy.wa.gov

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ATSDR Technical Project Officer
Alan Parham
Division of Health Assessment and Consultation
Agency for Toxic Substances and Disease Registry

References

1. Report on Groundwater Contamination that Affects Drinking Water in Washington State. Toxics Cleanup Program, Department of Ecology and Division of Drinking Water, Department of Health, April 1999. http://www.crcwater.org/issues7/19990419contamination.html

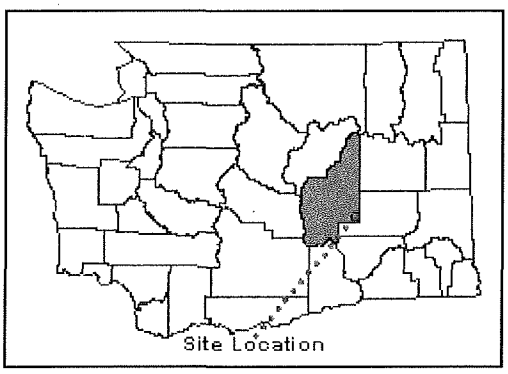
2. US Department of Health and Human Services, Agency for Toxic Substances and Disease Registry: Toxicological profile for 1,2-dibromomethane PB/93/110740/AS. Atlanta: US Department of Health and Human Services; July 1992.

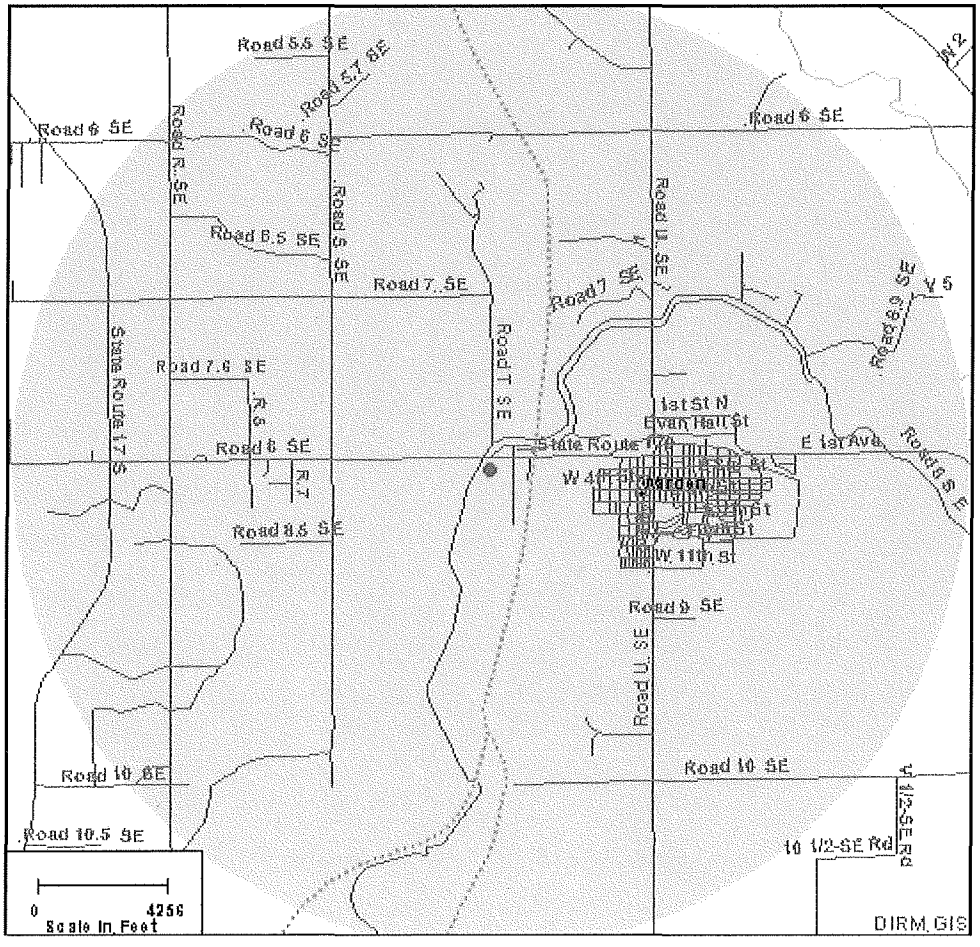
3. Foster, S.A. and Chrostowski, P.C. (1987) Inhalation Exposures to Volatile Organic Contaminants in the Shower. Presentation at the 80th Annual Meeting of APCA. New York, NY. June 21-26, 1987.

4. National Center for Environmental Assessment. Exposure Factors Handbook Volume 1 – General Factors EPA/600/P-95/002Fa: U.S. Environmental Protection Agency; August 1997.

Figure.1: Demographic Statistics Within 3 Miles of the Site* - Warden area, Grant County, Washington.

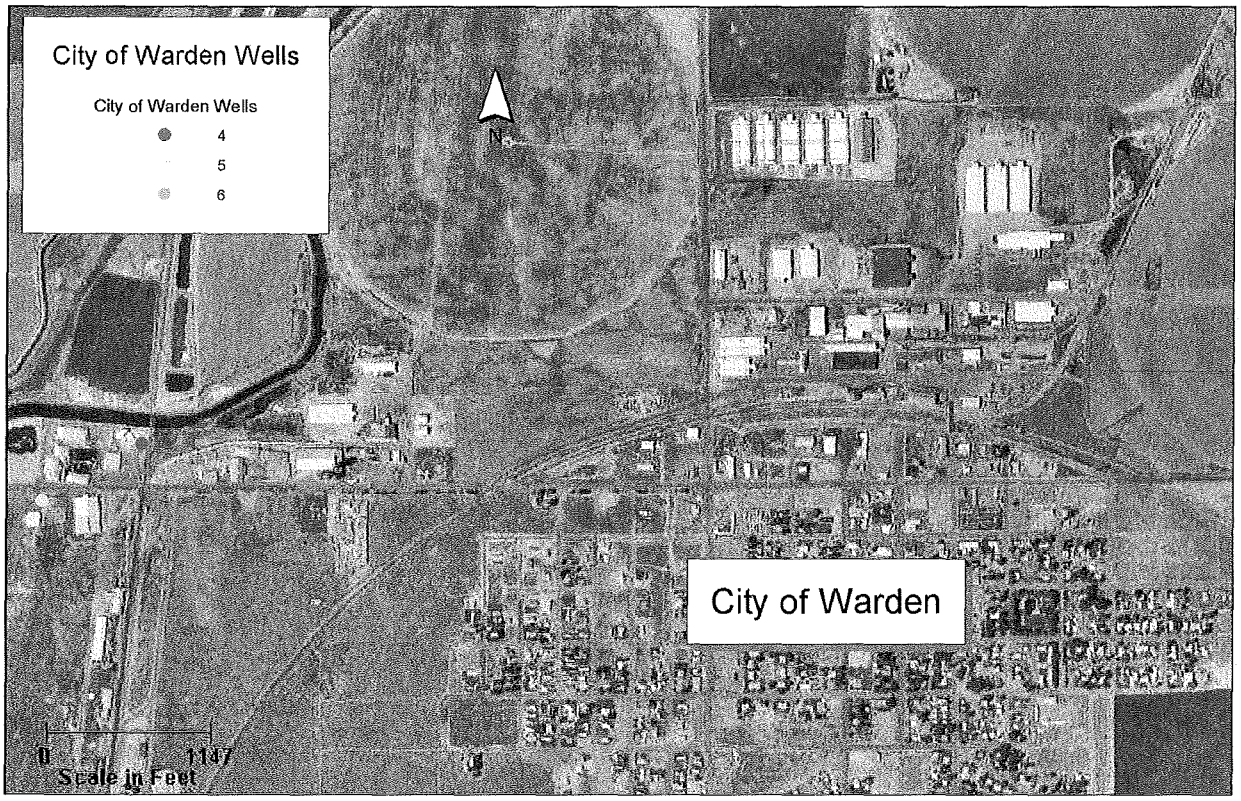
Total Population	**2941**
White	**1359**
Black	**5**
American Indian, Eskimo, Aleut	**25**
Asian or Pacific Islander	**16**
Other Race	**1451**
Hispanic Origin	**1930**
Children Aged 6 and Younger	**474**
Adults Aged 65 and Older	**216**
Females Aged 15 – 44	**623**
Total Aged over 18	**1800**
Total Aged under 18	**1142**
Total Housing Units	**921**





*** Calculated using the area proportion technique. Source: 2000 U.S. CENSUS**

Figure. 2: Arial photograph of Warden area, Warden, Washington, showing the city wells, July 16, 1995.



