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LOST CREEK ISR, LLC

March 3, 2015

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555-0001

Re: Addendum 1 to Technical and Environmental Reports
UIC Class V Amendment
Lost Creek ISR Project License SUA-1598, Docket 040-09068

To Whom It May Concern:

Please find behind this cover a license amendment request seeking approval to inject treated water into Underground Injection Control (UIC) Class V well(s) at the Lost Creek In Situ Uranium Mine. The binder includes both the Technical and Environmental Reports as well as the completed Form 313 for your convenience.

Please feel free to contact me if you have any questions.

Sincerely,
Lost Creek ISR, LLC

John W. Cash
Vice President

cc: NRC Deputy Director, Decommissioning and Uranium Recovery Licensing Directorate
Mrs. Theresa Horne, Ur-Energy, Littleton

KIMSS01
NMSS

NRC FORM 313 (3-2009)
10 CFR 30, 32, 33, 34, 35, 36, 39, and 40

U.S. NUCLEAR REGULATORY COMMISSION

APPLICATION FOR MATERIALS LICENSE

APPROVED BY OMB: NO. 3150-0120 EXPIRES: 3/31/2012

Estimated burden per response to comply with this mandatory collection request: 4.3 hours. Submittal of the application is necessary to determine that the applicant is qualified and that adequate procedures exist to protect the public health and safety. Send comments regarding burden estimate to the Records and FOIA/Privacy Services Branch (T-5 F53), U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001, or by internet e-mail to infocollects.resource@nrc.gov, and to the Desk Officer, Office of Information and Regulatory Affairs, NEOB-10202, (3150-0120), Office of Management and Budget, Washington, DC 20503. If a means used to impose an information collection does not display a currently valid OMB control number, the NRC may not conduct or sponsor, and a person is not required to respond to, the information collection.

INSTRUCTIONS: SEE THE APPROPRIATE LICENSE APPLICATION GUIDE FOR DETAILED INSTRUCTIONS FOR COMPLETING APPLICATION. SEND TWO COPIES OF THE ENTIRE COMPLETED APPLICATION TO THE NRC OFFICE SPECIFIED BELOW.

APPLICATION FOR DISTRIBUTION OF EXEMPT PRODUCTS FILE APPLICATIONS WITH:

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ENVIRONMENTAL MANAGEMENT PROGRAMS
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U.S. NUCLEAR REGULATORY COMMISSION
WASHINGTON, DC 20555-0001

ALL OTHER PERSONS FILE APPLICATIONS AS FOLLOWS:

IF YOU ARE LOCATED IN:

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U.S. NUCLEAR REGULATORY COMMISSION, REGION I
475 ALLENDALE ROAD
KING OF PRUSSIA, PA 19406-1415

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U.S. NUCLEAR REGULATORY COMMISSION, REGION III
2443 WARRENVILLE ROAD, SUITE 210
LISLE, IL 60532-4352

ALASKA, ARIZONA, ARKANSAS, CALIFORNIA, COLORADO, HAWAII, IDAHO, KANSAS, LOUISIANA, MISSISSIPPI, MONTANA, NEBRASKA, NEVADA, NEW MEXICO, NORTH DAKOTA, OKLAHOMA, OREGON, PACIFIC TRUST TERRITORIES, SOUTH DAKOTA, TEXAS, UTAH, WASHINGTON, OR WYOMING, SEND APPLICATIONS TO:

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U.S. NUCLEAR REGULATORY COMMISSION, REGION IV
612 E. LAMAR BOULEVARD, SUITE 400
ARLINGTON, TX 76011-4125

PERSONS LOCATED IN AGREEMENT STATES SEND APPLICATIONS TO THE U.S. NUCLEAR REGULATORY COMMISSION ONLY IF THEY WISH TO POSSESS AND USE LICENSED MATERIAL IN STATES SUBJECT TO U.S.NUCLEAR REGULATORY COMMISSION JURISDICTIONS.

1. THIS IS AN APPLICATION FOR *(Check appropriate item)*

- [ ] A. NEW LICENSE
- [x] B. AMENDMENT TO LICENSE NUMBER SUA-1598
- [ ] C. RENEWAL OF LICENSE NUMBER

2. NAME AND MAILING ADDRESS OF APPLICANT *(Include ZIP code)*

Lost Creek ISR, LLC
5880 Enterprise Drive, Suite 200
Casper, WY 82609

3. ADDRESS WHERE LICENSED MATERIAL WILL BE USED OR POSSESSED

Lost Creek Project in Sweetwater County, Wyoming, within the license area boundaries shown in Figure 1.3-1 of the approved license application

4. NAME OF PERSON TO BE CONTACTED ABOUT THIS APPLICATION

Mr. John Cash

TELEPHONE NUMBER

(307) 265-2373

SUBMIT ITEMS 5 THROUGH 11 ON 8-1/2 X 11" PAPER. THE TYPE AND SCOPE OF INFORMATION TO BE PROVIDED IS DESCRIBED IN THE LICENSE APPLICATION GUIDE.

5. RADIOACTIVE MATERIAL
   a. Element and mass number; b. chemical and/or physical form; and c. maiximum amount which will be possessed at any one time.

6. PURPOSE(S) FOR WHICH LICENSED MATERIAL WILL BE USED.

7. INDIVIDUAL(S) RESPONSIBLE FOR RADIATION SAFETY PROGRAM AND THEIR TRAINING EXPERIENCE.

8. TRAINING FOR INDIVIDUALS WORKING IN OR FREQUENTING RESTRICTED AREAS.

9. FACILITIES AND EQUIPMENT.

10. RADIATION SAFETY PROGRAM.

11. WASTE MANAGEMENT.

12. LICENSE FEES *(See 10 CFR 170 and Section 170.31)*

FEE CATEGORY 2A(2) AMOUNT ENCLOSED $ 0.00

13. CERTIFICATION. *(Must be completed by applicant)* THE APPLICANT UNDERSTANDS THAT ALL STATEMENTS AND REPRESENTATIONS MADE IN THIS APPLICATION ARE BINDING UPON THE APPLICANT.

THE APPLICANT AND ANY OFFICIAL EXECUTING THIS CERTIFICATION ON BEHALF OF THE APPLICANT, NAMED IN ITEM 2, CERTIFY THAT THIS APPLICATION IS PREPARED IN CONFORMITY WITH TITLE 10, CODE OF FEDERAL REGULATIONS, PARTS 30, 32, 33, 34, 35, 36, 39, AND 40, AND THAT ALL INFORMATION CONTANED HEREIN IS TRUE AND CORRECT TO THE BEST OF THEIR KNOWLEDGE AND BELIEF.

WARNING: 18 U.S.C. SECTION 1001 ACT OF JUNE 25, 1948 62 STAT. 749 MAKES IT A CRIMINAL OFFENSE TO MAKE A WILLFULLY FALSE STATEMENT OR REPRESENTATION TO ANY DEPARTMENT OR AGENCY OF THE UNITED STATES AS TO ANY MATTER WITHIN ITS JURISDICTION.

CERTIFYING OFFICER -- TYPED/PRINTED NAME AND TITLE	SIGNATURE	DATE
Mr. John W. Cash, Vice President of Lost Creek ISR, LLC	[signature]	03/03/2015

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TYPE OF FEE	FEE LOG	FEE CATEGORY	AMOUNT RECEIVED	CHECK NUMBER	COMMENTS
			$		
APPROVED BY				DATE	

ADDENDUM 1
TECHNICAL AND ENVIRONMENTAL REPORTS
UIC CLASS V AMENDMENT

Lost Creek ISR, LLC
3424 Wamsutter Crooks Gap Road
Wamsutter, Wyoming 82336 USA

LOST CREEK ISR, LLC
LICENSE SUA-1598
DOCKET 40-9068

March 2015

ADDENDUM 1
TECHNICAL REPORT
UIC CLASS V AMENDMENT

Lost Creek ISR, LLC
3424 Wamsutter Crooks Gap Road
Wamsutter, Wyoming 82336 USA

LOST CREEK ISR, LLC
LICENSE SUA-1598
DOCKET 40-9068

March 2015

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Abbreviations:

bgs	below ground surface
BLM	U.S. Bureau of Land Management
dpm	disintegrations per minute
EPA	U.S. Environmental Protection Agency
ft.	feet
gpm	gallons per minute
GWS	Groundwater Sweep
LQD	Land Quality Division
MCL	Maximum Contaminant Limit
NRC	U.S. Nuclear Regulatory Commission
RO	Reverse Osmosis
ROFD	Radius of Fluid Displacement
RSO	Radiation Safety Officer
SOP	Standard Operating Procedure
UIC	Underground Injection Control
U_{nat}	Uranium occurring in the natural ratio of its isotopes
WDEQ	Wyoming Department of Environmental Quality
WQD	Water Quality Division
WY	Wyoming

1.0 INTRODUCTION

Lost Creek ISR, LLC (LCI) is engaged in *in situ* uranium recovery at its Lost Creek Project in northeastern Sweetwater County, Wyoming, see **Figure 1-1**. Facility construction began in October 2012 after receipt of Permit to Mine 788 from the Wyoming Department of Environmental Quality – Land Quality Division (WDEQ-LQD), License SUA-1598 from the U.S. Nuclear Regulatory Commission (NRC), approval of a Plan of Operations from the U.S. Bureau of Land Management (BLM), and numerous other regulatory approvals. Production commenced in early August 2013 upon completion of construction.

In situ uranium recovery is a mining method that utilizes a series of injection and production wells completed in the mineralized aquifer. A solution consisting of groundwater, oxygen and a source of bicarbonate is injected into the mineralized aquifer where it dissolves the naturally occurring uranium minerals. The uranium laden groundwater is then pumped to the surface via the production wells and sent to the processing plant where the uranium is recovered. The groundwater is then refortified with oxygen and bicarbonate and re-injected into the formation where it repeats the process until the mineralization is recovered. In situ mining requires the maintenance of a hydrologic sink, or area of low groundwater pressure, so the mining solution can be contained within the mineralized body instead of migrating outward into potentially clean groundwater. The hydrologic sink is generated by removing about 0.5 to 1.5% of the water from the flow circuit prior to re-injection; this is often referred to as a bleed. For example, if the production rate is 1,000 gallons per minute (gpm), then the bleed rate would typically be 5 to 15 gpm. The water generated from the bleed, as well as plant process water and waste water generated from groundwater restoration, must be disposed of as waste.

The original mine site plan for waste water disposal called for utilizing up to five (5) Underground Injection Control (UIC) Class I deep disposal wells. To date, three of the five Class I wells have been installed and put into use. LCI desires to utilize technology that will be more cost effective than Class I disposal wells and also reduce water consumption. Therefore, LCI is proposing with this application, to treat various streams of waste water to a quality that can be disposed of in shallow wells using a UIC Class V Subclass 5C3 Permit (referred to as an "Industrial Process Water and Waste Disposal Facility" in the WDEQ-Water Quality Division Chapter 16 regulations). If approved, this practice would allow for increased production rates while maintaining the required bleed rate, and would also significantly expedite the rate of future groundwater restoration. Most importantly, the consumption of groundwater could be reduced by more than 70% depending on the efficiency of the treatment system.

As described in greater detail in **Section 2.0**, LCI has selected shallow horizons within the Battle Spring Formation, as the receiving zones because these horizons are:

- relatively shallow and easy to access;
- the water quality of these horizons are relatively poor due to naturally occurring radionuclides and associated metals;
- the horizons are naturally oxidized and barren of uranium mineralization;
- vertical confinement is sufficient so fluids will not migrate to the surface;
- structural and lithologic boundaries, as well as distance, will significantly reduce communication with in situ uranium mining monitor wells or the mining aquifer. These factors will prevent Class V injection from having an impact on mining operations; and
- the horizons possess sufficient transmissivity to serve as receiving zones.

Prior to Class V injection, the waste water will be treated with: 1) ion exchange to remove uranium, 2) with reverse osmosis (RO) to remove total dissolved solids, radionuclides and metals, and 3) with Dowex Complexer resin to ensure radium levels are less than effluent limits. A slip stream of well water which contains low concentrations of sulfate may be added to the circuit prior to the radium removal in order to minimize dissolution of barium sulfate from the resin surface.

During commercial uranium production, the flow rate through the Class V treatment circuit is expected to be on the order of 10 to 70 gpm (exclusive of the sulfate rich slip stream). During groundwater restoration, the flow rate through the Class V treatment circuit will be much greater, on the order of 50 to 200 gpm, due to groundwater sweep and RO treatment of the wellfield fluids.

The facility will be located on Federal lands managed by the Bureau of Land Management, Rawlins Field Office. The nearest commercial neighbor is the Sweetwater Uranium Mine and Mill located approximately four miles to the southwest. No residences are in the vicinity. The village of Bairoil is located about 15 miles to the northeast. The prevailing wind direction, based on over seven years of nearly continuous onsite monitoring, is from the west southwest to the east northeast. The terrain consists of gently rolling high plains desert steppe.

2.0 HYDROGEOLOGIC SETTING

The Lost Creek Mine is geographically located in the northeastern portion of the Great Divide Basin, an oval shaped structural depression encompassing approximately 3,500 square miles. The basin is broadly bounded on the north and east by mountains and hills. The regional sagebrush-dominated plains are characterized by low ridges and shallow draws with few rock outcroppings. Drainage is strictly ephemeral. No drainages exhibit perennial surface water flow or permanent water bodies.

2.1 Geology, Stratigraphy and Structure

Geology

Outcrop within the entire Mine Permit area is represented solely by the upper portions of

the Battle Spring Formation, which is also the host to uranium mineralization and the planned Class V injection. The Battle Spring Formation, in the vicinity of the Lost Creek Project, was deposited within a major alluvial fan system resulting in a multitude of thin to thick beds of sandstones separated by numerous thin to medium thick layers of mudstone, claystone and siltstone. The sandstone facies represent fluvial channel fill depositional environments. The intervening shaly units represent channel margin and overbank depositional environments. The anastomosing nature of the fluvial channels has resulted in stratigraphy which tends to be erratic and lacking long-range continuity.

Lithology of the Battle Spring Formation, within the Mine Permit area, consists of approximately 60% to 80% clean arkosic sands, weakly consolidated, medium to coarse-grained, commonly conglomeratic, in units from five to 50 feet thick; separated by 20% to 40% interbedded mudstone, claystone, siltstone, and fine sandstone, generally less than 25 feet thick (see Cross Section **Plates 1** and **2**, and **Appendix A**: Well Completion Logs). This Battle Spring Formation lithological assemblage remains relatively consistent throughout the entire vertical section of interest, such that the lithology of the shallowest units is virtually identical to that of the deepest units of interest. Economic uranium mineralization is generally associated with medium to coarse-grained sand facies.

Uranium deposits within the Lost Creek Project occur as roll front type deposits. The most significant mineral resources occur within two major stratigraphic horizons within the Battle Spring Formation, which underlie the proposed Class V injection interval. These resources occur within a trend called the Main Mineral Trend, most of which is overlain by Mine Unit 1 (MU1) and planned Mine Unit 2 (MU2) (**Figure 2-1**).

The proposed injection interval is barren of mineralization in the Class V area of interest. However, elsewhere in the Lost Creek Project, subordinate mineralization has been identified within the injection interval and remains to be investigated for economic viability. The nearest occurrence to the Class V area is approximately one-half mile to the south.

Stratigraphy

Being the product of an alluvial fan depositional environment, the Battle Spring Formation can be described as a very thick sequence composed of innumerable individual channel sands occurring as sand sheets typically from five to 50 feet thick interfingered with shales typically two to 25 feet thick, which represent channel margin and overbank environments. Lateral extent of both of these lithologies can range from 100 feet to miles. Where multiple sand channels are stacked on top of each other, the cumulative sand thickness and width can be considerable. The erratic nature of these narrow channels results in stratigraphy which can be highly variable. The outcome can be very complex, where interfingering or abrupt facies changes may result in drastic changes in shale or sand thickness over short distances.

Sedimentary and depositional patterns throughout the entire Battle Spring interval of interest remained quite consistent and uniform. Consequently, from a lithological and stratigraphic perspective there is little difference between deeper units and those near the surface. Characteristics of given stratigraphic intervals are subtle and generally are not consistent regionally; consequently, partitioning into meaningful stratigraphic units remains largely arbitrary. In the Class V area of interest, the top 500 feet of the Battle Spring Formation represents the interval of interest.

The proposed injection interval represents a depth interval from approximately 190 feet to 455 feet. It is dominated by numerous relatively thin sands separated from each other by numerous shaley intervals (see Cross Sections **Plates 1** and **2**). Sands range in thickness from five to 50 feet, typically being 15-25 feet thick. Shales may range in thickness from two to 20 feet thick and commonly occur in en-echelon configuration. Collectively, the shales exhibit considerable influence on aquifer characteristics, particularly with regard to vertical migration of fluids. Note also that the term "shale" is used here loosely to reference low permeability horizons that my include siltstone and fine silty sands. Both sands and shaley facies tend to be erratic in extent. They rarely exhibit regional continuity, but typically show only local continuity on the scale of hundreds to thousands feet. Notable exceptions to this are two shales which have been named by LCI as the Lost Creek Shale (LCS) and the EF Shale (**Plates 1** and **2**). Both show continuity throughout the Class V area of interest. Regional continuity of the LCS Shale is significant, and is consequently employed as a stratigraphic datum throughout the Project. The LCS Shale also represents the underlying confining aquiclude to the proposed Class V injection zone. Current ISR uranium production is occurring approximately ½ mile to the south of the Class V area of interest in a 120 foot thick interval immediately below the LCS Shale.

Note that for internal purposes, LCI has sub-divided the Battle Spring stratigraphy into "horizons" employing an alphabetical system. As such, the proposed injection interval encompasses the entire FG Horizon and most or all of the overlying DE Horizon, as is illustrated in the Well Completion Logs in **Appendix A**.

Structure

Bedding within the Battle Spring Formation in the Lost Creek Project area is nearly flat-lying, dipping gently to the west and northwest at roughly three degrees. This regional pattern of strike and dip is locally modified due to horst and graben features resulting from normal faulting in the Lost Creek area.

The dominant geologic structural features within the Lost Creek Project area are a series of normal faults as shown on **Figure 2-1**. The faults exhibit variable displacement ranging from 10 feet to 80 feet. Geographically these appear to be related to the Chicken Springs fault system; however, there is no evidence that the faults are currently active. Detailed correlation of drill data supports this, and there is virtually no surface expression of the faults. Fault movement post-dates and displaces mineralization, which is estimated

by some studies to be approximately 20-25 million years ago.

Mine Unit 1 is bisected by a pair of normal faults which are collectively referred to as the Lost Creek Fault. This consists essentially of two faults, lying roughly parallel and en-echelon, trending from east-northeast to west-southwest. The 'main' Lost Creek Fault trends northeast to southwest and dissects the central portion of the Lost Creek Permit area. Downward displacement occurs on the south block. Throw is approximately 70 to 80 feet in the eastern portion of the Project area, decreasing to the west and eventually losing identity in the western one-third of the Project area. In that area a second parallel fault becomes dominant, with throw opposite that of the main fault. Both faults are nearly vertical in orientation, as are the majority of normal faults in the Lost Creek area. The dominant fault in the Class V area of interest is the North Fault (**Figures 2-2**). It closely parallels the Lost Creek Fault, approximately 2,500 feet to the north of that fault and roughly 1,300 feet to the north of the Mine Unit 1 monitor well ring. Downward displacement is approximately 70 feet to the north, opposite that of the Lost Creek Fault.

Pumping tests have demonstrated that the Lost Creek Fault plane in Mine Units 1 and 2 acts as a substantial barrier to groundwater flow within the current production horizon. Likewise, a recent pump test has shown that the North Fault plane is relatively well sealed within the proposed injection horizon, thus restricting the movement of groundwater across the fault. Observed drawdown differences across the North Fault are typically 8:1. A secondary "splay" fault, named the Plant Fault, emanates from the North Fault immediately to the south of the Plant site (**Figure 2-2**). Displacement is less than in the North Fault and in the opposite direction. The Plant Fault also exhibits a considerably lower angle of dip than is typical of most normal faults within the Project (see **Plate 1**).

A third, unnamed fault is found north of the plant site and lies between wells M-FG7 and M-FG10 (see **Figure 2-2** and **Plate 1**). Displacement is approximately 20 feet with downward displacement to the south, placing the proposed injection well (M-FG7) in a small graben structure between this fault and the North Fault.

The potential for reactivation of the faults by fluid injection is viewed to be negligible to nil for the following reasons:

- The proposed injection rate is low and the pressure build-up limited to only 45.7 psi;
- The shallow receiving aquifer is unconfined; therefore, the mechanism permitting pressure build-up is absent;
- The areal extent of injection fluid impact is small due to the low injection rate (see **Section 4.2** calculation);
- In situ mining operations in and around the Lost Creek Fault system have been operating at higher injection pressures (100 psi) for the past 18 months without having induced seismic activity;
- Based on LCI's geologic studies, the Lost Creek Fault system is inactive;

In summary, lubrication or pressurization of the faults, should that occur, would not in itself activate movement given the tensile nature of normal faults, and the assumption that the those stresses are no longer active within the Lost Creek Project area.

2.2 Class V Wells

Five Class V wells, one injection well and four monitor wells, were installed on and around the Plant facility as shown on **Figure 2-2**. The four wells located north of the North Fault are considered current or potential future injection wells, and were constructed as such. The well located south of the North Fault (M-FG8) is considered strictly a monitor well. LCI proposes to use M-FG7 as its primary injection well with M-FG6 designated as the backup injection well should the need arise. Currently, wells M-FG6, M-FG8, M-FG9 and M-FG10 are considered injection monitoring wells for M-FG7. Should well M-FG6 be activated to injection well status, LCI commit to adding a replacement monitor well; likely located up gradient and 600 feet directly east of M-FG6. Should a well fail for any reason, injection or monitor, LCI will install a replacement well immediately adjacent to the failed well.

2.2.1 Injection and Monitor Well Siting Criteria

The primary rationale for siting injection well M-FG7 close to the Plant was to minimize infrastructure build-out, and facilitate disposal and monitoring. Secondarily, the Plant site location is separated from Mine Unit 1 by two faults (North and Plant Faults) which have been shown to be hydrologic barriers, thus isolating or limiting the injection pressure wave to the north side of the faults.

The four injection monitor wells were located radially around M-FG7 at distances ranging from 765 to 1,362 feet as shown on **Figure 2-2**. Note that three of the four monitor wells are located north of the North Fault. A fourth monitor well (M-FG8) was intentionally installed south of the North Fault as an observation well for the M-FG6 pump test. The purpose of this observation well was to help in assessing whether the North Fault was a groundwater flow barrier. The observation well spacing criteria was based on a "radius of fluid displacement" (ROFD) calculation, which is discussed further in **Section 4.0**. The ROFD is the distance at which the injectate should be detectable after 14 years of continuously injecting 60 gpm.

2.2.2 Well Construction and Completion Design

Monitor and injection wells were drilled, logged and then reamed to accommodate casing. Casing was set to the top of the planned completion interval and cemented in place to isolate the completion interval from overlying horizons. All injection and monitor wells were constructed with either 4.5-inch or 6-inch I.D. polyvinyl chloride (PVC) casing. After the cement set, the pilot hole was deepened below the

casing to the desired total depth, after which the completion interval was under-reamed to a diameter of 10.5 or 12-inches.

Slotted or wire wrap, flush-joint PVC, schedule 80 well screen was installed on a K-packer system in the open completion interval. **Table 2-1** presents a compilation of well completion information. Well Completion Logs are provided in **Appendix A**. **Figures 2-3** and **2-4** are well construction schematics for injection well M-FG7 and back-up injection well M-FG6, respectively.

After the well screen was set, a mechanical integrity test (MIT) of the well casing was conducted. The MIT method entails performing a pressure test whereby a packer is placed near the casing bottom (just above the well screen) and another at the wellhead, and the interval between is pressurized to 160 psi. The well successfully passes if the pressure remains within 5 percent of the initial pressure for a period of 10 minutes. All of the Class V wells passed the MIT.

The top of the injection well casing will rise at least 18-inches above the ground level, and a sloped cement pad at least 4-inch thick will be placed around the casing to divert water away from the well. The wellhead will be sealed in order to prevent artesian flow to the surface in the event the well pressures up. A manual pressure gauge, e-line port, and manual vent controlled by a ball valve will be placed on the wellhead so appropriate measurements can be taken. The wellhead will be covered by a weather resistant cover.

The proposed injection well(s) are within the secured fence surrounding the Lost Creek processing Plant. The facility is occupied by employees around the clock during operations. Two, all-weather graveled roads provide access to the Plant facility.

Well M-FG7 is located at an elevation of 6,980.4 feet above mean sea level, which is estimated to be above the 100 year flood level. The well sits on a small gentle hillside within a local drainage basin of about 0.5 square miles.

2.2.3 State Engineer's Permits

The State Engineer's Office was consulted to determine the need for permitting injection wells. According to the State Engineer, permits are not required for monitor wells or for Class V wells permitted through the WDEQ-Water Quality Division.

2.3 Confining Horizons

Underlying confinement of the injection interval is provided by a shale unit locally named the Lost Creek Shale (LCS) (see **Plates 1** and **2**). This shale lies at a depth of approximately 500 feet (+/- 25 feet) and ranges in thickness from five feet to 25 feet.

Extensive drilling throughout the Project has demonstrated that the LCS is regionally continuous. The top of the injection interval is near the static water table, consequently true overlying confinement is absent. However, the presence of numerous shale units above the injection interval will impede vertical migration to the surface.

2.4 Receiving Aquifer Characteristics

A pump test was performed on monitor well M-FG6 for the purpose of establishing the receiving aquifer characteristics in the specific area of interest. The test was initiated at 10:00 Hours on December 10, 2014 and terminated at 15:00 Hours on December 11, 2014. The duration of the test was 1,740 minutes, and the time weighted average pumping rate was 49.65 gpm.

Water levels in observation wells M-FG7, M-FG8, M-FG9 and M-FG10 were monitored with In-Situ LevelTROLL datalogger pressure transducers and or manually e-lined. Analysis of the drawdown data yielded transmissivity values ranging from 2,000 to 3,300 gallons per day per foot (gpd/ft.) with an average storage coefficient of 3.4×10^{-4}. The specific capacity calculation was approximately 1 gpm per foot of drawdown.

Drawdown in monitor well M-FG8, located on the opposite side of the North Fault from the pumping well, was about an eighth of the drawdown observed in a monitor, at a comparable distance from the pumped well, but located on the same side of the fault as the pumping well. This difference in drawdown indicates that the North Fault acts as a low-flow barrier to the movement of groundwater. This impediment to groundwater flow will serve to confine injectate to the north side of the fault, thus limiting or negating the effect on nearby Mine Unit 1 and 2 receiving aquifer monitor well water levels.

2.5 Fracture Pressure Calculation

As indicated in **Table 2-1**, injection well M-FG7 is cased to a depth of 190 ft. below ground surface and screened from 190 to 455 feet bgs. Permeate will be injected into this interval which has a phreatic surface at approximately 205 feet bgs. The water table resides in the upper portion of the injection interval approximately 15 feet below the top of the screened interval; therefore, about 15 feet of unsaturated formation will receive injectate.

The receiving aquifer is comprised of alternating sand and shale layers that are saturated except for the uppermost sand layer, which is under atmospheric conditions. In calculating the formation fracture pressure it was assumed that the 15 feet of unsaturated formation would eventually fill and become confined thus becoming the limiting factor in the calculation. Based on this assumption, the bottom of the well casing was used in the following fracture pressure calculation (note this calculation is very conservative).

Fracture pressure was calculated using the following equation:

$$P_f = S_f * D_c * (O_p - V_g)$$

Where: S_f = safety factor; 90%
D_c = depth of casing in feet; 190 ft.
O_p = overburden pressure gradient; 0.7 psi/ft.
V_g = vertical pressure gradient of water; 0.433 psi/ft.

$$P_f = 0.90 * 190 \text{ ft.} * (0.7 - 0.433) = 45.7 \text{ psi}$$

Accordingly, the M-FG7 and M-FG6 injection pressure will be restricted to 45.7 psi. The injection pressure limit will be revised, if appropriate, based on the results of the testing described in **Section 5.5**.

3.0 RECEIVING AQUIFER AND PERMEATE WATER QUALITY

3.1 Groundwater Classification

The water quality of the proposed injection well and four surrounding monitor wells, all completed in the receiving aquifer, is provided in **Table 3-1**. The receiving aquifer in other areas of the Project hosts uranium roll front mineralization and contains significant quantities of radionuclides and associated metals; especially in areas proximal to roll fronts. The concentrations of combined total radium and gross alpha exceed Class I, II, and III standards as shown in **Table 3-3**. Therefore, LCI believes the receiving aquifer should be classified as Class VI due to excessive concentrations of specific constituents.

3.2 Regional Receiving Aquifer Background Water Quality

Regional water quality data for all Lost Creek receiving aquifer monitor wells (**Figure 3-1**) are summarized in **Table 3-2**, which presents a data summary and statistical analysis of each individual analyte. The data show that the mean dissolved uranium concentration exceeds EPA's MCL criteria. Additionally, the mean Gross Alpha and Ra-226+Ra-228 concentrations exceed both the EPA MCLs, as well as the WDEQ-WQD livestock class-of-use (Class III). The exceedance of EPA's MCLs and WDEQ-LQD criteria was paramount in LCI's decision to dispose of permeate into the upper Battle Spring Formation.

All five Class V wells (injection and monitoring) were sampled for the first time in November/December 2014. The samples were analyzed for LQD Guideline 8 Appendix 1 Tables IV and VA1 parameters which includes major ions, several dissolved and suspended metals and numerous radionuclides. **Table 3-1** presents a compilation of the analytical results.

3.3 Permeate Description / Characterization

Prior to initiating uranium production, LCI sent the RO manufacturer the baseline water quality of the current mine production horizon and the expected RO feed chemistry. Using that data, the RO manufacturer calculated the expected brine and permeate quality. The data from the RO manufacturer was adjusted to account for the addition of pH neutralizing caustic soda, and is presented in **Table 3-3** (Expected Post Treatment Quality column).

3.4 Groundwater / Permeate Compatibility

In June 2014, a series of geochemical models using PHREEQC version 3 (Parkhurst and Appelo, 2013) and PHAST for Windows (Parkhurst et al. 2010) were run to check the compatibility of injecting a reverse osmosis produced permeate with natural formation water (Mahoney Geochemical Consulting Memorandum, **Appendix B**). Details about water compositions and formation details were provide to Mahoney Geochemical Consulting by LCI staff.

This geochemical evaluation was primarily aimed at major elements such as calcium, magnesium, sodium, potassium, alkalinity (including carbon dioxide partial pressures), chloride and sulfate. Some minor elements such as silicon as silica (SiO_2) and aluminum were also considered.

The Battle Spring sediments in the vicinity of the proposed injection well are already oxidized so there is virtually no reduced material to be oxidized or uranium to be released. Furthermore, the approximately three percent calcite present in the receiving aquifer should neutralize any acid and form ferric hydroxide minerals such as ferrihydrite [$Fe(OH)_3$].

Because permeate is dilute (i.e., has a low total dissolved solid concentration), well clogging via mineral precipitation is not expected to be an issue. Similarly, because the carbonic acid concentration is also relatively low, the dissolution of minerals in the formation is expected to be slight. The mineral showing the greatest potential for dissolution will be calcite, but the dissolution volume will be slight relative to the amount of calcite present in the receiving aquifer.

Permeate is too dilute to cause any well plugging. But, mineral dissolution has a *slight* potential to cause detrimental effects, and that was the major focus of the modelling. Trace metal concentrations were generally at or less than detection limits in permeate and also in the formation water; consequently, trace metals will not be an issue.

In summary, the models demonstrated that the injection permeate is essentially benign and its impact on the receiving aquifer water quality will be minor.

4.0 AREA OF REVIEW

4.1 Method of Calculation

LCI used the "radius of fluid displacement" (ROFD) calculation method for this Technical Report. The input parameters are derived from field/laboratory tests, and an assumed operational period of 14 years. As a base case, the following conditions were applied: 1) a continuous initial injection rate of 60 gpm, 2) a 265 foot thick receiving aquifer, and 3) a lab measured core porosity of 25 percent.

ROFD Formula: $r = \sqrt{(V/((pi)*h*\phi))}$ where: r = radius of fluid displacement

V = injection volume (ft^3)

ϕ = porosity

Elapse Time (yrs.)	Inj. Vol. (ft^3)	r (ft.)
1	4,215,479	142
7	29,508,354	377
14	59,016,709	533

4.2 Maximum Area of Impact

The amount of void space required to accept the injectate generated over 14 years is contained in a cylinder with a radius of approximately 533 feet as calculated above. A circle circumscribed around injector well M-FG7 would encompass the center portion of Section 18, T25N, Range 92W as shown on **Figure 4-1**. Note that the area of impact is contained well within the mine permit boundary.

The effect on the local hydraulic gradient due to permeate injection is calculated as follows:

Linear Velocity: $v_l = (K*\Delta h) / \phi$ Hydraulic Gradient Displacement = (v_l) * (Time)

Where: K = hydraulic conductivity = 1.136 ft/day

ϕ = porosity = 0.25

Δh = hydraulic gradient = 0.006 ft/ft

Elapse Time (yrs.)	Injection Displacement (ft.)	Hyd. Grad. Displacement (ft.)	Total Fluid Displacement (ft.)
1	142	9.95	152
7	377	69.7	448
14	533	139.3	672

4.3 Existing Water Rights Within Impact Area

Figure 4-1 identifies existing water rights located within a 1-mile radius of the injection well's ROFD (**Table 4-1** is a compilation of water rights obtained from the State Engineer's database shown on **Figure 4-1**). Note that there are no private water rights within the impact area other than those owned by LCI/NFU (NFU is a subsidiary of Ur-Energy, Inc.). There are however, eleven listed BLM wells that were jointly registered water rights with LCI, but are functionally part of LCI's operation.

Note that the closest water supply wells (potable LC1148W and fire water LC229W) belong to LCI, and are completed in different hydrostratigraphic horizons separated vertically by over 400 feet of sand/shale interbedded layers, and horizontally by approximately 200 feet (**Plate 1** and **Figure 2-2**).

5.0 FACILITY CONSTRUCTION AND OPERATION

5.1 Source Water Characterization

The water to be treated and injected will be derived from a combination of sources including:

- Mining solutions captured during the maintenance of the hydrologic sink;
- Water derived from plant processing including but not limited to solutions from: plant wash-down, washing of product, chemical makeup, and dryer condensate;
- Chemistry lab waste water;
- Water derived from groundwater restoration;
- Water derived from UIC Class I and Class III wells during drilling, completion and maintenance; and
- Water captured from spills of mining solutions.

Most of the source waters listed above are defined by the NRC as byproduct material because they were generated during the recovery of uranium. As such, the average analyte composition of the fluids must be less than the corresponding effluent standard in 10 CFR 20 Appendix B, Table 2, Column 2 prior to being injected into a UIC Class V well or better than the background quality of the groundwater. In other words, the average quality of the effluent must be better than the NRC effluent standard or the baseline water quality; whichever is higher.

The WDEQ-WQD also regulates the quality of water injected into a UIC Class V well. Specifically, the WQD regulates the parameters described in the Primary Drinking Water MCLs listed in 40 CFR §140. In cases where the water quality of the receiving horizon is of poorer quality than the respective EPA MCL, the quality of the injection fluid must be equal to or better than the receiving horizon. In other words, the quality of the effluent must be better than the MCL or the baseline water quality; whichever is higher.

The treatment process will consist of several steps in order to remove the contaminants of concern to the NRC and WQD (EPA Drinking Water MCLs).

5.2 Injection Infrastructure

5.2.1 Construction and Engineering Design

The water treatment system will consist of the following major components (listed in order of treatment):

1. Ion exchange using Dowex 21k, or similar, anionic exchange resin to remove uranium. The water will be treated using either the existing commercial or existing restoration ion exchange circuit.
2. Bag filtration down to at least 5 micron size.
3. Reverse osmosis to remove approximately 98% of total dissolved solids, radionuclides and metals. The existing pumps prior to the RO skid were specified by the RO manufacturer, and will generate sufficient pressure to push water through the remainder of the circuit and into the Class V well(s). The brine generated from the RO will be sent to the sites' waste disposal systems (temporary storage in the plant, holding ponds and UIC Class I disposal wells). The RO system may utilize multiple passes depending on the need to minimize waste water generation.
4. Sodium hydroxide (NaOH) will be added, via a positive displacement chemical metering pump, to increase pH to at least 6.0. A small, caustic day storage tank will be utilized to simplify chemical metering.
5. Dowex Radium Selective Complexer (RSC) resin will be used to remove radium (**Appendix C**). Two fiberglass vessels, approximately 4 feet in diameter and 6 feet tall, will be placed next to the resin water transfer tanks on the north end of the processing plant.
6. On occasion, treated water may be sent to temporary storage to allow for ease of handling prior to injection.
7. 3-inch, High Density Polyethylene (HDPE) SDR 13.5 pipeline from the radium resin vessels to the Class V injection well(s). The length of the pipeline from the radium resin vessel to injection well M-FG7 is approximately 410 feet. The pipeline will be buried at least 6 feet deep to minimize the likelihood of freezing.

The location of each of the major components is shown on **Figures 5-1 and 5-2**. The uranium ion exchange, bag filtration and RO treatment equipment are already installed as described and approved in the NRC Technical Report. Each component will be able to treat approximately 200 gpm. Valves will be placed before and after each of the major components so each component can be easily isolated from the remainder of the system to allow for maintenance, as appropriate.

