District I
1625 N. French Dr., Hobbs, NM 88240
District II
811 S. First St., Artesia, NM 88210
District
1000 Rio Brazos Road, Aztec, NM 87410
District IV
1220 S. St. Francis Dr., Santa Fe, NM 87505

State of New Mexico
Energy Minerals and Natural
Resources Department

Oil Conservation Division
1220 South St. Francis Dr.
Santa Fe, NM 87505

Form C-141
Revised August 24, 2018
Submit to appropriate OCD District office

Incident ID	
District RP	1RP-5140
Facility ID	
Application ID	

Release Notification

pCH1821251149

Responsible Party

Responsible Party: JR Cone Operating, LLC	OGRID
Contact Name: Jim Cone (Managing Member)	Contact Telephone: 806-763-8211
Contact email: jcone@coneelevator.com	Incident #: *(1RP-5140)*
Contact mailing address: P. O. Box 10217, Lubbock, Texas 79408	

Location of Release Source

Latitude 32.46347° Longitude -103.16190° *(NAD 83 in decimal degrees to 5 decimal places)*

Site Name: (*Lease name*) : Anderson	Site Type: Historic unlined pit and blowout vent
Date Release Discovered: (*by NMOCD staff*) July 19, 2018	API# *30-025-06696 (nearest well; not source)*

Unit Letter	Section	Township	Range	County
I	21	21S	37E	Lea

Surface Owner: ☐ State ☐ Federal ☐ Tribal ☒ Private (*Name:*) *Robert Gilbert et al (previously Estate of Mary L. Wantz)*

Nature and Volume of Release

Material(s) Released (Select all that apply and attach calculations or specific justification for the volumes provided below)

☒ Crude Oil	Volume Released (bbls): Unknown	Volume Recovered (bbls): Unknown
☒ Produced Water	Volume Released (bbls): Unknown	Volume Recovered (bbls): Unknown
	Is the concentration of dissolved chloride in the produced water >10,000 mg/l?	☒ Yes ☐ No
☐ Condensate	Volume Released (bbls)	Volume Recovered (bbls)
☐ Natural Gas	Volume Released (Mcf)	Volume Recovered (Mcf)
☐ Other (describe)	Volume/Weight Released (provide units)	Volume/Weight Recovered (provide units)

Cause of Release:

Historic unlined pit located ~ 200 ft northeast of Anderson tank battery and 330 ft NNW of Anderson #1 well (30-025-6696). The pit contains unknown volumes of crude oil generated from historical operations on lease. Early indications are such that there are only minor amounts of produced water impact.

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State of New Mexico
Oil Conservation Division

Incident ID	
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Was this a major release as defined by 19.15.29.7(A) NMAC? ☐ Yes ☐ No	If YES, for what reason(s) does the responsible party consider this a major release? Release was historical with unknown volume.

If YES, was immediate notice given to the OCD? By whom? To whom? When and by what means (phone, email, etc)?

NMOCD responded to a report of a possible release on July 12, 2018. During the inspection, an unauthorized pit was identified northeast of the battery as well as a vent pipe, where the area immediately surrounding it appears to have been impacted. On July 19, 2018, C. Hernandez NMOCD District 1 contacted the operator via email requesting a work plan.

Initial Response

The responsible party must undertake the following actions immediately unless they could create a safety hazard that would result in injury

☒ The source of the release has been stopped.

☒ The impacted area has been secured to protect human health and the environment.

☒ Released materials have been contained via the use of berms or dikes, absorbent pads, or other containment devices.

☒ All free liquids and recoverable materials have been removed and managed appropriately.

If all the actions described above have not been undertaken, explain why:

Per 19.15.29.8 B. (4) NMAC the responsible party may commence remediation immediately after discovery of a release. If remediation has begun, please attach a narrative of actions to date. If remedial efforts have been successfully completed or if the release occurred within a lined containment area (see 19.15.29.11(A)(5)(a) NMAC), please attach all information needed for closure evaluation.

I hereby certify that the information given above is true and complete to the best of my knowledge and understand that pursuant to OCD rules and regulations all operators are required to report and/or file certain release notifications and perform corrective actions for releases which may endanger public health or the environment. The acceptance of a C-141 report by the OCD does not relieve the operator of liability should their operations have failed to adequately investigate and remediate contamination that pose a threat to groundwater, surface water, human health or the environment. In addition, OCD acceptance of a C-141 report does not relieve the operator of responsibility for compliance with any other federal, state, or local laws and/or regulations.

Printed Name: Jim Cone
Title: Managing Member
Signature:
Date: 2-12-19
email: jcone@coneelevator.com
Telephone: 806-763-8211

OCD Only

Received by:
Date:

Form C-141
Page 5

State of New Mexico
Oil Conservation Division

Incident ID	
District RP	1RP-5140
Facility ID	
Application ID	

Remediation Plan

Remediation Plan Checklist: ***Each of the following items must be included in the plan.***

☒ Detailed description of proposed remediation technique
☒ Scaled sitemap with GPS coordinates showing delineation points
☒ Estimated volume of material to be remediated
☒ Closure criteria is to Table 1 specifications subject to 19.15.29.12(C)(4) NMAC
☒ Proposed schedule for remediation (note if remediation plan timeline is more than 90 days OCD approval is required)

Deferral Requests Only: ***Each of the following items must be confirmed as part of any request for deferral of remediation.***

☐ Contamination must be in areas immediately under or around production equipment where remediation could cause a major facility deconstruction.

☐ Extents of contamination must be fully delineated.

☐ Contamination does not cause an imminent risk to human health, the environment, or groundwater.

I hereby certify that the information given above is true and complete to the best of my knowledge and understand that pursuant to OCD rules and regulations all operators are required to report and/or file certain release notifications and perform corrective actions for releases which may endanger public health or the environment. The acceptance of a C-141 report by the OCD does not relieve the operator of liability should their operations have failed to adequately investigate and remediate contamination that pose a threat to groundwater, surface water, human health or the environment. In addition, OCD acceptance of a C-141 report does not relieve the operator of responsibility for compliance with any other federal, state, or local laws and/or regulations.

Printed Name: Jim Cone Title: Managing Member
Signature: Jim Cone Date: 5-3-2019
email: jcone@coneelevator.com Telephone: 806-763-8211

OCD Only

Received by: OCD DIII Date: 5/14/19

☒ Approved ☐ Approved with Attached Conditions of Approval ☐ Denied ☐ Deferral Approved

Signature: Date: 5/17/19

Date: April 29, 2019

NMOCD Case No. : 1RP-5140

Site Name: Anderson Lease

Operator: J. R. Cone Operating, LLC (JRCO)

Location: T21S, R37E, SECTION 21, UNIT LETTER I, Eunice, Lea County NM

Remediation Work Performed

A total of 9,168 cubic yards of contaminated soil has been excavated from the historic pit and vent areas and transported to Sundance Services which has substantially mitigated any further threat to groundwater.

Pit Excavation Conditions

Target concentrations meeting NMOCD closure criteria in accordance with Table 1 of 19.15.29.12 NMAC and agreement with District 1 NMOCD Office in Hobbs have been met, with the exception of the DRO 1,000 mg/kg threshold at the base of the pit excavation in grid areas M, N, O, and P where DRO concentrations vary from 1,019 mg/kg to 2,706 mg/kg (average 1,657 mg/kg) at a depth of 15 ft below ground surface (bgs) as summarized in Table 1 and depicted in Figure 1. Analytical results for samples taken at 19 ft bgs and below from a borehole located immediately below the center of the former pit verify that all constituents of concern have met the closure criteria.

Vent Excavation Conditions

Excavation at the vent area proceeded to a depth of 12 ft bgs where all closure criteria were met with the exception of the DRO 1,000 mg/kg threshold at the base of the north half of the vent excavation which indicates a DRO concentration of 1,670 mg/kg at a depth of 12 ft below ground surface (bgs) as summarized in Table 2 and depicted in Figure 2. Analytical results for samples taken at 16 ft bgs and below from a borehole located below the north half of the excavation verify that all constituents of concern have met the closure criteria.

Proposed Remediation Method to Treat Residual Contamination

Now that the excavated areas have exposed smaller areas with remnant DRO impact at depth we propose to remediate each excavation by in-situ chemical oxidation (ISCO) to further mitigate any threat to groundwater.

Chemical oxidants are capable of converting the petroleum hydrocarbon mass to carbon dioxide and water and ultimately irreversibly reduce concentrations of petroleum hydrocarbons in soil, as explained in Chapter XIII of the Environmental Protection Agency's *Guide For Corrective Action Plan Reviewers* (EPA 510-B-17-003, October 2017). The technology degrades pollutants through direct oxidation, as well as through the generation of a suite of free radical compounds which in turn oxidize recalcitrant contaminants. An additional benefit of chemical oxidation is the temporary increase of oxygen levels in and around the treatment area which can enhance naturally occurring aerobic biodegradation processes that reduce contaminant mass. In addition to enhancing aerobic biodegradation, reduced nitrogen and sulfur are oxidized to nitrate and sulfate, which can be used by anaerobic microbes. Post-application, any residual chemical oxidants will act as a permeable reactive barrier over the long term.

