DEPARTMENT OF THE AIR FORCE
AIR FORCE CIVIL ENGINEER CENTER

February 23, 2017

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FROM: AFCEC/CIBE – Plattsburgh
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SUBJECT: Final In-Situ Chemical Oxidation Work Plan, RW042 – Wash Rack Area of Concern, Former Plattsburgh Air Force Base

Attached for your information is the Final In-Situ Chemical Oxidation (ISCO) Work Plan for RW042 – Wash Rack Area of Concern at the Former Plattsburgh Air Force Base located in Plattsburgh, NY. This Work Plan discusses the methodology, implementation, and performance monitoring of the ISCO injection to be conducted and the related health and safety requirements.

If you have any questions, please contact me at 518-563-2871 or david.farnsworth@us.af.mil.

David S. Farnsworth
Program Manager/BRAC Environment Coordinator
BRAC Program Execution Branch

cc: See Attachment 2 Distribution List

Attachments:

1. Final ISCO Work Plan, RW042 – Wash Rack Area of Concern
2. Distribution List

Distribution Requirements
Final In-Situ Chemical Oxidation Work Plan, RW042 – Wash Rack Area of Concern
Former Plattsburgh Air Force Base
February 2017

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Air Force Civil Engineer Center

FINAL

IN-SITU CHEMICAL OXIDATION WORK PLAN

RW042 – Wash Rack Area of Concern
Former Plattsburgh Air Force Base
Plattsburgh, New York

February 2017

Contract/Task Order No: FA8903-16-F-0012

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FINAL

IN-SITU CHEMICAL OXIDATION WORK PLAN

RW042 – Wash Rack Area of Concern
Former Plattsburgh Air Force Base
Plattsburgh, New York

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Our Ref.:

GP16BRAC.B000

Date:

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ACRONYMS AND ABBREVIATIONS

µg/L	micrograms per liter
AFB	Air Force Base
AHA	Activity Hazard Analysis
Air Force	United States Air Force Civil Engineer Center
Arcadis	Arcadis of New York, Inc.
bgs	below ground surface
Bhate	Bhate Environmental Associates, Inc
BRAC	Base Realignment and Closure
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COC	constituent of concern
DPT	direct push technology
g/L	grams per liter
GPS	global positioning system
HAZWOPER	Hazardous Waste Operations and Emergency Response
ISCO	in-situ chemical oxidation
NYSDEC	New York State Department of Environmental Conservation
PPE	personal protective equipment
psi	pounds per square inch
PVC	polyvinyl chloride
SDS	Safety Data Sheet
SSHP	Site-Specific Safety and Health Plan
SVOC	semi-volatile organic compound
UIC	Underground Injection Control
URS	URS Group, Inc.
USEPA	United States Environmental Protection Agency
VOC	volatile organic compound
Work Plan	In-Situ Chemical Oxidation Work Plan

1 INTRODUCTION

On behalf of the United States Air Force Civil Engineer Center (Air Force), Arcadis of New York, Inc. (Arcadis) and Bhate Environmental Associates, Inc. (Bhate) have prepared this In-Situ Chemical Oxidation (ISCO) Work Plan (Work Plan) for Site RW042 - Wash Rack Area of Concern located at the former Plattsburgh Air Force Base (AFB) in Plattsburgh, New York (Figure 1). As part of the Air Force's Installation Restoration Program and Base Realignment and Closure (BRAC) Program, which involve investigation and cleanup under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), activities were initiated at the former Plattsburgh AFB to identify, evaluate, and remediate hazardous material areas. The Installation Restoration Program is being implemented according to Federal Facilities Agreement, Docket No. II-CERCLA-FFA-10201, signed by the Air Force, the United States Environmental Protection Agency (USEPA), and the New York State Department of Environmental Conservation (NYSDEC) on July 10, 1991. The former Plattsburgh AFB was placed on the National Priorities List on November 21, 1989 (USEPA ID #NY4571924774). The former Plattsburgh AFB was closed in 1995 as part of the third round of base closures mandated under the BRAC Program.

Based on groundwater data collected through May 2016 for the former Plattsburgh AFB, contamination in groundwater at concentrations exceeding NYSDEC groundwater quality standards appears to be limited to the vicinity of the monitoring well closest to the Wash Rack: MW-WR-001 (URS 2016). During the May 2016 groundwater sampling event, naphthalene, ethylbenzene, and xylenes were detected at concentrations greater than NYSDEC groundwater quality standards (URS Group, Inc. [URS] 2016). To remediate the remaining groundwater contamination, an ISCO injection approach, utilizing alkaline-activated sodium persulfate as the oxidant, will be implemented. Sodium persulfate has been selected as the oxidant because of its applicability to treat naphthalene, ethylbenzene, and xylenes.

This Work Plan discusses the methodology, implementation, and performance monitoring of the ISCO injection to be conducted at the former Plattsburgh AFB and the health and safety requirements related to the injection.

1.1 Objectives

This Work Plan outlines the use of ISCO technology to address the residual contamination in groundwater near monitoring well MW-WR-001. The objective of ISCO implementation is to destroy dissolved chemical of concern (COC) mass in groundwater. The injection will be conducted utilizing a series of temporary injection points within a target treatment area (Figure 1). One groundwater monitoring event will be completed prior to the ISCO injection event to establish baseline conditions.

The objectives for the ISCO injection are to accomplish the following:

- Install ISCO injection points and inject alkaline-activated sodium persulfate into the impacted groundwater plume at safe injection pressures; and
- Complete post-ISCO injection groundwater monitoring to confirm successful treatment.

1.2 Site Overview

1.2.1 Site Background

The Wash Rack area (Figure 2) was used historically as a staging area for cleaning the exteriors of airplanes using solvents and detergents. Wastewater from the Wash Rack drained via a 24-inch-diameter vitreous clay drain to Building 2887, the industrial wastewater pre-treatment plant, before being discharged to the former Plattsburgh AFB sanitary sewer. The 24-inch-diameter pipe was removed in 1999 (URS 2016).

To define the extent of groundwater contamination at the Wash Rack, three monitoring wells (MW-WR-001, MW-WR-002, and MW-WR-003) were installed in February 2003 (Versar, Inc. 2004), and semiannual sampling commenced in May 2005. Between 2008 and 2010, the groundwater monitoring programs for the Wash Rack, Nose Dock 8 (Site SS-016), and Kemp Lane were combined.

Currently, groundwater samples are collected from one monitoring well, MW-WR-001, on a semiannual basis. Monitoring well MW-WR-001 was constructed with 10-foot-long screen installed at 10.5 to 20.5 feet below ground surface (Versar, Inc. 2004). During the most recent groundwater sampling event, conducted in May 2016, the primary COCs (naphthalene, ethylbenzene, and xylenes) were detected at concentrations greater than NYSDEC groundwater quality standards. Additionally in May 2016, 1,1'-biphenyl was detected at a concentration of 5.2 micrograms per liter (µg/L), which slightly exceeds the NYSDEC groundwater quality standard of 5 µg/L and the first exceedance of this parameter since May 2008 (URS 2016).

The overall concentration trends for naphthalene, ethylbenzene, and xylenes are decreasing but have remained fairly steady in recent years (URS 2016). Naphthalene concentrations have ranged from 16.6 µg/L in May 2013 to 120 µg/L in November 2006. Ethylbenzene concentrations have ranged from 1.3 µg/L in May 2007 to 18.1 µg/L in May 2005. Xylenes concentrations have ranged from 16.9 µg/L in May 2007 to 177 µg/L in May 2005. The concentrations of the primary COCs detected in the May 2016 groundwater samples collected from monitoring well MW-WR-001 are presented in Table 1. Table 1 also includes the NYSDEC groundwater quality standard for naphthalene, ethylbenzene, and xylene.

Table 1: Primary Constituents of Concern for MW-WR-001

Primary Constituent of Concern	Concentration in MW-WR-001 in May 2016 (µg/L)	NYSDEC Groundwater Quality Standard (µg/L)
Naphthalene	49.6	10
Ethylbenzene	9	5
Xylenes	44.1	5

1.2.2 Geology/Hydrogeology

The stratigraphic sequence of the former Plattsburgh AFB can be divided into the following hydrogeological units: an unsaturated zone and an upper water table aquifer present in the sand unit (approximately 60 feet thick); a clay confining layer (approximately 13 feet thick); a confined till water-bearing zone (approximately 15 feet thick); and a confined bedrock aquifer (Versar, Inc. 2004). Groundwater contamination in the Wash Rack area at the former Plattsburgh AFB is limited to the upper water table aquifer. Groundwater in the area of the Wash Rack flows principally to the east toward Lake Champlain. During the May 2016 groundwater monitoring event, the depth to water measured in monitoring well MW-WR-001 was 14.96 feet below top of riser (URS 2016).

1.3 Overview of Technology

ISCO is an effective and proven technology for the remediation of soil and groundwater impacted with organic constituents. ISCO involves injection of oxidizing reagents such as sodium persulfate (proposed for this injection), permanganates, hydrogen peroxide, or ozone into an aquifer. Persulfate has considerable longevity in the subsurface, ranging from weeks to months. This stability is due to slower reaction kinetics. When compared to the more rapid kinetics of other oxidizing reagents, the use of persulfate allows for a comparatively greater radius of influence when deployed via injections. Persulfate requires activation in order for sulfate and hydroxyl radicals to be produced and improve kinetics. Activators include chelated iron, a base compound such as sodium hydroxide (proposed for this injection), hydrogen peroxide, or heat. Persulfate ISCO is achieved by delivering oxidant (i.e., sodium persulfate) and activator (i.e., sodium hydroxide) to contaminated media, such that the targeted constituents are transformed to less toxic compounds and ultimately into carbon dioxide, water, and sulfate. Following persulfate depletion, transient sulfate continues to provide additional remedial benefits by supporting the anaerobic biological oxidation of hydrocarbons as an electron acceptor. ISCO injections may generate transient byproducts through radical chain reactions and may alter the biogeochemistry of the injection area temporarily. The natural biogeochemical conditions are reestablished once the ISCO reagents are utilized.

