UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 8
1595 Wynkoop Street
DENVER, CO 80202-1129
Phone 800-227-8917
http://www.epa.gov/region08

STATEMENT OF BASIS
FOR
UNDERGROUND INJECTION CONTROL
CLASS V DRAFT PERMIT
PERMT NUMBER: CO52209-08412

Powertech (USA) Incorporated
5575 DTC Parkway, Suite 140
Greenwood Village, Colorado 80111

CONTACT: Valois Shea
U. S. Environmental Protection Agency
Region 8, 8P-W-GW
1595 Wynkoop Street
Denver, Colorado 80202-1129

Telephone: 1-800-227-8917 x 312-6276

I. INTRODUCTION AND BACKGROUND

On April 30, 2009, the Environmental Protection Agency Region 8 received an application for a Class V Underground Injection Control permit submitted by Powertech (USA) Incorporated (Powertech). Powertech proposes to reinject groundwater pumped from the upper portion of the Fox Hills Formation during an aquifer-pump test back into the same aquifer, using the pumping well that pumped the groundwater to the surface. The EPA is issuing a Draft Permit to authorize the injection of groundwater back into the aquifer from which it was pumped. The permit limits the injectate to groundwater pumped to the surface during any aquifer-pump test conducted using the well designated at IN08-33-PW1 as the pumping well and any minor volume of fluids approved by the Director that may need to be added to the stored groundwater for the purposes of corrective action so the injectate will meet permit limits. More than one aquifer-pump test may be conducted. While Powertech has only one aquifer-pump test currently planned, the permit specifies they must meet the requirements and obtain an Authorization to Commence Injection prior to the reinjection of groundwater after any subsequent pump tests performed by Powertech for the duration of the permit. The pump test and injection site is located in NE quarter of Section 33 in Township 10 North and Range 67 West, as shown in Figure 1. This location is 17 miles northeast of Fort Collins, 25 miles northwest of Greeley, 8 miles northwest of Nunn and 8 miles northeast of Wellington.

Powertech will be conducting an aquifer-pump test to meet the following objectives:

- Site specific and regional characterization of geology and groundwater.
- Assessment of hydrological characteristics and their lateral continuity within the A2 sandstone, the formation within the Fox Hills Formation containing uranium mineralization.
- Evaluation of hydrologic communication within the A2 sandstone between the pumping well and surrounding observation wells.
- Assessment of the presence of hydrologic boundaries, if any, within the A2 sandstone.
- Evaluation of integrity of the confinement zones above and below the A2 sandstone to determine the degree of hydrologic communication, if any, between the A2 sandstone and the overlying and underlying aquifers in the test area.

The EPA, Region 8, previously issued a Final Permit for this action on December 3, 2010. The Final Permit was appealed by two parties. The EPA Region 8 withdrew the Final Permit in its entirety pursuant to the process at 40 C.F.R. § 124.19(d). This Draft Permit is issued in accordance with the process at 40 C.F.R. § 124.6.

II. DESCRIPTION OF HYDROGEOLOGY

The proposed injection well is completed in the A2 sandstone of the Upper Fox Hills Formation and penetrates the overlying Laramie Formation shown in Figure 2. The Upper Fox Hills aquifer includes the "A" Sands and the "WE" Sand aquifers. The "A" Sands are divided into as many as four (4) individual sandstone units throughout the Centennial Site. In some areas the four individual sandstone units are separated from each other by shale/siltstone intervals; in some areas two or more of the sandstone units join, as demonstrated by the A3/4 sandstone unit shown in Figure 2. The injection well is screened only in the A2 sandstone unit of the "A" Sands, and

