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Revitalizing Auto Communities Environmental Response (RACER) Trust

Approval Request: Lower 1,4-Dioxane Trace Study and In-Situ Chemical Oxidation (ISCO) Injection Pilot Test

Plants 2 & 3, Industrial Land
Lansing, Michigan

March 12, 2015

ARCADIS

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Prepared for:
Revitalizing Auto Communities
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Our Ref.:
B0064479.2015
B0064480.2015

Date:
March 12, 2015

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Acronyms and Abbreviations

bgs	below ground surface
cm/d	centimeters per day
D2O	deuterated water (deuterium oxide)
DGR	directed groundwater recirculation
FSH	ferrous sulfate heptahydrate
ft/d	feet per day
g/L	grams per liter
ISCO	in situ chemical oxidation
µg/L	micrograms per liter
MDEQ	Michigan Department of Environmental Quality
NaOH	sodium hydroxide
NREPA	Natural Resources Environmental Protection Act
PFM	passive flux meter
PVC	polyvinyl chloride
RACER	Revitalizing Auto Communities Environmental Repsonse
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
SDS	Safety Data Sheet
TOD	total oxidant demand
VOC	volatile organic compound

1. Introduction

ARCADIS has been retained by the Revitalizing Auto Communities Environmental Response (RACER) Trust to perform groundwater and soil remediation at the Lansing Plants 2, 3, and 6 (Site) located in Lansing, Michigan (see Figures 1 and 2). The purpose of this work plan is to provide information required to obtain Michigan Department of Environmental Quality (MDEQ) approval to perform a tracer and in situ chemical oxidation (ISCO) injection test with respect to a groundwater discharge permit exemption pursuant to R323.2210(u) of the Part 22 Rules promulgated under Part 31 of Natural Resources Environmental Protection Act (NREPA).

The objective of the injection is to evaluate hydraulic parameters and determine whether ISCO, using sodium persulfate as an oxidant, is an appropriate remedial technology to treat dissolved-phased 1,4-dioxane present in the weathered bedrock on Plants 2 and 3 (lower 1,4-dioxane plume). Two areas have been selected for the injection pilot test: one near the southwest portion of Plant 3 and one near the northwest portion of Plant 2 (Figure 2).

Prior to initiation of the pilot test, a laboratory treatability study will be conducted with Site soil and groundwater extracted from the weathered bedrock to determine the most effective activation method for the oxidant (sodium persulfate). During the treatability study, three activation methods will be tested: iron, sodium hydroxide (NaOH; elevated pH), and ambient or unactivated. Based on the results of the treatability study, the most effective method of activation will be selected for implementation in the field study. All three treatment scenarios are discussed herein.

1.1 Lower 1,4-Dioxane Plume Overview

The lower 1,4-dioxane plume is present in the deep overburden and weathered bedrock at depths generally ranging from 70 to 90 feet below grade. The lower 1,4-dioxane plume, extending from the Plant 3 “coliseum” area to the south-central portion of Plant 2, has been delineated with numerous vertical aquifer profiling borings and monitoring wells. The extent of the lower 1,4-dioxane plume and the general Site layout are presented on Figure 2.

At the 1,4-dioxane source area, the plume is present in the saturated, deep overburden and weathered bedrock zones. South of the source area, the lower 1,4-dioxane plume coalesces and migrates primarily within the weathered bedrock zone. The transition from weathered bedrock to consolidated rock is gradational and, for the purposes of

this injection test, the weathered bedrock zone is estimated to be approximately 10 feet thick. The bedrock consists of the Grand River Formation to the north and Saginaw Formation to the south. The contact between these units is in the vicinity of the Plant 2 North test wells (Figure 2). The Grand River Formation is fine- to medium-grained sandstone that occupies erosional valleys within the Saginaw Formation (United States Geological Survey and National Park Service 2000). The Saginaw Formation consists of finer-grained sandstone with thin layers of shale that vary in thickness.

Groundwater elevation measurements collected from the monitoring wells installed along the lower 1,4-dioxane plume reflect a complex heterogeneous aquifer structure. Due to large vertical gradients observed at certain areas of the Site, the observed groundwater elevation varies depending on the specific depth of a well. Based on the evaluation presented in the Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) Phase 2 Supplemental Report (ARCADIS 2014a), as well as analyses completed in March and April 2014 using passive flux meters (PFMs; EnviroFlux, Inc.), the groundwater flow along the lower 1,4-dioxane plume appears to be southerly, consistent with the plume morphology. The Passive Flux Meter and Transducer Study Memorandum (ARCADIS 2015d, as revised) presents a summary of the PFM study and results.

A north-south cross-section of the plume is presented on Figure 3 showing soil borings completed to delineate the 1,4-dioxane impacts. Data from monitoring wells installed within the deep overburden and weathered bedrock in the area beneath the perched zone near the south wall of the coliseum indicate concentrations of 1,4-dioxane up to 500 micrograms per liter (µg/L) in groundwater.

2. Tracer Study and ISCO Pilot Test

Hydraulic testing was completed in 2014 to evaluate design parameters for a potential directed groundwater recirculation (DGR) system to treat the lower 1,4-dioxane plume. Results of this test were presented in the Corrective Measure Pre-Design Summary Report – Lower 1,4-Dioxane Extraction and Injection Testing (ARCADIS 2015c). Hydraulic testing demonstrated that was that it is easier to inject than extract into the weathered bedrock due to the limitations of extraction imposed by the limited saturated thickness of the weathered bedrock zone. Based on this finding, a tracer injection test was recommended to evaluate DGR-complementary and/or injection only-based remedies including ISCO.

2.1 Test Objectives

The objectives of the tracer and ISCO injection pilot test are as follows:

- Determine injection volume to radius of influence relationship (i.e., mobile porosity of soils) in the injection areas.
- Evaluate tracer and oxidant distribution horizontally across the treatment areas.
- Determine localized groundwater flow direction.
- Evaluate reduction of groundwater concentrations in the injection area and downgradient of the injection area.
- Evaluate the potential of the temporary generation of oxidation by products and/or metals mobilization.
- Assess rebound of groundwater concentrations in the injection area and downgradient of the injection area.

2.2 Treatability Study

Prior to initiation of the pilot test, a laboratory treatability study will be conducted by the ARCADIS Laboratory in Durham, North Carolina. The treatability test will use crushed weathered bedrock from the Site, specified treatment reagents (discussed below), and

impacted Site groundwater collected from the deep aquifer. Groundwater samples from the test will be analyzed from three treatment scenarios:

- Iron-activated sodium persulfate - chemically activated with ferrous sulfate heptahydrate (FSH) chelated by citric acid.
- Sodium hydroxide activated sodium persulfate - chemically activated with NaOH to raise pH to greater than 10.5.
- Ambient activated - no engineered activation.

Each treatment scenario being evaluated will be tested at two concentrations of sodium persulfate: 15 grams per liter (g/L) and 30 g/L. Assuming a groundwater dilution factor of 2, these tests will simulate groundwater injection concentrations of 30 and 60 g/L, respectively. In addition to the six treatment scenarios, a control will be prepared (no oxidant or activator added) to assess volatilization of 1,4-dioxane.

Periodically throughout the test, samples and controls will be analyzed for pH, total oxidant demand (TOD), dissolved metals, ferrous iron, 1,4-dioxane, and volatile organic compounds (VOCs). Analyses will be conducted to evaluate possible oxidation byproducts and intermediate formations including acetone, 2-butanone, and chloromethane. Metals, including arsenic, chromium, iron, and manganese, will be assessed due to the propensity for temporary mobilization due to geochemical changes resulting from the oxidative chemistry, as well as shifts in pH. Review of the results and comparison of the relative TOD among the three treatment scenarios will guide the selection of the activation method used during the pilot tests. Results from the evaluation of dissolved metals speciation and oxidation byproduct during the treatability study will guide development of the post-injection field monitoring plan.

2.3 Supplemental Well Installation

To collect the data required to meet the objectives of the tracer test, two new injection wells and two new monitoring wells will be installed at the locations identified on Figure 2. Existing monitoring well within each test area will be used for tracer dose response and downgradient drift monitoring.

Based on the results of the 2014 hydraulic testing activities, installation of wells via roto-sonic method may be partially responsible for the lower-than-expected well yields observed at Plants 2 and 3. To determine if well efficiency can be increased, the new

test injection wells will be installed using a dual-rotary drilling method. Dual-rotary drilling uses rotational forces to advance a drilling bit and casing, rather than sonic forces, and is less damaging to the formation. If successful, the potential for increased well efficiency and improved extraction rates will assist with the evaluation of potential remedies, in particular the evaluation of DGR proposed as part of the draft Corrective Measures Study (ARCADIS 2014b). Prior to initiating the injection testing, a short-term specific capacity test will be completed on each new injection well to measure well capacity and determine well efficiency.

The injection wells will be installed at each location such that existing hydraulic test wells can be used for tracer dose-response monitoring and downgradient drift monitoring. Injection wells will be constructed with a 4-inch diameter polyvinyl chloride (PVC) casing and 10-foot-long stainless steel wire-wrapped screen. The monitoring wells will be installed within the weathered bedrock to increase downgradient coverage during the tracer test and will be 2-inch diameter PVC casing with a 5-foot-long stainless steel wire-wrapped screen. The exact length and depth of the screen intervals will be dependent on the location, depth of impacts, and saturated thickness of weathered bedrock encountered at each location and is generally expected to be from approximately 83 feet to 88 feet deep in the Plant 3 area and 75 feet to 80 feet deep in the Plant 2 area.

2.4 Injection Plan

To achieve tracer and ISCO injection objectives, tracer (deuterium oxide [D_2O]) and an oxidant (sodium persulfate) will be injected into two areas (see Figure 2). Pending the results of the treatability study, the oxidant will be activated by naturally occurring iron in the weathered bedrock, by engineered chelated iron activation (injection of FSH and citric acid with the sodium persulfate), or by elevating the pH of groundwater to above 10.5 (injection of NaOH with the sodium persulfate). In addition to the oxidant and activator, D_2O (deuterated water) will be added to the injection solution as a conservative tracer. D_2O is an isotopic form of water that is slightly heavier, but otherwise physically and chemically identical to water. D_2O is not affected by the oxidant or activator, travels with groundwater, and can be detected using standard laboratory methods, making it an ideal conservative tracer to use with an oxidant. Safety data sheets (SDSs) for sodium persulfate, FSH, citric acid, NaOH, and D_2O are included in Appendix A. A mobile injection trailer will be used to perform the injection. Secondary containment for the batch mixing tank will be used during the injection.