ISCO injections are typically conducted by slightly pressurized injection or by gravity feeding the persulfate solution and activator into the subsurface. Groundwater quality parameters (i.e., specific conductance, pH, and depth to water) and injected oxidant are typically monitored during injection for real-time determination of injection breakthrough in the field. Groundwater COCs and presence of oxidant are also monitored following the ISCO injections to evaluate the effectiveness of the ISCO technology and to obtain site-specific design parameters for potential modifications to the injection system during successive injections (if warranted).

1.4 Implementation Methodology

The ISCO injection will be conducted to remediate groundwater impacted with COCs at concentrations greater than NYSDEC groundwater quality standards near well MW-WR-001 (Figure 2). Alkaline-activated sodium persulfate, as the selected oxidant, will be injected into a series of up to four temporary injection points utilizing direct push technology (DPT). The injection will be conducted through gravity feeding or under slight pressures if practical injection flow rates cannot be achieved through gravity feeding. Dose-response monitoring will be conducted during injection to monitor oxidant solution distribution. Post-injection monitoring will be conducted to confirm successful treatment.

1.5 Site Coordination

Arcadis and Bhate will notify the current owner of the property, Clinton County, of the planned injection. Arcadis will coordinate with the property owner to obtain access and will schedule the injection event to have minimal disturbance on site operations. The injection area is located outside the fenced area of the Plattsburgh International Airport and is easily accessible. The former Wash Rack is located within a restricted area of the airport, enclosed by the fence; however, access to the former Wash Rack is not required to complete the scope of work outlined in this Work Plan.

1.6 Work Plan Organization

The remainder of this Work Plan is organized as follows:

- Section 2 – Health and Safety: Health and safety procedures and the personal protective equipment (PPE) requirement related to ISCO injection activities are discussed in this section.
- Section 3 – Well Network: This section details the proposed injection and monitoring well network, drilling methodology, surveying, and waste management.
- Section 4 – ISCO Injection Implementation: This section describes the proposed injection system, reagent selection, and field implementation and monitoring procedures.
- Section 5 – Performance Monitoring: This section describes the proposed post-injection monitoring plan.
- Section 6 – Reporting: This section presents the report outline and other pertinent information that will be submitted as a deliverable.
- Section 7 – Project Schedule: This section outlines the timelines for the activities described in this Work Plan.
- Section 8 – References: Sources utilized to prepare this Work Plan are cited.

2 HEALTH AND SAFETY

This section summarizes health and safety issues that may be encountered during ISCO activities. The Site-Specific Safety and Health Plan (SSHP) prepared by Arcadis contains additional information relating to health and safety precautions. Safety Data Sheets (SDSs) for sodium persulfate and sodium hydroxide and ISCO Injection Activity Hazard Analysis (AHA) forms for injection of activated sodium persulfate via DPT are included in the SSHP and as Appendices A and B, respectively, of this Work Plan. The SSHP will be kept readily available during all on-site activities. During field activities, each day will begin with a health and safety tailgate briefing including all field staff and subcontractors.

The proposed ISCO activities will involve preparation and injection of sodium-hydroxide-activated persulfate solution. Sodium persulfate is an oxidizer and is purchased as a powdered solid. Sodium hydroxide is a strong corrosive agent and is purchased as either a powdered solid or pre-mixed as a liquid solution. To prevent injury and exposure when handling these compounds, field staff will wear chemical-resistant coveralls, chemical-resistant boots or boot covers, and chemical-resistant gloves when mixing solution, and a full-face respirator when mixing powdered chemicals. Respirator cartridges are to be changed out every six to eight hours of use. In situations other than mixing where exposure to the chemical solution is possible, staff will wear chemical-resistant splash aprons and face shields.

Safety precautions to be followed during this event include, but are not limited to, the following:

- To prevent inhalation, wear a full-face respirator while handling sodium persulfate and/or sodium hydroxide powder during mixing.
- To prevent exposure to sodium persulfate and sodium hydroxide solution:
  - Wear proper PPE as described above.
  - Ensure that all materials/piping/manifolds are chemically compatible with the corrosivity of persulfate (preferably polyvinyl chloride [PVC], polypropylene, and stainless steel but never carbon steel, brass, or other incompatible materials).
- To prevent chemical test kit or laboratory bottleware reagent exposure, wear proper PPE as described in the SSHP.
- To prevent the generation of excessive heat during sodium hydroxide solution mixing, mix solution slowly, add concentrated sodium hydroxide solution or sodium hydroxide prills into water, avoid adding water into concentrated sodium hydroxide solution, and use pre-mixed sodium hydroxide solution instead of powdered sodium hydroxide at high ambient temperatures.
- To minimize the potential for spills, utilize secondary containment (spill containment berms), absorbent socks, dilution, and neutralization.
- Conduct clean (potable) water injection to test piping and connections for leaks prior to ISCO injection.
- Store chemicals away from heat, moisture, and combustible materials, and keep a fire extinguisher near the work and chemical storage areas.
- Keep work area clear of tripping hazards within the tank batch mixing area, near wells/hoses, etc.; watch footing, and lay out hoses on paths outside of main walking paths where possible.
- Mark pinch points and tape off sharp edges.
- Use proper lifting techniques to prevent back strain.
- Use ear plugs when working around drill rigs.
- Use proper tools, fittings, and pressure gauges; wear proper PPE; and depressurize lines prior to working on or disconnecting them.
- Use shower/eye wash station for personal decontamination, and wear proper PPE as described above.

3 WELL NETWORK

ISCO injection will be performed at up to four injection points using DPT methodology. Groundwater monitoring, including baseline sampling prior to the injection and dose-response monitoring during the injection, will be conducted at monitoring well MW-WR-001. The injection well network may be revised based on field observations and subsurface conditions. The injection and monitoring well network is discussed in detail in this section.

3.1 Monitoring and Injection Network

The DPT injection points will be installed near monitoring well MW-WR-001 (Figures 2 and 3). Four temporary injection points will make up the injection network, while monitoring well MW-WR-001 will be used for performance groundwater monitoring. The locations of these points may be modified in the field based on observed conditions.

3.2 Utility Clearance

A utility clearance ticket will be placed with Dig Safely of New York prior to mobilization to the former Plattsburgh AFB and a minimum of three business days prior to beginning intrusive work. Arcadis will review any available utility maps for the property to identify potential conflicts prior to selecting the final locations for each boring location.

A private utility clearance company will be used to identify and mark all subsurface utilities and abnormal features within the proposed work area. The Arcadis field supervisor and the private utility company will discuss known on-site utilities and complete a walkthrough of the work area to identify any obvious signs of utility corridors or subsurface disturbances. The presence of utilities and/or metallic, energized, or non-metallic objects may be determined by the use of an electromagnetic metal detector, ground-penetrating radar, and/or various other utility-locating instruments.

Final locations for the temporary wells will be selected following the identification of any utility lines or other subsurface anomalies. Any temporary well placed within 5 feet of an identified utility or anomaly will be hand cleared with a hand auger, air knife, or similar appropriate method to a depth of at least 5 feet prior to drilling.

3.3 Direct Push Technology Point Installation and Construction

A New York State licensed driller with a direct push drilling rig will be subcontracted to install the temporary DPT injection points. It is anticipated that the injections will be conducted through the DPT drilling rods using a retractable injection screen located in the bottom rod in the chain of DPT rods. If this is determined to be impractical based on conditions observed in the field, temporary PVC well risers and screens will be installed.

The injection rods will be advanced to 20 feet below ground surface (bgs). After each rod has been advanced to its total depth, it will be raised to expose the injection screen. DPT injection screens have a length of 4 to 5 feet. Injections will be completed from the soil-groundwater interface (approximately 15 feet bgs) to 20 feet bgs. After injection is completed, the DPT rods will be withdrawn and the boring will be sealed.

If it is determined that injection through the DPT rods and screens is not practical at one or more locations, injection at those locations will be attempted using temporary wells with PVC risers and screens. A boring will be advanced to approximately 20 feet bgs using the DPT drilling rig and a PVC well screen will be installed. It is anticipated that the screens will be 5 feet in length with riser from the top of the screen to ground surface. The annular space around the well will be backfilled with sand to a depth of 1 foot above the top of the well screen, with a cement/bentonite (2 to 6 percent) seal above the filter pack. The well seal will be allowed to set for at least 24 hours prior to injection.

Following the installation of temporary wells or DPT rods and screens, injection will begin. Injections will be conducted simultaneously via manifolds if possible. The number of wells being injected simultaneously may be changed in the field based on observed injection conditions. The observed injection conditions at the first injection point will be used to determine whether any modifications to the installation procedure are required to improve performance of the injection points.

An Arcadis staff member will be present during the drilling process to record total depths for each location, to confirm that proper installation techniques are used, and to provide general oversight. Arcadis personnel will continuously monitor the air in the breathing zone and general work area for volatile organic compounds (VOCs) using a photoionization detector. Air monitoring and associated action levels will be in accordance with the SSHP.

Following completion of injection at each DPT point, the direct push rods (or PVC casing and screen) will be removed from the boring and the boring will be properly abandoned and restored to match the surrounding ground surface.