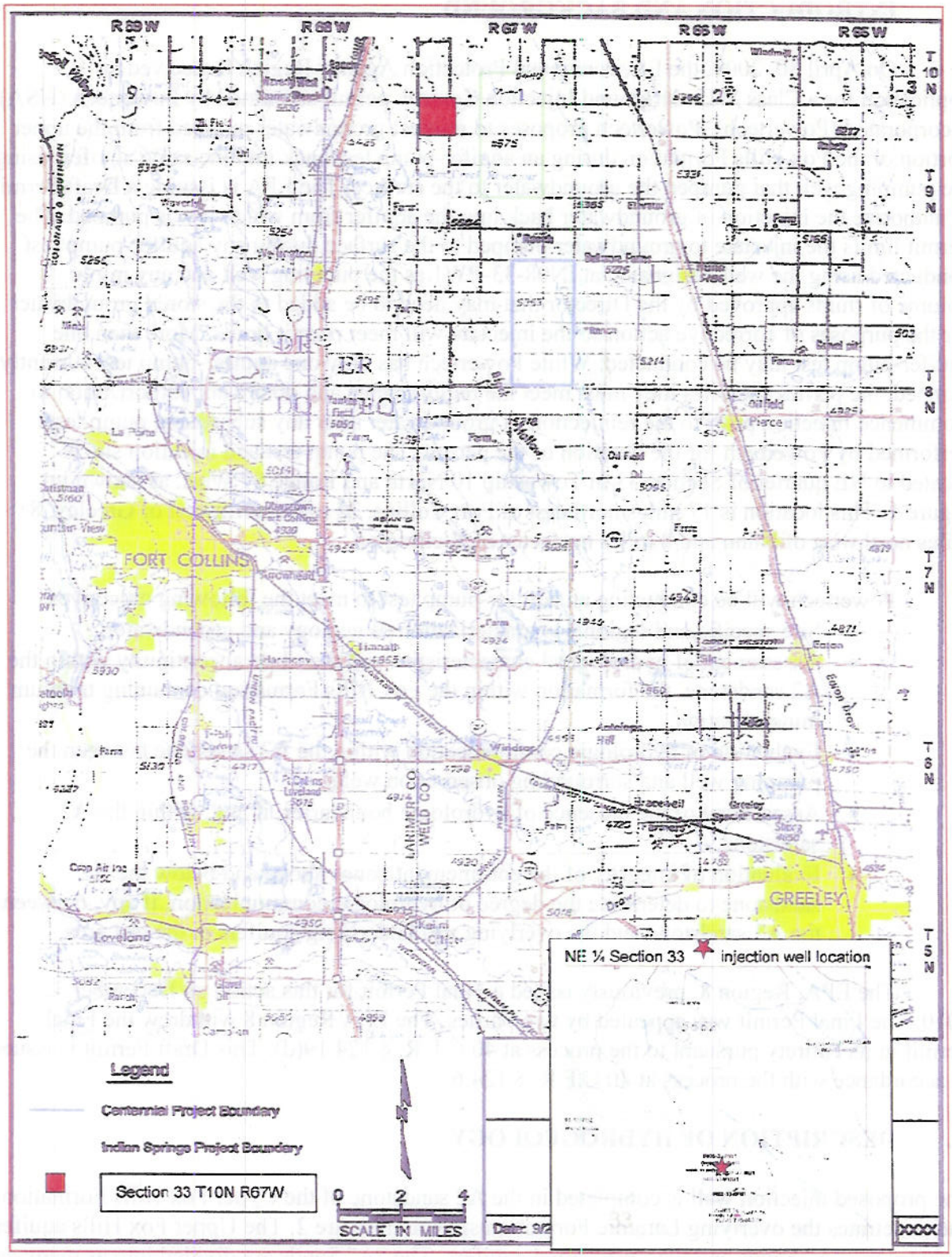


Figure 1. Location of Pump Test/Injection Well, IN08-33-PW1

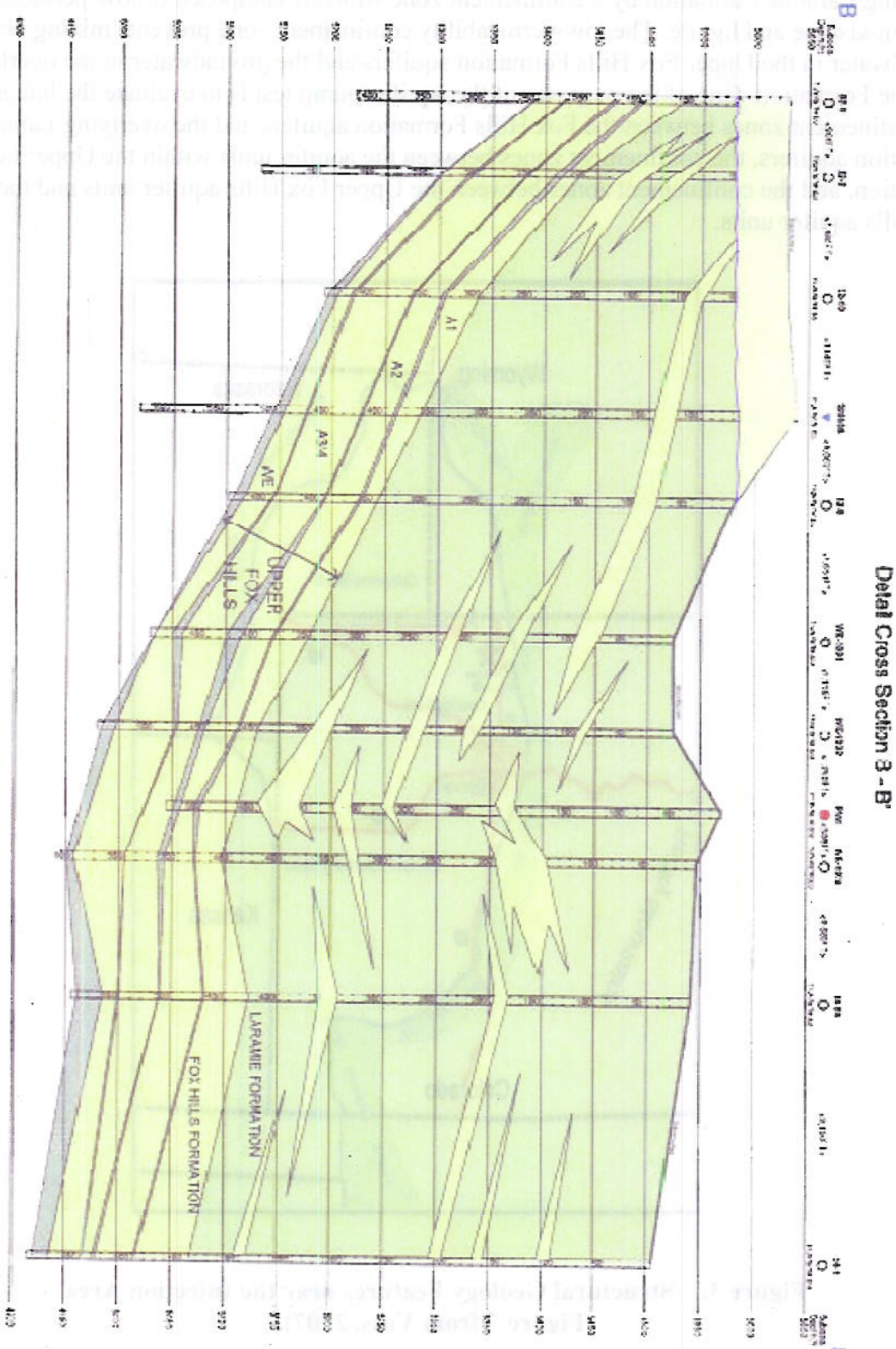


Figure 2. Stratigraphic Cross Section Showing the Laramie and Fox Hills Formations

will, therefore, be pumping water from, and injecting water into, the A2 sandstone unit. Groundwater in the Upper Fox Hills Formation aquifers is separated from groundwater in the overlying Laramie Formation by a confinement zone which is composed of low-permeability shale, mudstone and lignite. The low-permeability confinement zone prevents mixing between groundwater in the Upper Fox Hills Formation aquifers and the groundwater in the overlying Laramie Formation. One of the purposes of the aquifer-pump test is to evaluate the integrity of the confinement zones between the Fox Hills Formation aquifers and the overlying Laramie Formation aquifers, the confinement zones between the aquifer units within the Upper Fox Hills Formation, and the confinement zones between the Upper Fox Hills aquifer units and the Lower Fox Hills aquifer units.

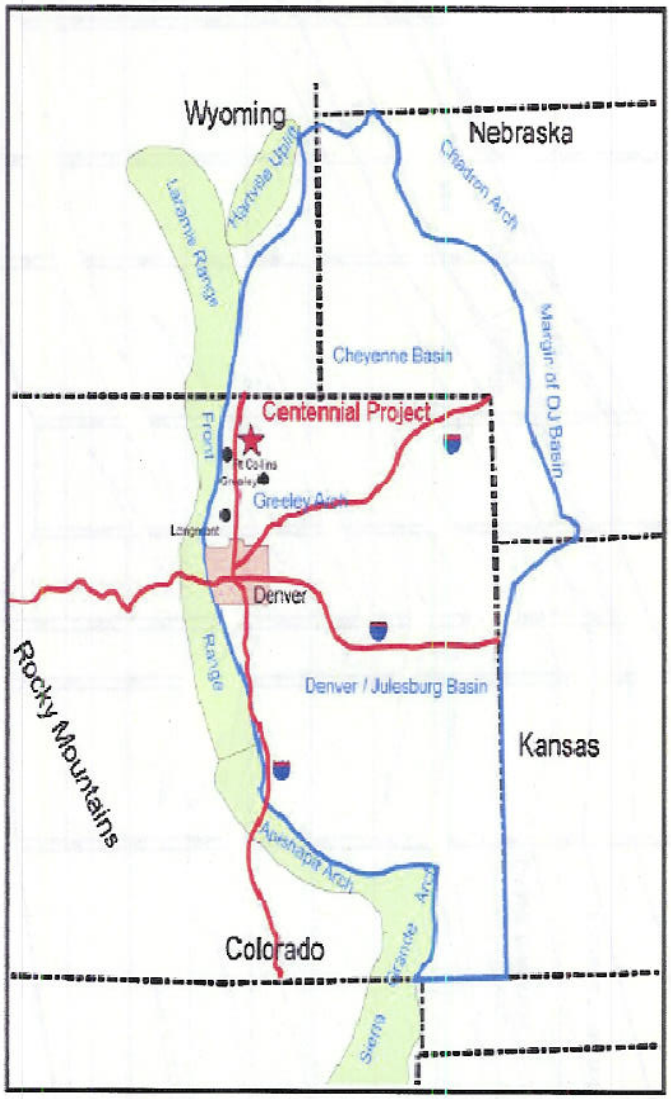


Figure 3. Structural Geology Features near the Injection Area (Figure 7 from Voss, 2007).

The injection well site is located within the Cheyenne Basin, located north of Denver-Julesburg Basin as shown in Figure 3. The Cheyenne Basin is separated from the Denver-Julesburg Basin by the Greeley Arch. The injection well location is on the western flank of the Cheyenne Basin where regional dip of the geologic strata is toward the east. Locally, within Section 33, the site of the aquifer-pump test, the flow of groundwater within the A2 sandstone is toward the south.

III. GROUNDWATER USE WITHIN ONE-HALF MILE OF INJECTION WELL

The current use of groundwater within a one-half mile radius of the injection well consists of livestock watering. There are two (2) livestock-watering wells located approximately one-quarter mile away from the injection wells. These wells are completed within the proposed injection zone, and are located either up-gradient or cross-gradient of the injection well, relative to groundwater flow within the Upper Fox Hills Formation.

The nearest domestic well completed in the Fox Hills Formation is located approximately 1 mile west of (up-gradient from) the injection well. Figure 4a shows the location of the domestic well, labeled by its permit number, 229556, and the proposed injection well, labeled PW1. The green line labeled B-B' in Figure 4a is the trend of the geologic cross section shown in Figure 2. Figure 4b is an enlarged portion of the Figure 2 geologic cross section. The driller's log for the domestic well has been superimposed on the cross section shown in Figure 4b. Based on the driller's log, the domestic well appears to be completed in the A3/4 sandstone and the B sandstone of the Fox Hills Formation. These two aquifers are located deeper than the A2 sandstone injection zone as shown in Figure 4b.