2.4.1 Injection Solution and Mixing

During the injection event, oxidant (sodium persulfate) and activator solutions (if applicable) will be prepared in separate tanks. The sodium persulfate stock solution will be mixed to a maximum concentration of 120 g/L, twice that of the desired injection concentration and four times that of the targeted in situ concentration. If iron activation is selected, the activator stock solution will be mixed to a maximum concentration of 5 g/L of FSH and 0.70 g/L of citric acid. If NaOH activation is selected, the activator stock solution will be mixed to a concentration of 42 g/L NaOH. If ambient activation is selected, no activator stock solution will be used, and the sodium persulfate stock solution will be mixed to a maximum concentration of 60 g/L. Each solution will be mixed until all visible solids in the tanks have dissolved.

In addition to oxidant and activator, D_2O will be injected into the injection wells to act as a conservative groundwater tracer. Approximately 8 liters of 99 percent D_2O will be mixed into the injection solution for each test location to increase the D_2O concentration enough for detection using analytical methods.

2.4.2 Injection

If an activator is used, equal volumes of the oxidant and activator solutions will be injected. The discharge lines from each tank will be combined into a single line before entering the well, diluting the tank concentrations by half to achieve the desired injection concentrations. The following are the maximum anticipated injection concentrations:

- Oxidant - 60 g/L sodium persulfate
- Activator - 2.5 g/L FSH and 0.35 g/L citric acid, or 21 g/L NaOH

If the treatability study reveals that ambient activated sodium persulfate is most effective, the solution will be injected at an oxidant concentration of 60 g/L without additional mixing with an activator.

A combined volume of approximately 7,200 gallons of ISCO solution will be split evenly between two new injection wells. This volume was determined assuming a radius of influence of 10 feet for each injection well, a mobile porosity of 0.15, and a treatment interval of 10 feet. The actual injected volume may be adjusted to achieve the required radius of influence based on field observations.

Injection wells will be fitted with a bleed valve open to atmosphere that will remain open to ensure that the well is not pressurized during the injection. Pressurization of the well could fracture the formation and create preferential pathways for the injection solution. If the injection rate is too fast, solution will discharge out of the bleed valve through a hose into a container providing a visual indication that the injection rate should be reduced. A 5-gallon bucket (or equivalent) will be placed at each injection well and inside secondary containment to capture any discharge from the bleed valves.

The flow rate from the injection tanks will be monitored to ensure that tanks are discharging at appropriate rates. The injection line will be equipped with a manifold that includes a flow meter, pressure gauge, and flow control valve to monitor and control the injection rate. Flow rates and total injection volume to the injection well will also be monitored and recorded.

3. Monitoring

Groundwater will be monitored during the pilot test in three phases: baseline sampling, injection test monitoring, and post-injection monitoring. The proposed monitoring well network is shown on Figure 2 and will consist of:

- Eleven existing wells (MW-13-43, MW-13-44, TW-14-03, TW-14-04, TW-14-05, TW-14-06, TW-14-07, TW-14-08, TW-14-09, PW-14-02, and PW-14-03).
- Two proposed monitoring wells (TW-15-11 and TW-15-13).
- Two proposed injection wells (TW-15-10 and TW-15-12).

3.1 Baseline Sampling

Prior to the ISCO injection test, baseline groundwater samples will be collected from each well in the network and analyzed for the following parameters:

- 1,4-dioxane.
- Michigan 10 Metals (arsenic, barium, cadmium, chromium, copper, lead, mercury, selenium, silver, and zinc).
- Sodium.
- Total alkalinity.
- Chloride.
- Sulfate.
- D2O.
- Any additional oxidation byproducts identified during the treatability test.

3.2 Injection Monitoring

During injection, pH and conductivity will be monitored in the monitoring well network to assess the distribution of the injected solution. Field tests for persulfate (and ferrous

iron if applicable) will be completed to confirm transport of the injected solution. Temperature and depth to water will also be monitored at the dose-response wells during injection.

3.3 Post-Injection Monitoring

Post-injection monitoring will include sampling of the injection wells and monitoring wells for field analysis of pH; conductivity; and sodium persulfate, iron (if applicable) and laboratory analysis of D_2O. Post-injection monitoring will be conducted following completion of the injection event until washout of the injection solution is observed through the treatment areas. The sampling frequency will be field-determined based on the results of each post-injection sampling event.

After all tracer and field parameter sampling events have been completed, groundwater samples will be collected from the injection wells and the monitoring well network for laboratory analysis of the same baseline parameters listed above to assess the performance of the ISCO injection test.

4. Injection Receptor Analysis

Deep groundwater encountered at the Site is not used as a drinking water source. Additionally, there are no drinking water wells located on site. However, the Site is located partially within a wellhead protection area, and the bedrock aquifer targeted for injection is used as a drinking water source for the City of Lansing and Lansing Township. The locations of the municipal water source wells relative to the Site are shown on Figure 4.

Municipal water wells are generally installed as open bedrock wells with total depths of 400 to 500 feet below grade. The well casings are generally set at 50 or more feet into bedrock to assure well stability. Lansing Board of Water and Light personnel have indicated that these wells are typically capable of pumping several hundred gallons per minute.

A transducer survey was completed at the Site to evaluate the hydraulic connection between the monitoring wells installed along the lower 1,4-dioxane plume and the municipal pumping wells. The results of the study show a hydraulic response at several bedrock wells located near the lower 1,4-dioxane source area at Plant 3. The highest amplitude of response was observed due to the pumping at Lansing Township Well #4, located approximately 1,000 feet west of the “coliseum” area (Figure 4). However, the bedrock in the 1,4-dioxane source area is not impacted, and operation of the municipal wells does not appear to effect the distribution of the lower 1,4-dioxane plume within the weathered bedrock zone (ARCADIS 2015d).

Because the municipal wells have not affected the distribution of the lower 1,4-dioxane plume, it is logical to assume that they will not affect the distribution of injected oxidant. In addition, oxidant is not expected to persist in the subsurface for more than 2 to 3 months. The measured Darcy velocity ranges from 6.7 centimeters per day (cm/d) at Plant 3 to a minimum of 2.1 cm/d at Plant 2. With an assumed mobile porosity of 15 percent, seepage velocities for the test areas are estimated to be range from approximately 1.7 feet per day (ft/d) to 0.5 ft/d (ARCADIS 2014b). Based on these seepage velocities, the maximum distance oxidant is expected to travel is approximately 140 feet downgradient of injection wells. Therefore, oxidant is not expected to migrate off site or pose any threat to the off-site municipal wells.

Utilities within the injection areas or immediately downgradient of the injection area are shallow, typically less than 30 feet below ground surface (bgs). Due to the depth of the

proposed injection (>65 feet bgs), the oxidant will not contact any underground utilities or pose a threat to surface water.

4.1 Estimated Discharges

The injected oxidant concentration used for the pilot test will be selected based on the treatability study results as described above. To estimate potential discharges for each of the three treatment scenarios, the highest potential oxidant concentration (60 g/L) was assumed. The estimated potential discharge concentrations are as follows:

1. Ambient activated oxidant

At a sodium persulfate injection concentration of 60 g/L, assuming complete dissociation, the maximum sulfate and sodium concentrations in the injection solution could be up to 49 and 12 g/L, respectively.

2. Iron activated oxidant

At a sodium persulfate injection concentration of 60 g/L, an activator concentration of 2.5 g/L FSH, and a chelator concentration of 0.35 g/L citric acid, assuming complete dissociation of the compounds, the maximum sulfate, sodium, and iron concentrations in the injection solution are 50, 12, and 0.5 g/L, respectively.

3. NaOH activated oxidant

At a sodium persulfate injection concentration of 60 g/L and an activator concentration of 21 g/L NaOH, assuming complete dissociation, the maximum sulfate and sodium concentrations in the injection solution are 49 and 24 g/L, respectively. Additionally, the pH of the injection solution is expected to be higher than 10.5 pH units.

In all cases, the injection solution will immediately be diluted by groundwater once introduced into the subsurface. Therefore, the actual concentrations of sulfate, sodium, and/or iron migrating from the injection area are expected to be significantly lower.

Additionally, groundwater pH will be affected by the injection. The pH of groundwater will be increased to above 10.5 if NaOH is selected as an oxidant activator and may decrease to as low as 2 in the case of ambient or iron activation. The matrix within the weathered bedrock is expected to buffer the pH within weeks of injection; therefore,

any increase in pH is expected to be temporary and it is not expected that groundwater with pH above background would migrate off site. Routine pH measurements will be collected as part of the post-injection monitoring plan to ensure that groundwater pH in the treatment area and downgradient returns to background as expected.

ISCO may temporarily alter the geochemical conditions in the vicinity of the injection well and result in temporary mobilization of naturally occurring metals present in soil. Based on ARCADIS' experience with sodium persulfate injections, the geochemical changes do not migrate downgradient of the injection radius of influence. Therefore, any metals mobilization will be temporary, and any potentially mobilized metals should not be observed outside of the injection area. Metals will be analyzed as part of the post-injection monitoring plan, and a contingency plan for metals mobilizing outside of the treatment area has been developed as discussed below.

5. Data Evaluation

The data collected during the ISCO injection test and associated post-injection sampling will be evaluated to assess the following:

- Mobile porosity of the soils in the injection area.
- Tracer and oxidant distribution across the treatment area horizontally.
- Localized groundwater flow direction.
- Groundwater flow velocity.
- Reduction of dissolved constituent concentrations in the injection area.
- Generation of temporary oxidation byproducts or metals mobilization.
- Reduction of dissolved constituent concentrations downgradient of the injection area.

Evaluation of these data will determine if ISCO, using sodium persulfate, can meet the overall goal of treating dissolved-phased 1,4-dioxane in the weathered bedrock zone beneath Plants 2 and 3.

6. Contingency Plan

As discussed, groundwater samples will be collected from the monitoring network for analysis of field pH, and laboratory 1,4-dioxane, Michigan 10 Metals (arsenic, barium, cadmium, chromium, copper, lead, mercury, selenium, silver, and zinc), sodium, total alkalinity, chloride, and sulfate. If concentrations above background levels or applicable MDEQ criteria (whichever is higher) of any of these parameters are observed migrating, an exposure pathway evaluation will be completed to assess the associated risk and determine the need for additional groundwater sample collection. If deemed necessary due to migrating constituents, groundwater samples from one or more of the following downgradient wells will be analyzed for the aforementioned parameters (see Figure 2):

- Plant 2 area: PW-14-01, MW-14-61, and/or MW-13-50.
- Plant 3 area: MW-13-34, MW-13-46, and/or MW-13-49.