3.4 Surveying

The DPT injection points will be measured and located in the field via a handheld global positioning system (GPS) unit. Field measurements will include distances measured from well MW-WR-001 to each DPT injection point in order to confirm radius of influence calculations. In addition, each DPT injection point will be recorded using a handheld GPS unit that will identify each location in the New York State Plane Coordinate System.

3.5 Investigation-Derived Waste Disposal

Any soil cuttings generated during utility clearance and temporary well installation activities and purge water will be containerized in 55-gallon United States Department of Transportation approved drums pending characterization and removal for transport to an approved off-site disposal facility.

4 ISCO INJECTION IMPLEMENTATION

This section describes the details of the injection program, including components of the injection system, injection solution composition and volumes, and injection and injection monitoring procedures.

Prior to implementation of the injection event, Arcadis will coordinate with USEPA and NYSDEC to obtain an underground injection control (UIC) permit. The UIC permit application process requires submittal of a written letter to USEPA. Arcadis intends to combine this permitting application process with other injections to be proposed at the former Plattsburgh AFB.

4.1 Injection System

Injection system operations will be performed by a drilling subcontractor under Arcadis' supervision. System monitoring will be performed by Arcadis in conjunction with the subcontractor. At a minimum, 40-hour Hazardous Waste Operations and Emergency Response (HAZWOPER) and 8-hour HAZWOPER refresher training are required for all personnel involved in injection system operations and monitoring-related activities.

The injection system will consist of solution mixing tanks, a water source, generator or other power source, pumps for solution mixing/injection and water transfer, manifolds with flow totalizers and flow control valves for solution distribution, wellhead fittings with pressure gauges and pressure relief valves, and flexible solution distribution hoses. Injection solution will be distributed via an aboveground hose to the injection wellhead of each of the injection points. The parts and components of equipment and supplies that will be in contact with injection solution will be made of materials chemically compatible with sodium persulfate and sodium hydroxide.

Secondary containment will be used to prevent potential minor leaks and spills of the injection solution from the mixing tank and the manifold from reaching the ground surface. The solution mixing tanks, mixing and injection pumps, and solution distribution manifolds will be placed inside the secondary containment units. If pre-mixed liquid sodium hydroxide solution is used, the sodium hydroxide tanks will also be placed inside secondary containment units. Unused chemicals will be stored securely near the injection area.

4.2 Injection Reagent and Solution

Injection solution will be prepared using water from a fire hydrant or nearby water source located on the former Plattsburgh AFB. If it is determined during injection that use of the hydrant is not practical, clean water from a local water vendor may be used. The injection solution will be prepared in portable aboveground storage tanks that are in turn placed in the secondary containment.

Sodium persulfate and sodium hydroxide solutions will be mixed to a target injection solution concentration of 50 grams per liter (g/L) of sodium persulfate and 25 g/L of sodium hydroxide, respectively. The injection solution concentrations are based on an assumed target post-injection persulfate concentration of 20 mg/L. The injection solution will be immediately diluted with groundwater once introduced into the subsurface and react with all oxidant demand in the subsurface. These concentrations are based on the anticipated oxidant demand of the remaining groundwater impacts as well as the natural chemical oxidant demand of the local geology.

The following procedure will be used to mix the solution:

- The mixing tank will be partially filled with water;

- The required amount of sodium persulfate for the volume to be mixed will be added to the mixing tank and agitated until it is completely mixed into solution;
- The required amount sodium hydroxide solution for the volume to be mixed will be added to the mixing tank and agitated until it is completely mixed into solution; and
- Sufficient water to finish filling the tank to the specified volume will be added.

During mixing, the solution and tanks will be monitored for evidence of excessive heat generation due to dilution of the sodium hydroxide. If excessive heat generation is observed, the mixing method may be modified to reduce heat generation. Arcadis staff will measure the pH, conductivity, and persulfate concentration of the mixed injection solution at least once per day to verify that the injection solution is being prepared to the target oxidant concentration.

To complete the scope of work outlined in this Work Plan, approximately 4,800 gallons of injection solution will be required for the four injection points. The theoretical demands (i.e., quantities of reagents required for injection of estimated volume) of sodium persulfate and sodium hydroxide are estimated at 2,000 pounds and 1,000 pounds, respectively. The injection points have been spaced to achieve the desired radius of influence of 10 feet. Injections will be completed over a 5-foot interval from the soil-groundwater interface (approximately 15 feet bgs) to 20 feet bgs. The estimated total solution volume was calculated using the following equation:

$$V_{inj} = ROI^2 \times \pi \times h \times n_m \times \left(\frac{7.481 gal}{ft^3} \right)$$

Where:

V_{inj} = volume of injection

ROI = radius of influence

h = target treatment aquifer thickness

n_m = mobile porosity (estimate based on geology)

As discussed in detail in Section 4.3, the actual injection volumes and reagent demand may be adjusted based on the progress of injection. The solution will be prepared in batches on an as-needed basis to eliminate or reduce the need to store unused injection solution at the end of each injection day.

4.3 Field Implementation

Following installation of the injection points as described in Section 3.3, hoses will be run from the mixing tanks through a chemically compatible injection pump to a distribution manifold outfitted with enough flow totalizers and flow control valves to allow simultaneous injection into the four injection points. From the manifold, a hose will be connected to a wellhead fitting attached to each injection rod. The wellhead fittings will include pressure gauges and pressure relief valves. An additional hose will be run from the manifold back to the mixing tank as a recirculation line to allow additional control of flow rates and pressures at the injection points.

Prior to the injection of mixed solution, a clean (potable) water injection will be conducted to test the injection system for any potential leaks in the piping configuration. In the event that leaking occurs, the leaks will be fixed prior to the start of reagent injection.

Following the clean water test, injection solution will be mixed as described in Section 4.2. The mixed solution will be injected into the injection wells either under gravity feed or at low pressures of up to 5 pounds per square inch (psi). If injections cannot be conducted under low pressure, site conditions will be evaluated and the allowable injection pressure may be altered. During injection, Arcadis personnel will record injection flow rates, injected volumes, and pressures to monitor the progress of the injection and ensure that safe injection pressures are not exceeded. Arcadis personnel will also monitor for signs of injection solution reaching the surface.

Injection will continue until the target injection volume for each injection point (approximately 1,200 gallons per point) is attained. Target injection volumes for each well may be adjusted based on field observations. Dose-response monitoring will be performed during the injection event to confirm solution delivery in monitoring well MW-WR-001. Field water quality parameter measurements (e.g., conductivity and pH) and field test kits (CHEMetrics' persulfate test kit, PeroxyChem's Kit "K," or similar) will be used to verify sufficient volume has been injected. In the event that breakthrough is not observed, additional volume may be injected into injection point(s) or additional injection points may be advanced.

If surfacing of injection solution is observed before the target volume is achieved, the flow rate for the nearest wells will be slowed; if the surfacing does not stop, injection at that location will be suspended. A neutralization solution will be applied to neutralize any surfaced injection solution.

Following the completion of injections at the end of each day and at the end of the injection event, a small volume of clean water will be run through the pumps and hoses to reduce the potential for accidental exposure to injection solution and prevent potential equipment damage from injection solution remaining in place overnight. The valves at the manifold and the shut-off valves at wellheads will be closed completely to prevent accidental releases of residual solution remaining in the hoses.

The injection event will be conducted approximately 8 to 12 hours per day and is anticipated to be completed in one week. The exact duration of the injection event will be directly related to the injection flow rate and proposed redevelopment construction schedule, which may be limited by the geology at Site RW042. As discussed, the injection is anticipated to be performed under gravity or minimal injection pressure; however, changes to the injection strategy, including using the temporary monitoring wells for injection, may be made in the field to increase productivity.

4.4 Injection Monitoring

This section describes the monitoring to be performed during injection activities, including monitoring of injection field parameters, dose response, and hydraulic response.

4.4.1 Injection Parameters

The injection solution flow rates, cumulative injected volumes, and injection pressures will be monitored and recorded in an injection log. When injection is conducted under pumping, injection pressures will be monitored and adjusted as necessary during injection. Injection flow rates and cumulative injected volumes at each individual DPT point and depth interval will be monitored with designated flow totalizers. Injection flow rates and total injected volume will be recorded and calculated based on the changes of volumes in solution tanks. In addition, mixed reagent quantities will be recorded for every batch. Persulfate concentration, pH, and conductivity of the mixed solution will be analyzed at least once per day.

4.4.2 Dose Response

Dose-response monitoring will be performed for monitoring well MW-WR-001 to confirm solution arrival. Dose-response monitoring will be conducted at least twice per day for field parameters (specific conductivity, pH, temperature, and reduction-oxidation [redox] potential) using a field water quality meter, and at least once per day for sodium persulfate (using a field test kit). If an increase in conductivity or pH is observed, the frequency of monitoring for both field parameters and sodium persulfate may be increased. These data will be utilized to evaluate the arrival of injection solution at the monitoring well.

4.4.3 Hydraulic Response

In conjunction with dose-response monitoring, hydraulic-response monitoring will be conducted. Water levels in well MW-WR-001 will be manually measured at least twice per day.

5 PERFORMANCE MONITORING

Performance monitoring associated with the injection event will consist of baseline monitoring, post-injection monitoring, and confirmation sampling. The performance monitoring sampling program is summarized in Table 2. The current groundwater monitoring program, which consists of sampling of monitoring well MW-WR-001 for VOCs and semi-volatile organic compounds (SVOCs) on a semiannual basis, will continue until NYSDEC groundwater quality standards have been met.