5.3 Injection Controls

The injection pipeline will be monitored after the addition of sodium hydroxide for pressure, flow rate, and pH. Each of these automated systems, with local displays, will communicate with the Plant operations computer system. If any parameter exceeds the respective limit, the system will alarm and shutdown the RO circuit pump. The water feeding the RO will be diverted to the waste management system while the plant operator shuts down the system in a safe and orderly manner or corrects the problem.

The initial maximum permissible injection pressure will be 45.7 psi at the injection wellhead, but may be adjusted based on the results of testing. The actual automated measurement will occur post sodium hydroxide addition in the processing plant, but will be adjusted for the change in elevation between the meter and the wellhead. Friction loss will not be accounted for.

The acceptable pH range will be 6.0 to 9.0 standard units measured post sodium hydroxide addition. The pH probe will be calibrated as directed by the manufacturer with the results of the calibration documented and maintained for inspection. In order to smooth out pH fluctuations, which will occur with system start up and shut down, the pH values will be averaged over five minutes with the results electronically documented.

The flow rate, measured post addition of sodium hydroxide, will be designed for 200 gpm, but ultimately limited by the formation injection pressure. This flow rate limit is not based on a regulatory standard or environmental concern, but is based on the design criteria of the facility. The flow meter will be either a magnetic or turbine flow meter, and will be maintained as described in the owner's manual.

The Plant Operator shall visually check and document the injection pressure, flow rate and pH once per day during operations.

The sodium hydroxide addition pump shall be interlocked with the flow meter and pH probe and automatically turn on when there is flow and turn off when there is no flow.

The Wellfield Operator shall visually inspect the Class V injection well(s) daily to ensure the wellhead is in good working condition with no leakage. The results of the inspection will be documented and available for agency inspection.

5.4 Process Controls

In order to detect RO membrane failure, permeate will be continuously monitored by an automated system for conductivity. If the conductivity falls outside the preset value, the system will alarm and automatically divert flow to the waste water system until the Plant Operator shuts down the system in a safe and orderly manner or corrects the problem. The acceptable conductivity ranges will be determined once the efficiency of the RO unit is determined. The acceptable range will change over time depending on the quality of

the feed water and efficiency of the RO membranes. The automated systems will be calibrated pursuant to manufacturer recommendations with the results documented and maintained for inspection. The Plant Operator will inspect the conductivity meter daily and record the values from the local display screen.

5.5 Injection Test Protocol

Preliminary testing, using Battle Spring Formation water, will be performed to test the injection parameters exhibited by the wells designated as injection wells for the Class V program. Currently, well M-FG7 is designated as the primary injection well with well M-FG6 designated as the back-up option; however, both wells will be tested. The well completion schematics, included as **Figures 2-3** and **2-4**, detail the casing and screen sizes for each constructed injection well. Well M-FG7 is a 4.5-inch ID cased PVC well with a 3-inch diameter slotted PVC screen insert, while well M-FG6 is a 6-inch ID cased well with a 5-inch diameter wire wrapped PVC screen insert.

The primary objectives of the injection tests are to: 1) confirm that the proposed rates and pressures are executable, 2) potentially identify upper operating limits and, 3) determine the formation frac pressure/gradient if possible, which is dependent on the well completion effectiveness. Testing will be accomplished by connecting a pump to a stored water supply source and injecting at increasing rates for specified periods of time. The wellhead will be sealed with only the injection connection and a pressure gauge attached. The injection rates and surface wellhead pressures will be monitored for the duration of the test. The proposed testing rates are as follows:

Rate (gpm)	Duration (minutes)	Step Volume (gallons)	Cumulative Volume (gallons)
50	30	1,500	1,500
100	30	3,000	4,500
150	30	4,500	9,000
200	30	6,000	15,000

Initial calculations (**Section 2.5**) show the operating pressure limit to be 45.7 psig at the wellhead based on the formation frac pressure with a 10 percent safety factor included. Each well will be tested and data analyzed to determine if the fracture pressure was reached and, if so, what the final fracture gradient is.

6.0 PERMEATE MONITORING PROGRAM

In order to ensure treatment processes are working properly and that EPA MCLs and NRC effluent standards are being met, the injectate quality will be monitored as described in **Table 3-3** and as discussed in **Section 5.3**.

Continuous monitoring of pH and conductivity will be performed by automated systems with the results used to ensure the treatment systems are functioning properly. In the event the automated monitoring system fails, the treatment system may still be operated

but LCI will record the pH and conductivity of the effluent at least every three (3) hours, and retain the records for inspection.

The monthly effluent samples will consist of daily aliquot samples that are physically combined into a composite. The monthly composite sample will be submitted to a commercial laboratory for analysis of the dissolved fraction of the parameters which have an NRC effluent limit listed in **Table 3-3**. A quarterly grab sample will be collected and analyzed for each EPA MCL parameter listed in **Table 3-3**.

The water level in each of the four (4) monitor wells will be measured quarterly, and water samples will be collected and analyzed for alkalinity, chloride and conductivity in order to determine if treated injectate has migrated to the monitor well. Fluid (permeate) migration to one or more monitor wells will not constitute a violation.

7.0 ENVIRONMENTAL MONITORING PROGRAM

7.1 Operation Monitoring and Testing

The operational monitoring and testing are described in **Sections 5.3** and **6.0**.

7.2 Standard Operating Procedure

The Manager of EHS, or their designee, will ensure samples of the injection fluid are collected and supplied to the laboratory pursuant to the scheduled provided in **Table 3-3**. A chain of custody, generally provided by the contract laboratory, will be completed for each set of samples collected and submitted to a contract laboratory. The analytical results will be maintained on file until license termination. The anion/cation balance and measured TDS versus calculated TDS will be reviewed for each analytical result that includes measurements of major ions. A duplicate sample will be submitted to the commercial lab at least twice per year to verify lab results. Only approved EPA analytical methods will be used by the commercial laboratory.

The Plant Operator will verify that the injection pressure and flow rate are within limitations at least once per day. Any non-conformance will be corrected immediately and reported to the Manager of EHS. If the non-conformance cannot be immediately corrected, the system will be shut down until corrections can be made and verified.

LCI has developed and implemented extensive health physics SOPs that will be followed when working on the treatment system. These procedures include, but are not limited to: Contamination Control, Screening and Decontamination of Materials, Personnel Surveys, Radiation Work Permits, Gamma Surveys, Surface Contamination Surveys, Byproduct Waste Management, Radiation Dose Determinations and Radiation Safety Inspections. These SOPs already consider the radiologic hazards that will be generated by the treatment and injection system including the potential for significant alpha, beta, and gamma emissions, as well as, the release of radon during maintenance and upset conditions.

7.3 Point of Compliance

The point of compliance for effluent concentration, flow rate, and injection pressure will be at the discharge point from the processing plant or storage; whichever is immediately prior to injection. Corrections to the injection pressure will be made to account for change in elevation between the plant and Class V well(s).

7.4 Health Physics

The main health physics concern will result from the gamma emitters, which will be concentrated in the brine solution derived from the RO and radium resin. Since the brine will be disposed of in the deep well or sent to the holding ponds, the opportunity for exposure to its radioactive components will be minimal.

The radium resin vessel will concentrate radium. The majority of alpha and beta emitters will be absorbed by the water and vessel. However, gamma rates could become elevated and will pass through the sides of the vessel. The Health Physics department will monitor the gamma rates in the vicinity of the vessel at least weekly during the first charge of resin in order to determine how quickly the gamma rates increase. After the first charge of resin is disposed of, the Radiation Safety Officer (RSO) may reduce the frequency of gamma readings, but shall take readings at least monthly.

Since the majority of alpha and beta particles will be absorbed by the water and containing vessels, the potentially significant routes of exposure to these particles would only exist during maintenance or a spill event. LCI has developed SOPs to address these situations and may also rely on the established Radiation Work Permit practice if the SOP(s) is inadequate to address the radiologic hazard. Since the radium resin vessel has the increased radiologic hazard of radium, all personnel will wear waterproof clothing, gloves, and rubber boots as minimum protection when performing maintenance which may result in exposure to radium resin. Upon completion of the work, the area will be washed down and a representative removable alpha survey performed once the area is dry. Since the work is within a restricted area there is no regulatory limit on removable alpha. However, in order to maintain ALARA (an NRC acronym defined in 10 CFR 20 regulations meaning As Low As Reasonably Achievable), a removable alpha action limit of 1,000 dpm/100 cm^2 will be utilized. If the removable action limit is exceeded, the area will be washed and resurveyed as many times as necessary to get below the action limit. All workers will wash their protective clothing upon completion of work on the system. If contamination may have breached the protective clothing, the affected worker will wash the affected area or shower and then get assistance from the Health Physics department to scan out to the appropriate standard defined in Regulatory Guide 8.30.

Radon, which will not be removed by any of the treatment processes, is not expected to be released as an airborne effluent since it will be within closed vessels. If effluent is sent to the holding ponds the water is expected to trap the radon gas and prevent release as outlined in EPA 520/1-86-009, Final Rule for Radon-222 Emissions from Licensed Uranium Mill Tailings, August 1986, Background Information Document, section 3.4.3.

Since the concentration of radium-226 in the treated water will be less than 60 pCi/L, there will be little in growth of radon in permeate. The half-life of radon-222 is 3.8 days, so it will rapidly decay.

The unrestricted release of materials involved in radium treatment would be handled as follows:

Items from the radium treatment circuit would be thoroughly washed and then released to the radium standard in Table 1 of NRC's Reg Guide 1.86 *"Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source or Special Nuclear Material,"* August 1987. Specifically, the average acceptable surface contamination level would be 100 dpm/100 cm^2 with a maximum reading of 300 dpm/100 cm^2. The removable limit would be 20 dpm/100 cm^2. However, in most cases, items removed from the radium treatment circuit will be disposed of as byproduct material instead of being released for unrestricted use.

Materials from all other portions of the treatment circuit would be released to the U-nat, line 1, standard from Table 1 unless there is reason to believe that radium has been chemically enriched.

Radium resin removed from the extraction vessel will be stored outdoors in a shipping container. The RSO or Health Physics Technician will ensure the gamma rate in the area does not exceed any applicable standards. The waste radium resin will be shipped in a strong tight container to a licensed disposal facility after ensuring the gamma rates do not exceed any DOT standards and all applicable DOT standards are met.

7.5 Sage Grouse

The proposed injection wells and associated trunk lines fall within the boundary of the Lost Creek plant complex. The three existing monitor wells, which fall just outside the plant complex, resulted in a total disturbance of 0.08 acres. The activities completed to date, as well as the proposed activities, fall within the sage grouse PIAA (now known as DDCT) that was approved during the original review of the Permit to Mine application. The PIAA anticipated construction of the plant facility, several wellfields, roads, power lines, monitor and injection wells, trunk lines and other infrastructure required to mine uranium. The approval letter from the Wyoming Department of Game and Fish, as well as a map showing the area of disturbance, is included in **Appendix D**.

8.0 FACILITY ABANDONMENT

Once the useful life of the project has ended, the injection well and each of the monitor wells will be abandoned by pumping high solids bentonite grout from the bottom to the top with a tremmie pipe. After allowing the grout to settle for at least 24-hours, additional high solids bentonite grout or bentonite pellets will be added until the grout is approximately seven feet below ground surface. The casing will be cut off at least two feet

below ground surface. Approximately five feet of cement will be placed on the grout plug. The last two feet will be backfilled with native soil and the affected area will be re-vegetated using the seed mix approved in the Permit to Mine.

9.0 WATER BALANCE

Utilization of UIC Class V wells(s) to place treated water back into the Battle Spring aquifer will have a substantial impact on the water balance during production and groundwater restoration. The production flow rate could be increased potentially without the need for installing additional Class I UIC wells. Also, groundwater restoration will be expedited since the UIC Class I wells will no longer be the sole method of water disposal.

Figures 9-1a through **9-1e** estimate the water balance through various stages of operations and groundwater restoration. There is no flow rate limitation on the Class V wells, however, the injection pressure will be limited as discussed above. For the purposes of modeling only, the maximum flow rate into the UIC Class V wells is assumed to be around 200 gpm. The model also assumes that no additional RO systems are installed. LCI reserves the right to reconfigure the RO system and/or add additional components in order to increase treatment capacity and/or improve efficiency. The surety estimate will be revised to reflect any changes to decommissioning costs related to the installation of equipment and changes to groundwater restoration. The surety estimate submitted for 2014-2015 included the cost to plug the UIC Class V injection and monitor wells and the cost to remove the entire treatment system except the radium treatment IX columns which have not been purchased yet. **Figures 9-1a** through **9-1e** are intended to demonstrate the potential impact of Class V well(s) on the water balance and should not be interpreted as limitations on flow or the distribution of flow.

Table 2-1 - Well Completion Information

Well ID	Well Type	NAD 83 Northing	NAD 83 Easting	Distance from Pumping Well (ft.)	Ground Elevation (ft. amsl)	TOC Elev. (ft. amsl)	Depth To SWL (ft. TOC)	Static Water Elev. (ft. amsl)	Screened Interval (ft. bgs)	Total Screen Length (ft.)
M-FG6	Monitor/Injection	598,278.38	2,210,065.08	0.00	6,977.17	6,978.47	200.22	6,778.25	190-410	220
M-FG7	Injection	598,135.65	2,209,313.58	764.93	6,979.71	6,981.10	205.03	6,776.07	190-455	265
M-FG8	Monitor	597,239.29	2,209,761.77	1,082.45	6,960.57	6,962.27	186.85	6,775.42	120-385	265
M-FG9	Monitor	598,134.99	2,208,711.00	1,361.65	6,983.20	6,984.40	210.83	6,773.57	230-470	240
M-FG10	Monitor	598,736.00	2,209,311.85	881.35	6,987.74	6,989.03	211.24	6,777.79	200-440	240

amsl = Above Mean Sea Level
bgs = Below Ground Surface
ft. = Feet
SWL = Static Water Level
TOC = Top of Casing

Table 3-1 - Class V Well Chemistry

Analyte	Test Type	Units	M-FG6	M-FG7	M-FG8	M-FG9	M-FG10	Method Test No.
Total Alkalinity as $CaCO_3$	TOT	mg/L	95	96	129	119	101	A2320 B
Carbonate as CO_3	TOT	mg/L	7	ND	ND	ND	ND	A2320 B
Bicarbonate as HCO_3	TOT	mg/L	101	114	157	146	123	A2320 B
Calcium	TOT	mg/L	26	26	40	45	26	E200.7
Chloride	TOT	mg/L	5	5	10	7	43	E300.0
Fluoride	TOT	mg/L	0.3	0.30	0.3	0.3	0.4	A4500-F C
Magnesium	TOT	mg/L	1	2	2	1	2	E200.7
Nitrogen, Ammonia as N	TOT	mg/L	0.21	0.27	0.07	2.01	0.05	A4500-NH3 G
Nitrogen, Nitrate+Nitrite as N	TOT	mg/L	1.2	0.7	2.2	0.5	1.8	E353.2
Potassium	TOT	mg/L	2	2	2	4	3	E200.7
Silica	TOT	mg/L	14.3	13	14.8	12.6	13.8	E200.7
Sodium	TOT	mg/L	25	25	29	38	25	E200.7
Sulfate	TOT	mg/L	21	25	31	89	49	E300.0
Specific Conductance at 25 °C	TOT	umhos/cm	253	266	344	443	263	A2510 B
Laboratory pH	TOT	s.u.	8.94	8.40	8.03	8.30	8.35	A4500-H B
TDS Dried at 180 °C	TOT	mg/L	154	157	210	311	159	A2540 C
Aluminum	DIS	mg/L	ND	ND	ND	ND	ND	E200.7
Arsenic	DIS	mg/L	0.003	0.003	0.001	0.004	0.002	E200.8
Barium	DIS	mg/L	ND	ND	ND	ND	ND	E200.7
Beryllium	DIS	mg/L	ND	ND	ND	ND	ND	E200.7
Boron	DIS	mg/L	ND	ND	ND	ND	ND	E200.7
Cadmium	DIS	mg/L	ND	ND	ND	ND	ND	E200.7
Chromium	DIS	mg/L	ND	ND	ND	ND	ND	E200.7
Copper	DIS	mg/L	ND	ND	ND	ND	ND	E200.8
Iron	DIS	mg/L	0.03	ND	0.04	0.04	ND	E200.7
Lead	DIS	mg/L	ND	ND	ND	0.002	ND	E200.8
Manganese	DIS	mg/L	ND	ND	ND	ND	ND	E200.7
Mercury	DIS	mg/L	ND	ND	ND	ND	ND	E200.8
Molybdenum	DIS	mg/L	ND	ND	ND	ND	ND	E200.7
Nickel	DIS	mg/L	ND	ND	ND	ND	ND	E200.7
Selenium	DIS	mg/L	0.004	0.004	0.008	0.010	0.002	E200.8
Uranium	DIS	mg/L	0.0813	0.1130	0.1580	0.132	0.0913	E200.8
Vanadium	DIS	mg/L	ND	ND	ND	ND	ND	E200.7
Zinc	DIS	mg/L	ND	ND	0.14	ND	ND	E200.7
Beryllium	SUS	mg/L	ND	ND	ND	ND	ND	E200.8
Iron	TOT	mg/L	0.2	ND	1.03	0.87	0.08	E200.7
Manganese	TOT	mg/L	ND	ND	ND	ND	ND	E200.7
Gross Alpha	DIS	pCi/L	92.6	102	129	146	103	E900.0
Gross Alpha precision (±)	DIS	pCi/L	3.3	3.7	3.8	4.3	3.4	E900.0
Gross Alpha MDC	DIS	pCi/L	1.8	1.5	1.2	2.0	1.6	E900.0
Gross Beta	DIS	pCi/L	8.9	11.1	15.1	12.3	8.3	E900.0
Gross Beta precision (±)	DIS	pCi/L	2.1	1.9	2.4	2.2	2.0	E900.0
Gross Beta MDC	DIS	pCi/L	2.9	2.7	3.0	2.9	2.7	E900.0
Lead 210	DIS	pCi/L	0.04	0.3	-0.2	1.5	-0.4	E909.0
Lead 210 precision (±)	DIS	pCi/L	0.7	0.7	0.6	0.7	0.6	E909.0
Lead 210 MDC	DIS	pCi/L	1.1	1.2	1.1	1.1	1.1	E909.0
Polonium 210	DIS	pCi/L	0.3	0.6	0.3	1.6	0.5	H Po-02-RC
Polonium 210 precision (±)	DIS	pCi/L	0.6	0.7	0.5	1.1	0.7	H Po-02-RC
Polonium 210 MDC	DIS	pCi/L	1.1	0.8	0.8	0.9	1.0	H Po-02-RC
Radium-226	DIS	pCi/L	1.0	1.7	2.2	3.6	2.9	E903.0
Radium-226 precision (±)	DIS	pCi/L	0.23	0.25	0.28	0.40	0.36	E903.0
Radium-226 MDC	DIS	pCi/L	0.19	0.13	0.16	0.17	0.18	E903.0

Table 3-1 - Class V Well Chemistry

Analyte	Test Type	Units	M-FG6	M-FG7	M-FG8	M-FG9	M-FG10	Method Test No.
Radium-228	DIS	pCi/L	1.9	0.9	0.8	1.8	1.3	RA-05
Radium-228 precision (±)	DIS	pCi/L	0.8	0.7	0.8	0.8	0.8	RA-05
Radium-228 MDC	DIS	pCi/L	1.2	1.2	1.2	1.2	1.2	RA-05
Thorium 230	DIS	pCi/L	0.1	-0.01	0.08	0.05	0.1	E908.0
Thorium 230 precision (±)	DIS	pCi/L	0.1	0.04	0.09	0.2	0.09	E908.0
Thorium 230 MDC	DIS	pCi/L	0.1	0.1	0.2	0.5	0.1	E908.0
Lead 210	SUS	pCi/L	0.2	0.8	2.0	1.5	0.2	E909.0
Lead 210 precision (±)	SUS	pCi/L	0.4	0.5	0.5	0.6	0.5	E909.0
Lead 210 MDC	SUS	pCi/L	0.7	0.7	0.7	0.7	0.7	E909.0
Polonium 210	SUS	pCi/L	0.8	0.8	2.5	3.5	0.5	H Po-02-RC
Polonium 210 precision (±)	SUS	pCi/L	0.5	0.5	0.9	0.7	0.4	H Po-02-RC
Polonium 210 MDC	SUS	pCi/L	0.4	0.4	0.5	0.4	0.4	H Po-02-RC
Thorium 230	SUS	pCi/L	0.2	0.05	1.8	1.4	0.07	E908.0
Thorium 230 precision (±)	SUS	pCi/L	0.1	0.07	0.3	0.3	0.08	E908.0
Thorium 230 MDC	SUS	pCi/L	0.1	0.1	0.05	0.05	0.1	E908.0
Radon 222	TOT	pCi/L	1,600	2,820	3,400	8.1	878	D5072-92
Radon 222 precision (±)	TOT	pCi/L	54.0	62.6	69.6	40.5	40.5	D5072-92
Radon 222 MDC	TOT	pCi/L	62.0	59.0	63.0	70.0	52.0	D5072-92
A/C Balance (± 5)	TOT	%	0.25	-2.39	-2.11	-2.41	-29.7	A1030E
Anions	TOT	meq/L	2.57	2.68	3.67	4.48	4.77	A1030E
Cations	TOT	meq/L	2.58	2.55	3.52	4.27	2.58	A1030E
Solids, Total Dissolved Calculated	TOT	mg/L	160	160	220	280	260	A1030E
TDS Balance (0.80 - 1.20)	TOT		0.96	0.96	0.95	1.13	0.62	A1030E

DIS = Dissolved
ND = Not detected at minimum detectable concentration
SUS = Suspended
TOT = Total

Table 3-2 - Regional Receiving Aquifer Water Quality Summary

Parameters	Outlier Tolerance Interval Calculation [1]						Values with Outliers (if any) Removed					
	No. of Obs.	Mean	Tolerance Limit Factor	Standard Deviation	Lower Range	Upper Range	Minimum	Mean	Maximum	Standard Deviation	Mean ± 3 Standard Deviations [2]	
Total Alkalinity as $CaCO_3$	82	104	2.971	20.1	44.5	164.1	30	104	160	20.1	43.6	164.4
CO_3	88	1.68	2.958	1.78	-3.59	6.94	2	1.52	6.00	1.45	ND	5.88
HCO_3	88	127.09	2.958	26.93	47.44	206.75	26	127.09	196.00	26.93	46.30	207.88
Dissolved Calcium	87	63.0	2.958	25.2	-11.6	137.7	26.0	63.0	157.0	19.0	5.9	120.1
Total Chloride	95	6.23	2.945	1.33	2.31	10.16	4.00	6.23	10.00	1.33	2.23	10.23
Dissolved Fluoride	86	0.189	2.958	0.0484	0.045	0.332	-0.1	0.186	0.300	0.043	0.058	0.314
Dissolved Magnesium	87	3.15	2.958	1.23	-0.50	6.80	0	3.15	6.00	1.23	ND	6.85
Total NH_3-N	86	0.059	2.958	0.112	-0.271	0.390	0	0.044	0.360	0.041	ND	0.167
Dissolved NO_3+NO_2-N	86	0.2312	2.958	0.3311	-0.7482	1.2106	0	0.2151	1.2000	0.2972	ND	1.1067
Dissolved Potassium	87	3.16	2.958	2.43	-4.03	10.35	2.00	3.16	10.00	1.48	ND	7.60
Dissolved SiO_2	87	14.68	2.958	1.68	9.70	19.67	11.7	14.68	19.40	1.68	9.63	19.73
Dissolved Sodium	87	30.05	2.958	4.33	17.23	42.86	17.00	30.05	42.00	4.33	17.05	43.04
Total $S0_4$	86	131	2.958	55	-32	294	21	131	307	55	ND	296
Specific Conductance at 25 °C	82	485	2.971	124	116	855	291	485	879	124	112	858
Laboratory pH	86	8.10	2.958	0.39	6.95	9.25	7.32	8.07	9.16	0.32	7.10	9.04
TDS Dried at 180 °C	86	325.7	2.958	99.3	32.0	619.5	142.0	325.7	654.0	99.3	27.8	623.6
Dissolved Aluminum	87	0.1	2.958	1.81E-16	0.1	0.1	0	0.1	0.1	0	0.1	0.1
Dissolved Arsenic	87	0.0023	2.958	0.0019	-0.0034	0.0079	-0.001	0.0022	0.0080	0.0014	ND	0.0064
Dissolved Barium	87	0.0967	2.958	0.0058	0.0795	0.1139	0	0.0967	0.1	0.0058	0.0793	0.1141
Dissolved Boron	87	0.1	2.958	1.81E-16	0.1	0.1	0	0.1	0.1	0	0.1	0.1
Dissolved Cadmium	87	0.005	2.958	3.49E-18	0.005	0.005	-0.005	0.005	0.005	0	0.005	0.005
Dissolved Chromium	87	0.05	2.958	9.07E-17	0.05	0.05	0	0.05	0.05	0	0.05	0.05
Dissolved Copper	86	0.01	2.958	0.0018	0.0045	0.0155	-0.02	0.01	0.02	0	0.01	0.01
Dissolved Iron	87	0.074	2.958	0.0503	-0.0745	0.2231	-0.03	0.074	0.16	0.0503	ND	0.2249
Dissolved Lead	87	0.0019	2.958	0.0010	-0.0010	0.0048	-0.001	0.0019	0.004	0.0010	ND	0.0049
Dissolved Manganese	87	0.014	2.958	0.007	-0.0067	0.0347	-0.01	0.014	0.030	0.007	ND	0.035
Dissolved Mercury	87	0.001	2.958	0	0.001	0.001	-0.001	0.001	0.001	0	0.001	0.001
Dissolved Molybdenum	87	0.100	2.958	0.000	0.100	0.100	0.000	0.100	0.100	0.000	0.100	0.100
Dissolved Nickel	87	0.05	2.958	0	0.05	0.05	0	0.05	0.05	0	0.05	0.05
Dissolved Selenium	87	0.0189	2.958	0.0142	-0.0232	0.0609	0	0.0189	0.0630	0.0142	ND	0.0615
Dissolved Uranium	87	0.3762	2.958	0.2038	-0.2266	0.9789	0.0098	0.3762	0.9330	0.2038	ND	0.9876
Dissolved Vanadium	87	0.1	2.958	0	0.1	0.1	0	0.1	0.1	0	0.1	0.1
Dissolved Zinc	86	0.0335	2.958	0.0300	-0.0552	0.1222	0	0.0335	0.0900	0.0300	ND	0.1235
Total Iron	86	0.0778	2.958	0.2170	-0.5641	0.7197	0	0.0367	0.2700	0.0364	ND	0.1458
Total Manganese	86	0.0200	2.958	0.0110	-0.0125	0.0525	-0.0200	0.0200	0.0400	0.0110	ND	0.0530
Gross Alpha	86	367.49	2.958	191.14	-197.90	932.89	36.10	353.90	837.00	170.40	ND	865.10
Gross Beta	86	113.39	2.958	78.88	-119.92	346.70	16.80	113.39	382.00	63.70	ND	304.49
Dissolved Ra-226	87	13.890	2.958	45.466	-120.599	148.379	0	7.300	38.000	9.500	ND	35.800
Dissolved Ra-228	87	2.607	2.958	1.613	-2.164	7.378	0	2.578	9.000	1.599	ND	7.375
Dissolved Ra-226+Ra-228	87	12.320	2.958	25.467	-63.012	87.652	0	9.8	40.900	9.648	ND	38.784

[1] Less than values are denoted by a minus sign in front of the detection limit.

[2] When the mean minus three standard deviations is a negative value, ND is written for "not detected".

Parameter value exceeds WDEQ-WQD Domestic Class-of-Use (Class I).

Parameter value exceeds WDEQ-WQD Agriculture Class-of-Use (Class II).

Parameter value exceeds WDEQ-WQD Livestock Class-of-Use (Class III).

Parameter value exceeds EPA MCL criterion.

Calculation excludes outlier(s).

Table 3-3 Effluent Limits

Frequency	Parameter (dissolved)	EPA MCL: 40 CFR 140	NRC Effluent Limit: 10 CFR Part 20 App B	Receiving Aquifer Background [2]	Injectate Limit	Expected Post Treatment Quality	Groundwater Classification from WDEQ-WQD R&R Chapter 8 Table I	Sample Point(s)
Continuous	pH (standard units)	N/A	N/A	8.94	N/A	6.0 to 9.0	II	Post Treatment[1]
	Conductivity (μmhos/cm)	N/A	N/A	443	N/A	150	N/A	Post RO & Post Treatment[1]
Quarterly Grab	Selenium (mg/L)	0.05	N/A	0.01	0.05	0.0015	I	Post Treatment
	Arsenic (mg/L)	0.01	N/A	0.004	0.01	0.0005	I	
	Barium[3] (mg/L)	2	N/A	ND	2	0.0001	I	
	Beryllium[3] (mg/L)	0.004	N/A	ND	0.004	[5]	I	
	Cadmium[3]	0.005	N/A	ND	0.005	0.001	I	
	Chromium[3] (mg/L)	0.1	N/A	ND	0.1	0.0004	I	
	Copper[3] (mg/L)	1.3	N/A	ND	1.3	0.0005	I	
	Flouride[3] (mg/L)	4	N/A	0.4	4	0.0001	I	
	Lead[3] (mg/L)	0.015	N/A	ND	0.015	0.0001	I	
	Mercury[3] (mg/L)	0.002	N/A	ND	0.002	0.0001	I	
Quarterly Grab & Monthly Composite	Unat (mg/L)	0.03	0.44	0.158	0.158	0.012	N/A	
	Ra-226 (pCi/L)	5	60	3.6	5.5	0.78	Exceeds all Classes	
	Ra-228 (pCi/L)		60	1.9		[5]		
	Gross Alpha[6] (pCi/L)	15	N/A	57	57	[5]	Exceeds all Classes	
	Gross Beta (pCi/L)	4	N/A	15.1	15.1	[5]	N/A	
Monthly Composite	Th-230 (pCi/L)	N/A	100	1.9[4]	100	[5]	N/A	
	Pb-210 (pCi/L)	N/A	10	3.5[4]	10	[5]	N/A	
	Po-210 (pCi/L)	N/A	40	5.1[4]	40	[5]	N/A	

(1) Sample collected to verify treatment systems are working as designed.
(2) Receiving aquifer background water quality is based on the maximum value from samples collected from injection well and surrounding monitor wells.
(3) Since these parameters are not expected to be in the feed stock, LCI proposes to halt routine analysis for these parameters if four consecutive monthly grab samples of the feed stock contain less than the EPA MCL of the respective parameter.
(4) Includes dissolved and particulate fractions.
(5) Value not determined, but RO rejection estimated to be approximatly 98% of feed concentration.
(6) Gross Alpha value presented does not include uranium or radon contributions.