If the tracer and ISCO injection test is not successful in treating dissolved-phased impacts beneath the former Plants 2 and 3, subsequent injections may be performed if deemed appropriate based on the data collected. Subsequent ISCO injection tests may use both, one, or neither of the ISCO injection wells proposed within this plan.

7. Schedule

Planning and coordination of this work will begin immediately after approval from MDEQ is obtained. Implementation of this work is estimated to begin in the spring of 2015.

8. References

United Stated Geological Survey and National Parks Service. 2000. Geologic Provinces of the United States. Retrieved April 21, 2006 from: www2.nature.ups..gov/geology/usgenpa/province.

ARCADIS 2014a. Resource Conservation and Recovery Act (RCRA) Facilities Investigation (RFI) Supplemental Phase 2 Activities Summary Report. RACER Trust, Lansing, Michigan Plants 2, 3, & 6 Industrial Land. February 26.

ARCADIS 2014b. RCRA Corrective Action; Draft Corrective Measures Study. Plants 2, 3, & 6 Industrial Land. June 4.

ARCADIS 2015c. Corrective Measure Pre-Design Summary Report – Lower 1,4-Dioxane Extraction and Injection Testing. January 29.

ARCADIS 2015d. Passive Flux Meter and Transducer Study Memorandum. RACER Trust, Lansing, Michigan Plants 2, 3, & 6 Industrial Land. January 30.

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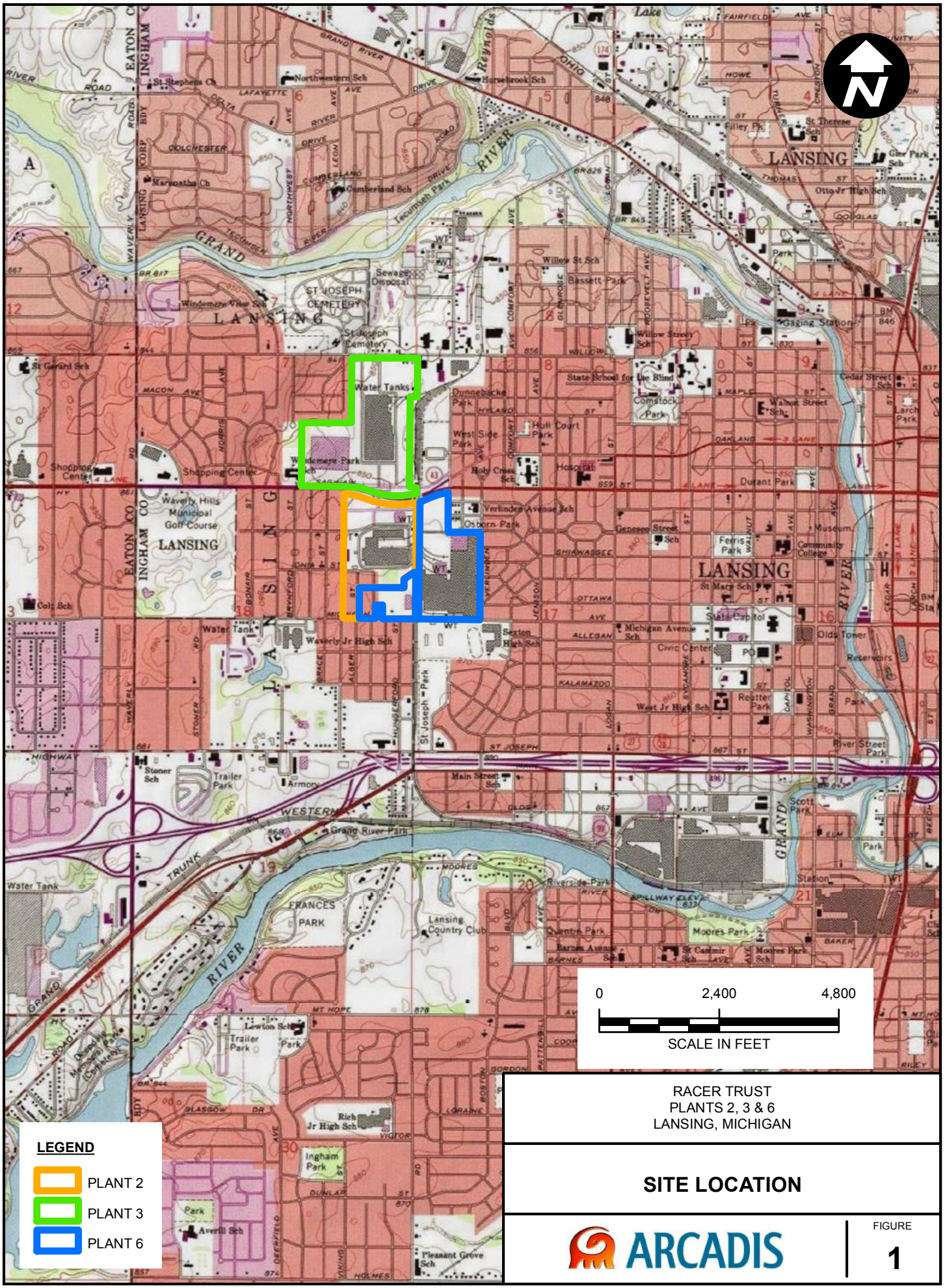
Figures



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PLANTS 2, 3 & 6
LANSING, MICHIGAN

SITE LOCATION

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FIGURE
1

CITY: KNOXVILLE DIV: ENV DB: A.SMITH PIC: D. KAIDING PM: R. CHRISTENSEN TM: K. TEMPLIN TR: J. SALING PROJECT NUMBER: B0064479.2015/B0064480.2015 COORDINATE SYSTEM: NAD 1983 StatePlane Michigan South FIPS 2113 Feet Intl
G:\GIS\Project Files\MotorsLiquidationCompany\Lansing\Docs\Phase 2 RFI Report Figs\FIG 1 - SITE LOCATION.mxd PLOTTED: 3/29/2013 12:25:25 PM BY: dolexa

PLANT 3 INJECTION AREA

TW-14-06
TW-14-07
TW-15-10
TW-14-08
TW-14-09
TW-15-11
PW-14-03

MW-13-46
MW-13-34
MW-13-49
MW-14-61
PW-14-01
MW-13-50

PLANT 2 INJECTION AREA

TW-14-03
TW-15-12
MW-13-43
MW-13-44
TW-14-04
TW-15-13
TW-14-05
PW-14-02

LEGEND

- PROPOSED INJECTION WELL
- PROPOSED WEATHERED BEDROCK TEST WELL
- DEEP OVERBURDEN MONITORING WEL
- WEATHERED BEDROCK MONITORING WELL
- BEDROCK MONITORING WELL
- WEATHERED BEDROCK TEST WELL
- APPROXIMATE EXTENT LOWER 1,4-DIOXANE PLUME > 8.5 µg/L
- APPROXIMATE EXTENT LOWER 1,4-DIOXANE PLUME > 85 µg/L
- PLANT 2
- PLANT 3
- PLANT 6

NOTES:

µg/L: MICROGRAMS PER LITER

0 280 560
SCALE IN FEET

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PLANTS 2, 3, & 6
LANSING, MICHIGAN

PROPOSED TRACER TEST AND ISCO PILOT WELL LAYOUT

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FIGURE
2

CITY: Novi DIV: ENV DB: TRY PIC: D. KAIDING PM: R. CHRISTENSEN TM: K. TEMPLIN TR: J. SALING PROJECT NUMBER: B0064479.2015/B0064480.2015 COORDINATE SYSTEM: NAD 1983 StatePlane Michigan South FIPS 2113 Feet Intl
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A
North

A'
South

MW-12-21 MW-13-22 MW-13-28 PW-14-03 MW-13-29 MW-13-48 MW-13-34 MW-13-47 VAP-P2-JO68 VAP-P2-KH71 VAP-P2-KW91 VAP-P2-L091 MW-13-43 MW-13-44 PW-14-02 MW-12-05 VAP-P2-OS100 PW-14-01 VAP-P2-PV101 MW-13-52 MW-13-50

Plant 3 Plant 2 Plant 6

Coliseum

W. Saginaw Ave

Perched Zone

DRY DRY DRY DRY

410 181 <5 360 15 130 136 49 <5 121 10 16 <5 18 106 350 580 6 7 196 350 <5 <5 <5 <5

Weathered Bedrock Interface

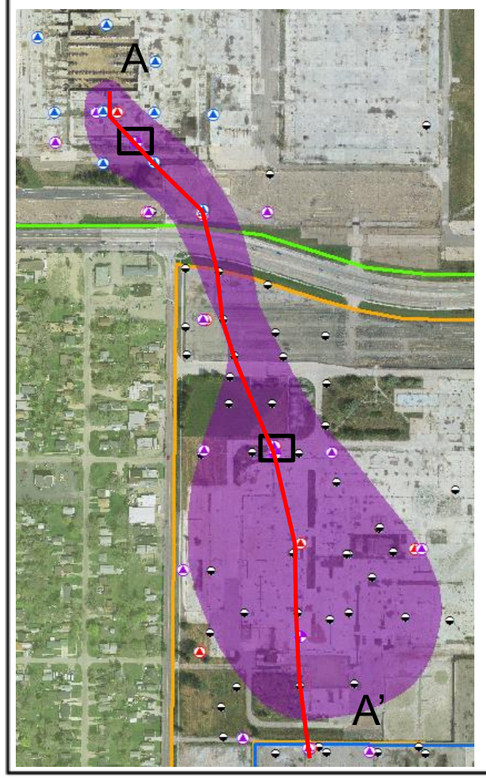
GR Fm

Sag Fm

880 860 840 820 800 780 760 740 720

0.0 250 500 750 1,000 1,250 1,500 1,750 2,000 2,250 2,500 2,750 3,000 3,250

Feet



LEGEND

106 — 1,4-Dioxane concentration in groundwater (µg/L)

GR Fm – Grand River Formation – fine to medium grained sandstone

Sag Fm – Saginaw Formation - fine sandstone interbedded with shale

Approximate extent of 1,4-dioxane in perched groundwater

Approximate Monitoring Well Screen Interval
- Blue - Deep Overburden
- Purple- Weathered Bedrock
- Red - Bedrock

Approximate Groundwater Elevation
- Blue - Deep Overburden
- Purple - Weathered Bedrock
- Red - Bedrock