5.1 Baseline Monitoring

The current semiannual monitoring program (i.e., collection of VOC and SVOC samples and field water quality parameters from monitoring well MW-WR-001) is implemented during the months of May and November of each year. The sampling event immediately prior to the injection will be utilized to establish baseline conditions. On the first day of DPT injections, field water quality parameters and baseline persulfate concentrations (using a field test kit) from well MW-WR-001 will be recorded prior to any solution being injected into the formation.

5.2 Post-Injection Monitoring

Post-injection monitoring will be conducted to measure the rate at which persulfate persists at concentrations above baseline. Based on experience at similar project sites, persulfate concentrations are expected to return to baseline conditions in approximately three to six months. Using field test kits, persulfate concentrations will be measured at approximately two weeks post-injection, four weeks post-injection, and then monthly until persulfate concentrations have approached baseline conditions. At that time, confirmation sampling will be initiated.

5.3 Confirmation Sampling

Confirmation sampling will be conducted once persulfate concentrations in the aquifer have approached baseline conditions. The current semiannual monitoring program for well MW-WR-001 will continue following injection activities and will serve as the post-injection monitoring program. However, depending on the findings of post-injection monitoring, semiannual monitoring may be completed at a different schedule (i.e., at months other than May and November). The semiannual monitoring program, which consists of sampling well MW-WR-001 for select VOCs and SVOCs, will continue until results of four consecutive sampling events confirm treatment of COCs to concentrations that meet NYSDEC groundwater quality standards. Once four consecutive events confirm that COC concentrations are in accordance with regulatory standards, the monitoring program will cease and the site closure process will commence.

6 REPORTING

Data collected during and following the ISCO injection will be evaluated against the performance objectives, and the results will be summarized in a Remedial Action Completion Report/Well Decommissioning Work Plan. The report will present groundwater performance monitoring results that demonstrate the effectiveness of the ISCO treatment and will also describe the plan for decommissioning the monitoring wells at the former Plattsburgh AFB.

7 PROJECT SCHEDULE

Arcadis plans to proceed with the scope of work detailed in this Work Plan during spring 2017 prior to the planned sampling event in May 2017. Injection work of this manner is not practical during the winter in northern New York due to freezing temperatures and, therefore, will be conducted when above-freezing temperatures are expected. Drilling subcontractors will be evaluated and coordinated in a timely manner prior to commencement of the injection. ISCO injection will begin immediately following the completion of the temporary injection points. It is anticipated that injection activities will take three to five business days to complete.

8 REFERENCES

URS Group (URS). 2016. Report on the May 2016 Groundwater Monitoring Event at the Wash Rack Area of Concern, Former Plattsburgh Air Force Base, Plattsburgh, New York. July.

Versar, Inc. 2004. Draft Closure Report, Washrack Area, Plattsburgh Air Force Base, Plattsburgh, New York. April.

TABLE

Table 2 - Performance Monitoring Program
In-situ Chemical Oxidation Work Plan
RW042 - Wash Rack Area of Concern

Monitoring Location	Frequency	Parameters			
		VOC	SVOCs	Persulfate	Field Water Quality Parameters[1]
		USEPA 8260B	USEPA 8270C	Field Test Kit[2]	--
Baseline	One Time	X	X	X	X
Post-Injection Monitoring	2 weeks, 4 weeks, and then monthly until persulfate concentration approaches baseline			X	X
Confirmation Sampling	Semi-annual	X	X		X

Notes and abbreviations:

[1] The following water quality parameters will be recorded: dissolved oxygen, oxidation-reduction potential, pH, temperature, turbidity, and conductivity

[2] Persulfate concentrations will be measured using a field test kit such as CHEMetrics' persulfate test kit, PeroxyChem's Kit "K", or similar

SVOC - semi-volatile organic compound
USEPA - United States Environmental Protection Agency
VOCs - volatile organic compound

FIGURES

LEGEND:

Base Boundary

Site Boundary

0 2,650 5,300

SCALE IN FEET

FORMER PLATTSBURGH AFB,
PLATTSBURGH, NEW YORK

REMEDIAL ACTION WORK PLAN

SITE LOCATION

ARCADIS

FIGURE

1

Citrix DIV/GROUP: ENV/IMDV DB: LD: PIC: PM: TM:
PROJECT: PATH: \\corpstorage\Data\ArcGisData\GISPROJECTS_ENV\AFCEC_Plattsburgh\GIS\ArcMap_MXD\RAWP 2016\Fig1_SiteLocation.mxd DATE: 8/24/2016 6:28:14 PM Saved By: sbell

LEGEND:

- Monitoring Well
- Manhole
- Former Drain Pipe
- Storm Sewer Pipes
- Fence
- Base Boundary
- Buildings

0 100 200
SCALE IN FEET

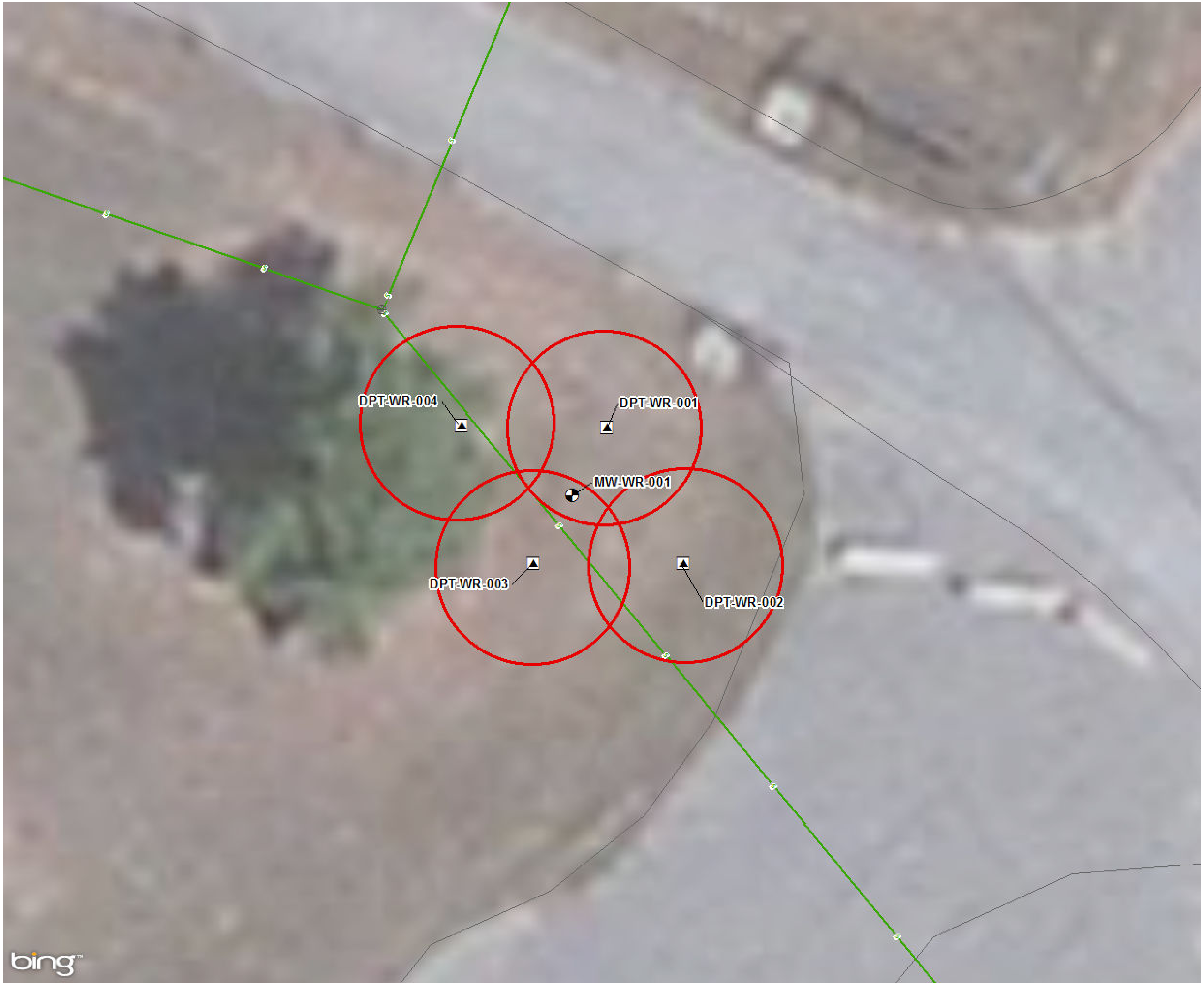
FORMER PLATTSBURGH AFB,
PLATTSBURGH, NEW YORK

REMEDIAL ACTION WORK PLAN

WASH RACK SITE MAP

ARCADIS

FIGURE
2



LEGEND:

- Monitoring Well
- Proposed ISCO Injection Point
- Manhole
- Storm Sewer Pipes
- ROI - 10 feet

Note:
1. ISCO - in situ chemical oxidation
ROI - radius of influence

0 10 20
SCALE IN FEET

FORMER PLATTSBURGH AFB,
PLATTSBURGH, NEW YORK

REMEDIAL ACTION WORK PLAN

PROPOSED ISCO INJECTION LOCATIONS

ARCADIS

FIGURE
3

APPENDIX A

Safety Data Sheets

MATERIAL SAFETY DATA SHEET

Klozur®

MSDS Ref. No.: 7775-27-1-12
Date Approved: 05/13/2009
Revision No.: 5

This document has been prepared to meet the requirements of the U.S. OSHA Hazard Communication Standard, 29 CFR 1910.1200 and Canada's Workplace Hazardous Materials Information System (WHMIS) requirements.