Table 4-1: Water Rights Table from State Engineer's Database

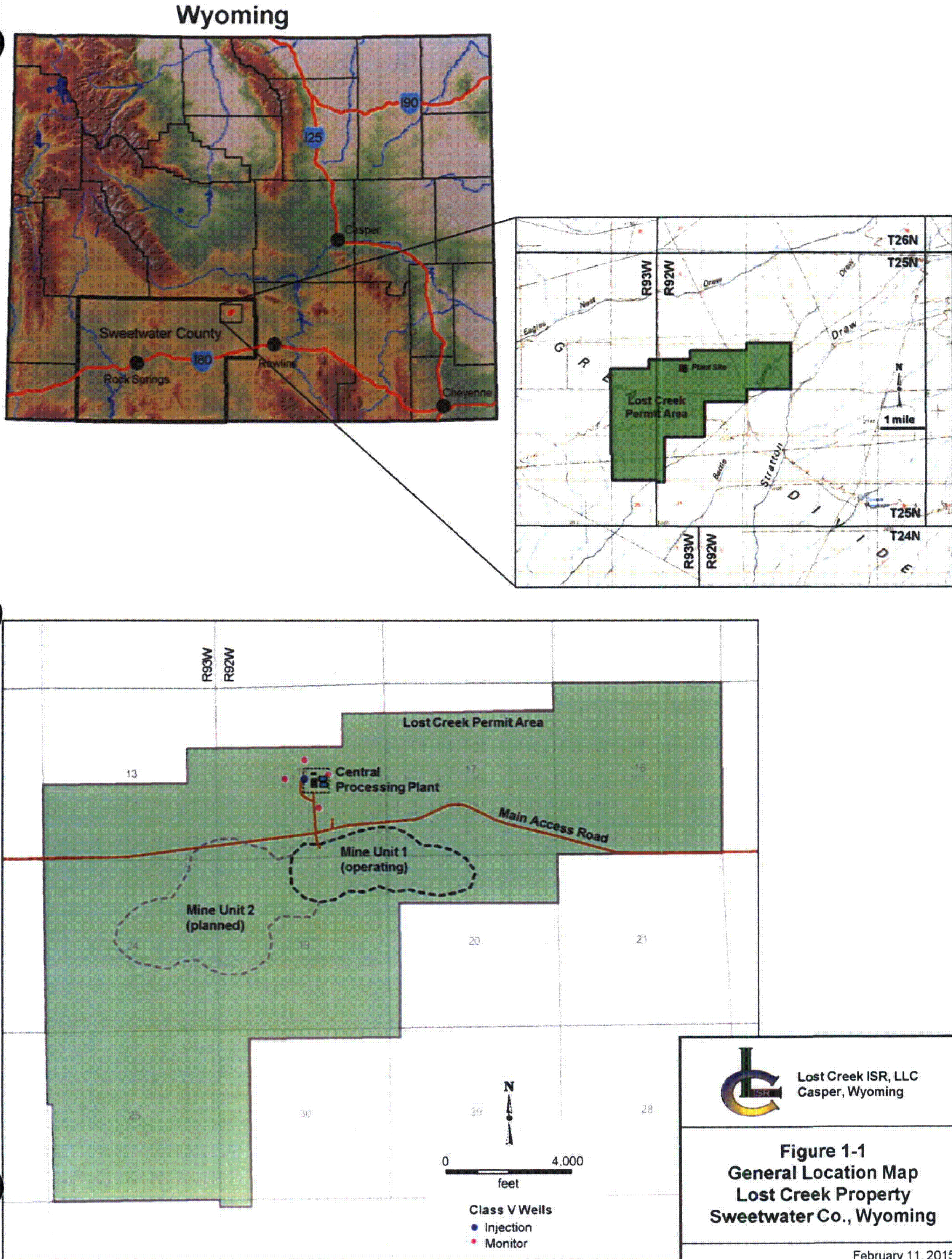
Water Rights Number	Priority Date	Summary WR Status	Company	First Name	Last Name	Facility Name	Uses	Twn	Rng	Sec	QTRQTR	Survey Type, Survey Number, Survey Suffix	Total Flow(CFS) / Appropriation (GPM)	Total depth (Ft)	Static Water Level (Ft)	Well Log (Y/N)	Depth Of Pump (Ft)	Stream Source	Active Capacity (AF)	Size of Reservoir (AF)	Facility type	Chemical Analysis (Y/N)	Latitude	Longitude	Created By
P179826.0W	02/28/2007	Unadjudicated	LOST CREEK ISR, LLC			LC 32W	MIS	025N	092W	17	NWSE	A	20	878	450	N	714		0	0	Well	N	42.136339	-107.839733	External
P186531.0W	04/08/2008	Complete	LOST CREEK ISR, LLC			ENLARGEMENT OF WELL LC32W	MIS	025N	092W	17	NWSE	A	30						0	0	Well		42.136686	-107.840703	External
P189584.0W	02/04/2009	Complete	LOST CREEK ISR, LLC			KMP-2	MON	025N	092W	17	SENE	A	0	590	226	N	400		0	0	Well	N	42.140903	-107.834978	External
P187650.0W	07/03/2008	Complete	LOST CREEK ISR, LLC			SESW17M	MON	025N	092W	17	SESW	A	0	436	173	N	0		0	0	Well	N	42.132298	-107.846011	External
P189585.0W	02/04/2009	Complete	LOST CREEK ISR, LLC			KMP-3	MON	025N	092W	17	SESW	A	0	565	204	N	400		0	0	Well	N	42.133006	-107.845522	External
P189590.0W	02/04/2009	Complete	LOST CREEK ISR, LLC			KMU-3	MON	025N	092W	17	SESW	A	0	650	205	N	400		0	0	Well	N	42.133638	-107.844056	External
P194690.0W	12/17/2010	Complete	LOST CREEK ISR, LLC			M-M6	MON	025N	092W	17	SESW	A	0	750	209	N	0		0	0	Well	N	42.133669	-107.84414	External
P175261.0W	06/09/2006	Complete	USDI - BLM[2]			LC18M, LC19M, LC20M	MON	025N	092W	17	SWSW	A	0	543	201	N	240		0	0	Well	Y	42.132444	-107.85275	External
P175263.0W	06/09/2006	Complete	USDI - BLM[2]			LC24M	MON	025N	092W	17	SWSW	A	0	531	192	N	275		0	0	Well	Y	42.131957	-107.848881	External
P179890.0W	03/01/2007	Complete	LOST CREEK ISR, LLC			HJMU-110	MON	025N	092W	17	SWSW	A6-	0	532	197	N	0		0	0	Well	N			External
P179891.0W	03/01/2007	Complete	LOST CREEK ISR, LLC			HJMP-110	MON	025N	092W	17	SWSW	A6-	0	476	175	N	0		0	0	Well	N			External
P179892.0W	03/01/2007	Complete	LOST CREEK ISR, LLC			HJMO-110	MON	025N	092W	17	SWSW	A6-	0	330	162	N	0		0	0	Well	N			External
P179893.0W	03/01/2007	Complete	LOST CREEK ISR, LLC			HJMU-111	MON	025N	092W	17	SWSW	A11-	0	545	199	N	0		0	0	Well	N			External
P179894.0W	03/01/2007	Complete	LOST CREEK ISR, LLC			HJMP-111	MON	025N	092W	17	SWSW	A11-	0	440	176	N	0		0	0	Well	N			External
P179895.0W	03/01/2007	Complete	NFU WYOMING, LLC[1]			HJMO-111	MON	025N	092W	17	SWSW	A11-	0	330	164	N	0		0	0	Well	N			External
P179908.0W	03/01/2007	Complete	LOST CREEK ISR, LLC			UKMU-102	MON	025N	092W	17	SWSW	A11-	0	580	190	N	0		0	0	Well	N			External
P179909.0W	03/01/2007	Complete	LOST CREEK ISR, LLC			UKMP-102	MON	025N	092W	17	SWSW	A11-	0	498	189	N	0		0	0	Well	N			External
P179910.0W	03/01/2007	Complete	LOST CREEK ISR, LLC			UKMO-102	MON	025N	092W	17	SWSW	A11-	0	420	165	N	0		0	0	Well	N			External
P179911.0W	03/01/2007	Complete	LOST CREEK ISR, LLC			UKMU-103	MON	025N	092W	17	SWSW	A11-	0	590	196	N	0		0	0	Well	N			External
P179912.0W	03/01/2007	Complete	LOST CREEK ISR, LLC			UKMP-103	MON	025N	092W	17	SWSW	A11-	0	537	196	N	0		0	0	Well	N			External
P179913.0W	03/01/2007	Complete	LOST CREEK ISR, LLC			UKMP-103	MON	025N	092W	17	SWSW	A11-	0	430	173	N	0		0	0	Well	N			External
P187649.0W	07/03/2008	Complete	LOST CREEK ISR, LLC			SWSW17M	MON	025N	092W	17	SWSW	A	0	428	177	N	0		0	0	Well	N	42.133455	-107.850035	External
P198903.0W	07/06/2012	Incomplete	LOST CREEK ISR, LLC			SWSW17P (UP TO 50 WELLS)	IND_GW; MIS	025N	092W	17	SWSW	A	2500						0	0	Well		42.133592	-107.850406	External
P189586.0W	02/04/2009	Complete	LOST CREEK ISR, LLC			KMP-4	MON	025N	092W	18	NESE	A	0	600	217	N	400		0	0	Well	N	42.136692	-107.855281	External
P13595.0R	02/17/2010	Complete	LOST CREEK ISR, LLC			PONDS 1 AND 2	IND_SW	025N	092W	18	NWSE	A						Blue Gulch	4.58	4.58	Reservoir		42.138278	-107.858333	SEO
P198794.0W	05/17/2012	Incomplete	LOST CREEK ISR, LLC			LC229W	MIS	025N	092W	18	NWSE	A	150	1000	300	N	813		0	0	Well	N	42.13866	-107.86179	External
P199978.0W	03/20/2013	Incomplete	LOST CREEK ISR, LLC			LC1148W	IND_GW; MIS	025N	092W	18	NWSE	A	150						0	0	Well		42.138637	-107.861808	External
P179870.0W	03/01/2007	Complete	LOST CREEK ISR, LLC			HJMP-103	MON	025N	092W	18	SESE	A16-	0	432	168	N	0		0	0	Well	N			External
P179878.0W	03/01/2007	Complete	LOST CREEK ISR, LLC			HJMU-106	MON	025N	092W	18	SESE	A16-	0	546	192	N	0		0	0	Well	N			External
P179879.0W	03/01/2007	Complete	LOST CREEK ISR, LLC			HJMP-106	MON	025N	092W	18	SESE	A16-	0	480	170	N	0		0	0	Well	N			External
P179880.0W	03/01/2007	Complete	LOST CREEK ISR, LLC			HJMO-106	MON	025N	092W	18	SESE	A16-	0	326	159	N	0		0	0	Well	N			External
P179884.0W	03/01/2007	Complete	LOST CREEK ISR, LLC			HJMU-108	MON	025N	092W	18	SESE	A16-	0	540	201	N	0		0	0	Well	N			External
P179885.0W	03/01/2007	Complete	LOST CREEK ISR, LLC			HJMP-108	MON	025N	092W	18	SESE	A16-	0	434	180	N	0		0	0	Well	N			External
P179886.0W	03/01/2007	Complete	LOST CREEK ISR, LLC			HJMO-108	MON	025N	092W	18	SESE	A16-	0	333	167	N	0		0	0	Well	N			External
P188861.0W	09/26/2008	Complete	LOST CREEK ISR, LLC	JOHN	CASH	MB-10	MON	025N	092W	18	SESE	A	0	160	160	N	0		0	0	Well	N	42.133397	-107.855292	External
P187663.0W	07/03/2008	Complete	LOST CREEK ISR, LLC			SESE18PW	MON	025N	092W	18	SESE	A	0	467	171	N	0		0	0	Well	N	42.131901	-107.85631	External
P187648.0W	07/03/2008	Complete	LOST CREEK ISR, LLC			SESE18M	MON	025N	092W	18	SESE	A	0	451	183	N	0		0	0	Well	N	42.133959	-107.855212	External
P194698.0W	12/17/2010	Complete	LOST CREEK ISR, LLC			M-M8	MON	025N	092W	18	SESE	A	0	740	203	N	0		0	0	Well	N	42.132304	-107.853619	External
P194699.0W	12/17/2010	Incomplete	LOST CREEK ISR, LLC			M-L5	MON	025N	092W	18	SESE	A	0						0	0	Well		42.13229	-107.85379	External
P198900.0W	07/06/2012	Incomplete	LOST CREEK ISR, LLC			SESE18P (UP TO 100 WELLS)	IND_GW; MIS	025N	092W	18	SESE	A	5000						0	0	Well		42.133633	-107.855275	External
P187646.0W	07/03/2008	Complete	LOST CREEK ISR, LLC			SESW18M	MON	025N	092W	18	SESW	A	0	459	183	N	0		0	0	Well	N	42.133028	-107.864972	External
P187647.0W	07/03/2008	Complete	LOST CREEK ISR, LLC			SWSE18M	MON	025N	092W	18	SWSE	A	0	459	185	N	0		0	0	Well	N	42.132969	-107.859539	External
P193897.0W	09/02/2010	Complete	LOST CREEK ISR, LLC			TW1-1	MON	025N	092W	18	SWSE	A	0	483	167	N	0		0	0	Well	N	42.13258	-107.857867	External
P198899.0W	07/06/2012	Incomplete	LOST CREEK ISR, LLC			SWSE18P (UP TO 10 WELLS)	IND_GW; MIS	025N	092W	18	SWSE	A	500						0	0	Well		42.133632	-107.860142	External
P198926.0W	08/22/2012	Incomplete	LOST CREEK ISR, LLC			LC1007W	MIS	025N	092W	18	SWSE	A	50						0	0	Well		42.134944	-107.860463	External
P201134.0W	09/20/2013	Incomplete	LOST CREEK ISR, LLC			SWSW18P (UP TO 17 WELLS)	IND_GW; MIS	025N	092W	18	SWSW	L4	850						0	0	Well		42.133392	-107.869728	External
P175264.0W	06/09/2006	Complete	USDI - BLM[2]			LC25M	MON	025N	092W	19	NENE	A	0	349	164	N	280		0	0	Well	Y	42.130396	-107.853233	External
P179856.0W	03/01/2007	Complete	LOST CREEK ISR, LLC			HJT 101	MON	025N	092W	19	NENE	A1-	0	477	174	N	0		0	0	Well	N			External
P179857.0W	03/01/2007	Complete	LOST CREEK ISR, LLC			HJT-102	MON	025N	092W	19	NENE	A1-	0	417	171	N	0		0	0	Well	N			External
P179858.0W	03/01/2007	Complete	LOST CREEK ISR, LLC			HJT 103	MON	025N	092W	19	NENE	A1-	0	450	188	N	0		0	0	Well	N			External
P179863.0W	03/01/2007	Complete	LOST CREEK ISR, LLC			HJMU-101	MON	025N	092W	19	NENE	A1-	0	535	199	N	0		0	0	Well	N			External
P179864.0W	03/01/2007	Complete	USDI - BLM[2]			HJMP-101	MON	025N	092W	19	NENE	A1-	0	465	179	N	0		0	0	Well	N			External
P179865.0W	03/01/2007	Complete	LOST CREEK ISR, LLC			HJMO-101	MON	025N	092W	19	NENE	A1-	0	326	167	N	0		0	0	Well	N			External
P179866.0W	03/01/2007	Complete	USDI - BLM[2]			HJMV-102	MON	025N	092W	19	NENE	A1-	0	525	179	N	0		0	0	Well	N	42.130822	-107.856467	External
P179867.0W	03/01/2007	Complete	LOST CREEK ISR, LLC			HJMP-102	MON	025N	092W	19	NENE	A1-	0	435	171	N	0		0	0	Well	N			External
P179868.0W	03/01/2007	Complete	USDI - BLM[2]			HJMO-102	MON	025N	092W	19	NENE	A1-	0	330	155	N	0		0	0	Well	N			External
P179869.0W	03/01/2007	Complete	USDI - BLM[2]			HJMU-103	MON	025N	092W	19	NENE	A16-	0	540	190	N	0		0	0	Well	N			External
P179871.0W	03/01/2007	Complete	LOST CREEK ISR, LLC			HJMO-103	MON	025N	092W	19	NENE	A16-	0	327	156	N	0		0	0	Well	N			External
P179872.0W	03/01/2007	Complete	LOST CREEK ISR, LLC			HJMU-104	MON	025N	092W	19	NENE	A1-	0	550	193	N	0		0	0	Well	N			External
P179873.0W	03/01/2007	Complete	LOST CREEK ISR, LLC			HJMP-104	MON	025N	092W	19	NENE	A1-	0	430	173	N	0		0	0	Well	N			External
P179874.0W	03/01/2007	Complete	LOST CREEK ISR, LLC			HJMO-104	MON	025N	092W	19	NENE	A1-	0	326	160	N	0		0	0	Well	N			External
P179875.0W	03/01/2007	Complete	LOST CREEK ISR, LLC			HJMU-105	MON	025N	092W	19	NENE	A1-	0	542	191	N	0		0	0	Well	N			External
P179876.0W	03/01/2007	Complete	LOST CREEK ISR, LLC			HJMP-105	MON	025N	092W	19	NENE	A1-	0	463	168	N	0		0	0	Well	N			External
P179877.0W	03/01/2007	Complete	LOST CREEK ISR, LLC			HJMO-105	MON	025N	092W	19	NENE	A1-	0	323	157	N	0		0	0	Well	N			External
P187653.0W	07/03/2008	Complete	LOST CREEK ISR, LLC			NENE19M	MON	025N	092W	19	NENE	A	0	424	177	N	0		0	0	Well	N	42.128861	-107.85539	External
P189591.0W	02/04/2009	Complete	LOST CREEK ISR, LLC			KMU-4	MON	025N	092W	19	NENE	A	0	635	197	N	400		0	0	Well	N	42.130939	-107.855778	External
P189593.0W	02/04/2009	Complete	LOST CREEK ISR, LLC			KPW-2	MON	025N	092W	19	NENE	A	0	590	193	N	470		0	0	Well	N	42.130911	-107.856412	External
P198898.0W	07/06/2012	Incomplete	LOST CREEK ISR, LLC			NENE19P (UP TO 190 WELLS)	IND_GW; MIS	025N	092W	19	NENE	A	9500						0	0	Well		42.129991	-107.855256	External
P187656.0W	07/03/2008	Complete	LOST CREEK ISR, LLC			NENW19M	MON	025N	092W	19	NENW	A	0	472	188	N	0		0	0	Well	N	42.129326	-107.863214	External
P193898.0W	09/02/2010	Incomplete	LOST CREEK ISR, LLC			TW1-2	MON	025N	092W	19	NENW	A	25						0	0	Well		42.130123	-107.862661	External

Table 4-1: Water Rights Table from State Engineer's Database

Water Rights Number	Priority Date	Summary WR Status	Company	First Name	Last Name	Facility Name	Uses	Twn	Rng	Sec	QTRQTR	Survey Type, Survey Number, Survey Suffix	Total Flow(CFS) / Appropriation (GPM)	Total depth (Ft)	Static Water Level (Ft)	Well Log (Y/N)	Depth Of Pump (Ft)	Stream Source	Active Capacity (AF)	Size of Reservoir (AF)	Facility type	Chemical Analysis (Y/N)	Latitude	Longitude	Created By
P201137.0W	09/20/2013	Incomplete	LOST CREEK ISR, LLC			NENW19P (UP TO 460 WELLS)	IND_GW; MIS	025N	092W	19	NENW	A	23000						0	0	Well		42.129948	-107.864969	External
P187659.0W	07/03/2008	Complete	LOST CREEK ISR, LLC			NWNE19MP	MON	025N	092W	19	NWNE	A	0	438	180	N	0		0	0	Well	N	42.130632	-107.860055	External
P187658.0W	07/03/2008	Complete	LOST CREEK ISR, LLC			NWNE19MO	MON	025N	092W	19	NWNE	A	0	342	165	N	0		0	0	Well	N	42.130616	-107.860081	External
P187657.0W	07/03/2008	Complete	LOST CREEK ISR, LLC			NWNE19MU	MON	025N	092W	19	NWNE	A	0	539	195	N	0		0	0	Well	N	42.130633	-107.860125	External
P193899.0W	09/01/2010	Complete	LOST CREEK ISR, LLC			OW1-1	MON	025N	092W	19	NWNE	A	0	525	188	N	0		0	0	Well	N	42.129796	-107.860133	External
P198897.0W	07/06/2012	Incomplete	LOST CREEK ISR, LLC			NWNE19P (UP TO 280 WELLS)	IND_GW; MIS	025N	092W	19	NWNE	A	14000						0	0	Well		42.130002	-107.86013	External
P201138.0W	09/20/2013	Incomplete	LOST CREEK ISR, LLC			NWNE19P (UP TO 35 WELLS)	IND_GW; MIS	025N	092W	19	NWNE	A	1750						0	0	Well		42.130004	-107.860127	External
P200773.0W	07/18/2013	Incomplete	LOST CREEK ISR, LLC			PW202A	TST	025N	092W	19	NWNW	L1	0						0	0	Well		42.129534	-107.871701	External
P200774.0W	07/18/2013	Incomplete	LOST CREEK ISR, LLC			M-HJ211	TST	025N	092W	19	NWNW	L1	0						0	0	Well		42.128148	-107.867853	External
P201136.0W	09/20/2013	Incomplete	LOST CREEK ISR, LLC			NWNW19P (UP TO 230 WELLS)	IND_GW; MIS	025N	092W	19	NWNW	L1	11500						0	0	Well		42.129803	-107.869729	External
P201147.0W	09/20/2013	Incomplete	LOST CREEK ISR, LLC			NWSW19P (UP TO 58 WELLS)	IND_GW; MIS	025N	092W	19	NWSW	L3	2900						0	0	Well		42.122518	-107.869742	External
P201143.0W	09/20/2013	Incomplete	LOST CREEK ISR, LLC			SENW19P (UP TO 46 WELLS)	IND_GW; MIS	025N	092W	19	SENW	A	2300						0	0	Well		42.126241	-107.864977	External
P187655.0W	07/03/2008	Complete	LOST CREEK ISR, LLC			SWNE19M	MON	025N	092W	19	SWNE	A	0	488	180	N	0		0	0	Well	N	42.127847	-107.860481	External
P189587.0W	02/04/2009	Complete	LOST CREEK ISR, LLC			KMP-5	MON	025N	092W	19	SWNE	A	0	585	184	N	400		0	0	Well	N	42.125728	-107.860144	External
P201144.0W	09/20/2013	Incomplete	LOST CREEK ISR, LLC			SWNE19P (UP TO 6 WELLS)	IND_GW; MIS	025N	092W	19	SWNE	A	300						0	0	Well		42.126267	-107.860127	External
P201142.0W	09/20/2013	Incomplete	LOST CREEK ISR, LLC			SWNW19P (UP TO 202 WELLS)	IND_GW; MIS	025N	092W	19	SWNW	L2	10100						0	0	Well		42.126135	-107.869737	External
P175265.0W	06/09/2006	Complete	USDI - BLM[2]			LC26M	MON	025N	092W	20	NENE	A	0	431	169	N	259		0	0	Well	Y	42.130835	-107.835541	External
P179827.0W	02/28/2007	Unadjudicated	LOST CREEK ISR, LLC			LC 33W	MIS	025N	092W	20	NENE	A	20	945	400	N	762		0	0	Well	N			External
P186532.0W	04/08/2008	Complete	LOST CREEK ISR, LLC			ENLARGEMENT OF WELL LC33W	MIS	025N	092W	20	NENE	A	30						0	0	Well		42.129411	-107.835783	External
P189583.0W	02/04/2009	Complete	LOST CREEK ISR, LLC			KMP-1	MON	025N	092W	20	NENE	A	22	505	167	N	400		0	0	Well	N	42.129369	-107.835847	External
P179862.0W	03/01/2007	Complete	USDI - BLM[2]			HJT 107	MON	025N	092W	20	NENW	A5-	0	163	162	N	0		0	0	Well	N			External
P179902.0W	03/01/2007	Complete	LOST CREEK ISR, LLC			HJMU-114	MON	025N	092W	20	NENW	A5-	0	553	187	N	0		0	0	Well	N			External
P179903.0W	03/01/2007	Complete	LOST CREEK ISR, LLC			HJMP-114	MON	025N	092W	20	NENW	A5-	0	460	179	N	0		0	0	Well	N			External
P179904.0W	03/01/2007	Complete	LOST CREEK ISR, LLC			HJMO-114	MON	025N	092W	20	NENW	A5-	0	360	156	N	0		0	0	Well	N			External
P187662.0W	07/03/2008	Complete	LOST CREEK ISR, LLC			NENW20MP	MON	025N	092W	20	NENW	A	0	439	172	N	0		0	0	Well	N	42.130023	-107.845391	External
P187661.0W	07/03/2008	Complete	LOST CREEK ISR, LLC			NENW20MO	MON	025N	092W	20	NENW	A	0	340	159	N	0		0	0	Well	N	42.130059	-107.845409	External
P187660.0W	07/03/2008	Complete	LOST CREEK ISR, LLC			NENW20MU	MON	025N	092W	20	NENW	A	0	541	188	N	0		0	0	Well	N	42.130018	-107.845453	External
P187651.0W	07/03/2008	Complete	LOST CREEK ISR, LLC			NENW20M	MON	025N	092W	20	NENW	A	0	442	177	N	0		0	0	Well	N	42.129301	-107.844586	External
P189588.0W	02/04/2009	Complete	LOST CREEK ISR, LLC			KMU-1	MON	025N	092W	20	NENW	A	0	675	192	N	400		0	0	Well	N	42.129339	-107.845486	External
P189592.0W	02/04/2009	Complete	LOST CREEK ISR, LLC			KPW-1	MON	025N	092W	20	NENW	A	0	610	188	N	490		0	0	Well	N	42.13101	-107.845192	External
P192102.0W	01/22/2010	Incomplete	LOST CREEK ISR, LLC			M-M2	MON	025N	092W	20	NENW	A	0						0	0	Well		42.129422	-107.845528	External
P192103.0W	01/22/2010	Incomplete	LOST CREEK ISR, LLC			M-UKM1	MON	025N	092W	20	NENW	A	0						0	0	Well		42.129525	-107.845486	External
P192104.0W	01/22/2010	Complete	LOST CREEK ISR, LLC			M-L1	MON	025N	092W	20	NENW	A	0	670	0	N	0		0	0	Well	N	42.129444	-107.845403	External
P192106.0W	01/22/2010	Complete	LOST CREEK ISR, LLC			M-M1	MON	025N	092W	20	NENW	A	0	770	0	N	0		0	0	Well	N	42.129631	-107.845756	External
P194694.0W	12/17/2010	Complete	LOST CREEK ISR, LLC			M-KM2	MON	025N	092W	20	NENW	A	0	580	193	N	0		0	0	Well	N	42.128156	-107.844983	External
P194696.0W	12/17/2010	Complete	LOST CREEK ISR, LLC			KPW-3	MON	025N	092W	20	NENW	A	0	590	97	N	0		0	0	Well	N	42.130117	-107.845331	External
P194697.0W	12/17/2010	Complete	LOST CREEK ISR, LLC			M-N1	MON	025N	092W	20	NENW	A	0	850	205	N	0		0	0	Well	N	42.130093	-107.84575	External
P194709.0W	12/20/2010	Incomplete	LOST CREEK ISR, LLC			5S-L1	MON	025N	092W	20	NENW	A	0						0	0	Well		42.130417	-107.845494	External
P194710.0W	12/20/2010	Complete	LOST CREEK ISR, LLC			5S-M1	MON	025N	092W	20	NENW	A	0	900	210	N	0		0	0	Well	N	42.13118	-107.845134	External
P198902.0W	07/06/2012	Incomplete	LOST CREEK ISR, LLC			NENW20P (UP TO 140 WELLS)	IND_GW; MIS	025N	092W	20	NENW	A	7000						0	0	Well		42.129901	-107.845518	External
P189589.0W	02/04/2009	Complete	LOST CREEK ISR, LLC			KMU-2	MON	025N	092W	20	NWNE	A	0	650	194	N	400		0	0	Well	N	42.129403	-107.840675	External
P190176.0W	04/20/2009	Complete	LOST CREEK ISR, LLC			NWNE20	MON	025N	092W	20	NWNE	A	0	438	174.7	N	0		0	0	Well	N	42.130261	-107.842644	SEO
P192101.0W	01/22/2010	Complete	LOST CREEK ISR, LLC			M-M3	MON	025N	092W	20	NWNE	A	0	770	0	N	0		0	0	Well	N	42.131008	-107.84287	External
P192105.0W	01/22/2010	Complete	LOST CREEK ISR, LLC			M-L2	MON	025N	092W	20	NWNE	A	0	675	0	N	0		0	0	Well	N	42.129631	-107.840717	External
P194689.0W	12/17/2010	Complete	LOST CREEK ISR, LLC			M-M5	MON	025N	092W	20	NWNE	A	0	775	204	N	0		0	0	Well	N	42.130937	-107.840508	External
P194695.0W	12/17/2010	Complete	LOST CREEK ISR, LLC			M-KM1	MON	025N	092W	20	NWNE	A	0	590	194	N	0		0	0	Well	N	42.130979	-107.840751	External
P194708.0W	12/20/2010	Complete	LOST CREEK ISR, LLC			5S-KM5	MON	025N	092W	20	NWNE	A	0	610	190	N	0		0	0	Well	N	42.130961	-107.842928	External
P175260.0W	06/09/2006	Complete	LOST CREEK ISR, LLC			LC15M, LC16M, LC17M, LC29M	MON	025N	092W	20	NWNW	A	0	565	184	N	280		0	0	Well	Y	42.130963	-107.848961	External
P179859.0W	03/01/2007	Complete	LOST CREEK ISR, LLC			HJT 104	MON	025N	092W	20	NWNW	A6-	0	460	170	N	0		0	0	Well	N			External
P179860.0W	03/01/2007	Complete	LOST CREEK ISR, LLC			HJT 105	MON	025N	092W	20	NWNW	A6-	0	438	170	N	0		0	0	Well	N			External
P179861.0W	03/01/2007	Complete	LOST CREEK ISR, LLC			HJT 106	MON	025N	092W	20	NWNW	A6-	0	162	151	N	0		0	0	Well	N			External
P179881.0W	03/01/2007	Complete	LOST CREEK ISR, LLC			HJMU-107	MON	025N	092W	20	NWNW	A1-	0	580	188	N	0		0	0	Well	N			External
P179882.0W	03/01/2007	Complete	USDI - BLM[2]			HJMP-107	MON	025N	092W	20	NWNW	A1-	0	460	182	N	0		0	0	Well	N			External
P179883.0W	03/01/2007	Complete	LOST CREEK ISR, LLC			HJMO-107	MON	025N	092W	20	NWNW	A1-	0	369	161	N	0		0	0	Well	N			External
P179887.0W	03/01/2007	Complete	LOST CREEK ISR, LLC			HJMU-109	MON	025N	092W	20	NWNW	A6-	0	574	189	N	0		0	0	Well	N			External
P179888.0W	03/01/2007	Complete	LOST CREEK ISR, LLC			HJMP-109	MON	025N	092W	20	NWNW	A6-	0	512	183	N	0		0	0	Well	N			External
P179889.0W	03/01/2007	Complete	LOST CREEK ISR, LLC			HJMO-109	MON	025N	092W	20	NWNW	A6-	0	370	160	N	0		0	0	Well	N			External
P179896.0W	03/01/2007	Complete	LOST CREEK ISR, LLC			HJMU-112	MON	025N	092W	20	NWNW	A6-	0	560	182	N	0		0	0	Well	N			External
P179897.0W	03/01/2007	Complete	LOST CREEK ISR, LLC			HJMP-112	MON	025N	092W	20	NWNW	A6-	0	400	176	N	0		0	0	Well	N			External
P179898.0W	03/01/2007	Complete	LOST CREEK ISR, LLC			HJMO-112	MON	025N	092W	20	NWNW	A6-	0	350	155	N	0		0	0	Well	N			External
P179899.0W	03/01/2007	Complete	LOST CREEK ISR, LLC			HJMU-113	MON	025N	092W	20	NWNW	A6-	0	555	185	N	0		0	0	Well	N			External
P179900.0W	03/01/2007	Complete	LOST CREEK ISR, LLC			HJMP-113	MON	025N	092W	20	NWNW	A6-	0	462	179	N	0		0	0	Well	N			External
P179901.0W	03/01/2007	Complete	LOST CREEK ISR, LLC			HJMO-113	MON	025N	092W	20	NWNW	A6-	0	356	157	N	0		0	0	Well	N			External
P179905.0W	03/01/2007	Complete	LOST CREEK ISR, LLC			UKMU-101	MON	025N	092W	20	NWNW	A6-	0	630	191	N	0		0	0	Well	N			External
P179906.0W	03/01/2007	Complete	LOST CREEK ISR, LLC			UKMP-101	MON	025N	092W	20	NWNW	A6-	0	575	190	N	0		0	0	Well	N			External
P179907.0W	03/01/2007	Complete	LOST CREEK ISR, LLC			UKMO-101	MON	025N	092W	20	NWNW	A6-	0	487	178	N	0		0	0	Well	N			External
P187664.0W	07/03/2008	Complete	LOST CREEK ISR, LLC			NWNW20PW	MON	025N	092W	20	NWNW	A	0	495	185	N	0		0	0	Well	N	42.130254	-107.851717	External
P187652.0W	07/03/2008	Complete	LOST CREEK ISR, LLC			NWNW20M	MON	025N	092W	20	NWNW	A	0	436	174	N	0		0	0	Well	N	42.12867	-107.850202	External
P194691.0W	12/17/2010	Complete	LOST CREEK ISR, LLC			M-M7	MON	025N	092W	20	NWNW	A	0	770	195	N	0		0	0	Well	N	42.130476	-107.84975	External
P194693.0W	12/17/2010	Complete	LOST CREEK ISR, LLC			M-L3	MON	025N	092W	20	NWNW	A	0	700	189	N	0		0	0	Well	N	42.130522	-107.849895	External

Table 4-1: Water Rights Table from State Engineer's Database

Water Rights Number	Priority Date	Summary WR Status	Company	First Name	Last Name	Facility Name	Uses	Twn	Rng	Sec	QTRQTR	Survey Type, Survey Number, Survey Suffix	Total Flow(CFS) / Appropriation (GPM)	Total depth (Ft)	Static Water Level (Ft)	Well Log (Y/N)	Depth Of Pump (Ft)	Stream Source	Active Capacity (AF)	Size of Reservoir (AF)	Facility type	Chemical Analysis (Y/N)	Latitude	Longitude	Created By
P198901.0W	07/06/2012	Incomplete	LOST CREEK ISR, LLC			NWNW20P (UP TO 170 WELLS)	IND_GW; MIS	025N	092W	20	NWNW	A	8500						0	0	Well		42.129961	-107.850387	External
P194688.0W	12/17/2010	Incomplete	LOST CREEK ISR, LLC			M-M4	MON	025N	092W	20	SENW	A	0						0	0	Well		42.12799	-107.84479	External
P194692.0W	12/17/2010	Complete	LOST CREEK ISR, LLC			M-L4	MON	025N	092W	20	SENW	A	0	670	197	N	0		0	0	Well	N	42.127993	-107.845191	External
P198446.0W	06/05/2012	Incomplete	LOST CREEK ISR, LLC			M-HJ3	MON	025N	092W	20	SWSE	A	0						0	0	Well		42.118028	-107.842266	External
P198447.0W	06/05/2012	Incomplete	LOST CREEK ISR, LLC			M-KM6	MON	025N	092W	20	SWSE	A	0						0	0	Well		42.118333	-107.842262	External
P201133.0W	09/20/2013	Incomplete	LOST CREEK ISR, LLC			SESE13P (UP TO 6 WELLS)	IND_GW; MIS	025N	093W	13	SESE	A	300						0	0	Well		42.133339	-107.874554	External
P188852.0W	09/26/2008	Complete	LOST CREEK ISR, LLC	JOHN	CASH	MB-01	MON	025N	093W	13	SWSE	A	0	280	233	N	0		0	0	Well	N	42.134021	-107.879655	External
P188853.0W	09/26/2008	Complete	LOST CREEK ISR, LLC	JOHN	CASH	MB-02	MON	025N	093W	13	SWSE	A	0	450	242	N	0		0	0	Well	N	42.134038	-107.879448	External
P188854.0W	09/26/2008	Complete	LOST CREEK ISR, LLC	JOHN	CASH	MB-03	MON	025N	093W	13	SWSE	A	0	587	259	N	0		0	0	Well	N	42.134023	-107.879275	External
P188855.0W	09/26/2008	Complete	LOST CREEK ISR, LLC	JOHN	CASH	MB-04	MON	025N	093W	13	SWSE	A	0	640	274	N	0		0	0	Well	N	42.134069	-107.879101	External
P189581.0W	02/04/2009	Complete	LOST CREEK ISR, LLC			MB-12	MON	025N	093W	13	SWSE	A	17	770	277	N	400		0	0	Well	N	42.132911	-107.87945	External
P198928.0W	09/06/2012	Incomplete	LOST CREEK ISR, LLC			LC1008W	MIS	025N	093W	13	SWSW	A	50						0	0	Well		42.133808	-107.887072	External
P201135.0W	09/20/2013	Incomplete	LOST CREEK ISR, LLC			NENE24P (UP TO 87 WELLS)	IND_GW; MIS	025N	093W	24	NENE	A	4350						0	0	Well		42.129727	-107.87455	External
P201146.0W	09/20/2013	Incomplete	LOST CREEK ISR, LLC			NESE24P (UP TO 12 WELLS)	IND_GW; MIS	025N	093W	24	NESE	A	600						0	0	Well		42.122507	-107.874559	External
P201145.0W	09/20/2013	Incomplete	LOST CREEK ISR, LLC			NWSE24P (UP TO 29 WELLS)	IND_GW; MIS	025N	093W	24	NWSE	A	1450						0	0	Well		42.122543	-107.879489	External
P200456.0W	06/07/2013	Incomplete	LOST CREEK ISR, LLC			M-HJ203	TST	025N	093W	24	SENE	A	0						0	0	Well		42.126006	-107.876517	External
P200772.0W	07/18/2013	Incomplete	LOST CREEK ISR, LLC			PW201	TST	025N	093W	24	SENE	A	0						0	0	Well		42.124898	-107.874467	External
P200775.0W	07/18/2013	Incomplete	LOST CREEK ISR, LLC			M-HJ202A	TST	025N	093W	24	SENE	A	0						0	0	Well		42.127401	-107.875944	External
P201141.0W	09/20/2013	Incomplete	LOST CREEK ISR, LLC			SENE24P (UP TO 202 WELLS)	IND_GW; MIS	025N	093W	24	SENE	A	10100						0	0	Well		42.12612	-107.874555	External
P201139.0W	09/20/2013	Incomplete	LOST CREEK ISR, LLC			SENW24P (UP TO 12 WELLS)	IND_GW; MIS	025N	093W	24	SENW	A	600						0	0	Well		42.126163	-107.884415	External
P175262.0W	06/09/2006	Complete	USDI - BLM[2]			LC21M, LC22M, LC23M, LC30M	MON	025N	093W	24	SWNE	A	0	630	219	N	275		0	0	Well	Y	42.125696	-107.879523	External
P189618.0W	02/06/2009	Complete	LOST CREEK ISR, LLC			MB-14	MON	025N	093W	24	SWNE	A	0	740	222	N	400		0	0	Well	N	42.125698	-107.879717	External
P201140.0W	09/20/2013	Incomplete	LOST CREEK ISR, LLC			SWNE24P (UP TO 357 WELLS)	IND_GW; MIS	025N	093W	24	SWNE	A	17850						0	0	Well		42.126142	-107.879485	External