Approximate Tracer Study Test Area

1,4-DIOXANE PLUME
- 500 ug/L
- 300 ug/L
- 100 ug/L
- 30 ug/L
- 10 ug/L
- <5 ug/L

STRATIGRAPHY
- CONCRETE/ASPHALT/TOPSOIL
- FILL
- GRAVELLY SAND
- SAND
- SANDY SILT/SILT
- SILTY/SANDY/GRAVELLY CLAY
- CLAY
- PEAT
- BEDROCK-SANDSTONE
- BEDROCK-SHALE
- NO RECOVERY

NOTE:
Vertical A uifer Profiling data was collected between March to November 2013
Monitoring Well data was collected 12/2014
µg/L: Micrograms per liter

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PLANTS 2, 3, & 6
LANSING, MICHIGAN

LOWER 1,4-DIOXANE PLUME CROSS SECTION A-A'

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FIGURE 3

BWL 10-05
BWL 10-14
BWL 10-13
BWL 10-01
BWL 10-03
BWL 10-02
TWP-WELL-#7
BWL 10-12
BWL 10-09
TWP-WELL-#6
BWL 10-11
BWL 10-08
BWL 10-10
BWL 10-15
TWP-WELL-#5
BWL 15-08
BWL 15-07
BWL 10-07
TWP-WELL-#4
BWL 10-06
TWP-WELL-#3
TWP-WELL-#1
TWP-WELL-#2
NO-ID

LEGEND

- MUNICIPAL WATER SUPPLY WELLS
- APPROXIMATE TRACER TEST STUDY AREA
- PLANT 2
- PLANT 3
- PLANT 6

WELLHEAD PROTECTION AREAS

- LANSING TOWNSHIP
- CITY OF LANSING

0 860 1,720
SCALE IN FEET

Source: Esri, DigitalGlobe, Ge
USGS, AEX, Getmapping, Aer

RACER TRUST
PLANTS 2, 3 & 6
LANSING, MICHIGAN

MUNICIPAL WATER SUPPLY AND WELLHEAD PROTECTION AREAS

ARCADIS

FIGURE
4

CITY: KNOXVILLE DIV: ENV DB: A.SMITH PIC: D. KAIDING PM: R. CHRISTENSEN TM: K.TEMPLIN TR: J. SALING PROJECT NUMBER: B0064479.2015 / B0064480.2015 COORDINATE SYSTEM: NAD 1983 StatePlane Michigan South FIPS 2113 Feet Intl
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Appendix A

Proposed Injection Chemical Safety Data Sheets

Material Safety Data Sheet

Klozur® SP

MSDS #: 7775-27-1-12
Revision Date: 2014-04-15
Version 3

This MSDS has been prepared to meet U.S. OSHA Hazard Communication Standard 29 CFR 1910.1200 And Canadian Workplace Hazardous Materials Information System (WHMIS) requirements.

1. PRODUCT AND COMPANY IDENTIFICATION

Product name **Klozur® SP**

Synonyms Sodium Peroxydisulfate; Disodium Peroxydisulfate; Peroxydisulfuric acid, disodium salt; Peroxydisulfuric acid, sodium salt

Formula Na2O8S2 and $Na_2S_2O_8$

Recommended use: In situ and ex situ chemical oxidation of contaminants and compounds of concern for environmental remediation applications

Restrictions on use: No uses to be advised against were identified

Manufacturer

PeroxyChem LLC
1735 Market Street
Philadelphia, PA 19103
Phone: +1 215/ 299-5858 (General Information)
E-Mail: sdsinfo@peroxychem.com

Emergency telephone number

For leak, fire, spill or accident emergencies, call:
1 800 / 424 9300 (CHEMTREC - U.S.A.)
1 703 / 527 3887 (CHEMTREC - Collect - All Other Countries)
1 303/ 389-1409 (Medical - U.S. - Call Collect)

2. HAZARDS IDENTIFICATION

Emergency Overview

White, odorless crystals
Oxidizer; Contact with combustible material may cause fire.
Decomposes in storage under conditions of moisture and/or excessive heat causing release of sulfur oxides and oxygen that supports combustion (See Section 10).

Potential health effects

Acute Toxicity

Eyes Causes moderate eye irritation.
Skin Moderately irritating to the eyes. May cause sensitization by skin contact.
Inhalation May cause irritation of respiratory tract. Respiratory sensitizer.
Ingestion Harmful if swallowed.

3. COMPOSITION/INFORMATION ON INGREDIENTS

Ingredients

Chemical Name	CAS-No	Weight %
Sodium Persulfate	7775-27-1	> 99

4. FIRST AID MEASURES

General advice Remove from exposure, lie down. Show this material safety data sheet to the doctor in attendance.

Eye contact Rinse thoroughly with plenty of water for at least 15 minutes, lifting lower and upper eyelids intermittently. Consult a physician. In case of contact, immediately flush eyes with plenty of water. If symptoms persist, call a physician.

Skin contact Wash off immediately with soap and plenty of water while removing all contaminated clothes and shoes. Get medical attention if irritation develops and persists.

Inhalation Remove from exposure, lie down. If breathing is irregular or stopped, administer artificial respiration. Call a physician immediately.

Ingestion Do NOT induce vomiting. Call a physician or poison control center immediately. Rinse mouth. Drink 1 or 2 glasses of water.

5. FIRE-FIGHTING MEASURES

Flash Point Not flammable

Suitable extinguishing media Water. Cool containers with flooding quantities of water until well after fire is out.

Unsuitable Extinguishing Media Do not use carbon dioxide or other gas filled fire extinguishers; they will have little effect on decomposing persulfate.

Explosion Data
Sensitivity to Mechanical Impact Not applicable
Sensitivity to Static Discharge Not applicable

Specific hazards arising from the chemical Decomposes under fire conditions to release oxygen that intensifies the fire.

Protective equipment and precautions for firefighters As in any fire, wear self-contained breathing apparatus pressure-demand, MSHA/NIOSH (approved or equivalent) and full protective gear.

NFPA	Health Hazard 2	Flammability 0	Stability 1	Special Hazards OX

6. ACCIDENTAL RELEASE MEASURES

Personal precautions Keep off any unprotected persons. Avoid contact with the skin and the eyes. Avoid breathing dust. Wear personal protective equipment.

Methods for containment Vacuum, shovel or pump waste into a drum and label contents for disposal. Avoid dust formation Store in closed container

Methods for cleaning up Clean up spill area and treat as special waste. Clean up the area with plenty of water.

Other Never add other substances or combustible waste to product residues.

7. HANDLING AND STORAGE

Handling

Wear personal protective equipment. Refer to Section 8. Use only in area provided with appropriate exhaust ventilation. Avoid dust formation. Handle product only in closed system or provide appropriate exhaust ventilation at machinery. Avoid contact with skin and eyes. Avoid breathing dust. Remove and wash contaminated clothing before re-use.

Storage

Keep containers tightly closed in a dry, cool and well-ventilated place. Keep away from heat. Do not store near combustible materials. Avoid contamination of opened product. Keep away from food, drink and animal feedingstuffs. Avoid formation and deposition of dust.

8. EXPOSURE CONTROL / PERSONAL PROTECTION

Exposure guidelines .

Chemical Name	ACGIH TLV	OSHA PEL	NIOSH	Mexico
Sodium Persulfate 7775-27-1	TWA: 0.1 mg/m³			

Chemical Name	British Columbia	Quebec	Ontario TWAEV	Alberta
Sodium Persulfate 7775-27-1	TWA: 0.1 mg/m³		TWA: 0.1 mg/m³	TWA: 0.1 mg/m³

Occupational exposure controls

Engineering measures

Local exhaust ventilation w >90% efficiency.

Respiratory protection

If exposure limits are exceeded or irritation is experienced, NIOSH/MSHA approved respiratory protection should be worn. Positive-pressure supplied air respirators may be required for high airborne contaminant concentrations. Respiratory protection must be provided in accordance with current local regulations.

Eye/face protection

Eye protection recommended. Chemical goggles consistent with EN 166 or equivalent.

Skin and body protection

Wear suitable protective clothing. Protective shoes or boots.

Hand protection

Protective gloves: Neoprene gloves, Polyvinylchloride, Natural Rubber.

Hygiene measures

Keep away from food, drink and animal feeding stuffs. Do not eat, drink or smoke when using this product. Wash hands before breaks and after shifts. Keep work clothes separate, remove contaminated clothing - launder after open handling of product.

9. PHYSICAL AND CHEMICAL PROPERTIES

Information on basic physical and chemical properties

Appearance	Crystalline solid
Color	white
Physical state	solid
Odor	Odorless
Odor Threshold	Not applicable
pH	6.0 (1% solution)
Melting Point/Range	Decomposes on heating. 180 °C
Freezing point	Not applicable
Boiling Point/Range	Decomposes
Flash Point	Not flammable
Evaporation rate	Not applicable
Oxidizing properties	Oxidizer
Explosive properties	Not explosive
Vapor pressure	6.07E-30 mm Hg at 25ºC
Vapor density	No information available

Specific Gravity	1.68
Molecular Weight	238.1
Water solubility	730 g/L @ 25 °C
Percent volatile	No information available
Partition coefficient	Not applicable
Viscosity	(Solid)
Decomposition Temperature	> 100 °C
Autoignition Temperature	No evidence of combustion up to 600°C

10. STABILITY AND REACTIVITY

Stability Stable.

Conditions to avoid Heat; Moisture; Combustibles such as paper and wood.

Materials to avoid Acids, Bases, Halides, Oxidizing agents, Strong reducing agents, Combustible materials,

Hazardous decomposition products None known .

Hazardous polymerization Hazardous polymerization does not occur.

Hazardous reactions Use of persulfates in chemical reactions 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

Acute effects

Eye irritation Irritating to eyes. Has been shown to exhibit eye irritation properties in human case reports following occupational exposure and consumer use. Slight irritation (rabbit).

Skin irritation Irritating to skin. Persulfates in general, specifically diammonium persulfate and dipotassium persulfate, exhibited skin irritation properties in human case reports, following occupational exposure and consumer use. Slight irritation (rabbit).

LD50 Oral	1200 mg/kg (Rat) Sodium Persulfate
LD50 Dermal	> 10,000 mg/kg (rabbit) Sodium Persulfate
LC50 Inhalation	= > 5.1 mg/L (4-hr) (Rat) Sodium Persulfate

Sensitization Sensitizing to skin and respiratory system Positive in a local lymph node assay.

Chronic Toxicity

Carcinogenicity Did not show carcinogenic effects in animal experiments

Mutagenicity In vivo tests did not show mutagenic effects. In vitro tests did not show mutagenic effects.

Target Organ Effects Eyes, Skin, Respiratory system.

