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June 30, 2016

Ms. Aimee Reynolds
Project Officer, Remediation Division
Montana Department of Environmental Quality
1225 Cedar Street
Helena, Montana 59601

Re: Joint Livingston Restoration Group (LRG) and BNSF Railway Company (BNSF) Submittal – Revised Task L Bedrock Remedial Pilot Test Work Plan.

Dear Ms. Reynolds,

The BNSF Railway Company and the Livingston Restoration Group jointly submit the enclosed *Revised Task L Bedrock Remedial Pilot Test Work Plan, Burlington Northern Livingston Shop Complex Facility, Livingston, Montana* (Work Plan) to the Montana Department of Environmental Quality (DEQ) for review and approval.

Please feel free to contact me with any questions.

Sincerely,

Allen M. Stegman

ENCLOSURE

cc: Pat Thomson, WET
David Erickson, WET
Yueh Chuang, BNSF
Todd Miller, Kennedy/Jenks Consultants
Cynthia Brooks, DEQ Legal
Courtney Lawellin
Lezlie Nelson, LRG

REVISED TASK L BEDROCK REMEDIAL PILOT TEST WORK PLAN

Burlington Northern Livingston Shop Complex Facility, Livingston, Montana

Prepared for:

Livingston Restoration Group

Livingston, MT

Prepared by:

Water & Environmental TECHNOLOGIES

Moonlight Professional Building
480 East Park Street, Suite 200
Butte, MT 59701

June 2016

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1.0 INTRODUCTION

This Task L Bedrock Remedial Pilot Test Work Plan (Pilot Test Work Plan) has been prepared as part of ongoing investigation to address the requirements of Task L: Investigation of Volatile Organic Compounds in Bedrock Aquifer(s) of the Statement of Work for Spring 2005 Activities, Burlington Northern Shop Complex, Park County, Montana [Montana Department of Environmental Quality (DEQ, 2005)].

The scope of the additional investigation described herein for the Burlington Northern Livingston Shop Complex (Facility) was developed in cooperation with/between the Montana Department of Environmental Quality (DEQ), BNSF Railway Company (BNSF), and the Livingston Restoration Group (LRG) and their respective consultants CDM Smith Consultants (CDM), Kennedy/Jenks Consultants, and Water & Environmental Technologies (WET) and Dr. Bernie Kueper (hereinafter the parties); in accordance with the requirements of DEQ; and based upon the findings of work conducted, including well installations, hydraulic testing, groundwater sampling, and bromide injection tracer testing in accordance with the Revised Bedrock Hydraulic Testing Work Plan dated August 27, 2015 (Hydraulic Testing Work Plan) (Kennedy/Jenks Consultants; 2015b). The Hydraulic Testing Work Plan was developed based on previous bedrock investigations as summarized in the Task L Supplemental Investigation Report for Bedrock Aquifer(s), dated April 2015 (Task L SI Report) (Kennedy/Jenks Consultants; 2015a).

Based on the findings of the bedrock bromide tracer injection test, a technical discussion session was held in Helena, Montana on February 25, 2016, between the parties. The technical discussion focused on establishing criteria for a remedial pilot test for injection of chemical oxidation solution into shallow bedrock. The scope for this Pilot Test Work Plan was further developed through ongoing discussions of data quality objectives (DQOs) for the test. The primary objectives established include the ability to distribute chemical oxidant into shallow bedrock under low pressure conditions; the efficacy of using sodium permanganate to permanently reduce tetrachloroethene (PCE) concentrations in shallow bedrock; and evaluating the impact of chemical oxidant injections into shallow bedrock on alluvial aquifer dissolved PCE concentrations. The DQOs are described in detail in Section 2.0.

The DQOs will be achieved through the installation of additional wells to be located and completed in accordance with discussions between the parties on March 29, 2016. The purpose of the new wells is to provide a three dimensional monitoring network to be used to define connectivity between the alluvial aquifer, and shallow and deep bedrock, and allow the monitoring of the chemical oxidant as it migrates under natural gradients to further define flow paths and to determine the potential effectiveness/practicability of shallow bedrock treatment in meeting site cleanup objectives. The location, designation, and type of well are presented on Figure 1. Recirculation may be incorporated as appropriate in an attempt to improve disbursement of oxidant following low-head injection.

New wells to be installed will include two alluvial aquifer wells (16-1 and 16-2), three shallow bedrock wells (16-3, 16-5 and 16-7), and two deep bedrock wells (16-4 and 16-6). Well testing and completion details will follow criteria specified in the previously approved Task L work plans and associated addenda with specific deviation or additions outlined in this Pilot Test Work Plan. Previously approved Task L work plans/addenda include:

- Task L Supplemental Investigation Work Plan for Bedrock Aquifer(s) – DEQ Version (DEQ, 2010) (Task L SI Work Plan)

- Addendum No. 1 to DEQ Version of Task L Supplemental Investigation Work Plan for Bedrock Aquifer(s) (Revision No. 1) (Addendum No. 1) (Kennedy/Jenks Consultants, 2012)

- Addendum No. 2 to DEQ Version of Task L Supplemental Investigation Work Plan for Bedrock Aquifer(s) (Addendum No. 2) (Kennedy/Jenks Consultants, 2013a)

- Addendum No. 3 to DEQ Version of Task L Supplemental Investigation Work Plan for Bedrock Aquifer(s) (Addendum No. 3) (Kennedy/Jenks Consultants, 2013b)

- Revised Addendum No. 4 to DEQ Version of Task L Supplemental Investigation Work Plan for Bedrock Aquifer(s) (Addendum No. 4) (Kennedy/Jenks Consultants, 2014)

- Revised Bedrock Hydraulic Testing Work Plan (Kennedy/Jenks Consultants, 2015b).

Injection of chemical oxidant (sodium permanganate) amendments will be introduced into the shallow bedrock via wells 15-5, 15-7, and 15-8. Injection will be sustained under low-head (two feet or less) conditions. The low-head injection test will be conducted in a manner to prevent/limit the loss of amendment mass into the alluvium. General injection procedures and sodium permanganate material handling will follow the criteria outlined in the Final Task F Stage I – Part 2 Pilot Test Work Plan (Kennedy/Jenks Consultants, 2008b).

Sampling and monitoring will include wells:

- Alluvial aquifer; 16-1, 16-2, ISCO-1, ISCO-2, 92-1/E-7, E-8, 13-2, and 13-3
- Shallow bedrock; 15-6, 16-3, 16-5, and 16-7
- Deep bedrock; 10-2, 13-9, 16-4, and 16-6.

Based on the bromide tracer test results at alluvial aquifer well ISCO-2, connection between the shallow bedrock and alluvium exists in this area, which could potentially reduce the overall lateral distribution of the chemical oxidant in the shallow bedrock (i.e., it may disperse upwards into the alluvium as a result of the injection head). Therefore, injection of the chemical oxidant will begin at a low-head and will be gradually increased until the proposed maximum injection head of two feet is reached. Well ISCO-2 will

be monitored continually throughout initiation of injection activities using real-time transducer observations of conductivity, temperature, and pressure, and the use of a peristaltic pump to collect grab groundwater samples for visual evidence of sodium permanganate breakthrough. Should evidence of permanganate not appear in well ISCO-2 the head will be increased to the design head (1.5 to 2.0 feet), however, if permanganate appears in well ISCO-2 prior to reaching the design head, the injection pressure will be maintained at that threshold (or reduced slightly) to limit upward movement to the alluvial aquifer.

The final volume of sodium permanganate solution to be injected will be calculated using methods described in Section 3.4. In addition to an estimated secondary porosity, the volume calculation includes a designated thickness of bedrock, an estimate of lateral influence due to the proposed injection head across the 15-5, 15-7, 15-8 well set, an estimate of the amount of PCE mass to be treated, and the length of proposed treatment area (from well 15-5 to well 15-6). The volume of injection solution will be adjusted based on samples to be collected during well drilling activities which will provide data for bedrock natural oxidant demand (NOD) and measured hydraulic parameters of the wells. The approximate duration of injection activities will then be estimated based on the total calculated injection volume and an average flow rate for the median hydraulic conductivity of the injection wells. Final volumes and injection approach will be included in a revised Decision Flow Chart.

BNSF in con junction with LRG is performing this phase of Task L and the scope of work presented in this Pilot Test Work Plan. The scope of work will be implemented by the LRG's consultant (WET), with support from BNSF's contractor Kennedy/Jenks Consultants to assist in field implementation and to ensure that the procedures defined in the Work Plan are followed.

1.1 BACKGROUND

The results of investigation of bedrock groundwater east of the Former Electric and Locomotive Shops at the Livingston railyard identified elevated PCE concentrations in groundwater indicating the potential for PCE in the form of a dense, non-aqueous phase liquid (DNAPL) to exist in bedrock (Kennedy/Jenks Consultants, 2015a). Based on the results of testing, DEQ requested further study to determine aquifer parameters in the vicinity of bedrock wells 10-2 and 13-9 for the purpose of determining potential for in-situ treatment. The Hydraulic Testing Work Plan was submitted by BNSF to conduct 1) well bore tests to determine hydraulic conductivities and 2) a bromide tracer injection test to assess communication within the shallow bedrock and communication between the alluvial aquifer and bedrock groundwater (Kennedy/Jenks, 2015a). The Hydraulic Testing Work Plan incorporated a data-based decision tree that ultimately guided towards potential remedial options in the shallow bedrock. Results of the testing identified reasonable hydraulic conductivities within the shallow bedrock. Based on this outcome, DEQ requested a pilot test to inject remedial amendments to assess the efficacy of sodium permanganate on reducing PCE mass in shallow bedrock and to further assess communication between the alluvial aquifer, shallow bedrock, and deep bedrock.

During the March 2016 quarterly groundwater monitoring event at the Facility, elevated PCE concentrations were reported in alluvial aquifer well E-7. The presence of PCE in well E-7 may be due to either drilling activities or the movement of fluids created by the bromide tracer injection test at shallow bedrock well 15-5. To determine any potential influence due to drilling activities, well installations will

be sequenced to allow monitoring to confirm background concentrations and verify any potential effects of drilling activities on groundwater chemistry.

As a continuation of the Hydraulic Testing Work Plan and in line with proposed DQOs, this Pilot Test Work Plan will further study the shallow bedrock for the effectiveness of sodium permanganate injection on PCE mass removal, PCE concentration rebound, groundwater movement in the shallow bedrock, and communication between the shallow and deep bedrock and the alluvial aquifer.

1.2 HEALTH AND SAFETY

The existing Task-Specific Health and Safety Plans (HASP) for Task L (dated January 2015) and Final Task F Stage I – Part 2 Pilot Test Work Plan will be reviewed and updated as necessary prior to starting the planned field activities. The Task-Specific HASP is designed for use in conjunction with the 2008 Facility-Wide Health and Safety Plan (Revision No. 3) (Kennedy/Jenks Consultants 2008a). A copy of the final, signed Task-Specific HASP (if updated) will be submitted to DEQ before the start of field activities for inclusion in the Facility-Wide HASP.

1.3 ENVIRONMENTAL REQUIREMENTS, CRITERIA, AND LIMITATIONS (ERCLs)

ERCLs developed by DEQ for the Facility are included in Appendix A of the Record of Decision (ROD) (DEQ, 2001). An analysis of how the proposed field activities will comply with ERCLs is provided in the previously approved Task L Work Plans and the Final Task F Stage I – Part 2 Pilot Test Work Plan. Planned activities identified in this Pilot Test Work Plan will comply with ERCLs. Well construction activities described herein will be performed by a Montana-licensed well driller and in compliance with Title 36, Chapter 21, Subchapter 8 of the Administrative Rules of Montana (36.21.8 ARM).

1.4 PERMITS

The City of Livingston requires permits to construct groundwater monitoring wells; these permits will be obtained prior to well construction activities.

An Underground Injection Control (UIC) permit will be obtained from the U.S. Environmental Protection Agency (EPA) prior to initiation of the injection activities.

2.0 OBJECTIVES

The primary objectives of the low-head injection test include monitoring the distribution of sodium permanganate into shallow bedrock under near-natural flow conditions; evaluating the impact sodium permanganate may have on DNAPL, dissolved and adsorbed PCE contained in bedrock; and monitoring changes to the alluvial aquifer from injection of sodium permanganate into shallow bedrock. Data collected during implementation of the proposed activities will be provided to DEQ as available and evaluated in real time, to understand if or when changes to the proposed scope are warranted. In addition, weekly conference calls will be conducted during drilling activities, and prior to and throughout the injection process The decision process is illustrated on the Decision Flow Chart (Figure 2).

2.1 DATA QUALITY OBJECTIVES

The following Pilot Test Work Plan DQOs were developed through discussions between the parties:

1) Evaluate the lateral and vertical distribution of oxidant in shallow bedrock through low-head injection.
2) Evaluate the viability and long-term effectiveness of reducing mass (evaluate source strength) in the shallow bedrock.
   a) Use a model to predict back-diffusion effects (West and Kueper, 2005)
   b) Conduct oxidant pilot test
   c) Monitor shallow bedrock wells to:
      i) Assess oxidant use rate
      ii) Evaluate PCE mass destruction and concentration rebound over time
   d) Re-calibrate model and use as predictive tool
3) Evaluate short and/or long-term impacts to dissolved alluvial aquifer concentrations from potential reductions in shallow bedrock concentrations.
   a) Work to maintain reduced shallow bedrock concentrations through multiple injections (up to three injection events over three to six months).
   b) Monitor shallow and deep bedrock and alluvial aquifer groundwater through sampling and analytical testing for six to twelve months.
4) Evaluate hydraulic communications between the alluvial aquifer, shallow bedrock, and deep bedrock during and following passive injection.
5) Further evaluate and define spatial distribution of DNAPL/source material by installation of additional bedrock wells.

Modelling of back-diffusion effects will be conducted concurrent with pilot test activities and will incorporate data collected during well installation and testing. The model (West and Kueper, 2005) simulates dissolved PCE migration through a set of parallel fractures subject to advection, dispersion, first order decay, sorption and diffusion in/out of the bedrock matrix. The model will be recalibrated using data collected during monitoring and possible subsequent injection events. Modelling results will be available concurrent with data reporting/discussions for individual injection events and following completion of the pilot test.

2.2 CONTINGENCIES

Distribution of the sodium permanganate under a low-head injection program is uncertain. The data collected during implementation of the monitoring program described in Section 3.0 will be used to evaluate whether enhancing distribution of the oxidant through groundwater pumping/recirculation will be needed as presented in the Decision Flow Chart (see Figure 2). A groundwater pumping/recirculation plan is currently under development and will be provided to DEQ prior to starting injection.

3.0 SCOPE OF WORK

Field work included in this Pilot Test Work Plan will be implemented in accordance with previously approved Task L work plans, specifically, the Hydraulic Testing Work Plan and the Final Task F Stage I – Part 2 Pilot Test Work Plan (Kennedy/Jenks Consultants; 2015b, 2008b). This Pilot Test Work Plan

was prepared with specific reference to these previous Task F and Task L work plans/addenda and to be used in conjunction with the Facility-Wide Sampling and Analysis Plan (Facility-Wide SAP) (Kennedy/Jenks Consultants, 2006).

The Facility-Wide SAP addresses (1) health and safety considerations (including location of underground utilities); (2) personnel and equipment decontamination; (3) calibration and use of field measuring devices and instrumentation; (4) sample collection, preservation, packaging, and shipping; (5) borehole logging; (6) well construction and development; and (7) handling and disposal of investigation-derived waste (IDW).

Field activities will be performed in a manner consistent with the Standard Operating Guidelines (SOGs) identified in the Facility-Wide SAP, and in accordance with the previously approved Task L Work Plan and addenda (as cross-referenced in this section), and Final Task F Stage I – Pilot Test Work Plan, unless otherwise noted.

In accordance with the scope outlined during discussion between the parties this Pilot Test Work Plan includes the installation of seven new monitoring wells (two deep alluvial aquifer wells, three shallow bedrock wells, and two deep bedrock wells). Well locations are illustrated on Figure 1. Each of these wells will be advanced and completed in general accordance with the approach outlined in the Task L work plans/addenda and specifically the Hydraulic Testing Work Plan.

As discussed between the parties, well sets will be installed sequentially beginning with the deep alluvial aquifer wells (16-1 and 16-2). Following construction, the alluvial aquifer wells will be developed in accordance with the Facility SOGs, incorporating low-flow purge and sample collection followed by an extended 3-volume purge consisting of **3 times the combined volume of the well casing and filter pack (assuming 35% porosity)** prior to sample collection (see Section 3.3). The wells will be allowed to stabilize for one week prior to collecting a second set of samples, again employing both low-flow and extended purge sampling techniques. Shallow bedrock wells 16-3, 16-5, and 16-7 will then be installed immediately upgradient of their associated deep alluvial aquifer wells. The new shallow bedrock wells will be developed and sampled consistent with the process used for the deep alluvial wells. Concurrent with the shallow bedrock well sampling, deep alluvial aquifer wells 16-1 and 16-2 will be sampled as well as existing wells ISCO-1, 92-1, E-7, and 15-6. A second round of shallow bedrock samples and fourth round of alluvial aquifer samples will be collected approximately one week to ten days following installation of the shallow bedrock wells. This process will be repeated for deep bedrock wells 16-4 and 16-6 and will include sampling of all wells to be monitored during the injection test. Deep alluvial wells, shallow bedrock wells, and existing network wells will be sampled again when the deep bedrock wells are sampled.

As part of the analytical requirements, bedrock samples will be collected from the new borings, crushed, and submitted for natural oxidant demand (NOD) analysis. Samples of shallow and deep bedrock collected for NOD testing will be crushed to the consistency of coarse sand prior to submission for NOD testing. In addition, groundwater samples will be submitted for NOD testing. NOD results will be used to refine volumes of sodium permanganate necessary to overcome NOD. It is recognized that crushing the bedrock samples could lead to an overestimate of NOD during the test duration, but this will be accounted for by not utilizing the full volume of bedrock in calculating oxidant demand (Appendix C).

Once all wells have been installed and are exhibiting stabilized background concentrations, slug tests will be performed to estimate hydraulic conductivities for each well. Pilot Test injection equipment will be installed after baseline groundwater sampling and will include the following:

- Pressure/Conductivity loggers in alluvial aquifer wells ISCO-2 and 16-1, E-7; shallow bedrock wells 16-3, 16-5, 16-7, and 15-6; and deep bedrock wells 10-2, 13-9, 16-4 and 16-6.
- Level sensors and associated relays to control peristaltic injection pump will be installed in wells 15-5, 15-7, and 15-8 to manage injection head levels
- ¼-inch tubing will extend from peristaltic pump to below static water level in wells 15-5, 15-7, and 15-8 to use for delivery of sodium permanganate to the well.