The subsurface soil lithology, which is primarily fine-grained sand, is consistent with the preferred higher permeability and homogenous conditions that support effective ISCO treatment. A combination of Klozur SP® and hydrated lime creates an alkaline activated persulfate that has been chosen as the most practical and effective ISCO treatment method for this site.

Klozur SP® is a chemical oxidant formulated by PeroxyChem consisting of sodium persulfate ($Na_2S_2O_8$) and is one of the strongest chemical oxidants for short-term ISCO. It also provides electron acceptors (oxygen and sulfate) for longer-term biological oxidation. The persulfate anion is the most powerful oxidant of the peroxygen family of compounds.

Calcium hydroxide ($Ca(OH)_2$), commonly known as hydrated lime, acts to raise the soil pH to a more alkaline state allowing for more effective oxidation by the sodium persulfate. The demand for alkalinity arises to neutralize the acid generated during reactions with persulfate and to compensate for the natural oxygen demand (NOD) from soil. For soil mixing applications calcium hydroxide is typically preferred over calcium oxide (CaO) because it releases significantly less heat (less exothermic) upon hydration. Another key benefit is that the alkalinity from the lime with help reduce the corrosiveness of the persulfate on the equipment. In addition, residual calcium from the lime will react with residual sulfate from persulfate to form gypsum (calcium sulfate; $CaSO_4$) which can significantly reduce the amount of soluble sulfate in the system while increasing soil strength and stability.

Klozur SP® and hydrated lime product technical information, application guidelines, demand calculations, and safety data sheets are included in Attachment A.

ISCO Application Procedures

JRCO proposes to treat the previously described areas that have not met the DRO closure criteria with a soil mixing strategy that involves the mechanical agitation of subsurface soils with a trackhoe excavator while blending in the sodium persulfate and hydrated lime mixture. The mechanical agitation breaks apart the natural soil structure and helps to establish contact between alkaline activated persulfate and the contamination found in the soils. During application of the chemical oxidants, freshwater will be applied at the manufacturers recommended dosage rates (Attachment A) during the mechanical mixing and agitation process. A soil mixing application strategy can be particularly useful in treating source zones and lower permeable soils such as silts or clays. Key advantages of soil mixing are as follows:

- Rapid process that is well suited for source zones.
- Very effective in establishing contact between the activated persulfate and contaminant on soils
- Can be used to breakup low permeability materials allowing better contact minimizing the impact of site soil heterogeneity.
- Helps establish contact of reagents with zones of high concentration.

Mixing will proceed over approximate 10-ft by 10-ft sections until the designated areas have been treated. Fresh water will be applied during the mechanical mixing of the contaminated soil with the chemical oxidant products. Mechanical mixing will progress at a minimum rate of 3 minutes per cubic yard to ensure adequate contact time between the chemical oxidant and impacted soil zone.

Upon completion of the mixing activities described above the treated areas will remain in a moist condition for 10-14 days to maximize the efficacy of the chemical oxidation process. Additional water may be applied during this period to maintain adequate moisture content.

Backfill and Restoration

An additional strategy and benefit is to only partially backfill the excavation such that a gentle slope towards the center of the treatment area whereas the treatment area remains at about 5 ft below the original surface as depicted in Figure 3 (Pit Backfill Plan) and Figure 4 (Vent Backfill Plan). A 1-ft thick final topsoil layer will then be applied over the entire excavated area to re-establish the native vegetation. The lower elevation of the backfilled excavations will allow capture of intermittent precipitation events such that the subsurface can be rehydrated for further oxidation of recalcitrant contaminants by free radical compounds generated during the initial chemical application within the treated zones.

The backfill material will not exceed the following maximum concentration criteria:

- 600 mg/kg for Chloride
- 100 mg/kg for TPH (GRO+DRO+MRO)
- 50 mg/kg for BTEX
- 10 mg/kg for Benzene

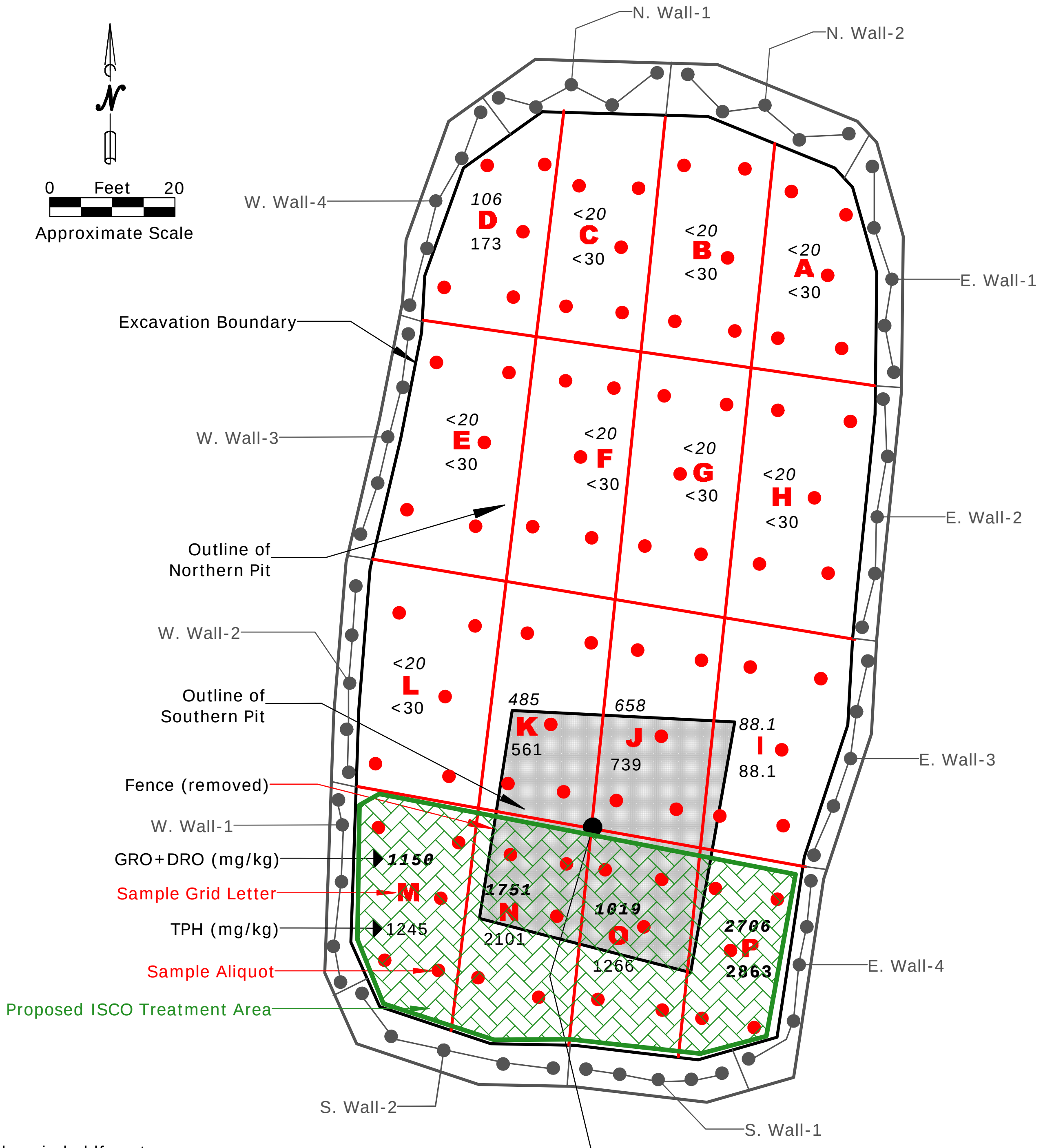
The disturbed area will be re-seeded with native grass species in the first favorable growing season following closure of the site to restore the land surface to productive vegetative capacity.

The proposed remediation plan as described above is protective of the surface vegetation, human health, the environment, and groundwater.

Proposed schedule for remediation

Upon concurrence of the Remediation Plan by NMOCD it is expected to take about 30 days to initiate ISCO remediation activities. Arrangements for availability and delivery of the oxidation chemicals will begin within days upon NMOCD approval of the Remediation Plan. Also, scheduling availability for a subcontractor to perform the product application and mixing will be initiated at that time. It is expected to take about 1 week to apply the chemical oxidants. Post-application, it is expected to take another 10-30 days to allow for the product to interact with the treatment zone with periodic additions of water to maintain moist conditions. Upon completion of that phase backfilling may take another week.