Lost Creek ISR, LLC
Casper, Wyoming

Figure 1-1
General Location Map
Lost Creek Property
Sweetwater Co., Wyoming

February 11, 2015

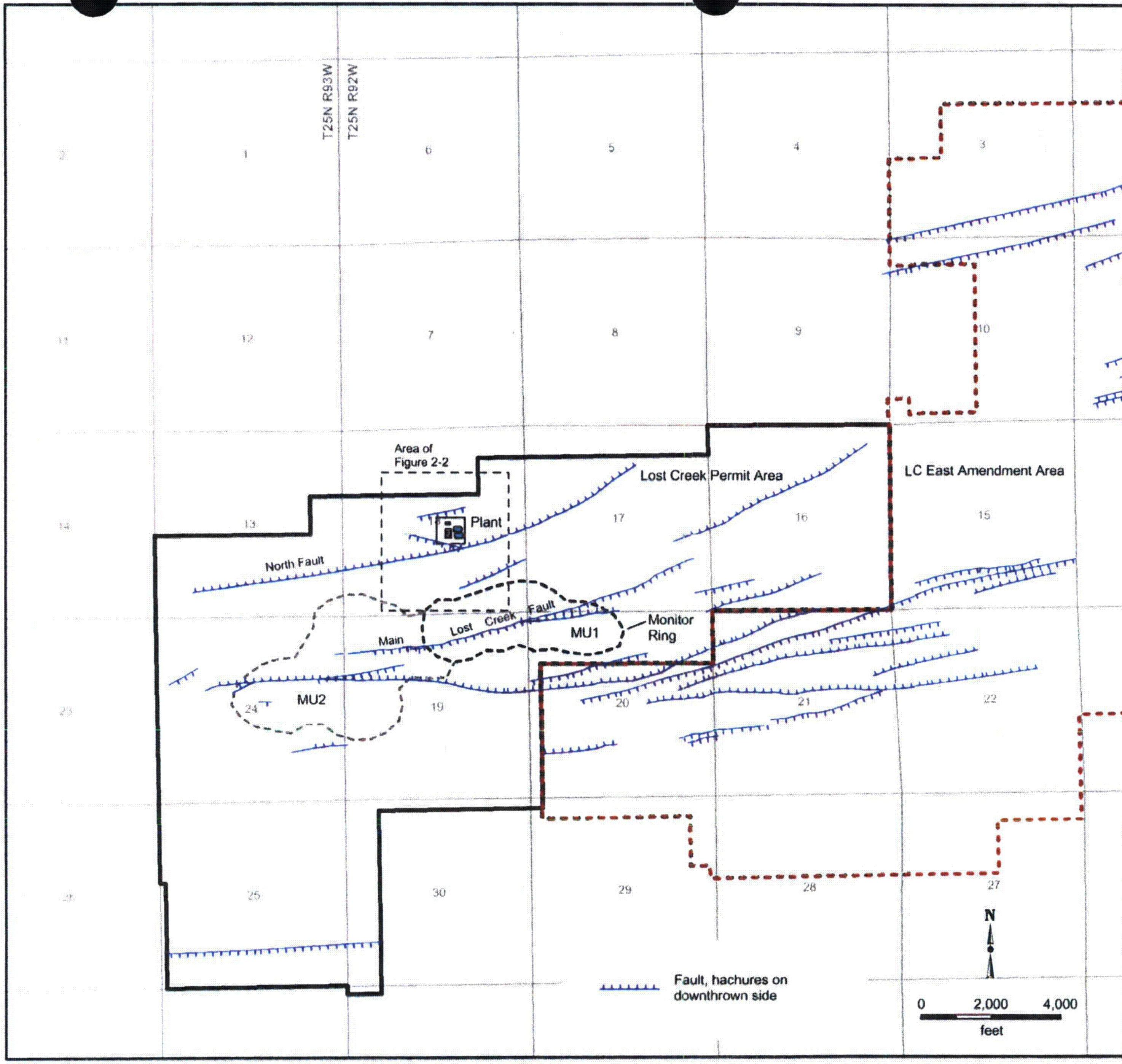
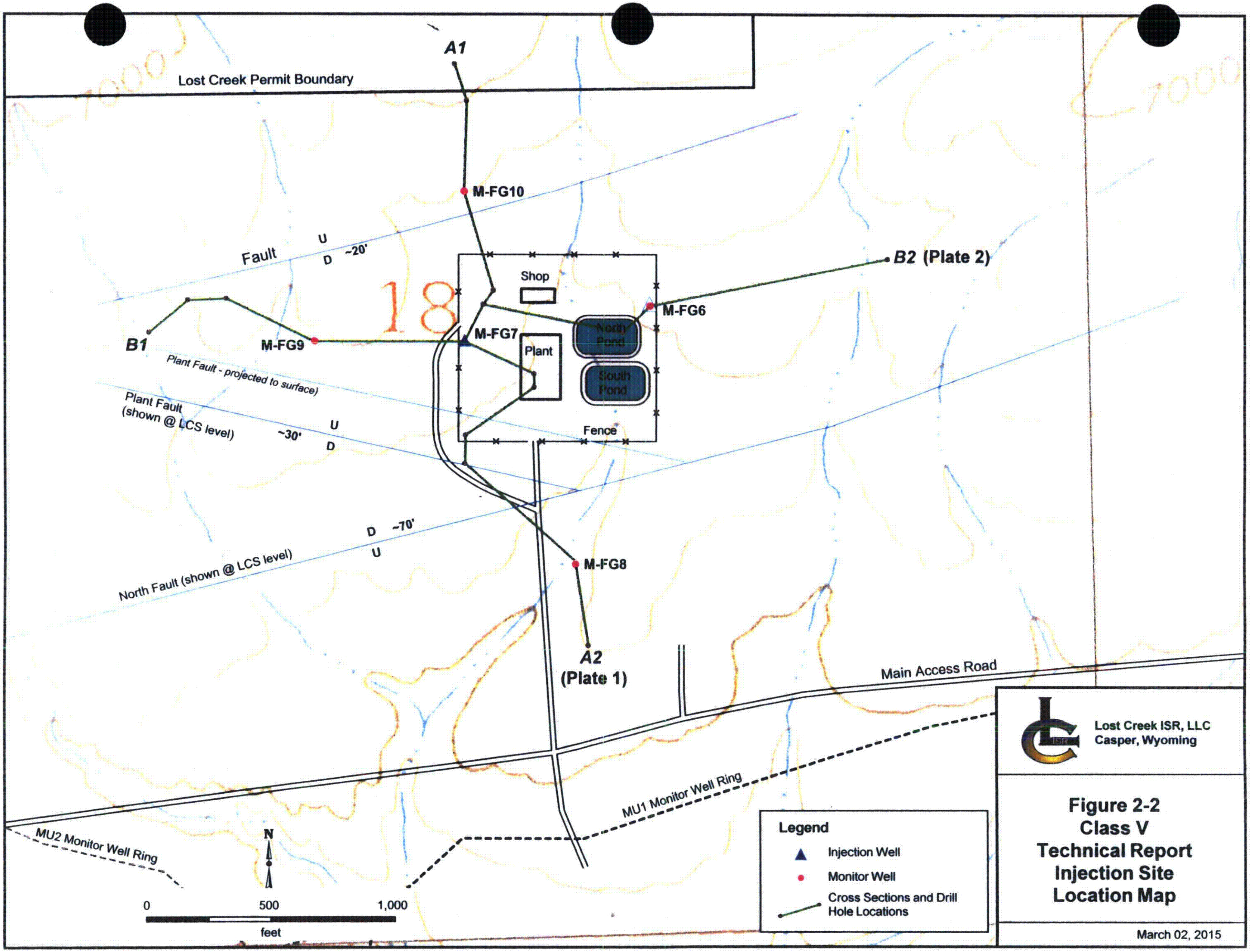
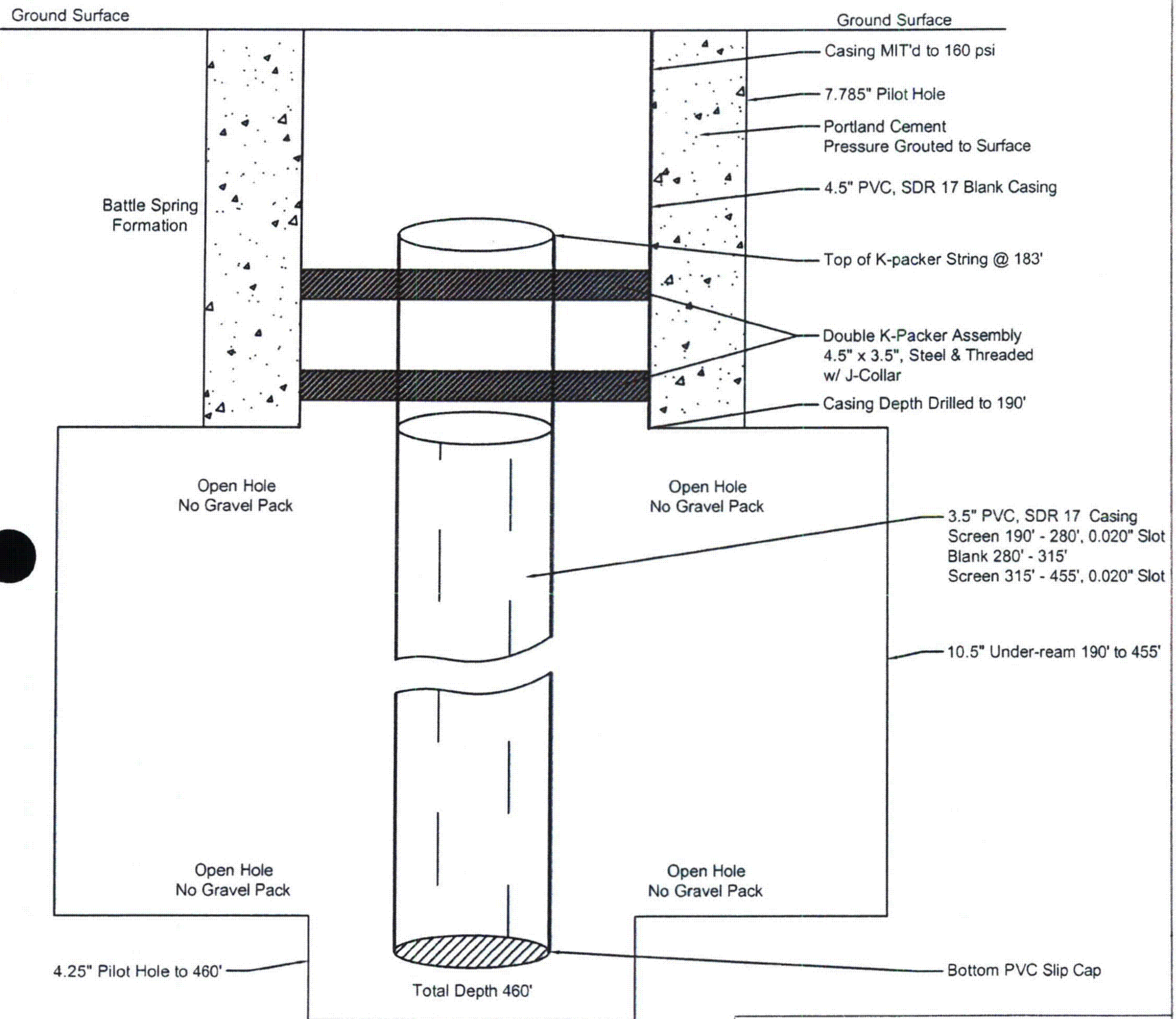


Figure 2-1
Faults within the Lost Creek Permit and LC East Amendment Areas

February 11, 2015


A1
Lost Creek Permit Boundary
7000
M-FG10
Fault
U
D
~20'
18
Shop
B2 (Plate 2)
M-FG6
North Pond
South Pond
M-FG7
Plant
B1
M-FG9
Plant Fault - projected to surface)
Plant Fault
(shown @ LCS level)
~30'
U
D
Fence
D
~70'
U
North Fault (shown @ LCS level)
M-FG8
A2
(Plate 1)
Main Access Road
MU1 Monitor Well Ring
MU2 Monitor Well Ring
N
0
500
1,000
feet
Legend
Injection Well
Monitor Well
Cross Sections and Drill Hole Locations
Lost Creek ISR, LLC
Casper, Wyoming
Figure 2-2
Class V
Technical Report
Injection Site
Location Map
March 02, 2015



Lost Creek ISR, LLC
Casper, Wyoming

Figure 2-3

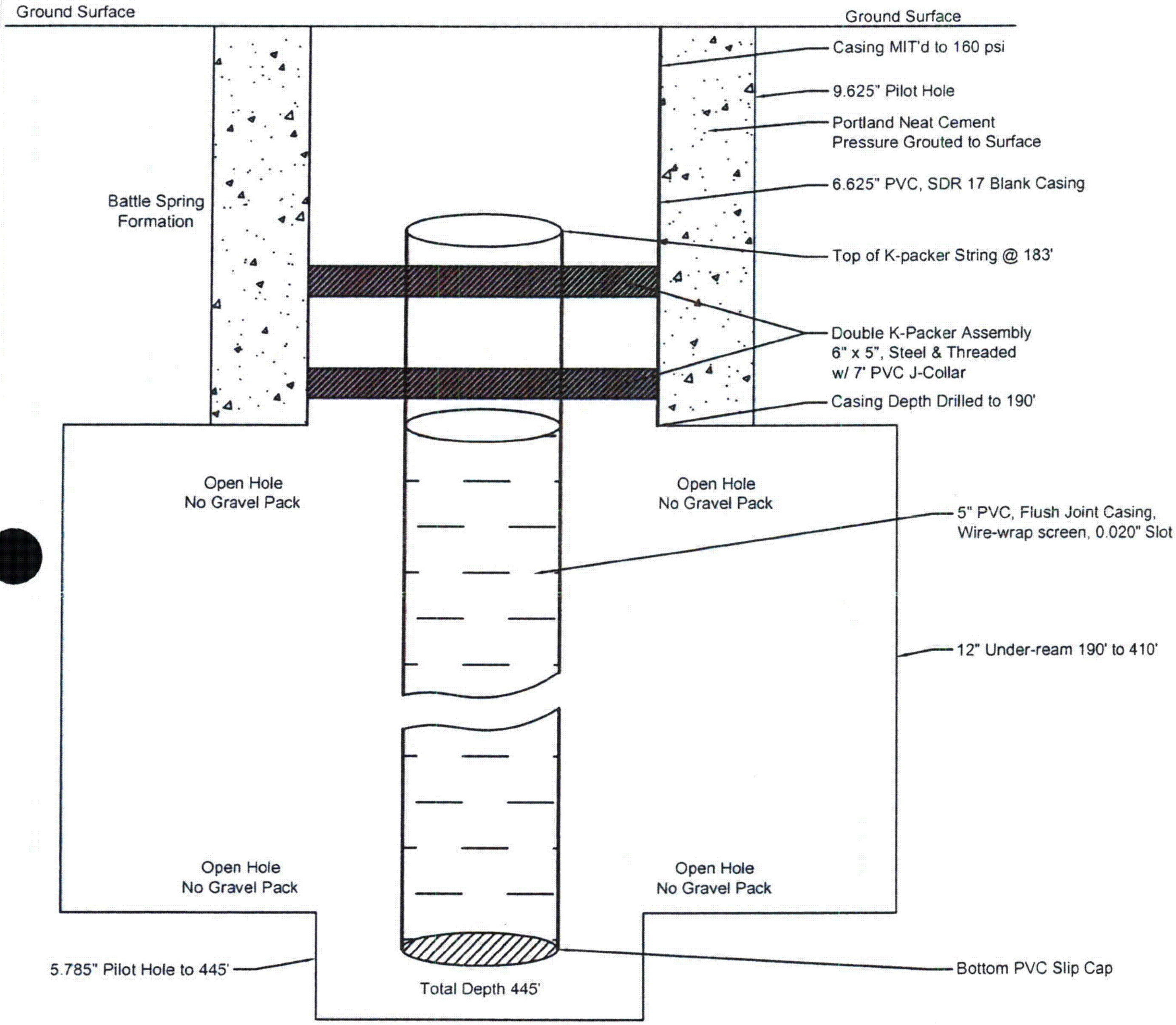
Injection Well M-FG7 Construction Schematic

Scale: Not To Scale | Drawn By: JHC

Issued / Revised: 02.09.2015

Drawing Name: Injection Well M-FG7 Construction Diagram.dwg

File Path: S:\GIS\LostCreek\Class V Wells



Lost Creek ISR, LLC
Casper, Wyoming

Figure 2-4

Injection Well M-FG6 Construction Schematic

Scale: Not To Scale	Drawn By: JHC
Issued / Revised: 02.10.2015	
Drawing Name: Injection Well M-FG6 Construction Diagram.dwg	
File Path: S:\GIS\LostCreek\Class V Wells	

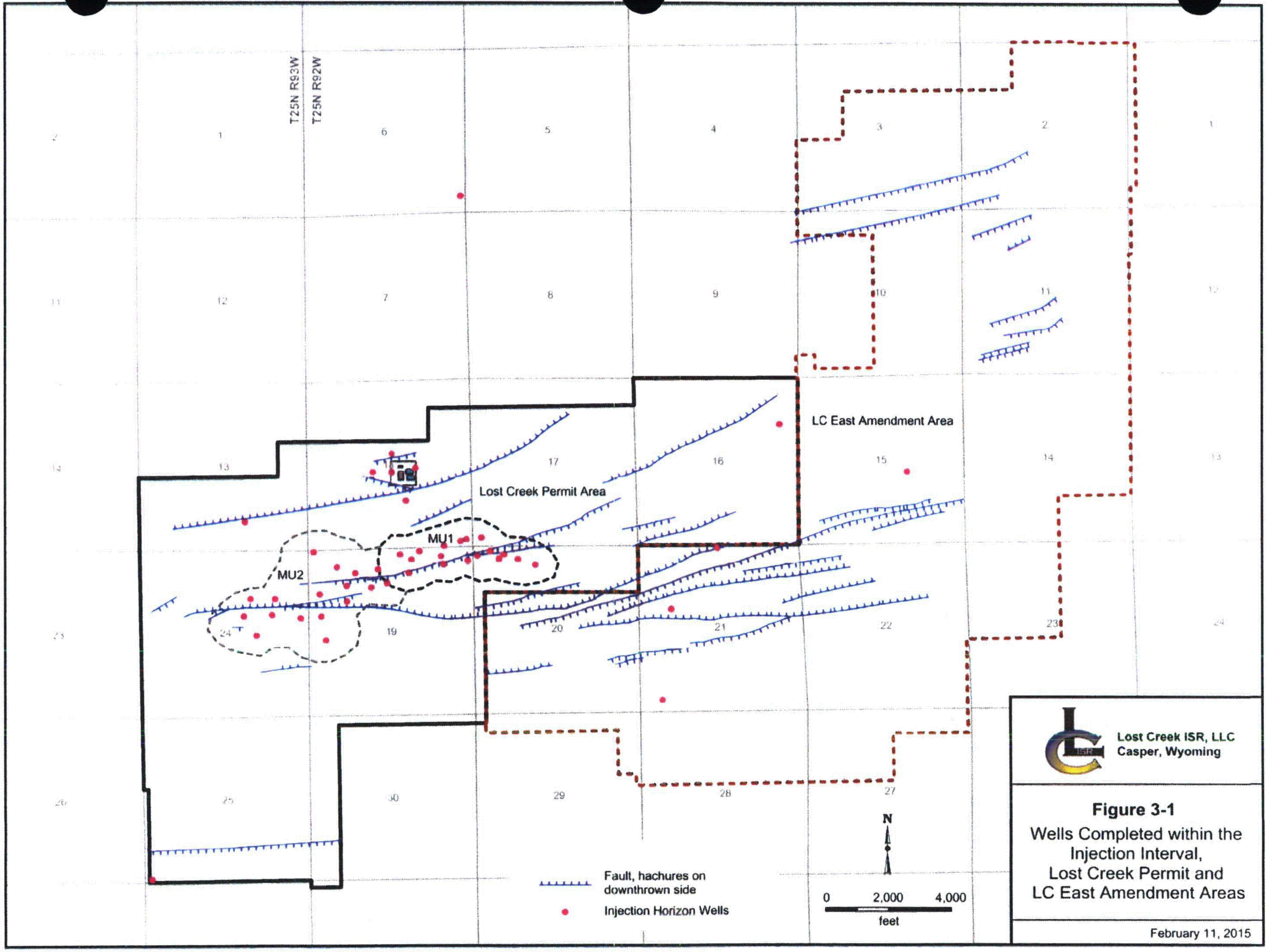
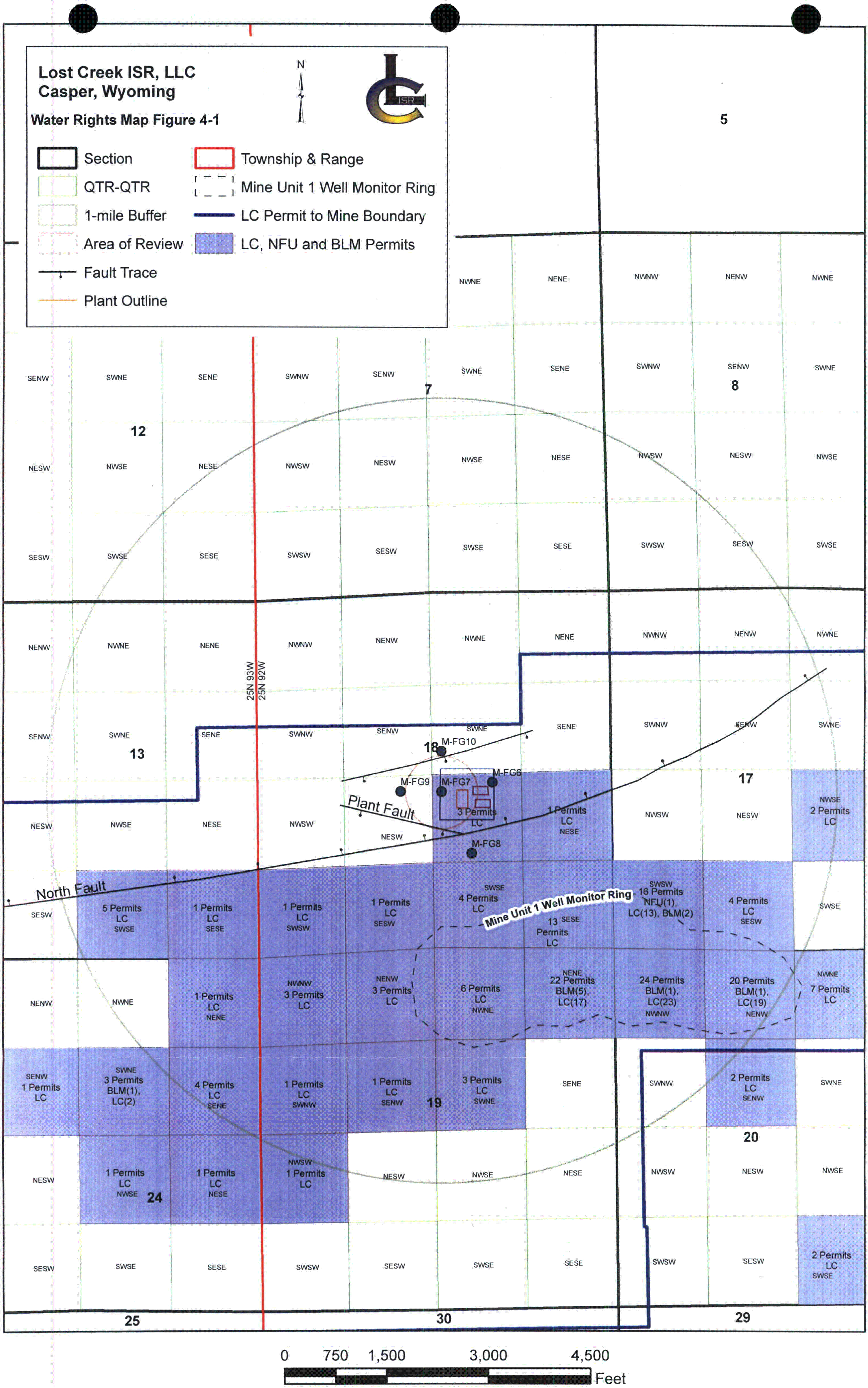
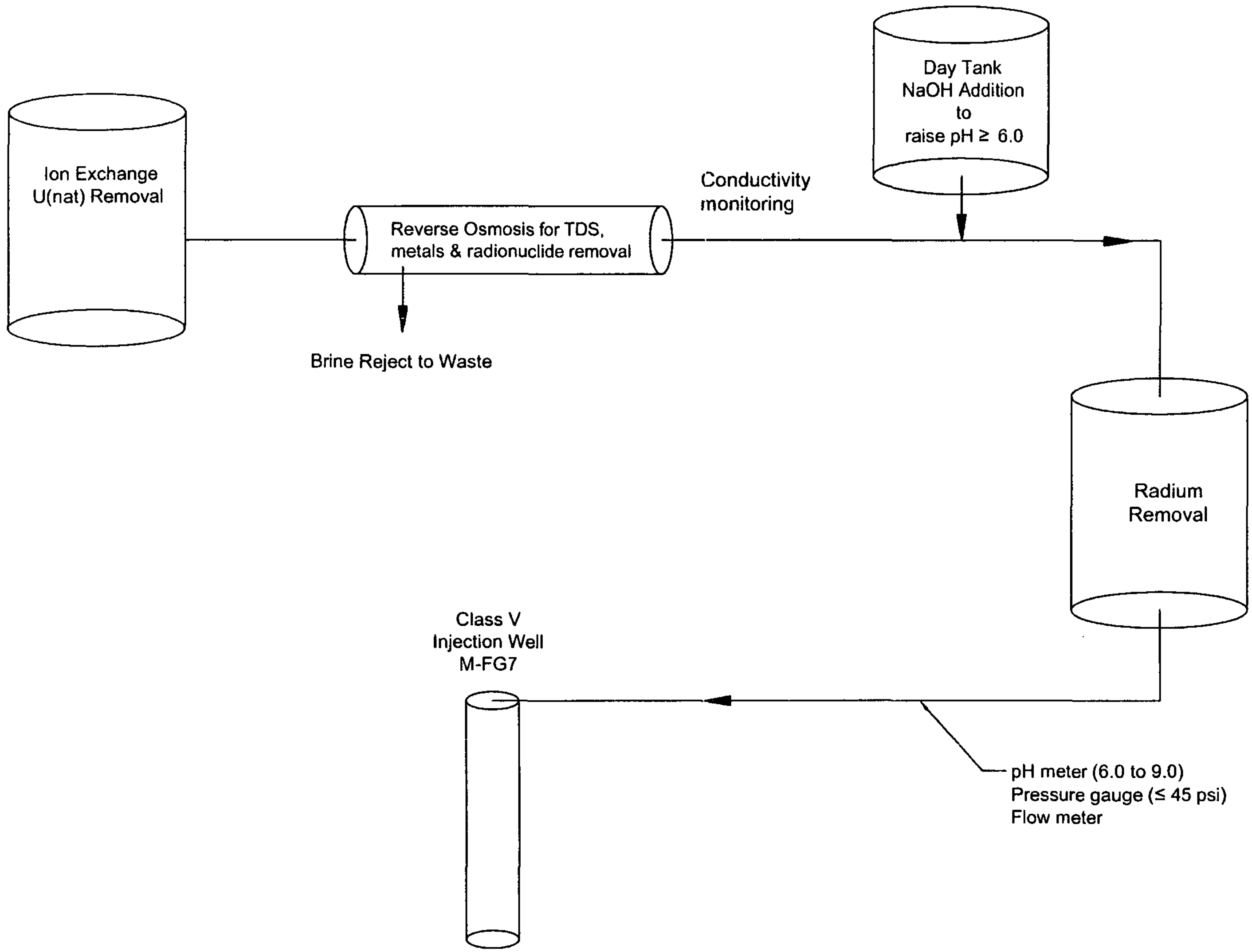


Figure 3-1
Wells Completed within the Injection Interval, Lost Creek Permit and LC East Amendment Areas

February 11, 2015

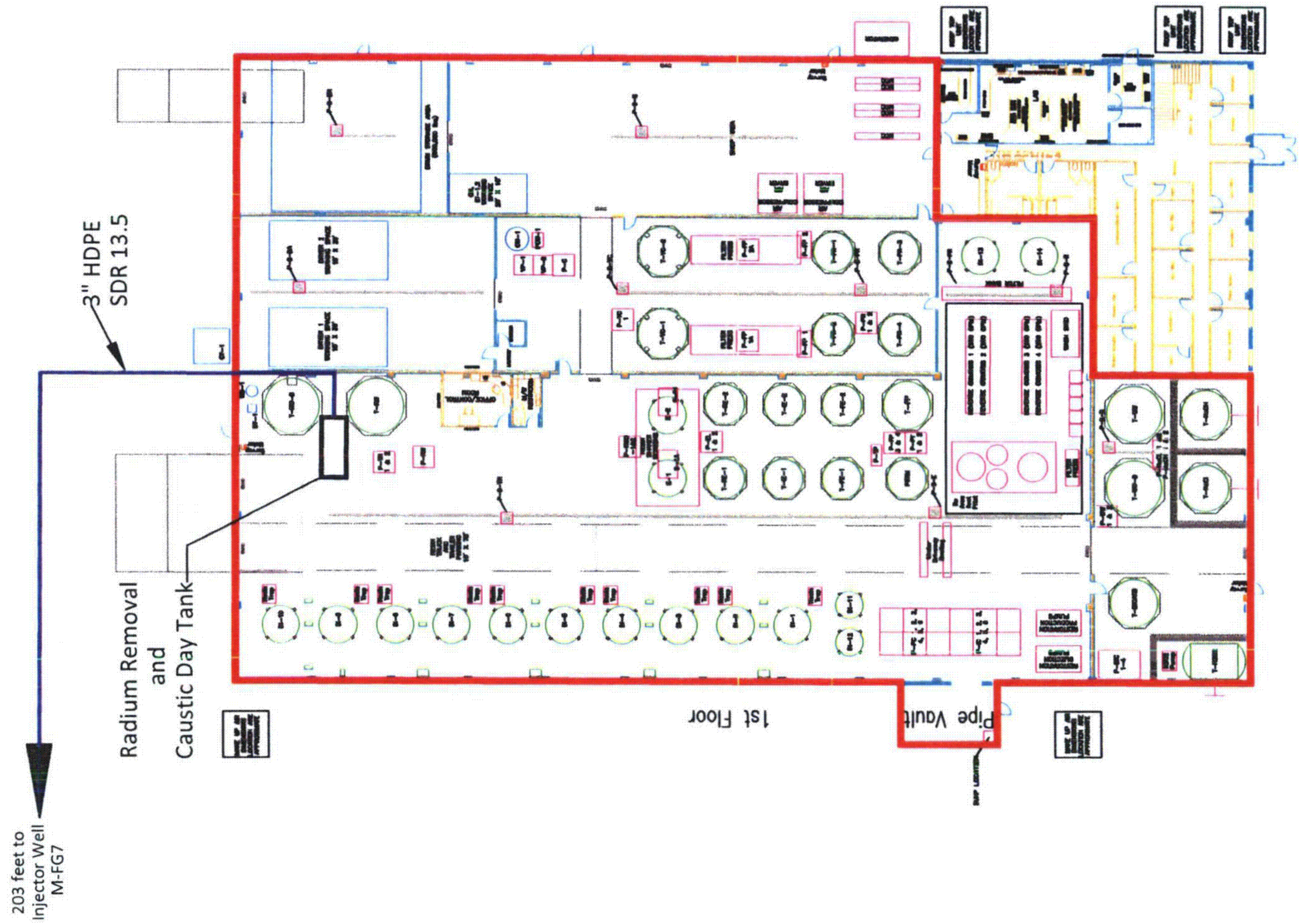

Lost Creek ISR, LLC
Casper, Wyoming
Water Rights Map Figure 4-1
N
ISR
Section
QTR-QTR
1-mile Buffer
Area of Review
Fault Trace
Plant Outline
Township & Range
Mine Unit 1 Well Monitor Ring
LC Permit to Mine Boundary
LC, NFU and BLM Permits
5
7
8
12
13
17
18
19
20
24
25
29
30
25N 93W
25N 92W
M-FG10
M-FG9
M-FG7
M-FG6
M-FG8
Plant Fault
North Fault
Mine Unit 1 Well Monitor Ring
3 Permits LC
1 Permits LC NESE
2 Permits LC NWSE
5 Permits LC SWSE
1 Permits LC SESE
1 Permits LC SWSW
1 Permits LC SESW
4 Permits LC SWSE
13 Permits LC SESE
16 Permits NFU(1), LC(13), BLM(2) SWSW
4 Permits LC SESW
1 Permits LC NENE
3 Permits LC NWNW
3 Permits LC NENW
6 Permits LC NWNE
22 Permits BLM(5), LC(17) NENE
24 Permits BLM(1), LC(23) NWNW
20 Permits BLM(1), LC(19) NENW
7 Permits LC NWNE
1 Permits LC SENW
3 Permits BLM(1), LC(2) SWNE
4 Permits LC SENE
1 Permits LC SWNW
1 Permits LC SENW
3 Permits LC SWNE
2 Permits LC SENW
1 Permits LC NWSE
1 Permits LC NESE
1 Permits LC NWSW
2 Permits LC SWSE
0
750
1,500
3,000
4,500
Feet

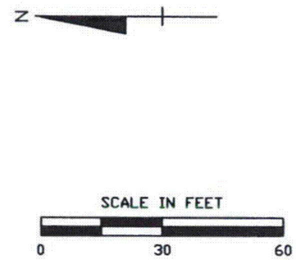


Lost Creek ISR, LLC
Casper, Wyoming

Figure 5-1
Class V Water Treatment Schematic

Scale: Not To Scale Drawn By: JHC
Issued / Revised: 01.26.2015
Drawing Name: Water Treatment Flow Diagram.dwg
File Path: S:\GIS\LostCreek\Plant





LEGEND

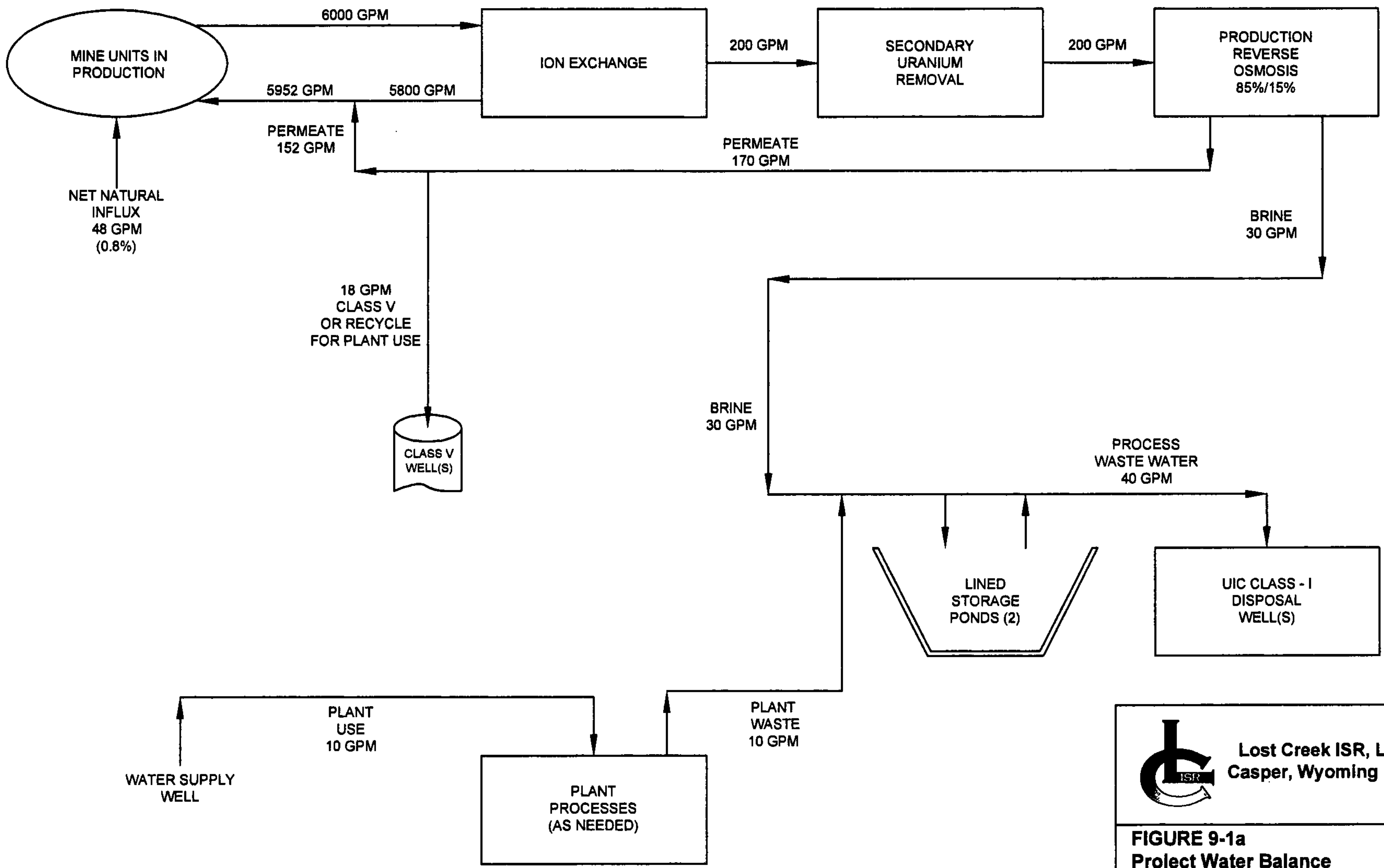
Pipeline to Injection Well

Lost Creek ISR, LLC
Casper, Wyoming

Figure 5-2

Class V Pipeline Layout

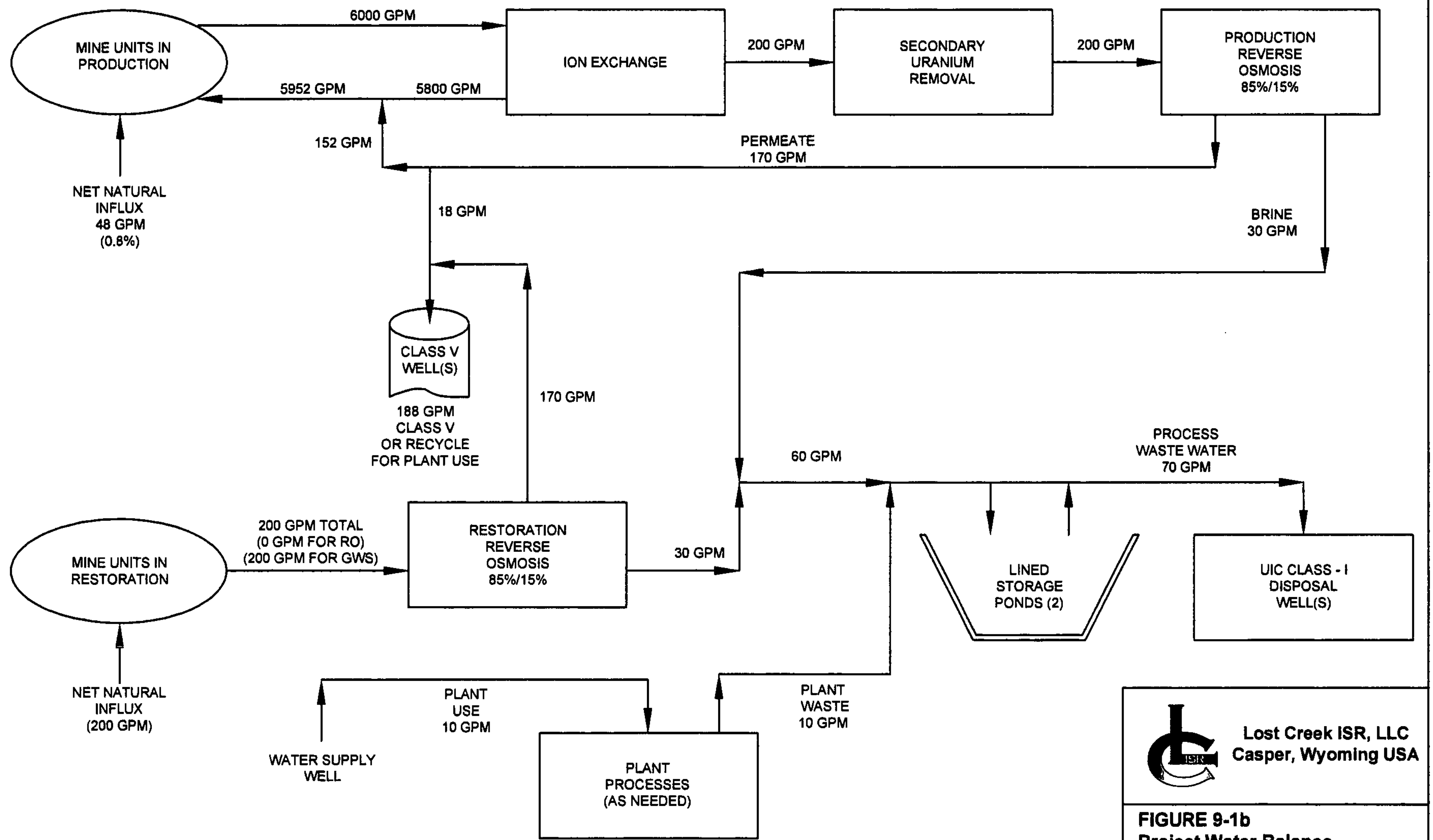
Scale: 1:30	Drawn By: JHC
Issued / Revised: 01.26.2015	
Drawing Name: Lost Creek Plant Treatment Layout.DWG	
File Path: S:\GIS\Lost Creek\Plant\	