Appendix A

Exposure Calculations

This section provides calculated exposure doses and assumptions used for exposure to EDB in water from the City well. The following exposure parameters and dose equations were used to estimate exposure doses from ingestion, direct contact, and inhalation of EDB in water. The reader should be aware that maximum concentrations were used to calculate these doses in order to represent a worst-case scenario. This assumption may overestimate actual exposure, but it is intended to be protective of public health.

Three different receptor populations were considered when calculating non-cancer doses: children, older children, and adults. Cancer dose calculations assumed a 30-year exposure of a child growing to adulthood. Maximum air concentrations reached during a 20-minute shower were estimated using a mathematical model [3]. Use of maximum concentrations will likely over-estimate total shower inhalation exposure since maximum levels will not be present during the entire shower. This conservative approach was used to account for other sources of exposure such as clothes and dish washing that were not considered in the dose estimate. Dermal absorption during a 20-minute shower was estimated using EPA guidance.

Exposure to EDB in Water via ingestion, inhalation, and dermal absorption.

Total dose $_{(non\text{-}cancer)}$ = Ingested dose + inhaled dose + dermally absorbed dose

Ingestion Route

$$\text{Dose}_{(\text{non-cancer (mg/kg-day)})} = \frac{Cw \times CF \times IR \times EF \times ED}{BW \times AT_{non\text{-}cancer}}$$

$$\text{Cancer Risk} = \frac{Cw \times CF \times IR \times EF \times CSF \times ED}{BW \times AT_{cancer}}$$

Dermal Route - (Shower)

$$\text{Dermal Absorbed } (DA_{event}) = \frac{2 \times Kp \times Cw \times SqR \text{ of } 6 \times tau \times t/pi}{ORAF}$$

$$\text{Dermal Absorbed Dose (DAD)}_{(\text{non-cancer (mg/kg-day)})} = \frac{DA_{event} \times EV \times SA \times EF \times ED}{BW \times AT_{non\text{-}cancer}}$$

$$\text{Dermal Absorbed Dose (DAD)}_{(\text{cancer (mg/kg-day)})} = \frac{DA_{event} \times EV \times SA \times EF \times ED \times CSF}{BW \times AT_{cancer}}$$

Inhalation Route – (Shower)

Concentration in air (Ca) = S/R x (1 – (EXP (-R x t))

$$Dose_{non\text{-}cancer\ (mg/kg\text{-}day)} = \frac{Ca \times IHR \times EF \times ED}{BW \times AT_{non\text{-}cancer}}$$

$$Cancer\ Risk = \frac{Ca \times IHR \times EF \times ED \times CSF}{BW \times AT_{cancer}}$$

Table A1. Exposure Assumptions for exposure to EDB in the City drinking water in Warden, Grant County, WA.

Parameter	Value	Unit	Comments
Concentration (Cw)	Variable	ug/l	Maximum detected value
Conversion Factor (CF)	0.001	ug/mg	Converts contaminant concentration from micrograms(ug) to milligrams (mg)
Ingestion Rate (IR) – adult	0.9	l/day	Exposure Factors Handbook [4]
Ingestion Rate (IR) – older child	1.0		
Ingestion Rate (IR) - child	1.4		
Exposure Frequency (EF)	350	days/year	Two weeks vacation
Exposure Duration (ED)	30 (5, 10,15)	years	Number of years at one residence (child, older child, adult yrs).
Body Weight (BW) - adult	72	kg	Adult mean body weight
Body Weight (BW) – older child	41		Older child mean body weight
Body Weight (BW) - child	15		0-5 year-old child average body weight
Surface area (SA) - adult	20000	cm^2	Exposure Factors Handbook [4]
Surface area (SA) – older child	11800		
Surface area (SA) - child	6640		
Averaging $Time_{non\text{-}cancer}$ (AT)	1825	days	5 years
Averaging $Time_{cancer}$ (AT)	27375	days	75 years
Cancer Slope Factor (CSF)	2	$mg/kg\text{-}day^{-1}$	Source: EPA
Event frequency (EV)	1	unitless	events/day
Oral route adjustment factor (ORAF)	1	unitless	Non-cancer (nc) / cancer (c) - default
Dermally absorbed dose per event (DA_{event})	Variable	mg/cm^2	Source: EPA
Dermally absorbed dose (DAD)	Variable	mg/kg-day	Source: EPA
Skin permeability coef. (Kp)	0.0033	cm/hr	Chemical specific
Lag time (tau)	1.2	hr	Chemical specific
Inhalation rate (IHR) - adult	0.21	m^3/day	Exposure Factors Handbook [4]
Inhalation rate (IHR) – older child	0.19		
Inhalation rate (IHR) - child	0.11		
Air exchange rate (R)	0.0083	min^{-1}	Model Parameters [3]
Time concentration calculated (t)	15	min	Model Parameters [3]
Concentration in air (Ca)	Variable	mg/m^3	Model Parameters [3]
S	Variable	mg/m^3-min	Model Parameters [3]

Table A2. Non-cancer hazard calculations resulting from exposure to EDB in the City drinking water in Warden, Grant County, WA.

Contaminant	Concentration (ppb) (ug/L)	Receptor population	Estimated Dose (mg/kg/day)			Total Dose	RfD (mg/kg/day)
			Ingestion	Dermal Contact	Inhalation		
EDB	0.5	Child	2.9E-5	1.1E-6	2.0E-7	3.0E-5	9 E-3
		Older child	1.2E-5	6.9E-7	1.3E-7	1.3E-5	
		Adult	9.3E-6	6.7E-7	7.8E-8	1.0E-5	

Table A3. Cancer risk resulting from exposure to EDB in the City drinking water in Warden, Grant County, WA.

Contaminant	Maximum Concentration (ppb)	EPA Cancer Group	Cancer Slope Factor ($mg/kg\text{-}day^{-1}$)		Receptor population	Cancer Risk			Total Cancer Risk
			Oral	Inhalation		Ingestion	Dermal Contact	Inhalation	
EDB	0.5	B2	2	2	Child	3.8E-6	1.4E-7	2.7E-8	3.97E-6
					Older child	3.1E-6	1.8E-7	3.4E-8	3.31E-6
					Adult	3.7E-6	2.7E-7	3.1E-8	4.00E-6

Lifetime cancer risk: 3.97E-6 + 3.31E-6 + 4.00E-6 = 1.13E-5

Appendix B: DOH letter and Public Notification to the City of Warden

December 19, 2003

Mike Thompson, City Administrator
City of Warden
P.O. Box 428
Warden, WA 98857

Re: Ethylene Dibromide (EDB) Public Notification
City of Warden PWS #92850Q - Grant Co.

Dear Mr. Thompson:

Attached for your use is a public notice for EDB. The requirement for public notification was triggered when the City of Warden violated the EDB maximum contaminant level (MCL) in samples collected from Well #5 during the period June through November 2003.

According to the Public Notification (PN) Rule, violating the EDB MCL is a "Tier 2" violation. A Tier 2 violation requires public notification within 30 days of learning that the MCL was violated. According to DOH records, the lab reported the most recent EDB sample result on December 1, 2003. Therefore, delivery of the EDB public notice must be made no later than January 1, 2004.

According to the PN Rule, the City must deliver a written copy of the public notice by mail or other direct delivery to each customer receiving a bill, and to post the notice at a location where a persons would not normally receive a bill, but that is regularly served by the water system (e.g., at schools, industrial sites, hospitals, nursing homes, office buildings, etc.).

You will note a suggestion to have the following statement translated into Spanish and positioned at the top of the attached public notice: Important! Take this to your community center to be translated or take this to someone who can translate it for you. If there is a Spanish translation service in the City, or at the Grant County Health District, then please reference the name and phone number of these available resources in the Spanish statement at the top of the notice.