Days	Task
30	Prepare shipment of chemical oxidants and schedule subcontractor
7	Apply chemical oxidants
10-30	Allow chemical oxidants to interact under moist conditions
7	Perform backfilling operations
54-74	Total Estimated timeframe



Values in boldface type exceed closure criteria:

GRO+DRO >1000 mg/kg

GRO+DRO+ORO (TPH) >2500 mg/kg

A-K Samples collected on November 20-21, 2018

M-P Samples collected on February 28, 2019

B-1 Samples collected on January 18, 2019

Depth of floor from surface varies from 12 ft to 20 ft

B-1 Borehole Lab Results

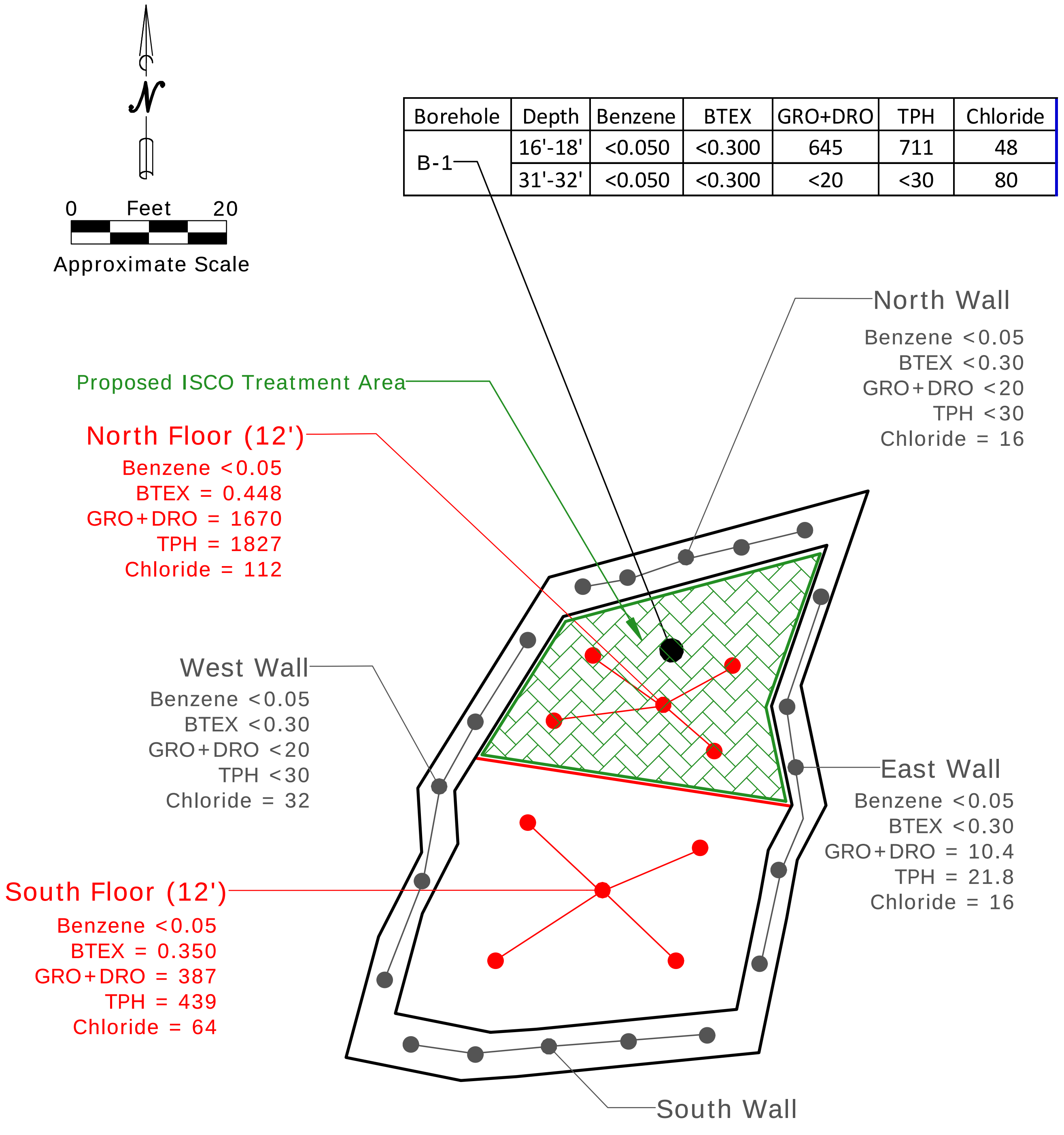
Depth	Benzene	BTEX	GRO+DRO	TPH	Chloride
19'-21'	<0.050	<0.300	390	432	384
34'-35'	<0.050	<0.300	<20	<30	656
49'-51'	<0.050	<0.300	<20	<30	320

TRIDENT ENVIRONMENTAL

J. R. Cone Operating, LLC
Anderson Lease (1R-5140)
T21S R37E Sec 21
Lea County New Mexico

FIGURE 1

Pit Treatment Plan



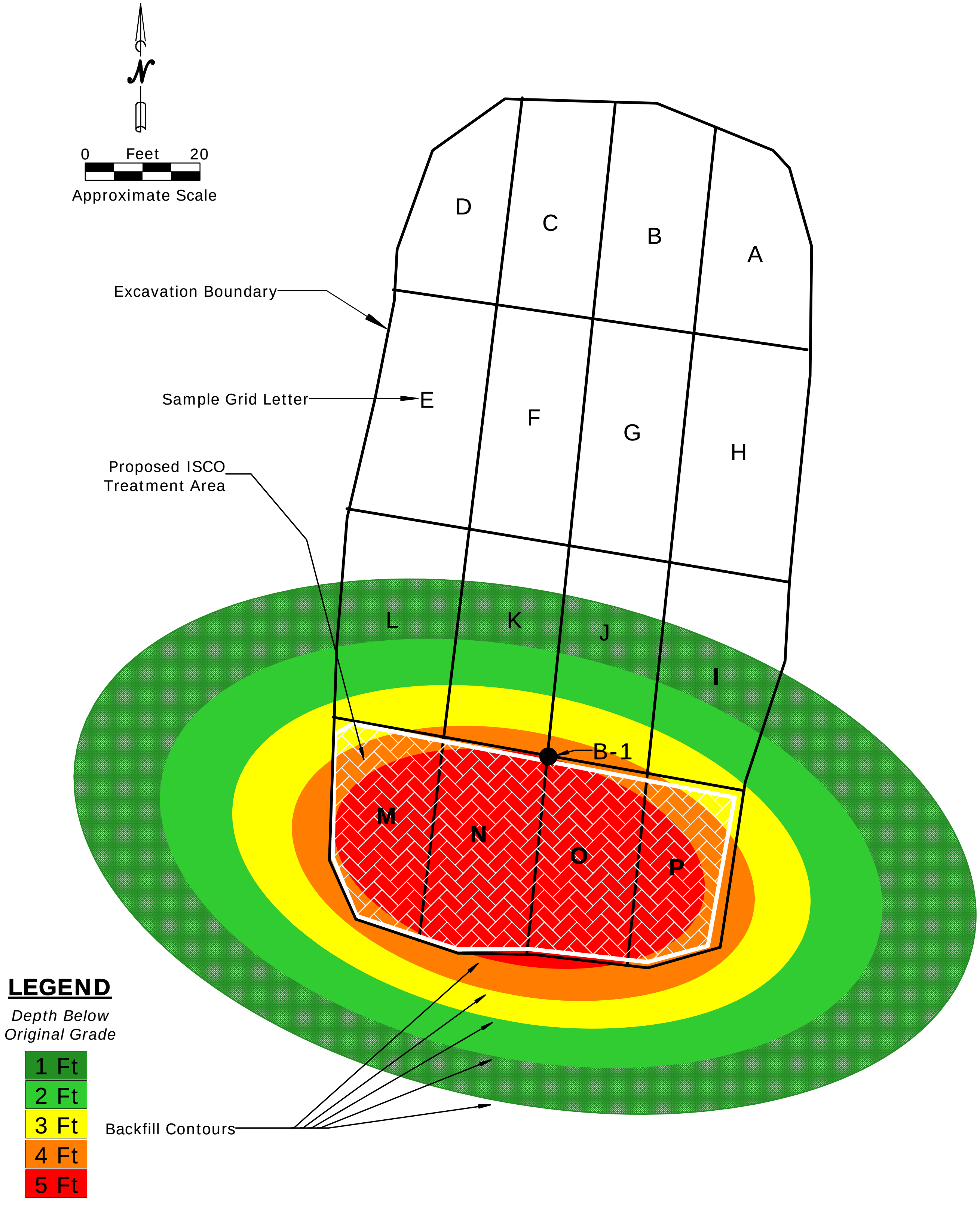
Borehole	Depth	Benzene	BTEX	GRO+DRO	TPH	Chloride
B-1	16'-18'	<0.050	<0.300	645	711	48
	31'-32'	<0.050	<0.300	<20	<30	80

Excavation samples collected on January 8, 2019
B-1 borehole samples collected on January 17, 2019
Depth of floor from surface approx. 12 ft
Concentration units in mg/kg