Conductivity loggers will be used in each well to document possible breakthrough of permanganate, chloride, or dissolved manganese. Each logger includes a pressure sensor which will provide additional information for nested well pairs regarding vertical changes in level for individual wells providing information for direction of transport or change in relative head between wells.

3.1 DRILLING

Well installation activities will be performed as described in the Hydraulic Testing Work Plan, in accordance with applicable Facility SOGs, and will be performed by a Montana-licensed well driller. Consistent with the Hydraulic Testing Work Plan, borings through alluvium and the upper two feet of bedrock will be advanced using roto-sonic drilling methods. Drilling within the bedrock unit will utilize wireline coring techniques. Prior to the start of drilling, well construction permits will be obtained from the City of Livingston.

Borings will be logged in accordance with SOG-13 to include documentation of alluvium lithology, depth of bedrock contact, description of bedrock including degree of weathering, fracturing, and any observations relative to volatile organic compounds and/or oily sheens. Roto-sonic drilling will be utilized for borings from the ground surface through the alluvium and extending into the bedrock approximately two feet to verify the alluvium-bedrock contact. Borings to be completed as alluvial aquifer wells will have the lower two feet of borehole abandoned using cement grout to the depth of the contact with well completion occurring above that depth. Representative samples will be collected of fine-grained soils encountered at or near the base of the alluvium, and submitted to the laboratory for analysis of volatile organic compounds following USEPA Method 8260.

Bedrock well construction will follow protocol outlined in Task L Supplemental Investigation Work Plan for Bedrock Aquifer(s) and associated addenda. Consistent with alluvial aquifer borings, bedrock borings will be advanced approximately two feet beneath the alluvial bedrock contact using an isolation casing. Shallow bedrock well borings will utilize a conductor casing of 10 to 12 inches in diameter. The conductor casing will be grouted in place using Portland cement to isolate the bedrock aquifer unit from the overlying alluvium. Shallow bedrock wells 16-3, 16-5, and 16-7 will be advanced through a cement seal and into the underlying bedrock to approximately 7 feet below the alluvium-bedrock contact as determined through field observations and consultation with field crew and DEQ's representative CDM Smith.

Deep bedrock wells 16-6 and 16-4 will initially utilize a conductor casing 12 inches in diameter advanced two feet into the shallow bedrock. This larger casing will provide sufficient annulus to allow a 8-inch diameter telescoped section to extend through the shallow bedrock zone to a depth determined using field observations and in consultation between field personnel (presumed to be 15 feet beneath the alluvium-bedrock contact. The inner casing will then be sealed prior to continuation of drilling to approximately five feet beneath the bottom of the casing.

Field personnel (WET, Kennedy/Jenks Consultants, CDM Smith) will work together to assure the drilling and logging of the borings are consistent with the previously approved Task L Work Plans/addenda and in accordance with applicable SOGs in the Facility-Wide SAP.

As discussed in Task L Supplemental Investigation Work Plan and associated addenda, the intent of the isolation casing is to isolate specific zones within the bedrock and to distinguish individual zones within the bedrock from each other and the overlying alluvium. Consistent with Task L Addendum No. 4, following installation of the grout seal water present inside the isolation casing will be removed to the extent practicable. The depth to any residual water inside the casing will be recorded, and the grout seal will then be allowed to set for a minimum of 24 hours. Following the minimum 24-hour grout curing, the depth to water in the casing, if any, will be recorded and compared to the previous measurement. If the casing seal is effective, water should not enter the isolation casing. If water has entered the isolation casing and the seal is not considered satisfactory, additional grout will be added and the seal tested again. If the seal continues to leak, the casing will be removed and re-installed.

As discussed previously, bedrock drilling activities will include installation of the shallow bedrock wells first with subsequent groundwater baseline sampling followed by deep bedrock wells installation. Installation of the shallow and deep bedrock well sets will be staggered between boring locations to the extent practicable (e.g., when the seal at one location is being tested, work to advance the well boring at another location will be performed) to minimize downtime.

3.2 WELL CONSTRUCTION

Alluvial aquifer wells 16-1 and 16-2 will be completed in accordance with Facility SOGs-14 and -15. Each well will be constructed with five feet of screen set at, or immediately above, the alluvium-bedrock contact. Shallow and deep bedrock wells will be constructed in accordance with the previously approved Task L work plan and addenda. The screened interval for shallow bedrock wells 16-3, 16-5 and 16-7 will extend from 2 to 7 feet below the alluvium-bedrock contact. Deep bedrock wells 16-4 and 16-6 will be completed with five feet of screen at the base of the well and will be completed with sufficient depth to assure distinct screened interval to avoid direct communication with nearby co-located shallow bedrock wells 16-3 and 16-5 respectively. The top of deep bedrock well screened intervals will be approximately 15 feet below the alluvium-bedrock contact.

Wells included in the Pilot Test Work Plan will be completed using 4-inch diameter, polyvinyl chloride (PVC) Schedule 40 well casing and 0.020-inch screen. A 10/20 sand or equivalently sized sand filter pack will be installed in the annulus from the bottom of the well boring to a minimum of two feet above the top of the screen for alluvial aquifer wells and a minimum of one foot above the top of screen for bedrock wells. A minimum of one foot of hydrated bentonite chips will be placed at the top of the filter

pack. Hydrated bentonite chips or cement/bentonite grout will then be placed to approximately one foot below the ground surface. Surface completion will be with the use of flush-mount well protectors consistent with other wells at the Facility.

Following construction, the new monitoring wells will be developed as appropriate by surging and over-pumping and/or hand-bailing to remove fine-grained particles that might have entered the well and filter pack during construction. After development, baseline groundwater samples will be collected from the newly constructed wells as outlined in Section 3.2.1 and in accordance with SOG-8 and submitted to Energy Laboratories in Billings, Montana (Energy) under chain-of-custody protocol for analysis of volatile organic compounds (VOCs) using EPA Method 8260 on a rush turnaround time.

A Montana State registered land surveyor will survey the new wellhead to determine the vertical elevation with respect to the North American Vertical Datum 1988 (NAVD88) in accordance with SOG-15. Horizontal location will also be surveyed. Surveyed horizontal coordinates are based on the North American Datum of 1983 (NAD 83).

3.3 WELL TESTING

3.3.1 Groundwater Sampling

As part of establishing baseline VOC concentrations in individual wells and to evaluate the potential for drilling activities to mobilize PCE, samples collected from the wells will be analyzed for VOCs. The wells will be allowed to stabilize for approximately one to two weeks (as described above) prior to a second sampling event to confirm baseline VOC concentrations. Samples will be submitted for VOC analysis using EPA Method 8260.

An attempt will be made to conduct a low-flow purge of each well. If the purge rates of any individual well are insufficient to allow a low-flow purge the borehole will be purged dry and allowed to recharge two to three times. If the borehole does not recharge within 24 hours, a sample will be collected without performing additional purge cycles.

3.3.2 Hydraulic Testing

Following initial baseline sampling activities and adequate time for stabilization, slug testing will be performed on the completed shallow and deep bedrock wells to determine the hydraulic conductivity at each well. Both falling and rising head tests will be performed. Slug testing will follow the procedures described in SOG-23, provided in Addendum No.1 and consistent with the Hydraulic Testing Work Plan.

3.4 OXIDANT INJECTION TESTING

3.4.1 Injection of Sodium Permanganate

In situ chemical oxidation (ISCO) technology attempts to address concentrations of organic chemicals by placing oxidizing agents in the groundwater system to allow destruction or reduction of chemical mass. Based on the agreement between the parties during the teleconference on May 31, 2016, this Work Plan proposes injection of a 3% sodium permanganate ($NaMnO_4$) solution (30 g/L) via a gravity fed low-head delivery. The final concentration will be determined following NOD testing. The permanganate solution

will be delivered simultaneously to shallow bedrock wells 15-5, 15-7 and 15-8. Injection pressures will be maintained at approximately 1.5 to 2 feet of head or less at all times to limit the amount of upward movement of PCE impacted groundwater or oxidant to the overlying alluvial aquifer. Specific details regarding injection pressures, flows, and lateral distribution are discussed in greater detail in following paragraphs. Final sodium permanganate volume and dosage will be provided for DEQ review following determination of parameters including NOD and PCE concentrations.

In determining the volume of permanganate solution to be injected, a flow model was used to analyze pathway and time of arrival of permanganate at wells 16-3 and 15-6. The Multi Layer Analytic Element Model (MLAEM; Strack, 2005) was used incorporating data from the bromide tracer test while accounting for lateral inhomogeneity, and using the proposed injection parameters to calculate breakthrough time. Hydraulic conductivities established during the bromide testing were incorporated to define boundaries between varying hydraulic conductivities while combining similar conductivities (i.e. 15-8 and 15-6). A description of input parameters and outputs for flow and lateral distribution of the model are included in Appendix B. Using distributions generated with the MLAEM model and resulting breakthrough at wells 16-3 and 15-6, combined with an estimated secondary porosity established through discussion between the parties, input parameters include the following:

Maximum Head (feet; 15-5/15-7)		2
Hydraulic Conductivity (ft/day)		
15-5	=	2.65
15-7	=	0.54
15-8	=	13.74 (arithmetic mean for 15-8/15-6)
Thickness (feet)		5
Effective porosity of Bedrock Matrix		0.01

Based on these parameters the model produced flow rates for each well (gpm):

15-5	=	0.134
15-7	=	0.0277
15-8	=	0.134

The duration for sodium permanganate to reach breakthrough at 16-3 and 15-6 is essentially equal based on hydraulic conductivities and would be approximately 6.42 days at a total flow of 0.29 gpm. Therefore, the volume of injection is estimated to be:

Volume	=	0.29 * 1440 * 6.42 days
	≈	2,680 gallons

In practice, the time for breakthrough at 16-3 and 15-6 will likely be greater than 6.42 days because of (i) the attenuation attributable to forward matrix diffusion, and (ii) consumption of permanganate in reactions. Additionally, these estimates will be reviewed following installation and slug testing of the new shallow and deep bedrock wells.

Due to porosity unknowns, a factor of 50% will be added to assure adequate solution to displace the volume of the treatment area, resulting in a full injection volume of 3,900 gallons. The final volume to be injected will be adjusted based on data collected during well installation. Assuming an average dissolved PCE concentration of 5,000 µg/L, adsorbed PCE concentrations in equilibrium with groundwater, a NOD of 0.5 grams/kg and 39.1 kilograms of DNAPL present in the test area, approximately 681 pounds of oxidant will be needed for the pilot test. At a concentration of 30 g/L, approximately 980 pounds of oxidant will be injected. Final oxidant mass and oxidant solution volume will be verified following bedrock sampling, establishing NOD, and concurrence with DEQ. Preliminary oxidant demand calculations are provided in Appendix C.

Based on the volume of injection, the delivery of permanganate will be gravity fed from a single 4,000-gallon Poly tank. The discharge from the tank will flow to a T-fitting and then reduced to a 1-inch diameter Schedule 40 PVC injection manifold leading to each individual well head. Each pipe will be fitted with delivery lines consisting of ¼-inch to 3/8-inch tubing connected to a peristaltic pump with discharge tubing extending into the standing water in each well. Finally, each well delivery system will be equipped with a level sensor to control operation of the peristaltic pump, stopping flow whenever the maximum design head is reached for the well. A conceptual design for the test configuration is presented in Figure 3. The flow rates from the peristaltic pump will be adjusted as needed to equilibrate head in the wells to approximate uniform flow. Due to the difference in PCE concentrations at shallow bedrock wells 15-5 and 15-8 and relative hydraulic conductivity (K) values for each, equal volumes will be delivered to these two wells to assure adequate treatment at well 15-5 and the central injection zone. This will result in less head applied to well 15-8 due to its higher conductivity. The flow to shallow bedrock well 15-7 will be controlled by its actual injection rate at the applied head of two feet.

At the start of injection activities, the head will be gradually increased in each well with visual monitoring conducted hourly for alluvial aquifer wells ISCO-2 and 16-1 for any permanganate breakthrough. If breakthrough to either well is observed during this period, the injection head will be stabilized to limit potential upward movement of permanganate to the alluvial aquifer. Provided no breakthrough is observed at wells ISCO-2 or 16-1, the head will be gradually increased at the rate of approximately 0.3 feet per hour to a maximum of approximately two feet. Levels will be maintained between 1.8 and 2.0 feet above the measured static water elevation at the start of injection until the full volume of solution is exhausted.

3.4.2 Monitoring

The monitoring network for the permanganate injection includes wells 16-1 through 16-7, 15-6, 10-2, 13-2, 13-3, 13-9, ISCO-1, ISCO-2, E-7, E-8 and 92-1. Each well will be sampled prior to injection activities to provide baseline PCE concentrations. Sample collection and procedures will be conducted in accordance with Facility SOGs with samples submitted to Energy under standard chain-of-custody

protocol for VOC analysis using EPA Method 8260. The samples will be submitted for 48-hour turn-around unless otherwise agreed-upon by the parties.

Wells ISCO-1, ISCO-2, 16-1 through 16-7, and E-7 will have pressure/conductivity loggers dedicated to them. Transducers will be placed at the base of wells 16-1, 16-2, and ISCO-2, and at the mid-point of the screened interval of wells 16-3 through 16-7. The transducers will be equipped with dedicated reader cables for observation while limiting disturbance. Transducers will provide pressure, temperature and conductivity readings continuously throughout the test with readings every 30 minutes.

A portion of the wells included in the monitoring network are equipped with dedicated bladder pumps. Therefore, wells to be used for sampling will be equipped with similar bladder pumps to provide consistency of methodology. The sample inlet of each pump will be placed at equivalent depth as the corresponding conductivity logger. Throughout the injection period selected wells will be monitored/sampled daily for the following:

- Sodium Permanganate (using colorimeter)
- Chloride using EPA Method 300 (and field test Hach Test Kit).
- Dissolved Manganese using EPA Method 6010.

As discussed, alluvial aquifer wells ISCO-2 and 16-1 will be monitored hourly during initiation of injection testing until maximum head is reached, and daily thereafter, for visual evidence of permanganate and chloride concentrations. Verification of breakthrough in any wells as evidenced by transducer readings, permanganate, or chloride increases will result in sample collection for laboratory verification of chloride, dissolved manganese and PCE, and will reduce individual well sampling/monitoring to a weekly schedule for the first month and monthly thereafter. Monthly schedule will be continued until PCE concentrations have either stabilized or rebounded to pre-injection concentrations.

4.0 DATA REPORTING

Laboratory reports/data generated from the scope of work will be forwarded to DEQ upon receipt and validation. In addition, data will be submitted to DEQ in routine monthly status/data reports summarizing transducer data, field measurements, and summarized laboratory data as appropriate and required by the Spring 2005 SOW. During drilling and hydraulic testing of the newly installed wells and throughout the stages of the test, WET and BNSF will communicate with DEQ and CDM Smith on an as needed basis to discuss field results and apprise the parties of decisions being made in real time.

Following completion of this Pilot Test Work Plan field activities WET and BNSF will prepare a Task L Bedrock ISCO Pilot Test Report summarizing the work performed, deviations, if any, from the DEQ-approved work plan, well construction activities, hydraulic testing calculations, and sodium permanganate injection testing and sampling/monitoring activities.

Sodium permanganate injection test data will be evaluated to assess the effect on PCE concentration trends and lateral and vertical distribution of oxidant injection fluids. Time-concentration plots (breakthrough curves) will be prepared to facilitate the evaluation.

5.0 SCHEDULE

Scheduling of field activities will begin immediately following DEQ's approval of this Pilot Test Work Plan. The DEQ will be notified prior to start of field activities and of any potential schedule delays. A final report of field activities and results will be delivered within 90 days of completion of field work. A baseline schedule for project activities is presented in Figure 4.

6.0 REFERENCES

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FIGURES

Legend

- Proposed Alluvial Well
- Proposed Deep Bedrock Well
- Proposed Shallow Bedrock Well
- Well NOT included in Pilot Test Monitoring
- Alluvial Well
- Deep Bedrock Well
- Shallow Bedrock Well