12. ECOLOGICAL INFORMATION

Ecotoxicity

Sodium Persulfate (7775-27-1)

Active Ingredient(s)	Duration	Species	Value	Units
Sodium Persulfate	96 h LC50	Rainbow trout	163	mg/L
Sodium Persulfate	48 h LC50	Daphnia magna	133	mg/L
Sodium Persulfate	96 h LC50	Grass shrimp	519	mg/L
Sodium Persulfate	72 h EC50	Algae S. capricornutum	116	mg/L

Persistence and degradability Biodegradability does not pertain to inorganic substances.

Bioaccumulation Does not bioaccumulate.

Mobility Dissociates into ions.

Other adverse effects None known

13. DISPOSAL CONSIDERATIONS

Waste disposal methods This material, as supplied, is a hazardous waste according to federal regulations (40 CFR 261). It must undergo special treatment, e.g. at suitable disposal site, to comply with local regulations.

RCRA D Waste Code D001 (ignitable).

Contaminated packaging Dispose of in accordance with local regulations.

14. TRANSPORT INFORMATION

DOT

UN/ID No UN 1505
Proper shipping name SODIUM PERSULFATE
Hazard Class 5.1
Packing group III
Reportable Quantity (RQ) not applicable

TDG

UN/ID No UN 1505
Proper shipping name SODIUM PERSULFATE
Hazard Class 5.1
Packing group III

ICAO/IATA

UN/ID No UN 1505
Proper shipping name SODIUM PERSULFATE
Hazard Class 5.1
Packing group III

IMDG/IMO

UN/ID No UN 1505
Proper shipping name SODIUM PERSULFATE
Hazard Class 5.1
Packing group III

ADR/RID

UN/ID No 1505
Proper shipping name SODIUM PERSULFATE

Hazard Class	5.1
Packing group	III
Description	Oxidizer

15. REGULATORY INFORMATION

International Inventories

TSCA Inventory (United States of America)	Complies
DSL (Canada)	Complies
NDSL (Canada)	Complies
EINECS/ELINCS (Europe)	Complies
ENCS (Japan)	Complies
IECSC (China)	Complies
KECL (Korea)	Complies
PICCS (Philippines)	Complies
AICS (Australia)	Complies
NZIoC (New Zealand)	Complies

U.S. Federal Regulations

SARA 313

Section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986 (SARA). This product does not contain any chemicals which are subject to the reporting requirements of the Act and Title 40 of the Code of Federal Regulations, Part 372.

SARA 311/312 Hazard Categories

Acute Health Hazard	yes
Chronic Health Hazard	no
Fire Hazard	yes
Sudden Release of Pressure Hazard	no
Reactive Hazard	no

CERCLA

This material, as supplied, does not contain any substances regulated as hazardous substances under the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) (40 CFR 302) or the Superfund Amendments and Reauthorization Act (SARA) (40 CFR 355). There may be specific reporting requirements at the local, regional, or state level pertaining to releases of this material.

International Regulations

Mexico - Grade Moderate risk, Grade 2

Canada

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

WHMIS Hazard Class

C Oxidizing materials
D2A Very toxic materials
D2B Toxic materials

16. OTHER INFORMATION

HMIS	Health Hazard 2	Flammability 0	Stability 1	Special precautions J

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

Product Certifications

Revision Date: 2014-04-15
Reason for revision: Initial Release.

Disclaimer
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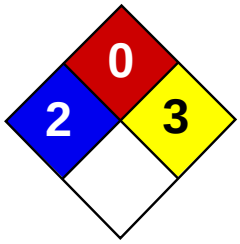
Prepared By

PeroxyChem

End of Material Safety Data Sheet



Material Safety Data Sheet
Ferrous sulfate heptahydrate MSDS

Section 1: Chemical Product and Company Identification

Product Name: Ferrous sulfate heptahydrate

Catalog Codes: SLF2029, SLF1228

CAS#: 7782-63-0

RTECS: OD5525000

TSCA: TSCA 8(b) inventory: No products were found.

CI#: Not available.

Synonym:

Chemical Name: Ferric Sulfate Heptahydrate

Chemical Formula: FeSO4.7H2O

Contact Information:

Sciencelab.com, Inc.
14025 Smith Rd.
Houston, Texas 77396

US Sales: **1-800-901-7247**
International Sales: **1-281-441-4400**

Order Online: ScienceLab.com

CHEMTREC (24HR Emergency Telephone), call:
1-800-424-9300

International CHEMTREC, call: 1-703-527-3887

For non-emergency assistance, call: 1-281-441-4400

Section 2: Composition and Information on Ingredients

Composition:

Name	CAS #	% by Weight
Ferrous sulfate heptahydrate	7782-63-0	100

Toxicological Data on Ingredients: Ferrous sulfate heptahydrate: ORAL (LD50): Acute: 1520 mg/kg [Mouse].

Section 3: Hazards Identification

Potential Acute Health Effects: Hazardous in case of skin contact (irritant), of eye contact (irritant), of ingestion, of inhalation.

Potential Chronic Health Effects:
CARCINOGENIC EFFECTS: Not available. MUTAGENIC EFFECTS: Mutagenic for bacteria and/or yeast. TERATOGENIC EFFECTS: Not available. DEVELOPMENTAL TOXICITY: Not available. The substance is toxic to liver. The substance may be toxic to kidneys, cardiovascular system, central nervous system (CNS). Repeated or prolonged exposure to the substance can produce target organs damage.

Section 4: First Aid Measures

Eye Contact:
Check for and remove any contact lenses. In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Cold water may be used. Get medical attention.

Skin Contact:
In case of contact, immediately flush skin with plenty of water. Cover the irritated skin with an emollient. Remove contaminated clothing and shoes. Cold water may be used.Wash clothing before reuse. Thoroughly clean shoes before reuse. Get medical attention.

Serious Skin Contact:
Wash with a disinfectant soap and cover the contaminated skin with an anti-bacterial cream. Seek immediate medical attention.

Inhalation:
If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention.

Serious Inhalation: Not available.

Ingestion:
Do NOT induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person. If large quantities of this material are swallowed, call a physician immediately. Loosen tight clothing such as a collar, tie, belt or waistband.

Serious Ingestion: Not available.

Section 5: Fire and Explosion Data

Flammability of the Product: Non-flammable.

Auto-Ignition Temperature: Not applicable.

Flash Points: Not applicable.

Flammable Limits: Not applicable.

Products of Combustion: Not available.

Fire Hazards in Presence of Various Substances: Not applicable.

Explosion Hazards in Presence of Various Substances:
Risks of explosion of the product in presence of mechanical impact: Not available. Risks of explosion of the product in presence of static discharge: Not available. Explosive in presence of heat.

Fire Fighting Media and Instructions: Not applicable.

Special Remarks on Fire Hazards: Not available.

Special Remarks on Explosion Hazards: Not available.

Section 6: Accidental Release Measures

Small Spill:
Use appropriate tools to put the spilled solid in a convenient waste disposal container. Finish cleaning by spreading water on the contaminated surface and dispose of according to local and regional authority requirements.

Large Spill:
Use a shovel to put the material into a convenient waste disposal container. Finish cleaning by spreading water on the contaminated surface and allow to evacuate through the sanitary system. Be careful that the product is not present at a concentration level above TLV. Check TLV on the MSDS and with local authorities.

Section 7: Handling and Storage

Precautions:

Keep locked up.. Do not ingest. Do not breathe dust. Wear suitable protective clothing. In case of insufficient ventilation, wear suitable respiratory equipment. If ingested, seek medical advice immediately and show the container or the label. Avoid contact with skin and eyes. Keep away from incompatibles such as oxidizing agents, alkalis.

Storage:
Hygroscopic. Air Sensitive. Keep container tightly closed. Keep container in a cool, well-ventilated area. Do not store above 24°C (75.2°F).

Section 8: Exposure Controls/Personal Protection

Engineering Controls:
Use process enclosures, local exhaust ventilation, or other engineering controls to keep airborne levels below recommended exposure limits. If user operations generate dust, fume or mist, use ventilation to keep exposure to airborne contaminants below the exposure limit.

Personal Protection:
Splash goggles. Lab coat. Dust respirator. Be sure to use an approved/certified respirator or equivalent. Gloves.

Personal Protection in Case of a Large Spill:
Splash goggles. Full suit. Dust respirator. Boots. Gloves. A self contained breathing apparatus should be used to avoid inhalation of the product. Suggested protective clothing might not be sufficient; consult a specialist BEFORE handling this product.

Exposure Limits:
TWA: 1 CEIL: 2 Consult local authorities for acceptable exposure limits.

Section 9: Physical and Chemical Properties

Physical state and appearance: Solid.

Odor: Not available.

Taste: Not available.

Molecular Weight: 278.01 g/mole

Color: Blue to blue-green. (Light.)

pH (1% soln/water): Not available.

Boiling Point: Not available.

Melting Point: Not available.

Critical Temperature: Not available.

Specific Gravity: 1.898 (Water = 1)

Vapor Pressure: Not applicable.

Vapor Density: Not available.

Volatility: Not available.

Odor Threshold: Not available.

Water/Oil Dist. Coeff.: Not available.

Ionicity (in Water): Not available.

Dispersion Properties: See solubility in water.

Solubility: Soluble in cold water.

Section 10: Stability and Reactivity Data

Stability: The product is stable.

Instability Temperature: Not available.

Conditions of Instability: Incompatibles

Incompatibility with various substances:
Reactive with oxidizing agents, alkalis. Slightly reactive to reactive with moisture.

Corrosivity: Not available.

Special Remarks on Reactivity:
Hygroscopic. Oxidizes when in contact with mositure to form ferric sulfate. Air Sensitive Incompatible with alkalies, soluble carbonates, Au and Ag salts, Pb acetate, lime water, KI, K, and Na tartrate, Na Borate, tannin, vegetable astringent infusions and decoctions.

Special Remarks on Corrosivity: Not available.

Polymerization: Will not occur.

Section 11: Toxicological Information

Routes of Entry: Inhalation. Ingestion.

Toxicity to Animals: Acute oral toxicity (LD50): 1520 mg/kg [Mouse].

Chronic Effects on Humans:
MUTAGENIC EFFECTS: Mutagenic for bacteria and/or yeast. Causes damage to the following organs: liver. May cause damage to the following organs: kidneys, cardiovascular system, central nervous system (CNS).

Other Toxic Effects on Humans: Hazardous in case of skin contact (irritant), of ingestion, of inhalation.