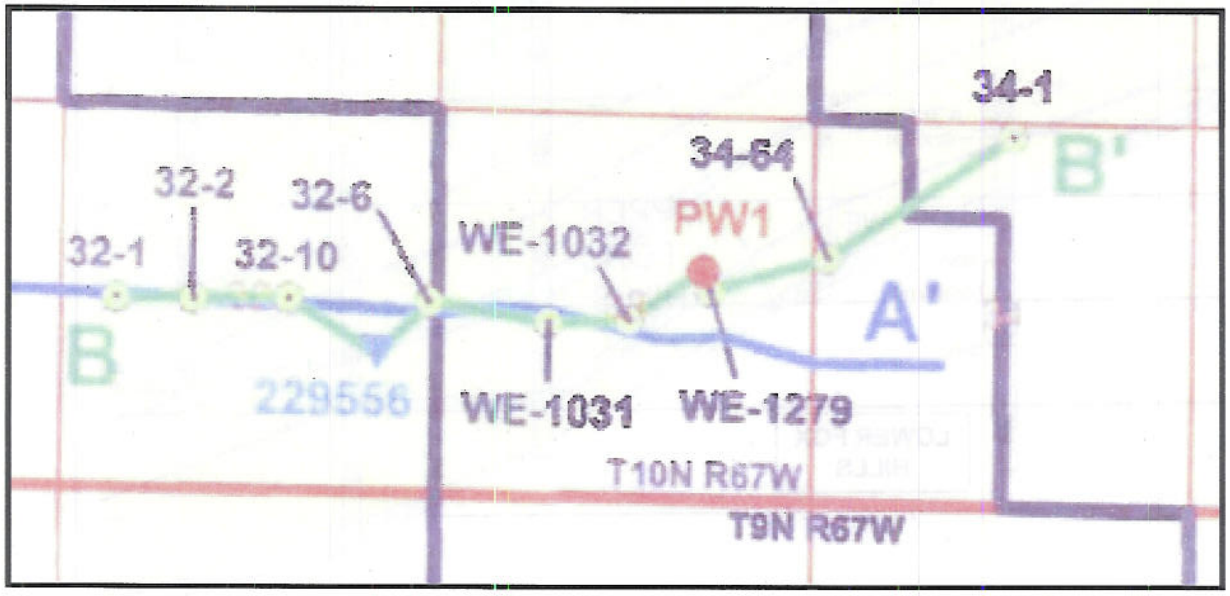


Figure 4a. Trend of cross-section shown in Figure 2 across Sections 32 and 33, Township 10 North, Range 67 West.

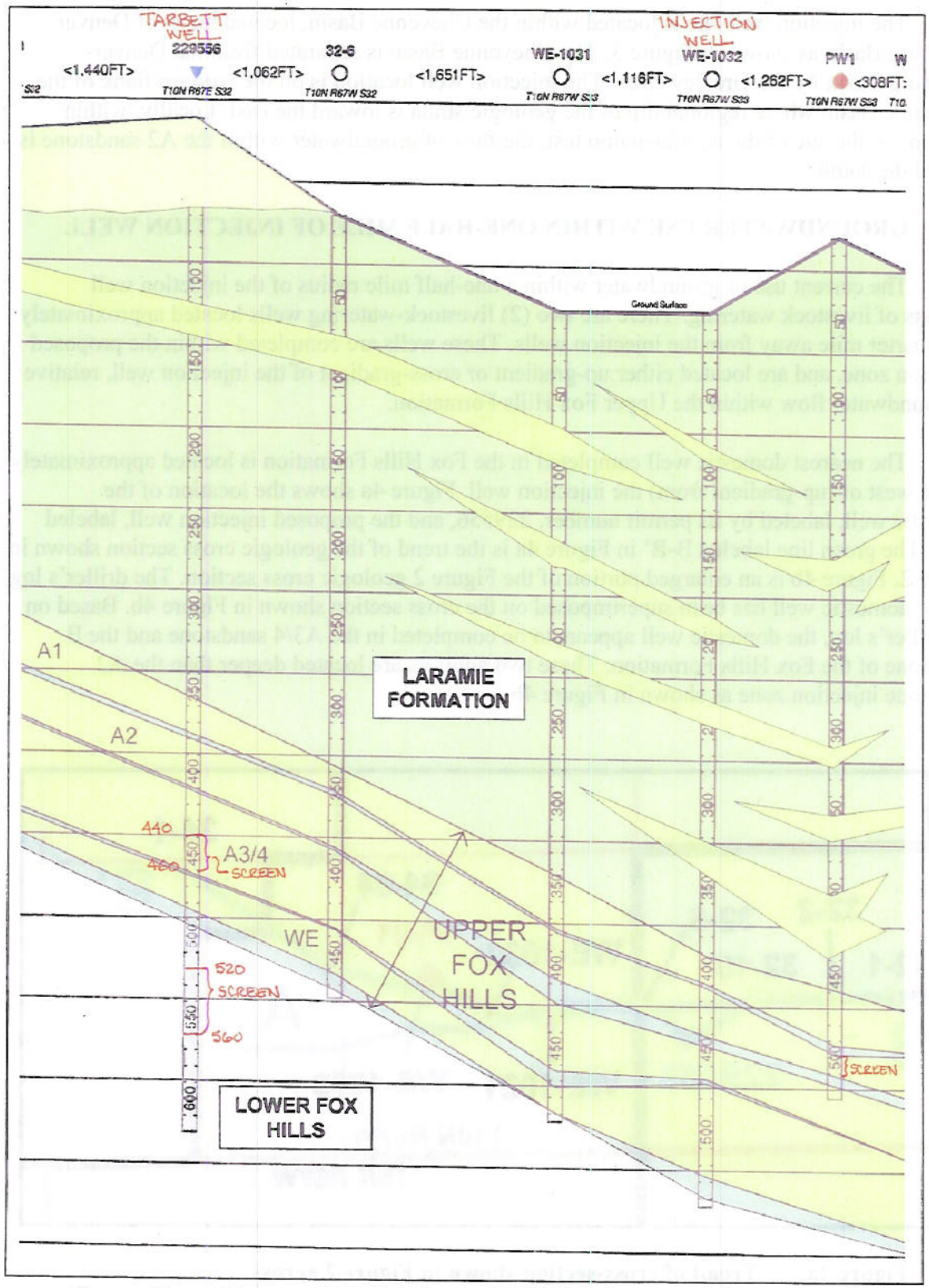


Figure 4b. Cross section showing well 229556, the nearest domestic well to the proposed injection well.

IV. TYPE AND QUANTITY OF INJECTED FLUIDS

The fluid to be injected will consist of groundwater pumped from the A2 sandstone unit of the Upper Fox Hills Formation "A" Sands. Powertech estimates that approximately 43,200 gallons of groundwater will be produced during the proposed pump test. This volume was calculated from the anticipated pumping rate of 10 gallons per minute for an expected duration of 72 hours. The well development report for the proposed pumping/injection well provides a record of pumping rate, duration at each pumping rate, and the extent of drawdown of the water level in the pumping well. This information supports the estimate that the pumping well will be able to sustain a pumping rate of 10 gallons per minute for 72 hours. The well development report is included in Appendix A of this document.

The permit limits the injectate to groundwater produced during aquifer-pump testing from the well designated as IN08-33-PW1 and any minor volume of fluids approved by the Director that may need to be added to the stored groundwater for the purposes of corrective action so the injectate will meet permit limits. The permit does not place a limit on the volume of injectate that may be injected, but the volume is limited to the amount of groundwater pumped to the surface during the aquifer pump test, plus any minor volume of additional fluids that may need to be added to the stored groundwater for the purposes of corrective action. If additional aquifer-pump tests are conducted, the volume of groundwater pumped to the surface will be approximately the same as anticipated for the proposed first pump test. The requirement to obtain an Authorization to Commence Injection from the UIC Director before each injection event provides the Director the opportunity to evaluate the parameters of each proposed injection event, including the volume of injectate, to ensure injection activity will not endanger USDWs. The Colorado State Engineer's regulations place a limit on the cumulative number of hours that aquifer pump testing can be conducted on a monitoring or observation well, which results in a volume limit on groundwater pumped to the surface. Therefore, a permit requirement placing a volume limit on the injectate would not result in additional protection to USDWs.