TRIDENT
ENVIRONMENTAL

J. R. Cone Operating, LLC
Anderson Lease (1R-5140)
T21S R37E Sec 21
Lea County New Mexico

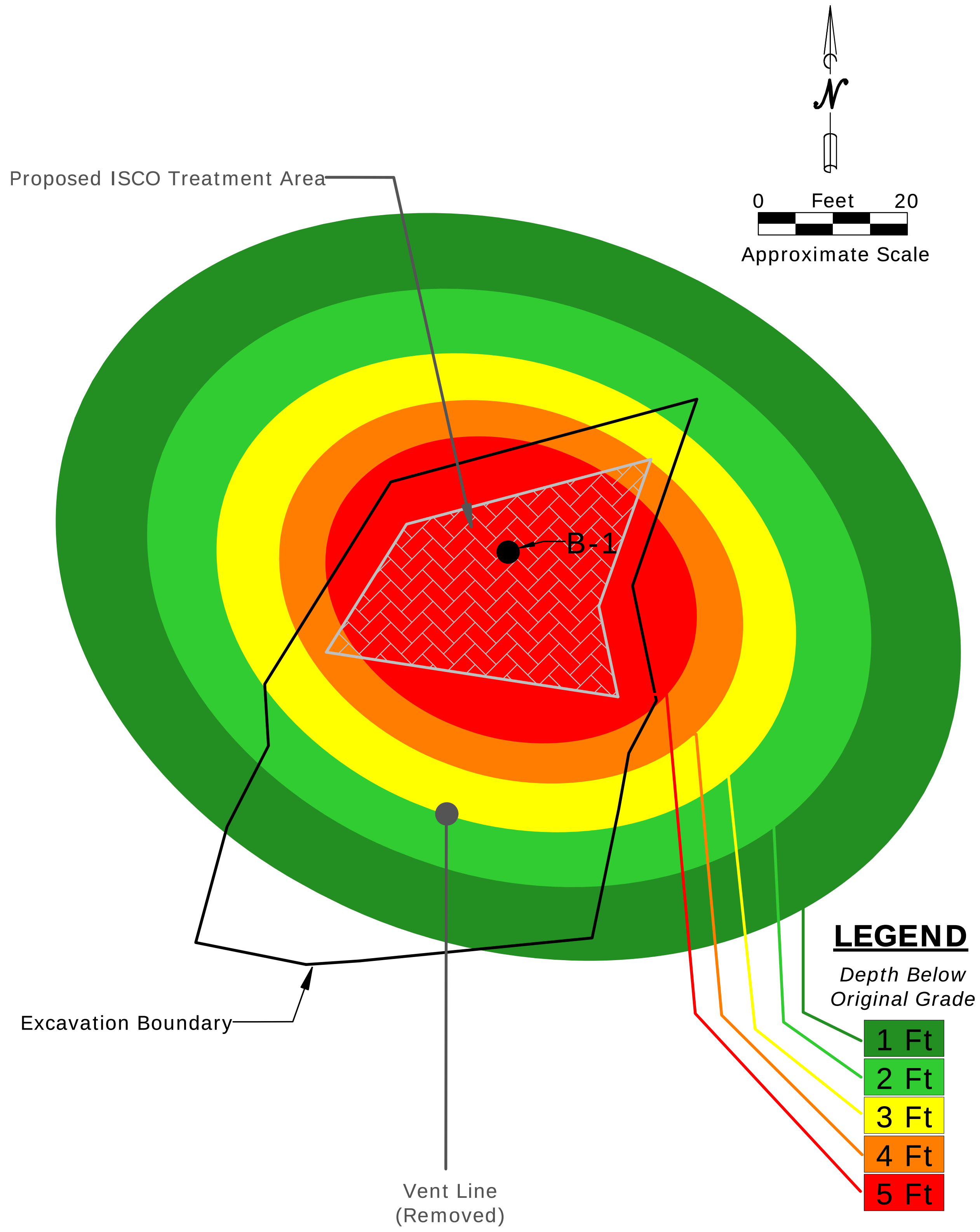
FIGURE 2
Vent
Treatment
Plan



TRIDENT ENVIRONMENTAL

J. R. Cone Operating, LLC
Anderson Lease (1R-5140)
T21S R37E Sec 21
Lea County New Mexico

FIGURE 3
Pit
Backfill
Plan



TRIDENT ENVIRONMENTAL

J. R. Cone Operating, LLC
Anderson Lease (1R-5140)
T21S R37E Sec 21
Lea County New Mexico

FIGURE 4
Vent Backfill Plan

Table 1
Pit Excavation: Summary of Benzene, BTEX, TPH, and Chloride Concentrations (mg/kg)

Location	Sample ID	Depth BGS (Ft)	Sample Type	Sampling Date	Benzene (mg/kg)	BTEX (mg/kg)	GRO C6-C10 (mg/kg)	DRO C10-C28 (mg/kg)	ORO C28-C36 (mg/kg)	GRO+DRO C6-C28 (mg/kg)	TPH C6-C36 (mg/kg	Chloride (mg/kg)
Pit Wall Samples	E. Wall-1	2'-10'	Comp	11/20/18	<0.050	<0.300	<10	<10	<10	<20	<30	176
	E. Wall-2	2'-10'	Comp	11/20/18	<0.050	<0.300	<10	<10	<10	<20	<30	304
	E. Wall-3	2'-10'	Comp	11/20/18	<0.050	<0.300	<10	<10	<10	<20	<30	160
	E. Wall-4	2'-10'	Comp	11/20/18	<0.050	<0.300	<10	106	67.0	106	173	80
	S. Wall-1	2'-10'	Comp	11/20/18	<0.050	<0.300	<10	<10	<10	<20	<30	176
	S. Wall-2	2'-10'	Comp	11/20/18	<0.050	<0.300	<10	<10	<10	<20	<30	64
	W. Wall-1	2'-10'	Comp	11/20/18	<0.050	<0.300	<10	<10	<10	<20	<30	<16
	W. Wall-2	2'-10'	Comp	11/20/18	<0.050	<0.300	<10	<10	<10	<20	<30	64
	W. Wall-3	2'-10'	Comp	11/20/18	<0.050	<0.300	<10	<10	<10	<20	<30	464
	W. Wall-4	2'-10'	Comp	11/20/18	<0.050	<0.300	<10	<10	<10	<20	<30	64
	N. Wall-1	2'-10'	Comp	11/20/18	<0.050	<0.300	<10	<10	<10	<20	<30	208
	N. Wall-2	2'-10'	Comp	11/20/18	<0.050	<0.300	<10	<10	<10	<20	<30	32
Pit Floor Samples	A	12'	Comp	11/20/18	<0.050	<0.300	<10	<10	<10	<20	<30	96
	B	12'	Comp	11/20/18	<0.050	<0.300	<10	<10	<10	<20	<30	112
	C	12'	Comp	11/20/18	<0.050	<0.300	<10	<10	<10	<20	<30	48
	D	12'	Comp	11/20/18	<0.050	<0.300	<10	<10	<10	<20	<30	48
	E	12'	Comp	11/21/18	<0.050	<0.300	<10	<10	<10	<20	<30	400
	F	12'	Comp	11/21/18	<0.050	<0.300	<10	<10	<10	<20	<30	256
	G	12'	Comp	11/21/18	<0.050	<0.300	<10	<10	<10	<20	<30	160
	H	12'	Comp	11/21/18	<0.050	<0.300	<10	<10	<10	<20	<30	1,840
	I	12'	Comp	11/21/18	<0.050	<0.300	65.5	**1,480**	162	**1,546**	1,708	672
		15'		02/28/19	<0.050	<0.300	<10.0	88.1	<10.0	88.1	88.1	144
	J	12'	Comp	11/21/18	<0.050	1.72	248	**2,420**	326	**2,668**	**2,994**	144
		15'		02/28/19	<0.050	2.97	45.8	612	81.5	658	739	128
	M	12'	Comp	11/21/18	<0.050	0.656	171	**3,500**	457	**3,671**	**4,128**	192
		15'		02/28/19	<0.050	<0.300	<50.0	**1,150**	95.4	**1,150**	1,245	208
	N	12'	Comp	11/21/18	<0.050	<0.300	<100	**2,150**	689	**2,150**	**2,839**	800
		15'		02/28/19	<0.050	0.937	50.7	**1,700**	350	**1,751**	2,101	224
	O	12'	Comp	11/21/18	<0.050	<0.300	<100	**1,260**	466	**1,260**	1,726	1,170
		15'		02/28/19	<0.050	0.627	38.3	981	247	**1,019**	1,266	320
	P	12'	Comp	11/21/18	<0.050	<0.300	<100	**1,870**	284	**1,870**	2,154	880
		15'		02/28/19	<0.050	1.17	156	**2,550**	157	**2,706**	**2,863**	288
Boring	B-1	19'-21'	Grab	01/17/19	<0.050	<0.300	<10	390	41.5	390	432	384
		34'-35'			<0.050	<0.300	<10	<10	<10	<20	<30	656
		49'-51'			<0.050	<0.300	<10	<10	<10	<20	<30	320
				Closure Criteria	*10*	*50*				*1,000*	*2,500*	*10,000*

All concentrations listed in milligrams per kilogram (mg/kg)

Comp: Composite samples collected from walls and floor consist of representative five-point aliquots.