Feet

0 10 20 40

Water & Environmental TECHNOLOGIES

BN LIVINGSTON
SHOP COMPLEX - LIVINGSTON MT

2016 Pilot Test Well Network

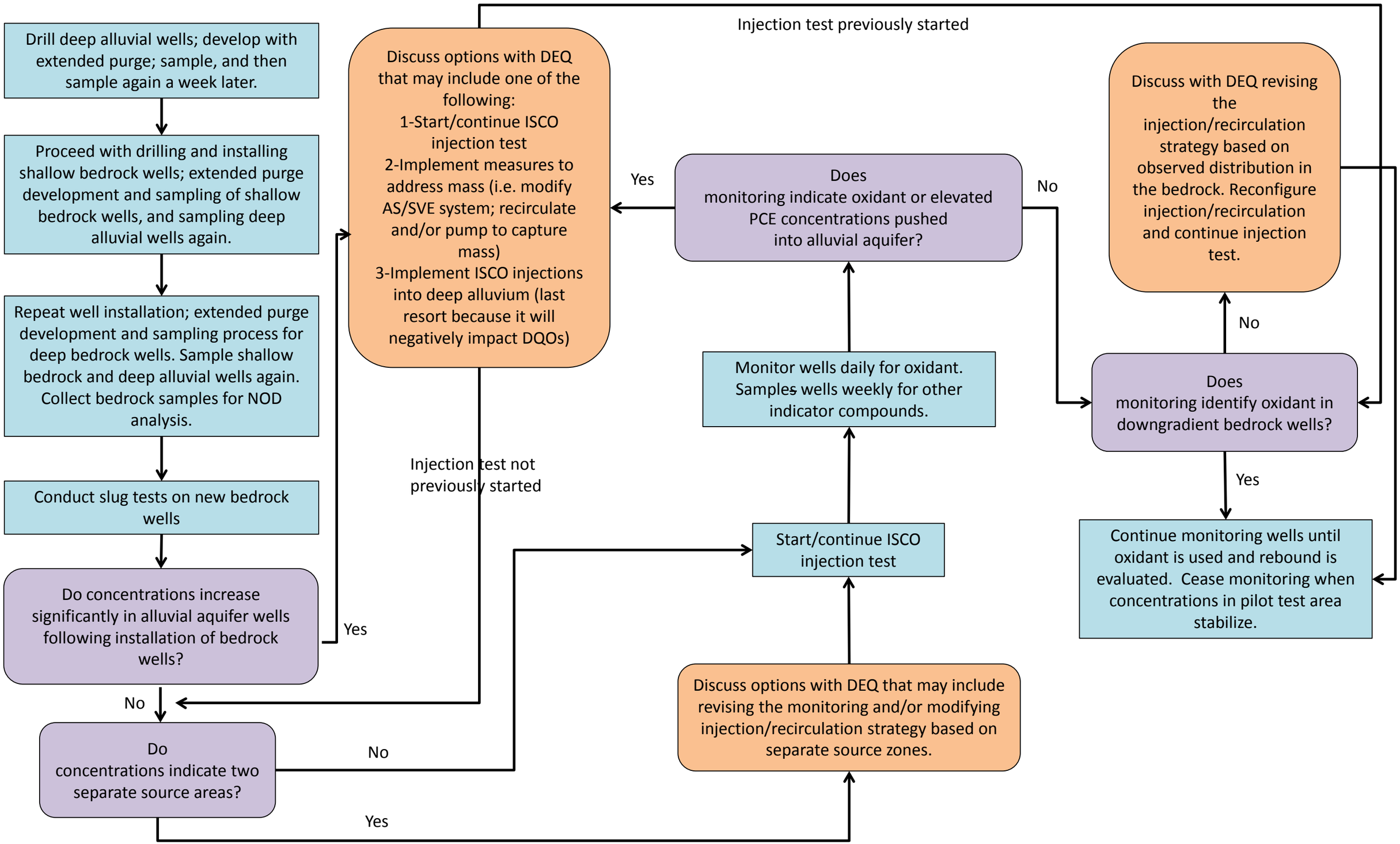
Job#: LRGM01 Task 9

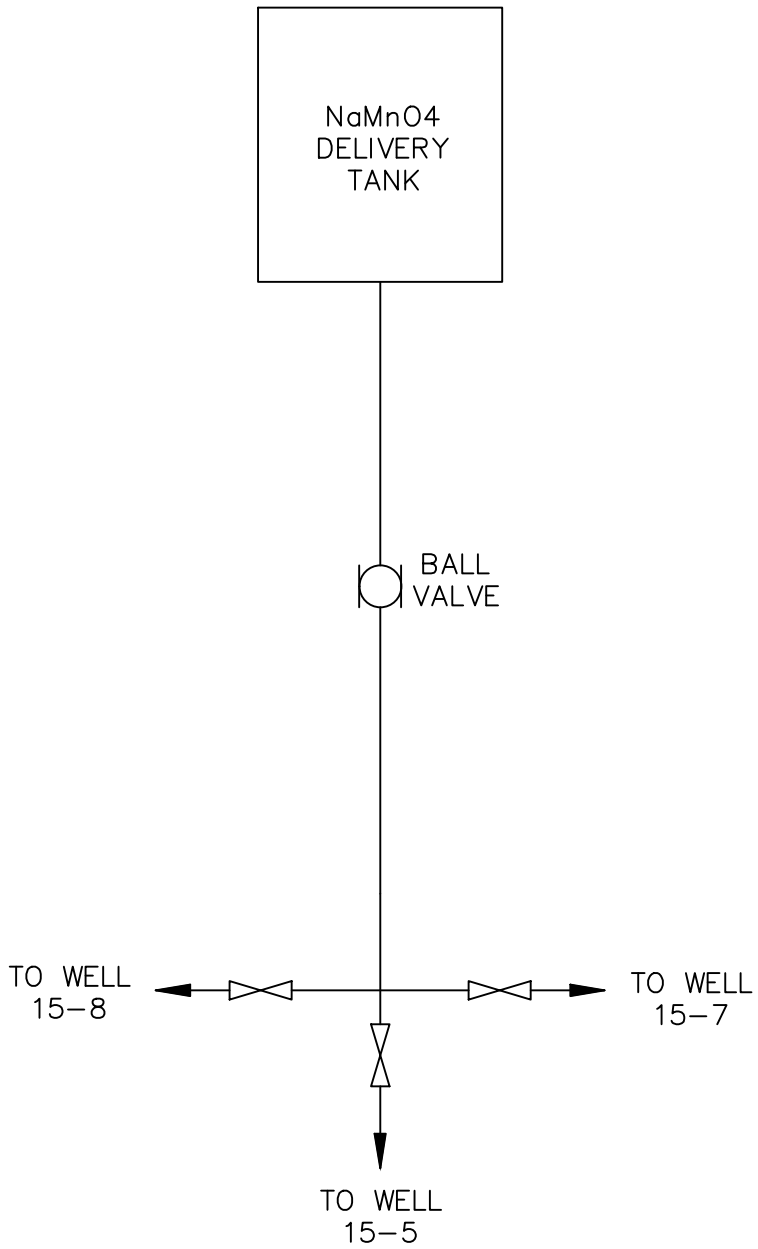
Date: 6/27/2016

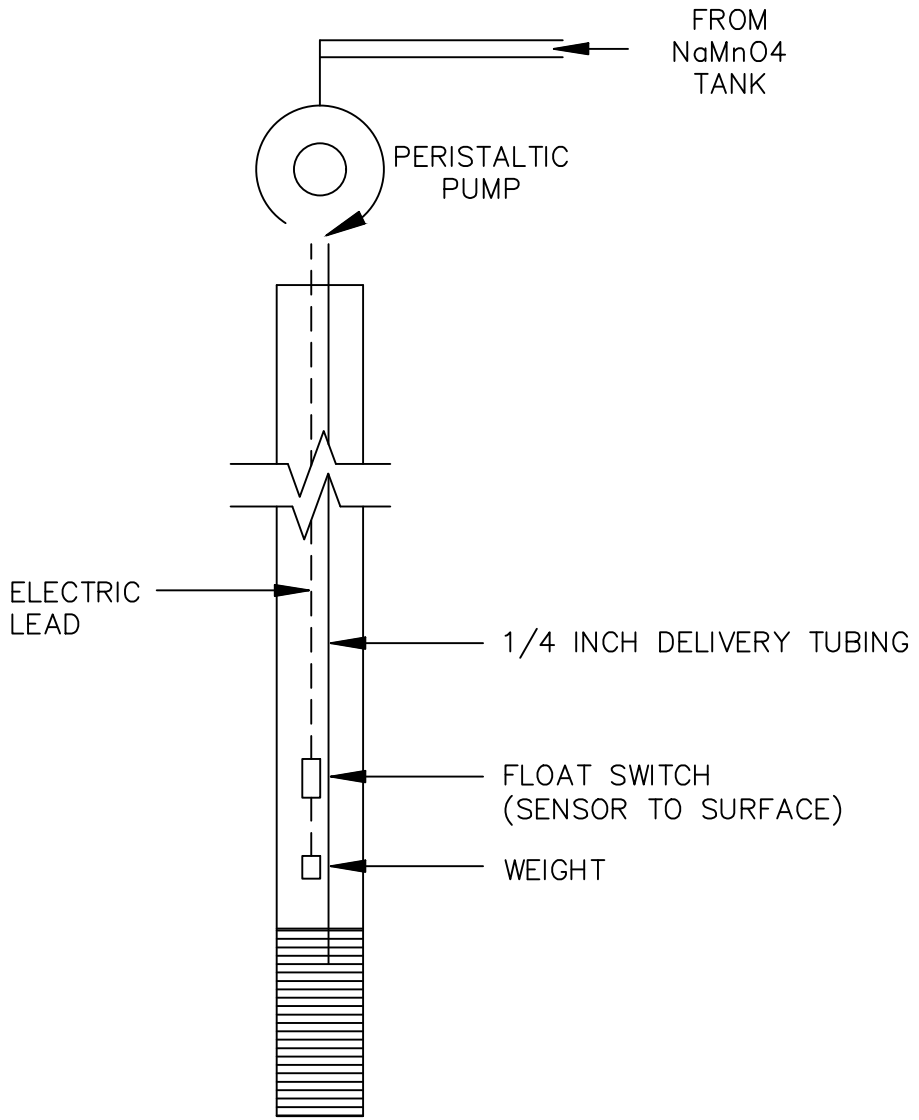
Path: M:\LRGM01\Task9\PT_PropWells416.mxd, Author: jleprowse

FIGURE 1

Figure 3 - Decision Flow Chart - Shallow Bedrock ISCO Pilot Test







TYPICAL WELL
SCHEMATIC

JOB NO: LRGM01-T9
DATE: 5/31/16
DRAFTER: JH
CHECKED BY: PT
SHEET
Fig 3

SODIUM PERMANGANATE
DELIVERY CONFIGURATION

PROJECT NAME: AS/SVE PIOLT STUDY
LOCATION: LIVINGSTON, MONTANA
FILE NO. SD-EI01-LRGM01-T9.dwg

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Figure 4 - Task L Bedrock Remedial Pilot Test Work Plan
BN Livingston Shop Complex
2016 Bedrock Pilot Test Schedule

Task	Duration	May	June	July	August	September	October	November	December
Remedial Pilot Testing									
Drilling/Well Installation	5 Weeks								
Alluvial Wells	1-2 Days								
Shallow Bedrock	8-10 Days								
Deep Bedrock	8-10 Days								
Well Baseline Monitoring									
Alluvial Wells	5 Weeks								
Shallow Bedrock	3 Weeks								
Deep Bedrock	1-2 Weeks								
Injection Equipment Setup	3 Days								
Injection Test	7 Days								
Injection Monitoring									
Daily Visual for Breakthrough	TBD								
Weekly Sampling	12 Weeks								

APPENDIX A

ENVIRONMENTAL REQUIREMENTS, CRITERIA, AND LIMITATIONS (ERCLS)

APPENDIX C

ANALYSIS OF ENVIRONMENTAL REQUIREMENTS, CRITERIA, AND LIMITATIONS (ERCLS)[a] FOR AIR SPARGE / SOIL VAPOR EXTRACTION PILOT TEST WORK PLAN
Burlington Northern Livingston Shop Complex

Federal or State ERCL Citation	Description	Compliance
FEDERAL AND STATE CONTAMINANT SPECIFIC ERCLS		
Surface and Groundwater Quality Standards (Applicable)		
Section 75-5-605, Montana Code Annotated (MCA)	Causing of Pollution Section 75-5-605 of the Montana Water Quality Act prohibits the causing of pollution of any state waters. Section 75-5-103(21)(a)(i) defines pollution as contamination or other alteration of physical, chemical, or biological properties of state waters which exceeds that permitted by the water quality standards. Placement of Wastes Section 75-5-605, MCA states that it is unlawful to place or cause to be placed any wastes where they will cause pollution of any state waters. Any permitted placement of waste is not placement if the agency's permitting authority contains provisions for review of the placement of materials to ensure it will not cause pollution to state waters.	Pilot test activities proposed in ISCO Pilot Test Work Plan will not impact surface water. The ISCO pilot test activities involve the injection of sodium permangenate into the subsurface through well casings. This will force sodium permangenate into the aquifer to volatilize volatile organic compounds (VOCs) [i.e., tetrachloroethene (PCE)]. No physical change will occur in groundwater with exception of removal of VOCs.
Section 75-5-303, MCA	Nondegradation Section 75-5-303, MCA states that existing uses of state waters and the level of water quality necessary to protect the uses must be maintained and protected, with certain limited exceptions.	
Groundwater Quality Standards		
40 Code of Federal Regulations (CFR) 141	Maximum Contaminant Levels and Maximum Contaminant Level Goals (Well-Suited) Because the aquifer affected by the site is currently and has been used as a drinking water source, the MCLs and non-zero MCLGs specified in 40 CFR Part 141 (Primary Drinking Water Standards) are well-suited requirements which are ultimately to be attained by the remedy for the site[1]. Because many of the MCLs are equivalent with the State groundwater standards, the Primary Drinking Water Standards are listed below with the State groundwater standards.	The Record of Decision (ROD) (DEQ, 2001) specifies groundwater remediation as part of the remedial action and allows the treatment of groundwater as part of the selected remedy. The ISCO Pilot Test Work Plan includes pilot testing a treatment technology to assess whether it will achieve the ROD cleanup levels.
40 CFR 143.3	Secondary Maximum Contaminant Levels (Well-Suited) Because the aquifer affected by the site is currently and has been used as a drinking water source, the Secondary Maximum Contaminant Levels (SMCLs) specified in 40 CFR Part 143.3 are well-suited requirements which are ultimately to be attained by the remedy for the site. 40 CFR 143.3 contains standards for color, odor (3 threshold odor number) and corrosivity which are well-suited to the remedial action.	To ensure state waters are not degraded/polluted, investigation-derived waste (IDW) generated during field activities associated with the ISCO Pilot Test Work Plan will be managed as outlined in the Facility-Wide Sampling and Analysis Plan and associated Addendum No. 1 and Addendum No. 2 (herein collectively referred to as the Facility-Wide SAP) . Investigation-derived water will be treated to the groundwater cleanup levels presented in the ROD and will meet all applicable permit requirements as specified in Petroleum Cleanup General Permit MTG7900013 before discharge to the Yellowstone River or will be disposed of according to the hazardous waste procedures specified in Section 8.4 of the Final Facility-Wide Sampling and Analysis Plan and the SAP Addendum (Facility-Wide SAP).
Administrative Rules of Montana (ARM) 17.30.1006	Montana Groundwater Pollution Control System (Applicable) ARM 17.30.1006 classifies groundwater into Classes I through IV based upon its specific conductance and establishes the groundwater quality standards applicable with respect to each groundwater classification. Based upon its specific conductance, the groundwater at the site must meet the standards for Class I groundwater. These standards are applicable. Concentrations of substances in Class I may not exceed the human health standards for groundwater listed in department Circular WQB-7[2]. For the primary contaminants of concern, the Circular WQB-7 standards and MCLs are listed below. For all contaminants of concern except vinyl chloride, the MCLs and Circular WQB-7 standards are equivalent[3]. All levels are ug/l and are dissolved phase. VOCs: Tetrachloroethene - 5.0; Trichloroethene - 5.0; Cis-1,2-Dichloroethene - 70; Vinyl chloride - 0.15; Chlorobenzene - 100; 1,4-Dichlorobenzene - 75 PAHs (SVOCs): Acenaphthene - 420; Anthracene - 2,100; Benzo(a)anthracene - 0.48; Benzo(a)pyrene - 0.048; Benzo(b)fluoranthene - 0.48; Benzo(k)fluoranthene - 4.79; Chrysene - 48; Dibenzo(a,h)anthracene - 0.048; Fluoranthene - 280; Fluorene - 280; Indeno(1,2,3-cd)pyrene - 0.48; Naphthalene - 28; Pyrene - 210 Lead - 15 For concentrations of parameters for which human health standards are not listed in WQB-7, ARM 17.30.1006 allows no increase of a parameter to a level that renders the waters harmful, detrimental or injurious to the beneficial uses listed for Class I water. This includes the following petroleum constituents. All levels are "ug/l" and are dissolved phase.	The use of ISCO injection is not anticipated to require a Montana Groundwater Pollution Control System (MGWPCS) permit under ARM 17.30.1023, because the pilot test injection medium will not increase concentrations of contaminants of concern and work is being performed under the Statement of Work for the Spring 2005 Activities (Spring 2005 SOW) (DEQ, 2005). All substantive requirements of these regulations will be met. Actions included in the ISCO Pilot Test Work Plan will not degrade water quality. The ISCO pilot test is being conducted to remove VOCs from groundwater to reduce concentrations below ROD cleanup levels and/or State of Montana water quality standards (DEQ-7).
ARM 17.30.1011	ARM 17.30.1011 provides that any groundwater whose existing quality is higher than the standard for its classification must be maintained at that high quality unless degradation may be allowed under the principles established in Section 75-5-303, MCA, and the nondegradation rules at ARM Title 17,chapter 30, subchapter 7.	Activities included in the ISCO Pilot Test Work Plan will not degrade groundwater quality and comply with all non-degradation rules.
Surface Water Quality Standards (Applicable)		
Montana Water Quality Act, Section 75-5-101, et seq., MCA Federal Clean Water Act, 33 U.S.C. §§ 1251, et seq.	The Montana Water Quality Act, Sections 75-5-101 et seq., establishes requirements for restoring and maintaining the quality of surface and ground waters and the federal Clean Water Act 33 U.S.C. Sections 1251 et seq., establishes requirements for restoring and maintaining the quality of surface waters. Under these Acts the state has authority to adopt water quality standards designed to protect beneficial uses of each water body and to designate uses for each water body. Montana's regulations classify state waters according to quality, place restrictions on the discharge of pollutants to state waters and prohibit the degradation of state waters.	To ensure state waters are not degraded/polluted, IDW generated during field activities associated with this ISCO Pilot Test Work Plan will be managed as outlined in the Facility-Wide SAP. Investigation-derived water will be treated to the groundwater cleanup levels presented in the ROD and will meet all applicable permit requirements as specified in Petroleum Cleanup General Permit MTG7900013 before discharge to the Yellowstone River or will be disposed of according to the hazardous waste procedures specified in the Facility-Wide SAP.
ARM 17.30.611	ARM 17.30.611(1) (Applicable) provides that the waters of the Yellowstone River drainage upstream of the Laurel water supply intake, which includes the Livingston area, are classified "B-1" for water use.	Tasks included in this ISCO Pilot Test Work Plan will not degrade groundwater and will not adversely affect surface water.
ARM 17.30.623	ARM 17.30.623 provides that concentrations of carcinogenic, bioconcentrating, toxic or harmful parameters which would remain in the water after conventional water treatment may not exceed the applicable standards set forth in department Circular WQB-7.	
WQB-7 standards	WQB-7 provides that "For surface waters the Standard is the more restrictive of either the Aquatic Life Standard or the Human Health Standard." For the primary Contaminants of Concern the Circular WQB-7 standards are the same as listed above in groundwater.	
ARM 17.30.623	The B-1 classification standards at ARM 17.30.623 also include the following criteria: 1) Dissolved oxygen concentration must not be reduced below the levels given in department Circular WQB-7; 2) Hydrogen ion concentration (pH) must be maintained within the range of 6.5 to 9.5; 3) the maximum allowable increase above naturally occurring turbidity is 5 nephelometric turbidity units; 4) Temperature increases must be kept within prescribed limits; 5) No increase are allowed above naturally occurring concentrations of sediment, settleable solids, oils, floating solids, which will or is likely to create a nuisance or render the waters harmful, detrimental, or injurious to public health, recreation, safety, welfare, livestock, wild animals, birds, fish or other wildlife. 6) True color must be kept within specified limits.	