1. PRODUCT AND COMPANY IDENTIFICATION

PRODUCT NAME:	Klozur®
SYNONYMS:	Sodium Persulfate, Sodium Peroxydisulfate; Disodium Peroxydisulfate
GENERAL USE:	In situ and ex situ chemical oxidation of contaminants and compounds of concern for environmental remediation applications.

MANUFACTURER

FMC CORPORATION
FMC Peroxygens
1735 Market Street
Philadelphia, PA 19103
(215) 299-6000 (General Information)
msdsinfo@fmc.com (Email - General Information)

EMERGENCY TELEPHONE NUMBERS

(303) 595-9048 (Medical - U.S. - Call Collect)

For leak, fire, spill, or accident emergencies, call:
(800) 424-9300 (CHEMTREC - U.S.A. & Canada)

2. HAZARDS IDENTIFICATION

EMERGENCY OVERVIEW:

- White, odorless, crystals
- Oxidizer.
- Decomposes in storage under conditions of moisture (water/water vapor) and/or excessive heat causing release of oxides of sulfur and oxygen that supports combustion. Decomposition could form a high temperature melt. See Section 10 ("Stability and Reactivity").

POTENTIAL HEALTH EFFECTS: Airborne persulfate dust may be irritating to eyes, nose, lungs, throat and skin upon contact. Exposure to high levels of persulfate dust may cause difficulty in breathing in sensitive persons.

3. COMPOSITION / INFORMATION ON INGREDIENTS

Chemical Name	CAS#	Wt.%	EC No.	EC Class
Sodium Persulfate	7775-27-1	>99	231-892-1	Xn-O; R8-R22-R36/37/38-R42/43

4. FIRST AID MEASURES

EYES: Flush with plenty of water. Get medical attention if irritation occurs and persists.

SKIN: Wash with plenty of soap and water. Get medical attention if irritation occurs and persists.

INGESTION: Rinse mouth with water. Dilute by giving 1 or 2 glasses of water. Do not induce vomiting. Never give anything by mouth to an unconscious person. See a medical doctor immediately.

INHALATION: Remove to fresh air. If breathing difficulty or discomfort occurs and persists, contact a medical doctor.

NOTES TO MEDICAL DOCTOR: This product has low oral toxicity and is not irritating to the eyes and skin. Flooding of exposed areas with water is suggested. For gastric lavage or emesis induction, consider the possible aggravation of esophageal injury, and the expected absence of system effects. Treatment is controlled removal of exposure followed by symptomatic and supportive care.

5. FIRE FIGHTING MEASURES

EXTINGUISHING MEDIA: Deluge with water.

FIRE / EXPLOSION HAZARDS: Product is non-combustible. On decomposition releases oxygen which may intensify fire. Presence of water accelerates decomposition.

FIRE FIGHTING PROCEDURES: Do not use carbon dioxide or other gas filled fire extinguishers; they will have no effect on decomposing persulfates. Wear full protective clothing and self-contained breathing apparatus.

FLAMMABLE LIMITS: Non-combustible

SENSITIVITY TO IMPACT: No data available

SENSITIVITY TO STATIC DISCHARGE: Not available

6. ACCIDENTAL RELEASE MEASURES

RELEASE NOTES: Spilled material should be collected and put in approved DOT container and isolated for disposal. Isolated material should be monitored for signs of decomposition (fuming/smoking). If spilled material is wet, dissolve with large quantity of water and dispose as a hazardous waste. All disposals should be carried out according to regulatory agencies procedures.

7. HANDLING AND STORAGE

HANDLING: Use adequate ventilation when transferring product from bags or drums. Wear respiratory protection if ventilation is inadequate or not available. Use eye and skin protection. Use clean plastic or stainless steel scoops only.

STORAGE: Store (unopened) in a cool, clean, dry place away from point sources of heat, e.g. radiant heaters or steam pipes. Use first in, first out storage system. Avoid contamination of opened product. In case of fire or decomposition (fuming/smoking) deluge with plenty of water to control decomposition. For storage, refer to NFPA Bulletin 430 on storage of liquid and solid oxidizing materials.

COMMENTS: VENTILATION: Provide mechanical general and/or local exhaust ventilation to prevent release of dust into work environment. Spills should be collected into suitable containers to prevent dispersion into the air.

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

EXPOSURE LIMITS

Chemical Name	**ACGIH**	**OSHA**	**Supplier**
Sodium Persulfate	0.1 mg/m^3 (TWA)		

ENGINEERING CONTROLS: Provide mechanical local general room ventilation to prevent release of dust into the work environment. Remove contaminated clothing immediately and wash before reuse.

PERSONAL PROTECTIVE EQUIPMENT

EYES AND FACE: Use cup type chemical goggles. Full face shield may be used.

RESPIRATORY: Use approved dust respirator when airborne dust is expected.

PROTECTIVE CLOTHING: Normal work clothes. Rubber or neoprene footwear.

GLOVES: Rubber or neoprene gloves. Thoroughly wash the outside of gloves with soap and water prior to removal. Inspect regularly for leaks.

9. PHYSICAL AND CHEMICAL PROPERTIES

ODOR:	None
APPEARANCE:	White crystals
AUTOIGNITION TEMPERATURE:	Not applicable. No evidence of combustion up to 800°C. Decomposition will occur upon heating.
BOILING POINT:	Not applicable
COEFFICIENT OF OIL / WATER:	Not applicable
DENSITY / WEIGHT PER VOLUME:	Not available
EVAPORATION RATE:	Not applicable (Butyl Acetate = 1)
FLASH POINT:	Non-combustible
MELTING POINT:	Decomposes
ODOR THRESHOLD:	Not applicable
OXIDIZING PROPERTIES:	Oxidizer
PERCENT VOLATILE:	Not applicable
pH:	typically 5.0 - 7.0 @ 25 °C (1% solution)
SOLUBILITY IN WATER:	73 % @ 25 °C (by wt.)
SPECIFIC GRAVITY:	2.6 (H_2O=1)
VAPOR DENSITY:	Not applicable (Air = 1)
VAPOR PRESSURE:	Not applicable

10. STABILITY AND REACTIVITY

CONDITIONS TO AVOID:	Heat, moisture and contamination.
STABILITY:	Stable (becomes unstable in presence of heat, moisture and/or contamination).
POLYMERIZATION:	Will not occur
INCOMPATIBLE MATERIALS:	Acids, alkalis, halides (fluorides, chlorides, bromides and iodides), combustible materials, most metals and heavy metals, oxidizable materials, other oxidizers, reducing agents, cleaners, and organic or carbon containing compounds. Contact

with incompatible materials can result in a material decomposition or other uncontrolled reactions.

HAZARDOUS DECOMPOSITION PRODUCTS: Oxygen that supports combustion and oxides of sulfur.

COMMENTS: PRECAUTIONARY STATEMENT: Pumping and transport of Klozur persulfate requires appropriate precautions and design considerations for pressure and thermal relief.

Decomposing persulfates will evolve large volumes of gas and/or vapor, can accelerate exponentially with heat generation, and create significant and hazardous pressures if contained and not properly controlled or mitigated.

Use with alcohols in the presence of water has been demonstrated to generate conditions that require rigorous adherence to process safety methods and standards to prevent escalation to an uncontrolled reaction.

11. TOXICOLOGICAL INFORMATION

EYE EFFECTS: Non-irritating (rabbit) [FMC Ref. ICG/T-79.029]

SKIN EFFECTS: Non-irritating (rabbit) [FMC Ref. ICG/T-79.029]

DERMAL LD_{50}: > 10 g/kg [FMC Ref. ICG/T-79.029]

ORAL LD_{50}: 895 mg/kg (rat) [FMC Ref. ICG/T-79.029]

INHALATION LC_{50}: 5.1 mg/l (rat) [FMC Ref. I95-2017]

SENSITIZATION: May be sensitizing to allergic persons. [FMC Ref. ICG/T-79.029]

TARGET ORGANS: Eyes, skin, respiratory passages

ACUTE EFFECTS FROM OVEREXPOSURE: Dust may be harmful and irritating. May be harmful if swallowed.

CHRONIC EFFECTS FROM OVEREXPOSURE: Sensitive persons may develop dermatitis and asthma [Respiration 38:144, 1979]. Groups of male and female rats were fed 0, 300 or 3000 ppm sodium persulfate in the diet for 13 weeks, followed by 5000 ppm for 5 weeks. Microscopic examination of tissues revealed some injury to the gastrointestinal tract at the high dose (3000 ppm) only. This effect is not unexpected for an oxidizer at high concentrations. [Ref. FMC I90-1151, Toxicologist 1:149, 1981].

CARCINOGENICITY:

NTP:	Not listed
IARC:	Not listed
OSHA:	Not listed
OTHER:	ACGIH: Not listed

12. ECOLOGICAL INFORMATION

ECOTOXICOLOGICAL INFORMATION:

Bluegill sunfish, 96-hour LC_{50} = 771 mg/L [FMC Study I92-1250]
Rainbow trout, 96-hour LC_{50} = 163 mg/L [FMC Study I92-1251]
Daphnia, 48-hour LC_{50} = 133 mg/L [FMC Study I92-1252]
Grass shrimp, 96-hour LC_{50} = 519 mg/L [FMC Study I92-1253]

CHEMICAL FATE INFORMATION: Biodegradability does not apply to inorganic substances.

13. DISPOSAL CONSIDERATIONS

DISPOSAL METHOD: Dispose as a hazardous waste in accordance with local, state and federal regulatory agencies.