If you should have any questions concerning this letter, please do not hesitate to contact me at the number shown below, or Jeff Johnson at (509) 456-2797.

Sincerely,

Scott Torpie, P.E.
Assistant Regional Office Manager
(509) 456-3183

cc: Grant Co. Health District
Jeff Johnson, DOH
Denise Clifford, DOH

Appendix C:

Notice to Water System Users
Ethylene Dibromide (EDB) Maximum Contaminant Level Exceeded

The City of Warden Water System, PWS ID No. 92850Q, located in Grant County, is reporting that water samples collected from one of its two active drinking water supply wells tested positive for Ethylene Dibromide (also known as EDB or 1,2 –Dibromoethane). Samples collected from Well #5 during the period June through November of this year have shown concentrations ranging from 61 to 92 parts per trillion (ppt). The state and federal drinking water standard, also known as the maximum contaminant level (MCL), is 50 parts per trillion (ppt).

State and federal drinking water regulations require the City to inform its customers that some people who drink water containing EDB in excess of the MCL over many years could experience problems with their liver, stomach, reproductive system, or kidneys, and may have an increased risk of getting cancer. The Department of Health (DOH) expects none of these human health problems to occur when EDB concentrations are at or below the MCL. When the MCL is violated, DOH requires that action be taken to assure that exposures will be reduced to levels that will not cause a health concern.

The exact cause of the EDB contamination is not known at this time. EDB is a colorless, heavy organic liquid with a mildly sweet chloroform-like odor. EDB was mainly used in Washington as a soil and grain fumigant (pesticide). Other uses of EDB include as an anti-knock agent in gasoline mixtures, as a solvent for resins, gums, and waxes; in waterproofing preparations; and in making dyes and drugs. In 1984, EPA banned its use as a soil and grain fumigant. EDB is a stable chemical compound that will last for a long time in the environment.

The City of Warden is working with the State Department of Health's Office of Drinking Water in evaluating the actions needed to bring the City's water supply back into compliance with federal and state drinking water standards. Until levels of EDB are consistently below the MCL, water samples from each of the City's active groundwater supply wells will be collected every three months and analyzed for EDB. In addition, a public notice will be published in the local newspaper and posted in public places throughout the City every three months, providing information regarding:

1. The recent concentration of EDB measured in each active water source;
2. recommendations, if any, for use of alternate water supplies and/or home treatment units, and;
3. steps being taken by the City to bring the water into compliance with state and federal drinking water standards.

Possible options for dealing with the EDB contamination include:

1. rehabilitating the contaminated well(s);
2. installing source treatment; and/or
3. the abandonment of the existing well(s) and construction of a new well(s).

While the above options are being considered by the City, consumers who wish to reduce their exposure to EDB may wish to consider the following:

1. purchase bottled water for drinking purposes; and/or
2. install granulated activated carbon (GAC) filters on showerheads, individual faucets, or at the point of entry to the home. The U.S. EPA states that granular activated carbon is considered best available technology for treatment of EDB. DOH recommends that these units be NSF or UL certified.

For more information about your drinking water, contact:

Mike Thompson, Warden City Manager (509) 349-2033
Warden City Hall
201 South Ash Street
Warden, WA 98857

Additional information about EDB can be found at the following websites:
http://www.atsdr.cdc.gov/tfacts37.html
http://www.atsdr.cdc.gov/es/toxfaqs/es_tfacts37.html (Spanish Version)

Please share this notice with all the other people who drink this water, especially those who may not have received this notice directly (for example, people in apartments, nursing homes, schools, and businesses). You can do this by posting this notice in a public place or distribution copies by hand or mail.

This notice is sent to you by the City of Warden Water System on ___/___/____

Appendix D: DOH Question and Answer Sheet

Washington State Department of Health
ENVIRONMENTAL HEALTH

January 2004
Q & A

City of Warden
Drinking Water and Ethylene Dibromide
Background

The City of Warden water system located in Grant County, has reported that one of the city's two active drinking water supply wells have tested positive for ethylene dibromide (also known as EDB or 1,2-dibromoethane). Samples collected from Well #5 during the period June through November of this year have shown concentrations ranging from 61 to 92 parts per trillion (ppt). EDB was also detected in he city's backup emergency well (Well # 4), which is not currently in use. The state and federal drinking water standard, also known as the maximum contaminant level (MCL), is 50 parts per trillion (ppt) for EDB.

The Department of Health (DOH) is working with the City of Warden to assure a safe and reliable drinking water supply. To that end, the City is required to develop a strategy that will bring water quality back into compliance with federal and state drinking water standards. Until levels of EDB are consistently below the MCL, water samples from each of the City's active groundwater supply wells will be collected every three months and analyzed for EDB. The results will be made available to the community.

Commonly Asked Questions

In addition to the public notice provided to customers by the City, the following information is intended to answer questions from the community.

Q: What is EDB?

Ethylene dibromide (EDB or 1,2-dibromoethane) was used extensively in the past as a soil fumigant pesticide and as a leaded-gasoline additive. EDB is a colorless, heavy organic liquid with a mildly sweet chloroform-like odor. EDB is a stable chemical compound that will last for a long time in the environment. The US Environmental Protection Agency (EPA) banned EDB for soil fumigation in 1984. This restriction along with a decline in the use of leaded gasoline has significantly reduced the amount of EDB used in the United States over the past two decades.

Q: Will the levels of EDB found in the City of Warden's drinking water affect my health?

It is not expected that exposure to the levels of EDB found in the Warden water system would make anyone sick in the short term. Immediate adverse effects associated with EDB exposure can only be expected at much higher levels than those detected in City of Warden water supply system. Standards that are used for EDB and other chemicals in drinking water are set below levels that have been shown to cause health problems. However, since EDB can cause adverse

effects, such as cancer, at higher levels when consumed over a long period, DOH and EPA require that action be taken at any level above the established standard. More information is available about the health effects of EDB from DOH, EPA and the Agency for Toxic Substances and Disease Registry (ATSDR).

Q: How does EDB in drinking water get into my body?
EDB enters the body when you drink the water, through the skin from activities like showering or bathing, or from breathing EDB vapors released from the water into indoor air. Drinking water with EDB is expected to contribute about half of the exposure with the rest coming during activities such as showering and bathing. Exposure during other household uses (e.g. cooking, clothes or dish washing) is expected to contribute only a small fraction of the total dose.

Q: How did EDB get into the city water wells?
At this time, the exact cause of the EDB contamination is not known. We do know EDB was used in Grant County prior to the 1984 EPA ban. It was used as a soil fumigant pesticide on crops such as potatoes. EPA banned the continued use of EDB partly because of the concern that it could contaminate ground water – even when used as directed. The Department of Health has seen EDB contamination of groundwater in other areas of the state and has learned to identify some of the more common risk factors associated with EDB contamination: These include:

1. The historical use of EDB in an area,
2. The presence of unprotected shallow groundwater that could become contaminated, and,
3. Vulnerable wells constructed in such a way that allow contaminated shallow groundwater to mix with deeper uncontaminated water.

In the case of Warden, all three factors apply. The two city wells that have detected EDB, are the oldest and although they are relatively deep, they have only been "cased" (lined) to a depth of less than 100 feet.

Q: Since EDB was found in two of the City's wells, how do you know it isn't in the third well?
The City has tested all of their wells and EDB was not found in Well # 6. This testing will continue and the city will report the results to the community as they work on a long- term solution. In addition, the construction of Well # 6 is different from Wells # 4 and #5. All of the wells are deep but unlike the other two wells, Well # 6 was built more recently and has been "cased" to a much deeper depth. That casing lines the drilled hole and helps to seal out any potential contaminants that might leak into to the well and contaminate the water.

Q: How widespread is the EDB contamination?
At this point, it is not known if the problem is local or more widespread. The positive samples from the city wells are what first alerted the DOH to the EDB contamination. While DOH's Office of Drinking Water works with the City to address its water quality problem, DOH's Office of Environmental Health Assessment will work with the Local Health Department, and the Department of Ecology to determine if there is a more extensive concern. That work will provide a better understanding of the possible sources and extent of the contamination. It will also consider actions the community might consider to reduce the overall long-term risk of exposure to EDB.