Grab: Grab samples collected from 2-ft split-spoon while drilling with hollow stem auger rig.

Samples delivered to and analyzed by Cardinal Laboratories (Hobbs NM)

Table 2
Vent Excavation: Summary of Benzene, BTEX, TPH, and Chloride Concentrations (mg/kg)

Location	Sample ID	Depth BGS (Ft)	Type	Sampling Date	Benzene	BTEX	GRO C6-C10	DRO C10-C28	ORO C28-C36	GRO+DRO C6-C28	TPH C6-C36	Chloride
Wall Samples	E. Wall	2'-10'	Comp	01/08/19	<0.050	<0.300	<10	10.4	11.4	10.4	21.8	48
	W. Wall	2'-10'	Comp	01/08/19	<0.050	<0.300	<10	<10	<10	<20	<30	32
	S. Wall	2'-10'	Comp	01/08/19	<0.050	<0.300	<10	<10	<10	<20	<30	16
	N. Wall	2'-10'	Comp	01/08/19	<0.050	<0.300	<10	<10	<10	<20	<30	32
Floor	N. Floor	12'	Comp	01/08/19	<0.050	0.448	<50	**1,670**	157	**1,670**	1,827	112
	S. Floor	12'	Comp	01/08/19	<0.050	0.350	<50	387	51.7	387	439	64
Boring	B-1	16'-18'	Grab	01/17/19	<0.050	<0.300	20.4	625	65.4	645	711	48
		31'-32'	Grab	01/17/19	<0.050	<0.300	<10	<10	<10	<20	<30	80
				Closure Criteria	*10*	*50*				*1,000*	*2,500*	*10,000*

All concentrations listed in milligrams per kilogram (mg/kg)

Comp: Composite samples collected from walls and floor consist of representative five-point aliquots.
Grab: Grab samples collected from 2-ft split-spoon while drilling with hollow stem auger rig.
Samples delivered to and analyzed by Cardinal Laboratories (Hobbs NM)

ATTACHMENT A

CHEMICAL OXIDATION PRODUCT INFORMATION

APPLICATION DEMAND ESTIMATIONS

SAFETY DATA SHEETS

Persulfates
Technical Information

Leading the persulfate market with the highest
quality products and reliable supply.

PeroxyChem

OXIDATION CHEMISTRY

The persulfate anion is the most powerful oxidant of the peroxygen family of compounds.

The electromotive force data listed below compares three commonly used peroxygens:

$$S_2O_{8-2} + 2H^+ + 2e^- \longrightarrow 2HSO_4^- \qquad E = 2.12V$$

$$H_2O_2 + 2H^+ + 2e^- \longrightarrow 2H_2O \qquad E = 1.77V$$

$$HSO_5^- + 2H^+ + 2e^- \longrightarrow HSO_4^- + H_2O \qquad E = 1.44V$$

Many metals are oxidized by persulfate to form soluble metal sulfates, for example, copper:

$$Cu + S_2O_8^{-2} \longrightarrow CuSO_4 + SO_4^{-2}$$

Under certain circumstances, hydrolysis of the persulfate anion will yield the bisulfate anion and hydrogen peroxide a kinetically faster oxidant than persulfate:

$$S_2O_8^{-2} + 2H_2O \xrightarrow{H+} 2HSO_4^{-2} + H_2O_2$$

Another reaction of note is the acid-catalyzed hydrolysis of persulfate to form peroxymonosulfate anion. Fast, high-temperature, acid hydrolysis followed by thermal quenching will yield solutions of peroxymonosulfate:

$$S_2O_8^{-2} + H_2O \longrightarrow HSO_4^- + HSO_5$$

The resulting solution is a useful replacement for Caro's acid, H_2SO_5 and potassium caroate, $KHSO_5$. Reactions at different pH:

NEUTRAL (PH 3 TO 7)

$$S_2O_8^{-2} + H_2O \longrightarrow 2HSO_4^- + 1/20_2$$

DILUTE ACID (PH > 0.3; [H+] < 0.5M)

$$S_2O_8^{-2} + 2H_2O \longrightarrow 2HSO_4^- + H_2O_2$$

STRONG ACID ([H+] > 0.5M)

$$S_2O_8^{-2} + H_2O \longrightarrow 2HSO_4^- + HSO_5^-$$

ALKALINE (PH > 13)

$$S_2O_8^{-2} + OH^- \longrightarrow HSO_4^- + SO_{4-2} + 1/20_2$$

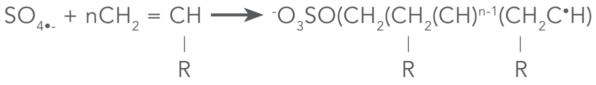
FREE RADICAL CHEMISTRY

Persulfates produce free radicals in many diverse reaction situations.

When solutions of the persulfates are heated, free radicals are formed:

$$S_2O8^{-2} + Heat \longrightarrow 2SO_{4\bullet-}$$

In the presence of suitable monomers, the radical anions act as polymerization initiators to produce polymer molecules:



$$SO_{4\bullet-} + nCH_2 = \underset{\substack{|\\R}}{CH} \longrightarrow {}^-O_3SO(CH_2(\underset{\substack{|\\R}}{CH_2}(CH)^{n-1}(\underset{\substack{|\\R}}{CH_2}C^\bullet H)$$

Free radicals suitable as polymerization initiators are also generated in the presence of reducing agents, for example, the bisulfite anion:

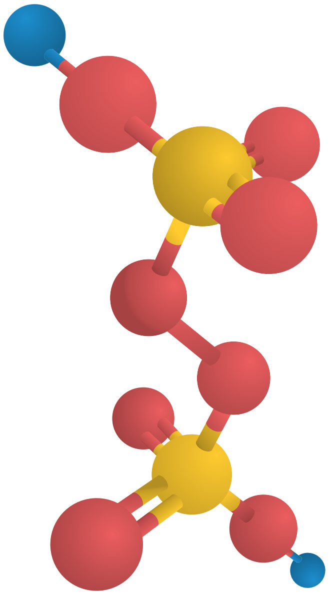
$$S_2O_8^{-2} + HSO_{3-} + 1/20_2 \longrightarrow HSO_{4-} + 2SO_{4\bullet-}$$

Free radicals can also be generated in the presence of transition metals:

$$S_2O_8^{-2} + Fe^{+2} \longrightarrow Fe^{+3} + SO_4^{-2} + SO_{4\bullet-}$$

and mercaptans:

$$S_2O_8^{-2} + 2RSH \longrightarrow 2HSO_{4-} + 2RS^\bullet$$



Persulfate Chemical Structure

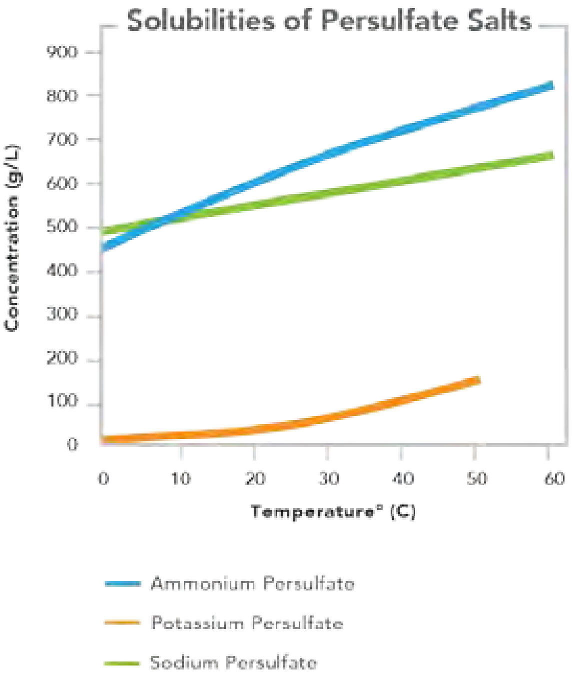
Physical & Chemical Data

PHYSICAL AND CHEMICAL PROPERTIES OF PERSULFATES

> **PeroxyChem conducted physical and chemical studies of persulfates to provide the data for this section.**

You will find the data useful for applying persulfate chemicals to various processes and products. The density, viscosity, electrical conductance, and solution heat capacity data are presented in graphic and equation form. This format enables you to view the general trend of the physical data. Then, with the aid of equations, you can calculate the correct values for your application.