Lost Creek ISR, LLC
Casper, Wyoming USA

FIGURE 9-1a
Project Water Balance
Production Only
Lost Creek Permit Area

Issued For: WDEQ-LQD 1.0 Drawn By: JHC
Issued / Revised: 03.01.2015
Dwg. No. WDEQLQD1.0 FIG 9-1a 03.01.15



Lost Creek ISR, LLC
Casper, Wyoming USA

FIGURE 9-1b
Project Water Balance
Production with GWS
Lost Creek Permit Area

Issued For: WDEQ-LQD 1.0 Drawn By: JHC
Issued / Revised: 03.01.2015
Dwg. No. WDEQLQD1.0 FIG 9-1b 03.01.15

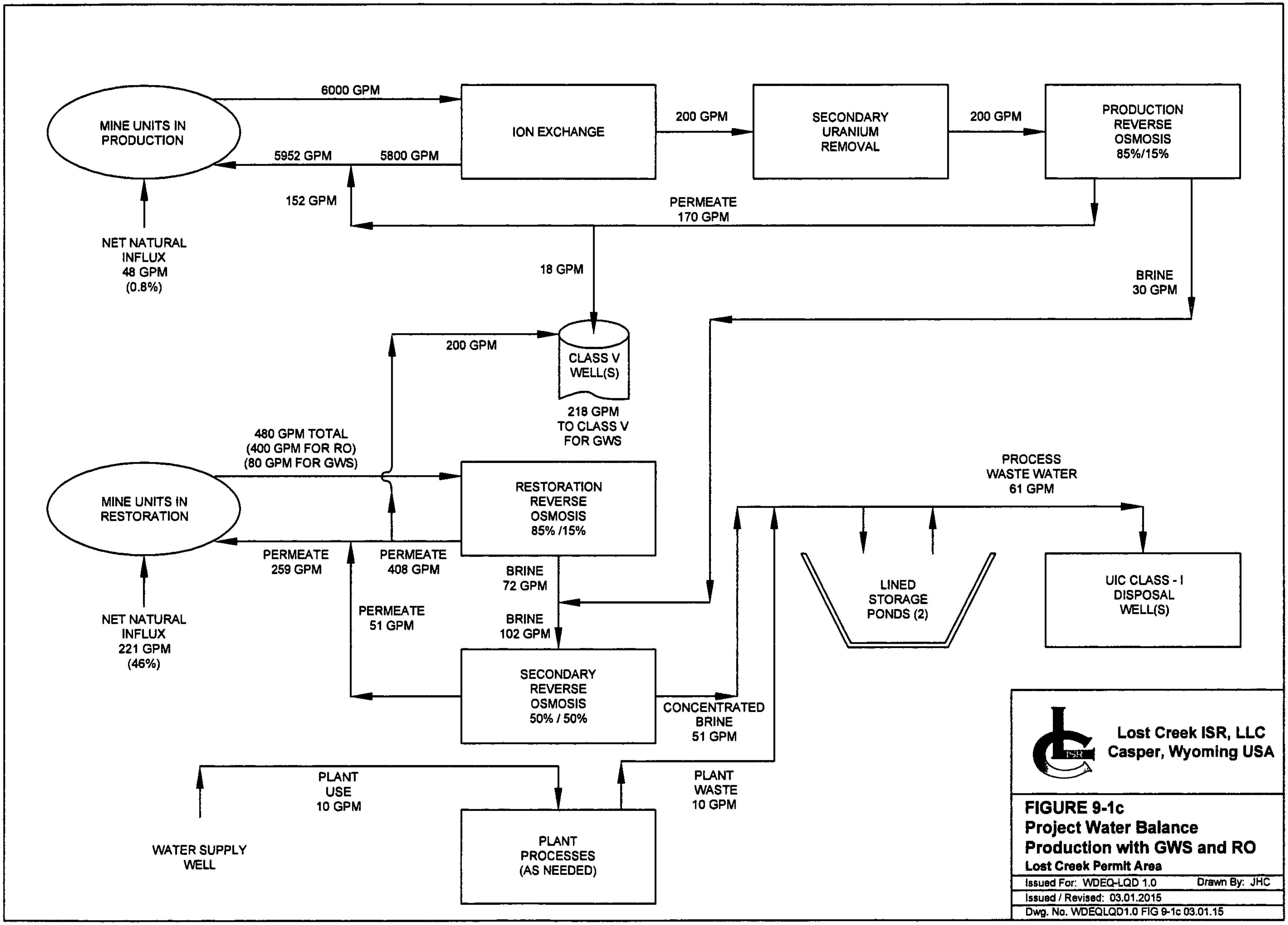
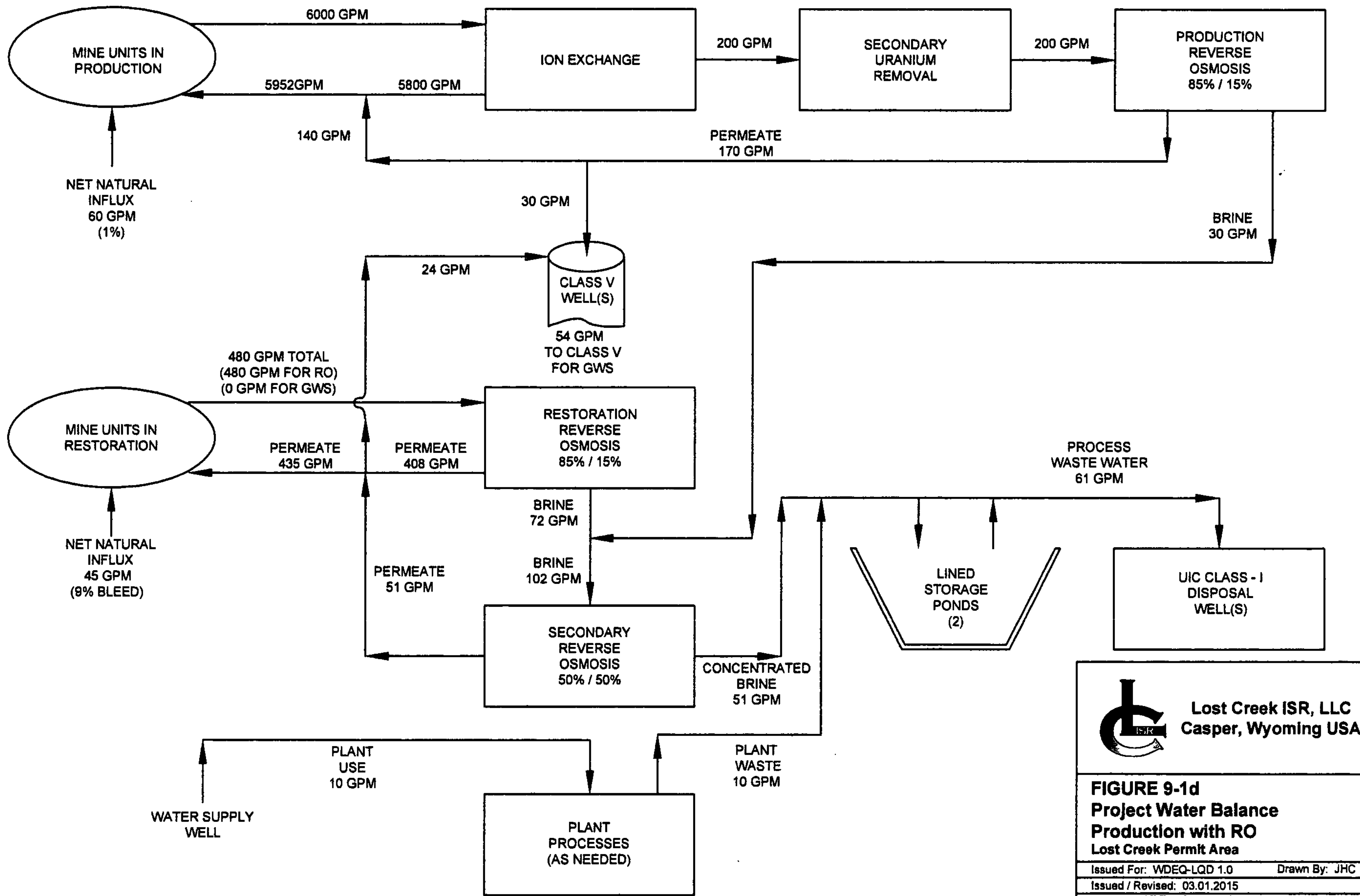


FIGURE 9-1c
Project Water Balance
Production with GWS and RO
Lost Creek Permit Area

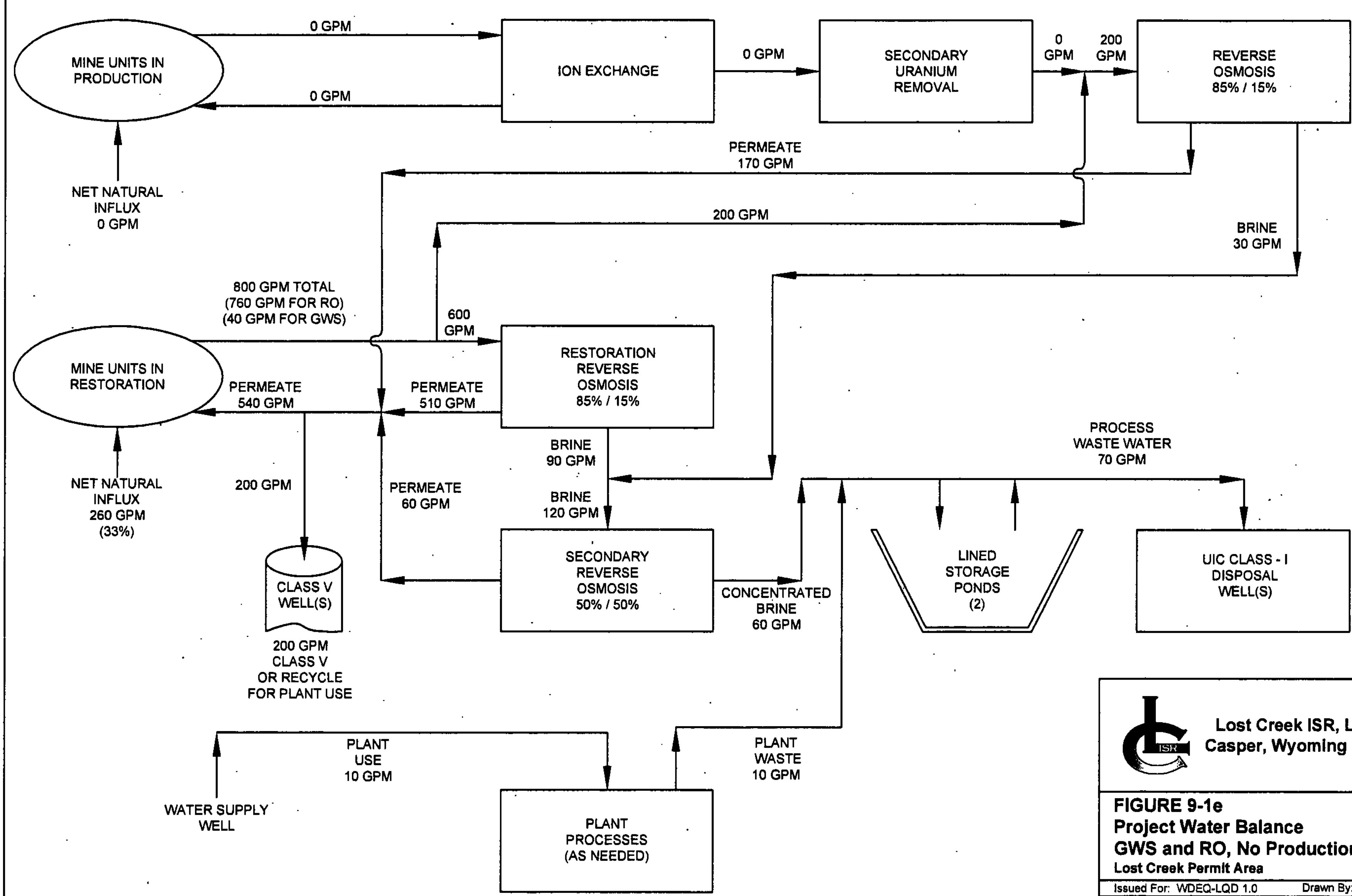
Issued For: WDEQ-LQD 1.0 Drawn By: JHC
Issued / Revised: 03.01.2015
Dwg. No. WDEQLQD1.0 FIG 9-1c 03.01.15



Lost Creek ISR, LLC
Casper, Wyoming USA

FIGURE 9-1d
Project Water Balance
Production with RO
Lost Creek Permit Area

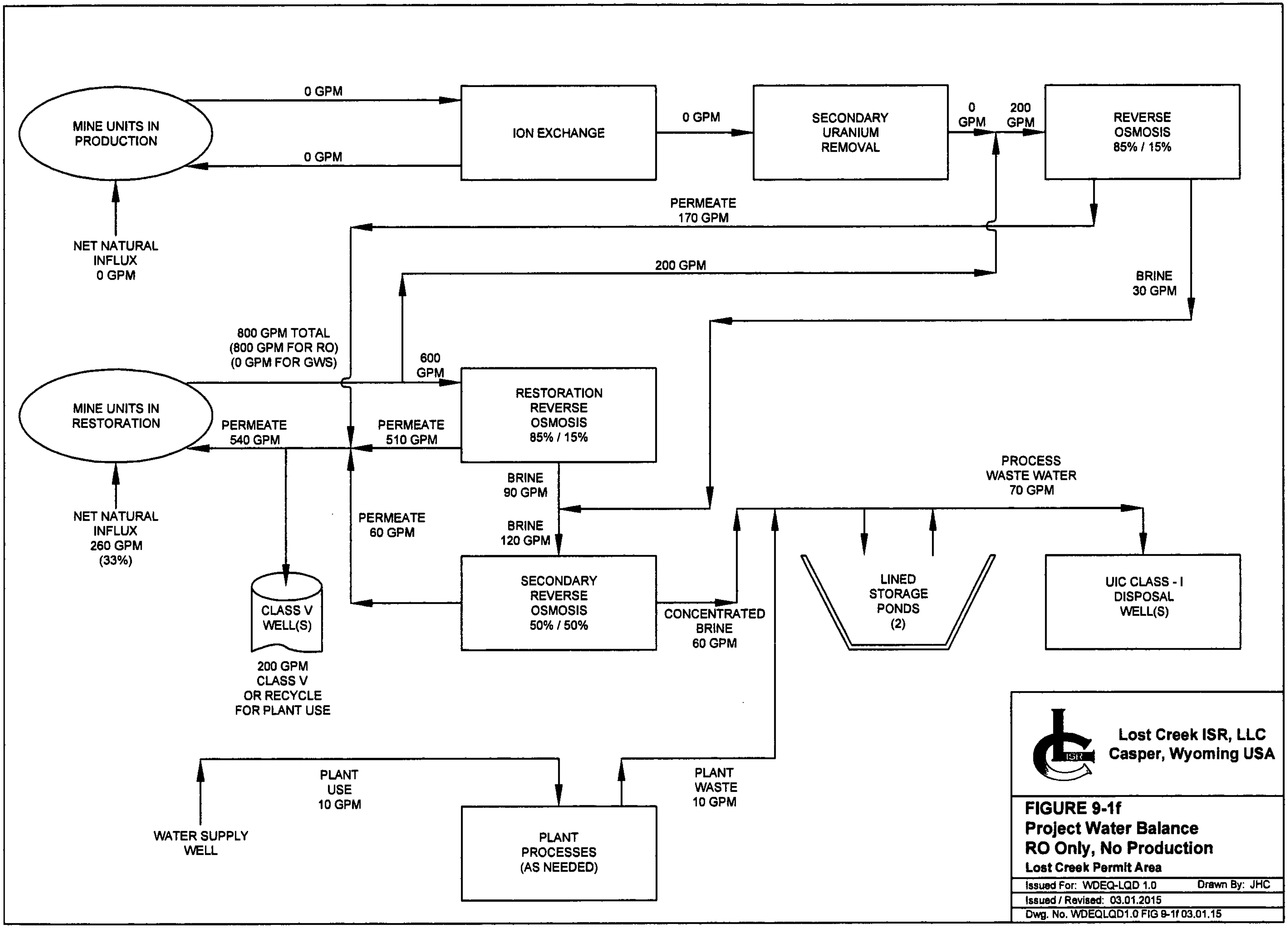
Issued For: WDEQ-LQD 1.0 Drawn By: JHC
Issued / Revised: 03.01.2015
Dwg. No. WDEQLQD1.0 FIG 9-1d 03.01.15



Lost Creek ISR, LLC
Casper, Wyoming USA

FIGURE 9-1e
Project Water Balance
GWS and RO, No Production
Lost Creek Permit Area

Issued For: WDEQ-LQD 1.0 Drawn By: JHC
Issued / Revised: 03.01.2015
Dwg. No. WDEQLQD1.0 FIG 9-1e 03.01.15



Lost Creek ISR, LLC
Casper, Wyoming USA

FIGURE 9-1f
Project Water Balance
RO Only, No Production
Lost Creek Permit Area

Issued For: WDEQ-LQD 1.0 Drawn By: JHC
Issued / Revised: 03.01.2015
Dwg. No. WDEQLQD1.0 FIG 9-1f 03.01.15

The 2 drawings specifically referenced in the table of contents have been processed into ADAMS.

These drawings can be accessed within the ADAMS package or by performing a search on the Document/Report Number.

D01 – D02X

APPENDIX A

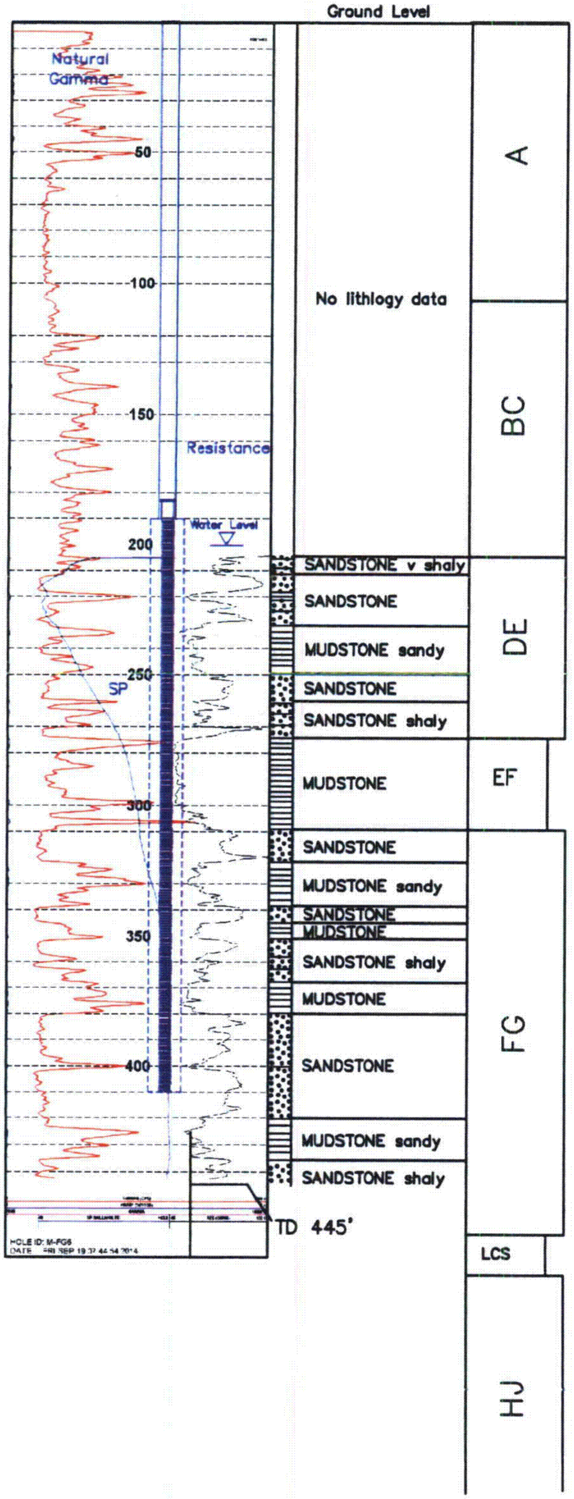
Well Completion Logs

M–FG6

Lost Creek ISR, LLC

WELL COMPLETION REPORT

M–FG6



WELL # M–FG6 SEO # N/A Date Drilled: 9/19/14

Location: E 2,210,065.1 / N 598,278.4 (NAD 83)

Ground Elev: 6980.4 Measure Point Elev: 6978.46'

TD: 445' Hole Dia.: 9 5/8"

CASED to: 190' Casing: PVC SDR17 ID: 6" OD: 6.625" (nominal)

GROUT: Portland Neat Cement – Type I/II
Pumped thru casing, displaced w/fresh water

Completion AQUIFER: DE & FG Horizons

Static Water Level: Depth 200' Elev: 6779'
12/09/14

UNDERREAM: Blade Dia: 12"

Intervals: from 190' to 410' /length 220'

from ____ to ____ /length ____

SCREEN LINER ASSEMBLY

Description	Depth From	Depth To	Elev. From	Elev. To	Length
K–packer string	183'	190'			7'
Screen	190'	410'	6790'	6570'	220'

SCREEN SPECIFICATIONS:

Slot: 0.020" Composition 5" PVC Slotted Casing (flush joint)

FILTER PACKING: N/A

Volume: ____ (bags)(ft^3) Sand Specs. ____

Method: ____

WELL STIMULATION: Method Airlift

Yield: Good / Moderate / Poor
Not Recorded

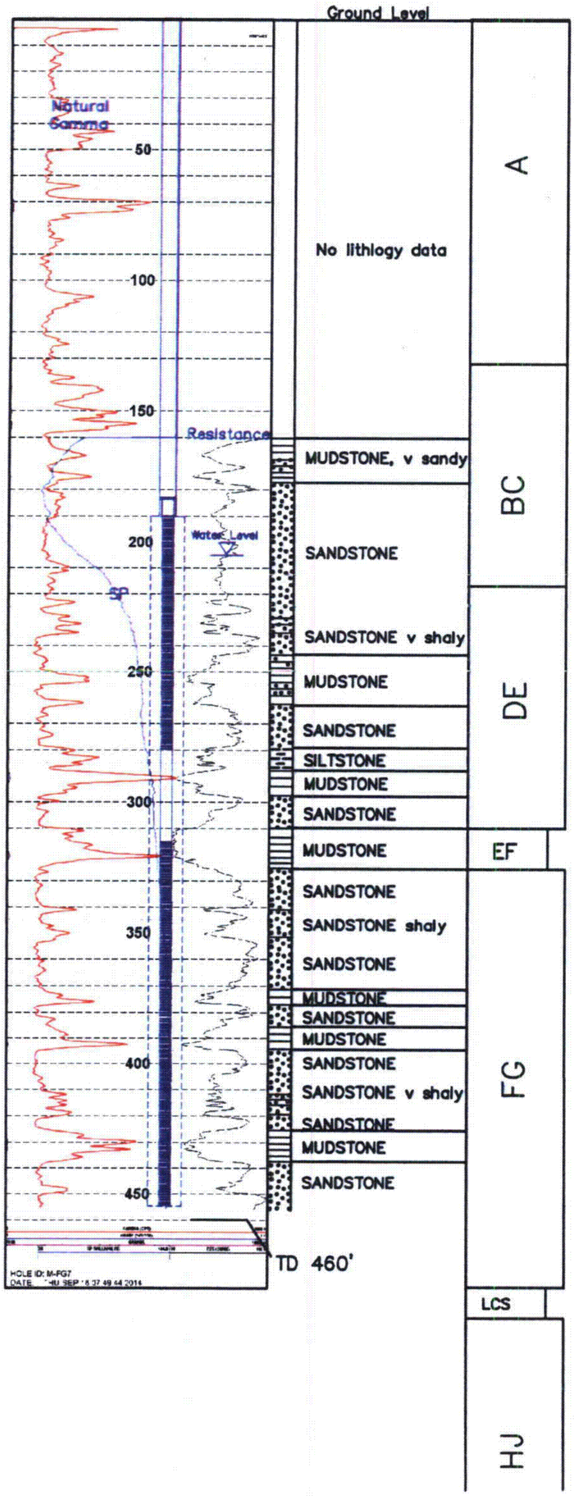
M–FG6

M–FG7

Lost Creek ISR, LLC

WELL COMPLETION REPORT

M–FG7



WELL # M–FG7 SEO # N/A Date Drilled: 9/18/14

Location: E 2,209,313.6 / N 598,135.7 (NAD 83)

Ground Elev: 6983.1 Measure Point Elev: 6981.10'

TD: 460' Hole Dia.: 7 7/8"

CASED to: 190' Casing: PVC SDR17 ID: 4.5" OD: 4.95" (nominal)

GROUT: Portland Neat Cement – Type I/II
Pumped thru casing, displaced w/fresh water

Completion AQUIFER: BC, DE & FG Horizons

Static Water Level: Depth 205' Elev: 6776'
12/09/14

UNDERREAM: Blade Dia: 10 1/2"

Intervals: from 190' to 455' /length 265'

from ____ to ____ /length ____

SCREEN LINER ASSEMBLY

Description	Depth From	Depth To	Elev. From	Elev. To	Length
K–packer string	183'	190'			7'
Screen	190'	280'	6793'	6703'	90'
Blank	280'	315'			35'
Screen	315'	455'	6668'	6528'	140'
				Total	265'

SCREEN SPECIFICATIONS:

Slot: 0.020" Composition 3" PVC Slotted Casing

FILTER PACKING: N/A

Volume: ____ (bags)(ft^3) Sand Specs. ____

Method: ____

WELL STIMULATION: Method Airlift

Yield: Good / Moderate / (Poor)

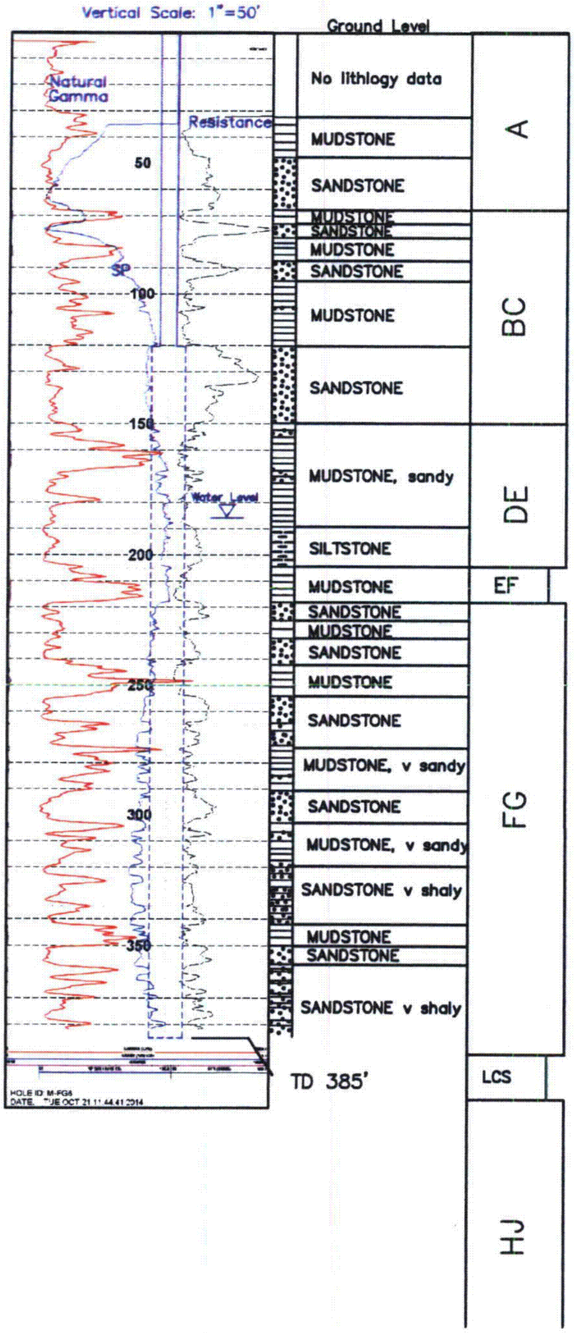
10–15 gpm

M–FG8

Lost Creek ISR, LLC

WELL COMPLETION REPORT

M–FG8



WELL # M–FG8 SEO # N/A Date Drilled: 10/21/14

Location: E 2,209,761.8 / N 597,239.3 (NAD 83)

Ground Elev: 6959.9' Measure Point Elev: 6962.27'

TD: 385' Hole Dia.: 7 7/8"

CASED to: 120' Casing: PVC SDR17 ID: 4.5" OD: 4.95" (nominal)

GROUT: Portland Neat Cement – Type I/II
Pumped thru casing, displaced to surface w/fresh water

Completion AQUIFER: BC, DE & FG Horizons

Static Water Level: Depth 187' Elev: 6775'
12/09/14

UNDERREAM: Blade Dia: 10 1/2"

Intervals: from 120' to 385' /length 265'

from ____ to ____ /length ____

SCREEN LINER ASSEMBLY

Description	Depth From	Depth To	Elev. From	Elev. To	Length
Open Completion	120'	385'	6840'	3575'	265'

SCREEN SPECIFICATIONS: No Screen

Slot: N/A Composition N/A

FILTER PACKING: N/A

Volume: ____ (bags)(ft^3) Sand Specs. ____

Method: ____

WELL STIMULATION: Method Airlift

Yield: Good / Moderate / Poor
Not Recorded

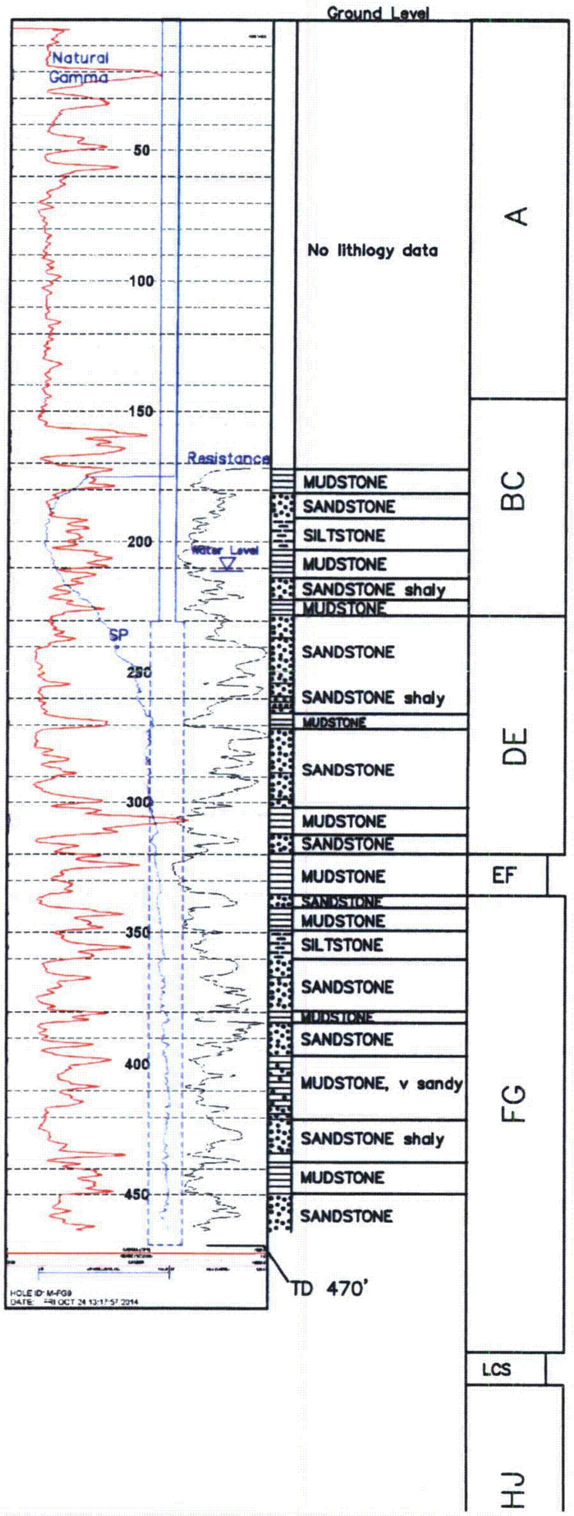
M–FG8

M–FG9

Lost Creek ISR, LLC

WELL COMPLETION REPORT

M–FG9



WELL # M-FG9 SEO # N/A Date Drilled: 10/24/14

Location: E 2,208,711.0 / N 598,135.0 (NAD 83)

Ground Elev: 6983.1' Measure Point Elev: 6984.4

TD: 470' Hole Dia.: 7 7/8"

CASED to: 230' Casing: PVC SDR17 ID: 4.5" OD: 4.95" (nominal)

GROUT: Portland Neat Cement – Type I/II
Pumped thru casing, displaced w/fresh water

Completion AQUIFER: DE & FG Horizons

Static Water Level: Depth 211' Elev: 6773.4'
12/09/14

UNDERREAM: Blade Dia: 10 1/2"

Intervals: from 230' to 470' /length 240'
from ____ to ____ /length ____

SCREEN LINER ASSEMBLY

Description	Depth From	Depth To	Elev. From	Elev. To	Length
Open Completion	230'	470'	6753'	6513'	240'

SCREEN SPECIFICATIONS: No Screen

Slot: N/A Composition N/A

FILTER PACKING: N/A

Volume: ____ (bags)(ft^3) Sand Specs. ____

Method: ____

WELL STIMULATION: Method Airlift

Yield: Good / Moderate / (Poor)

10 gpm

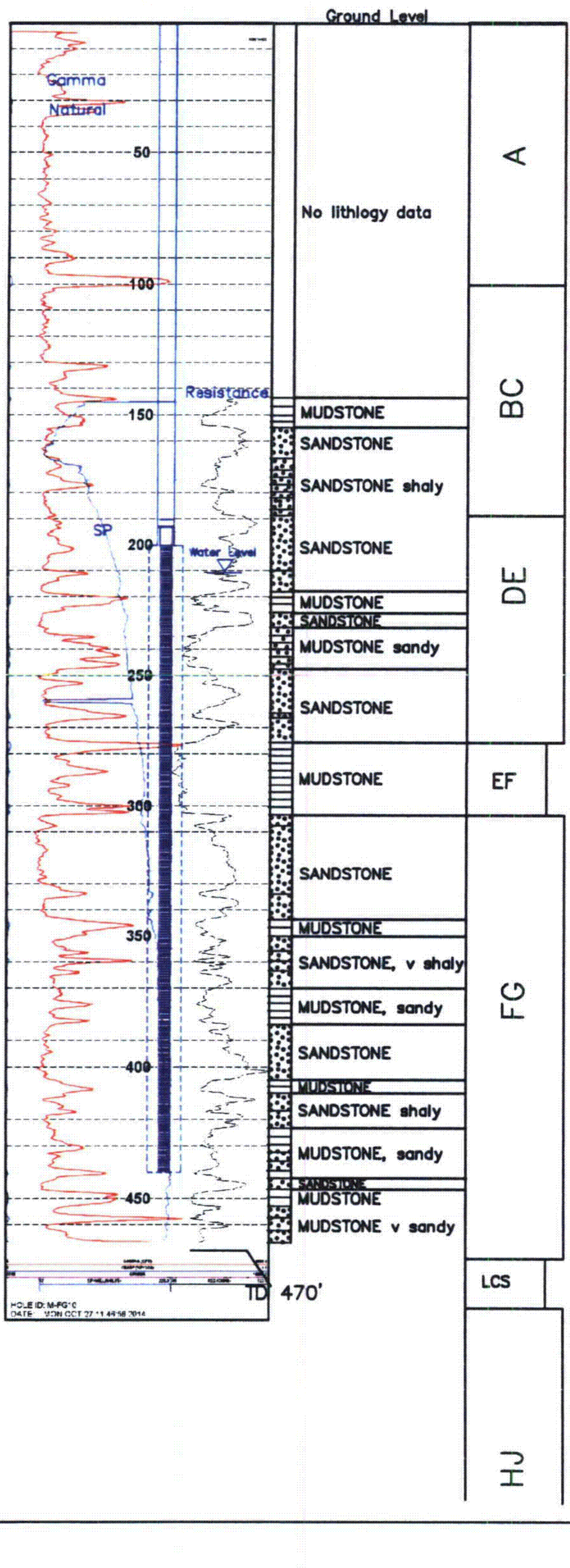
M–FG9

M–FG10

Lost Creek ISR, LLC

WELL COMPLETION REPORT

M–FG10



WELL # M–FG10 SEO # N/A Date Drilled: 10/27/14

Location: E 2,209,312.0 / N 598,736.0 (NAD 83)

Ground Elev: 6987.1' Measure Point Elev: 6989.03

TD: 470' Hole Dia.: 7 7/8"

CASED to: 200' Casing: PVC SDR17 ID: 4.5" OD: 4.95" (nominal)

GROUT: Portland Neat Cement – Type I/II
Pumped thru casing, displaced w/fresh water

Completion AQUIFER: DE & FG Horizons

Static Water Level: Depth 211' Elev: 6778'
12/09/14

UNDERREAM: Blade Dia: 10 1/2"

Intervals: from 200' to 440' /length 240'
from ____ to ____ /length ____

SCREEN LINER ASSEMBLY

Description	Depth From	Depth To	Elev. From	Elev. To	Length
K–packer string	193'	200'			7'
Screen	200'	440'	6787'	6547'	240'

SCREEN SPECIFICATIONS:

Slot: 0.020" Composition 3" PVC Slotted Casing

FILTER PACKING: N/A

Volume: ____ (bags)(ft^3) Sand Specs. ____

Method: ____

WELL STIMULATION: Method Airlift

Yield: Good / Moderate / Poor
Not Recorded

M–FG10

APPENDIX B

Mahoney Geochemistry Report

MGC
MAHONEY GEOCHEMICAL CONSULTING

MEMORANDUM

To: John Cash - Lost Creek ISR, LLC

From: John Mahoney, Ph.D. - Mahoney Geochemical Consulting LLC

Date: June 17, 2014

Subject: Geochemical Modeling of Permeate Injection

INTRODUCTION

A series of geochemical models using PHREEQC version 3 (Parkhurst and Appelo, 2013) and PHAST for Windows (Parkhurst et al. 2010) were run to check the compatibility of injecting a reverse osmosis produced permeate into the FG Horizon in Ur-Energy Inc.'s Lost Creek ISR Project. Details about water compositions and formation details were provide to Mahoney Geochemical Consulting by staff of the Lost Creek ISR Project.