For further information, call or e-mail:

Jeff Johnson
Regional Engineer
Office of Drinking Water
Phone: 509-456-2797
Email: Jeff.Johnson@doh.wa.gov

Lenford O'Garro
Public Health Advisor
Office of Environmental Health Assessment
Phone: 360-236-3376
Email: Lenford.O'Garro@doh.wa.gov

Information is also available on the following websites:

EPA Consumer Fact Sheet on EDB:
http://www.epa.gov/safewater/contaminants/dw_contamfs/ethylene.html

ATSDR Frequently Asked Questions
http://www.atsdr.cdc.gov/tfacts37.html *(English Version)*
http://www.atsdr.cdc.gov/es/toxfaqs/es_tfacts37.html *(Spanish Version)*

Certification

This Health Consultation was prepared by the Washington State Department of Health under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with approved methodology and procedures existing at the time the health consultation was begun. Editorial review was completed by the Cooperative Agreement partner.

Alan Parham
Technical Project Officer, CAT, SPAB, DHAC
ATSDR

The Division of Health Assessment and Consultation, ATSDR, has reviewed this public health consultation and concurs with the findings.

Team Lead, CAT, SPAB, DHAC
ATSDR

Anatek Labs, Inc.

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504 E Sprague Ste. D • Spokane WA 99202 • (509) 838-3999 • Fax (509) 838-4433 • email spokane@anateklabs.com

Synthetic Organic Chemicals (SOC's) Analysis Report
EPA Test Method - EPA 504.1

System ID#:	92850Q	System Name:	CITY OF WARDEN	
Lab/Sample Number:	125 73426	Collect Date:	7/25/2012	DOH Source #: S02
Multiple Source Nos:		Sample Type:	B	Sample Purpose: C
Date Received:	7/26/2012	Date Reported:	7/31/2012	Supervisor: KAS
Date Analyzed:	7/30/2012			
County:	GRANT	Sample Location: S02		
Report To:	Address:	201 S. ASH ST		
	City, State, ZIP	WARDEN, WA 98857		
	Phone Number:	509 349-2326		

EPA Regulated Chemicals

DOH #	Analytes	Result	Units	SRL	Trigger	MCL	Method	Analyst	Qualifier
0102	EDB	0.086	ug/L	0.01	0.01	0.05	EPA 504.1	MAH	
0103	DBCP	ND	ug/L	0.02	0.02	0.2	EPA 504.1	MAH	

State Unregulated Chemicals

DOH #	Analytes	Result	Units	SRL	Trigger	MCL	Method	Analyst	Qualifier
0079	1,2,3-Trichloropropane	ND	ug/L	0.5	0.5	21	EPA 504.1	MAH	

Notes:
ND = Not Detected within the sensitivity of the instrument
Numerical Entry = Detection at level indicated
SRL - Minimum reporting level for Washington DOH
MCL - EPA maximum contaminant level
Trigger - Washington DOH response level. If results exceed this level, contact the DOH

This report shall not be reproduced except in full, without the written approval of the laboratory.
The results reported relate only to the samples indicated.
Soil/solid results are reported on a dry-weight basis unless otherwise noted.

Lab Supervisor: Kathleen A. Sattler **Date:** 7/31/2012

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Synthetic Organic Chemicals (SOC's) Analysis Report
EPA Test Method - EPA 504.1

System ID#:	92850Q	~~System Name: CITY OF~~ WARDEN		
Lab/Sample Number:	125 75369	Collect Date:	8/31/2012	DOH Source #: S02
Multiple Source Nos:		Sample Type:	B	Sample Purpose: I
Date Received:	9/4/2012	Date Reported:	9/7/2012	Supervisor: KAS
Date Analyzed:	9/6/2012			
County:	GRANT	~~Sample Location: S02~~		
Report To:	Address:	201 S. ASH ST		
	City, State, ZIP	WARDEN, WA 98857		
	Phone Number:	509 349-2326		

EPA Regulated Chemicals

DOH #	Analytes	Result	Units	SRL	Trigger	MCL	Method	Analyst	Qualifier
0102	EDB	0.099	ug/L	0.01	0.01	0.05	EPA 504.1	MAH	
0103	DBCP	ND	ug/L	0.02	0.02	0.2	EPA 504.1	MAH	

State Unregulated Chemicals

DOH #	Analytes	Result	Units	SRL	Trigger	MCL	Method	Analyst	Qualifier
0079	1,2,3-Trichloropropane	ND	ug/L	0.5	0.5	21	EPA 504.1	MAH	

Notes: ND = Not Detected within the sensitivity of the instrument
Numerical Entry = Detection at level indicated
SRL - Minimum reporting level for Washington DOH
MCL - EPA maximum contaminant level
Trigger - Washington DOH response level. If results exceed this level, contact the DOH

The results reported relate only to the samples indicated.
Soil/solid results are reported on a dry-weight basis unless otherwise noted.

Lab Supervisor: Kathleen A. Sattler **Date:** 9/7/2012

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Synthetic Organic Chemicals (SOC's) Analysis Report
EPA Test Method - EPA 504.1

System ID#:	92850Q	System Name.	CITY OF WARDEN		
Lab/Sample Number:	125 75601	Collect Date:	9/7/2012	DOH Source #:	S02
Multiple Source Nos:		Sample Type:	B	Sample Purpose:	I
Date Received:	9/10/2012	Date Reported:	9/13/2012	Supervisor:	JWC
Date Analyzed:	9/12/2012				
County:	GRANT	Sample Location:	S02		
Report To:	Address:	201 S. ASH ST			
	City, State, ZIP	WARDEN, WA 98857			
	Phone Number:	509 349-2326			

EPA Regulated Chemicals

DOH #	Analytes	Result	Units	SRL	Trigger	MCL	Method	Analyst	Qualifier
0102	EDB	0.063	ug/L	0.01	0.01	0.05	EPA 504.1	MAH	
0103	DBCP	ND	ug/L	0.02	0.02	0.2	EPA 504.1	MAH	

State Unregulated Chemicals

DOH #	Analytes	Result	Units	SRL	Trigger	MCL	Method	Analyst	Qualifier
0079	1,2,3-Trichloropropane	ND	ug/L	0.5	0.5	21	EPA 504.1	MAH	

Notes:
ND = Not Detected within the sensitivity of the instrument
Numerical Entry = Detection at level indicated
SRL - Minimum reporting level for Washington DOH
MCL - EPA maximum contaminant level
Trigger - Washington DOH response level. If results exceed this level, contact the DOH

This report shall not be reproduced except in full, without the written approval of the laboratory.
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Soil/solid results are reported on a dry-weight basis unless otherwise noted.

Lab Supervisor: Kathleen A. Sattler **Date:** 9/13/2012

Anatek File # [illegible]

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Cleanup Levels Worksheets and TEE Assessment

CLARC Summary

Chemical:	ethylene dibromide (EDB)
CAS #:	106-93-4
Air, Method B, Carcinogen, Standard Formula Value (µg/m3)	4.2E-03
Air, Method B, Non-Carcinogen, Standard Formula Value (µg/m3)	4.1E+00
Air, Method C, Carcinogen, Standard Formula Value (µg/m3)	4.2E-02
Air, Method C, Non-carcinogen, Standard Formula Value (µg/m3)	9E+00
Aqueous Solubility (S)	Not Researched
Bioconcentration Factor (BCF)	Not Researched
Ground Water ARAR - Federal Maximum Contaminant Level Goal (MCLG) (mg/L)	0E+00
Ground Water ARAR - Federal Primary Maximum Contaminant Level (MCL) (mg/L)	5E-05
Ground Water ARAR - State Primary Maximum Contaminant Level (MCL) (mg/L)	5E-05
Ground Water, Method A, Table Value (µg/L)	1E-02
Ground Water, Method B, Carcinogen, Standard Formula Value (µg/L)	2.2E-02
Ground Water, Method B, Non-carcinogen, Standard Formula Value (µg/L)	7.2E+01
Ground Water, Method C, Non-carcinogen, Standard Formula Value (µg/L)	1.6E+02
Ground Water, Method C, Carcinogen, Standard Formula Value (µg/L)	2.2E-01
Henrys Law Constant (unitless) (Hcc)	Not Researched
Inhalation Cancer Potency Factor (CPFi) (kg-day/mg)	2.1E+00
Inhalation Cancer Potency Factor Based on Kidney Cancer with Mutagenic Mode of Action and Potential for Early-life Exposure	Not Researched
Inhalation Cancer Potency Factor Based on Liver Cancer	Not Researched
Inhalation Cancer Potency Factor Based on Non-Hodgkin Lymphoma	Not Researched
Inhalation Correction Factor (INH) (unitless)	2E+00
Inhalation Reference Dose (RfDi) (mg/kg-day)	2.6E-03
Kd (Distribution Coefficient for metals)	Not Researched
Koc (Soil Organic Carbon-Water Partitioning Coefficient) (L/kg)	6.6E+01
Oral Cancer Potency Factor (CPFo) (kg-day/mg)	2E+00
Oral Cancer Potency Factor Based on Kidney Cancer with Mutagenic Mode of Action and Potential for Early-life Exposure	Not Researched
Oral Cancer Potency Factor Based on Liver Cancer	Not Researched
Oral Cancer Potency Factor Based on Non-Hodgkin Lymphoma	Not Researched
Oral Reference Dose (RfDo) (mg/kg-day)	9E-03