Special Remarks on Toxicity to Animals:
Lowest Published Lethal Dose LDL [Rat] - Route: Oral; Dose: 1389 mg/kg

Special Remarks on Chronic Effects on Humans:
May affect genetic material (mutagenic). It is excreted in maternal milk in animal.

Special Remarks on other Toxic Effects on Humans:
Acute Potential Health Effects: Skin: May cause skin irritation. Eyes: May cause eye irritation. Inhalation: May cause respiratory tract irritation. Ingestion: Harmful if swallowed. May cause gastrointestinal tract distrubances and irritation with nausea, vomiting, colic, constipation, diarrhea, black stool. May also affect behavior/Central Nervous System (somnolence -general depressed activity), respiration, cardiovascular system, liver, kidneys (pink urine discoloration). Chronic Potential Health Effects: Repeated exposure via ingestion may increase iron levels in the liver, and spleen. Damage may occur to spleen and liver.

Section 12: Ecological Information

Ecotoxicity: Not available.

BOD5 and COD: Not available.

Products of Biodegradation:
Possibly hazardous short term degradation products are not likely. However, long term degradation products may arise.

Toxicity of the Products of Biodegradation: The products of degradation are less toxic than the product itself.

Special Remarks on the Products of Biodegradation: Not available.

Section 13: Disposal Considerations

Waste Disposal:
Waste must be disposed of in accordance with federal, state and local environmental control regulations.

Section 14: Transport Information

DOT Classification: Not a DOT controlled material (United States).

Identification: Not applicable.

Special Provisions for Transport: Not applicable.

Section 15: Other Regulatory Information

Federal and State Regulations:
Connecticut carcinogen reporting list.: Ferrous sulfate heptahydrate Illinois toxic substances disclosure to employee act: Ferrous sulfate heptahydrate New York release reporting list: Ferrous sulfate heptahydrate Pennsylvania RTK: Ferrous sulfate heptahydrate Massachusetts RTK: Ferrous sulfate heptahydrate Massachusetts spill list: Ferrous sulfate heptahydrate New Jersey spill list: Ferrous sulfate heptahydrate Louisiana spill reporting: Ferrous sulfate heptahydrate CERCLA: Hazardous substances.: Ferrous sulfate heptahydrate: 1000 lbs. (453.6 kg)

Other Regulations: OSHA: Hazardous by definition of Hazard Communication Standard (29 CFR 1910.1200).

Other Classifications:

WHMIS (Canada): Not controlled under WHMIS (Canada).

DSCL (EEC):
R36/38- Irritating to eyes and skin. S2- Keep out of the reach of children. S46- If swallowed, seek medical advice immediately and show this container or label.

HMIS (U.S.A.):

Health Hazard: 2

Fire Hazard: 0

Reactivity: 0

Personal Protection: E

National Fire Protection Association (U.S.A.):

Health: 2

Flammability: 0

Reactivity: 3

Specific hazard:

Protective Equipment:
Gloves. Lab coat. Dust respirator. Be sure to use an approved/certified respirator or equivalent. Splash goggles.

Section 16: Other Information

References: Not available.

Other Special Considerations: Not available.

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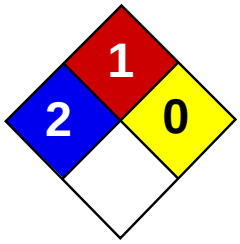
Last Updated: 05/21/2013 12:00 PM



Material Safety Data Sheet
Citric acid MSDS

Section 1: Chemical Product and Company Identification

Product Name: Citric acid

Catalog Codes: SLC5449, SLC2665, SLC4453, SLC1660, SLC3451

CAS#: 77-92-9

RTECS: GE7350000

TSCA: TSCA 8(b) inventory: Citric acid

CI#: Not available.

Synonym: 2-Hydroxy-1,2,3-propanetricarboxylic acid

Chemical Name: Citric Acid

Chemical Formula: C6H8O7

Contact Information:

Sciencelab.com, Inc.
14025 Smith Rd.
Houston, Texas 77396

US Sales: **1-800-901-7247**
International Sales: **1-281-441-4400**

Order Online: ScienceLab.com

CHEMTREC (24HR Emergency Telephone), call: 1-800-424-9300

International CHEMTREC, call: 1-703-527-3887

For non-emergency assistance, call: 1-281-441-4400

Section 2: Composition and Information on Ingredients

Composition:

Name	CAS #	% by Weight
Citric acid	77-92-9	100

Toxicological Data on Ingredients: Citric acid: ORAL (LD50): Acute: 5040 mg/kg [Mouse]. 3000 mg/kg [Rat].

Section 3: Hazards Identification

Potential Acute Health Effects:
Hazardous in case of eye contact (irritant), of inhalation (lung irritant). Slightly hazardous in case of skin contact (irritant, sensitizer), of ingestion. The amount of tissue damage depends on length of contact. Eye contact can result in corneal damage or blindness. Skin contact can produce inflammation and blistering. Severe over-exposure can produce lung damage, choking, unconsciousness or death.

Potential Chronic Health Effects:
Slightly hazardous in case of skin contact (sensitizer). CARCINOGENIC EFFECTS: Not available. MUTAGENIC EFFECTS: Not available. TERATOGENIC EFFECTS: Not available. DEVELOPMENTAL TOXICITY: Not available. The substance may be toxic to teeth. Repeated or prolonged exposure to the substance can produce target organs damage. Repeated exposure of the eyes to a low level of dust can produce eye irritation. Repeated skin exposure can produce local skin destruction, or dermatitis. Repeated inhalation of dust can produce varying degree of respiratory irritation or lung damage.

Section 4: First Aid Measures

Eye Contact:
Check for and remove any contact lenses. In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Cold water may be used. Get medical attention.

Skin Contact:
In case of contact, immediately flush skin with plenty of water. Cover the irritated skin with an emollient. Remove contaminated clothing and shoes. Cold water may be used.Wash clothing before reuse. Thoroughly clean shoes before reuse. Get medical attention.

Serious Skin Contact:
Wash with a disinfectant soap and cover the contaminated skin with an anti-bacterial cream. Seek medical attention.

Inhalation:
If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention.

Serious Inhalation: Not available.

Ingestion:
Do NOT induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person. Loosen tight clothing such as a collar, tie, belt or waistband. Get medical attention if symptoms appear.

Serious Ingestion: Not available.

Section 5: Fire and Explosion Data

Flammability of the Product: May be combustible at high temperature.

Auto-Ignition Temperature: 1010°C (1850°F)

Flash Points: Not available.

Flammable Limits: LOWER: 0.28 Kg/M3 (Dust) UPPER: 2.29 Kg/M3 (Dust)

Products of Combustion: These products are carbon oxides (CO, CO2).

Fire Hazards in Presence of Various Substances:
Slightly flammable to flammable in presence of heat. Non-flammable in presence of shocks.

Explosion Hazards in Presence of Various Substances:
Slightly explosive in presence of open flames and sparks. Non-explosive in presence of shocks.

Fire Fighting Media and Instructions:
SMALL FIRE: Use DRY chemical powder. LARGE FIRE: Use water spray, fog or foam. Do not use water jet.

Special Remarks on Fire Hazards: As with most organic solids, fire is possible at elevated temperatures

Special Remarks on Explosion Hazards:
Fine dust dispersed in air in sufficient concentrations, and in the presences of an ignition source is a potential dust explosion hazard.

Section 6: Accidental Release Measures

Small Spill:
Use appropriate tools to put the spilled solid in a convenient waste disposal container. Finish cleaning by spreading water on the contaminated surface and dispose of according to local and regional authority requirements.

Large Spill:
Stop leak if without risk. Do not get water inside container. Do not touch spilled material. Use water spray to reduce vapors. Prevent entry into sewers, basements or confined areas; dike if needed. Eliminate all ignition sources. Call for assistance on disposal. Finish cleaning by spreading water on the contaminated surface and allow to evacuate through the sanitary system.

Section 7: Handling and Storage

Precautions:
Keep away from heat. Keep away from sources of ignition. Ground all equipment containing material. Do not ingest. Do not breathe dust. Avoid contact with eyes. Wear suitable protective clothing. In case of insufficient ventilation, wear suitable respiratory equipment. If ingested, seek medical advice immediately and show the container or the label. Keep away from incompatibles such as oxidizing agents, reducing agents, metals, alkalis.

Storage: Keep container tightly closed. Keep container in a cool, well-ventilated area.

Section 8: Exposure Controls/Personal Protection

Engineering Controls:
Use process enclosures, local exhaust ventilation, or other engineering controls to keep airborne levels below recommended exposure limits. If user operations generate dust, fume or mist, use ventilation to keep exposure to airborne contaminants below the exposure limit.

Personal Protection:
Safety glasses. Lab coat. Gloves (impervious). Dust respirator. Be sure to use an approved/certified respirator or equivalent. The dust respirator should be used for conditions where exposure has exceeded recommended exposure limits, dust is apparent, and engineering controls(adequate ventilation) are not feasible.

Personal Protection in Case of a Large Spill:
Splash goggles. Full suit. Dust respirator. Boots. Gloves. A self contained breathing apparatus should be used to avoid inhalation of the product. Suggested protective clothing might not be sufficient; consult a specialist BEFORE handling this product.

Exposure Limits:
No exposure guidelines have been established. ACGIH, NIOSH and OSHA have not developed exposure limits for this product. The exposure limits given below are for particulates not otherwise classified: ACGIH: 10 mg/m3 TWA (Total Inhalable fraction); 3 mg/m3 TWA (Respirable fraction) OSHA: 15 mg/m3 TWA (Total dust); 5 mg/m3 TWA (Respirable Fraction)

Section 9: Physical and Chemical Properties

Physical state and appearance: Solid. (Crystalline powde)

Odor: Odorless.

Taste: Acid. (Strong.)

Molecular Weight: 192.13 g/mole

Color: Not available.

pH (1% soln/water): Not available.

Boiling Point: Decomposes.

Melting Point: 153°C (307.4°F)

Critical Temperature: Not available.

Specific Gravity: 1.665 (Water = 1)

Vapor Pressure: Not applicable.

Vapor Density: Not available.

Volatility: Not available.

Odor Threshold: Not available.

Water/Oil Dist. Coeff.: The product is more soluble in water; log(oil/water) = -1.7

Ionicity (in Water): Not available.

Dispersion Properties: See solubility in water, diethyl ether.

Solubility:
Soluble in cold water, hot water, diethyl ether. Insoluble in benzene.

Section 10: Stability and Reactivity Data

Stability: The product is stable.

Instability Temperature: Not available.