The groundwater pumped to the surface during the aquifer-pump test will be stored in enclosed steel tanks. The groundwater produced from the A2 sandstone unit contains concentrations of uranium and radium above the primary drinking water standards, also called the Maximum Contaminant Limits or MCLs. The A2 sandstone groundwater also contains concentrations of iron above the Region 8 permit limit. The Laramie Formation groundwater does not contain uranium and radium above the MCLs or iron above the Region 8 permit limit. Water quality information for groundwater sampled in both formations is presented in Table 1.

V. AQUIFER-PUMP TEST AND RESULTS

Powertech will be conducting an aquifer-pump test to meet the following objectives:

- Site specific and regional characterization of geology and groundwater.
- Assessment of hydrological characteristics and their lateral continuity within the A2 sandstone, the formation within the Fox Hills Formation containing uranium mineralization.
- Evaluation of hydrologic communication within the A2 sandstone between the pumping well and surrounding observation wells.

Table 1. Comparison of Ground Water Quality in the Laramie Formation Aquifer and the A2 Sandstone of the Upper Fox Hills Formation based on Total Metals Analyses.

Parameter Name	Concentration in Laramie (µg/L)	Concentration in Fox Hills A2 (µg/L)	Regulatory Limit (µg/L)	Standard Type*
Antimony	1	66	6	MCL
Arsenic	3	ND	10	MCL
Barium	ND	ND	2,000	MCL
Beryllium	ND	ND	4	MCL
Boron	200	100	1,400	HA-Lifetime
Cadmium	ND	ND	5	MCL
Chromium(total)	ND	ND	100	MCL
Copper	10	20	1,300	MCL-TT
Iron	250	13,000	5,000	Region 8 Permit Limit
Lead	ND	ND	15	MCL-TT
Manganese	150	220	800	Region 8 Permit Limit
Mercury (inorganic)	ND	ND	2	MCL
Molybdenum	ND	ND	40	HA-Lifetime
Nickel	ND	ND	100	HA-Lifetime
Selenium	ND	2	50	MCL
Silver	ND	ND	100	HA-Lifetime
Strontium	2,900	1,500	4,000	HA-Lifetime
Thallium	ND	ND	2	MCL
Uranium	11.2	250	30	MCL
Zinc	80	30	2,000	HA-Lifetime

= concentrations above permit limits

* Explanation of Standard Type

HA: Health Advisory. An estimate of acceptable drinking water levels for a chemical substance based on health effects information; a Health Advisory is not a legally enforceable Federal standard, but serves as technical guidance to assist federal, state, and local officials.
HA-Lifetime: The concentration of a chemical in drinking water that is not expected to cause any adverse, noncarcinogenic effects for a lifetime of exposure. The Lifetime HA is based on exposure of a 70-kg adult consuming 2-liters of water per day. The Lifetime HA for Group C carcinogens includes an adjustment for possible carcinogenicity.
MCL: Maximum Contaminant Level. The highest level of a contaminant allowed in drinking water. MCLs are set as close to the MCLG as feasible using the best available analytical and treatment technologies and taking cost into consideration. MCLs are enforceable standards.
MCL-TT: Treatment Technique. A required process intended to reduce the level of a contaminant in drinking water.
Region 8 Permit Limit: Permit limit calculated by Region 8 Drinking Water Toxicologist based on human-health criteria.

- Assessment of the presence of hydrologic boundaries, if any, within the A2 sandstone.
- Evaluation of integrity of the confinement zones above and below the A2 sandstone to determine the degree of hydrologic communication, if any, between the A2 sandstone and the overlying and underlying aquifers in the test area.

The aquifer-pump test will include the measurement of water levels in observation wells completed in the same aquifer as the aquifer-pump test well, the A2 sandstone. The test will also include the measurement of water levels in observation wells completed in aquifers above and below the aquifer being pumped. As groundwater is withdrawn from the test well being pumped, there will be a decrease in the water level of the A2 sandstone in the area surrounding this well known as the cone of depression. As pumping continues, the cone of depression moves laterally away from the pumping well. As the cone of depression reaches each A2 sandstone observation

well, the water level in each of the observation wells will begin to show a decrease in elevation, called "drawdown." The amount of drawdown measured in each well is plotted on a graph with amount of drawdown shown along the vertical axis and time shown along the horizontal axis. When both the axes for drawdown and time have a logarithmic scale, this curve has a characteristic shape if the aquifer being pumped is fully confined. Any breaches in the confinement zones will manifest themselves in one or both of two ways:

1) as a deviation in the drawdown curve based on measured water levels in observation wells completed in the pumped aquifer and located at some distance from the pumping well, and/or
2) as a change in water level in observation wells completed in aquifers above or below the aquifer being pumped.

If the aquifer is fully confined, the drawdown curves in the observations wells completed in the aquifer being pumped plot as a curve of the characteristic shape of the Theis curve shown in Figure 5a[1] . Figure 5b[2] is an example of how the plot of the drawdown curve should look for a fully confined aquifer.

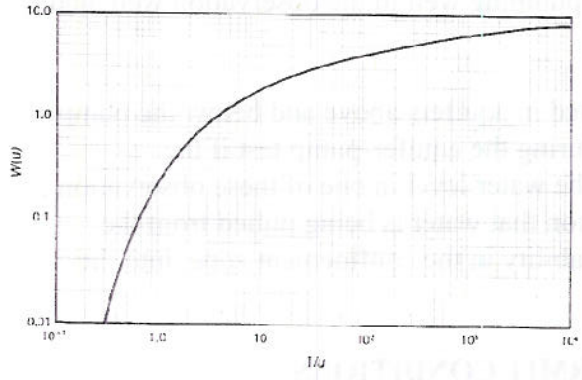


Figure 5a. Theis curve for fully confined aquifers.

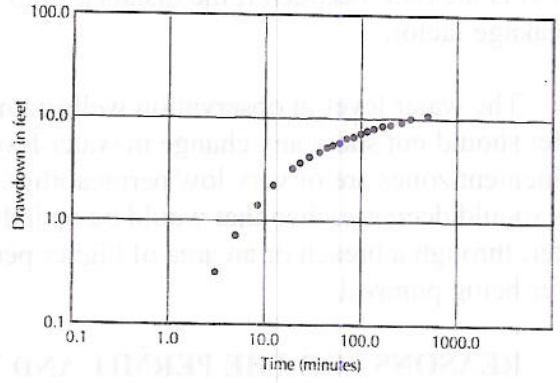


Figure 5b. Field data from observation well during an aquifer-pump test.

If groundwater were to be pulled across a confinement zone into the pumped aquifer from an aquifer above or below the pumped aquifer through a breach in a confinement zone, the drawdown curve will deviate from the expected shape. Figure 6[3] shows a series of drawdown curves from aquifers with "leaky" confinement zones.

---

[1] From Fetter, C.W. 1994. *Applied Hydrology.* Upper Saddle River, New Jersey: Prentice-Hall, p. 220.
[2] *Ibid.*, p. 221.
[3] From Walton, W.C. 1962, *Selected Analytical Methods for Well and Aquifer Evaluation.* Illinois State Water Survey Bulletin 49, p.81

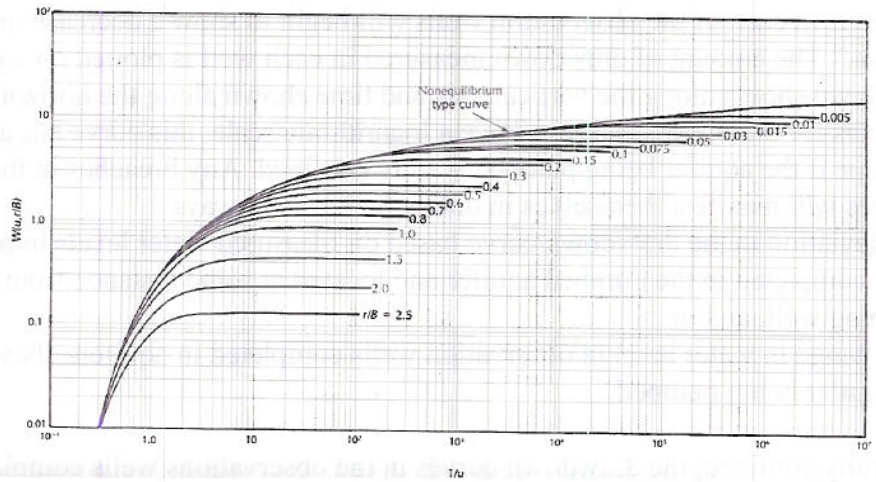


Figure 6. Type curves for aquifers with leaky confining zones.