CLARC Summary

Chemical:	ethylene dibromide (EDB)
CAS #:	106-93-4
Soil, Method A, Industrial Land Use, Table Value (mg/kg)	5E-03
Soil, Method A, Unrestricted Land Use, Table Value (mg/kg)	5E-03
Soil, Method B, Carcinogen, Standard Formula Value, Direct Contact (ingestion only), unrestricted land use (mg/kg)	5E-01
Soil, Method B, Non-carcinogen, Standard Formula Value, Direct Contact (ingestion only), unrestricted land use (mg/kg)	7.2E+02
Soil, Method C, Carcinogen, Standard Formula Value, Direct Contact (ingestion only), industrial land use (mg/kg)	6.6E+01
Soil, Method C, Non-carcinogen, Standard Fomula Value, Direct Contact (ingestion only), industrial land use (mg/kg)	3.2E+04
Surface Water ARAR - Aquatic Life - Fresh/Acute - Ch. 173-201A WAC	Not Researched
Surface Water ARAR - Aquatic Life - Fresh/Acute - Clean Water Act §304	Not Researched
Surface Water ARAR - Aquatic Life - Fresh/Acute - National Toxics Rule - 40 CFR 131	Not Researched
Surface Water ARAR - Aquatic Life - Fresh/Chronic - Ch. 173-201A WAC	Not Researched
Surface Water ARAR - Aquatic Life - Fresh/Chronic - Clean Water Act §304	Not Researched
Surface Water ARAR - Aquatic Life - Fresh/Chronic - National Toxics Rule, 40 CFR 131	Not Researched
Surface Water ARAR - Aquatic Life - Marine/Acute - Ch. 173-201A WAC	Not Researched
Surface Water ARAR - Aquatic Life - Marine/Acute - Clean Water Act §304	Not Researched
Surface Water ARAR - Aquatic Life - Marine/Acute - National Toxics Rule, 40 CFR 131	Not Researched
Surface Water ARAR - Aquatic Life - Marine/Chronic - Ch. 173-201A WAC	Not Researched
Surface Water ARAR - Aquatic Life - Marine/Chronic - Clean Water Act §304	Not Researched
Surface Water ARAR - Aquatic Life - Marine/Chronic - National Toxics Rule, 40 CFR 131	Not Researched
Surface Water ARAR - Human Health – Fresh Water – Clean Water Act §304	Not Researched
Surface Water ARAR - Human Health – Fresh Water – National Toxics Rule, 40 CFR 131	Not Researched
Surface Water ARAR - Human Health – Marine – Clean Water Act §304	Not Researched
Surface Water ARAR - Human Health – Marine – National Toxics Rule, 40 CFR 131	Not Researched
Surface Water, Method B, Carcinogen, Standard Formula Value	Not Researched
Surface Water, Method B, Non-Carcinogen, Standard Formula Value	Not Researched
Surface Water, Method C, Carcinogen, Standard Formula Value	Not Researched
Surface Water, Method C, Non-Carcinogen, Standard Formula Value	Not Researched

Worksheet for Calculating Soil Cleanup Levels for Unrestricted & Industrial Land Use

Date: 11/18/2013
Site Name: Simplot Warden, WA
Evaluator: M Murray

Refer to WAC 173-340-720, 740, 745, 747 and 750 for details.

[1]Soil ingestion only; [2]Soil dermal contact; [3]Soil to Ground Water; [4]Ground Water ingestion; [5]Vapor exposure pathway

A. INPUT PARAMETERS FOR SOIL CLEANUP LEVEL CALCULATIONS

Note: If no data is available for any of the following inputs, then leave the input box blank

Item	Symbol	Value	Units
1. General information			
1.1 Name of Chemical:		EDB	
1.2 Measured Soil Concentration, if any:	C_s	0.218	mg/kg
1.3 Natural Background Concentration for Soil, if any:	NB_s	0	mg/kg
1.4 Practical Quantitation Limit for Soil, if any:	PQL_s	0.004	mg/kg
* To evaluate the ingestion and dermal pathways concurrently, check here and input values for ***AF, ABS$_d$, GI***:	☑		
2. Toxicological Properties of the Chemical: Chemical-Specific			
2.1 Oral Reference Dose[1, 3]	RfD_o	0.009	mg/kg-day
2.2 Oral Carcinogenic Potency Factor[1, 3]	CPF_o	2	kg-day/mg
2.3 Inhalation Reference Dose[5]	RfD_i	2.60E-03	mg/kg-day
2.4 Inhalation Carcinogenic Potency Factor[5]	CPF_i	2.1	kg-day/mg
3. Exposure Parameters			
3.1 Inhalation Correction Factor (default = "2" for volatiles; "1" for all others)[4]	*INH*	2	unitless
3.2 Inhalation Absorption Fraction (default = "1")[5]	ABS_i	1	unitless
3.3 Gastrointestinal Absorption Fraction (default = "1")[1, 2]	*AB1*	1	unitless
3.4 Adherence Factor (default = "0.2")[2]	*AF*	0.2	mg/cm^2-day
3.5 Dermal Absorption Fraction (chemical-specific or defaults)[2]	ABS_d	0.1	unitless
3.6 Gastrointestinal Absorption Conversion Factor (chemical-specific or defaults)[2]	*GI*	0.5	unitless
4. Physical and Chemical Properties of the Chemical: Chemical-Specific			
Soil Organic Carbon-Water Partitioning Coefficient: for metals, enter K_d value here and enter "1" for f_{oc} value	K_{oc}	6.600E+01	l/kg
Henry's Law Constant: for the evaluation of ground water and vapor exposure pathway	H_{cc}	2.768E-02	unitless
**If the value for Henry's Law Constant is given in the unit of "atm.m^3/mol", enter value here:*	*H*	*6.500E-04*	atm.m^3/mol
**Converted unitless form of H_{cc} @13^{o}C: (Enter this converted value into "H_{cc} input Box" above for a calculation)*	H_{cc}	*2.768E-02*	unitless

Solubility of the Chemical in Water: for the calculation of soil saturation limit	S	4.320E+03	mg/l

5. Target Ground Water Cleanup Level

Target Ground Water Cleanup Level applicable for a soil cleanup level calculation: **Results from the Ground Water Cleanup Level Worksheet are not*	C_w	**5.00E-02**	ug/l

6. Site-Specific Hydrogeological Characteristics

Total Soil Porosity (default = "0.43"):	n	0.43	unitless
Volumetric Water Content (default = "0.30"):	Θ_w	0.3	unitless
Volumetric Air Content (default = "0.13"):	Θ_α	0.13	unitless
Dry Soil Bulk Density (default = "1.50"):	ρ_b	1.5	kg/l
Fraction Soil Organic Carbon (default = "0.001"): for metals, enter "1" for f_{oc} value here	f_{oc}	0.001	unitless
Dilution Factor (default = "20" for unsaturated zone soil; "1" for saturated zone soil; or site-specific)	DF	20	unitless

7. Vapor Attenuation Factor due to Advection (building structure) & Diffusion (soil layer) Mechanisms

** Vapor Attenuation Factor is the ratio of air concentration at the exposure point (e.g., within the building) to the vapor-phase contaminant concentration within the soil at the source*