14. TRANSPORT INFORMATION

U.S. DEPARTMENT OF TRANSPORTATION (DOT)

PROPER SHIPPING NAME:	Sodium Persulfate
PRIMARY HAZARD CLASS / DIVISION:	5.1 (Oxidizer)
UN/NA NUMBER:	UN 1505
PACKING GROUP:	III
LABEL(S):	5.1 (Oxidizer)
PLACARD(S):	5.1 (Oxidizer)
MARKING(S):	Sodium Persulfate, UN 1505
ADDITIONAL INFORMATION:	Hazardous Substance/RQ: Not applicable

49 STCC Number: 4918733

This material is shipped in 225 lb. fiber drums, 55 lb. poly bags and 1000 - 2200 lb. IBC's (supersacks).

INTERNATIONAL MARITIME DANGEROUS GOODS (IMDG)

PROPER SHIPPING NAME: Sodium Persulfate

INTERNATIONAL CIVIL AVIATION ORGANIZATION (ICAO) / INTERNATIONAL AIR TRANSPORT ASSOCIATION (IATA)

PROPER SHIPPING NAME: Sodium Persulfate

OTHER INFORMATION:

Protect from physical damage. Do not store near acids, moisture or heat.

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15. REGULATORY INFORMATION

UNITED STATES

SARA TITLE III (SUPERFUND AMENDMENTS AND REAUTHORIZATION ACT)

SECTION 302 EXTREMELY HAZARDOUS SUBSTANCES (40 CFR 355, APPENDIX A):
Not applicable

SECTION 311 HAZARD CATEGORIES (40 CFR 370):
Fire Hazard, Immediate (Acute) Health Hazard

SECTION 312 THRESHOLD PLANNING QUANTITY (40 CFR 370):
The Threshold Planning Quantity (TPQ) for this product, if treated as a mixture, is 10,000 lbs; however, this product contains the following ingredients with a TPQ of less than 10,000 lbs.: None

SECTION 313 REPORTABLE INGREDIENTS (40 CFR 372):
There are no ingredients in this product, which are subject to Section 313 reporting requirements.

CERCLA (COMPREHENSIVE ENVIRONMENTAL RESPONSE COMPENSATION AND LIABILITY ACT)

CERCLA DESIGNATION & REPORTABLE QUANTITIES (RQ) (40 CFR 302.4):
Unlisted, RQ = 100 lbs., Ignitability

TSCA (TOXIC SUBSTANCE CONTROL ACT)

TSCA INVENTORY STATUS (40 CFR 710):

All components are listed or exempt.

RESOURCE CONSERVATION AND RECOVERY ACT (RCRA)

RCRA IDENTIFICATION OF HAZARDOUS WASTE (40 CFR 261):

Waste Number: D001

CANADA

WHMIS (WORKPLACE HAZARDOUS MATERIALS INFORMATION SYSTEM):

This product has been classified in accordance with the hazard criteria of the Controlled Products Regulations and the MSDS contains all the information required by the Controlled Products Regulations.

Hazard Classification / Division:	C D2A D2B
Domestic Substance List:	All components are listed or exempt.

INTERNATIONAL LISTINGS

Australia (AICS): Listed
China: Listed
Japan (ENCS): (1)-1131
Korea: KE-12369
Philippines (PICCS): Listed

HAZARD AND RISK PHRASE DESCRIPTIONS:

EC Symbols:	Xn	(Harmful)
	O	(Oxidizer)
EC Risk Phrases:	R8	(Contact with combustible material may cause fire)
	R22	(Harmful if swallowed.)
	R36/37/38	(Irritating to eyes, respiratory system and skin.)
	R42/43	(May cause sensitization by inhalation or by skin contact.)

16. OTHER INFORMATION

HMIS

Health	1
Flammability	0
Physical Hazard	1
Personal Protection (PPE)	J

Protection = J (Safety goggles, gloves, apron & combination dust & vapor respirator)

HMIS = Hazardous Materials Identification System

Degree of Hazard Code:
4 = Severe
3 = Serious
2 = Moderate
1 = Slight
0 = Minimal

NFPA

Health	1
Flammability	0
Reactivity	1
Special	OX

SPECIAL = OX (Oxidizer)

NFPA (National Fire Protection Association)

Degree of Hazard Code:
4 = Extreme
3 = High
2 = Moderate
1 = Slight
0 = Insignificant

REVISION SUMMARY:
This MSDS replaces Revision #4, dated September 18, 2006.
Changes in information are as follows:
Section 1 (Product and Company Identification)
Section 3 (Composition / Information on Ingredients)
Section 15 (Regulatory Information)
Section 16 (Other Information)

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Safety Data Sheet

1. IDENTIFICATION OF THE MATERIAL AND SUPPLIER

Product Name: **PEARL CAUSTIC SODA**

Other name(s): Sodium hydroxide; Soda lye; Sodium hydrate; White caustic; Caustic soda solid; Caustic soda pearl; Solid caustic soda.

Recommended Use: General chemical.

Supplier: Orica Australia Pty Ltd
ABN: 99 004 117 828
Street Address: 1 Nicholson Street,
Melbourne 3000
Australia
Telephone Number: +61 3 9665 7111
Facsimile: +61 3 9665 7937
Emergency Telephone: **1 800 033 111 (ALL HOURS)**

2. HAZARDS IDENTIFICATION

This material is hazardous according to criteria of Safe Work Australia; HAZARDOUS SUBSTANCE.

Classified as Dangerous Goods by the criteria of the Australian Dangerous Goods Code (ADG Code) for Transport by Road and Rail; DANGEROUS GOODS.

Risk Phrases: Causes severe burns. Risk of serious damage to eyes.

Safety Phrases: Do not breathe dust. Avoid contact with skin and eyes. In case of contact with eyes, rinse immediately with plenty of water and seek medical advice. Wear suitable protective clothing, gloves and eye/face protection. In case of accident or if you feel unwell, seek medical advice immediately (show the label whenever possible).

Poisons Schedule: S6 Poison.

3. COMPOSITION/INFORMATION ON INGREDIENTS

Components	CAS Number	Proportion	Risk Phrases
Sodium hydroxide	1310-73-2	100%	R35, R41

4. FIRST AID MEASURES

For advice, contact a Poisons Information Centre (e.g. phone Australia 131 126; New Zealand 0800 764 766) or a doctor.

Inhalation:
Remove victim from area of exposure - avoid becoming a casualty. Remove contaminated clothing and loosen remaining clothing. Allow patient to assume most comfortable position and keep warm. Keep at rest until fully recovered. If patient finds breathing difficult and develops a bluish discolouration of the skin (which suggests a lack of oxygen in the blood - cyanosis), ensure airways are clear of any obstruction and have a qualified person give oxygen through a face mask. Apply artificial respiration if patient is not breathing. Seek immediate medical advice.

Skin Contact:
If spilt on large areas of skin or hair, immediately drench with running water and remove clothing. Continue to wash skin and hair with plenty of water (and soap if material is insoluble) until advised to stop by the Poisons Information Centre or a doctor. For skin burns, cover with a clean, dry dressing until medical help is available.

Eye Contact:
If in eyes, hold eyelids apart and flush the eye continuously with running water. Continue flushing until advised to stop by a Poisons Information Centre or a doctor, or for at least 15 minutes.

Ingestion:
Immediately rinse mouth with water. If swallowed, do NOT induce vomiting. Give a glass of water. Seek immediate medical assistance.

Medical attention and special treatment:
Treat symptomatically. Can cause corneal burns.

5. FIRE FIGHTING MEASURES

Hazards from combustion products:
Non-combustible material.

Precautions for fire fighters and special protective equipment:
Fire fighters to wear self-contained breathing apparatus and suitable protective clothing if risk of exposure to products of decomposition.

Suitable Extinguishing Media:
Not combustible, however, if material is involved in a fire use: Fine water spray, normal foam, dry agent (carbon dioxide, dry chemical powder).

Hazchem Code: 2W

6. ACCIDENTAL RELEASE MEASURES

Emergency procedures:
Clear area of all unprotected personnel. If contamination of sewers or waterways has occurred advise local emergency services.

Methods and materials for containment and clean up:
Wear protective equipment to prevent skin and eye contact and breathing in dust. Work up wind or increase ventilation. Cover with damp absorbent (inert material, sand or soil). Sweep or vacuum up, but avoid generating dust. Collect and seal in properly labelled containers or drums for disposal. Caution - heat may be evolved on contact with water.

7. HANDLING AND STORAGE

This material is a Scheduled Poison S6 and must be stored, maintained and used in accordance with the relevant regulations.

Conditions for safe storage:
Store in a cool, dry, well ventilated place and out of direct sunlight. Store away from foodstuffs. Store away from incompatible materials described in Section 10. Keep containers closed when not in use - check regularly for spills.

Precautions for safe handling:
Avoid skin and eye contact and breathing in dust. Keep out of reach of children. There is a risk of splash-back causing injury if Pearl Caustic Soda is added to HOT water.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Sodium hydroxide: Peak Limitation = 2 mg/m^3

As published by the National Occupational Health and Safety Commission.

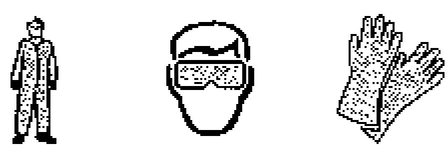
Peak Limitation - a ceiling concentration which should not be exceeded over a measurement period which should be as short as possible but not exceeding 15 minutes.

These Exposure Standards are guides to be used in the control of occupational health hazards. All atmospheric contamination should be kept to as low a level as is workable. These exposure standards should not be used as fine dividing lines between safe and dangerous concentrations of chemicals. They are not a measure of relative toxicity.