This effort is primarily aimed at major elements such as calcium, magnesium, sodium, potassium, alkalinity (including carbon dioxide partial pressures), chloride and sulfate. Some minor elements such as silicon as silica (SiO_2) and aluminum were also considered. The permeate is too dilute to cause any well plugging. But mineral dissolution has a slight potential to cause detrimental effects, and that was the major focus of the modelling. Trace metal concentrations were generally at or below detection limits in the permeate and also in the formation water, consequently trace metal issues will not be discussed.

INITIAL PHREEQC MODELS

Table 1 shows the expected permeate concentration and the average composition of the FG Horizon. Table 2 shows the results of PHREEQC simulations for the permeate. The sample shows a significant charge imbalance, but this is not surprising as the water composition is an estimate at best. One other issue was noted, the permeate gave both an alkalinity and bicarbonate (HCO_3^-) concentration. The primary model used the 5 mg/L alkalinity value and an alternative model replaced the alkalinity value with the bicarbonate concentration. The differences to the model results were slight.

Table 2 indicates that these waters are strongly undersaturated with respect to the phases most likely to cause plugging issues in wells. Calcite, simple silicates, and gypsum are too undersaturated to cause plugging issues in the injection well. However, possible dissolution of these phases if they are present in the formation is an issue and PHAST was employed to evaluate the extent of the dissolution reactions.

Lost Creek Staff raised issues about the low pH and elevated carbon dioxide partial pressures. A pH of 5.6 is about the pH of rainwater. The solution is dilute, and it is poorly buffered, so it does not have a lot of dissolving potential. The CO_2 partial pressure is elevated, but not to an extreme level. The pressures are slightly greater than 1 percent, or $10^{-2.0}$ atmospheres, and the low pH is partially responsible for this increased partial pressure. Any increase in pH will decrease the effective pressure, and this pH change will be caused by the dissolution of carbonate minerals such as calcite. Also partial pressure values for CO_2 gas of around $10^{-2.0}$ atmospheres or even higher pressures are common in soils where biological (bacterial) respiration is active (Langmuir, 1997).

The composition of the ambient water, representing the FG Horizon ground water, was calculated in PHREEQC using the MIX keyword. The mixture, which is essentially an average composition, was based upon 22 samples from wells screened within the FG Horizon. These samples represented the latest samples from each location and to avoid bias from multiple samples from a specific location only one sample from each well was selected. Generally, the selected samples were the most recent sample available for that well that provided a complete analysis. Table 3 shows the samples used in this estimate. Many of the parameters, particularly for trace metals when the majority of the results were at or below detection limit, were eliminated from the analysis. Consequently, aluminum and iron were not included in these models. However, the low concentrations present in the ambient ground water already demonstrate that dissolution of significant amounts of aluminum or iron bearing phases will not occur.

A series of simple mixing calculations between permeate and water in the FG Horizon was performed using PHREEQC (Table 4). Only the first mixture of 5% permeate and 95% ground water suggested that calcite was oversaturated. But the estimated composition of the FG Horizon average indicated that the formation water was already slightly oversaturated with a value of 0.311 for calcite. Increasing proportions of permeate decrease the saturation indices. So the mixing actually decreases the potential for calcite precipitation.

PHAST MODELS

The program PHAST (PHREEQC And Solute Transport) was selected to evaluate the extent of the mixing and reactions when the permeate is injected into the FG Horizon. PHAST is a finite difference transport code that includes all the functions of PHREEQC. It was developed at the USGS by the author of PHREEQC and others. There are several reasons PHAST was selected.

- It provides "3-D" graphics showing the distribution of solids including phases that are responding to rate based dissolution equations (kinetic phases), equilibrium based phases, and dissolved constituents,
- These images can be examined over time, and if required these figures can be developed into simple animations,
- Models of an injection well can be readily set up, and
- These models can show the displacement and areas of mixing around the injection well.

The following conditions were defined for the receiving aquifer. A block 5000 feet by 5000 feet and 170 feet was defined. The injection well was placed in the center of this block. The hydraulic

conductivity values were Kx = 0.59 ft/day, Ky =0.59ft/d, Kv=0.059 ft/d, porosity was 0.25 (25%) and specific storage was set to 0.0001, longitudinal, horizontal and vertical dispersivities were all set to 1.0. The model was setup to simulate confined conditions, a variably spaced finite difference grid was used. As shown in Fgure 1, the grid spacings were finer near the injection well.

The PHAST model setup is shown on Figure 1. The injection well is located in the center of the grid and it is surrounded by additional wells that serve as markers. PHAST and the data viewing program Model Viewer (Hsieh and Winston, 2002) do not provide a simple means to include a distance scale so these "wells" have been added. The first marker is due north of the injection well and 250 feet away. This well can serve as a sampling point if needed. The next four wells make up a set that are 500 feet away from the injection point and the next set of four wells are 1000 feet away from the center. The model assumed constant injection of the permeate at 135 gpm for twelve years. Well construction details for the injection well are shown in Figure 2. The well was screened over 170 feet and was 10.5 inches in diameter. The composition of the injection solution was the same as used in the initial PHREEQC models (Table 1) less most of the trace metals.

Figure 1. Basic setup of PHAST model.

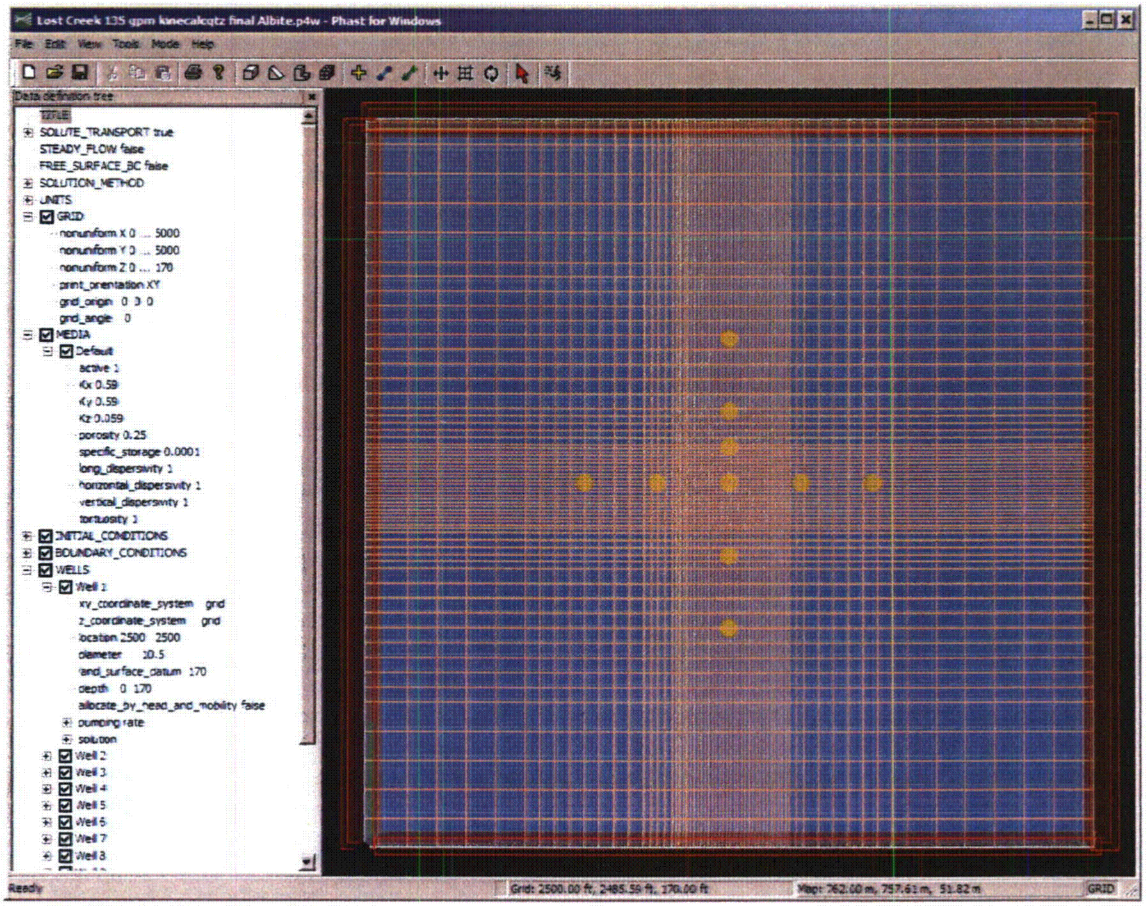
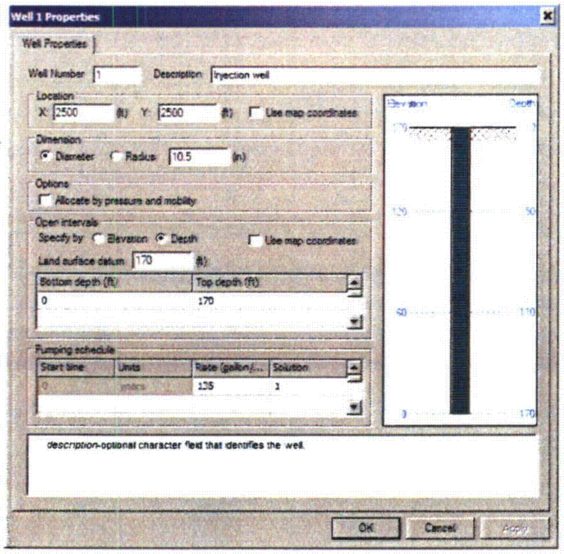
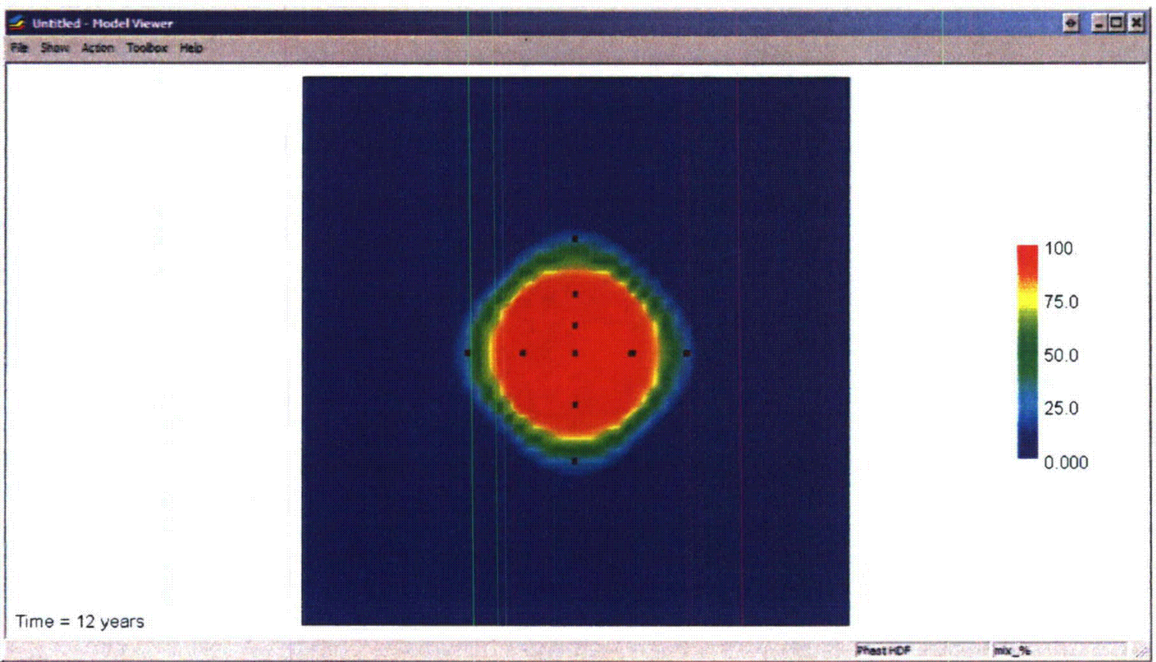


Figure 2. Basic details of injection well.



The extent of mixing is estimated by adding a conserved component Mx to the PHREEQC database and to the model. This "component" does not form complexes with any other component, nor does it interact with surfaces or minerals. It does provide a direct means of assessing the areal extent of the injected plume, plus it shows the zone of mixing around the injected solution. Figure 3 shows the extent of the plume after 12 years injection at 135 gpm. The outer reaches of the mixed zone extend to just beyond 1000 feet radius. Complete displacement has occurred out to almost 700 feet.

Figure 3. Extent of mixing after 12 years injection at 135 gpm. Prepared using Model Viewer.



Based upon the differences noted in calcium, alkalinity, pH and silica between the injectate and the FG Horizon water compositions, it was decided that the rate controlled dissolution of calcite and quartz would explain the major compositional development of the permeate to the ambient composition. In a flowing reacting systems such as the volume around an injection well, kinetic based models provide a more realistic setup than an equilibrium based model, which instantaneously achieves saturation.

Based upon the amount of quartz and calcite in the formation (Figures 4 and 5) concentrations of these kinetic phases were calculated based upon moles/Kg of water. This is the standard unit used by PHREEQC. Because the specific gravity of water is one liter can replace the kilogram if the solution is not too concentrated. Also surface areas were estimated assuming cubes of 0.1 mm for each side. These surface areas terms are used in the kinetic models. PHREEQC calculations are referenced to the volume of water, which is generally 1 liter. For a material that has 25% porosity one liter of water is in contact with three liters of rock. For a sandstone that is dominantly quartz, three liters of rock weighs about 7.95 kilograms. If that rock contains 3 percent calcite then one liter of water can potentially be in contact with 2.385 moles of calcite. PHAST can use these concentration units in its subsequent calculations.

Figure 4. Calculation of molar concentration and surface area for calcite in the FG Horizon. A concentration of 3 percent was assumed. For one liter of water at a porosity of 25% the molar concentration of calcite is 2.385 moles/L. Surface area was 5.4 meters^2/Liter. Values in the maroon blocks with light red letters have deliberately been made difficult to read, they are intermediate calculation results used to check the setup of the spreadsheet.

SOLUTION CENTRIC CALCULATION FOR MINERAL PERCENTAGE and SA/V ESTIMATES KINETICS AND RATES						
Percent MINERAL = phase		3	MINERAL NAME=	Calcite		Phase
Formula weight for MINERAL (phase) =		100	[illegible]	Moles MINERAL/Kg (Rock)		
Specific Gravity of Rock =		2.65				
Specific Gravity of Mineral (phase) =		2.65		MINERAL IN CALCULATION phase		
a (mm) =	b (mm) =	c (mm) =	single particle SA (mm^2)	SA particle (m^2)	volume of particle m^3	
0.1	0.1	0.1	[illegible]	[illegible]	[illegible]	
Porosity %	Liters of Rock in Contact with 1.0 L	Kilograms of Rock in Contact with 1.0 L	Moles	Volume phase m^3	number of particles	SA/V m^2/L
25	3.00	7.95	2.385	[illegible]	[illegible]	5.400

Figure 5. Calculation of molar concentration and surface area for quartz in the FG Horizon. A concentration of 35 percent quartz was assumed. For one liter of water at a porosity of 25% the molar concentration of quartz is 46.313 moles/L. Surface area was 63 meters²/Liter.

SOLUTION CENTRIC CALCULATION FOR MINERAL PERCENTAGE and SA/V ESTIMATES KINETICS AND RATES							
Percent MINERAL = phase		35	MINERAL NAME=	Quartz			Phase
Formula weight for MINERAL (phase) =		60.08	[illegible]	Moles MINERAL/Kg (Rock)			
Specific Gravity of Rock =		2.65					
Specific Gravity of Mineral (phase) =		2.65		MINERAL IN CALCULATION phase			
a (mm) =	b (mm) =	c (mm) =	single particle SA (mm²)	SA particle (m²)	volume of particle m³		
0.1	0.1	0.1	0.06	[illegible]	[illegible]		
Porosity %	Liters of Rock in Contact with 1.0 L	Kilograms of Rock in Contact with 1.0 L	Moles	Volume phase m³	number of particles		SA/V m²/L
25	3.00	7.95	46.313	[illegible]	[illegible]		63.000

The calcite dissolution rate equation and the appropriate BASIC language RATES block were included in the PHREEQC package. The rate law originally defined by Plummer et al. (1978) was used. The quartz dissolution reaction was based upon the neutral (pH) dissolution mechanism reported in Palandri and Kharaka (2004). Rates and user defined parameters are listed in the appendix to this memo. In most of the PHAST models, only one equilibrium phase was included. That was $CO_2(g)$ at $10^{-2.90}$ atmospheres, which is the estimated partial pressure of the FG Horizon mixture.

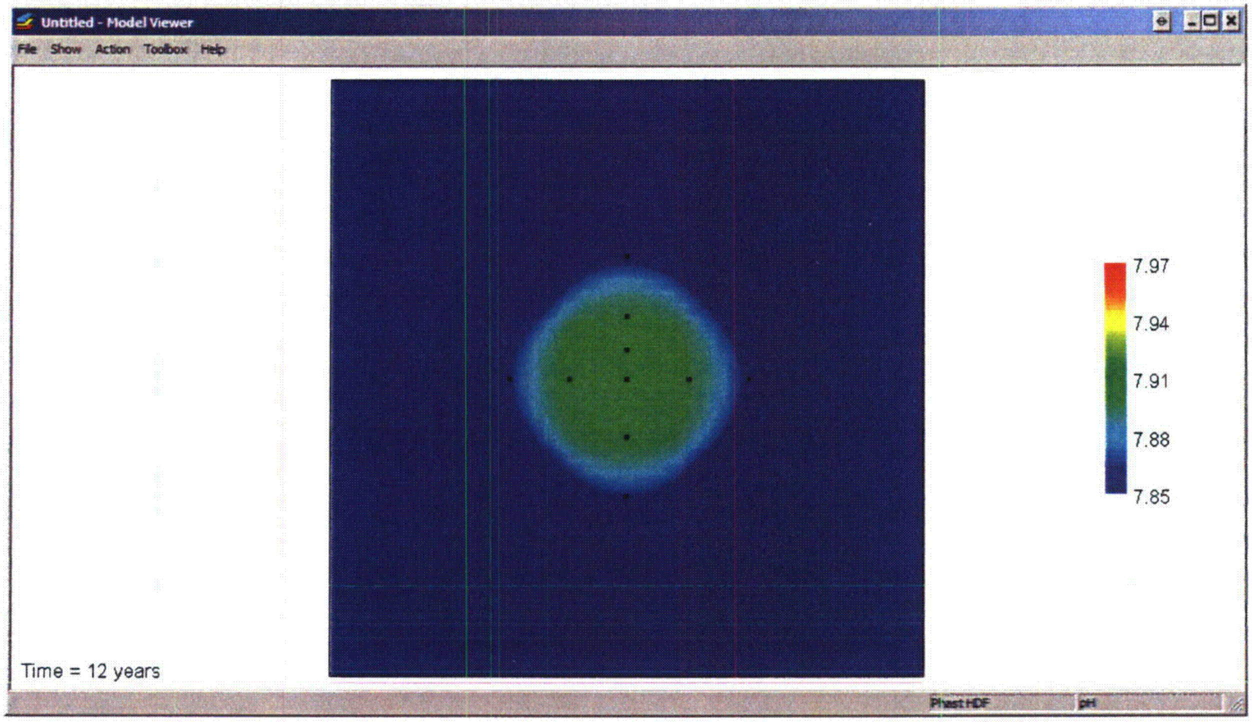
PHAST MODEL RESULTS

Figure 6 shows the pH distribution after 12 years of injection. Because Model Viewer automatically scales the color bar based upon the upper and lower limits of the data set for that figure, the original (unmodified) figure was similar to the mixing proportions shown on Figure 3, but the pH scale ran from 7.85 to 7.90. The scale (color bar) on Figure 6 has been adjusted to include the initial pH of the background water listed in Table 3.[1] Of particular note is the fact that even with these adjustments the range of pH is small. The injected permeate rapidly increases in pH through the dissolution of calcite. The 0.25 year timestep is too long to really see the lower pH of the injected solution. An additional simulation was prepared that used a much smaller time

[1] Adjustments of these color bar scales to the initial value serve another purpose. Inclusion of the starting values simplifies any future figure preparation. If additional figures are needed, particularly for early time steps, using these scales will maintain consistency between this document and any future presentations, reports or animations.

step (0.01 years rather than 0.25 years) the area of this lowered pH was still very small at 0.25 years.

Figure 6. Distribution of pH after 12 years. The color bar scale has been set up to reference the initial pH of 7.97 noted in the average composition of the FG Horizon water.



Calcium concentrations within the FG Horizon start at 56.6 mg/L, and the ambient water is slightly oversaturated with respect to calcite. A saturation index of 0.311 for calcite was calculated using PHREEQC for the FG Horizon average composition (Table 4). The PHAST kinetic based model adjusts the concentrations to about 46.76 mg/L within the first time step at 0.25 years. Figure 7 shows the calcium concentrations at 12 years. The color bar scale has been adjusted to include the maximum concentration of 56.6 mg/L at time 0.0.

The decreased concentration of calcium in the center of the diagram will probably remain nearly constant. As shown in Figure 6 the injected water increases in pH relative to the ambient water. Calcite dissolution also increases the alkalinity of the injected solution. The alkalinity values near 82 mg/L as $CaCO_3$ are actually closer to the average concentration of 100 mg/L noted in the average composition. As discussed above, the average water composition is slightly oversaturated with respect to calcite, it rapidly precipitates and the alkalinity of the background water decreases to 75.4 mg/L (Figure 8). Setting the maximum alkalinity to 100 mg/L on the color bar scale demonstrates the subtle nature of these differences. Calcite equilibrium is controlling the pH, alkalinity and calcium concentrations.

Figure 7. Distribution of calcium (concentration in mg/L) after 12 years of injection. The color bar (scale) has been adjusted to reference the initial starting concentration of 56.6 mg/L Ca.

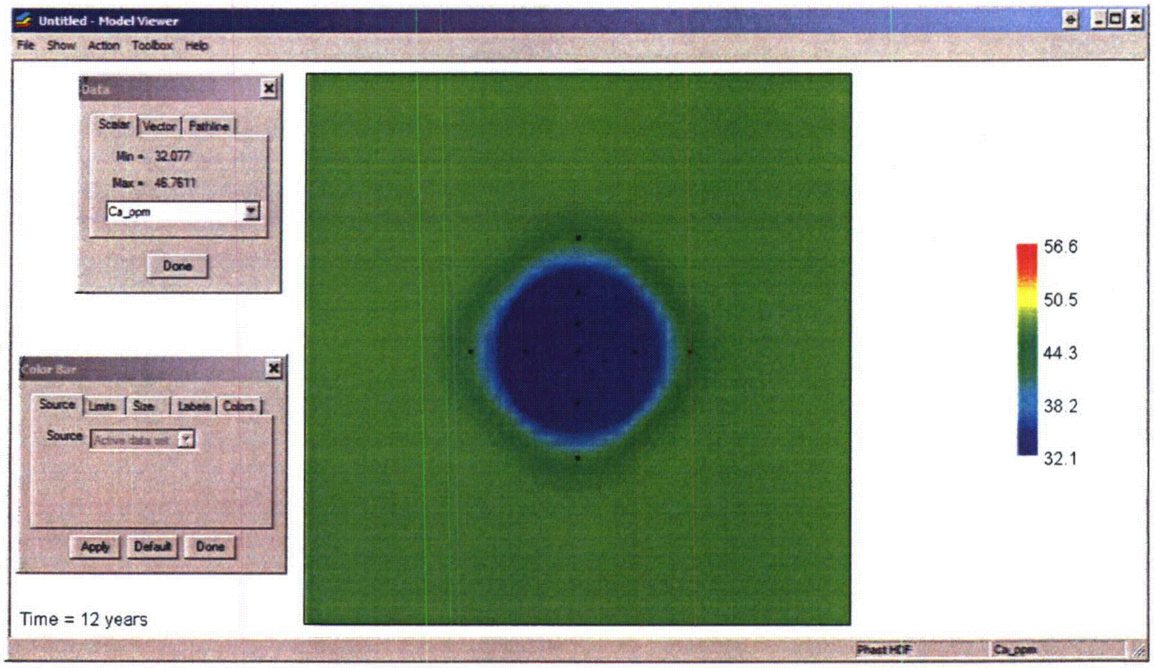
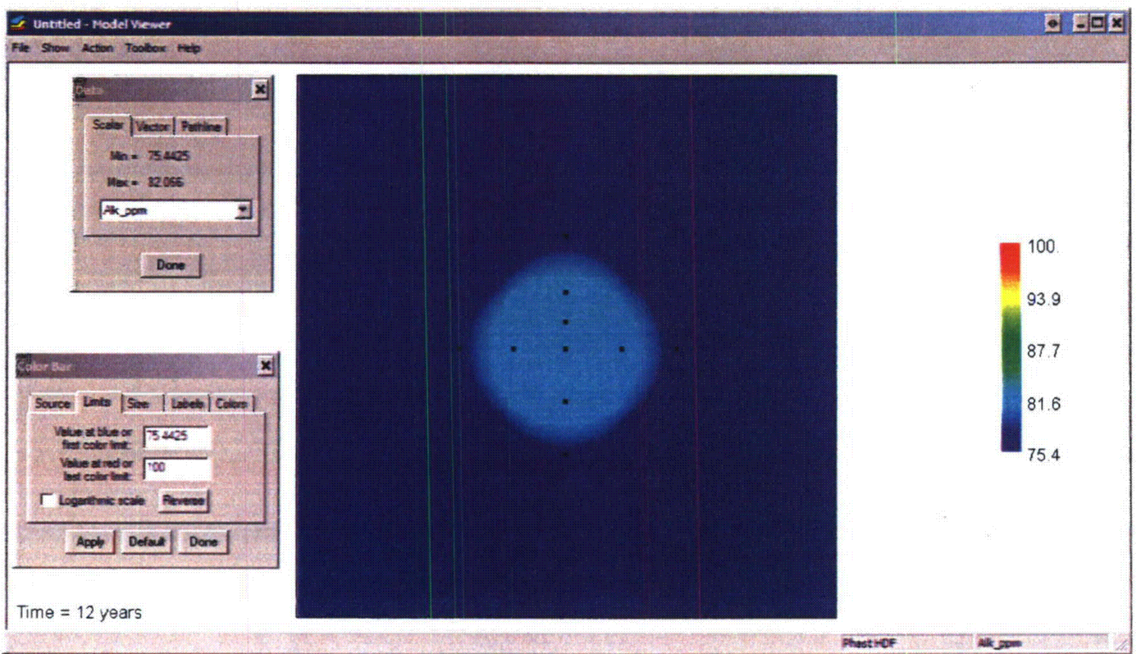


Figure 8. Distribution of alkalinity after 12 years of injection. The color bar (scale) has been adjusted to reference the initial starting concentration of 100 mg/L, alkalinity as mg/L $CaCO_3$.



Calcite dissolution and equilibration are relatively rapid processes so the model is always close to saturation with respect to calcite. Figure 9 is the untouched image of the calcite saturation index at 12 years using the default color bar scale. The differences in values are extremely small and represent minor calculational differences. If any reasonable scale was selected the image would be completely green. But this default scale does show a small zone near the injection well that is slightly undersaturated. This spot is present in all of the images (time steps from 0.25 years to 12 years) and it demonstrates how small and how slight the zone of undersaturation is with respect to calcite. Even with the greater initial concentration and surface area, the dissolution kinetics for quartz (Figure 10) are much slower than for calcite and the area and amount of undersaturation is much larger.

Figure 9. Distribution of Calcite saturation indices after 12 years of injection. The default color bar (scale) has been selected. Other than the slight decrease in the center of the diagram the other values represent numerical uncertainties in the calculation of the saturation index. This becomes more readily appreciated when one notices that blue blocks are often in contact with red blocks.

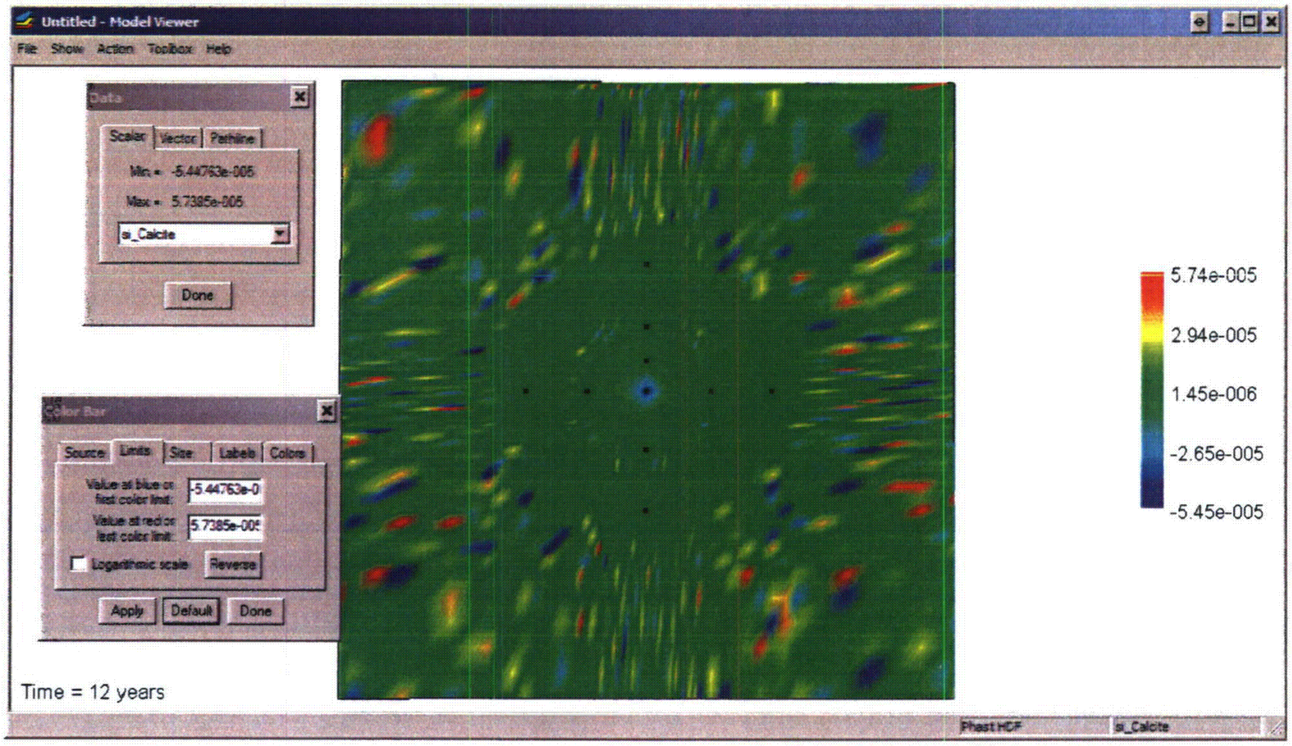
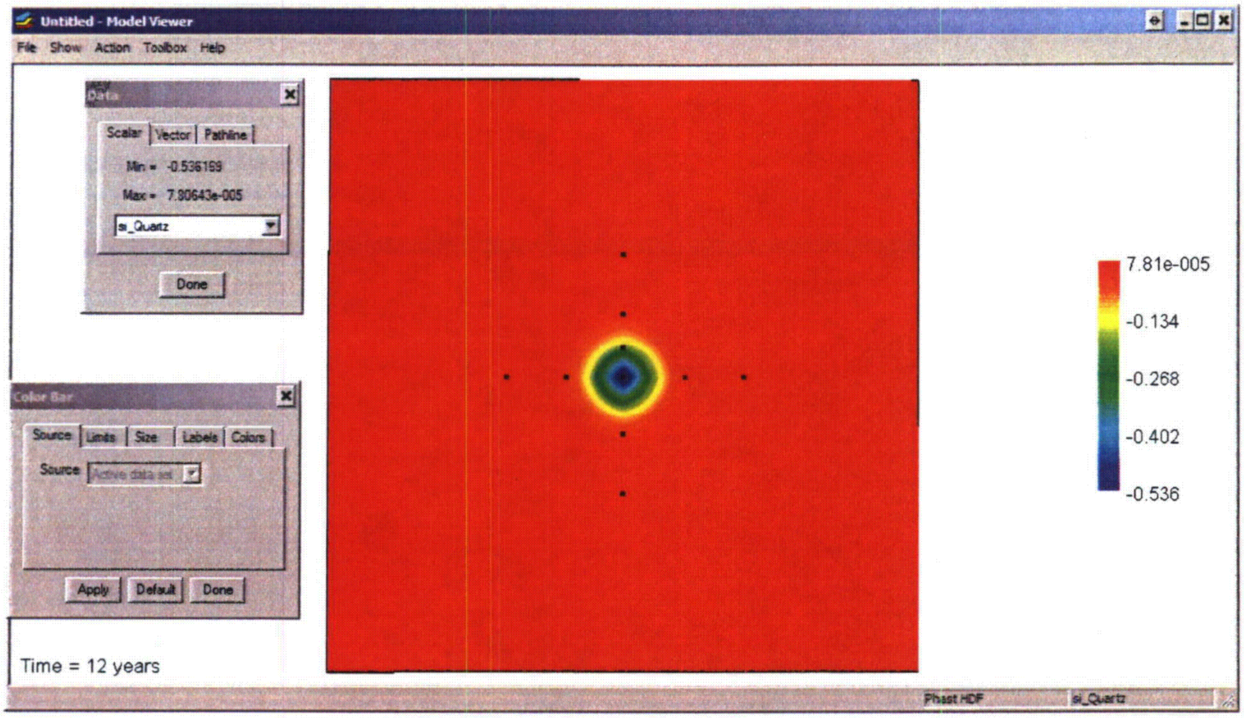


Figure 10. Distribution of saturation indices for quartz after 12 years of injection. The default color bar (scale) has been selected.



As mentioned previously, these models were set up mainly to evaluate the impacts to the mineralogical composition of the FG Horizon. Changes to the amount of calcite as a function of time were also evaluated. The initial concentration was 2.385 moles of calcite per liter of water. Because the solution is slightly oversaturated this amount rapidly increases to 2.39 moles/L. By about 1.5 years a slight decrease is noted at the injection well. By year three the concentration in the center of the figure has dropped to about 2.38 moles/L and the diameter of the circle is less than 100 feet. Figure 11 shows the concentrations after 12 years when injection stops. The differences represent less than 2 % of the initial 3 percent of calcite estimated to be in the FG formation.

Because of the slower precipitation and dissolution kinetics of quartz, the difference becomes even smaller. The initial concentration of quartz at time zero is about 46.302 moles/L. The precipitated amount slowly increases to about 46.303 moles/L within about 2 years (Figure 12). Because the dissolution rate is slow, the decreases are correspondingly slight and we have to add more figures beyond the decimal point to even see these differences. The slower dissolution kinetics spreads the quartz dissolution through a greater area, which further decreases the impact to any location. Figure 12 shows the distribution of quartz after 12 years.

Figure 11. Distribution of calcite in moles/L after 12 years of injection. The default color bar (scale) has been selected.