Enter Vapor Attenuation Factor: for the evaluation of vapor exposure pathway	VAF	0.01	unitless

B. SUMMARY OF SOIL CLEANUP LEVEL CALCULATIONS

Chemical of Concern: EDB

1. Summary of Results

To calculate a soil cleanup level based on Industrial Land Use (Method C) for Direct Soil Contact, check here: ☑

To calculate a soil concentration based on Method C vapor pathway, check here: ☑

Basis for Soil Concentration	Conc	Units
Most stringent soil concentration based on Soil Direct Contact & Ground Water Protection:	2.684E-04	mg/kg
Natural Background concentration for Soil:	0	mg/kg
Practical Quantitation Limit for Soil:	0.004	mg/kg
Soil Cleanup Level (not considering vapor pathway):	4.000E-03	mg/kg
Warning! Soil Cleanup Level above may not be protective of vapor exposure pathway - evaluate vapor pathway further.		
Soil concentration based on Vapor Pathway (informational purposes only):	8.824E-07	mg/kg
Soil Saturation Limit, C_{sat}:	1.159E+03	mg/kg

C_{sat} corresponds to the total soil chemical concentration saturated in soil.

R is the ratio of the ground water flow velocity to the contaminant migration velocity in saturated zone

Retardation Factor, ***R*** :	1.2	unitless

contaminant migration velocity in saturated zone.

2. Summary of Calculation for each Exposure Pathway

Summary by Exposure Pathway

			Method B *Unrestricted Land Use* @ HQ=1.0; RISK =1.0E-6		*Method C* *Industrial Land Use* @ HQ=1.0; RISK =1.0E-5	
			Ingestion only	Ingestion & Dermal	Ingestion only	Ingestion & Dermal
Soil Direct Contact	Under the Current Condition	HQ? @ Exposure Point	3.028E-04	4.360E-04	6.921E-06	3.633E-05
		RISK? @ Exposure Point	4.360E-07	6.278E-07	3.322E-08	1.744E-07
	Target Soil CUL? mg/kg	@HQ=1.0	7.200E+02	5.000E+02	3.150E+04	6.000E+03
		@RISK =1.0E-6 or 1.0E-5	5.000E-01	3.472E-01	6.563E+01	1.250E+01

			Method B @ HQ=1.0; RISK =1.0E-6	*Method C* @ HQ=1.0; RISK =1.0E-5
Protection of Potable Ground Water	Under the Current Condition	Predicted Ground Water Conc? ug/l	4.061E+01	
		HQ? @ Exposure Point	5.640E-01	2.578E-01
		RISK? @ Exposure Point	1.857E-03	1.857E-03
	Target Ground Water CUL? ug/l		5.000E-02	
	Target Soil CUL? mg/kg		2.684E-04	

			Method B @ HQ=1.0; RISK =1.0E-6	*Method C* @ HQ=1.0; RISK =1.0E-5
Protection of Air Quality ***(for informational purpose only)***	Under the Current Condition	Predicted Air Conc? ug/m^3 @Exposure Point	2.248E+02	
		HQ? @ Exposure Point	5.404E+01	2.471E+01
		RISK? @ Exposure Point	5.396E-02	5.396E-02
	Target Air CUL? ug/m^3	@ HQ=1.0	4.160E+00	9.100E+00
		@ RISK=1.0E-6 or 1.0E-5	4.167E-03	4.167E-02
	Target Soil CUL? mg/kg	@ HQ=1.0	4.034E-03	8.824E-07
		@ RISK=1.0E-6 or 1.0E-5	4.040E-06	4.040E-05

NOTES: "CUL" = Cleanup Level; "Conc" = concentration; "HQ" = hazard quotient; "RISK" = carcinogenic risk.

CAUTION: The requirements and procedures for establishing soil cleanup levels that are protective of human health and the environment are specified in the MTCA Cleanup Regulation (see WAC 173-340-740, 173-340-745, 173-340-747 and 173-340-7490 through 173-340-7494). The use of this Workbook is not sufficient to establish soil cleanup levels under the regulation. Specifically, the soil cleanup levels derived using this Workbook do not account for the following:

- Concentrations based on applicable state and federal laws (see WAC 173-340-740(3)(b)(i) and 173-340-745(5)(b)(i));
- Soil residual saturation (see WAC 173-340-747(10));
- Ecological impacts (see WAC 173-340-7490 through 7494); and
- Total site risk (see WAC 173-340-740(5)(a) and 173-340-745(6)(a)).

Other exposure pathways may also need to be evaluated on a site-specific basis to establish soil cleanup levels.

CAUTION: The requirements and procedures for establishing air cleanup levels that are protective of human health and the environment are specified in the MTCA Cleanup Regulation (see WAC 173-340-750). The use of this Workbook may not be sufficient to establish air cleanup levels under the regulation. Specifically, the air cleanup levels derived using this Workbook do not account for the following:

- Concentrations based on applicable state and federal laws (see WAC 173-340-750(3)(b)(i) and (4)(b)(i));
- Concentrations based on natural background and the practical quantitation limit (see WAC 173-340-750(5)(c));
- Total site risk (see WAC 173-340-750(5)(a)).

Voluntary Cleanup Program

Washington State Department of Ecology
Toxics Cleanup Program

TERRESTRIAL ECOLOGICAL EVALUATION FORM

Under the Model Toxics Control Act (MTCA), a terrestrial ecological evaluation is necessary if hazardous substances are released into the soils at a Site. In the event of such a release, you must take one of the following three actions as part of your investigation and cleanup of the Site:

1. Document an exclusion from further evaluation using the criteria in WAC 173-340-7491.
2. Conduct a simplified evaluation as set forth in WAC 173-340-7492.
3. Conduct a site-specific evaluation as set forth in WAC 173-340-7493.

When requesting a written opinion under the Voluntary Cleanup Program (VCP), you must complete this form and submit it to the Department of Ecology (Ecology). The form documents the type and results of your evaluation.

Completion of this form is not sufficient to document your evaluation. You still need to document your analysis and the basis for your conclusion in your cleanup plan or report.

If you have questions about how to conduct a terrestrial ecological evaluation, please contact the Ecology site manager assigned to your Site. For additional guidance, please refer to www.ecy.wa.gov/programs/tcp/policies/terrestrial/TEEHome.htm.

Step 1: IDENTIFY HAZARDOUS WASTE SITE	
Please identify below the hazardous waste site for which you are documenting an evaluation.	
Facility/Site Name: Simplot Grower Solutions, Warden	
Facility/Site Address: 1800 West 1st Street, Warden, WA	
Facility/Site No: 2802409	VCP Project No.: Agreed Order 8421

Step 2: IDENTIFY EVALUATOR			
Please identify below the person who conducted the evaluation and their contact information.			
Name: Michael Murray		Title: Project Manager	
Organization: HDR Engineering			
Mailing address: 412 E Parkcenter Boulevard			
City: Boise	State: ID	Zip code: 83706	
Phone: 208 387-7033	Fax:	E-mail: mike.murray@hdrinc.com	

Step 3: DOCUMENT EVALUATION TYPE AND RESULTS

A. Exclusion from further evaluation.

1. Does the Site qualify for an exclusion from further evaluation?

☒ Yes *If you answered **"YES,"** then answer **Question 2**.*

☐ No or Unknown *If you answered **"NO" or "UKNOWN,"** then skip to **Step 3B** of this form.*

2. What is the basis for the exclusion? *Check all that apply. Then skip to **Step 4** of this form.*

Point of Compliance: WAC 173-340-7491(1)(a)

☐ All soil contamination is, or will be,* at least 15 feet below the surface.

☒ All soil contamination is, or will be,* at least 6 feet below the surface (or alternative depth if approved by Ecology), and institutional controls are used to manage remaining contamination.

Barriers to Exposure: WAC 173-340-7491(1)(b)

☐ All contaminated soil, is or will be,* covered by physical barriers (such as buildings or paved roads) that prevent exposure to plants and wildlife, and institutional controls are used to manage remaining contamination.