Engineering controls:
Ensure ventilation is adequate to maintain air concentrations below Exposure Standards. Avoid generating and breathing in dusts. Use with local exhaust ventilation or while wearing dust mask. Keep containers closed when not in use.

Personal Protective Equipment:
The selection of PPE is dependant on a detailed risk assessment. The risk assessment should consider the work situation, the physical form of the chemical, the handling methods, and environmental factors.

Orica Personal Protection Guide No. 1, 1998: F - OVERALLS, SAFETY SHOES, CHEMICAL GOGGLES, GLOVES, DUST MASK.



Wear overalls, chemical goggles and impervious gloves. Avoid generating and inhaling dusts. If dust exists, wear dust mask/respirator meeting the requirements of AS/NZS 1715 and AS/NZS 1716. Always wash hands before smoking, eating, drinking or using the toilet. Wash contaminated clothing and other protective equipment before storage or re-use.

9. PHYSICAL AND CHEMICAL PROPERTIES

Physical state:	Solid
Colour:	White
Molecular Formula:	$NaOH$
Solubility:	Soluble in water.
Specific Gravity:	2.13 @20°C
Relative Vapour Density (air=1):	Not available
Vapour Pressure (20 °C):	Not available
Flash Point (°C):	Not applicable
Flammability Limits (%):	Not available
Autoignition Temperature (°C):	Not available
Melting Point/Range (°C):	318
Boiling Point/Range (°C):	1390
pH:	12.7 (1% aqueous solution)

10. STABILITY AND REACTIVITY

10. STABILITY AND REACTIVITY

Chemical stability: Stable. Hygroscopic: absorbs moisture or water from surrounding air.

Conditions to avoid: Avoid dust generation. Avoid exposure to moisture. Avoid contact with foodstuffs.

Incompatible materials: Incompatible with ammonium salts , acids , chlorinated hydrocarbons , aluminium , zinc , lead , tin , and their alloys .

Hazardous decomposition products: None known.

Hazardous reactions: Reacts with ammonium salts, evolving ammonia gas. In the presence of moisture, the material is corrosive to aluminium, zinc and tin producing highly flammable hydrogen gas. May react violently with acids and chlorinated hydrocarbons . Can react vigorously with water .

11. TOXICOLOGICAL INFORMATION

No adverse health effects expected if the product is handled in accordance with this Safety Data Sheet and the product label. Symptoms or effects that may arise if the product is mishandled and overexposure occurs are:

Ingestion: Swallowing can result in nausea, vomiting, diarrhoea, abdominal pain and chemical burns to the gastrointestinal tract.

Eye contact: A severe eye irritant. Corrosive to eyes; contact can cause corneal burns. Contamination of eyes can result in permanent injury.

Skin contact: Contact with skin will result in severe irritation. Corrosive to skin - may cause skin burns.

Inhalation: Breathing in dust may result in respiratory irritation.

Long Term Effects:
No information available for the product.

Toxicological Data: No LD50 data available for the product.

12. ECOLOGICAL INFORMATION

Ecotoxicity Avoid contaminating waterways.

13. DISPOSAL CONSIDERATIONS

Disposal methods:
Refer to local government authority for disposal recommendations. Dispose of material through a licensed waste contractor. Decontamination and destruction of containers should be considered.

14. TRANSPORT INFORMATION

Road and Rail Transport
Classified as Dangerous Goods by the criteria of the Australian Dangerous Goods Code (ADG Code) for Transport by Road and Rail; DANGEROUS GOODS.

UN No:	1823
Class-primary	8 Corrosive
Packing Group:	II
Proper Shipping Name:	SODIUM HYDROXIDE, SOLID
Hazchem Code:	2W

Marine Transport

Classified as Dangerous Goods by the criteria of the International Maritime Dangerous Goods Code (IMDG Code) for transport by sea; DANGEROUS GOODS.

UN No:	1823
Class-primary:	8 Corrosive
Packing Group:	II
Proper Shipping Name:	SODIUM HYDROXIDE, SOLID

IMDG EMS Fire:	F-A
IMDG EMS Spill:	S-B

Air Transport

Classified as Dangerous Goods by the criteria of the International Air Transport Association (IATA) Dangerous Goods Regulations for transport by air; DANGEROUS GOODS.

UN No:	1823
Class-primary:	8 Corrosive
Packing Group:	II
Proper Shipping Name:	SODIUM HYDROXIDE, SOLID

15. REGULATORY INFORMATION

Classification: This material is hazardous according to criteria of Safe Work Australia; HAZARDOUS SUBSTANCE.

Hazard Category: C: Corrosive

Risk Phrase(s):

R35: Causes severe burns.
R41: Risk of serious damage to eyes.

Safety Phrase(s):

S22: Do not breathe dust.
S24/25: Avoid contact with skin and eyes.
S26: In case of contact with eyes, rinse immediately with plenty of water and seek medical advice.
S36/37/39: Wear suitable protective clothing, gloves and eye/face protection.
S45: In case of accident or if you feel unwell, seek medical advice immediately (show the label whenever possible).

Poisons Schedule: S6 Poison.

This material is listed on the Australian Inventory of Chemical Substances (AICS).

16. OTHER INFORMATION

This safety data sheet has been prepared by Orica SDS Services.

Reason(s) for Issue:
5 Yearly Revised Primary SDS

This SDS summarises to our best knowledge at the date of issue, the chemical health and safety hazards of the material and general guidance on how to safely handle the material in the workplace. Since Orica Limited cannot anticipate or control the conditions under which the product may be used, each user must, prior to usage, assess and control the risks arising from its use of the material.

If clarification or further information is needed, the user should contact their Orica representative or Orica Limited at the contact details on page 1.

Orica Limited's responsibility for the material as sold is subject to the terms and conditions of sale, a copy of which is available upon request.

APPENDIX B

ISCO Activity Hazard Analysis

ACTIVITY HAZARDS ANALYSIS

Overall Risk Assessment Code (RAC) (Use highest code): L

Date: 22 August 2016

Project: Plattsburgh Air Force Base- Wa

Activity: Sodium Persulfate and Sodium Hydroxide Injection, Handling, and Treatment

Activity Location: Plattsburgh, NY

Prepared By: M. Lennertz

Risk Assessment Code Matrix

E = Extremely High Risk
H = High Risk
M = Moderate Risk
L = Low Risk

Severity	Probability: Frequent	Likely	Occasional	Seldom	Unlikely
Catastrophic	E	E	H	H	M
Critical	E	H	H	M	L
Marginal	H	M	M	L	L
Negligible	M	L	L	L	L

Add Identified Hazards

	JOB STEPS	HAZARDS	ACTIONS TO ELIMINATE OR MINIMIZE HAZARDS	RAC
X	Site reconnaissance and walk-around	Slips/trips/falls can occur from uneven ground surface, slippery walkways or from tripping over equipment	Survey the site upon arrival. Note any site conditions that may pose a potential hazard, and make note of any changes since the last injection event.	L
X		Personnel could be struck by vehicle	• Secure work area with cones. • Position vehicle to serve as a barrier between personnel and site traffic. • Unload equipment as close to the work area as possible. • Plan the location where the injection equipment will be set up making sure to not block any ingress/egress to the work area • Choose vehicle staging/parking areas that minimize vehicle movement in and around the work area	L
X	Setting up of the trailer with injection equipment or unloading the trailer into an injection compound	Pinch points on the trailer or equipment can cause hand injury	• Look for pinch points and sharp edges/burrs that can be present on the metal portions of the trailer or injection equipment before handling. • Wear work leather gloves.	L
X		Heavy equipment can fall and strike personnel	• Make sure jack stands, if present, are secured on the equipment trailer. • Make sure that the wheels of the trailer have been chocked prior to trailer operation or unloading. • Level the trailer utilizing jack stands if necessary.	L
X		Truck and/or trailer becomes stuck on soft or uneven ground causing potential property damage and impact injury to workers during extraction	• Plan trailer setup and factor weight of full tanks when accessing and egressing from injection areas and selecting a staging area for the tanks. • Ensure adequate hose lengths are available to pump solutions to wells in soft ground areas from stable road surface or another firm surface.	L