ANALYSIS OF ENVIRONMENTAL REQUIREMENTS, CRITERIA, AND LIMITATIONS (ERCLS)[a] FOR AIR SPARGE / SOIL VAPOR EXTRACTION PILOT TEST WORK PLAN
Burlington Northern Livingston Shop Complex

Federal or State ERCL Citation	Description	Compliance
ARM 17.30.637	ARM 17.30.637 which prohibits discharges containing substances that will: (a) settle to form objectionable sludge deposits or emulsions beneath the surface of the water or upon adjoining shorelines; (b) create floating debris, scum, a visible oil film (or be present in concentrations at or in excess of 10 milligrams per liter) or globules of grease or other floating materials; (c) produce odors, colors or other conditions which create a nuisance or render undesirable tastes to fish flesh or make fish inedible; (d) create concentrations or combinations of materials which are toxic or harmful to human, animal, plant or aquatic life; (e) create conditions which produce undesirable aquatic life.	ISCO pilot test activities will not result in discharges that will degrade/pollute state waters.
ARM 17.30.705	ARM 17.30.705 provides that for any surface water, existing and anticipated uses and the water quality necessary to protect these uses must be maintained and protected unless degradation is allowed under the nondegradation rules at ARM 17.30.708.	To ensure state waters are not degraded/polluted, IDW generated during field activities associated with the ISCO Pilot Test Work Plan will be managed as outlined in the Facility-Wide SAP. Investigation-derived water will be treated to the groundwater cleanup levels presented in the ROD and will meet all applicable permit requirements as specified in Petroleum Cleanup General Permit MTG7900013 before discharge to the Yellowstone River or disposed of according to the hazardous waste procedures specified in the Facility-Wide SAP.
Water Quality Act, Title 17, Chapter 30, Sub-Chapters 6 and 13 and ARM 17.30.1332	Stormwater Runoff (Applicable) Pursuant to authority under the Water Quality Act, Title 17, Chapter 30, Sub-Chapter 6, and Title 17, Chapter 30, Sub-Chapter 13, including ARM 17.30.1332, the Water Quality Division issues general stormwater permits for certain activities. For construction activities, the following permit must be obtained: General Discharge Permit for Storm Water Associated with Construction Activity, Permit No. MTR100000 (May 19, 1997). Generally, the permits require the permittee to implement Best Management Practices (BMP) and to take all reasonable steps to minimize or prevent any discharge which has a reasonable likelihood of adversely affecting human health or the environment. However, if there is evidence indicating potential or realized impacts on water quality due to any storm water discharge associated with the activity, an individual MPDES permit or alternative general permit may be required.	ISCO pilot test activities will not impact surface water runoff at the Facility.
Ambient Air Quality Standards (Applicable)		
40 CFR 50.12 and ARM 17.8.222 40 CFR 50.9 and ARM 17.8.213 40 CFR 50.10 ARM 17.8.220	The following standards are applicable at the site[4]: 40 CFR 50.12 and ARM 17.8.222. Ambient air quality standard for lead. Lead concentrations in the ambient air shall not exceed the following 90-day average: 1.5 micrograms lead per cubic meter of air. 40 CFR 50.9 and ARM 17.8.213. Ambient air quality standard for ozone. No person shall cause or contribute to concentrations of ozone in the ambient air exceeding: 0.10 ppm 1-hour average (0.12 ppm federal standard). 40 CFR 50.10 establishes a daily maximum 8-hour average 0.08 parts per million (ppm). ARM 17.8.220. Ambient air quality standard for settled particulate matter. Particulate matter concentrations in the ambient air shall not exceed the following 30-day average: 10 grams per square meter.	ISCO pilot test activities will not result in exceedances of ambient air quality standards for lead or ozone.
40 CFR 50.6 and ARM 17.8.223	40 CFR 50.6 and ARM 17.8.223. Ambient air quality standards for PM-10. PM-10 concentrations in the ambient air shall not exceed the following standards: 150 micrograms/cubic meter of air, 24-hour average; and 50 micrograms/cubic meter of air, expected annual average.	ISCO pilot test activities include well installations. However, these actions will include wetting and other best management practices related to fugitive dust control. Remedial actions will be halted if significant dust is generated and will not resume until adequate dust control measures are in place. These dust control measures will ensure that ambient air standards will not be exceeded during the proposed remedial action.
40 CFR 50.8 and ARM 17.8.212	40 CFR 50.8 and ARM 17.8.212. Ambient air quality standards for carbon monoxide. Carbon monoxide concentrations in the ambient air shall not exceed the following standards: 9 ppm 8-hour average; and 23 ppm for a 1-hour average (35 ppm for federal).	ISCO pilot test activities will not result in exceedances of ambient air quality standards for carbon monoxide.
Emission Standards (Applicable)		
Sections 75-2-101, et seq., MCA	Montana has promulgated standards to regulate emissions of certain contaminants into the air. The state emission standards are enforceable under the Montana Clean Air Act, Sections 75-2-101 et seq., MCA.	ISCO pilot test activities will not result in VOC emissions.
ARM 17.8.304	ARM 17.8.304. Visible Air Contaminants. No source may discharge emissions into the atmosphere that exhibit an opacity of 20 percent or greater, averaged over six consecutive minutes. This standard is limited to point sources, but excludes wood waste burners, incinerators, and motor vehicles.	
ARM 17.8.308	ARM 17.8.308. Airborne Particulate Matter. Emissions of airborne particulate matter from any stationary source shall not exhibit an opacity of 20 percent or greater, averaged over six consecutive minutes. This standard applies to the production, handling, transportation, or storage of any material; to the use of streets, roads, or parking lots; and to construction or demolition projects.	ISCO pilot test activities include well installations. However, these actions will include wetting and other best management practices related to fugitive dust control. Remedial actions will be halted if significant dust is generated and will not resume until adequate dust control measures are in place. These dust control measures will ensure that ambient air standards will not be exceeded during the proposed remedial action.
ARM 17.8.315	ARM 17.8.315. Odors. If a business or other activity will create odors, those odors must be controlled, and no business or activity may cause a public nuisance.	ISCO pilot test activities will not generate odors. No open burning will be conducted during implementation of the pilot test.
ARM 17.8.604	ARM 17.8.604. Prohibited open burning. Open burning of numerous specific materials, including but not limited to oil and petroleum products and hazardous wastes, is prohibited.	
ARM 17.8.705	ARM 17.8.705 requires that permits be obtained for the construction, installation, alteration, or use of specified air contaminant sources. All air permits required for remedial actions must be obtained.	According to the Air Resources Management Bureau of Montana Deprtament of Environmental Quality (DEQ), the proposed ISCO system does not require air permits.
ARM 17.8.715	ARM 17.8.715 requires sources for which air quality permits are required to use best available control technology (BACT) or to meet the lowest achievable emission rate (LAER), as applicable.	
FEDERAL LOCATION SPECIFIC ERCLS		
Criteria Classification of Solid Waste Disposal Facilities and Practices (Applicable and Well-Suited)		
40 CFR 257	Under the selected remedy, no solid or hazardous waste (other than media treated to cleanup levels) may be disposed on-site. The standards therefore are pertinent to the cinder pile (well-suited) and placement of ex situ soils treated to cleanup levels (applicable) and post-jurisdictional wastes (applicable). The criteria contained in 40 CFR Part 257, establish standards with which solid waste disposal must comply to avoid possible adverse effects on health or the environment. 40 CFR Part 257 includes the following standards: Section 257.3-1(a) requires that facilities or practices in the floodplain not result in the washout of solid waste so as to pose a hazard to human life, wildlife, or land or water resources. Section 257.3-2 provides for the protection of threatened or endangered species. Section 257.3-3 provides that a facility shall not cause the discharge of pollutants into waters of the United States. Section 257.3-4 states that a facility or practice shall not contaminate underground drinking water.	Non-hazardous IDW will be generated during implementation of the ISCO pilot test(s). Depending on the constituents and concentrations present and upon approval from the DEQ, this material may be landspread at the Livingston railyard, or treated, if feasible, and landspread at the Livingston railyard. Alternatively, the IDW will be disposed offsite at an appropriate permitted disposal facility. See the Facility-Wide SAP for additional information on how IDW generated during implementation of the ISCO pilot test(s) will be managed to comply with these ERCLs. Landspreading of soil and water, if approved by DEQ, will not occur in areas of a floodplain nor be conducted in a manner to cause discharge of pollutants into water. Other IDW or solid waste generated during implementation of the ISCO pilot test(s) will be disposed offsite at an appropriate permitted disposal facility.

ANALYSIS OF ENVIRONMENTAL REQUIREMENTS, CRITERIA, AND LIMITATIONS (ERCLS)[a] FOR AIR SPARGE / SOIL VAPOR EXTRACTION PILOT TEST WORK PLAN
Burlington Northern Livingston Shop Complex

Federal or State ERCL Citation	Description	Compliance
The Endangered Species Act (Well-Suited)		
16 U.S.C. §§ 1531 – 1544, 50 CFR Part 402, 40 CFR 6.302(h), 40 CFR 257.3-2	This statute and implementing regulations (16 U.S.C. § 1531 et seq., 50 CFR Part 402, 40 CFR 6.302(h), and 40 CFR 257.3-2) require that any federal activity or federally authorized activity may not jeopardize the continued existence of any threatened or endangered species or destroy or adversely modify a critical habitat. Compliance with this requirement involves consultation with the U.S. Fish and Wildlife Service (USFWS) and a determination of whether there are listed or proposed species or critical habitats present at the Site, and, if so, whether any proposed activities will impact such wildlife or habitat. No endangered or threatened species was identified onsite although the Yellowstone Trout is treated as a species of special concern by the State. Any action affecting federal or State endangered or threatened species must comply with all listed requirements.	ISCO pilot test activities will not impact endangered species. According to the ROD, no endangered species or threatened specifies were identified at the Facility, although the Yellowstone Trout is treated as a species of special concern by the State.
Sections 87-5-106, -107, -111, and -201, MCA	Sections 87-5-106, 107, and 111, MCA (Applicable): Endangered species should be protected in order to maintain and to the extent possible enhance their numbers. These sections list endangered species, prohibited acts and penalties. See also, §§ 87-5-106 and 87-5-201, MCA, (Applicable) concerning protection of wild birds, nests and eggs.	
ARM 12.5.201	ARM 12.5.201 (Applicable). Certain activities are prohibited with respect to specified endangered species.	
Migratory Bird Treaty Act (Well-Suited)		
16 U.S.C. §§ 703, et seq.	This requirement (16 U.S.C. § 703 et seq.) establishes a federal responsibility for the protection of the international migratory bird resource and requires continued consultation with the USFWS during remedial design and remedial action to ensure that the cleanup of the site does not unnecessarily impact migratory birds.	ISCO pilot test activities will not impact migratory birds. Migratory birds may be present near the Facility. However, the Livingston railyard does not provide the majority of habitat for these species relative to the surrounding area, and no features exist that are particularly attractive to these species.
Bald Eagle Protection Act (Well-Suited)		
16 U.S.C. §§ 668, et seq.	This requirement (16 U.S.C. § 668 et seq.) establishes a federal responsibility for protection of bald and golden eagles, and requires continued consultation with the USFWS during remedial design and remedial action to ensure that any cleanup of the site does not unnecessarily adversely affect the bald and golden eagle.	ISCO pilot test activities will not impact bald eagles. Bald eagles may be present near the Facility. However, the Livingston railyard does not provide the majority of habitat for these species relative to the surrounding area, and no features exist that are particularly attractive to these species.
Historic Sites, Buildings, Objects, and Antiquities Act (Well-Suited)		
16 U.S.C. 461, et seq.	These requirements, found at 16 U.S.C. 461 et seq., provide that, in conducting an environmental review of a proposed action, the responsible official shall consider the existence and location of natural landmarks using information provided by the National Park Service pursuant to 36 CFR 62.6(d) to avoid undesirable impacts upon such landmarks. No historic sites were identified.	ISCO pilot test activities will not impact historic sites. According to the ROD, no historic sites were identified at the Livingston railyard.
Fish and Wildlife Coordination Act (Well-Suited)		
16 U.S.C. 661, et seq. and 40 CFR 6.302(g)	These standards are found at 16 U.S.C. § 661 et seq. and 40 CFR 6.302(g) and require that federally funded or authorized projects ensure that any modification of any stream or other water body affected by a funded or authorized action provide for adequate protection of fish and wildlife resources.	ISCO pilot test activities do not involve the modification of any stream or other water body.
Floodplain Management Order (Well-Suited)		
40 CFR Part 6, Appendix A, Executive Order No. 11,988	This requirement (40 CFR Part 6, Appendix A, Executive Order No. 11,988) mandates that federally funded or authorized actions within the 100 year floodplain avoid, to the maximum extent possible, adverse impacts associated with development of a floodplain.	The proposed area(s) where the ISCO pilot test(s) will be implemented and locations of the proposed new wells are not located in the floodway or floodplain. Therefore, the ISCO pilot test activities will not impact a floodway or floodplain.
Protection of Wetlands Order (Well-Suited)		
40 CFR Part 6, Appendix A, Executive Order No. 11,990 Section 404(b)(1), 33 U.S.C. Section 1344(b)(1)	This requirement (40 CFR Part 6, Appendix A, Executive Order No. 11,990) mandates that federal agencies and potentially responsible parties avoid, to the extent possible, the adverse impacts associated with the destruction or loss of wetlands and to avoid support of new construction in wetlands if a practicable alternative exists. Section 404(b)(1), 33 U.S.C. § 1344(b)(1), also prohibits the discharge of dredged or fill material into waters of the United States. Together, these requirements create a "no net loss" of wetlands standard.	According to Montana's Natural Resource Information System, no wetlands have been identified in the Livingston area. ISCO pilot test activities will not impact wetlands.
STATE LOCATION SPECIFIC ERCLS		
Solid Waste Management Regulations (Applicable and Well-Suited)		
Solid Waste Management Act, Sections 75-10-201 et seq., MCA	Regulations promulgated under the Solid Waste Management Act, Sections 75-10-201 et seq., MCA, specify requirements that apply to the location of any solid waste management facility. Under the selected remedy, no solid or hazardous waste (other than media treated to cleanup levels) may be disposed on-site. The standards therefore are pertinent to the cinder pile (well-suited) and placement of ex situ soils treated to cleanup levels (applicable) and post-jurisdictional wastes (applicable).	Non-hazardous IDW such as personal protective equipment (PPE) and IDW that has determined to be non-hazardous through analytical testing generated during implementation of the ISCO pilot test(s) will be contained in 55-gallon drums or other appropriate containers and temporarily stored in a centralized storage area pending characterization and final disposition. If non-hazardous investigation-derived soil or water cannot be landspread at the Livingston railyard, it will be disposed offsite along with other non-hazardous IDW at an appropriate permitted disposal facility. See the Facility-Wide SAP for additional information regarding the management of IDW. Any other solid waste generated (i.e., tape removed from boxes, plastic bags and/or boxes containing supplies that are not reused, etc.) will be contained in a plastic garbage bag (if necessary) and placed in a garbage can for collection and appropriate disposal as solid waste. ISCO pilot test activities do not involve the cinder pile or propose treatment of soil (ex-situ). If treatment of soil (ex-situ) is proposed, a SAP addendum will be submitted to DEQ as discussed in Section 8.4.2 of the Facility-Wide SAP.
ARM 17.50.505(1)	Under ARM 17.50.505(1), a facility for the treatment, storage or disposal of solid wastes: (a) must be located where a sufficient acreage of suitable land is available for solid waste management; (b) may not be located in a 100-year floodplain; (c) may be located only in areas which will prevent the pollution of ground and surface waters and public and private water supply systems; (d) must be located to allow for reclamation and reuse of the land; (e) drainage structures must be installed where necessary to prevent surface runoff from entering waste management areas; and (f) where underlying geological formations contain rock fractures or fissures which may lead to pollution of the ground water or areas in which springs exist that are hydraulically connected to a proposed disposal facility, only Class III disposal facilities may be approved.	IDW generated during implementation of the ISCO pilot test(s) will be contained in 55-gallon drums or other appropriate containers and stored inside/near the Former C&P Packing Building (see Section 8.4.4 1 of the Facility-Wide SAP). The Former C&P Packing Building and surrounding areas represent sufficient acreage for IDW management. The area is not located in a 100-year floodplain. IDW will be stored in appropriate containers to prevent pollution of groundwater, surface water, and public supply systems.

ANALYSIS OF ENVIRONMENTAL REQUIREMENTS, CRITERIA, AND LIMITATIONS (ERCLS)[a] FOR AIR SPARGE / SOIL VAPOR EXTRACTION PILOT TEST WORK PLAN
Burlington Northern Livingston Shop Complex