Undeveloped Land: WAC 173-340-7491(1)(c)

☐ There is less than 0.25 acres of contiguous[#] undeveloped[±] land on or within 500 feet of any area of the Site and any of the following chemicals is present: chlorinated dioxins or furans, PCB mixtures, DDT, DDE, DDD, aldrin, chlordane, dieldrin, endosulfan, endrin, heptachlor, heptachlor epoxide, benzene hexachloride, toxaphene, hexachlorobenzene, pentachlorophenol, or pentachlorobenzene.

☒ For sites not containing any of the chemicals mentioned above, there is less than 1.5 acres of contiguous[#] undeveloped[±] land on or within 500 feet of any area of the Site.

Background Concentrations: WAC 173-340-7491(1)(d)

☐ Concentrations of hazardous substances in soil do not exceed natural background levels as described in WAC 173-340-200 and 173-340-709.

* An exclusion based on future land use must have a completion date for future development that is acceptable to Ecology.

[±] "Undeveloped land" is land that is not covered by building, roads, paved areas, or other barriers that would prevent wildlife from feeding on plants, earthworms, insects, or other food in or on the soil.

[#] "Contiguous" undeveloped land is an area of undeveloped land that is not divided into smaller areas of highways, extensive paving, or similar structures that are likely to reduce the potential use of the overall area by wildlife.

B. Simplified evaluation.

1. Does the Site qualify for a simplified evaluation?

☐ Yes *If you answered **"YES,"** then answer **Question 2** below.*

☐ No or Unknown *If you answered **"NO"** or **"UNKNOWN,"** then skip to **Step 3C** of this form.*

2. Did you conduct a simplified evaluation?

☐ Yes *If you answered **"YES,"** then answer **Question 3** below.*

☐ No *If you answered **"NO,"** then skip to **Step 3C** of this form.*

3. Was further evaluation necessary?

☐ Yes *If you answered **"YES,"** then answer **Question 4** below.*

☐ No *If you answered **"NO,"** then answer **Question 5** below.*

4. If further evaluation was necessary, what did you do?

☐ Used the concentrations listed in Table 749-2 as cleanup levels. *If so, then skip to **Step 4** of this form.*

☐ Conducted a site-specific evaluation. *If so, then skip to **Step 3C** of this form.*

5. If no further evaluation was necessary, what was the reason? *Check all that apply. Then skip to **Step 4** of this form.*

Exposure Analysis: WAC 173-340-7492(2)(a)

☐ Area of soil contamination at the Site is not more than 350 square feet.

☐ Current or planned land use makes wildlife exposure unlikely. Used Table 749-1.

Pathway Analysis: WAC 173-340-7492(2)(b)

☐ No potential exposure pathways from soil contamination to ecological receptors.

Contaminant Analysis: WAC 173-340-7492(2)(c)

☐ No contaminant listed in Table 749-2 is, or will be, present in the upper 15 feet at concentrations that exceed the values listed in Table 749-2.

☐ No contaminant listed in Table 749-2 is, or will be, present in the upper 6 feet (or alternative depth if approved by Ecology) at concentrations that exceed the values listed in Table 749-2, and institutional controls are used to manage remaining contamination.

☐ No contaminant listed in Table 749-2 is, or will be, present in the upper 15 feet at concentrations likely to be toxic or have the potential to bioaccumulate as determined using Ecology-approved bioassays.

☐ No contaminant listed in Table 749-2 is, or will be, present in the upper 6 feet (or alternative depth if approved by Ecology) at concentrations likely to be toxic or have the potential to bioaccumulate as determined using Ecology-approved bioassays, and institutional controls are used to manage remaining contamination.

C. Site-specific evaluation. A site-specific evaluation process consists of two parts: (1) formulating the problem, and (2) selecting the methods for addressing the identified problem. Both steps require consultation with and approval by Ecology. *See* WAC 173-340-7493(1)(c).

1. Was there a problem? *See* WAC 173-340-7493(2).

☐ Yes *If you answered **"YES,"** then answer **Question 2** below.*

☐ No *If you answered **"NO,"** then identify the reason here and then skip to **Question 5** below:*

- ☐ No issues were identified during the problem formulation step.
- ☐ While issues were identified, those issues were addressed by the cleanup actions for protecting human health.

2. What did you do to resolve the problem? *See* WAC 173-340-7493(3).

☐ Used the concentrations listed in Table 749-3 as cleanup levels. *If so, then skip to **Question 5** below.*

☐ Used one or more of the methods listed in WAC 173-340-7493(3) to evaluate and address the identified problem. *If so, then answer **Questions 3 and 4** below.*

3. If you conducted further site-specific evaluations, what methods did you use?
Check all that apply. See WAC 173-340-7493(3).

- ☐ Literature surveys.
- ☐ Soil bioassays.
- ☐ Wildlife exposure model.
- ☐ Biomarkers.
- ☐ Site-specific field studies.
- ☐ Weight of evidence.
- ☐ Other methods approved by Ecology. If so, please specify:

4. What was the result of those evaluations?

- ☐ Confirmed there was no problem.
- ☐ Confirmed there was a problem and established site-specific cleanup levels.

5. Have you already obtained Ecology's approval of both your problem formulation and problem resolution steps?

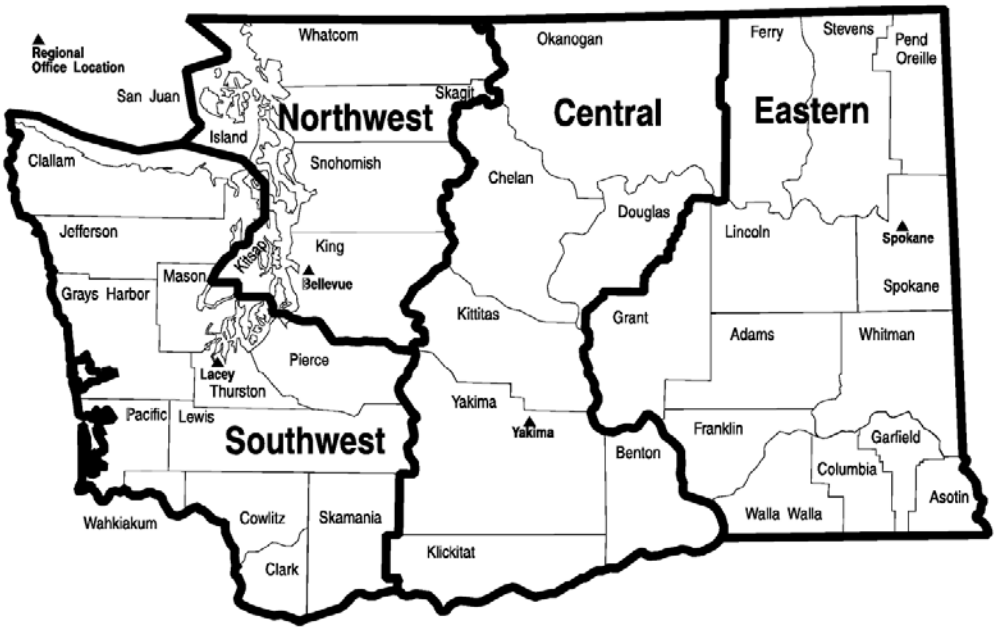
☐ Yes If so, please identify the Ecology staff who approved those steps:

☐ No

Step 4: SUBMITTAL

Please mail your completed form to the Ecology site manager assigned to your Site. If a site manager has not yet been assigned, please mail your completed form to the Ecology regional office for the County in which your Site is located.