The r/B is the ratio between r, the distance from the pumping well to the observation well, and B, the leakage factor.

The water level in observation wells completed in aquifers above and below the pumped aquifer should not show any change in water level during the aquifer-pump test if the confinement zones are of very low permeability. If the water level in one of these observation wells should decrease, then that would be an indication that water is being pulled from the aquifer, through a breach or an area of higher permeability in the confinement zone, into the aquifer being pumped.

VI. REASONS FOR THE PERMIT AND PERMIT CONDITIONS

The UIC Program, created under the authority of the Safe Drinking Water Act, is a preventive program tasked with protecting underground sources of drinking water (USDWs) from endangerment during underground injection activities. The UIC program protects USDWs by regulating the discharge of fluids into the subsurface through injection wells. A Class V injection well is any well that does not fall under Classes I, II, III, IV, or VI. It can include discharges of some types of fluids into or above a USDW. Class V wells injecting fluids containing constituents with National Primary Drinking Water Standards or Health Advisories may have the potential to contaminate or degrade groundwater, and are usually required to operate under a permit.

In this case, the permit is written to protect USDWs in two formations: the Laramie and the Fox Hills. The groundwater being pumped from, and reinjected into, the A2 sandstone has higher concentrations of some contaminants regulated under the SDWA than the Laramie Formation. Because the injection well will penetrate the Laramie Formation, the EPA has included requirements to protect groundwater in the Laramie Formation, as well as the Fox Hills Formation, from contamination resulting from the proposed injection activities. The permit requirements are discussed below.

1. Injection Well Construction Design

The proposed injection well is an existing well constructed with the purpose of serving as the pumping well for an aquifer-pump test. The well will then serve temporarily as an injection well as the groundwater pumped to the surface during the aquifer-pump test is returned to the aquifer from which it was originally pumped. The permit requires that the well construction design prevents movement of injectate into the overlying Laramie Formation. The EPA has evaluated the construction design of the injection well and has determined that the design is protective of the Laramie Formation groundwater. The injection well is completed at a depth of 526 feet and has been constructed according to the specifications shown in Figure 7. The cement between the well casing and the borehole wall extends from just above the injection zone to the ground surface. The presence of cement isolates the intersected aquifers from having connection with one another and will, therefore, prevent the movement of fluids along the injection well. The cement will also isolate the injection zone to the A2 sandstone from the overlying aquifers.

2. Demonstration of Mechanical Integrity.

The permit requires the permittee to demonstrate mechanical integrity (MI) prior to injection. According to UIC regulations found at 40 CFR 146.8(a), an injection well has mechanical integrity if:

1) There is no significant leak in the casing, tubing, or packer; and
2) There is no significant fluid movement into an underground source of drinking water through vertical channels adjacent to the injection well bore.

Accordingly, the permit requires that the permittee demonstrate internal MI by conducting a pressure test with liquid or gas and external MI by submitting information about cementing to the EPA.

UIC regulations found at 40 CFR 146.8(b)(2) indicate that a pressure test with liquid or gas is adequate for determining if there is a significant leak in the casing. Powertech conducted a pressure test on the well casing to detect any leaks in the casing and submitted the results of the test to the EPA for review. The EPA determined that the results of the pressure test met the requirements of 40 CFR 146.8(a)(1) and 40 CFR 146.8(b)(2).

To demonstrate no significant fluid movement through vertical channels adjacent to the injection well bore, the regulations found at 40 CFR 146.8(c)(1) require a temperature or noise log. However, in situations where the nature of the well casing precludes the use of the prescribed logging techniques, UIC regulations found at 40 CFR 146.8(c)(3) indicate that cementing records demonstrating the presence of adequate cement to prevent such migration are sufficient for demonstrating there are no significant fluid movement through vertical channels adjacent to the injection well bore. UIC regulations found at 40 CFR 147.305 indicate that adequate cement isolates all USDWs by:

1) placing the cement between the outermost casing and the well bore [147.305(d)(1)(iii)];

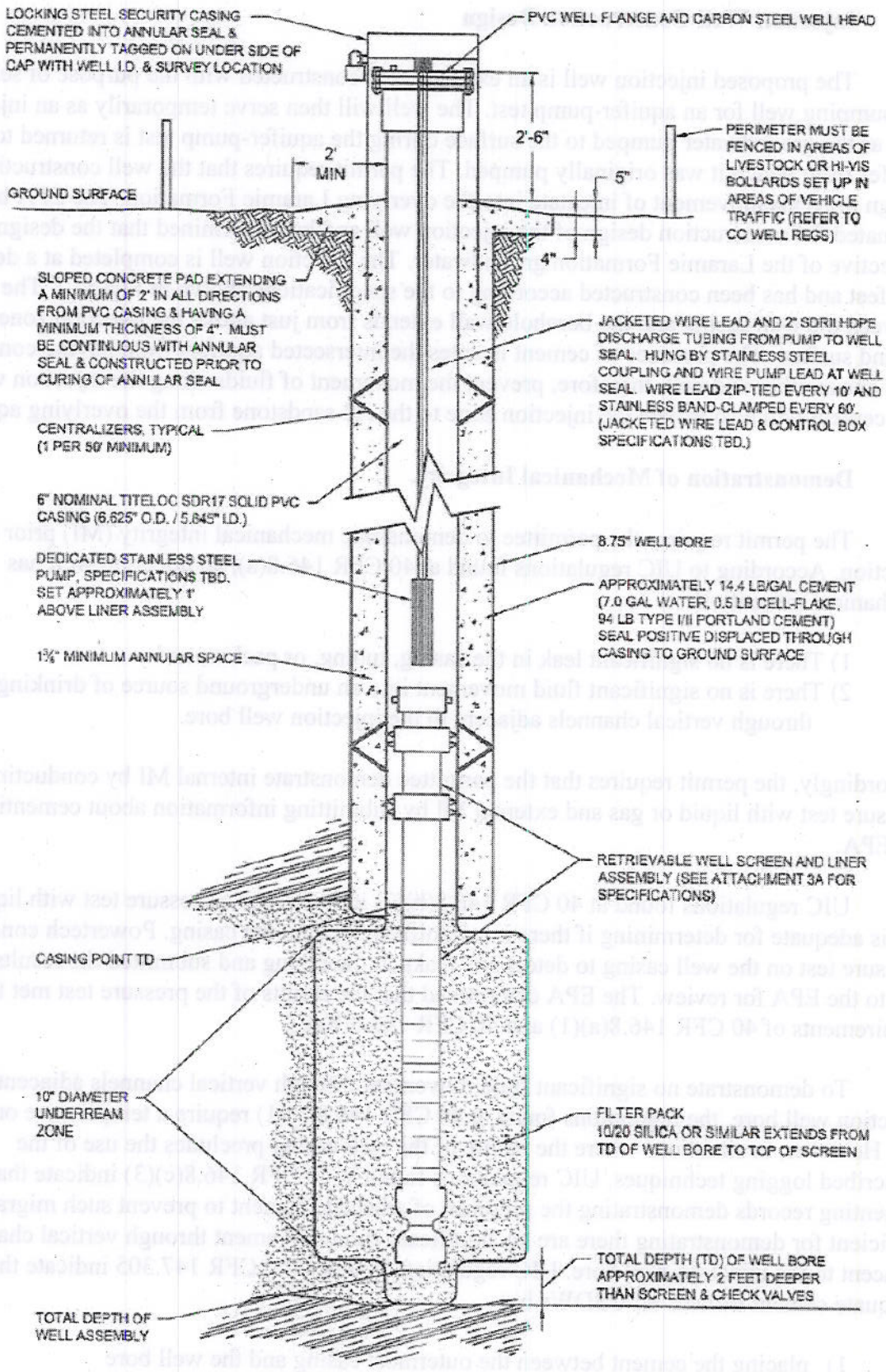


Figure 7. Injection Well Construction Design

2) placing sufficient cement to fill the calculated space between the casing and the well bore to a point 250 feet above the injection zone [147.305(d)(2)]; and

3) using cement [147.305(d)(3)]:
   (i) Of sufficient quantity and quality to withstand the maximum operating pressure;
   (ii) Which is resistant to deterioration from formation and injection fluids; and
   (iii) In a quantity no less than 120% of the calculated volume necessary to cement off a zone.