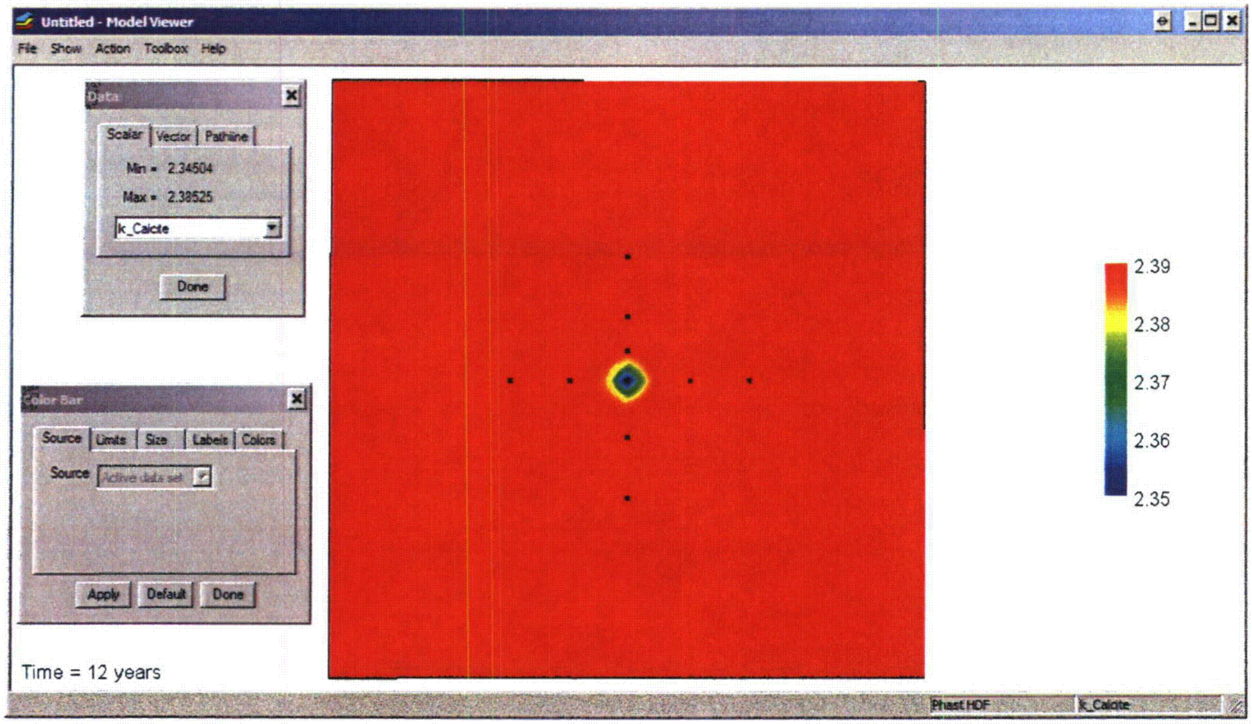
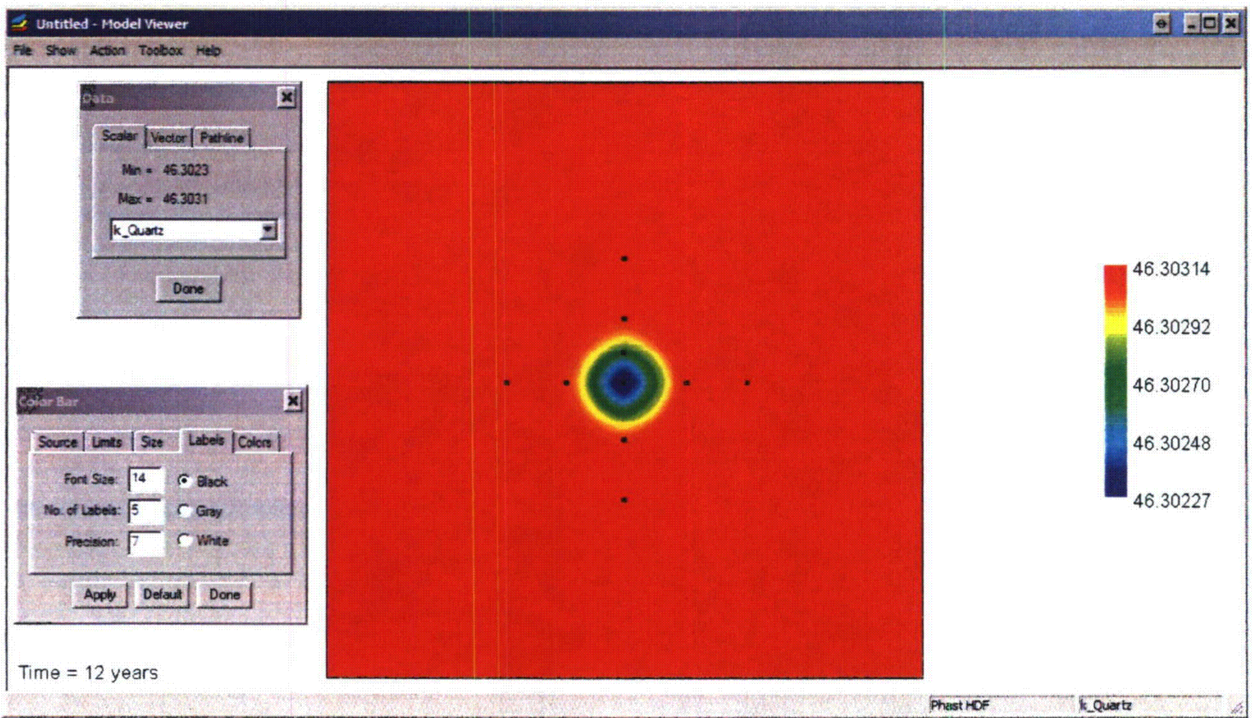


Figure 12. Distribution of quartz in moles/L after 12 years of injection. The default color bar (scale) has been selected, but the number of decimals has been increased to demonstrate these subtle differences.

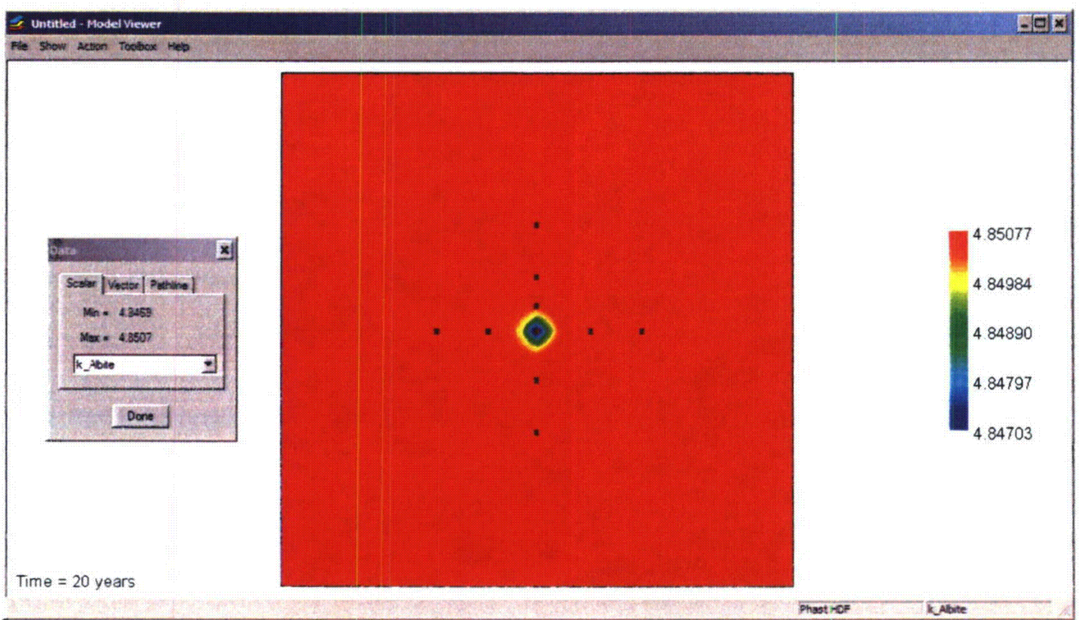


Aluminum

Aluminum concentrations were below the reporting limits of 0.1 mg/L for the FG Horizon samples, and the projected permeate water composition did not provide an estimated concentration either. At near neutral pH, aluminum concentrations are expected to be low. So these less than values are expected and indicate that little is actually going on with respect to aluminum.

Some additional modeling was developed to evaluate aluminum concentrations. The kinetic dissolution of albite ($NaAlSi_3O_8$) was added to the PHAST model. This addition greatly increased simulation run times to often more than 12 hours. In the simplest model that included the kinetic dissolution of calcite, quartz and albite, after 12 years aluminum concentrations increased to about 6 mg/L. But the highest concentrations were in the outer unimpacted areas beyond the injection well. This demonstrates one of the issues with the model. Sodium concentrations also increased slightly; from 30.5 to 35.7 mg/L. These values are within the range of the samples collected from within the FG Horizon. After 20 years sodium was 37.4 mg/L away from the injection point and concentration near the injection well were about 34.5 mg/L. Basically the model is equilibrating all the water within the formation with albite and it is producing these concentrations as the reaction proceeds. More important are the small differences in the albite concentrations (Figure 13). These differences are slight and they demonstrate that the extent of albite dissolution is correspondingly small. Furthermore, the mineralogical composition of the FG Horizon contains approximately the same amount of K-feldspar ($KAlSi_3O_8$) as it does albite. So there is another similar source of aluminum that could dissolve at about the same rate as albite in the formation. So for a first approximation the dissolution of albite would be lessened if this second feldspar mineral was included in the kinetic dissolution model. Clearly dissolution of aluminum bearing phases is not an issue.

Figure 13. Distribution of albite in moles/L after 20 years of injection. The default color bar (scale) has been selected, but the number of decimals has been increase to demonstrate these subtle differences.



Additional models were prepared that included a sink to precipitate the released aluminum. This tended to accelerate the albite dissolution, which increased sodium concentrations to much higher concentrations and increased pH slightly. These models were rejected.

A simple PHREEQC model suggested that the solution present at year 12, could potentially form diaspore (AlOOH), which would lower aluminum concentrations to about 0.002 mg/L, far below the reporting limit for aluminum. Even selecting the more soluble boehmite (another form of AlOOH) produces concentration of about 0.015 mg/l for aluminum. In both simulations, calcite precipitation buffered the pH to about 7.8 to 7.9. The low concentrations of aluminum in the ambient FG Horizon ground water indicate that there are no significant issues with respect to aluminum.

CONCLUSIONS

These models demonstrate that the injection water is essentially benign and it impacts to the FG Horizon will be minor. The slow dissolution kinetics of quartz can be extended to other phases such as feldspars to estimate the aluminum concentrations. Additional models support this observation.

Dissolved oxygen has also been mentioned as a concern. But there was limited information about the iron minerals in this formation. Reduced iron minerals, such as pyrite, could consume the oxygen, and could form some acid. It was assumed that the area around the proposed injection well is already oxidized so there is little additional reduced material to be oxidized. Furthermore, the approximately 3 percent calcite should neutralize any acid and form ferric hydroxide minerals such as ferrihydrite [$Fe(OH)_3$]. The mineralogical summary provided by Lost Creek did not mention pyrite, so if it is present it is at a very low concentration.

Because the permeate is dilute (i.e., has a low total dissolved solid concentration), well clogging via mineral precipitation is not expected to be an issue. Similarly because the carbonic acid concentration is also relatively low, the dissolution of minerals in the formation is expected to be slight. The mineral showing the greatest amount of dissolution will be calcite, but the volume is slight relative to the amount of calcite present in the FG Horizon.

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Plummer, L.N., Wigley, T.M.L., and Parkhurst, D.L., 1978, The kinetics of calcite dissolution in CO2-water systems at 5 to 60°C and 0.0 to 1.0 atm CO_2 : American Journal of Science, v. 278, p. 179-216.

Table 1. Summary of Permeate concentrations used in PHREEQC modeling. Parameters listed with - - were not included in the PHAST modeling efforts.

Parameter	Value	PHAST Model
pH	5.6	5.6
pe	7.6	7.6
Alkalinity	5	5
Ammonia	0.017	--
Arsenic	0.0005	--
Barium	0.0001	--
Boron	0.45	--
Cadmium	0.001	--
Calcium	1.2	1.2
Chloride	18.7	18.7
Chromium	0.0004	--
Copper	0.0005	--
Fluoride	0.0001	--
Iron	0.0001	--
Lead	0.0001	--
Magnesium	0.3	0.3
Manganese	0.0001	--
Molybdenum	0.05	--
Nickel	0.068	--
Nitrate	0.0001	0.0001
Potassium	1.1	1.1
Silica as SiO2	1*	1*
Sodium	28.7	28.7
Sulfate	15	15
Uranium	0.0122	0.0122
Vanadium	0.008	--
Zinc	0.0019	--
Concentrations in mg/L		
* Silica estimated		
Alkalinity as CaCO3		

Table 2. Summary of Saturation Index Calculations for Permeate.

Solution Model	pH	percent error	Calcite	Dolomite	Magnesite	Quartz	SiO2(a)	Gypsum	CO2(g)
Version 1 Alk 5	5.6	18.4	-4.86	-9.98	-5.70	-0.798	-2.07	-3.906	-1.788
Version 2 HCO3=30.5	5.6	19.7	-4.98	-10.21	-5.82	-0.798	-2.07	-3.905	-1.907

Table 3. Composition of FG Horizon groundwaters.

Number	Location	Date	pH	Alkalinity	Ca	Cl	F	Mg	Ammonia	Nitrate	K	Si	Na	Sulfate	Se	U
101	LC15M	5/4/2007	8.27	70	46	6	0.2	3		0.4	9	13	34	142	0.01	0.358
102	LC18M	5/4/2012	8.09	92	49	5	0.2	3		0.05	3	12.6	30	119	0.001	0.419
103	LC21M	5/3/2007	8.17	102	41	5	0.2	3		0.9	2	13.7	30	58	0.032	0.236
104	LC25M	5/3/2007	8.57	30	34	4	0.2	3		0.05	4	13.5	34	133	0.015	0.289
105	LC1W	5/3/2007	8.16	108	29	5	0.4	2		1.6	2	12.8	26	21	0.008	0.119
106	MB02	7/6/2010	7.78	105	37	8	0.2	3		1.1	2	15.1	31	59	0.013	0.178
107	MB05	7/6/2010	7.57	114	61	6	0.1	3		0.05	2	16.2	26	109	0.001	0.0156
108	MB08	6/29/2010	7.78	130	72	6	0.1	5		0.05	2	16.1	25	131	0.004	0.207
109	MO101	6/4/2009	7.87	112	89	10	0.2	4		0.05	2	15.4	29	199	0.012	0.368
110	MO102	6/4/2009	7.93	109	77	6	0.2	4		0.05	3	14.8	29	180	0.001	0.339
111	MO103	6/4/2009	7.83	114	79	6	0.2	4		0.1	2	15.4	32	174	0.014	0.464
112	MO104	6/3/2009	7.73	124	91	9	0.2	5		0.84	2	15.5	35	177	0.047	0.899
113	MO105	6/4/2009	7.91	105	56	5	0.2	3		0.15	2	15.1	31	122	0.016	0.313
114	MO106	6/3/2009	8.25	86	49	5	0.2	2		0.15	3	14.1	31	116	0.037	0.359
115	MO107	6/3/2009	7.93	104	57	5	0.2	3		0.08	2	14.3	33	116	0.022	0.419
116	MO108	6/3/2009	7.94	103	58	5	0.2	3	0.14	0.05	2	14.1	32	127	0.005	0.334
117	MO109	6/3/2009	7.93	107	58	7	0.2	3		0.18	3	14.8	30	124	0.027	0.397
118	MO110	6/2/2009	8.06	96	47	8	0.2	1		0.13	3	13.6	31	101	0.019	0.294
119	MO111	11/18/2009	7.92	105	49	5	0.2	2		0.2	2	14.4	32	97	0.027	0.32
120	MO112	6/2/2009	8.75	70	42	7	0.2	2		0.33	2	17.5	29	83	0.032	0.331
121	MO113	6/2/2009	7.85	105	56	6	0.2	2		0.17	2	15.6	32	106	0.042	0.641
122	MO114	2/3/2010	8.05	111	68	6	0.2	3		0.1	3	14.1	30	160	0.017	0.383
FINAL MIXED COMPOSITION			**7.97**	**100.04**	**56.6**	**6.14**	**0.20**	**3.00**	**0.00**	**0.31**	**2.68**	**14.6**	**30.6**	**120.6**	**0.018**	**0.35**

Table 4. Results of Mixing Calculations. Saturation indices for selected phases.

Permeate	FG Horizon	pH	Calcite	Dolomite	Magnesite	Quartz	SiO2(a)	Gypsum
0	**1**	7.967	0.311	-0.309	-1.201	0.361	-0.908	-1.579
0.05	**0.95**	7.801	0.112	-0.706	-1.399	0.342	-0.926	-1.611
0.1	**0.9**	7.650	-0.076	-1.080	-1.585	0.322	-0.947	-1.645
0.2	**0.8**	7.404	-0.408	-1.739	-1.912	0.276	-0.993	-1.720
0.3	**0.7**	7.207	-0.703	-2.323	-2.201	0.224	-1.045	-1.806
0.4	**0.6**	7.037	-0.987	-2.884	-2.478	0.164	-1.105	-1.905
0.5	**0.5**	6.878	-1.281	-3.462	-2.762	0.095	-1.174	-2.022

Appendix: KINETIC PARAMETERS AND RATE LAWS USED IN PHREEQC BASED KINETIC MODELS

```
KINETICS 600

Calcite
        -tol    1e-8
         -m0    2.385
        -parms  5.4     0.67

Quartz
-m0  46.303
-parms  63  -13.4   90.9
# Surface Area  63 m^2/L logKneutral = -13.4    Ea = 90.9 Kjoules/mole

RATES
Calcite
 -start
  1 REM       Modified from Plummer and others, 1978
  2 REM       M = current moles of calcite
  3 REM       M0 = initial moles of calcite
  4 REM       parm(1) = Area/Volume, cm^2/L   (or cm^2 per cell)
  5 REM       parm(2) = exponent for M/M0 for surface area correction
  10  REM rate = 0 if no calcite and undersaturated
  20   si_cc = SI("Calcite")
  30   if (M <= 0  and si_cc < 0) then goto 300
  40   k1 = 10^(0.198 - 444.0 / TK )
  50   k2 = 10^(2.84 - 2177.0 / TK )
  60   if TC <= 25 then k3 = 10^(-5.86 - 317.0 / TK )
  70   if TC > 25 then k3 = 10^(-1.1 - 1737.0 / TK )
  80  REM surface area calculation
  90   t = 1
  100   if M0 > 0 then t = M/M0
  110   if t = 0 then t = 1
  120   area = PARM(1) * (t)^PARM(2)
  130   rf = k1 * ACT("H+") + k2 * ACT("CO2") + k3 * ACT("H2O")
  140 REM 1e-3 converts mmol to mol
  150   rate = area * 1e-3 * rf * (1 - 10^(2/3*si_cc))
  160   moles = rate * TIME
  170 REM do not dissolve more calcite than present
  180   if (moles > M) then moles = M
  190   if (moles >= 0) then goto 300
  200 REM do not precipitate more Ca or C(4) than present
  210   temp = TOT("Ca")
  220   mc  = TOT("C(4)")
  230   if mc < temp then temp = mc
  240   if -moles > temp then moles = -temp
  300 SAVE moles
 -end
```

```
Quartz
 -start
  65  dif_T = (1/TK - 1/298.15)
  70  rate =  10^parm(2)*2.718^((-parm(3)*1000/8.314)*(dif_T))
  80  moles = parm(1) * rate * (1 - SR("Quartz")) * time
  90  save moles
 -end
```

KINETICS SETUP FOR ALBITE

```
Kinetics
          Albite
        -m0 4.851
 -parms  28.8  -10.16  65 0.457  -12.56 69.8  -15.6   71   -0.572
# parms S/A    logkH+  Ea   n     logKneutral  Ea      logkbase   Ea  n
```

```
RATES
Albite
 -start
  5   dif_T = (1/TK - 1/298.15)
  10   rate = 10^parm(2)*2.718^((-parm(3)*1000/8.314)*(dif_T))*ACT("H+")
^parm(4) + 10^parm(5) *2.718^ ((-parm(6)*1000/8.314)*(dif_T)) + 10^parm(7) *2.718^ ((
parm(8)*1000/8.314) *(dif_T)) *ACT("H+")^parm(9)
  20   moles = parm(1) * rate * (1 - SR("Albite")) * time
  30   save moles
 -end
```

APPENDIX C

Radium Resin Specifications

Remove Radium Efficiently with DOWEX™ Radium Selective Complexer Resin

The Challenge – Removing Radium without Generating Undesirable Waste

Radium is a radioactive element that occurs naturally in trace amounts in rocks, soils and some groundwater. Surface water is usually low in radium, but groundwater can contain significant amounts of radium due to local geology. The U.S. Environmental Protection Agency has set a maximum contaminant level (MCL) for radium in public water supplies of 5 picoCuries per liter (pCi/L).

The uranium mining industry is also concerned about radium where it is a by-product of solution mining. This is dealt with by direct barium precipitation techniques, but these processes take up a lot of space and generate large quantities of sludge that must be further treated.

The Solution – DOWEX™ Radium Selective Complexer Resin

Why Selective Removal of Radium is Better than Unselective

Radium and barium can be unselectively removed from groundwater through standard cation exchange resins, using several different regeneration cycles, but these processes change the composition of the water hardness components and produce undesirable wastes that contain radium.

DOWEX™ Radium Selective Complexer (RSC) resin was developed to meet the growing need for selective removal of radium and barium from groundwater, without generating sludge or undesirable waste.

DOWEX RSC resin is a barium salt complexed in an ion exchange matrix. Water soluble radium and barium react with the DOWEX RSC resin, forming an insoluble complex for excellent, cost-effective removal.

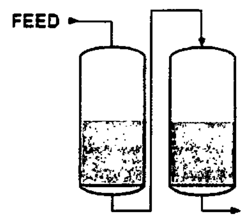
DOWEX RSC is certified by NSF under NSF/ANSI Std. 61 for Municipal Drinking Water System Components. For more information on this certification, see the NSF web site at www.nsf.org.

Typical System Configuration

A double-pass bed configuration, as shown in Figure 1, will allow the DOWEX RSC resin in the lead bed to be completely loaded before change-out, resulting in higher system efficiency. A typical system configuration is designed for a throughput of 10 gpm/square foot of bed. Bed depths of DOWEX RSC resin are a minimum of three feet. Prefiltration for particulate removal may be necessary, depending on the groundwater quality.

Form No. 177-01675-0209

Figure 1. Double-pass system configuration



A typical loading capacity might be 10 to 20 nanocuries/gram (11,000 to 22,000 nanocuries/liter). This means that a single bed volume of DOWEX™ RSC resin may be capable of treating millions of bed volumes of water before exhaustion.

DOWEX RSC resin is not regenerated like an ion exchanger. The radium-loaded DOWEX RSC resin can be conveniently disposed of with an accredited radioactive waste disposal company. However, DOWEX RSC generates only a fraction of the volume of waste that would be produced by classical barium precipitation.

Typical Physical Properties[1]

Physical form	Spheres
Total exchange capacity	0.65 meq/mL (min.)
Water retention capacity	65 - 75%
Packing density**	49 lb/cu ft 780 g/L
True density	1.18 - 1.25 g/cc
Estimated capacity	10 - 20 nanocuries/gram
Particle size analysis	
Through 40 mesh, max.	8%
Through 50 mesh, max.	1%

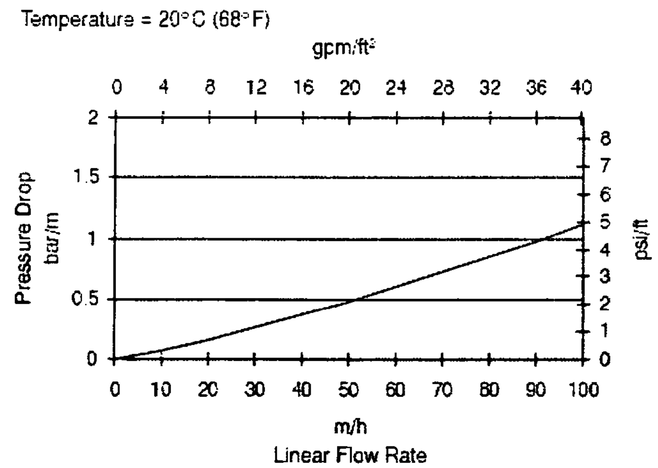
[1] Typical properties, not to be considered sales specifications.

General Design Criteria

1. Throughput of 10 gpm/square foot of bed.
2. Bed depth should be at least three feet deep.
3. Tanks and piping may be steel, lined or unlined, as per normal corrosion criteria.
4. Piping system should be designed to permit backwashing.
5. Tank size should allow 75-100% bed expansion during backwash.
6. Prefiltration for particulate matter is necessary.
7. Double tank system will allow DOWEX RSC resin in the lead tank to be completely loaded before change-out.

** As per the backwashed and settled density of the resin, determined by ASTM D-2187.

Figure 2. Pressure drop data



For other temperatures use:

$P_T = P_{20°C}(0.026T_{°C} + 0.48)$, where P ≡ bar/m

$P_T = P_{68°F}(0.014T_{°F} + 0.05)$, where P ≡ psi/ft

References

Snoeyink, V.L.; Chamber, C.C.; Schmidt, C.K.; Manner, R.F.; Myers, A.G.; Pfeffer, J.L.; Richter, S.K.; Snyder, D.W. "Removal of Barium and Radium from Groundwater." U.S. EPA 600/M-86/021, Cincinnati, OH, February 1987.

Subramonian, S.; Clifford, D.; and Vijjeswarapu, W. "Evaluating Ion Exchange for Removing Radium From Groundwater." Jour. AWWA, May 1990.

Melis, L.A. "Radium Removal from Canadian Uranium Mining Effluents by a Radium Selective Ion Exchange Complexer." CIM Bulletin 78:883:82-90, November 1985.

Mangelson, K. A. and Lauch, R. P. "Removing and Disposing of Radium From Well Water." Jour. AWWA, June 1990.

DOWEX™ Ion Exchange Resins

For more information about DOWEX resins, call the Dow Water Solutions business:

North America: 1-800-447-4369
Latin America: (+55) 11-5188-9222
Europe: (+32) 3-450-2240
Pacific: +60 3 7958 3392
Japan: +813 5460 2100
China: +86 21 2301 9000
http://www.dowwatersolutions.com

Form No. 177-01675-0209

APPENDIX D

Sage Grouse DDCT

WYOMING GAME AND FISH DEPARTMENT

5400 Bishop Blvd. Cheyenne, WY 82006

Phone: (307) 777-4600 Fax: (307) 777-4699

wgfd.wyo.gov

April 16, 2013

WER 2792.04
Lost Creek ISR, LLC
Governor's Sage Grouse Executive Order 2011-5
2013 Density Disturbance Calculation Tool Analysis
Lost Creek Project ISR Mining Area
Sweetwater County

Charles Kelsey
Lost Creek ISR, LLC
5880 Enterprise Drive, Suite 200
Casper, WY 82609

Dear Mr. Kelsey:

The staff of the Wyoming Game and Fish Department (WGFD) has reviewed the Governor's Sage Grouse Executive Order 2011-5, Density Disturbance Calculation Tool (DDCT) Analysis for the Lost Creek Project ISR Mining Area in Sweetwater County. We offer the following comments for your consideration.

We have reviewed the DDCT for this project accompanying Sage Grouse Executive Order Worksheet (attached). Information provided in the worksheet documents conformity with the SGEO 2011-05. In addition, the DDCT area for this project occupies very closely the same area that was analyzed in the DDCT for the Lost Creek In-Situ project which conformed to the Governor's Executive Order for Sage Grouse 2011-05 and to which a permit from DEQ-LQD was issued in 2011. This DDCT shows 0.04 disruptions per 640 acres on average and the total disturbance acreage including current and proposed is 2.37% which is below the 5% threshold.

We did find one area of proposed disruption in T42N R 107W Sec 16 within the perimeter of the 0.6 mile buffer of the Crooked Well lek. Upon further examination and discussion with the proponent and WYGISC staff, it has been determined that this small "square" of proposed disturbance is incorrectly identified as a disturbance. The proposed disturbance for Section 16 is a series of exploratory wells that will be temporary in nature and immediately backfilled and reclaimed; therefore they do not constitute permanent disturbance per the SGEO. We recommend that if implemented the exploratory drilling occur outside of the seasonal stipulation period of March 15-June 30. Reclamation should occur as soon as possible with seed mixes consisting of at least two native grasses and two native forbs conducive to sage-grouse habitat. With our recommendations implemented, our policy review finds this project consistent with the SGEO 2011-05.

Thank you for the opportunity to comment. If you have any questions or concerns, please contact Scott Gamo, Staff Terrestrial Biologist, at 307-777-4509.

Sincerely,

John Emmerich
Deputy Director

JE/mf/gb

Enclosures
1) Sage-Grouse Executive Order 2011-5 Worksheet
2) Final Results

cc: USFWS
Nicholas Graf, WyGISC

WER: 2792.04
DUE: 4-17-13

Submit by E-Mail Print Form

Sage-Grouse Executive Order 2011-5 Worksheet

This worksheet is a tool for reviewers and preparers of the Greater Sage-Grouse (*Centrocercus urophasianus*) Core Area Protection Executive Order 2011-5 (SGEO) Density/Disturbance Calculation Tool (DDCT) (Attachment B-Permitting Process & Stipulations for Development) to help determine project compliance with the SGEO based on DDCT inputs and outputs, and other pertinent project information.

Please describe the following aspects of the project proponent:

Who is the project proponent? Lost Creek ISR, LLC., 5880 Enterprise Drive, Suite 200, Casper, WY 82609

Contact Name: Charles Kelsey Phone: (307) 265-2373 E-mail charles.kelsey@ur-energyusa.com

Address to send Executive Order 2011-2 Compliance Letter

Street Address: 5880 Enterprise Drive, Suite 200

City: Casper State: Wyoming Zip Code: 82609

Agencies for whom a permit is required (Please check all that apply)

- ☐ Wyoming Department of Environmental Quality - Air Quality Division
- ☒ Wyoming Department of Environmental Quality - Land Quality Division
  Name: Melissa Bautz Phone: (307) 332-3047 E-mail m.bautz@wyo.gov
- ☐ Wyoming Department of Environmental Quality - Solid and Hazardous Waste Division
- ☐ Wyoming Department of Environmental Quality - Water Quality Division
- ☐ Wyoming Office of State Lands and Investments
- ☐ Wyoming Oil and Gas Conservation Commission
- ☒ Wyoming State Engineer's Office
  Name: Mike Ebsen Phone: (307) 777-6166 E-mail mike.ebsen@wyo.gov
- ☐ Other State Agency
- ☒ United States Bureau of Land Management
  Name: Mark Newman Phone: (307) 328-4248 E-mail mnewman@blm.gov
- ☐ United States Bureau of Reclamation
- ☐ United States Forest Service
- ☐ Other Federal Agency

Sage-Grouse Executive Order 2011-5 Worksheet

Please describe the following aspects of the proposed project (or provide a project narrative with this worksheet):

What is the proposed project? Please describe all aspects of the project, including proposed surface disturbance acreage, and actions related to the implementation of the project that may result in disturbance or disruption within sage-grouse core area.

The original disturbance footprint of the Lost Creek Project ISR mining area is slightly enlarged within the Permitted Lost Creek Project Mining Area.

Where will the proposed project occur? Please provide information such as county or locality, township/range/section(s), surface and/or mineral ownership, etc.

The Project is an enlargement of the disturbance footprint within the Lost Creek ISR, LLC. mining Permit Area.

Does the proposed project description include all current and foreseeable future development activities associated with the proposed project? ☐ Yes ☒ No

Please provide all disturbance activities associated with the development of your project, including additional water wells, anticipated expansion,transmission, distribution and electrical lines, pipelines, roads, etc.

The only increase in disturbance will be a small increase in acreage to accommodate a permitted expansion of the monitoring and mining zone.

Does the proposed project involve an application for permit to drill (APD)? ☐ Yes ☒ No

When will the development of the proposed project begin? 03/01/08

When will the development of the proposed project end? 12/31/33

What is the expected life of the project? Indefinite

Example: 5 Months

Who has been your main point of contact with WGFD Habitat Protection Program? Scott Gamo

Sage-Grouse Executive Order 2011-5 Worksheet
Part 1 - Project Location and Large Disturbance Features

Question	Reference	Answer	Comments
1. Is the project located in a northeast WY core or connectivity area (i.e., Buffalo, North Gillette, Thunder Basin, Newcastle, Douglas, North Glenrock, or Natrona north of Hwy 20/26 and north of Casper Mtn.)?	SGEO Pages 11, 14-15	☐ Yes ☒ No	
2. Were there any large sagebrush disturbing wildfires or treatments within the DDCT area?	SGEO Page 14	☐ Yes ☒ No	
3. Is the project (proposed disturbance and the permit area) within a Federal oil and gas unit established prior to August 1, 2008?	SGEO Pages 2 & 12	☐ Yes ☒ No	
4. Is the DDCT area overlapped by a pre-August 1, 2008 unit, but the project lies outside the unit?		☐ Yes ☒ No	

Sage-Grouse Executive Order 2011-5 Worksheet
Part 2 - Disturbance Guidelines and Stipulations for Development

Question	Reference	Answer	Comments
1. Is the DDCT disturbance calculation output within the 5% surface disturbance threshold?	SGEO Pages 8-9	☒ Yes ☐ No	
2. Is all surface occupancy >0.6mi from the perimeter of occupied leks?	SGEO Page 9	☒ Yes ☐ No	
3. Are seasonal stipulations for development activities (March 15 - June 30) being applied to the project?	SGEO Page 9	☐ Yes ☒ No	NA because the Lost Creek Project has already been permitted for construction
4. Are main roads associated with the project located >1.9 miles and access/ maintenance roads located >0.6mi from the perimeter of occupied leks?	SGEO Page 9	☒ Yes ☐ No	Road layout for Lost Creek Project has been reviewed and approved by WGF and WDEQ in conjunction with previous DDCT's.
5. Will there be new transmission or distribution lines constructed as a result of the project?	SGEO Pages 4 & 9	☐ Yes ☒ No	Transmission lines have been reviewed and approved in conjunction with previous DDCT's.
6. March 1 - May 15: Will noise (activity) associated with the project occur between 6PM and 8AM during any phase of project implementation (i.e., development through production), including traffic to and from the project location?	SGEO Page 9	☒ Yes ☐ No	
6a. If **yes**, were ambient noise level measurements taken at sunrise at lek perimeters to ensure that new noise is limited to 10 dBA above baseline?		☒ Yes ☐ No	
7. Is vegetation removal associated with the project planned between March 15 and June 30 within 4mi of an occupied lek?	SGEO Pages 9-10	☐ Yes ☒ No	
8. Does the project include vegetation treatment?	SGEO Pages 10 & 14	☐ Yes ☒ No	

Sage-Grouse Executive Order 2011-5 Worksheet
Part 2 - Disturbance Guidelines and Stipulations for Development

Question	Reference	Answer	Comments
9. Has the proponent agreed to monitor affected and surrounding (control) leks?	SGEO Page 10	☒ Yes ☐ No	
9a. If **yes**, will they coordinate with the permitting agency and local WGFD biologist to determine monitoring/data needs?		☒ Yes ☐ No	
9b. Does the proponent indicate a willingness to use adaptive management if there are declines on monitored leks determined to be caused by the project?		☒ Yes ☐ No	
$9b_i$. If **yes**, what actions could be taken?		☒ Yes ☐ No	Reduced grazing; protective fencing; overseeding
10. Does the reclamation plan comply with Executive Order 2011-5?	SGEO Page 10	☒ Yes ☐ No	

Sage-Grouse Executive Order 2011-5 Worksheet
Part 3 - Density Guidelines and Specific Stipulations

Question	Reference	Answer	Comments
1. If the project includes oil and gas development and/or mining activity, is the 1 /640 density calculation accurate and within Executive Order 2011-5 guidelines?	SGEO Page 12	☒Yes ☐No	
2. Is the project located in a sage-grouse connectivity corridor?	SGEO Pages 12-13	☐Yes ☒No	

Sage-Grouse Executive Order 2011-5 Worksheet
Part 4 - Deviations and Mitigation

Question	Reference	Answer	Comments
1. Are there any deviations from Executive Order 2011-5 process or stipulations?	SGEO Pages 4, 12-13	☐ Yes ☒ No	Road locations relative to leks have been addressed in previous DDCT submittals approved by WGF, WDEQ and BLM
2. Are there additional mitigation efforts being proposed by the proponent or recommended by the biologist that could be implemented to offset anticipated impacts to sage-grouse?		☒ Yes ☐ No	Intensive radiocollaring and tracking of nesting birds has been conducted for three seasons in order to determine preferred habitat locations for future mitigation efforts.
2a. If **yes**, will the proponent implement these mitigation measures?		☒ Yes ☐ No	Preferred habitats will be avoided and improved through reduced grazing and over-seeding

20130205_1 **Lost Creek**

02/14/2013 **Mel Lahr**

Core Area: **Greater South Pass**

Category	**Acres**	**Percent**
Overall DDCT Boundary	101,835.90	100
Total Disturbed	2,418.41	2.37
Total Undisturbed	99,417.49	97.63
Disturbed - Project Only	928.16	0.91
Disturbed - Prior to Project	1,490.25	1.46
Disruptions	0.04 Dis/640 Ac	

Owner	**Total Acres**	**Pre-Acres**	**Pre-Percent**	**Post-Acres**	**Post-Percent**
Bureau of Land Management	98,947.27	1,455.35	1.47	2,377.60	2.40
State	2,888.63	34.90	1.21	40.81	1.41

LekID	**Total Acres**	**Pre-Acres**	**Pre-Percent**	**Post-Acres**	**Post-Percent**
9-Crooked Well	32,164.12	165.12	0.51	1,093.27	3.40
9-Discover	29,973.74	368.63	1.23	1,210.54	4.04
9-Discover East	29,775.62	278.44	0.94	1,206.59	4.05
9-Discover South	28,899.00	281.61	0.97	1,168.80	4.04
9-Eagles Nest Draw	32,164.01	554.16	1.72	1,482.31	4.61
9-Green Ridge	32,163.41	135.35	0.42	418.97	1.30
9-Prospects	32,163.57	328.03	1.02	728.51	2.27
9-Prospects South	32,164.11	281.14	0.87	864.21	2.69
9-Sand Gully	32,163.47	937.49	2.91	1,836.57	5.71
9-Sooner Oil	31,778.75	166.19	0.52	193.46	0.61

10 km
5 mi

ADDENDUM 1

UIC CLASS V ENVIRONMENTAL REPORT

Lost Creek ISR, LLC
3424 Wamsutter Crooks Gap Road
Wamsutter, Wyoming 82336 USA

LOST CREEK ISR, LLC

LICENSE SUA-1598

March 2015

General Table of Contents

Contents

1.0 Introduction

Lost Creek ISR, LLC (LCI) is submitting this Environmental Report (ER) to the United States (US) Nuclear Regulatory Commission (NRC) in support of an amendment to license SUA-1598 in accordance with the Atomic Energy Act of 1954, as amended, 10 Code of Federal Regulations (CFR) Parts 20, 40, 51, and 70, and other applicable laws, regulations and NRC guidelines. Approval of this amendment would allow LCI to treat waste water at the Lost Creek Mine and return the effluent to the Battle Spring Formation through the utilization of shallow Underground Injection Control (UIC) Class V well(s).