Northwest Region: Attn: VCP Coordinator 3190 160th Ave. SE Bellevue, WA 98008-5452	**Central Region:** Attn: VCP Coordinator 1250 West Alder St. Union Gap, WA 98903-0009
Southwest Region: Attn: VCP Coordinator P.O. Box 47775 Olympia, WA 98504-7775	**Eastern Region:** Attn: VCP Coordinator N. 4601 Monroe Spokane WA 99205-1295



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Costs Summary

Alternative 2 - Estimated Costs for Institutional Controls and Monitored Natural Attenuation with Semi-Annual Well Testing

DESCRIPTION	QUANTITY		ESTIMATED COST PER YEAR										
			YEAR -	1	2	3	4	5	6	7	8	9	10	TOTAL
	NUMBER	UNIT	UNIT COST($)	TOTAL COST($)	TOTAL COST($)	TOTAL COST($)	TOTAL COST($)	TOTAL COST($)	TOTAL COST($)	TOTAL COST($)	TOTAL COST($)	TOTAL COST($)	TOTAL COST($)	
Project Management, Accounting, and Institutional Controls	1	YEAR	$4,200	$4,326	$4,456	$4,589	$4,727	$4,869	$5,015	$5,165	$5,320	$5,480	$5,644	**$49,593**
Semi-Annual Reporting	1	YEAR	$4,200	$4,326	$4,456	$4,589	$4,727	$4,869	$5,015	$5,165	$5,320	$5,480	$5,644	**$49,593**
Groundwater Sampling (twice per year)	1	YEAR	$22,000	$22,660	$23,340	$24,040	$24,761	$25,504	$26,269	$27,057	$27,869	$28,705	$29,566	**$259,772**
Annual Sampling of EDB in Soil	1	YEAR	$4,100	$4,223	$4,350	$4,480	$4,615	$4,753	$4,896	$5,042	$5,194	$5,350	$5,510	**$48,412**
Semi-Annual Testing for EDB in Groundwater	1	YEAR	$2,800	$2,884	$2,971	$3,060	$3,151	$3,246	$3,343	$3,444	$3,547	$3,653	$3,763	**$33,062**
OMM of Wells (New wells MW-11S, MW-12S and assumed replacement of 2 wells over 10 years)		LS		$10,400	$206	$212	$5,219	$225	$232	$239	$5,446	$253	$261	**$22,693**
TOTAL				$44,493	$35,322	$36,381	$42,473	$38,597	$39,755	$40,948	$47,376	$43,441	$44,745	**$413,531**
3% inflation										**General Contingency (% of total direct and indirect)**				15%
										TOTAL ESTIMATED COST				**$475,560**

Alternative 3a - Soil Borings, Institutional Controls, Soil Excavation including soil/groundwater Interface, Treatment (Ex-Situ SVE), and Return (or use elsewhere), and Monitored Natural Attenuation of Groundwater

DESCRIPTION	QUANTITY		ESTIMATED COST	
	NUMBER	UNIT	UNIT COST($)	TOTAL COST($)
DIRECT CAPITAL COST				
Reporting and Natural Attenuation Monitoring (Alternative 2) Total Cost				
Workplan for Soil Borings, Soil Excavation and Well Installation	1	LS	$4,200	$4,200
Monitored Natural Attenuation (assume 5 years), same as Alt 2 for 1st 5 yrs. No soil sampling	1	5 YEAR	$148,854	$148,854
SUBTOTAL - REPORTING				**$153,054**
Soil Borings, Well Installation, and Abandonment				
Drill and Sample up to 6 soil borings, sample for EDB	1	LS	$7,300	$7,300
Abandon 2 Monitoring Wells (cost of MW-11S, MW-12S covered above)	1	LS	$3,000	$3,000
Reporting	1	LS	$4,200	$4,200
SUBTOTAL - MONITORING WELLS				**$14,500**
Excavation, Stockpiling, Sampling				
Surveying (pre-, during, and post-)	4	DAY	$1,400	$5,600
Equipment mobilization/demobilization	2	LS	$2,200	$4,400
Excavate and stockpile clean soil (12,000 cubic yards)	10	DAY	$2,800	$28,000
Excavate and stockpile EDB-impacted soil (1,180 cubic yards)	12	DAY	$2,800	$33,600
Confirmation sampling of pit (laboratory costs)	32	EA	$100	$3,200
Backfill excavation with clean soil and compact	5	DAY	$2,500	$12,500
Additional backfill for excavation	1,000	Cu Yd	$25	$25,000
SUBTOTAL - EXCAVATION/STOCKPILING/Treatment				**$112,300**
Soil Treatment (stockpiled EDB impacted soil and Ex-situ SVE on-site)				
Sampling of stockpile prior to SVE setup (laboratory)	12	EA	$100	$1,200
Work Plan for Ex-Situ SVE and Air Permitting	1	LS	$5,200	$5,200
SVE piping, blower (rental, 4 Mo), activated carbon (rental, vender), power (220V)	1	LS	$28,000	$28,000
Construction of Ex-situ treatment pad and SVE setup (run in 2 phases)	6	Day	$2,200	$13,200
Ex-Situ SVE over 4 month period on-site, system checks, and sampling	16	Week	$2,100	$33,600
SUBTOTAL - Soil Treatment				**$81,200**
TOTAL - DIRECT CAPITAL COSTS				**$361,054**
INDIRECT CAPITAL COST				
Construction Management and Environmental Oversight	1	LS	$30,000	$30,000
Contractor's General Requirements (assume Simplot personnel)	1	YEAR	$10,000	$10,000
SUBTOTAL -INDIRECT CAPITAL COSTS				**$40,000**
SUBTOTAL - CAPITAL COST (DIRECT AND INDIRECT)				**$401,054**
General Contingency (% of total direct and indirect)				15%
TOTAL ESTIMATED CAPITAL COST				**$461,212**

Alternative 3b - Soil Borings, Institutional Controls, Soil Excavation including soil/groundwater Interface, Landfill of excavated soils, and Monitored Natural Attenuation of Groundwater

DESCRIPTION	QUANTITY		ESTIMATED COST	
	NUMBER	UNIT	UNIT COST($)	TOTAL COST($)
DIRECT CAPITAL COST				
Reporting and Natural Attenuation Monitoring (Alternative 2) Total Cost				
Workplan for Soil Borings, Soil Excavation and Well Installation	1	LS	$4,200	$4,200
Monitored Natural Attenuation (assume 5 years), same as Alt 2 for 1st 5 yrs. No soil sampling	1	5 YEAR	$197,266	$148,854.23
SUBTOTAL - REPORTING				**$153,054**
Soil Borings, Well Installation, and Abandonment				
Drill and Sample up to 6 soil borings, sample for EDB	1	LS	$7,300	$7,300
Abandon 2 Monitoring Wells (cost of MW-11S, MW-12S covered above)	1	LS	$3,000	$3,000
Reporting	1	LS	$4,200	$4,200
SUBTOTAL - MONITORING WELLS				**$14,500**
Excavation, Stockpiling, Sampling				
Surveying (pre-, during, and post-)	4	DAY	$1,400	$5,600
Equipment mobilization/demobilization	2	LS	$2,200	$4,400
Excavate and stockpile clean soil (12,000 cubic yards)	10	DAY	$2,800	$28,000
Excavate and stockpile EDB-impacted soil (1,180 cubic yards)	12	DAY	$2,800	$33,600
Confirmation sampling of pit (laboratory costs)	32	EA	$100	$3,200
Backfill excavation with clean soil and compact	5	DAY	$2,500	$12,500
Additional backfill for excavation	1,000	Cu Yd	$25	$25,000
SUBTOTAL - EXCAVATION/STOCKPILING/Treatment				**$112,300**
Soil loading to trucks, transportation, and disposal at landfill (Greater Wenatchee)				
Sampling of stockpile and profile for landfill	12	EA	$100	$1,200
Work Plan for soil excavation and landfilling	1	LS	$5,200	$5,200
Loading to trucks (1180 yd3 or 1,770 tons), 60 loads, 10 days	10	LS	$2,200	$22,000
Landfill Fee (if used for daily cover)	1,770	Ton	$30	$53,330
Transportation (Dump truck and pup transportation)	1,770	Ton	$36	$63,720
Fees, reuse tax	1,770	Ton	$3	$5,310
Ex-Situ SVE over 4 month period on-site, system checks, and sampling	16	Week	$2,100	$33,600
SUBTOTAL - Soil Landfill				**$184,360**
TOTAL - DIRECT CAPITAL COSTS				**$464,214**
INDIRECT CAPITAL COST				
Construction Management and Environmental Oversight	1	LS	$30,000	$30,000
Contractor's General Requirements (assume Simplot personnel)	1	YEAR	$10,000	$10,000
SUBTOTAL -INDIRECT CAPITAL COSTS				**$40,000**
SUBTOTAL - CAPITAL COST (DIRECT AND INDIRECT)				**$504,214**
General Contingency (% of total direct and indirect)				15%
TOTAL ESTIMATED CAPITAL COST				**$579,846**