Federal or State ERCL Citation	Description	Compliance
Floodplain and Floodway Management Act and Regulations (Applicable)		
	A portion of the site is in a designated floodplain. The following standards are included here to indicate the restrictions on any related activities that might occur in or affect the floodway or floodplain.	The proposed area where the ISCO pilot test(s) will be implemented and locations of the proposed new wells are not located in the floodway or floodplain. Therefore, ISCO pilot test activities will not impact a floodway or floodplain.
Section 76-5-401, MCA and ARM 36.15.601	Residential, certain agricultural, industrial-commercial, recreational and other uses are permissible within the designated floodway, provided they do not require structures other than portabl structures, fill or permanent storage of materials or equipment. Section 76-5-401, MCA; ARM 36.15.601.	
Section 76-5-402, MCA and ARM 36.15.701	In the flood fringe (i.e., within the floodplain but outside the floodway), residential, commercial, industrial, and other structures may be permitted subject to certain conditions relating to placement of fill, roads, and floodproofing. Section 76-5-402, MCA; ARM 36.15.701.	
ARM 36.15.602(6)	Domestic water supply wells may be permitted, even within the floodway, provided the well casing and well meets certain conditions. ARM 36.15.602(6).	
ARM 36.15.602(5), 36.15.605, and 36.15.703	Solid and hazardous waste disposal and storage of toxic, flammable, hazardous, or explosive materials are prohibited anywhere in floodways or floodplains. ARM 36.15.602(5), 36.15.605, and 36.15.703.	
Section 76-5-402, MCA	The following are prohibited in a floodway: buildings for living purposes or place of assembly or permanent use by human beings; any structure or excavation that will cause water to be diverted from the established floodway, cause erosion, obstruct the natural flow of water, or reduce the carrying capacity of the floodway; and the construction or permanent storage of an object subject to flotation or movement during flood level periods. Section 76-5-402, MCA.	The proposed area where the ISCO pilot test(s) will be implemented and locations of the proposed new wells are not located in the floodway or floodplain. Therefore, ISCO pilot test activities will not impact a floodway or floodplain.
Section 76-5-406, MCA and ARM 36.15.216	Section 76-5-406, MCA and ARM 36.15.216 contain substantive factors which address obstruction or use within the floodway or floodplain.	
ARM 36.15.604, ARM 36.15.602(1), and ARM 36.15.603	Further conditions or restrictions that generally apply to specific activities within the floodway or floodplain can be found at ARM 36.15.604 (increase in upstream elevation or significantly increase flood velocities); ARM 36.15.602(1) (excavation of material from pits or pools); ARM 36.15.603 (water diversions or changes in place of diversion).	
ARM 36.15.701(3)(c)	ARM 36.15.701(3)(c) requires that roads, streets, highways and rail lines must be designed to minimize increases in flood heights.	
ARM 36.15.701(3)(d)	Structures and facilities for liquid or solid waste treatment and disposal must be floodproofed to ensure that no pollutants enter flood waters and may be allowed and approved only in accordance with DEQ regulations, which include certain additional prohibitions on such disposal. ARM 36.15.701(3)(d).	
ARM 36.15.702(2)	Standards applied to residential, commercial or industrial structures are found at ARM 36.15.702(2).	
ARM 36.15.606	Flood control works are subject to ARM 36.15.606, which requires compliance with safety standards for levees, floodwalls, and riprap.	
ARM 36.15.901	ARM 36.15.901 requires electrical systems to be flood-proofed.	
FEDERAL AND STATE ACTION SPECIFIC ERCLS		
Federal Hazardous Waste Management Regulations (Applicable)		
42 U.S.C. §§ 6901 et seq., and Montana Hazardous Waste Act, Sections 75-10-401 et seq., MCA	The Resource Conservation and Recovery Act (RCRA), 42 U.S.C. Sections 6901 et seq., and the Montana Hazardous Waste Act, Sections 75-10-401 et seq., MCA, and regulations under these acts establish a regulatory structure for the generation, transportation, treatment, storage and disposal of hazardous wastes. These requirements are applicable to substances and actions at the site which involve the active management of hazardous wastes. Burlington Northern operated the site and generated waste through 1986-7. Therefore, in certain instances, disposal was not pre-jurisdictional and the hazardous waste requirements are applicable now. However, DEQ does not have the documentation showing the dates of individual discharges, and therefore has, for purposes of this ROD, made a determination to treat all historic waste and media containing waste as pre-jurisdictional (in accord with the NCP and EPA guidance). Therefore, under this ROD, the historic waste which is characteristic or listed becomes hazardous upon excavation (generation).	ISCO pilot test activities are being conducted in the area containing F-listed constituents, IDW generated during the ISCO pilot test will be suspected of containing F-listed constituents and will be managed as a hazardous waste unless analytical testing shows otherwise. The types of hazardous IDW expected to be generated are discussed in Section 8.0 of the ISCO Pilot Test Work Plan. Hazardous IDW will be managed in accordance with Section 8.0 of the ISCO Pilot Test Work Plan and with the Facility-Wide SAP. While DEQ has the authority to waive non-substantive permit requirements for remedial actions conducted entirely at the Facility, that authority does not extend to offsite permitted activities such as transporting and disposing of hazardous waste. Environmental samples containing RCRA-regulated constituents submitted to the analytical laboratory are exempt from RCRA; however, they become subject to RCRA again when they are disposed of by the analytical laboratory. Analytical laboratory will dispose of environmental samples in accordance with state and federal regulations.
Indentification and Listing of Hazardous Waste		
40 CFR 261 ARM 17.54.501-502	Wastes may be designated as hazardous by either of two methods: listing or demonstration of a hazardous characteristic. Listed wastes are the specific types of wastes determined by EPA to be hazardous as identified in 40 CFR Part 261, Subpart D (40 CFR 261.30 - 261.33). Listed wastes are designated hazardous by virtue of their origin or source, and must be managed as hazardous wastes regardless of the concentration of hazardous constituents. Characteristic wastes are those that by virtue of concentrations of hazardous constituents demonstrate the characteristic of ignitability, corrosivity, reactivity or toxicity, as described at 40 CFR Part 261, Subpart C. Certain of the wastes at the site demonstrate the characteristic of toxicity, and are therefore characteristic hazardous wastes upon excavation. The site also contains F001 and F002 which are listed hazardous wastes for chlorinated solvents. The various media and wastes at the site contaminated by the F001 and F002 wastes are also hazardous wastes pursuant to 40 CFR Part 261 upon excavation. The RCRA requirements specified below are applicable requirements for the treatment, storage and disposal of these wastes. See 40 CFR 261.31 (Hazardous Waste Numbers F001 and F002) and ARM 17.54.501. These ERCLs apply to remedial activities; on-going operations must comply with State and federal requirements and permits. EPA has advised EPA Regions and States that conservative, health-based levels derived from direct exposure pathways would clearly be acceptable as "contained-in" levels. [See memorandum from Sylvia K. Lowrance to Jeff Zelikson, Region IX, (January 24, 1989)]. EPA and many States specify conservative, risk-based levels calculated with standard conservative exposure assumptions (usually based on unrestricted access), or site-specific risk assessments. 61 FR at 18795 (April 29, 1996); 63 FR 28556 (May 26, 1998) [Part I of II]. For the BN Livingston Shop Complex, soils treated to below cleanup levels will be allowed to return to the site (from, for example, the electric shop) to an approved location in compliance with RCRA.	ISCO pilot test activities are being conducted in the area containing F-listed constituents, IDW generated during the ISCO pilot test(s) will be suspected of containing F-listed constituents and will be managed as a hazardous waste unless analytical testing shows otherwise. Hazardous IDW will be managed in accordance with Section 8.0 of the ISCO Pilot Test Work Plan and with the Facility-Wide SAP. If offsite disposal is warranted, additional testing of the IDW may be required by the disposal facility and will be performed if necessary.
40 CFR 261 ARM 17.54.501-502 (cont.)	For media which contain hazardous waste, all standards are applicable except for disposal requirements for "contained-out" soils. For all non-media wastes, the standards are applicable. However, no on-site disposal of hazardous waste is allowed under the selected remedy. Therefore, all hazardous wastes, including all media not treated to cleanup levels must be disposed off-site at a regulated subtitle C facility. These standards specifically apply to free product removed from within the solvent plume. For free product removed from outside the solvent plume 40 CFR Part 279 is applicable.	

ANALYSIS OF ENVIRONMENTAL REQUIREMENTS, CRITERIA, AND LIMITATIONS (ERCLS)[a] FOR AIR SPARGE / SOIL VAPOR EXTRACTION PILOT TEST WORK PLAN
Burlington Northern Livingston Shop Complex

Federal or State ERCL Citation	Description	Compliance
ARM 17.53.111 and 112, MCA	Because of the presence of listed and characteristic hazardous waste, the permit requirements specified in ARM 17.53.112 are applicable. However, DEQ is exempting remedial actions involving hazardous waste from RCRA permit requirements pursuant to 75-10-721(3), MCA (1993) as long as substantive requirements are met. This does not, however, affect the requirement to comply with ARM 17.53.111, Registration and EPA Identification Numbers for Generators and Transporters. Workplans will require detailed information on compliance with all procedural and substantive standards (as well as all ERCLs). Set out below are the hazardous waste requirements that are applicable for the types of waste management units or the waste management practices anticipated in the remedial actions at the site.	BNSF has obtained a hazardous waste identification number for the Livingston railyard (EPA ID No. MTT310010087).
Standards for Transporters of Hazardous Waste		
40 CFR Part 263	The RCRA regulations at 40 CFR Part 263, establish standards that apply to transporters of hazardous waste. These standards include requirements for immediate action for hazardous waste discharges. These standards are applicable for any on-site transportation. These standards are independently applicable (see Other Laws section) for any off-site transportation.	DEQ has determined that a hazardous waste transporter is not required to transport hazardous waste from a work area to the centralized storage area, provided transportation remains within the Facility. If hazardous waste needs to be transported outside the Facility, the waste will be manifested and a hazardous waste transporter will be used as discussed in Section 8.4.4 of the Facility-Wide SAP.
Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities		
40 CFR 264, Subpart B	General Facility Standards The regulations at 40 CFR 264, Subpart B, establish general facility requirements. These standards include requirements for general waste analysis, security and location standards.	Hazardous IDW will be managed in accordance with the Facility-Wide SAP.
40 CFR 264, Subpart F	Releases from Solid Waste Management Units The regulations at 40 CFR 264, Subpart F, establish requirements for groundwater protection for RCRA-regulated solid waste management units (i.e., waste piles, surface impoundments, land treatment units, and landfills). The regulations at Subpart F establish monitoring requirements for RCRA-regulated solid waste management units (i.e., waste piles, surface impoundments, land treatment units, and landfills). Subpart F provides for three general types of groundwater monitoring: detection monitoring (40 CFR 264.98); compliance monitoring (40 CFR 264.99); and corrective action monitoring (40 CFR 264.100). Monitoring wells must be cased according to 264.97(c). Monitoring is required during the active life of a hazardous waste management unit. If hazardous waste remains, monitoring is required for a period necessary to protect human health and the environment.	Hazardous IDW will be managed in accordance with the Facility-Wide SAP.
40 CFR Part 264, Subpart G	Closure and Post-Closure Monitoring and Maintenance of Waste Management or Disposal Facilities 40 CFR Part 264, Subpart G, establishes that hazardous waste management facilities must be closed in such a manner as to (a) minimize the need for further maintenance and (b) control, minimize or eliminate, to the extent necessary to protect public health and the environment, post-closure escape of hazardous wastes, hazardous constituents, leachate, contaminated runoff or hazardous waste decomposition products to the ground or surface waters or to the atmosphere. Requirements for facilities requiring post-closure care include the following: the facilities must undertake appropriate monitoring and maintenance actions, control public access, and control postclosure use of the property to ensure that the integrity of the final cover, liner, or containment system is not disturbed. In addition, all contaminated equipment, structures and soil must b properly disposed of or decontaminated unless exempt and free liquids must be removed or solidified, the wastes stabilized, and the waste management unit covered.	
40 CFR Part 264, Subparts I and J 40 CFR 261.7	Waste Containers and Tanks 40 CFR Part 264, Subparts I and J apply to owners and operators of facilities that store hazardous waste in containers, and store or treat hazardous waste in tanks, respectively. These regulations are applicable to any storage or treatment in these units at the site. The related provisions of 40 CFR 261.7, residues of hazardous waste in empty containers, are also applicable.	Hazardous IDW and IDW suspected to be hazardous generated during implementation of the ISCO pilot test(s) will be stored in drums, tanks, or other appropriate containers and managed as outlined in the Facility-Wide SAP
40 CFR Part 264, Subpart L	Waste Piles 40 CFR Part 264, Subpart L, applies to owners and operators of facilities that store or treat hazardous waste in piles. The regulations include requirements for the use of run-on and run-off control systems and collection and holding systems to prevent the release of contaminants from waste piles. These regulations are applicable to any storage in waste piles at the site.	IDW generated during implementation of the ISCO pilot test(s) will not be stored in waste piles. IDW (soil, water, non-indigenous) generated during the ISCO pilot test(s) will be stored in drums, tank(s) or other appropriate containers as described in Section 8.4 of the Facility-Wide SAP.
40 CFR 264.554	Staging Piles 40 CFR 264.554 sets forth a new storage unit called the staging pile. A staging pile must be located within the contiguous property under the control of the owner/operator where the wastes to be managed in the staging pile originated. The staging pile must be designed so as to prevent or minimize releases of hazardous wastes and hazardous constituents into the environment and minimize or adequately control cross-media transfer, as necessary to protect human health and the environment (for example, through the use of liners, covers, run-off/run-on controls, as appropriate). The staging pile must not operate for more than two years and cannot be used for treatment.	IDW generated during implementation of the ISCO pilot test(s) will not be stored in staging piles. IDW (soil, water, non-indigenous) generated during the ISCO pilot test(s) will be stored in drums, tank(s) or other appropriate containers as described in Section 8.4 of the Facility-Wide SAP.
40 CFR Part 268	RCRA Land Disposal Restrictions Since the wastes to be treated are listed and characteristic wastes, the RCRA Land Disposal Restrictions (LDRs) treatment levels set forth in 40 CFR Part 268 are applicable requirements including the treatment levels for F001 and F002 listed wastes for the disposal of hazardous wastes generated at the site. With the exception of treated soils, hazardous wastes are prohibited from disposal on-site.	If investigation-derived soil or water is proposed for landspreading, documentation showing that concentrations are below LDR standards will be included in the request for a no-longer contained-in determination from DEQ as discussed in the Facility-Wide SAP.
HWIR Media Rule (63 Fed. Reg. 65874)	The HWIR Media Rule, promulgated at 63 Fed. Reg. 65874 (November 30, 1998) allows listed waste treated to levels protective of human health and the environment to be disposed on-site without triggering land ban or minimum technology requirements for these disposal requirements. Treated soils containing hazardous waste will need to meet cleanup levels to avoid triggering land ban or minimum technology requirements for these disposal requirements.	
40 CFR 268.45	Hazardous debris Since on-site disposal of solid and hazardous wastes is prohibited at the site, any hazardous debris remaining on-site must comply with 40 CFR 268.45 prior to off-site disposal as a solid waste (all off-site disposal must also comply with LDR certification requirements, which apply to these wastes). If the debris does not fully comply with 40 CFR 268.45, it must be disposed of site at a regulated subtitle C facility.	It is not anticipated that hazardous debris will be generated during ISCO pilot test activities; if any hazardous debris is generated, it will be managed as a hazardous waste along with hazardous IDW as outlined in the Facility-Wide SAP.
40 CFR Part 270	Substantive Permit Requirements 40 CFR Part 270 sets forth the hazardous waste permit program. The substantive requirements set forth in 40 CFR Part 270, Subpart C (permit conditions), including the requirement to properly operate and maintain all facilities and systems of treatment and control are applicable requirements.	The substantive permit requirements that pertain to the management of hazardous waste (including generation, storage, and disposal) are included in the Facility-Wide SAP.
40 CFR Part 279	Used Oil 40 CFR Part 279 sets forth the standards for the management of used oil. For product removed from outside the solvent plume, 40 CFR Part 279 is applicable.	ISCO pilot test activities will not result in the generation of used oil.

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Burlington Northern Livingston Shop Complex

Federal or State ERCL Citation	Description	Compliance
State Hazardous Waste Management Regulations (Applicable)		
Sections 75-10-401 et seq., MCA	The Montana Hazardous Waste Act, Sections 75-10-401 et seq., MCA, and regulations under this act establishes a regulatory structure for the generation, transportation, treatment, storage and disposal of hazardous wastes. These requirements are applicable to substances and actions at the site which involve listed and characteristic hazardous wastes.	ISCO pilot test activities are being conducted in an area containing F-listed constituents, IDW generated during the ISCO pilot test(s) will be suspected of containing F-listed constituents and will be managed as a hazardous waste unless analytical testing shows otherwise. Hazardous IDW will be managed in accordance with Section 8.0 of the ISCO Pilot Test Work Plan and with the Facility-Wide SAP.
ARM 17.53.501-502	ARM 17.53.501-502 adopts the equivalent of RCRA regulations at 40 CFR Part 261, establishing standards for the identification and listing of hazardous wastes, including standards for recyclable materials and standards for empty containers, with certain State exceptions and additions.	
ARM 17.53.601-604	ARM 17.53.601-604, adopts the equivalent to RCRA regulations at 40 CFR Part 262, establishing standards that apply to generators of hazardous waste, including standards pertaining to the accumulation of hazardous wastes, with certain State exceptions and additions.	
ARM 17.53.701-708	ARM 17.53.701-708, adopts the equivalent to RCRA regulations at 40 CFR Part 263, establishing standards that apply to transporters of hazardous waste, with certain State exceptions and additions.	
ARM 17.53.801-803	ARM 17.53.801-803, adopts the equivalent to RCRA regulations at 40 CFR Part 264, establishing standards that apply to hazardous waste treatment, storage and disposal facilities, with certain State exceptions and additions.	
ARM 17.53.1101-1102	ARM 17.53.1101-1102, adopts the equivalent to RCRA regulations at 40 CFR Part 268, establishing land disposal restrictions, with certain State exceptions and additions.	
Section 75-10-422 MCA	Section 75-10-422 MCA prohibits the unlawful disposal of hazardous wastes.	
ARM 17.53.1101-1102	ARM 17.53.1101-1102, adopts the equivalent to RCRA regulations at 40 CFR Part 270, which establish standards for permitted facilities, with certain State exceptions and additions.	
ARM 17.53.1401	ARM 17.53.1401, adopts the equivalent of RCRA regulations at 40 CFR Part 279 which set forth the standards for the management of used oil.	ISCO pilot test activities will not result in the generation of used oil.
National Emission Standards for Hazardous Air Pollutants (NESHAPs)		
ARM 17.8.341 (Incorporates by reference 40 CFR Part 61)	<u>Asbestos (Well-Suited)</u> The federal Clean Air Act requires the EPA to set emission standards for hazardous air pollutants. 42 U.S.C Section 7412. Implementation and enforcement of these standards in Montana has been delegated to the State. See 40 CFR 61.04(b)(BB). Federal standards for hazardous air pollutants (NESHAPs) at 40 CFR Part 61, are incorporated by reference by ARM 17.8.341. The NESHAPs for asbestos are well-suited to the cinder pile and are discussed in the Asbestos section below; however, the solid waste requirements are the more stringent of the ERCLs that must be complied with with respect to covering of the cinder pile.	ISCO pilot test activities will not result in air emissions of asbestos.
40 CFR 61.145	40 CFR 61.145. (well-suited). Standard for demolition and renovation. This section contains standards for demolition or renovation of a facility. The standards are designed to reduce or eliminate asbestos emissions from such operations, and include provisions for notification regarding intended project, wetting of asbestos materials, use of exhaust systems, careful movement of asbestos materials, and presence on site of a trained asbestos removal person. This section applies to any demolition or renovation of a structure, installation, building, or waste disposal area at the site containing asbestos materials.	
40 CFR 61.151	40 CFR 61.151. (well-suited). Standard for inactive waste disposal sites for asbestos mills and manufacturing and fabricating operations. There must either be no discharge of visible emissions from the site to the outside air, or the specified covering or treatment methods must be followed. Warning signs must be posted and prior notice must be given to EPA or the State before the waste material is excavated or disturbed.	
40 CFR Part 61, Subpart F	<u>Vinyl Chloride (Applicable)</u> 40 CFR Part 61, Subpart F contains the national emission standard for vinyl chloride. 40 CFR 61.64(b) requires concentrations from vinyl chloride in each exhaust gas stream from each stripper not exceed 10 ppm.	ISCO pilot test activities will not result in air emissions of vinyl chloride.
National Pollutant Discharge Elimination System (NPDES) and the Montana Pollutant Discharge Elimination System (MPDES) (Applicable)		
40 CFR Part 122, Subpart C and ARM 17.30.1342 - .1344	40 CFR Part 122, Subpart C and ARM 17.30.1342-1344 set forth the substantive requirements applicable to all MPDES and NPDES permits. Permits must be obtained for all surface and groundwater systems that are part of remedial actions, including proper operation and maintenance of all facilities and systems of treatment and control.	Investigation-derived water will be treated to the groundwater cleanup levels presented in the ROD and will meet all applicable permit requirements as specified in Petroleum Cleanup General Permit MTG7900013 before discharge to the Yellowstone River.
Technology-Based Treatment (Applicable)		
40 CFR Part 125 and ARM 17.30.1344	40 CFR Part 125 and ARM 17.30.1344 set forth criteria and standards for dischargers. Based on the source, the technology-based treatment standards include the best practicable control technology (BPT), best conventional pollutant control technology (BCT), or Best Available Technology Economically Achievable (BAT).	To ensure state waters are not degraded/polluted, investigation-derived water will be treated to the groundwater cleanup levels presented in the ROD and will meet all applicable permit requirements as specified in Petroleum Cleanup General Permit MTG7900013 before discharge to the Yellowstone River.
Underground Injection Control Program (Well-Suited)		
40 CFR 146	The Underground Injection Control Program set forth at 40 CFR 146, sets forth the standards and criteria for the injection of substances into aquifers. Wells are classified as Class I through V, depending on the location and the type of substance injected. For all classes, no owner may construct, operate or maintain an injection well in a manner that results in the contamination of an underground source of drinking water at levels that violate MCLs or otherwise adversely affect the health of persons. Each classification may also contain further specific standards, depending on the classification.	ISCO pilot test activities will involve the construction of wells for injection of sodium permangenate as part of environmental remediation. These are not subject to underground injection control (UIC) permitting and will be most likely rule-permitted. However, if requested by U.S. Environmental Protection Agency (EPA), information required and any mitigation measures will be provided for discussion.