Several NEPA actions related to in situ mining and the Lost Creek Project specifically have already been taken and concluded. These include the NRC's Generic EIS published as NUREG-1910 in May 2009. The NRC also completed a site specific Supplemental EIS for the Lost Creek which was published as NUREG-1910 Supplement 3. Also, in July 2012, the BLM completed a site specific EIS for the Lost Creek project and issued a subsequent Record of Decision approving the project. The analysis in the NRC's and BLM's site specific EIS documents included the area surrounding the processing plant where the UIC Class V injection and monitoring will occur.

This ER is generally organized in accordance with the guidance contained in NUREG-1748, Environmental Review Guidance for Licensing Actions Associated with Nuclear Material Safety and Safeguards (NMSS) Programs, dated August 2003. **Section 1** provides an introduction of the Project, discusses why LCI is requesting a license amendment, and presents a detailed Project description. **Section 2** discusses the proposed action versus alternatives, including the no-action alternative and alternatives considered but eliminated. **Section 3** describes the existing environmental conditions in the Permit Area; and **Section 4** discusses how those conditions could be impacted, if at all, by the proposed action, and the mitigation and monitoring measures that will be implemented during the Project. **Section 5** presents the Cost-Benefit Analysis. **Section 6** provides the summary of the environmental consequences from the Project.

1.1 Proposed Action

1.1.2 General Description

In situ uranium recovery is a mining method that utilizes a series of injection and production wells completed in the mineralized aquifer. A solution consisting of groundwater, oxidant and a source of bicarbonate is injected into the mineralized aquifer where it dissolves the naturally occurring uranium minerals. The uranium laden groundwater is then pumped to the surface via the production wells and sent to the processing plant where the uranium is recovered. The groundwater is then refortified with oxidant and bicarbonate and re-injected into the formation where it repeats the process until the mineralization is recovered. In situ mining requires the maintenance of a hydrologic sink, or area of low groundwater pressure, so the mining solution can be contained within the mineralized body instead of migrating outward into potentially clean

groundwater. The hydrologic sink is generated by removing about 0.5 to 1.5% of the water from the flow circuit prior to re-injection; this is often referred to as a bleed. For example, if the production rate is 1,000 gallons per minute (gpm), then the bleed rate would typically be 5 to 15 gpm. The water generated from the bleed, as well as plant process water and waste water generated from groundwater restoration, must be disposed of as waste.

The original mine site plan for waste water disposal called for utilizing up to five (5) UIC Class I deep disposal wells. To date, three of the five Class I wells have been installed and put into use. LCI desires to utilize technology that will be more cost effective than Class I disposal wells and also reduce water consumption. Therefore, LCI is proposing with this application, to treat various streams of waste water to a quality that can be returned to its native geologic formation using a UIC Class V Subclass 5C3 Permit (referred to as an "Industrial Process Water and Waste Disposal Facility" in the WDEQ-Water Quality Division Chapter 16 regulations). If approved, this practice would allow for increased production rates while maintaining the required bleed rate, and would also significantly expedite the rate of future groundwater restoration. Most importantly, the consumption of groundwater could be reduced by as much as 90%.

As described in greater detail in **Section 2.0** of the Class V Amendment Technical Report (TR), LCI has selected shallow horizons within the Battle Spring Formation, as the receiving zones because these horizons are:

- relatively shallow and easy to access;
- the water quality of these horizons are relatively poor due to naturally occurring radionuclides and associated metals;
- the horizons are naturally oxidized and barren of uranium mineralization;
- vertical confinement is sufficient so fluids will not migrate to the surface;
- structural and lithologic boundaries, as well as distance, will significantly reduce communication with in situ uranium mining monitor wells or the mining aquifer. These factors will prevent Class V injection from having an impact on mining operations; and
- the horizons possess sufficient transmissivity to serve as receiving zones.

Prior to Class V injection, the water will be treated with: 1) ion exchange to remove uranium, 2) with reverse osmosis (RO) to remove total dissolved solids, radionuclides and metals, and 3) with Dowex Complexer resin to ensure radium levels are less than effluent limits. A slip stream of well water which contains low concentrations of sulfate may be added to the circuit prior to the radium removal in order to minimize dissolution of barium sulfate from the resin surface.

During commercial uranium production, the flow rate through the Class V treatment circuit is expected to be on the order of 10 to 70 gpm (exclusive of the sulfate rich slip stream). During groundwater restoration, the flow rate through the Class V treatment circuit will be much greater, on the order of 50 to 200 gpm, due to groundwater sweep and RO treatment of the wellfield fluids.
The facility will be located on Federal lands managed by the Bureau of Land Management, Rawlins Field Office. The nearest commercial neighbor is the Sweetwater Uranium Mine and Mill located approximately four miles to the southwest. No residences are in the vicinity. The village of Bairoil is located about 15 miles to the northeast. The prevailing wind direction, based on over seven years of nearly continuous onsite monitoring, is from the west southwest to the east northeast. The terrain consists of gently rolling high plains desert steppe.

1.1.2 Discussion of Wells and Siting

Five Class V wells, one injection well and four monitor wells, were installed on and around the Plant facility as shown on **Figure 2-2** of the Class V Amendment TR. The four wells located north of the North Fault are considered current or potential future injection wells, and were constructed as such. The well located south of the North Fault (M-FG8) is considered strictly a monitor well. LCI proposes to use M-FG7 as its primary injection well with M-FG6 designated as the backup injection well should the need arise. Currently, wells M-FG6, M-FG8, M-FG9 and M-FG10 are considered injection monitoring wells for M-FG7. Should well M-FG6 be activated to injection well status, LCI commit to adding a replacement monitor well; likely located up gradient and 600 feet directly east of M-FG6. Should a well fail for any reason, injection or monitor, LCI will install a replacement well immediately adjacent to the failed well.

The primary rationale for siting injection well M-FG7 close to the Plant was to minimize infrastructure build-out, and facilitate disposal and monitoring. Secondarily, the Plant site location is separated from Mine Unit 1 by two faults (North and Plant Faults) which have been shown to be hydrologic barriers, thus isolating or limiting the injection pressure wave to the north side of the faults.

The four injection monitor wells were located radially around M-FG7 at distances ranging from 765 to 1,362 feet as shown on **Figure 2-2** of the Class V Amendment TR. Note that three of the four monitor wells are located north of the North Fault. A fourth monitor well (M-FG8) was intentionally installed south of the North Fault as an observation well for the M-FG6 pump test. The purpose of this observation well was to help in assessing whether the North Fault was a groundwater flow barrier. The observation well spacing criteria was based on a "radius of fluid displacement" (ROFD) calculation, which is

discussed further in **Section 4.0** of the Class V Amendment TR. The ROFD is the distance at which the injectate should be detectable after 14 years of continuously injecting 60 gpm.

1.1.3 Well Construction and Completion Design

Monitor and injection wells were drilled, logged and then reamed to accommodate casing. Casing was set to the top of the planned completion interval and cemented in place to isolate the completion interval from overlying horizons. All injection and monitor wells were constructed with either 4.5-inch or 6-inch I.D. polyvinyl chloride (PVC) casing. After the cement set, the pilot hole was deepened below the casing to the desired total depth, after which the completion interval was under-reamed to a diameter of 10.5 or 12-inches.

Slotted or wire wrap, flush-joint PVC, schedule 80 well screen was installed on a K-packer system in the open completion interval. **Table 2-1** of the Class V Amendment TR presents a compilation of well completion information. Well Completion Logs are provided in **Appendix A** of the Class V Amendment TR. **Figures 2-3** and **2-4** of the Class V Amendment TR are well construction schematics for injection well M-FG7 and back-up injection well M-FG6, respectively.

After the well screen was set, a mechanical integrity test (MIT) of the well casing was conducted. The MIT method entails performing a pressure test whereby a packer is placed near the casing bottom (just above the well screen) and another at the wellhead, and the interval between is pressurized to 160 psi. The well successfully passes if the pressure remains within 5 percent of the initial pressure for a period of 10 minutes. All of the Class V wells passed the MIT.

The top of the injection well casing will rise at least 18-inches above the ground level, and a sloped cement pad at least 4-inch thick will be placed around the casing to divert water away from the well. The wellhead will be sealed in order to prevent artesian flow to the surface in the event the well pressures up. A manual pressure gauge, e-line port, and manual vent controlled by a ball valve will be placed on the wellhead so appropriate measurements can be taken. The wellhead will be covered by a weather resistant cover.

The proposed injection well(s) are within the secured fence surrounding the Lost Creek processing Plant. The facility is occupied by employees around the clock during operations. Two, all-weather graveled roads provide access to the Plant facility.

Well M-FG7 is located at an elevation of 6,980.4 feet above mean sea level, which is estimated to be above the 100 year flood level. The well sits on a small gentle hillside within a local drainage basin of about 0.5 square miles.

Each of the injection and monitor wells were constructed to standards enumerated in LQD Chapter 11 Section 6 regulations on Class III UIC wells and further described in the **Section 3.2** of the Lost Creek Technical Report.

1.1.4 Source of Water to be Treated

The water to be treated and injected will be derived from a combination of sources including:

- Mining solutions captured during the maintenance of the hydrologic sink;
- Water derived from plant processing including but not limited to solutions from: plant wash-down, washing of product, chemical makeup, and dryer condensate;
- Chemistry lab waste water;
- Water derived from groundwater restoration;
- Water derived from UIC Class I and Class III wells during drilling, completion and maintenance; and
- Water captured from spills of mining solutions.

Most of the source waters listed above are defined by the NRC as byproduct material because they were generated during the recovery of uranium. As such, the average analyte composition of the fluids must be less than the corresponding effluent standard in 10 CFR 20 Appendix B, Table 2, Column 2 prior to being injected into a UIC Class V well or cleaner than the native groundwater; whichever is higher.

The WDEQ-WQD also regulates the quality of water injected into a UIC Class V well. Specifically, the WQD regulates the parameters described in the Primary Drinking Water MCLs listed in 40 CFR §140. In cases where the water quality of the receiving horizon is of poorer quality than the respective EPA MCL, the quality of the injection fluid must be equal to or better than the receiving horizon. In other words, the quality of the effluent must be better than the MCL or the baseline water quality; whichever is higher.

The treatment process will consist of several steps in order to remove the contaminants of concern to the NRC and WQD (EPA Drinking Water MCLs).

1.1.5 Construction and Engineering Design

The water treatment system will consist of the following major components (listed in order of treatment):

1. Ion exchange using Dowex 21k, or similar, anionic exchange resin to remove uranium. The water will be treated using either the existing commercial or existing restoration ion exchange circuit.
2. Bag filtration down to at least 5 micron size.
3. Reverse osmosis to remove approximately 98% of total dissolved solids, radionuclides and metals. The existing pumps prior to the RO skid were specified by the RO manufacturer, and will generate sufficient pressure to push water through the remainder of the circuit and into the Class V well(s). The brine generated from the RO will be sent to the sites' waste disposal systems (temporary storage in the plant, holding ponds and UIC Class I disposal wells). The RO system may utilize multiple passes depending on the need to minimize waste water generation.
4. Sodium hydroxide (NaOH) will be added, via a positive displacement chemical metering pump, to increase pH to at least 6.0. A small, caustic day storage tank will be utilized to simplify chemical metering.
5. Dowex Radium Selective Complexer (RSC) resin will be used to remove radium (**Appendix C** of the Class V Amendment TR). Two fiberglass vessels, approximately 4 feet in diameter and 6 feet tall, will be placed next to the resin water transfer tanks on the north end of the processing plant.
6. On occasion, treated water may be sent to temporary storage to allow for ease of handling prior to injection.
7. 3-inch, High Density Polyethylene (HDPE) SDR 13.5 pipeline from the radium resin vessels to the Class V injection well(s). The length of the pipeline from the radium resin vessel to injection well M-FG7 is approximately 410 feet. The pipeline will be buried at least 6 feet deep to minimize the likelihood of freezing.

The location of each of the major components is shown on **Figures 5-1 and 5-2** of the Class V Amendment Technical Report. The uranium ion exchange, bag filtration and RO treatment equipment are already installed as part of the originally approved facility. Each component will be able to treat approximately 200 gpm. Valves will be placed before and after each of the major components so each component can be easily isolated from the remainder of the system to allow for maintenance, as appropriate.

1.1.6 Facility Monitoring

In order to ensure treatment processes are working properly and that EPA MCLs and NRC effluent standards are being met, the injectate quality will be monitored as described in **Table 3-3** and as discussed in **Section 5.3** of the Class V Amendment TR.

Continuous monitoring of pH and conductivity will be performed by automated systems with the results used to ensure the treatment systems are functioning properly. In the event the automated monitoring system fails, the treatment system may still be operated but LCI will record the pH and conductivity of the effluent at least every three (3) hours, and retain the records for inspection.

The monthly effluent samples will consist of daily aliquot samples that are physically combined into a composite. The monthly composite sample will be submitted to a commercial laboratory for analysis of the dissolved fraction of the parameters which have an NRC effluent limit listed in **Table 3-3** of the Class V Amendment TR. A quarterly grab sample will be collected and analyzed for each EPA MCL parameter listed in **Table 3-3** of the Class V Amendment TR.

The water level in each of the four (4) monitor wells will be measured quarterly, and water samples will be collected and analyzed for alkalinity, chloride and conductivity in order to determine if treated injectate has migrated to the monitor well. Fluid (permeate) migration to one or more monitor wells will not constitute a violation.

The Manager of EHS, or their designee, will ensure samples of the injection fluid are collected and supplied to the laboratory pursuant to the scheduled provided in **Table 3-3** of the Class V Amendment TR. A chain of custody, generally provided by the contract laboratory, will be completed for each set of samples collected and submitted to a contract laboratory. The analytical results will be maintained on file until license termination. The anion/cation balance and measured TDS versus calculated TDS will be reviewed for each analytical result that includes measurements of major ions. A duplicate sample will be submitted to the commercial lab at least twice per year to verify lab results. Only approved EPA analytical methods will be used by the commercial laboratory.

The Plant Operator will verify that the injection pressure and flow rate are within limitations at least once per day. Any non-conformance will be corrected immediately and reported to the Manager of EHS. If the non-conformance cannot be immediately corrected, the system will be shut down until corrections can be made and verified.

LCI has developed and implemented extensive health physics SOPs that will be followed when working on the treatment system. These procedures include, but are not limited to: Contamination Control, Screening and Decontamination of Materials, Personnel Surveys, Radiation Work Permits, Gamma Surveys, Surface Contamination Surveys, Byproduct Waste Management, Radiation Dose Determinations and Radiation Safety Inspections. These SOPs already consider the radiologic hazards that will be generated by the treatment and injection system including the potential for significant alpha, beta, and

gamma emissions, as well as, the release of radon during maintenance and upset conditions.

The point of compliance for effluent concentration, flow rate, and injection pressure will be at the discharge point from the processing plant. Corrections to the injection pressure will be made to account for change in elevation between the plant and Class V well(s).

1.1.7 Health Physics

The main health physics concern will result from the gamma emitters, which will be concentrated in the brine solution derived from the RO and radium resin. Since the brine will be disposed of in the deep well or sent to the holding ponds, the opportunity for exposure to its radioactive components will be minimal.

The radium resin vessel will concentrate radium. The majority of alpha and beta emitters will be absorbed by the water and vessel. However, gamma rates could become elevated and will pass through the sides of the vessel. The Health Physics department will monitor the gamma rates in the vicinity of the vessel at least weekly during the first charge of resin in order to determine how quickly the gamma rates increase. After the first charge of resin is disposed of, the Radiation Safety Officer (RSO) may reduce the frequency of gamma readings, but shall take readings at least monthly.

Since the majority of alpha and beta particles will be absorbed by the water and containing vessels, the potentially significant routes of exposure to these particles would only exist during maintenance or a spill event. LCI has developed SOPs to address these situations and may also rely on the established Radiation Work Permit practice if the SOP(s) is inadequate to address the radiologic hazard. Since the radium resin vessel has the increased radiologic hazard of radium, all personnel will wear waterproof clothing, gloves, and rubber boots as minimum protection when performing maintenance which may result in exposure to radium resin. Upon completion of the work, the area will be washed down and a representative removable alpha survey performed once the area is dry. Since the work is within a restricted area there is no regulatory limit on removable alpha. However, in order to maintain ALARA (an NRC acronym defined in 10 CFR 20 regulations meaning As Low As Reasonably Achievable), a removable alpha action limit of 1,000 dpm/100 cm^2 will be utilized. If the removable action limit is exceeded, the area will be washed and resurveyed as many times as necessary to get below the action limit. All workers will wash their protective clothing upon completion of work on the system. If contamination may have breached the protective clothing, the affected worker will wash the affected area or shower and then get assistance from the Health Physics department to scan out to the appropriate standard defined in Regulatory Guide 8.30.

Radon, which will not be removed by any of the treatment processes, is not expected to be released as an airborne effluent since it will be within closed vessels. If effluent is sent to the holding ponds, the water is expected to trap the radon gas and prevent release as outlined in EPA 520/1-86-009, Final Rule for Radon-222 Emissions from Licensed Uranium Mill Tailings, August 1986, Background Information Document, section 3.4.3. Since the concentration of radium-226 in the treated water will be less than 60 pCi/L, there will be little in growth of radon in permeate. The half-life of radon-222 is 3.8 days, so it will rapidly decay.

The unrestricted release of materials involved in radium treatment would be handled as follows:

Items from the radium treatment circuit would be thoroughly washed and then released to the radium standard in Table 1 of NRC's Reg Guide 1.86 *"Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source or Special Nuclear Material,"* August 1987. Specifically, the average acceptable surface contamination level would be 100 dpm/100 cm^2 with a maximum reading of 300 dpm/100 cm^2. The removable limit would be 20 dpm/100 cm^2. However, in most cases, items removed from the radium treatment circuit will be disposed of as byproduct material instead of being released for unrestricted use.

Materials from all other portions of the treatment circuit would be released to the U-nat, line 1, standard from Table 1 unless there is reason to believe that radium has been chemically enriched.

Radium resin removed from the extraction vessel will be stored outdoors in a shipping container. The RSO or Health Physics Technician will ensure the gamma rate in the area does not exceed any applicable standards. The waste radium resin will be shipped in a strong tight container to a licensed disposal facility after ensuring the gamma rates do not exceed any DOT standards and all applicable DOT standards are met.

1.2 Purpose and Need for the Proposed Action

Waste water generated at in situ facilities is commonly disposed of by either UIC Class I deep wells or by treatment followed by land application.

UIC Class I wells present several significant challenges including:

- High installation cost. A Class I UIC well typically costs over $3 million to install and place into service. Despite the high cost, the performance of the well is

unknown until it is placed into service. This risk makes UIC Class I wells undesirable.

- The permitting of Class I wells is becoming increasingly difficult due to conflicts with oil and gas operators and reinterpretation of regulations.
- Operating and maintenance costs can be high.
- Once water is injected into a deep aquifer it is unlikely the water will ever be beneficially used again.
- The associated surface disturbance for drill pads and trunklines can be relatively significant.

Treatment followed by land application also presents challenges including:

- Long-term land application can result in an ingrowth of metals, salts and radionuclides in the affected soil; especially in dry climates. In order to prevent the buildup of undesirable constituents, the water may have to be treated to levels that are far below regulatory effluent standards. The additional treatment adds cost to this disposal method.

The utilization of UIC Class V well(s) to recycle water will provide several benefits as follows:

- The installation cost is significantly less than Class I UIC wells while the flow rates are likely much higher. Despite this benefit, the brine generated by the treatment system will still need to be disposed of in Class I UIC wells. However, the volume of water will be significantly diminished.
- The maintenance cost is significantly less than Class I UIC wells.
- Although the same quantity of water will be affected by in situ mining, a potentially large percentage, as much as 90%, of the waste water will be treated to below effluent standards and placed back into a shallow aquifer where it can be beneficially used in the future.
- There is no risk of increasing concentrations of undesirable constituents in the soil.

1.3 Applicable Regulatory Requirements, Permits, and Required Consultations

Prior to operating Class V UIC well(s) at the Lost Creek facility for the purpose of disposing of treated waste water, LCI will need to obtain the following:

- An amendment to the Lost Creek NRC License
- A Class V UIC permit from the WDEQ-WQD

- A permit amendment from the WDEQ-LQD
- A revision to the BLM Plan of Operations

A permit from the State Engineer to install and operate injection and monitor wells is not required as long as the wells are operated under a WDEQ-WQD Class V Permit.

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2.0 ALTERNATIVES

2.1 No-Action Alternative

Under this alternative, LCI would continue to dispose of all waste water via Class I UIC wells.

2.2 Alternatives Considered but Eliminated

The alternative use of land application was reviewed but eliminated for reasons discussed below. During the original licensing action, the use of evaporation ponds for process water disposal was considered as an alternative to the UIC Class I wells but was eliminated.

2.2.1 Land Application

The treated water generated from the facility could be land applied. However, this method was eliminated after a technical review due to several issues described below. While most of these issues could be resolved through the application of technology, the associated costs are not acceptable when another acceptable method is available.

- The level of treatment would have to be greater than for UIC Class V in order to minimize the potential for buildup of metals, salts and radionuclides in the soil. While the treatment methods are technically feasible, they would raise the cost above that required for UIC Class V recycling.
- The utilization of land application would potentially increase the rate of radon emissions from the facility. While the emissions rates would likely be below effluent standards it is not desirable to introduce another source of radon emissions when a good alternative is available.
- The proper utilization of land application during the winter would be difficult; especially during a harsh winter. Drifting snow and the buildup of ice from the effluent would likely interfere with the irrigation equipment. While these challenges could be overcome, the solutions would increase cost.
- The amount of land impacted is greater than for UIC Class V injection.
- A large percentage of the water would evaporate and would therefore not be available for beneficial use, at least in the immediate area.

2.3 Proposed Action

The proposed action involves the treatment of liquid byproduct material to a quality that is better than the EPA MCL's and/or NRC 10 CFR Part 20 Appendix B water effluent standards or the baseline water quality; whichever is higher. **Table 3-3** of the Technical Report lists the applicable effluent standards and the maximum allowable level for each potential contaminant.

Treatment will involve ion exchange to remove natural uranium, particulate filtration, reverse osmosis, pH balancing, and radium removal with the final option of temporary storage prior to injection in the UIC Class V well(s). The treatment circuit will be within the existing processing plant. The injection wells are located on the existing plant pad.

2.4 Reasonable Alternatives

Given the narrow scope of this proposal, no other reasonable alternatives were assessed.

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3.1 DESCRIPTION OF THE AFFECTED ENVIRONMENT

The land uses described in the original License Application will not change. The successful utilization of UIC Class V wells may reduce the site's overall surface disturbance if the installation of additional UIC Class I wells can be avoided.

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3.2 Transportation

The transportation described in the original License Application will not change as a result of using Class V wells.

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3.3 Soils

The original License Application describes the site soils. The total disturbance resulting from the UIC Class V well(s), beyond the existing disturbance, is expected to be on the order of 0.1 acres.

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3.4 Geology

The UIC Class V Technical Report provides a detailed description of the local geology in the area of the proposed injection well(s) (see **Section 2** and **Appendix B**). The original License Application provides a regional description of the geology. No impacts to the Geology are expected.

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3.5 Hydrology

Sections 2, 3 and 4 and **Appendix B** of the UIC Class V Technical Report provide site specific details of the hydrology. The original License Application provides additional information.

UIC Class V injection is planned for the uppermost zones of the Battle Spring Formation (commonly referred to as the FG and DE Horizons). The water quality of these horizons is typically good with the exception of radionuclides. The quality of the injected water will be equal to or better than the limits described in **Table 3-3** of the UIC Class V Technical Report. The injection pressure will be limited to 45.7 psi until the Wyoming Department of Environmental Quality-Water Quality Division approves a different pressure based upon test results. The injection pressure will be maintained low enough to prevent host rock fracturing during routine operations.

The geochemical interaction between the injected fluid and the host rock is minimal as described in Appendix B of the UIC Class V Technical Report.

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3.6 Ecology

The site's ecology is described in the original License Application. The additional surface impact expected from the proposal is mostly temporary in nature and is approximately 0.1 acres.

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3.7 Meteorology, Climatology and Air Quality

The original License Application describes the site meteorology.

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3.8 Noise

The original License Application describes the site's noise levels. The addition of the UIC Class V wells may reduce the noise level if fewer UIC Class I wells are needed.

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3.9 Existing Historic and Cultural Resources

Historic and cultural resource surveys for the entire project area were previously completed with results submitted to the NRC as part of the original License Application.

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3.10 Visual/Scenic Resources

The visual/scenic resources were previously described in the original License Application. Since the additional disturbance is expected to be on the order of 0.1 acres and mostly within the existing plant compound, little or no additional impact to visual/scenic resources are expected. The additional wells will be low to the ground and contained within naturally colored well boxes approximately three feet tall.

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3.11 Socioeconomic Conditions

The socioeconomic conditions were described in the original License Application. The UIC Class V wells are not expected to have any impact on socioeconomic conditions but could have the impact of shortening the time required for groundwater restoration.

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3.12 Background Radiological Characteristics

Background radiological characteristics were described in the original License Application. Additional radiologic characterization of the groundwater in the injection horizon is provided in **Section 3** and **Tables 3-1 and 3-2** of the UIC Class V Technical Report.

4.0 Environmental Impacts, Mitigation, and Monitoring

This section includes evaluations of the potential impacts of the Project on the various environmental characteristics of the Permit Area described in **Section 3**. The impacts of the Preferred Alternative described in **Section 2**, including cumulative impacts, are evaluated first. The impacts of the Other Alternatives described in **Section 2** are then evaluated. In large part, the impacts of the Other Alternatives differ little from those of the Preferred Alternative. Mitigation and monitoring associated with the Preferred Alternative are also included in this section.

4.1 Land Use

4.1.1 Land Use Impacts from Preferred Alternative

The preferred alternative, utilization of UIC Class V injection to recycle treated waste water, will result in approximately 0.1 acres of additional disturbance. If the system works effectively, the two additional approved UIC Class I wells may not need to be installed at a reduction of disturbance of approximately 3 acres per well.

4.1.1.1 Potential Interference with Existing and Future Land Uses

No interference with existing and future land uses is expected. It is possible that the utilization of UIC Class I wells will actually improve the availability of water in the area by adding water to near surface aquifers instead of sending the water for deep disposal in Class I UIC wells.

4.1.1.2 Short-term and Long-term Impacts

No impacts are expected.

4.1.2 Land Use Impacts from Other Alternatives

No other alternatives were found to be acceptable.

4.1.3 Mitigation of Impacts for the Preferred Alternative

The disturbance caused by drilling monitor and injection wells outside the plant compound will be reclaimed at the earliest opportunity. The ground will be reseeded with the seed mix approved by the BLM.

4.1.4 Monitoring for the Preferred Alternative

No monitoring of land use impacts is anticipated.

4.2 Transportation

4.2.1 Preferred Alternative

No impact to transportation is expected from the preferred alternative.

4.2.2 Transportation Impacts of Other Alternatives

No other alternative was considered.

4.2.3 Mitigation of the Preferred Alternative

No mitigation is necessary since there will be no impact.

4.2.4 Monitoring of the Preferred Alternative

No monitoring of the preferred alternative will be necessary.

4.3 Soils

4.3.1 Soil Impacts from the Preferred Alternative

Since the amount of disturbance beyond the plant compound is expected to be on the order of 0.1 acres, the impact to soils will be negligible.

4.3.2 Soil Impacts from Other Alternatives

4.3.2.1 Alternate Plant/Facility Locations

No alternatives were considered.

4.3.3 Mitigation and Monitoring of Soil Impacts

The topsoil will be stripped prior to the installation of wells. The topsoil will be replaced at the next appropriate season and the BLM approved seed mix applied. Further details regarding topsoil protection are included in the original License Application.

4.4 Geology

There will be no impacts to site geology.

4.5 Hydrology

4.5.1 Hydrology Impacts from the Preferred Alternative

Potential impacts to site hydrology include contamination of the aquifer from improperly treated water and fracturing of the host rock due to over-pressurization. However, proper monitoring and controls will prevent these impacts from occurring

4.5.1.1 Surface Water Impacts from the Preferred Alternative

No surface water impacts from the preferred alternative are expected.

4.5.1.2 Groundwater Impacts from the Preferred Alternative

The amount of groundwater used by the in situ facility will not change. However, instead of sending nearly 100% of waste water for disposal in UIC Class I wells, a large percentage of the waste water (on the order of 50 to 90% depending on system efficiency) will be treated and discharged back into the Battle Spring Formation. The introduction of treated water into the shallow aquifer and overlying dry zones will raise the level of the existing aquifer while the UIC Class V wells are in use and for a short time thereafter while the pressure wave dissipates.

The UIC Class V injection wells were intentionally located in the vicinity of the processing plant to allow for ease of system installation and monitoring and also because the plant is hydrologically separated from the UIC Class III in situ wellfield by two known faults as shown on **Figure 2-2** and **Plate 1** of the UIC Class V Technical Report. A hydrologic pumptest indicates that the faults are significant barriers to groundwater flow and will prevent or greatly minimize any impacts to the monitor wells overlying the in situ mining fields. The radius of fluid displacement is expected to be on the order of 533' over a period of 14 years with an average injection rate of 60 gpm (see **Section 4.1** of the UIC Class V Technical Report).

Downward vertical migration of the fluid into underlying zones isn't expected to occur due to a regional shale layer referred to as the LCS Shale. Upward vertical migration will largely be prevented by the presence of numerous shaley and silty layers that commonly occur from immediately above the injection zone to the surface.

The shallow portions (approximately 190' to 455' below ground surface) of the Battle Spring Formation was selected as the injection zone in part because the zone has already had uranium mineralization pass through the horizon and the host rock is oxidized. The oxidized host rock is expected to have minimal chemical interaction with the injection fluid as further described in The UIC Class V Technical Report, **Appendix B** entitled *"Mahoney Geochemical Consulting, LLC, Geochemical Modeling of Permeate Injection Memorandum June 17, 2014."*

4.5.1.3 Cumulative Hydrologic Impacts

The utilization of UIC Class V injection is not anticipated to have a negative cumulative impact on the hydrology. To the contrary, the regional drawdown modeled in the original License Application will be reduced since the treated water will be added back to the formation it was taken from instead of disposing of it in a UIC Class I deep well.

4.5.2 Hydrologic Impacts from Other Alternatives

No other alternatives are being considered.

4.5.3 Mitigation Measures

The specific conductivity will be monitored post reverse osmosis treatment and prior to injection as described in the UIC Class V Technical Report. Injection pressure, flow rate and pH will also be monitored prior to injection as described in the UIC Class V Technical Report.

The concentration of other chemicals parameters including radionuclides and metals of concern to the EPA and NRC will be monitored post treatment pursuant to the schedule in **Table 3-3** of the UIC Class V Technical Report.

If the water quality cannot be maintained within the allowable limits, the system will be shut down and necessary changes made prior to restarting the system.

4.5.4 Hydrologic Monitoring

The water level in each of the four (4) monitor wells will be measured quarterly, and water samples will be collected and analyzed for alkalinity, chloride and conductivity in order to determine if treated injectate has migrated to the monitor well. Fluid (permeate) migration to one or more monitor wells will not constitute a violation.

4.6 Ecology

Impacts to the environment are expected to be insignificant since the degree of disturbance is expected to be on the order of 0.1 acres and will be mostly temporary.

4.7 Air Quality and Noise

Impacts to air quality and noise are expected to be insignificant. The noise level may actually be reduced if the required number of UIC Class I wells can be reduced.

4.8 Historic and Cultural Resources

Historic and Cultural Resource information was previously submitted as part of the original License Application.

4.9 Impacts on Visual and Scenic Resources

Impacts to visual and scenic resources are expected to be minimal to non-existent since the disturbance area will only be about 0.1 acres and is immediately adjacent to the existing plant facility.

4.10 Socioeconomics

Impacts to socioeconomics are not expected.

4.11 Environmental Justice

The preferred alternative is not expected to have an impact on environmental justice since the location of the mine in relation to the public is not changing.

4.12 Public and Occupational Health

Since the water treatment system is completely contained, the opportunity for exposure to radionuclides, including emission of radon gas, is minimal. The facility management and staff are already trained and experienced to safely handle radiologic matters.

The potential for significant ingrowth of gamma ray emitting radium daughters on the radium removal resin does exist but this hazard is consistent with current operations. The health physics staff will routinely monitor the system to ensure the gamma levels are within acceptable levels.

No public health concerns related to the preferred alternative have been identified.

4.13 Waste Management

The radium recovery resin will be a new source of waste not previously handled at the facility. However, the facilities' management and staff are accustomed to handling solid 11e2 byproduct waste including ion exchange resin. Approximately 2 cubic yards of spent radium recovery resin will be generated each year. The waste will be sent to a facility licensed to receive and dispose of such material; such as the Shirley Basin Tailings Facility.

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5.0 COST-BENEFIT ANALYSIS

LC ISR, LLC has evaluated the costs of utilizing UIC Class V injection in concert with UIC Class I versus utilizing UIC Class I on its own.

5.1 Costs

5.1.1 Health and Environmental Costs

The impact to health is expected to be neutral. Employee exposure to gamma radiation in the immediate vicinity of the radium removal circuit will likely increase. However, the dose rates are expected to remain far below regulatory limits. Additional radiologic protection, such as shielding, can be easily implemented if dose rates are not ALARA.

The impact of UIC Class V wells on the environment is expected to be positive since the number of UIC Class I wells may be minimized thereby reducing the number of 3.0 to 3.5 acre drill pads and associated trunklines and traffic. UIC Class V wells will also recycle a large percentage of water by returning it to a shallow accessible aquifer instead of injecting it into deep wells where the water will likely never be used again. Finally, the use of UIC Class V wells may significantly shorten the time required to restore the groundwater which will allow the area to be returned to its original use sooner.

The majority of the UIC Class V infrastructure is located within the existing facility. The amount of additional disturbance is estimated to be about 0.1 acres in the immediate vicinity of the processing plant.

5.1.2 Internal Costs

The internal costs of installing a water treatment system and UIC Class V wells is estimated to be as follows:

- $50,000 to install the shallow injection and monitor wells
- $5,000 to install the trunkline with associated fittings
- $20,000 to purchase monitoring equipment and program system
- $15,000 for piping and valving in plant
- $50,000 for radium treatment skid; including resin

The ion exchange, filtration, reverse osmosis and caustic systems are already installed and are therefore captured cost.

The cost of operating the uranium IX, filtration and RO is expected to be at the same rates as presented in the annual surety update. Likewise, manpower costs are already captured since operation and monitoring will be carried out by the existing operators. Additional operating costs include:

- $6,200/year commercial lab analysis
- $17,500 for annual change out of 50 cubic feet of radium resin
- $1,000/year for miscellaneous supplies such as calibration fluids and replacement pH bulbs.

5.1.3 External costs

External costs impact the local economy and include the services and resources of the neighboring communities. The primary external costs will affect:

- housing;
- public facilities and services;
- historic, scenic, and recreational resources; and
- natural and material resources.

No changes to the external costs analyzed in the original license application are expected as a result of utilizing UIC Class V wells.

5.2 Benefits

The utilization of UIC Class V wells in combination with UIC Class I wells will likely shorten the time required for groundwater restoration. The impact is difficult to predict until the capacity of the Class V wells and efficiency of the ROs are determined, but the time required for groundwater sweep and reverse osmosis could be reduced by 75%.

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6.0 SUMMARY OF ENVIRONMENTAL CONSEQUENCES

The negative environmental consequences of implementing waste water treatment with UIC Class V injection are related to the disturbance of approximately 0.1 acres of native vegetation in the vicinity of the processing plant. The disturbed area will be leveled and vegetated using the BLM approved seed mix at the next appropriate season. Given the extremely small and temporary disturbance the impact to surface water, vegetation, wildlife, air quality and wildlife are expected to be small.

The impact to groundwater is expected to be positive since a large percentage of water typically removed from the mining horizons of the Battle Spring Formation and disposed of in deep UIC Class I wells will instead be treated and returned to the shallow portion of the Battle Spring Formation where it can be beneficially used.

Perhaps the greatest environmental consequence is that the length of time required to restore the groundwater will be substantially shortened since UIC Class V injection will provide an additional option for managing water. This will allow the facility to complete groundwater restoration and surface reclamation in a shorter time period and return the land to its former use.