Conditions of Instability: Excess heat, incompatible materials

Incompatibility with various substances: Reactive with oxidizing agents, reducing agents, metals, alkalis.

Corrosivity:
Corrosive in presence of aluminum, of zinc, of copper. Non-corrosive in presence of glass.

Special Remarks on Reactivity:
Incompatible with oxidizing agents, potassium tartrate, alkali, alkaline earth carbonates and bicarbonates, acetates, and sulfides, metal nitrates

Special Remarks on Corrosivity: Will corrode copper, zinc, aluminum and their alloys.

Polymerization: Will not occur.

Section 11: Toxicological Information

Routes of Entry: Inhalation. Ingestion.

Toxicity to Animals: Acute oral toxicity (LD50): 3000 mg/kg [Rat].

Chronic Effects on Humans: May cause damage to the following organs: teeth.

Other Toxic Effects on Humans:
Hazardous in case of inhalation (lung irritant). Slightly hazardous in case of skin contact (irritant, sensitizer), of ingestion.

Special Remarks on Toxicity to Animals: LDL[Rabbit] - Route: oral; Dose: 7000mg/kg

Special Remarks on Chronic Effects on Humans: Not available.

Special Remarks on other Toxic Effects on Humans:
Acute Potential Health Effects: Skin: Causes mild to moderate skin irritation. May cause skin sensitization, an allergic reaction, which becomes evident upon re-exposure to this material. Eyes: Causes moderate to severe eye irritation and possible injury. Ingestion: May cause gastrointestinal (digestive) tract irritation with nausea, vomiting, diarrhea. Excessive intake may cause erosion of teeth and hypocalcemia (calcium deficiency in blood). May affect behavior/central nervous system (tremor, convulsions, muscle contraction or spasticity). Inhalation: Causes moderate respiratory tract and mucous membrane irritation. Chronic Potential Health Effects: Frequent intake of citrated beverages may cause erosion of dental enamel and irritation of mucous membranes.

Section 12: Ecological Information

Ecotoxicity: Not available.

BOD5 and COD: Not available.

Products of Biodegradation:
Possibly hazardous short term degradation products are not likely. However, long term degradation products may arise.

Toxicity of the Products of Biodegradation: The product itself and its products of degradation are not toxic.

Special Remarks on the Products of Biodegradation: Not available.

Section 13: Disposal Considerations

Waste Disposal:
Waste must be disposed of in accordance with federal, state and local environmental control regulations.

Section 14: Transport Information

DOT Classification: Not a DOT controlled material (United States).

Identification: Not applicable.

Special Provisions for Transport: Not applicable.

Section 15: Other Regulatory Information

Federal and State Regulations: TSCA 8(b) inventory: Citric acid

Other Regulations: EINECS: This product is on the European Inventory of Existing Commercial Chemical Substances.

Other Classifications:

WHMIS (Canada): CLASS E: Corrosive solid.

DSCL (EEC):
R36/37/38- Irritating to eyes, respiratory system and skin. S26- In case of contact with eyes, rinse immediately with plenty of water and seek medical advice. S37/39- Wear suitable gloves and eye/face protection.

HMIS (U.S.A.):

Health Hazard: 2

Fire Hazard: 1

Reactivity: 0

Personal Protection: e

National Fire Protection Association (U.S.A.):

Health: 2

Flammability: 1

Reactivity: 0

Specific hazard:

Protective Equipment:
Gloves (impervious). Lab coat. Dust respirator. Be sure to use an approved/certified respirator or equivalent. Wear appropriate respirator when ventilation is inadequate. Safety glasses.

Section 16: Other Information

References: Not available.

Other Special Considerations: Not available.

Created: 10/09/2005 04:56 PM

Last Updated: 05/21/2013 12:00 PM

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MATERIAL SAFETY DATA SHEET

1 CHEMICAL PRODUCT AND COMPANY INFORMATION

Product Description DEUTERIUM OXIDE (D, 99%)

Cambridge Isotope Laboratories, Inc.
50 Frontage Rd
ANDOVER, MA 01810
USA

E-mail cilsales@isotope.com
Web Site www.isotope.com

Phone Numbers
- Emergency Contact Chemtrec
- Emergency Phone 1-800-424-9300 (24 hours)
- Customer Service Phone 1-800-322-1174 (8:30-5:30 EST)
- Transportation 1-202-483-7616 (24 hours)

General Use For professional use only.

2 HAZARDS IDENTIFICATION

OSHA Hazards
- No OSHA Hazards
- Hazards not otherwise classified (HNOC) or not covered by GHS - none

GHS Classification
- Not a hazardous substance or mixture.

HMIS Ratings
- Physical 0
- Flammability 0
- Health 0

NFPA Codes
- Fire 0
- Health 0
- Reactivity 0

3 COMPOSITION / INFORMATION ON INGREDIENTS

Composition / Information on Ingredients

MATERIAL SAFETY DATA SHEET

Chemical Formula	D2O
Molecular Weight	20.03
CAS No.	7789-20-0
EC No.	231-791-2

4 FIRST AID MEASURES

First Aid Measures

Ingestion	Never give anything by mouth to an unconscious person. Rinse mouth with water. Consult a physician.
Inhalation	If not breathing give artificial respiration.

5 FIRE FIGHTING MEASURE

Fire Fighting Measures

Extinguishing Media	Use extinguishing measures that are appropriate to local circumstances and the surrounding environment.
Fire Fighting Equipment	Not available
Fire Fighting Procedures	The product itself does not burn.

6 ACCIDENTAL RELEASE MEASURES

Accidental Release Measures

Environmental Precautions	No special environmental precautions required.
Methods and materials for containment and cleanup	Wipe up with absorbent material (e.g. cloth, fleece).

7 HANDLING AND STORAGE

Conditions for Safe Storage

Storage	Store at room temperature away from light and moisture.

MATERIAL SAFETY DATA SHEET

8 EXPOSURE CONTROL / PERSONAL PROTECTION

Personal Protecton

Eyes - Face	Wear safety glasses with side shields (or goggles) and a face shield.
Skin	Choose body protection according to the amount and concentration of the dangerous substance at the work place.
Respiratory	When appropriate, use NIOSH/CEN approved respirator.
Protective Clothing	Wear suitable protective clothing and gloves.
Work Hygienic Practices	Handle in accordance with good industrial hygiene and safety practice. Wash hands before breaks and at the end of workday.

9 PHYSICAL AND CHEMICAL PROPERTIES

Physical and Chemical Properties (Unlabeled Compound)

Form	Liquid
Color	Colourless
Odor	No data available
Odor Threshold	No data available
pH	6.0 - 8.0 at 25 °C (77 °F)
Melting Point	0.0 °C (32.0 °F)
Boiling Point	100.0 °C (212.0 °F)
Flashpoint	Not applicable
Evaporation Rate	No data available
Fammability	No data available
Flammable Limits	No data available
Lower Explosion Limit	Not applicable
Upper Explosion Limit	Not applicable
Vapor Pressure	No data available
Vapor Density	No data available
Solubility in Water	Completely miscible
Partition Coefficient	No data available
Auto Ignition Temperature	Not applicable
Decomposition	No data available

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Temperature	
Viscosity	No data available

10 STABILITY AND REACTIVITY

Stability and Reactivity

Chemical Stability	Stable if stored under recommended conditions.
Possibility of Hazardous Reactions	Not available
Conditions to Avoid	Not available
Hazardous decomposition products	No data available
Materials to avoid	No data available

11 TOXICOLOGICAL INFORMATION

Acute Toxicity

LD50 Oral Rat	> 90,000 mg/kg
Serious Damage/Eye Irritation	No data available
Skin Corrosion/Irritation	No data available
Inhalation	No data available
Respiratory or Skin Sensitization	Not available
Germ Cell Mutagenicity	Not available
IARC	No component of this product present at levels greater than or equal to 0.1% is identifiable as probable, possible, or confirmed human carcinogen by IARC.
ACGIH	No component of this product present at levels greater than or equal to 0.1% is identifiable as a carcinogen or potential carcinogen by ACGIH.
NTP	No component of this product present at levels greater than or equal to 0.1% is identifiable as a

MATERIAL SAFETY DATA SHEET

known or anticipated carcinogen by NTP.

OSHA	No component of this product present at levels greater than or equal to 0.1% is identified as a carcinogen or potential carcinogen by OSHA.
Reproductive Toxicity	Not available

Specific Target Organ Toxicity

Single Exposure	No data available
Repeated Exposure	No data available

Signs and Symptoms of Exposure

To the best of our knowledge, the chemical, physical, and toxicological properties have not been thoroughly investigated.

Other Information

RTECS	ZC0110000

12 ECOLOGICAL INFORMATION

Toxicity

Persistance and Degradability	Not available
Bioaccumulative Potential	Not available
Mobility in Soil	Not available
PBT and vPvB Assessment	Not available
Other Adverse Effects	Not available

13 DISPOSAL CONSIDERATIONS

Disposal Considerations

Product Disposal	Waste materials should be disposed of under conditions which meet Federal, State, and Local environmental control regulations.

MATERIAL SAFETY DATA SHEET

14 TRANSPORT INFORMATION

Transportation Information-DOT/IATA/IMDG

Special Shipping Notes	Not dangerous goods.

15 REGULATORY INFORMATION

Regulatory Information

No OSHA Hazards

SARA

Sara 302 Component	No chemicals in this material are subject to the reporting requirements.
Sara 313 Component	No chemicals in this material are subject to the reporting requirements.

STATE REGULATIONS

Massachusetts Right to Know	No
Pennsylvania Right to Know	Yes
New Jersey Right to Know	Yes
California Proposition 65	This product does not contain any chemicals known to State of California to cause cancer, birth defects, or any other reproductive harm.

Canada

DSL Status	All components are on the Canadian DSL list.

16 OTHER INFORMATION

Additional MSDS Information	This product is not radioactive. The data given for this product are those of the corresponding unlabeled compound, unless specifically indicated otherwise. Health and safety data for labeled compounds are generally not available, but are assumed to be similar or identical to the corresponding unlabeled compound.
Approved On	09/30/14
Version Number	7

MATERIAL SAFETY DATA SHEET

Klozur® Caustic

MSDS #: 1310-73-2--25
Revision date: 2014-07-21
Version 2

This MSDS has been prepared to meet U.S. OSHA Hazard Communication Standard 29 CFR 1910.1200 And Canadian Workplace Hazardous Materials Information System (WHMIS) requirements.