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Federal or State ERCL Citation	Description	Compliance
Solid Waste Management Regulation (Applicable and Well-Suited)		
ARM 17.50.505	ARM 17.50.505(2) specifies standards for solid waste management facilities, including the requirements that: 1. Class II landfills must confine solid waste and leachate to the disposal facility. If there is the potential for leachate migration, it must be demonstrated that leachate will only migrate to underlying formations which have no hydraulic continuity with any state waters; 2. adequate separation of group II wastes from underlying or adjacent water must be provided; and 3. no new disposal units or lateral expansions may be located in wetlands. ARM 17.50.505 also specifies general soil and hydrogeological requirements pertaining to the location of any solid waste management facility.	ISCO pilot test activities do not involve siting, construction, operation/maintenance, and closure of a solid waste management facility.
ARM 17.50.511	ARM 17.50.511 sets forth general operational and maintenance and design requirements for solid waste facilities using landfilling methods. Specific operational requirements, specified in ARM 17.14.511 are run-on and run-off control systems requirements, requirements that sites be fenced to prevent unauthorized access, and prohibitions of point source and nonpoint source discharges which would violate Clean Water Act requirements.	
ARM 17.50.530	ARM 17.50.530 sets forth the closure requirements for landfills. Class II landfills must meet the following criteria: 1. install a final cover that is designed to minimize infiltration and erosion. 2. design and construct the final cover system to minimize infiltration through the closed unit by the use of an infiltration layer that contains a minimum 18 inches of earthen material and has a permeability less than or equal to the permeability of any bottom liner, barrier layer, or natural subsoils or a permeability no greater than 1 X 10-5 cm/sec, whichever is less; 3. minimize erosion of the final cover by the use of a seed bed layer that contains a minimum of six inches of earthen material that is capable of sustaining native plant growth and protecting the infiltration layer from frost effects and rooting damage; 4. revegetate the final cover with native plant growth within one year of placement of the final cover[5].	
ARM 17.50.531	ARM 17.50.531 sets forth post closure care requirements for Class II landfills. Post closure care must be conducted for a period sufficient to protect human health and the environment. Post closure care requires maintenance of the integrity and effectiveness of any final cover, including making repairs to the cover as necessary to correct the effects of settlement, subsidence, erosion, or other events, and preventing run-on and run-off from eroding or otherwise damaging the cover and comply with the groundwater monitoring requirements found at ARM Title 17, chapter 14, subchapter 7.	
Transportation of Solid Waste (Applicable)		
Section 75-10-212	For solid wastes, Section 75-10-212 prohibits dumping or leaving any debris or refuse upon or within 200 yards of any highway, road, street, or alley of the State or other public property, or on privately owned property where hunting, fishing, or other recreation is permitted.	Non-hazardous IDW [including non-indigenous waste (i.e., PPE) and IDW determined through analytical testing to be non-hazardous] generated during implementation of the ISCO pilot test(s) will be contained in 55-gallon drums or other appropriate containers and temporarily stored in a centralized storage area pending characterization and final disposition. If investigation-derived soil and water cannot be landspread at the Livingston railyard, it will be disposed offsite along with other non-hazardous IDW as discussed in the Facility-Wide SAP. Any other solid waste generated (i.e., tape removed from boxes, plastic bags and/or boxes containing supplies that are not reused, etc.) will be contained in a plastic garbage bag (if necessary) and placed in a garbage can for collection and appropriate disposal as solid waste. Solid waste generated during implementation of the ISCO pilot test(s) will be transported in a manner to prevent discharge, dumping, spilling, and leaking.
ARM 17.50.523	ARM 17.50.523 requires that such waste must be transported in such a manner as to prevent its discharge, dumping, spilling, or leaking from the transport vehicle.	
Underground Storage Tank (USTs) Regulations (Applicable)		
	These standards are applicable. To the extent certain UST systems were removed prior to the effective date of the regulations, diesel is found separate and distinct from an UST system, or UST regulations are not applicable, the UST requirements remain well-suited since they address situations or problems sufficiently similar to those at the site.	ISCO pilot test activities do not involve USTs.
40 CFR Part 280, Subpart F	40 CFR Part 280, Subpart F sets forth requirements for Release Response and Corrective Action for UST Systems Containing Petroleum or Hazardous Substances. These include initial response, initial abatement measures, site characterization, free product removal, and investigations for soil and groundwater cleanup.	
40 CFR 280.64	40 CFR 280.64 provides that where investigations in connection with leaking underground storage tanks reveal the presence of free product, owners and operators must remove free produc to the maximum extent practicable as determined by the implementing agency. This regulation also requires that the free product removal be conducted in a manner that minimizes the spread of contamination into previously uncontaminated zones by using recovery and disposal techniques appropriate to the hydrogeologic conditions at the site, and that properly treats, discharges or disposes of recovery byproducts in compliance with applicable local, State and Federal regulations. 40 CFR 280.64 provides that abatement of free product migration is a minimum objective for the design of the free product removal system provides that any flammable products must be handled in a safe and competent manner to prevent fires or explosions.	
40 CFR Part 280, Subpart D	40 CFR Part 280, Subpart D sets forth requirements for release detection.	
40 CFR 280.43	40 CFR 280.43 (well-suited) specifies groundwater monitoring requirements for underground storage tanks and requires continuous monitoring devices or manual methods used to detect the presence of at least 1/8 of an inch of free product on top of the groundwater in the monitoring wells.	
Title 17, Chapter 56, Sub-Chapter 4	The Montana regulations regarding underground storage tanks include similar requirements. Title 17, Chapter 56, Sub-Chapter 4 specifies release detection.	
ARM 17.56.407	ARM 17.56.407 specifies groundwater monitoring requirements for underground storage tanks and requires continuous monitoring devices or manual methods used to detect the presence of at least 1/8 of an inch of free product on top of the groundwater in the monitoring wells.	
Title 17, Chapter 56, Sub-Chapter 6	Title 17, Chapter 56, Sub-Chapter 6 specifies release response and corrective action for tanks containing petroleum or hazardous substances.	
ARM 17.56.602 - 605	ARM 17.56.602 through 605 requires certain mitigation measures including removal of as much of the regulated substance from the system as is necessary to prevent further release into the environment and prevention of further migration of the released substance into surrounding soil and groundwater.	

ANALYSIS OF ENVIRONMENTAL REQUIREMENTS, CRITERIA, AND LIMITATIONS (ERCLS)[a] FOR AIR SPARGE / SOIL VAPOR EXTRACTION PILOT TEST WORK PLAN
Burlington Northern Livingston Shop Complex

Federal or State ERCL Citation	Description	Compliance
Asbestos Regulation in Building Construction and Demolition (Well-Suited)		
Sections 50-64-101, et seq., MCA 50-64-104, MCA	Sections 50-64-101 et seq., MCA, regulate construction and demolition of structures that contain asbestos. Section 50-64-104, MCA. provides for various safeguards to prevent release of asbestos into the air. The prescribed safeguards include notification of the local fire department, posting of warning signs, wetting of surfaces, dust emission control, covering and wetting during transport, and deposition at a landfill where materials are unlikely to be disturbed and where signs warn that asbestos-containing material is buried in the landfill. The listed safeguards are well-suited to the covering of the cinder pile.	ISCO pilot test activities do not involve construction or demolition of any asbestos-containing structures.
Well Drilling (Applicable)		
Section 85-2-505, MCA	Section 85-2-505, MCA, precludes the wasting of groundwater. Any well producing waters that contaminate other waters must be plugged or capped, and wells must be constructed and maintained so as to prevent waste, contamination, or pollution of groundwater.	ISCO pilot test activities involve the installation of wells. Wells will be constructed and maintained so as to prevent waste, contamination, or pollution of groundwater. Wells will be constructed and sampled in accordance with Standard Operating Guidelines (SOGs) presented in Appendix A of the Facility-Wide SAP. Drillers will be required to file a well log report with the Montana Bureau of Mines and Geology within 60 days after completion of the well.
Section 85-2-516, MCA	Section 85-2-516, MCA states that within 60 days after any well is completed a well log report must be filed by the driller with the Montana Department of Natural Resources and Conservation and the appropriate county clerk and recorder.	
ARM 17.30.641	ARM 17.30.641 provides standards for sampling and analysis of water to determine quality.	
ARM 17.30.646	ARM 17.30.646 requires that bioassay tolerance concentrations be determined in a specified manner.	Bioassays will not be performed during implementation of the ISCO pilot test(s).
ARM 36.21.670-678 and 810	ARM 36.21.670-678 and 810 specifies certain requirements that must be fulfilled when abandoning monitoring wells.	If wells are to be abandoned following completion of the ISCO pilot tests, they will be abandoned in accordance with SOG-20 (presented in Appendix A of the Facility-Wide SAP), which complies with these regulations.
Reclamation Requirements (Well-Suited)		
	Certain portions of the Montana Strip and Underground Mining Reclamation Act and Montana Metal Mining Act are well-suited requirements for certain revegetation and construction activities at the site.	ISCO pilot test activities do not involve any major land disturbances, which trigger these requirements.
Section 82-4-231, MCA	Section 82-4-231, MCA: Requires operators to reclaim and revegetate affected lands using most modern technology available.	
Section 82-4-233, MCA	Section 82-4-233, MCA: Operators must plant vegetation that will yield a diverse, effective, and permanent vegetative cover of the same seasonal variety native to the area and capable of self-regeneration.	
Section 82-4-336, MCA	Section 82-4-336, MCA: Disturbed areas must be reclaimed to utility and stability comparable to areas adjacent.	
ARM 17.24.501	ARM 17.24.501: Provides general backfilling and grading requirements.	
ARM 17.24.519	ARM 17.24.519: Pertinent areas where excavation will occur will be regraded to minimize settlement.	
ARM 17.24.631	ARM 17.24.631: Disturbances to the prevailing hydrologic balance will be minimized. Changes in water quality and quantity, in the depth to groundwater and in the location of surface water drainage channels will be minimized, to the extent consistent with the selected response alternatives. Other pollution minimization devices must be used if appropriate, including stabilizing disturbed areas through land shaping, diverting runoff, planting quickly germinating and growing stands of temporary vegetation, mulching, and control of toxic-forming waste materials.	
ARM 17.24.633	ARM 17.24.633: Surface drainage from a disturbed area must be treated by the best technology currently available (BTCA). Treatment must continue until the area is stabilized.	
ARM 17.24.634	ARM 17.24.634: Disturbed drainages will be restored to the approximate pre-disturbance configuration, to the extent consistent with the selected response alternatives.	
ARM 17.24.638	ARM 17.24.638: Sediment control measures must be implemented during operations.	
ARM 17.24.639	ARM 17.24.639: Sets forth requirements for construction and maintenance of sedimentation ponds.	
ARM 17.24.640	ARM 17.24.640: Discharges from sedimentation ponds, permanent and temporary impoundments, must be controlled to reduce erosion and enlargement of stream channels, and to minimize disturbance of the hydrologic balance.	
ARM 17.24.643 - 646	ARM 17.24.643 through 17.24.646: Provisions for groundwater protection, groundwater recharge protection, and groundwater and surface water monitoring.	
ARM 17.24.701 and 702	ARM 17.24.701 and 702: Requirements for redistributing and stockpiling of soil for reclamation. Also outline practices to prevent compaction, slippage, erosion, and deterioration of biologica properties of soil will be employed.	
ARM 17.24.711	ARM 17.24.711: Requires that a diverse, effective and permanent vegetative cover of the same seasonal variety and utility as the vegetation native to the area of land to be affected must be established. This provision would not be well-suited in certain instances, for example, where there is dedicated development.	
ARM 17.24.713	ARM 17.24.713: Seeding and planting of disturbed areas must be conducted during the first appropriate period for favorable planting after final seedbed.	
ARM 17.24.714	ARM 17.24.714: Mulch or cover crop or both must be used until adequate permanent cover can be established.	
ARM 17.24.716	ARM 17.24.716: Establishes method of revegetation.	
ARM 17.24.718	ARM 17.24.718: Requires soil amendments, irrigation, management, fencing, or other measures, if necessary to establish a diverse and permanent vegetative cover.	
ARM 17.24.723	ARM 17.24.723: States that operators shall conduct approved periodic measurements of vegetation, soils, and water.	
ARM 17.24.724	ARM 17.24.724: Specifies that revegetation success must be measured by approved unmined reference areas. Required management for these reference areas is set forth.	
ARM 17.24.726	ARM 17.24.726: Sets the required methods for measuring productivity.	
ARM 17.24.728	ARM 17.24.728: Sets requirements for measurements of the composition of vegetation on reclaimed areas.	
ARM 17.24.761	ARM 17.24.761: This specifies fugitive dust control measures which will be employed during excavation and construction activities to minimize the emission of fugitive dust.	

ANALYSIS OF ENVIRONMENTAL REQUIREMENTS, CRITERIA, AND LIMITATIONS (ERCLS)[a] FOR AIR SPARGE / SOIL VAPOR EXTRACTION PILOT TEST WORK PLAN
Burlington Northern Livingston Shop Complex

Federal or State ERCL Citation	Description	Compliance
Noxious Weeds (Applicable)		
ARM 4.5.201 through .204 Section 7-22-2109(2)(b) Section 7-22-2152 Section 7-22-2101(7)(a), MCA	§ 7-22-2101(7)(a), MCA defines "noxious weeds" as any exotic plant species established or that may be introduced in the state which may render land unfit for agriculture, forestry, livestock, wildlife, or other beneficial uses or that may harm native plant communities and that is designated: (i) as a statewide noxious weed by rule of the department; or (ii) as a district noxious weed by a board, following public notice of intent and a public hearing. Designated noxious weeds are listed in ARM 4.5.201 through 4.5.204 and must be managed consistent with weed management criteria developed under MCA § 7-22-2109(2)(b). Notification and plan must occur as set forth in § 7-22-2152, MCA, as amended.	ISCO pilot test activities do not involve the introduction or planting of plants, nor will significant land disturbance occur which would trigger these requirements.
OTHER LAWS		
	These laws are laws which are independently applicable rather than ERCLs for the site.	
Section 85-2-101, MCA	Surface Water and Groundwater Act Section 85-2-101, MCA, declares that all waters within the state are the state's property, and may be appropriated for beneficial uses. The wise use of water resources is encouraged for the maximum benefit to the people and with minimum degradation of natural aquatic ecosystems.	ISCO pilot test activities will not require any surface water or groundwater to be appropriated.
Parts 3 and 4 of Title 85, Chapter 2, MCA	Groundwater and Surface Water Appropriation Parts 3 and 4 of Title 85, Chapter 2, MCA, set out requirements for obtaining water rights and appropriating and utilizing water. All requirements of these parts are laws which must be complied with in any action using or affecting waters of the state.	ISCO pilot test activities will not require any water rights to be obtained.
Section 85-2-507, MCA Section 85-2-506, MCA	Controlled Ground Water Area Pursuant to Section 85-2-507 MCA, the Department of Natural Resources and Conservation may grant either a permanent or a temporary controlled ground water area. The maximum allowable time for a temporary area is four years.[6] Pursuant to 85-2-506 MCA, designation of a controlled groundwater area may be proposed if (a) that ground water withdrawals are in excess of recharge to the aquifer or aquifers within the ground water area; (b) that excessive ground water withdrawals are very likely to occur in the near future because of consistent and significant increases in withdrawals from within the ground water area; (c) that significant disputes regarding priority of rights, amounts of ground water in use by appropriators, or priority of type of use are in progress within the ground water area; (d) that ground water levels or pressures in the area in question are declining or have declined excessively; (e) that excessive ground water withdrawals would cause contaminant migration; (f) that ground water withdrawals adversely affecting ground water quality within the ground water area are occurring or are likely to occur; or (g) that water quality within the ground water area is not suited for a specific beneficial use defined by 85-2-102(2)(a).	ISCO pilot test activities will not require a controlled groundwater area.
29 CFR □Part□ 1910	Occupational Safety and Health Act The federal Occupational Safety and Health Act regulations found at 29 CFR 1910 are applicable to worker protection during conduct of RI/FS or remedial activities.	Field activities associated with the ISCO pilot test(s) will be conducted in accordance with the Facility-Wide Health and Safety Plan (HASP) and the task-specific HASP addenda.
ARM 17.74.101 ARM 17.74.102	Montana Occupational Health Act ARM Section 17.74.101, along with the similar federal standard in 29 CFR 1910.95, addresses occupational noise. ARM Section 17.74.102, along with the similar federal standard in 29 CFR 1910.1000 addresses occupational air contaminants.	
Sections 50-71-201, 202, and 203, MCA	Montana Safety Act Sections 50-71-201, 202 and 203, MCA, state that every employer must provide and maintain a safe place of employment, provide and require use of safety devices and safeguards, and ensure that operations and processes are reasonably adequate to render the place of employment safe.	Water & Environmental Technologies has a comprehensive Injury and Illness Prevention Program designed to help ensure the health and safety of its employees and provide a safe and healthful work environment. In addition, Water & Environmental Technologies has a Corporate Health and Safety Program and Hazardous Communication Program.
Section 50-78-201, 202, and 204, MCA	Employee and Community Hazardous Chemical Information Act Sections 50-78-201, 202, and 204, MCA, state that each employer must post notice of employee rights, maintain at the work place a list of chemical names of each chemical in the work place, and indicate the work area where the chemical is stored or used. Employees must be informed of the chemicals at the work place and trained in the proper handling of the chemicals.	
40 CFR Part 262 and ARM 17.53.601-604	Standards for Generators of Hazardous Waste The RCRA regulations at 40 CFR Part 262 and ARM 17.53.601-604 establish standards that apply to generators of hazardous waste. These standards include requirements for obtaining an EPA identification number and maintaining certain records and filing certain reports. These standards are applicable for any waste which will transported off-site.	Hazardous IDW generated during implementation of the ISCO pilot test(s) will be managed in accordance with Section 8.4 of the Facility-Wide SAP and will comply with these regulations.
40 CFR Part 263 and ARM 17.53.701-708	Standards for Transporters of Hazardous Waste The RCRA regulations at 40 CFR Part 263 and ARM 17.53.701-708 establish standards that apply to transporters of hazardous waste. These standards include requirements for immediate action for hazardous waste discharges. These standards are applicable for any off-site transportation.	
40 CFR 268 and ARM 17.53.1101-1102	RCRA Land Disposal Restrictions Since the wastes to be treated are listed and characteristic wastes, the RCRA Land Disposal Restrictions (LDRs) treatment levels set forth in 40 CFR Part 268 and ARM 17.53.1101-1102 are applicable requirements including the treatment levels for F001 and F002 listed wastes for the disposal of hazardous wastes generated at the site.	
49 CFR Chapter I, Subchapters B and C and ARM 23.5.101	Oil Transportation 49 CFR Chapter I, Subchapter B (Oil Transportation) and Subchapter C (Hazardous Materials) and ARM. 23.5.101 apply to transporters of oil and hazardous materials. These standards are applicable for any off-site transportation of oil meeting the quantity requirements set forth in Subchapter B or for the transportation of hazardous materials such as the transportation of asbestos-containing waste material.	ISCO pilot test activities do not involve the use of oil and will not generate used oil.