ACTIVITY HAZARDS ANALYSIS

	JOB STEPS	HAZARDS	ACTIONS TO ELIMINATE OR MINIMIZE HAZARDS	RAC
X	Receiving chemical deliveries	Chemical releases during delivery and storage	• Have a secondary containment set up and place the chemicals directly into the containment to minimize the potential for releases to the ground surface • Ensure proper equipment is available to move pallets/totes of chemical without requiring intermediate staging or repackaging • Ensure neutralization solution is available.	M
X	Load, unload and set up of required PPE, equipment including waterline hoses, injection hoses, flow meters and supplies in/out of vehicle or storage area	Ergonomic strain from improper lifting techniques or awkward body positions/twisting	• Follow proper lifting technique, bending with the knees and not with the back. Avoid twisting at the waist when lifting. • Ask a buddy for help when lifting objects weighing over 50 lbs. (as a general guide; may vary on specific circumstances)	L
X		Slips/trips/falls can occur from walking over dragging and unsecured hoses	• Keep coiled hose ends secured to coil when loading and unloading, stop and pick up dangling hoses that could be a trip hazard when carrying.	L
X	Connecting the water supply to the injection trailer or compound	Lifting hoses resulting in a back injury	• Do not lift more than your personal limits. • Use a second person if needed or when lifting hoses >50 lbs. • Lift with your knees and not your back.	L
X		Possible pressure build up can result in equipment failure or flying objects that can cause personal injury	• Check equipment and valves before making connections. • Check the water valves are in the off position. • Make the hose connections and secure the cam locks . • Open supply valves slowly to avoid damage to hoses or personnel. • Check supply lines and valves for leaking .	L
X	Connect the power supply	Electrocution or power surge resulting in equipment damage, injury or loss of life	• Inspect power cords for evidence of damage to the wire or connector. If damage is present, do not use power cord. • Inspect connection of power supply for evidence of damage. • Use GFCI 'pigtail'.	L
X		Misuse of generators or electrical equipment can cause electrocution, fire or equipment failure	• If using generator inspect components for damage before use. • Check oil/fuel levels and fill if necessary. • Inspect electrical equipment for evidence of damage to switches, circuits or breakers before connecting power. • Connect power cord then power supply. Watch for wet or other conductive surfaces.	L
X	Connecting the injection hoses and well heads to the injection wells	Pressure build up in wells can cause well caps to fly off causing head or bodily injury	• When opening injection wells, be sure your body is not over the well when opening. • If wells were constructed with a pressure relief valve (or retrofitted) open the pressure relief valve to release build-up of pressure within the well and listen for pressure escaping from the well. • Be sure that safety glasses are worn and your head is facing away from the well when opening.	L
X	Mixing of chemicals and water	Breathing or contact with sodium persulfate or sodium hydroxide can irritate nose, throat and lungs causing coughing, wheezing and/or shortness or breath. Contact may cause skin allergy resulting in itching and skin rash	• Use full-face respirator with P100 cartridges as needed. • Wear chemical protective clothing; splash shield (as needed) and gloves to minimize contact with skin/eyes/face when handling solid or solution.	M
X		Lifting/handling bags of sodium persulfate or sodium hydroxide can result in muscle strain	• Do not lift more than your personal limits. • Use a second person if needed or when lifting heavy items. • Lift with your knees and not your back. • Use a step stool and/or have a second person lift chemical bags to you if mixing in taller tanks.	M

ACTIVITY HAZARDS ANALYSIS

	JOB STEPS	HAZARDS	ACTIONS TO ELIMINATE OR MINIMIZE HAZARDS	RAC
X	Pump solution into wells and read pressure and flow gauges	Pressure can build up resulting in hose or flow meter failure leading to possible injury	• Start injections at low flow rate and pressure and adjust as needed. • Secure cam locks to hoses and flow meters. • Never place any body part directly over well heads or in front of fittings that may fly off. • Monitor pressures and stress points of the system during injection (connections, valves, threaded fitting, etc.) • When injection is complete, ensure there is no pressure prior to disassembly. • Shut down injection and let formation de-pressurize itself before disconnecting hoses.	L
X		Cold/wet conditions can cause improper well-head adapted connections, i.e. PVC glue/ cement may not cure properly	• Connect during a warmer day and for a cold weather injection event do any PVC glue related work a few days ahead of the injection event.	L
X		Slips/trips/falls can occur due to hoses laying on the ground resulting in injury	• Practice good housekeeping techniques. • For hoses used during introductions, avoid walking over hoses as much as practicable. • Use high visibility marking and warning devices and secure hose if traveling across a designated facility walking area.	L
X	Clean Equipment	Slips/trips/falls can occur from water and soap causing slippery surfaces. Tripping can occur from equipment being laid out for cleaning	• Be aware of surroundings when cleaning equipment. • Maintain good footing and walk slowly on wet/slippery surfaces. • Keep equipment in a designated cleaning area outside of main walkways	L
X		Heavy lifting of equipment can cause muscle strain	• Use proper lifting techniques. Request assistance when lifting heavy equipment.	L
X		Exposure to chemical solution	• Pump clean water through pumps and hoses before disconnecting for cleaning to remove chemical solution. • Wear PPE including splash aprons or chemical protective suits, chemical resistant gloves, safety glasses/face shield to prevent splashes with residual chemical solution. • Ensure hoses are drained and depressurized before disconnecting. • Ensure eye wash and neutralization solution are available	L
X	Site restoration/loading of equipment	Tripping on equipment laying on the ground	• Secure all equipment after use. • Leave the site clean and free from any trash or debris. • Secure all wells, gates and entrances to the site.	L
X		Heavy lifting can cause muscle strain	• Use proper lifting techniques when loading equipment.	L
X	Inspect injection/equipment trailer and demobilize from site	Improperly loading the trailer can cause flying debris on the roadway. Improper trailer connections can cause the trailer to detach during demobilization.	• Be sure all line items on the check list are satisfactory before departing from the site.	L
X	DPT drilling	Utility Strike	• A minimum of three lines of evidence are required prior to intrusive work • Boreholes cannot be located within 4 ft of a suspected utility. • The first 5 feet will be hand cleared • Properly trained and experienced personnel to be onsite	L

ACTIVITY HAZARDS ANALYSIS

	JOB STEPS	HAZARDS	ACTIONS TO ELIMINATE OR MINIMIZE HAZARDS	RAC
X		Pinch Points or intanglement	• Leather gloves are to be worn at all times while working near the drill rig • No loose fitting clothes or jewelry is allowed • Tear away high visibility vests are required\	L

Add Items

	EQUIPMENT	TRAINING	INSPECTION
X	Vehicles/Trailer		Perform inspection of vehicle at the start and end of each day and prior to each use.
X	PPE	Respirator training	Before each use.
X	Pumps, hoses, injection fittings		Inspect before use. Inspect for leaks during injection.
X	Secondary containment		Inspect on delivery and before placing equipment in containment. Inspect at least daily for holes/leaks.

Involved Personnel:

All site workers participating in injection, mixing, or monitoring activities while injections are occurring

Acceptance Authority (digital signature): ______________________________

ADDENDUM

ADDENDUM

To:
Daniel Eaton, NYSDEC
Robert Morse, USEPA

Copies:
Dave Farnsworth, AFCEC
Sean Eldredge, AFCEC Contractor

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From:
Allison Nelan
Peter Milionis

Date:
February 2017

Arcadis Project No.:
GP16BRAC.4019

Subject:
In-Situ Chemical Oxidation Work Plan Addendum
RW042 – Wash Rack Area of Concern

On behalf of the United States Air Force Civil Engineer Center, Arcadis of New York, Inc. (Arcadis) and Bhate Environmental Associates, Inc. have prepared this addendum to supplement the Draft In-Situ Chemical Oxidation (ISCO) Work Plan for RW042 – Wash Rack Area of Concern, dated November 2016. This addendum was prepared in response to a discussion about the proposed remedial action that is outlined in the Draft ISCO Work Plan for RW042 – Wash Rack Area of Concern.

During the December 6, 2016 BCT meeting, Mr. Daniel Eaton of the NYSDEC asked a question about the anticipated duration of post-injection performance monitoring to ensure that sufficient time would elapse to demonstrate that mass, if any, from upgradient of the proposed injection area would not re-enter the injection area around monitoring well MW-WR-001. Following review of historical reports including the *Final Closure Report for Removal Actions at the Washrack (Area 2891) and Building 2890 (Nose Dock 8)* (OHM 2001), *Draft Closure Report* (Versar 2004), and *Revised Supplemental Closure Report* (Versar 2008), Arcadis has prepared this addendum to propose additional injection points along the former 24-inch diameter vitrified clay drain pipe to address any residual constituents in groundwater that may be present. The 24-inch diameter vitrified clay drain pipe was historically used to convey waste liquids, paint chips, and other solids from the wash rack drain inlet to Building 2887 for treatment (OHM 2001). ISCO injections in this additional area will destroy residual source area mass that would otherwise have the potential to migrate further downgradient.

The proposed scope of work will be completed in addition to the work specified in the Draft ISCO Work Plan and includes implementation of ISCO injections via 7 temporary injection points spaced approximately 20 feet apart along the former 24-inch diameter vitrified clay drain pipe. Sodium persulfate and sodium hydroxide solutions will be mixed to a target injection solution concentration of 50 grams per liter (g/L) of sodium persulfate and 25 g/L of sodium hydroxide, respectively. Assuming a radius of influence of 10 feet, approximately 1,200 gallons of solution will be injected into each of the injection points. Injections will be conducted over an approximately 5-foot interval from the water table at approximately 15 feet below ground surface (bgs) to 20 feet bgs. Work will be completed in a manner consistent with the implementation procedures described in the Draft ISCO Work Plan and concurrent with the injection planned around monitoring well MW-WR-001.

REFERENCES

OHM Remediation Services Corporation (OHM). 2001. The Final Closure Report for Removal Actions at the Washrack (Area 2891) and Building 2890 (Nose Dock 8), Plattsburgh Air Force Base, Plattsburgh, New York. September 25.

Versar, Inc. (Versar). 2004. Draft Closure Report, Washrack Area, Plattsburgh Air Force Base, Plattsburgh, New York. April.

Versar. 2008. Revised Supplemental Closure Report, Washrack Area, Plattsburgh Air Force Base, Plattsburgh, New York. January 9.

FIGURE

4 – Proposed ISCO Injection Locations Along Former Drain Pipe

LEGEND:

- Monitoring Well
- Proposed ISCO Injection Point
- Manhole
- Former Drain Pipe
- Storm Sewer Pipes
- Fence
- ROI - 10 Feet
- Buildings

Notes:
ISCO - In Situ Chemical Oxidation
ROI - Radius of Influence

0 40 80
SCALE IN FEET

FORMER PLATTSBURGH AFB,
PLATTSBURGH, NEW YORK

REMEDIAL ACTION WORK PLAN ADDENDUM

PROPOSED ISCO INJECTION LOCATIONS ALONG FORMER DRAIN PIPE

ARCADIS

FIGURE
4

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