Common Name	Ammonium Persulfate	Potassium Persulfate	Sodium Persulfate
Chemical Name	Ammonium Peroxydisulfate	Potassium Peroxydisulfate	Sodium Peroxydisulfate
Physical Form	Crystalline (monoclinic)	Crystalline (triclinic)	Crystalline (monoclinic)
Formula	$(NH_4)_2S_2O_8$	$K_2S_2O_8$	$Na_2S_2O_8$
Molecular Weight	228.2	270.3	238.1
Crystal Density (g/cc)	1.98	2.48	2.59
Color	Off-white	Off-white	White
Odor	None	None	None
Loose Bulk Density (g/cc)	1.05	1.30	1.12



Maximum solubility of Persulfate salts in water

Solubility (g/100g of H_2O)	Ammonium Persulfate	Potassium Persulfate	Sodium Persulfate
25° C	85	6	73
50° C	116	17	86

General Material Information

Persulfate Handling and Safety

Persulfates are oxidizing chemicals that require careful attention to all aspects of handling and use. For more information, you may request a Safety Data Sheet (SDS) which is available from any PeroxyChem office and on our website at peroxychem.com.

Personal Protective Equipment

When handling persulfate chemicals, follow the guidelines listed here and in the SDS.

PROTECT YOUR EYES: Wear chemical-type goggles or a face mask whenever splashing, spraying, or any eye contact is possible.

PROTECT YOUR RESPIRATORY SYSTEM: Use dust respirators approved by NIOSH/MSA whenever exposure may exceed the established standard listed in the current SDS.

PROTECT YOUR HANDS: Wear general purpose neoprene gloves.

PROTECT YOURSELF WITH PROPER CLOTHING: Wear ordinary work clothes with long sleeves and full-length pants.

PROTECT YOURSELF WITH PROPER FOOTWEAR: Wear shoes with neoprene soles.

First Aid

EYE CONTACT: Flush with water for at least 15 minutes. If irritation occurs and persists, obtain medical attention.

SKIN CONTACT: Wash with plenty of soap and water. If irritation occurs and persists, obtain medical attention. Wash clothing before reuse.

INHALATION: Get fresh air. If breathing difficulty or discomfort occurs, call a physician.

INGESTION: Drink one to two glasses of water. Do not induce vomiting. Do not give anything by mouth to an unconscious individual. Call a physician immediately.

When properly handled and stored, persulfates and their solutions do not present serious health hazards. The SDS provides information concerning exposure, emergency, first aid, and disposal of persulfates.

Storage

Persulfates should be stored in accordance with the National Fire Protection Association (NFPA) 400 Hazardous Materials Code. PeroxyChem personnel can provide additional support in reviewing storage facilities.

GENERAL PRECAUTIONS: Persulfates should be kept in a cool, dry storage area, in a configuration that is appropriate for the sprinkler capacity of the building per NFPA 400.

Personnel should be trained to handle persulfates safely, properly dispose of spilled materials and prevent contamination.

If material gets wet or spills, it must be isolated and disposed of properly.

Containers and Packaging

PeroxyChem packages and ships crystalline persulfate chemicals in three different container types, according to customer requests.

Type	Construction	Persulfate wt/container	Containers per pallet	Persulfate wt/pallet
Bag	Polyethylene	55 lbs/25kg	40	2,200 lbs/1,000kg
Drum	Fiber drums, polyethylene liner	225 lbs/102kg	8	1,800 lbs/896kg
IBC*	Polypropylene sack	2,200 lbs/1,000kg	1	2,200 lbs/1,000kg

*IBC = Intermediate Bulk Container, equipped with easy opening bottom spout for discharging into tanks or hoppers.

Customer Support Services

Quality Assurance

PeroxyChem persulfate products are produced under an ISO-9002 certified quality system. Statistical Process Control (SPC) and a distributed control system combine to provide consistent process control. PeroxyChem operators monitor key parameters to ensure consistent quality for all products.

All materials–raw, intermediate and final–are checked and tested in a new, modern laboratory employing the latest analytical technology. Quality test results are maintained on each batch of product. Certificates of Analysis and other end-product information can be customized to meet your system requirements.

Our production facility uses SPC methods to improve and assure the quality of persulfate chemical products. PeroxyChem operators chart key operating parameters to maintain process control; this assures that quality is built in to each customer's order.

The SPC system is designed to meet your specific quality standards. Product is analyzed and identified as it leaves the packaging areas. Product quality is maintained by batch number. The information is then stored in a computer database, enabling PeroxyChem to issue Certificates of Analysis that are specific to each batch of materials received by our customers.

PeroxyChem is the only persulfate producer that uses cutting edge technology to ensure that our products are stable for storage or transport and use. We have established new product safety standards for thermal stability to ensure a high-quality, stable persulfate.

Technical Services

All PeroxyChem customers have access to our staff of technical service representatives. These chemists and engineers are experienced in the production, sale, and distribution of peroxygen chemicals. They are fully capable of answering questions on the safe handling and usage of persulfates. In fact, PeroxyChem specialists have helped our customers pioneer many successful applications for persulfate chemicals. Our engineering services include the design and construction of storage facilities, or the safety inspection of your present warehouse or production facilities. PeroxyChem also offers a complete list of technical articles, bulletins, data sheets, and patents.

Contact Information

For more information, please contact us at:

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CEP 04550-004
Ph +55 11 3280 1610

Subject: RE: Soil and Groundwater - Site Evaluation Form
From: Josephine Molin <josephine.molin@peroxychem.com>
Date: 4/26/2019, 8:13 AM
To: Gil Van Deventer <gil@trident-environmental.com>

Klozur SP activated by hydrated lime will be the more cost effective option and is the chemistry that we would typically recommend for soil mixing applications, so this would be my recommendation. The hydrated lime will also help stabilize the soil following mixing. Another key benefit is that the alkalinity from the lime with help reduce the corrosiveness of the persulfate on the equipment. Please find demand estimations for two reagent options attached:

AREA 1:	**Components**	**Mass (lbs)**
Option 1: Klozur CR (blend of 50% Klozur sodium persulfate and PermeOx calcium peroxide)	All-in-one	38,880
Option 2: Alkaline activated persulfate (Klozur SP + hydrated lime)	Klozur SP	15,428
	Hydrated lime	6,000

AREA 2:	**Components**	**Mass (lbs)**
Option 1: Klozur CR (blend of 50% Klozur sodium persulfate and PermeOx calcium peroxide)	All-in-one	14,310
Option 2: Alkaline activated persulfate (Klozur SP + hydrated lime)	Klozur SP	6,612
	Hydrated lime	4,000

Here are the assumptions that went into the calculation:

➢ • Demand from COCs calculated based on having to reduce DRO from 1,670 to 1,000 ppm (670 ppm reduction needed)
➢ • Degradation ratio of 20 lbs Klozur SP per lb DRO
➢ • Natural soil oxidant demand = 1 g/kg
➢ • Safety factor of 25% added on top of the calculated demand

Please let me know if this looks good and what reagent option you prefer and I will request freight rates to Hobbs. I included the cost for the hydrated lime as an FYI (sourced from third party), but if you could source the lime locally that may be preferred. For these volumes we can only supply hydrated lime in 50-lb bags and it will come out of Dallas (full pallet increments). For volumes >30,000 lbs we can offer more competitive pricing for the lime in supersacks, but again, please feel free to find a local supplier. Note, it needs to be HYDRATED lime.

PeroxyChem manufacturers persulfates and peroxides and we are the only manufacturer of persulfate with manufacturing here in the US. Note that we have a patent on alkaline activated persulfate and a limited use license is included when buying the persulfate (Klozur SP) from us.

Soil mixing guideline:
http://www.peroxychem.com/media/259403/peroxychem-klozur-persulfate-product-application-guide-soil-mixing-and-iss-97-01-esd-17.pdf

Info on alkaline activation:
http://www.peroxychem.com/media/247761/peroxychem-klozur-persulfate-alkaline-actitivation-guide-01-04-esd-17.pdf

Info on material compatibility (note how it is significantly less corrosive to carbon steel under high pH conditions -table 4:
http://www.peroxychem.com/media/131599/peroxychem-klozur-compatible-materials.pdf

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Klozur® Persulfate Soil Mixing Recommendations and Application Guidelines

Klozur® persulfate is a high purity environmental grade product used as an *in situ* chemical oxidation (ISCO) technology to treat a wide variety of contaminants of concern in soil and groundwater around the world. Klozur persulfate can be activated using PeroxyChem's patented technologies[1] to form the powerful oxidative and reductive radicals that aggressively treat targeted contaminants. This technology is well established having been successfully applied in thousands of field applications and scientifically validated in hundreds of independent peer-reviewed journal articles and conference presentations.

The Klozur persulfate portfolio includes several high purity products:

- **Klozur SP** is based on sodium persulfate which is highly soluble and has been used for over a decade to treat contaminated source areas.
- **Klozur One** is a blend of Klozur SP with carefully crafted activator technologies combined into a single all-in-one product. Klozur One makes applying Klozur SP more convenient than ever before.
- **Klozur KP** is based on potassium persulfate which has over an order of magnitude lower solubility than Klozur SP. This allows it to serve as an extended release oxidant to treat low permeable soils and in permeable reactive barriers.
- **Klozur CR** provides a combined remedy of chemical oxidation and bioremediation. The product is a blend of Klozur SP and PermeOx® Ultra, typically used to treat low to moderately contaminated site source zones, plumes, and in excavation backfill applications.