ANALYSIS OF ENVIRONMENTAL REQUIREMENTS, CRITERIA, AND LIMITATIONS (ERCLS)[(a)] FOR AIR SPARGE / SOIL VAPOR EXTRACTION PILOT TEST WORK PLAN
Burlington Northern Livingston Shop Complex

Federal or State ERCL Citation	Description	Compliance
Sections 75-2-501 et seq., M	Montana Asbestos Control Act The Montana Asbestos Control Act, Sections 75-2-501 et seq., MCA, and implementing rules establish standards and procedures for accreditation of asbestos-related occupations and control of the work performed by persons in asbestos-related occupations.	ISCO pilot test activities do not involve asbestos work.
Sections 75-2-502(4) and -511, MCA, and ARM 17.74.302(3)	A permit from DEQ is required before any person can conduct an asbestos project. The definition of "asbestos project" includes the encapsulation, enclosure, removal, transportation, or disposal of asbestos-containing waste. Section 75-2-502(4), MCA; ARM 17.74.302(3). In addition, a person who inspects, plans, designs, supervises, contracts for or works on an asbestos project must meet DEQ training and accreditation requirements. See also Section 75-2-511, MCA.	
ARM 17.74.314	ARM 17.74.314 states that no person may engage in an asbestos-type occupation unless accredited in that occupation or may employ or subcontract with nonaccredited individuals or contractors. No person may conduct an asbestos abatement project without a permit.	
ARM 17.74.335 29 CFR 1926.58 40 CFR 763.120-121 40 CFR Part 61, Subpart M	ARM 17.74.335 states that asbestos abatement projects require a DEQ permit. The permit conditions include but are not limited to: a. a requirement that all work performed be in accordance with 29 CFR 1926.58 (asbestos standards for the construction industry); and 40 CFR 763.120, 121 (requirements for asbestos abatement projects); b. a requirement that all asbestos be properly disposed in an approved asbestos disposal facility. "Approved asbestos disposal facility" is defined at ARM 17.54.302(1) as a properly operate and licensed class II landfill as described in ARM 17.50.504; c. a requirement that asbestos be disposed in accordance with 40 CFR Part 61, Subpart M. (National Emission Standard for Asbestos). See discussion above on National Emission Standard for Asbestos.	
ARM 17.74.338	ARM 17.74.338 requires an accredited asbestos abatement supervisor be physically present at all times at the work-site where a permitted asbestos abatement project is being performed and must be accessible to all workers. On-site air monitoring must be conducted by an accredited asbestos contractor/supervisor, an engineer or industrial hygienist.	
ARM 17.74.341	ARM 17.74.341 requires records of each asbestos abatement project be retained for a minimum of 30 years and must be made available to DEQ at any reasonable time. This section provides a noninclusive list of the records to be retained.	
40 CFR Part 92	Locomotive Emissions 40 CFR Part 92 establishes control of air pollution from locomotives and locomotive engines.	ISCO pilot test activities do not involve the use of locomotives.

Notes:

(a) These ERCLs were developed by the Montana Department of Environmental Quality and were included in Appendix A of the *Record of Decision* (ROD) (DEQ 2001).

[1] *Montana Maximum Contaminant Levels:*
Pursuant to the Public Water Safety Act, 75-6-101 et. seq., MCA and ARM 17.38.204, the MCLs specified in 40 CFR Part 141 (Primary Drinking Water Standards) are incorporated.

[2] *Montana Department of Environmental Quality, Planning, Prevention and Assistance Division, Circular WQB-7, Montana Numeric Water Quality Standards (September, 1999).*

[3] *For vinyl chloride, the WQB-7 standard was 0.15 ug/l; the MCL is 2 ug/l.*

[4] *Each of the ambient air quality standards includes in its terms specific requirements and methodologies for monitoring and determining levels. Such requirements are also applicable requirements. In addition, ARM 17.8.204 and 17.8.206, Ambient Air Monitoring; Methods and Data, respectively (Applicable), require that all ambient air monitoring, sampling and data collection, recording, analysis and transmittal shall be in compliance with the Montana Quality Assurance Manual except when more stringent requirements are determined by DEQ to be necessary.*

[5] *ARM 17.50.530(1)(b) allows the department to approve an alternative final cover design if it achieves the reduction in infiltration and protection from erosion to a level at least as equivalent as the stated criteria.*

[6] *If a temporary controlled ground water area is granted, the statute requires DNRC to commence studies to determine the designation or modification of a permanent controlled ground water area.*

APPENDIX B

MLAEM FLOW MODEL

Modeling of the Injection Flow Field

Modeling objectives

- The objective of the modeling efforts was to present the effect of inhomogeneity of the weathered bedrock aquifer on the flow field after injection, thus also on the distribution of the permanganate solution when injected.

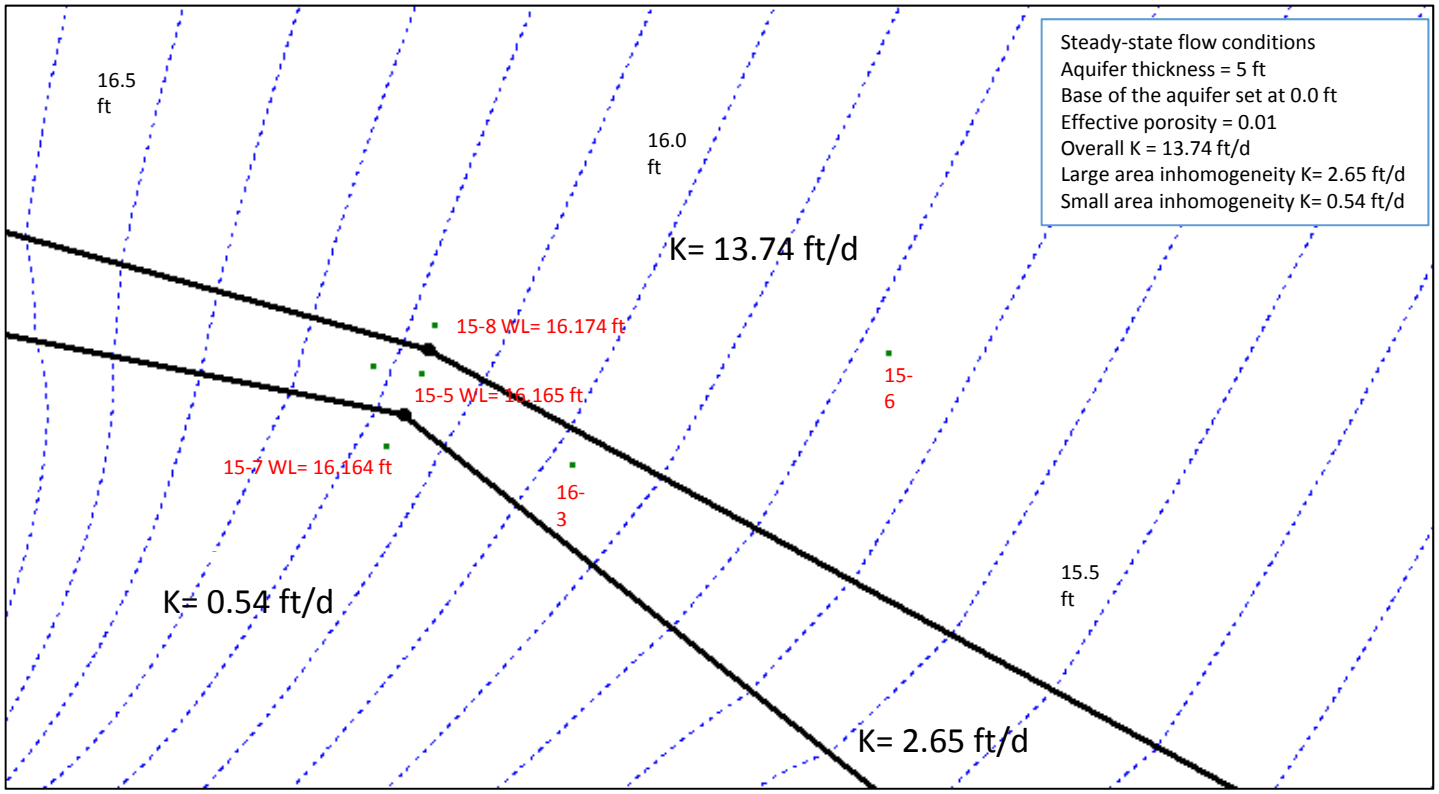
Modeling results

- With well 15-5, 15-8 injection rate 0.1323 gpm each and well 15-7 injection rate 0.0247 gpm (maintaining injection water level 2 ft above static) most of the injected solution migrates towards zones of higher hydraulic conductivity (as depicted in slides with stream function contours for the injection time).
- Time of arrival ("piston flow") of the injected solution at well 16-3 would be 6.42 days.

See following slides for details on the modeling

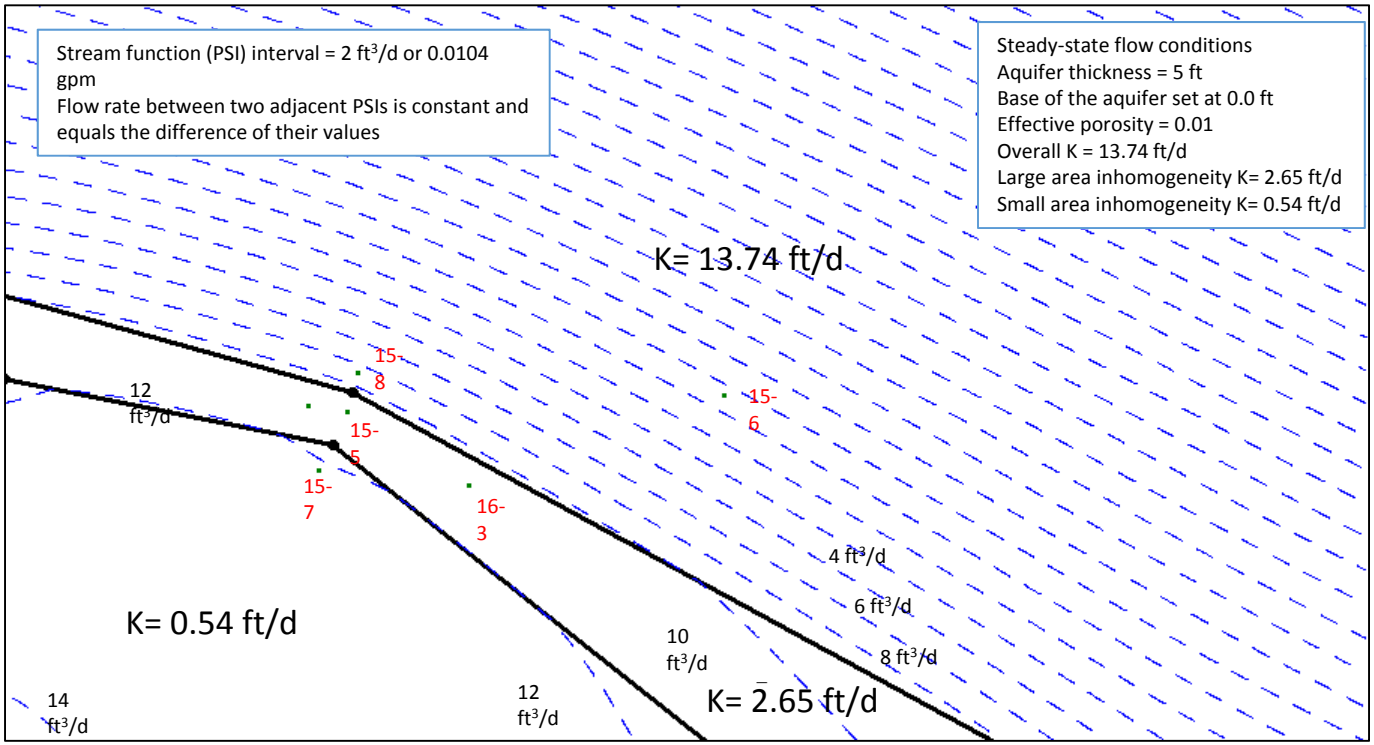
See last two slides for model setup and other relevant information