In the case of this proposed injection well, in order to seal off the injection zone, the calculated volume the cement needs to fill is the empty space between the outermost well casing and the well bore above the injection zone to the ground surface. This area is called the well annulus.

Powertech submitted the well completion report (see Appendix B) containing cementing information. This construction report shows that cement was placed from the ground surface down to A2 sandstone, fulfilling the requirements of 147.305(d)(1)(iii) and 147.305(d)(2). Although the well completion report indicates that the volume of cement used to fill the well annulus was 15% in excess of the calculated annulus volume, the EPA compared the 829 gallons of cement used with the calculated volume of the well annulus (675.94 gallons) and calculated 123% cement volume was used to cement the well casing above the injection zone to the ground surface, fulfilling 147.305(d)(3)(iii).

The type of cement used was Portland type I/II with additives as shown in Table 2. This cement composition is resistant to deterioration from formation and injection fluids meeting requirement 147.305(d)(3)(ii) above. The main component of pressure exerted on the cemented annulus consists of the confined pressure of the aquifers through which the well is completed. The cement was most vulnerable to the effects of this pressure before the cement solidified. The density of cement used was 13 lbs/gallon, which is sufficient to withstand the confined pressures of the intersected aquifers while the cement was solidifying. In addition, the results of the aquifer-pump test will further verify the integrity of the injection well and the confinement zones.

Table 2. Composition of Cement used in Injection Well Annulus

Portland I/II type cement	5, 287 lbs (as dry bulk cement)
Sacks Pol-e-Flake	1.01 sacks @ 25 lbs = 25.25 lbs
Sacks Aquagel Gold Seal (sodium bentonite)	6.34 sacks @ 50 lbs = 317 lbs
Total mixture	5,629 lbs
Percent bentonite	317 lbs /5,629 lbs = 5.6%
Makeup water	613 gallons* = 5,106.3 lbs
Total weight cement + water mixture	10,735.3 lbs
Percentage of water used	47.6%

* multiply the gallons by 8.33 to find how many pounds of water there are in the mix.

3. Maximum Allowable Injection Pressure (MAIP) of Zero Pumping Pressure at the Wellhead.

The permit sets a maximum allowable injection pressure of zero pumping pressure at the wellhead. To ensure this requirement is met, the permit prohibits the use of an injection pump at the wellhead. The stored groundwater will flow from the storage tanks, travel through pipe to the wellhead, then flow into the injection well under conditions of gravity flow. There will be a minimal pressure induced by the hydraulic head resulting from the difference in elevation from the level of the storage tanks to the injection wellhead.

Injection at zero pumping pressure will minimize the pressure of the injectate moving back into the A2 sandstone and will not create communication between Upper Fox Hills Formation aquifer units that are not already in hydrologic connection.

As discussed earlier in the section on hydrogeology, there is a thicker confinement zone between the Fox Hills Formation and the Laramie Formation aquifers. The zero pumping pressure requirement is an additional protective measure for the Laramie Formation aquifers beyond the well construction and mechanical integrity requirements. In addition, the permit at Part II, H.4, states that the results of the aquifer-pump must demonstrate there is no potential for migration of injectate or A2 sandstone aquifer fluids into the overlying Laramie Formation during reinjection of the A2 sandstone groundwater before the Director will issue the Authorization to Commence Injection.

4. Sampling and Analysis Requirements

The permit includes safeguards to ensure that the injection activity will not endanger groundwater in the injection zone. The Colorado Division of Reclamation, Mining, and Safety has a number of requirements that Powertech must meet before CDRMS will approve bringing the storage tanks onto the aquifer-pump test site. The UIC Class V permit requires the permittee to provide documentation to the EPA that these CDRMS requirements have been met.

While the water quality of the groundwater is not expected to change before reinjection, the EPA will ensure this by requiring that the permittee collect the following: samples of A2 sandstone groundwater from the proposed injection well prior to any aquifer-pump test, and samples from the pump test water in the storage tanks before reinjection to verify that no contamination of the groundwater has occurred during storage. The samples will be analyzed for: Total Metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver); Volatile Organic Compounds; Semi-volatile Organic Compounds; and Total Petroleum Hydrocarbons. A composite sample of the stored groundwater will also be analyzed for Total Coliforms to verify that the groundwater has not been exposed to microbial contamination.

The analytical results from the samples of pump test water collected from the storage tanks must demonstrate that the stored pump test water meets the permit limits before the Director will issue the Authorization to Commence Injection. The constituent concentration limits applicable to this permit are those promulgated under the SDWA, including the Maximum Contaminant Limits (MCLs) found in 40 CFR Part 141 National Primary Drinking Water

Standards, the Health Advisory concentration limit for silver, or the background concentrations present in the native A2 sandstone groundwater.

The concentration of any constituent in the pump test water collected from the storage tanks shall not exceed any MCL, the Health Advisory concentration limit for silver or native A2 sandstone groundwater concentrations ("background" as determined by the samples in Part II, Section E.1(a)), whichever is greater. This means that the permit limits will be the MCLs at 40 CFR Part 141 and the Health Advisory concentration limit for silver, except for those constituents that exceed these limits in the background samples. For any constituents that exceed the limits in the background samples taken pursuant to Part II, Section E.1(a), the permit limit will be the background level.

If the analytical results from the samples of pump test water collected from the storage tanks show that the stored pump test water is above the permit limits, the permittee will have to perform corrective action on the stored pump test water. Corrective action may include additional sampling and analysis, disinfection or treatment of the stored groundwater. After corrective action has been completed, follow-up sampling and analysis of the injectate shall be performed. The Director will review the results of any follow-up sampling to determine if they meet the conditions of this permit.

If analytical results for Total Coliforms in the sample required under Part II, Section E.1(b) show the presence of Total Coliforms, then the permittee shall either collect follow-up samples of the groundwater in each individual storage tank and analyze separately for regulated microbiological constituents or disinfect the stored groundwater in all storage tanks.

If analytical results for regulated microbial constituents in the sample required under Part II, Section E.1(b) show the presence of regulated microbiological constituents above the permit limit, then the permittee shall disinfect the stored groundwater. After disinfection, the permittee shall collect follow-up samples of the disinfected groundwater and re-analyze them for regulated microbes and, if detected, shall again disinfect the groundwater until no permit limit is exceeded for regulated microbial contaminants. Neutralization of disinfectant may be required before reinjection at the discretion of the Director.

In any case of corrective action, the permittee will have to collect additional samples of pump test water from the storage tanks and demonstrate that the treated water meets permit limits before the Director will issue the Authorization to Commence Injection.

5. The Aquifer-pump Test Results

The permit requires that the permittee submit the results from the aquifer-pump test to the Director for review. The Director will review the results from the aquifer-pump test to verify that

- the results of the aquifer-pump test indicate the integrity of the confinement zones in the Upper Fox Hills Formation is adequately characterized; and
- the results of the aquifer-pump demonstrate there is no potential for migration of injectate or A2 sandstone aquifer fluids into the overlying Laramie Formation during reinjection of the A2 sandstone groundwater.