Klozur products are typically applied using an injection, soil mixing or backfill strategies to establish contact between Klozur SP and the contaminants of concern. This document discusses the soil mixing strategies for applying Klozur products.

Soil Mixing

A soil mixing strategy typically involves the mechanical agitation of subsurface soils blending in both Klozur persulfate and the necessary activator reagents. The mechanical agitation breaks apart the natural soil structure and helps to establish contact between activated Klozur persulfate and the contamination found in the soils. This contact is key for successful remediation. A soil mixing application strategy can be particularly useful in treating source zones and lower permeable soils such as silts or clays.

ISCO works by establishing contact between sufficient mass of activated persulfate with the mass of contamination

Soil mixing has been used to target:

- Source areas as the primary method of treatment
- Residual contamination after excavation as a secondary method of treatment
- Combined with *in situ* stabilization (ISS) and other technologies
- To blend in reagents to form a permeable reactive barrier

Key Advantages of Soil Mixing

- Very effective in establishing contact between the activated persulfate and contaminant on soils
- Can be used to breakup low permeability materials allowing better contact minimizing the impact of site soil heterogeneity.
- Helps establish contact of reagents with zones of high concentration including non-aqueous phase liquids (NAPLs)
- Rapid process that is well suited for source zones
- Amendments can be added to increase soil strength and decrease contaminant flux from soils

In situ soil mixing of activated Klozur persulfate can be combined with a second remedial technology: *in situ* stabilization (ISS). The combination of ISCO and ISS occurs when Portland cement, bentonite, or other solidification compounds are blended in with the activated persulfate. The benefit of combining both technologies into a single application is that ISCO can be used to reduce the contaminant mass while ISS can be used to reduce the potential contaminant mass flux coming from the blended area. In addition, ISS using Portland cement can increase soil strength following a soil mixing application, providing surface support.

Methods of Soil Mixing

There are several different methods that can be used to mix the Klozur persulfate with soil to establish contact with the contamination.


Courtesy of CH2M

Excavation Buckets

The buckets on backhoes and excavators can be used to mix the reagents with the soils. This method typically has a low mobilization costs, but tends to be less efficient, have a limited depth range, and reagents tend to be applied at the surface and blended down into the target depth interval. Because of these limitations, excavation bucket mixing is typically used for smaller and shallow sites.


Courtesy of ISOTEC

Excavator Mounted Drum Mixers

Excavator mounted drum mixers have become more advanced and their use more commonplace. These drum mixers typically have a method to inject liquid or slurried reagents from the drum allowing for the placement of the reagents at depth and have teeth that rotate on a drum to mix the reagents with the soil. Many drum mixers allow the drum itself to rotate creating multiple axis of rotation. Drum mixers can have lower mobilization costs since they are typically on arms that can be mounted on excavators. The functional depth of drum mixers without benching or terracing of the soils is limited to reach of the excavator arm (typical: 15 to 25 ft; 4.5 to 7.5 m). These mixers tend to be efficient, mixing between 200 to 600 tons of soil per day.

Rotary Augers

Rotary augers are circular devices mounted to various rigs or cranes. The augers rotate mixing in the reagents and soils. Some rotary augers allow injection of liquid or slurried reagents at depth typically through injection ports in the rotary blades. Mobilization costs of rotary augers typically increase with the size and depth of which the auger is capable of treating. However, rotary augers can be used to soil mix at depths well below the other soil mixing methods and tend to be used for soil mixing projects where the tool needs to reach deeper than 25 to 30 ft. bgs (8 to 9 m bgs).

Screening

Dry reagents can be blended with excavated soils above ground and reapplied to the excavation area.

Soil mixing is usually accomplished by dividing a site area into cells. These cells will vary in size as needed, but are typically squares with sides of 10 to 15 feet (3 to 4.5 meters). If augers are to be used, the cell is typically defined by the auger diameter. If liquid or slurry reagents and tooling allow injection at depth, vertical intervals are also established with different mass of reagents being applied as required to each vertical interval. Another common approach is to mix the entire vertical target interval sufficiently assuming an average distribution of both the contaminant and reagent. This method allows the treatment of the entire vertical interval with a single approach and reagents can be added at the surface and blended down.


Courtesy of GeoSolutions

Soil mixing has been conducted in both saturated and unsaturated (vadose) zones. However, vadose zone applications may require the addition of water depending on the bound moisture content of the soil. If excess water is applied then additional time may be required for the soil to drain. Please see “Lessons Learned” section of this document for a discussion regarding post application drainage.

Persulfate Activation

Activated persulfate can generate powerful radicals capable of treating most contaminants of concern. Common activation methods include alkaline or high pH, iron-chelate, di-valent iron, zero valent iron, heat, and hydrogen peroxide. While all of PeroxyChem’s recommended activation methods can be used with an *in situ* mixing application strategy, materials compatibility with *in situ* mixing projects is often an important consideration, since mixing equipment typically has components that contain carbon steel, which is reactive with Klozur persulfate at neutral and acidic pH values.

Alkaline activated persulfate is the most common activation method used for *in situ* soil mixing projects because carbon steel has a significantly lower rate of corrosion under alkaline conditions. Any equipment contacting reagents needs to be chemically compatible with those reagents.

Lessons Learned

As with any technology, there have been lessons learned during field applications. A few of lessons learned from *in situ* soil mixing of activated persulfate are summarized below:

Dusting

Applying reagents in winds, from height or a combination can result in reagent dust. Mitigation measures for the various possible field conditions should be considered. Common mitigation measures include having staff in proper PPE, minimizing drop height of the reagents, misting, applying hydrated reagents, and avoiding exposing dry reagents if winds are above a certain velocity.

Soil Expansion

Soils are typically not as compacted following a soil mixing application and high plasticity clays can expand. This can result in excess soils that will no longer fit in the excavation area that is referred to as fluff. The excess materials are either typically stockpiled to the side of or on top of the excavation area, or removed for disposal. Material stockpiled on top of the excavation may partially or completely return to the excavation area as the mixed soils compress over time. Site management during an application may include building of berms around the treatment area.

Drainage

Soil mixing in the vadose zone, especially if significant amounts of water are added, can result in mostly dry soils becoming a soil slurry. These conditions may persist especially if drainage from the mixing area is limited. This issue is most common when soil mixing low permeability vadose zone soils that can remain a slurry for an extended period of time as the added water slowly moves out of the area.

Soil Strength

The resulting soil strength or compressive characteristics of soils following an *in situ* soil mixing project may not be suited for subsequent site activities. These characteristics may make moving machinery or building upon the soil following an *in situ* soil mixing project more challenging. This can be mitigated by increasing soil strength with the addition of a solidification agents such as a calcium source (calcium hydroxide, etc.) to form gypsum with the residual sulfate, Portland cement, or another bulking agent. Varying degrees of the solidification agents can be used to obtain different soil characteristics.

Mitigation of ISCO by ISS

While ISS and ISCO have been successfully applied together, if the ISS solidifies the soils too quickly it could interfere with the ISCO oxidation processes. This can occur if a significant concentration of Portland cement is added to the mixture or if the mixture contains too little water and the Portland cement effectively dries the soils. The rate of solidification and the percent treatment by ISCO can be evaluated on a bench scale test.

Health and Safety

Klozur persulfate has been applied safely and effectively at thousands of sites. However, as with any chemical, proper procedures and equipment are recommended in its use. When working with Klozur persulfate, ensure to have adequate ventilation and use the appropriate personal protective equipment, including safety glasses, suitable protective clothing, boots (steel toed or equivalent), chemical resistant gloves, hard hat, and hearing protection (when direct push is used). For dust, splash, mist, or spray exposures wear a filtering dust mask and chemical protective goggles. A face shield can also be used in addition to goggles.

Dust	**When applying any solid reagent, dust could evolve. PeroxyChem recommends proper consideration of this potential including personal protective equipment (PPE), and dust mitigation measures.**
Contaminant Vapors	The mixing process can expose contaminated soils to the atmosphere and allow vapors to escape potentially causing a health and safety hazard. Some mixing technologies have developed hoods to help minimize this risk.

Please consult the appropriate safety data sheets (SDS) for guidelines regarding proper handling procedures. Klozur persulfate SDS's can be found at http://www.peroxychem.com/remediation. Additional safety equipment may be required for mechanical and site operations.

Please contact PeroxyChem for additional guidance.

Notes

1. A limited use license is included with the purchase of Klozur Persulfate for PeroxyChem's suite of national and international patents for the *in situ* activation of persulfate to remediate environmental contaminants of concern including US 6019548, US 6474908, US 7524141, US 7576254B2, US 7785038, and US 9375768B2.