Simulated Potentiometric Surface Contours for Static Flow Conditions



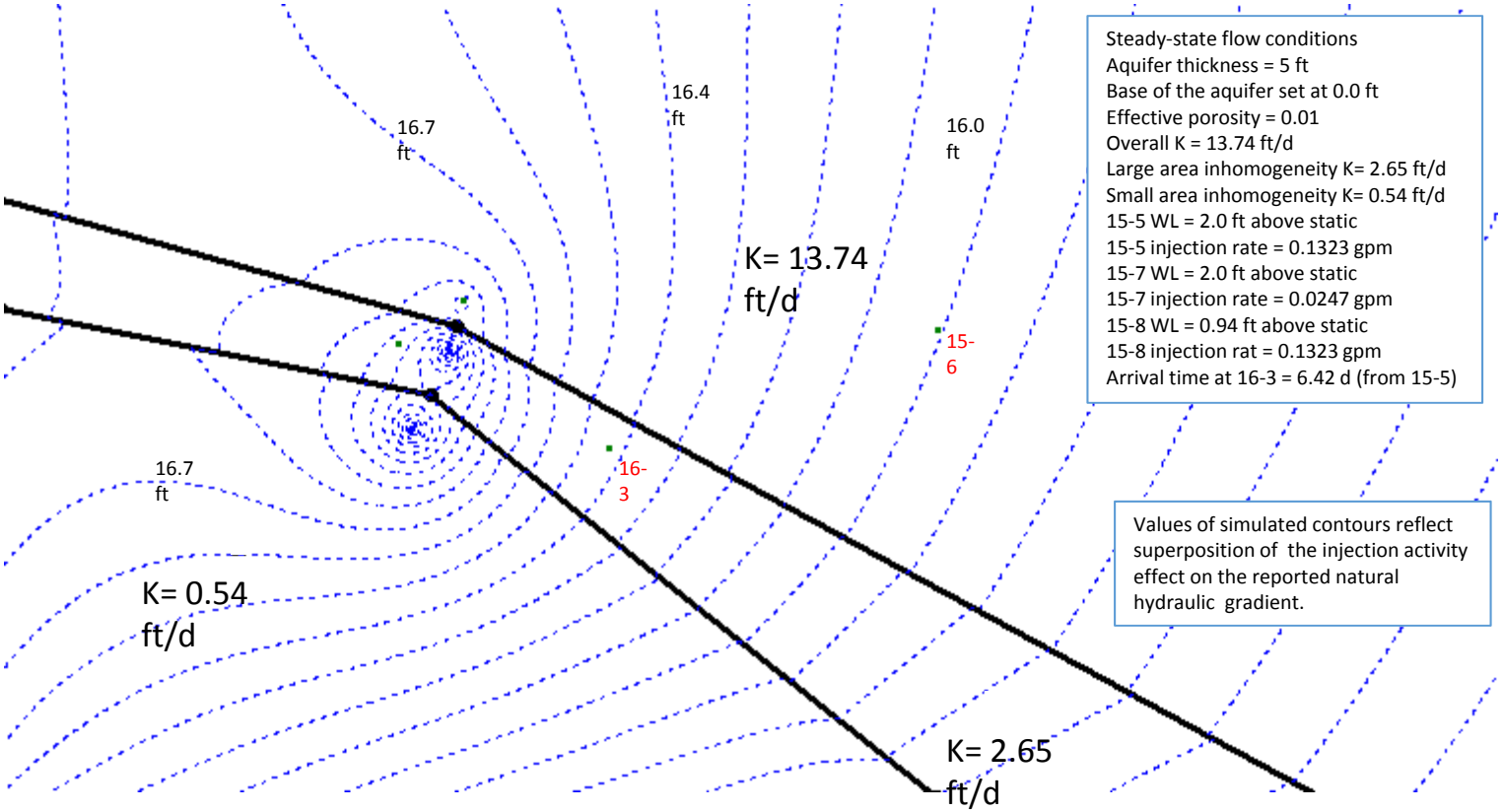
Pilot Test Work Plan

Simulated Stream Function for Static Flow Conditions



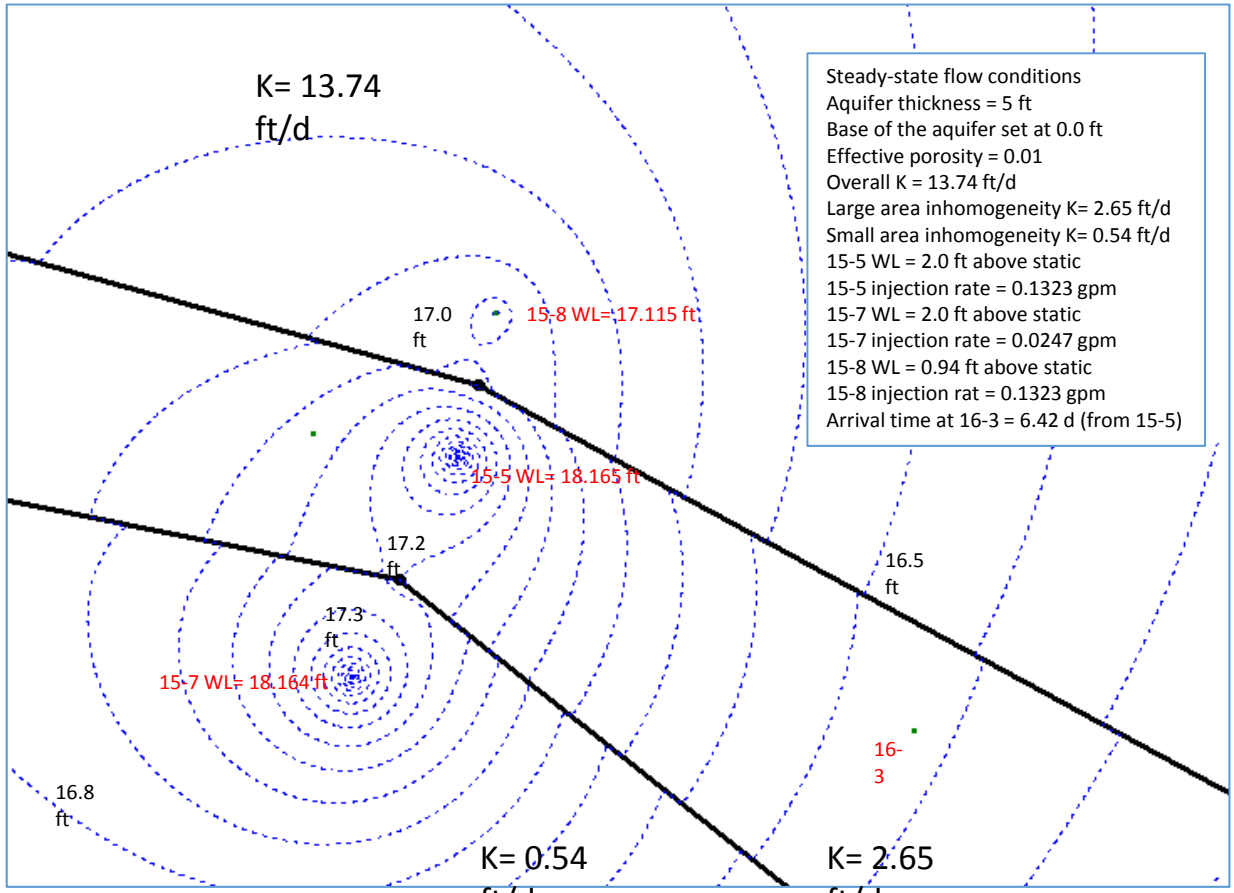
Pilot Test Work Plan

Simulated Potentiometric Surface Contours with Injection



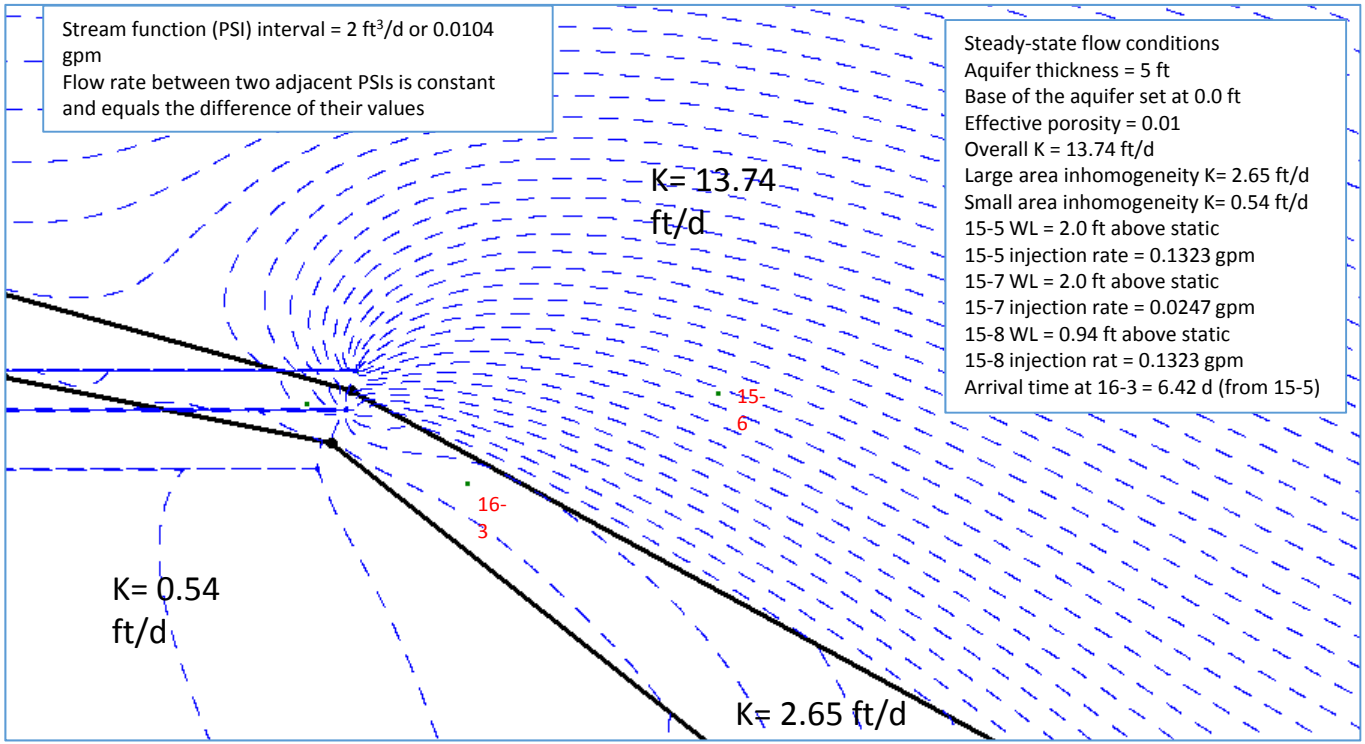
Simulated Potentiometric Surface Contours with Injection

close-up



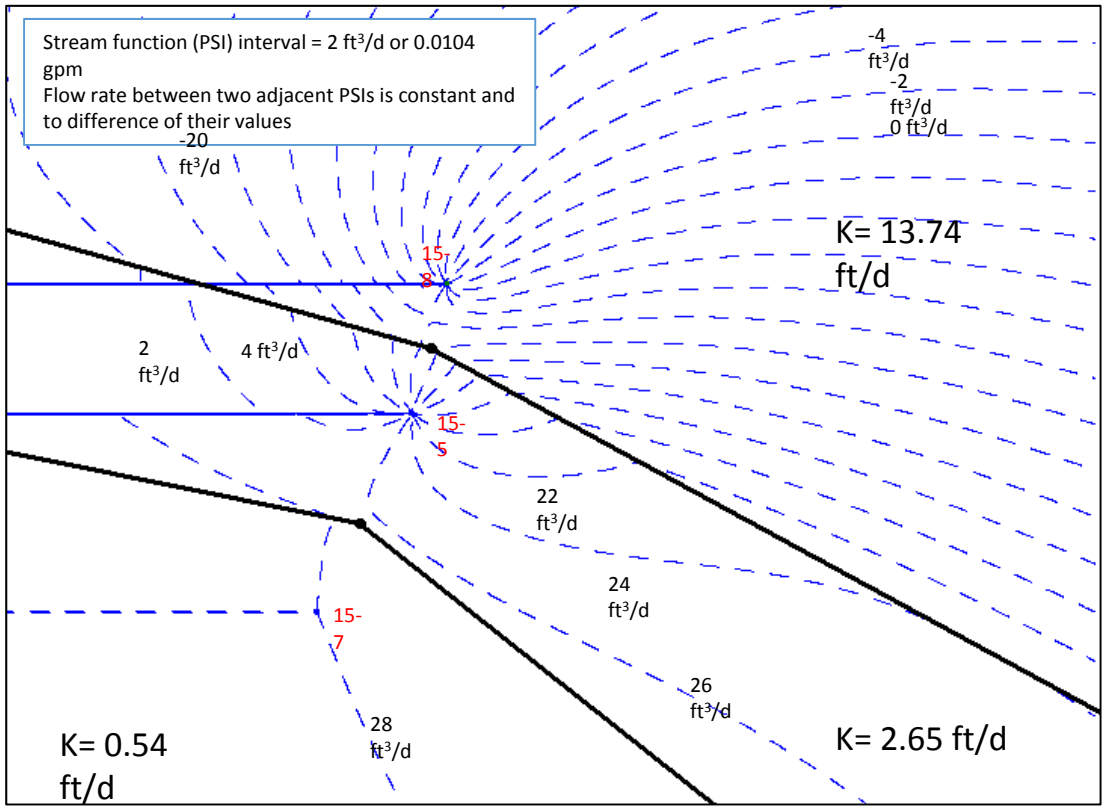
Pilot Test Work Plan

Simulated Stream Function with Injection

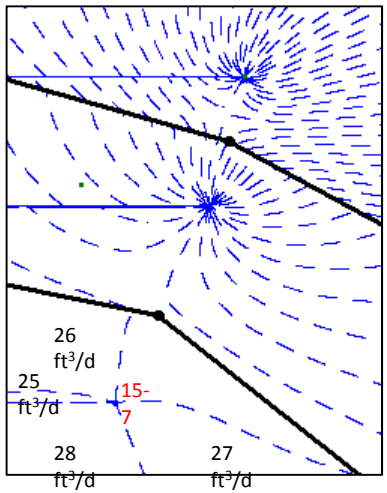


Pilot Test Work Plan

Simulated Stream Function with Injection



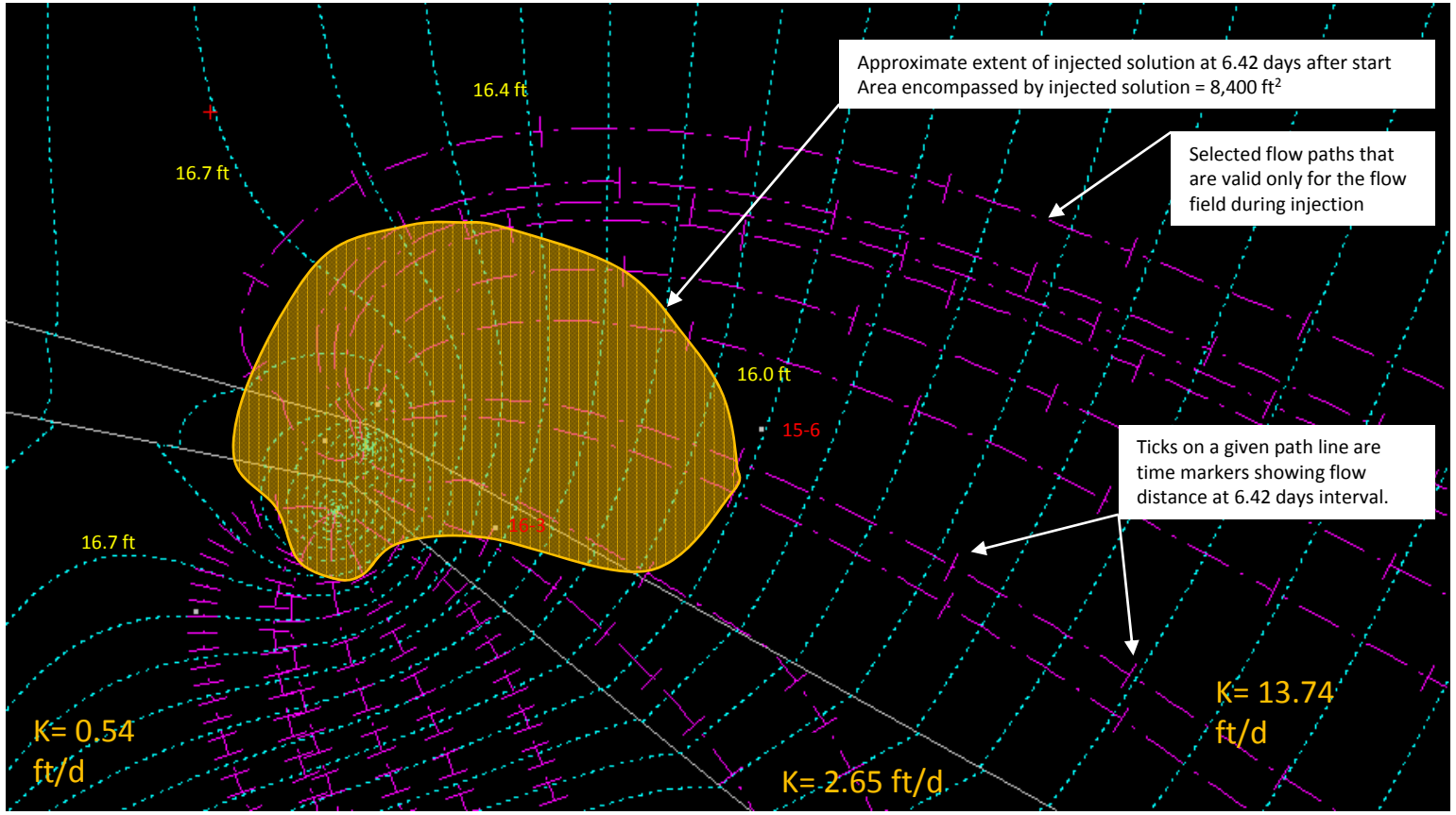
close-up



Close-up with 1 ft³/d intervals

Pilot Test Work Plan

Predicted Extent of Solution at the time of its Injection Completion



Pilot Test Work Plan

Model Setup Information (1)

Model set up information

- Multilayer Analytic Element Model (MLAEM) was used for simulation.
- Modeling was conducted using consistent units; feet and days, then converted to gpm for the results' presentation.
- Cartesian coordinate system was used wit X and Y collinear with the frames of *Figure 1, KJ 2015 Task L Bedrock Well Location, January, 2016;* and X=0, Y=0 at well 15-5.
- The simulations address inhomogeneity of the aquifer with respect to its hydraulic conductivity (K) as it was determined for wells 15-5, 15-6, 15-7 and 15-8. However, the areal extent of those inhomogeneities is hypothetical with the exception of the nearest vicinity of wells 15-5 and 15-7. The domain overall K value of 13.74 ft/d is a geometric mean of K values at 15-8 and 15-6.
- All simulations were done using a steady-state flow conditions in a 5 ft thick isotropic aquifer whose hydraulic gradient represents that reported for the project area.
- Value of the hydraulic gradient (0.004), the aquifer porosity (0.01) and the aquifer thickness (5 ft) used for modeling were those previously used for the diffusion model in 2014/2015 and/or for the design of tracer test in November/December 2015.

Model Setup Information (2)

Additional information on the results

- Values of simulated contours reflect superposition of the injection activity effect on the reported natural hydraulic gradient.
- Simulated potentiometric surface elevations are relative to a flat base of the weathered bedrock aquifer with Z=0 at the base of the aquifer.
- Slides with stream function contours quantify the distribution of the flow rate, as the flow is the same between two adjacent stream function contours and equals the difference of their values.
- The smaller the distance between two stream function contours, the larger the flow through a unit width of the aquifer
- Horizontal lines on slides with stream function are called *branch cuts* that can be thought of as lines that add or remove water from the aquifer (in this case adding water).
- Stream functions and flow paths showed for injection scenarios are valid for the injection period only. After injection is completed the flow regime will return to the flow pattern presented in slides for static conditions.

APPENDIX C

SODIUM PERMANGANATE MASS CALCULATION SHEET

TABLE 1

SODIUM PERMANGANATE LOADING CALCULATIONS
Burlington Northern Livingston Shop Complex

Item	Parameter	Calculated Value	Unit	Equation	Assumptions/References
A	Area	8,400	square feet	Length of 105 feet and width of 80 feet.	
B	Saturated Thickness	5	feet	Target treatment zone thickness.	
C1	Porosity of bedrock matrix (primary porosity)	0.05	percent		Geometric mean of measured values (PTS Laboratories)
C2	Portion of bedrock matrix contacted by oxidant	0.2	(-)		Estimate
C3	Effective Porosity of bedrock matrix (primary porosity)	0.01	percent	C2*C1	
D	Groundwater Pore Volume	31	gallon	A * B * (C3 / 100) * (7.48 gallon / cubic feet)	Assumes fracture pore volume is negligible (fracture porosity 0.001)
E		119	Liter	D * (3.785 liter / gallon)	
F	Tetrachloroethene (PCE) Concentration in Groundwater	5	milligram per Liter		Assumed average dissolved-phase PCE concentration in target treatment zone.
G	PCE Mass - Groundwater	0.0	pound	E * F / (1,000 milligram / gram) / (454 gram / pound)	
H	Mass of bedrock contacted by oxidant	528,436	kilogram	A * B * C2* (138.4 pound / cubic feet) / (2.2 pound / kilogram)	138.4 lbs/ft3 geometric mean of measured rock dry bulk densiy (PTS Laboratories)
I	Bedrock Fraction Organic Carbon (foc)	0.00150	gram per gram		Geometric mean of measured values (PTS Laboratories)
J	PCE Organic Carbon/Water Partitioning Coefficient (Koc)	155	Liter per kilogram		
K	PCE Distribution Coefficient (Kd)	0.23	Liter per kilogram	I * J	EPA 1996.
L	PCE Sorbed Concentration	1.16	milligram per kilogram	F * K	
M	PCE Mass - Rock	1.35	pound	H * L / (1,000 milligram / gram) / (454 gram / pound)	
N	Fracture Porosity	0.1	percent		Typical high end for fractured rock (therefore conservative)
O	Average residual PCE DNAPL saturation in fractures	2.0	percent		Estimate
P	Fracture Volume	314	gallon	A * B * (N / 100) * (7.48 gallon / cubic feet)	
Q		1,189	Liter	P * (3.785 liter / gallon)	
R	PCE Mass - DNAPL in fractures	84.9	pound	(O/100) * Q *1,620 / (454 gram / pound)	Density of PCE is 1,620 g/L.
S	Total PCE Mass	86.2	pound	G + M + R	
T	Average Stoichiometric Demand	1.15	pound $NaMnO_4$/pound PCE		Siegrist, R.L., M.A. Urynowicz, O.R. West, M.L. Crimi, and K.S. Lowe. 2001.
U	$NaMnO_4$ Required (PCE)	99	pound $NaMnO_4$	S * T	
V	$NaMnO_4$ Loading [(Natural Oxidant Demand (NOD)]	0.5	gram $NaMnO_4$/kilogram soil		Assumed NOD typical of bedrock (to be revised once site-specific value is available).
W	$NaMnO_4$ Required (NOD)	582	pounds $NaMnO_4$	H * V / (454 gram / pound)	
X	$NaMnO_4$ Required (PCE and NOD)	681	pounds $NaMnO_4$	U + W	
Y	40% Solution $NaMnO_4$ Required	1,710	pound $NaMnO_4$	X / 0.4	
	40% Solution $NaMnO_4$ Required	150	gallon	Y / 11.43	