1. PRODUCT AND COMPANY IDENTIFICATION

Product Name **Klozur® Caustic**

Synonyms Caustic Soda Solution; Lye Solution; Sodium Hydrate Solution, White Caustic Solution

Recommended Use: Activating agent for Klozur® Persulfate

Manufacturer

PeroxyChem LLC
1735 Market Street
Philadelphia, PA 19103
Phone: +1 215/ 299-5858 (General Information)
E-Mail: sdsinfo@peroxychem.com

Emergency telephone number

For leak, fire, spill or accident emergencies, call:
1 800 / 424 9300 (CHEMTREC - U.S.A.)
1 703 / 527 3887 (CHEMTREC - Collect - All Other Countries)
1 303/ 389-1409 (Medical - U.S. - Call Collect)

2. HAZARDS IDENTIFICATION

EMERGENCY OVERVIEW

Clear, colorless, odorless liquid.
Product may react violently with acids
Solution is corrosive to body tissues and metallic materials

Potential Health Effects

Eyes	Corrosive to the eyes and may cause severe damage including blindness.
Skin	Corrosive - causes skin burns.
Inhalation	Corrosive to nose, throat and respiratory tract.
Ingestion	Causes burns. MAY BE FATAL IF SWALLOWED.

Chronic toxicity Sodium hydroxide may produce inflammation of the eyes, skin, and mucous membranes. Esophageal carcinoma at the site of a chronic lye stricture has been reported. [Gosselin , Smith & Hodge 1984].

3. COMPOSITION/INFORMATION ON INGREDIENTS

Ingredients

Chemical name	CAS-No	Weight %
Water	7732-18-5	75
Sodium Hydroxide	1310-73-2	25

4. FIRST AID MEASURES

Eye Contact Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes. See a medical doctor or ophthalmologist immediately.

Skin Contact Wash off immediately with soap and plenty of water while removing all contaminated clothes and shoes. Wash off with soap and water. Seek immediate medical attention/advice.

Inhalation Remove person to fresh air. If signs/symptoms continue, get medical attention.

Ingestion Rinse mouth with water and afterwards drink plenty of water or milk. Do NOT induce vomiting. Never give anything by mouth to an unconscious person. Call a physician or poison control center immediately.

Indication of immediate medical attention and special treatment needed, if necessary Sodium hydroxide at this concentration is corrosive. Prolonged dilution with water is required. Neutralization of eye burns is absolutely contraindicated; for skin, 2% acetic acid has been recommended, but washing with water is effective. Ingestion requires milk or water dilution, consideration of esphagoscopy and management for possible esophageal structure.

5. FIRE-FIGHTING MEASURES

Flammable properties Not flammable.

Suitable Extinguishing Media Use extinguishing agent suitable for type of surrounding fire. Cool containers / tanks with water spray.

Explosion data
Sensitivity to Mechanical Impact Not sensitive
Sensitivity to Static Discharge Not sensitive

Protective equipment and precautions for firefighters Use water spray to cool fire exposed surfaces and protect personnel.

NFPA	Health Hazards 3	Flammability 0	Stability 1	Special Hazards -

6. ACCIDENTAL RELEASE MEASURES

Personal Precautions Use personal protective equipment. For personal protection see section 8.

Methods for Containment Absorb spill with inert material (e.g. dry sand or earth), then place in a chemical waste container

Methods for cleaning up After cleaning, flush away traces with water. Dispose of waste as indicated in Section 13.

7. HANDLING AND STORAGE

Handling Avoid contact by using personal protective equipment. Refer to Section 8. Use only in area provided with appropriate exhaust ventilation.

Storage Keep tightly closed in a dry and cool place. Keep away from incompatible products (acids).

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Exposure Guidelines .

Chemical name	ACGIH TLV	OSHA PEL	NIOSH	Mexico
Sodium Hydroxide 1310-73-2	Ceiling: 2 mg/m³	TWA: 2 mg/m³	IDLH: 10 mg/m³ Ceiling: 2 mg/m³	Mexico: Ceiling 2 mg/m³

Chemical name	British Columbia	Quebec	Ontario TWAEV	Alberta
Sodium Hydroxide 1310-73-2	Ceiling: 2 mg/m³	Ceiling: 2 mg/m³	CEV: 2 mg/m³	Ceiling: 2 mg/m³

Occupational exposure controls

Engineering measures Adequate engineering controls and/or personal protective equipment must be used to prevent contact with skin and eyes. Engineering controls and/or respirators may be necessary when the generation of airborn mists or fog are possible.

General information Clean water should be available for washing in case of eye or skin contamination.

Respiratory Protection When exposure above the established standard is likely, a respiratory protection program that complies with OSHA General Industry Standard 1910.134 should be implemented. Wear full face-piece respirators approved by MSHA/NIOSH if mists are expected.

Eye/Face Protection For dust, splash, mist or spray exposure, wear chemical protective goggles.

Skin and Body Protection Rubber or vinyl apron Rubber or plastic boots

Hand Protection Rubber or vinyl gloved with gauntlets. Wash the outside of gloves with soap and water prior to removal. Inspect regularly for leaks.

Hygiene measures Prevent contact with skin eyes and clothing. Clean water should be available for washing in case of eye or skin contamination.

9. PHYSICAL AND CHEMICAL PROPERTIES

Information on basic physical and chemical properties

Appearance Clear, Colorless
Physical State liquid
Odor odorless
pH 14 (7.4 % solution)
Freezing Point -16 To -20 °C
Boiling Point/Range 112 - 122 °C
Flash point Not Applicable
Flammable properties Not flammable
Vapor pressure 10 - 18 hPa @ 30 °C
Specific gravity 1.28 - 1.38 @ 15.5 °C
Water solubility completely soluble
percent volatile 65 - 75

Decomposition temperature No information available

10. STABILITY AND REACTIVITY

Stability Stable under recommended storage conditions.

Conditions to Avoid Heat; Incompatible products; Exposure to water.

Materials to avoid Acids, flammable liquids, organic halogen compounds, nitro compounds, and amphoteric metals, such as aluminum, magnesium and zinc

Hazardous Decomposition Products None known.

Hazardous polymerization Hazardous polymerization does not occur.

11. TOXICOLOGICAL INFORMATION

Acute Effects

Remarks Sodium hydroxide is corrosive and may produce severe eye, skin, and respiratory tract irritation and upper gastrointestinal tract damage. Ingestion of concentrated solutions has caused death in animals and humans.

Eye irritation Corrosive to the eyes and may cause severe damage including blindness
Skin irritation Severely irritating, corrosive

LD50 Oral 400 mg/kg (rabbit) (37 % solution)
LD50 Dermal corrosive
Inhalation LC50 corrosive

Chronic toxicity

Chronic toxicity Sodium hydroxide may produce inflammation of the eyes, skin, and mucous membranes. Esophageal carcinoma at the site of a chronic lye stricture has been reported. [Gosselin , Smith & Hodge 1984].

Target organ effects Skin, Eyes, Mucous membrane.

12. ECOLOGICAL INFORMATION

Ecotoxicity
Large amounts will affect pH and harm aquatic organisms

Chemical name	Toxicity to algae	Toxicity to fish	Toxicity to Microorganisms	Toxicity to daphnia and other aquatic invertebrates
Sodium Hydroxide		96 h LC50: = 45.4 mg/L (Oncorhynchus mykiss)		

Persistence and degradability There is no degradation of sodium hydroxide in waters, only loss by absorption or through chemical neutralization

Bioaccumulation Bioaccumulation is unlikely.

Mobility Will likely be mobile in the environment due to its water solubility.

13. DISPOSAL CONSIDERATIONS

Waste disposal methods Dispose of in accordance with local regulations. Check the pH of waste to be disposed. If it is greater than 12.5 it must be handled as a RCRA hazardous waste. Can be disposed as waste water, when in compliance with local regulations.

Contaminated Packaging Clean container with water. Empty containers should be taken to an approved waste handling site for recycling or disposal.

14. TRANSPORT INFORMATION

DOT

UN/ID no	1824
Proper Shipping Name	Sodium hydroxide solution
Hazard class	8
Packing Group	II
Reportable Quantity (RQ)	1000 lbs.

TDG

UN/ID no	1824
Proper Shipping Name	Sodium hydroxide solution
Hazard class	8
Packing Group	II

ICAO/IATA

UN/ID no	1824
Proper Shipping Name	Sodium hydroxide solution
Hazard class	8
Packing Group	II

IMDG/IMO

UN/ID no	1824
Proper Shipping Name	Sodium hydroxide solution
Hazard class	8
Packing Group	II

15. REGULATORY INFORMATION

International Inventories

TSCA (United States)	Complies
DSL (Canada)	Complies
NDSL (Canada)	Complies
EINECS/ELINCS (Europe)	Complies
ENCS (Japan)	Complies
China (IECSC)	Complies
KECL (Korea)	Complies
PICCS (Philippines)	Complies
AICS (Australia)	Complies
NZIoC (New Zealand)	Complies

U.S. Federal Regulations

SARA 313

Section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986 (SARA). This product does not contain any chemicals which are subject to the reporting requirements of the Act and Title 40 of the Code of Federal Regulations, Part 372

SARA 311/312 Hazard Categories

Acute health hazard	Yes

Chronic health hazard	No
Fire hazard	No
Sudden release of pressure hazard	No
Reactive Hazard	No

CERCLA
This material, as supplied, does not contain any substances regulated as hazardous substances under the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) (40 CFR 302) or the Superfund Amendments and Reauthorization Act (SARA) (40 CFR 355). There may be specific reporting requirements at the local, regional, or state level pertaining to releases of this material

Chemical name	Hazardous Substances RQs	Extremely Hazardous Substances RQs
Sodium Hydroxide	1000 lb	

International Regulations

Mexico - Grade Serious risk, Grade 3

Chemical name	Carcinogen Status	Mexico
Sodium Hydroxide		Mexico: Ceiling 2 mg/m³

CANADA
This product has been classified in accordance with the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all the information required by the CPR
WHMIS Hazard Class
D2B - Toxic materials
E - Corrosive material

16. OTHER INFORMATION

HMIS	Health Hazards 3	Flammability 0	Stability 1	Special precautions -

NFPA/HMIS Ratings Legend
Severe = 4; Serious = 3; Moderate = 2; Slight = 1; Minimal = 0

This product meets the chemical testing specifications defined in the Food Chemicals Codex (FCC), 8th Edition.

This product is certified to NSF/ANSI Standard 60 for use in drinking water treatment at the specified maximum use limit. The MUL (maximum use level) for caustic soda is 200 mg/L under NSF/ANSI Standard 60.

Revision date: 2014-07-21
Reason for revision: Initial Release.

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Prepared By:

PeroxyChem

End of Safety Data Sheet