Section VI of this document explains how the aquifer-pump test results characterize the confinement zones of the aquifer being pumped. The Director will review the aquifer-pump test results to determine that injection will not result in communication between the A2 sandstone and the Laramie Formation aquifer and between Upper Fox Hills Formation aquifer units that are not already in hydrologic connection.

One potential cause of a breach in a confinement zone is an improperly plugged historic exploration borehole. Figure 4a shows three abandoned exploration boreholes located near the proposed injection well: the WE-1032, the WE-1279, and the 34-64. Table 2 includes location information for the three boreholes. The results of the aquifer-pump test will demonstrate whether these boreholes are conduits for hydrologic communication between the A2 sandstone aquifer and the Laramie Formation sandstone.

Table 2. Location Information for Abandon Exploration Boreholes Located near the Proposed Injection Well.

Borehole Name	Elevation at Borehole Location	Northing	Easting	Distance from Proposed Injection Well (feet)
WE-1032	5523	531,312	2,167,393	1,271
WE-1279	5546	531,752	2,168,500	318
34-64	5551	532,236	2,170,110	1,703

6. Authorization to Commence Injection

The permit prohibits injection until the Director has issued an Authorization to Commence Injection. Prior to any injection event, the permittee must obtain an Authorization to Commence Injection. Part II, Section H of the permit requires the permittee to submit the following information to the UIC Program Director for review:

1. the analytical results from the injectate samples required under Part II, Section E.3 of the permit;
2. results of the Part I MI test and the well completion report required under Part II, Section G.2 of the permit; and
3. the results of the aquifer-pump test required under Part II, Section E.4 of the permit.

The Director will review the analytical results of the injectate samples (the A2 sandstone groundwater in the storage tanks) to determine if they meet the permit limits described under Part II, Section E.5 of the permit. If the analytical results indicate that any permit limits are exceeded, the permittee must take corrective action as discussed in Part VII, Section 5 of this Statement of Basis.

Powertech has already submitted documentation of a pressure test conducted on the proposed injection well and a well completion report for the proposed injection well. The Director has reviewed this information and determined that the requirement for demonstration of mechanical integrity has been met as discussed under Part VII, Section 2 of this Statement of Basis.

The Director will review the results of the aquifer-pump test to determine whether the integrity of the confinement zones in the Upper Fox Hills Formation is adequately characterized, and the test results demonstrate there is no potential for migration of injectate or A2 sandstone aquifer fluids into the overlying Laramie Formation during reinjection of the A2 sandstone groundwater. If the aquifer-pump test results indicate there is a hydrologic connection between the A2 sandstone and the overlying Laramie Formation, the Director will not issue an Authorization to Commence Injection.

The permittee will be required to follow the permit requirements to obtain the Authorization to Commence Injection before conducting any injection activities. The Director will issue the Authorization to Commence Injection only after a determination that the reviewed information meets all the requirements of the permit.

VII. REFERENCES

Bonner, J., 2009, Updated Technical Report on the Centennial Uranium Project Weld County, Colorado, 41 pages.

Voss, W. C. and Gorski, D. E., 2007, Report on the Centennial Project Weld County, Colorado, 41 pages.

Voss, W. C., 2010, Updated Technical Report on the Centennial Uranium Project Weld County, Colorado, 47 pages.

APPENDIX A

Attachment A: R Squared Inc.
Well Development Record

SHEET 1 of 3

Project Name: Centennial
Project No.: Section 33 Pumping Test
Well ID: IN08-33-PW1
Date Installed:
Casing Diameter: 6"

METHOD OF DEVELOPMENT

☒ Swabbing ☐ Bailing ☒ Pumping ☐ Describe

Equipment decontaminated prior to development ☒ Yes ☐ No

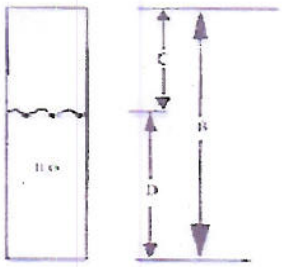
Describe
Aqua Clear PFD added. WV = well volume. Turned on pump at 0934 on 8/19/09.

CASING VOLUME INFORMATION

Casing ID (inch)	1.0	1.5	2.0	2.2	3.0	4.0	4.3	5.0	6.0	7.0	8.0
Unit Casing Volume (A) (gal/ft)	0.04	0.09	0.16	0.2	0.37	0.65	0.75	1.0	1.5	2.0	2.6

PURGING INFORMATION

Measured Well Depth (B) Casings 500 screens 525 ft. (j-collar 494)
Measured Water Level Depth (C) 277 ft.
Length of Static Water Column (D) 525 (B) - 277 (C) = 248 ft.
Casing Water Volume 248 (A) x 1.5 (D) = 372 gal
Volume of Water Added to Well During Installation = 0 gal
Total Purge Volume = 372 (gal)



Date	Time	Pump Rate	Water Level Depth (ft)	Volume Removed ~~(gal)~~	pH	Cond (uS/cm)	Temperature (F or C)	Turbidity ~~(NTU)~~	Comments
8/18/09	1415	n/a	277	30 gal	11.60	7352	62	84.1	gray murky
	1520	n/a	322	0.5	11.74	6329	64	82.8	~clear
	1600	n/a	319	1.0	11.71	5718	62.5	21.9	clear
8/19/09	0949	8gpm	352	1.5	11.19	868.5	63.91	118.3	murky tan
pump used	1010	8gpm	360	2.0	10.92	630.0	64.70	25.8	~clear
	1031	10gpm	368.7	2.5	10.79	585.3	64.03	22.9	~clear

Samplers Signature: [signature] Date: 8/18/09 - 8/19/09

Completeness Issue Item #7 Attachment

Attachment A: R Squared Inc.
Well Development Record

SHEET 2 of 3

Project Name: Centennial
Project No: Section 33 Pumping Test
Well ID: IN08-33-PW1
Date Installed:
Casing Diameter: 6

METHOD OF DEVELOPMENT

☒ Swabbing ☐ Bailing ☒ Pumping ☐ Describe

Equipment decontaminated prior to development ☒ Yes ☐ No

Describe
Aqua Clear PFD added. GWV = well volume. Shut 10gpm pump off at 1116 @ 372.5 mgs. Turned larger pump on at 1525 @ 305.7

CASING VOLUME INFORMATION

Casing ID (inch)	1.0	1.5	2.0	2.5	3.0	4.0	4.5	5.0	6.0	7.0	8.0
Unit Casing Volume (A) (gal/ft)	0.04	0.09	0.16	0.2	0.37	0.65	0.75	1.0	1.5	2.0	2.6

PURGING INFORMATION

Measured Well Depth (B) ft.

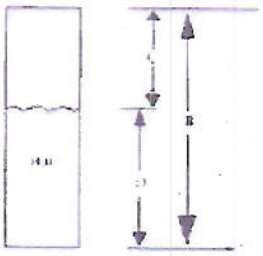
Measured Water Level Depth (C) ft.

Length of Static Water Column (D) (B) (C) 24.8 ft.

Casing Water Volume (A) x (D) gal

Volume of Water Added to Well During Installation gal

Total Purge Volume 372 (gal)



Time	Pump Rate	Water Level Depth (ft)	Volume Removed (gal)	pH	Cond (mS/cm)	Temperature (F or C)	Turbidity (NTU)	Comments
1055	16 gpm	372.7	3.0	10.05	550	65	18.0	clear
1112	10 gpm	372.5	3.5	9.99	517.1	65	12.0	clear
1533	15 gpm	382.5	4.0	10.67	609.6	64.5	39.3	clear
1548	15 gpm	392.5	4.5	9.97	539.7	64.65	59.5	fizzy white
1600	16 gpm	400.0	5.0	9.82	545.4	64.81	20.7	fizzy white
1614	16 gpm	403.9	5.5	9.63	549.8	64.82	15.9	fizzy white

change pump →

Samplers Signature: DT Date: 8/19/09

Attachment A: R Squared Inc.
Well Development Record

SHEET 3 of 3

Project Name: Centennial
Project No: Section 33 Pumping Test
Well ID: IN08-33 - PW1
Date Installed:
Casing Diameter: 6"

METHOD OF DEVELOPMENT

☒ Swabbing ☐ Bailing ☒ Pumping ☐ Describe:

Equipment decontaminated prior to development ☒ Yes ☐ No

Describe:

Avg. Clear PFD added. 2W c well volume. 19gpm pump shut off @ 1728 with 420.8 feet drawdown.

CASING VOLUME INFORMATION

Casing ID (inch)	1.0	1.5	2.0	2.2	3.0	4.0	4.3	5.0	6.0	7.0	8.0
Unit Casing Volume (A) (gal/ft)	0.04	0.09	0.16	0.2	0.37	0.65	0.75	1.0	1.5	2.6	2.6

PURGING INFORMATION

Measured Well Depth (B) _____ ft

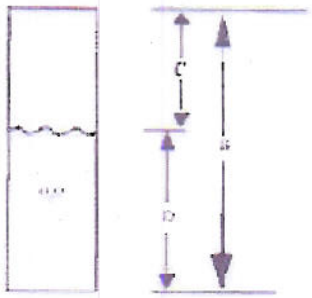
Measured Water Level Depth (C) _____ ft

Length of Static Water Column (D) _____ - _____ = 248 ft
(B) (C)

Casing Water Volume _____ x _____ = _____ gal
(A) (D)

Volume of Water Added to Well During Installation = _____ gal

Total Purge Volume = 372 (gal)



Time	Pump Rate	Water Level Depth (ft)	Volume Removed (gal)	pH	Cond (µS/cm)	Temperature F or C	Turbidity (NTU)	Comments
1625	17gpm	405.3	6.0	9.48	556.5	64.65	10.7	-Fizzy
1637	18gpm	409.1	6.5	9.55	575.2	64.68	11.8	-clear
1647	18gpm	414.2	7.0	9.46	578.6	64.27	10.2	-clear
1658	19gpm	416.3	7.5	9.37	583.8	64.39	10.0	-clear
1710	19.5gpm	420.0	8.0	9.31	600.5	64.72	9.7	-clear
1718	19gpm	420.6	8.5	9.15	603.0	64.23	7.2	clear
1728	19gpm	420.8	9.0	9.16	619.8	64.78	6.2	clear

Samplers Signature: _____ Date: 8/19/09

APPENDIX B

ATTACHMENT B-1

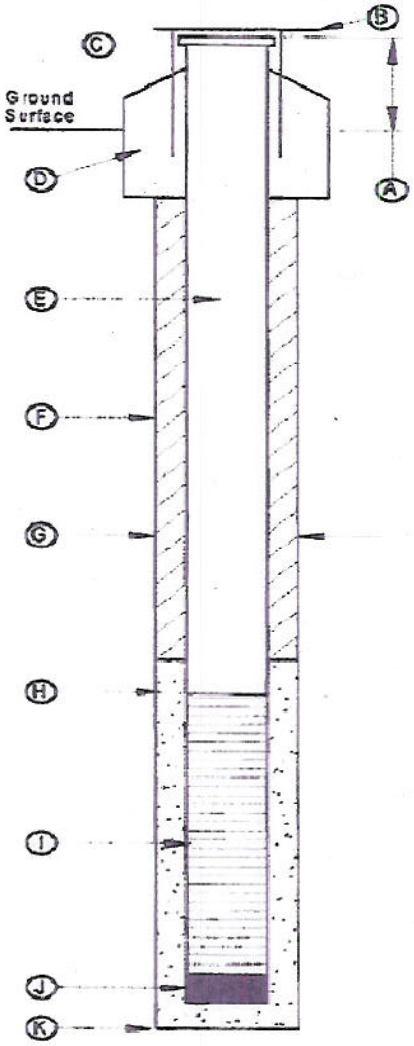
Well Completion Report For Well Number: IN08-33-PW1

General Location of Well	
County:	WELD
State:	CO
Township:	10N
Range:	R67W
Section:	33

Survey Information	NOI	As-Built
Easting:	2,168,417.16	
Northing:	532,049.38	
Ground Elevation:		
TOC Elevation:		
Datum:	STATE PLANE NAD27	

Contractor Information	Drilling	Casing	Completion	Development
Drilling Contractor:	Sharpe	Sharpe	Sharpe	Aftermax
Lead Driller:	Lyle	Lyle	Lyle	SCO Pump on Supply
Methods Used:	Direct Mud Rotary	Positive Displacement	Under Ream & J-Tool	Swab until clear
Drilling Fluids & Additives:	Soda Ash, Bentonite, & Baroid Polymers	Portland Type I/II Ready-Mixed Cement	Soda Ash, Bentonite, & Baroid Polymers	
Date(s) on Well:	5/12/09	5/13/09	6/01/09	
Notes or Comments:				Time Till Clear: Discharge Volume: Unload Pressure: Steady Lift Pressure: Estimated Yield: Other:

Generalized Well Construction Schematic - Please Fill Out as Constructing the Well and Give to Geologist Once Well is Complete



A. SURVEYED CASING STICK-UP		0 feet
B. KEY NUMBER	Master	
C. SURFACE COMPLETION		
Steel Well Head w/ 2" NPT Discharge & 2x 3/4"-1" Fittings		
Rubber Bunas Gasket Bolted between Well Head and Well Flange		
SDR17 PVC Well Flange Solvent-Welded to Casing Adapter		
D. CEMENT SLAB & LOCKING STEEL PROTECTIVE CASING		
E. WELL CASING DATA		
Material	6" Titeloc SDR17 PVC	
Inside Diameter	5.845	inches
Outside Diameter	6.625	inches
Total Depth	500.0	feet
Total Length	501.5	feet
Total Joints	25.00	sticks
Centralizer Interval	50	feet
Total Centralizers	10	centralizers
F. CEMENT GROUT		
Material	Portland Type I/II Ready-Mixed Cement	
Total Cement Grout Volume	829	gal
Percent Excess (%)	15.00	%
Make-up Water	673	gal
Sacks Pole-Flake	1.01	sacks
Sacks Aquagel Gold Seal	6.34	sacks
Bulk Dry Cement	5,287	lbs
Slurry Density of Cement Grout	13	lb/gal
Displacement Water/Mud	657.29	gal
Approximate Returns	4	bbls
Returns Constant?	Yes	
Method of Installation	Positive Displaced Through Casing to Surface	
Depth to Cement in Casing	465	feet
G. BOREHOLE DIMENSIONS		
Pilot Hole Diameter	8.75	inches
Pilot Hole Depth	528.5	feet
Well Bore Reaming Diameter	10.5	inches
Well Bore Ream Total Depth	527	feet
H. GRAVEL PACK SPECS		
Material	10/20 Colorado Silica Sand	
Gravel-Packed Interval	500 - 527	feet
Diameter of Interval	10.5	inches
Method of Installation	Under-ream and Place through J-Tool	
Weight of Gravel Pack	1550	pounds
I. SCREEN & LINER ASSEMBLY		
Screen Material	3" Sch80 PVC Wire on Pipe, 0.030" Slot	
Manufacturer	Johnson Well Products	
Screened Interval	500 - 526.3	feet
Screened Geology	A2	
Method of Installation	Pushed w/ J-Tool & Hung w/ K-Packers & Liner	
Top of J-Collar	494.3	feet
J. BOTTOM ASSEMBLY OF WELL		
Material	2x Opposing 2" Sch80 PVC Check Valves	
Total Depth of Screen Assembly	526.3	feet
K. Total Depth of Under-Ream Pilot	528	feet

Geophysical Logging of Pilot Hole	
Powertech Personnel:	Wyatt VanEaton
List Logs Run:	SP Resist, SP, Gamma, PEN, Dev.
Date of Logging:	5/12/09

Pump & Motor Installation	Date:
Contractor:	
Contractor Personnel:	
Pump Make/Model/Serial#:	
Motor Make/Model/Serial#:	
Assembled Length:	
Volts/Amps:	
Remarks:	

Mechanical Integrity Test	Date:
Contractor:	COLOG
Contractor Personnel:	

Filmed - no damage visible