References

Cassidy, D.P., Srivastava, V.J., Dombrowski, F.J., and Lingle, J.W., (2015) "Combining *in situ* chemical oxidation, stabilization, and anaerobic bioremediation in a single application to reduce contaminant mass and leachability in soil," J. of Hazardous Materials, 297, 347-355

Dyson, K.D., and Palko, P.J., (2012) "Chemically Activated Sodium Persulfate Soil Mixing Preceding Site Redevelopment Activities," Eighth International Conference on Remediation of Chlorinated and Recalcitrant Compounds, Monterey, CA

Fulkerson, M., Sale, T., and Simpkin, T., (2016) "Ten Years of Soil Mixing: Technology Applications, Advancements, and Lessons Learned," Tenth International Conference on Remediation of Chlorinated and Recalcitrant Compounds, Palm Springs, CA

Morris, K.A., Brown, R., Ross, D., and Butler, W.A., (2012) "ISCO Treatment of an Organochlorine Pesticide Source Area via Shallow Soil Mixing," Eighth International Conference on Remediation of Chlorinated and Recalcitrant Compounds, Monterey, CA

Perlmutter, M., Simpkin, T., Cassidy, D., and Smith B.A., (2017) "Soil Mixing and *In situ* Stabilization using Klozur® Persulfate: Theories, Benefits, and Lessons Learned," PeroxyChem Website, January 27, 2017

Tarmann, S., Kakarla, P., and Caldicott, W., (2012) "In-Situ Chemical Oxidation of Trichloroethylene in Clay Soil Using Rotating Dual Axis Blending Technology," Poster, Eighth International Conference on Remediation of Chlorinated and Recalcitrant Compounds, Monterey, CA

Wiley, J., Block, P., (2010) "Chemical Oxidation Using Sodium Persulfate at a Superfund Site in Texas," Seventh International Conference on Remediation of Chlorinated and Recalcitrant Compounds, Monterey, CA

SAFETY DATA SHEET
Sodium Persulfate

SDS # : 7775-27-1
Revision date: 2018-07-13
Format: NA
Version 1.04

1. PRODUCT AND COMPANY IDENTIFICATION

Product Identifier

Product Name	Sodium Persulfate
CAS-No	7775-27-1
Synonyms	Sodium Peroxydisulfate; Disodium Peroxydisulfate; Peroxydisulfuric acid, disodium salt; Peroxydisulfuric acid, sodium salt.

Recommended use of the chemical and restrictions on use

Recommended Use:	Polymerization initiator; Etchant and cleaner for printed circuit boards; Hair bleaching formulations; Secondary oil recovery; Oxidizing agent for a variety of organic reactions.
Restrictions on Use	No uses to be advised against were identified.

Manufacturer/Supplier

PeroxyChem LLC
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Suite 3200
Philadelphia, PA 19103
Phone: +1 267/ 422-2400 (General Information)
E-Mail: sdsinfo@peroxychem.com

Emergency telephone numbers

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

Classification

OSHA Regulatory Status
This material is considered hazardous by the OSHA Hazard Communication Standard (29 CFR 1910.1200)

Acute toxicity - Oral	Category 4
Skin corrosion/irritation	Category 2
Serious eye damage/eye irritation	Category 2B
Respiratory sensitization	Category 1
Skin sensitization	Category 1
Specific target organ toxicity (single exposure)	Category 3
Oxidizing Solids	Category 3

GHS Label elements, including precautionary statements

EMERGENCY OVERVIEW

Danger

Hazard Statements

H334 - May cause allergy or asthma symptoms or breathing difficulties if inhaled
H335 - May cause respiratory irritation
H319 - Causes serious eye irritation
H315 - Causes skin irritation
H317 - May cause an allergic skin reaction
H302 - Harmful if swallowed
H272 - May intensify fire; oxidizer

Precautionary Statements - Prevention

P261 - Avoid breathing dust/ fume/ gas/ mist/ vapors/ spray
P285 - In case of inadequate ventilation wear respiratory protection
P271 - Use only outdoors or in a well-ventilated area
P280 - Wear protective gloves/ protective clothing
P264 - Wash face, hands and any exposed skin thoroughly after handling
P210 - Keep away from heat/sparks/open flames/hot surfaces. - No smoking
P220 - Keep/Store away from clothing/combustible materials
P221 - Take any precaution to avoid mixing with combustibles

Precautionary Statements - Response

P305 + P351 + P338 - IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing
P337 + P313 - If eye irritation persists: Get medical advice/ attention
P302 + P352 - IF ON SKIN: Wash with plenty of water.
P333 + P313 - If skin irritation or rash occurs: Get medical advice/ attention
P362 - Take off contaminated clothing and wash before reuse
P304 + P340 - IF INHALED: Remove person to fresh air and keep comfortable for breathing
P342 + P311 - If experiencing respiratory symptoms: Call a POISON CENTER or doctor
P301 + P312 - IF SWALLOWED: Call a POISON CENTER or doctor if you feel unwell
P330 - Rinse mouth
P370 + P378 - In case of fire: Use water for extinction

Precautionary Statements - Storage

P403 + P235 - Store in a well-ventilated place. Keep cool

Hazards not otherwise classified (HNOC)

No hazards not otherwise classified were identified.

Other Information

Risk of decomposition by heat or by contact with incompatible materials

Unknown acute toxicity

0% of the mixture consists of ingredient(s) of unknown toxicity

3. COMPOSITION/INFORMATION ON INGREDIENTS

Formula $Na_2O_8S_2$

Chemical name	CAS-No	Weight %
Sodium Persulfate	7775-27-1	> 99
Sodium sulfate	7757-82-6	< 1

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.
Most important symptoms and effects, both acute and delayed	Itching; Redness; Coughing and/ or wheezing.
Indication of immediate medical attention and special treatment needed, if necessary	Treat symptomatically

5. FIRE-FIGHTING MEASURES

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.
Specific Hazards Arising from the Chemical	Decomposes under fire conditions to release oxygen that intensifies the fire.

Explosion data

Sensitivity to Mechanical Impact	Not sensitive.
Sensitivity to Static Discharge	Not sensitive.
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.

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

Environmental Precautions Knock down dust with water spray. Avoid penetration into waterways, sewers, soil or groundwater. Local authorities should be advised if significant spillages cannot be contained.

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. Dispose of waste as indicated in Section 13.

7. HANDLING AND STORAGE

Handling Wear personal protective equipment. Avoid breathing dust. Handle product only in closed system or provide appropriate exhaust ventilation at machinery. Avoid contact with skin and eyes. 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.

Incompatible products Acids. Bases, Halides, Oxidizing agents, Strong reducing agents, Combustible materials.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Control parameters

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

Appropriate engineering controls

Engineering measures Ensure adequate ventilation, especially in confined areas.

Individual protection measures, such as personal protective equipment

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

Skin and Body Protection Wear long-sleeved shirt, long pants, socks, and shoes.

Hand Protection Protective gloves: Neoprene gloves, Polyvinylchloride, Natural Rubber.

Respiratory Protection If exposure limits are exceeded or irritation is experienced, NIOSH/MSHA approved respiratory protection should be worn: particulate filtering facepiece respirators.

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.

General information Protective engineering solutions should be implemented and in use before personal protective equipment is considered.

9. PHYSICAL AND CHEMICAL PROPERTIES

Information on basic physical and chemical properties

Appearance	Crystalline solid
Physical State	Solid
Color	White
Odor	odorless
Odor threshold	Not applicable
pH	6.0 (1% solution)
Melting point/freezing point	180 °C (Decomposes)
Boiling Point/Range	Decomposes on heating
Flash point	Not flammable
Evaporation Rate	Not applicable
Flammability (solid, gas)	Not flammable
Flammability Limit in Air	Not applicable
Upper flammability limit:	No information available
Lower flammability limit:	No information available
Vapor pressure	6.07E-30 mm Hg at 25ºC
Vapor density	No information available
Density	2.59 g/cm³ (crystal density)
Specific gravity	No information available
Water solubility	42 % @ 25 °C
Solubility in other solvents	No information available
Partition coefficient	No information available
Autoignition temperature	No evidence of combustion up to 600°C
Decomposition temperature	> 100 °C (assume)
Viscosity, kinematic	No information available (Solid)
Viscosity, dynamic	No information available
Explosive properties	Not explosive
Oxidizing properties	oxidizer
Molecular weight	238.1
VOC content (%)	Not applicable
Bulk density	1.12 g/cm³ (loose)

10. STABILITY AND REACTIVITY

Reactivity	Strong oxidizer. Oxidizer. Contact with other material may cause fire.
Chemical Stability	Decomposition can occur on exposure to heat or moisture.
Possibility of 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.
Hazardous polymerization	Hazardous polymerization does not occur.
Conditions to avoid	Heat. (decomposes at 275 °C); Moisture.
Incompatible materials	Bases, Halides, Oxidizing agents, Strong reducing agents, Combustible materials. Acids.
Hazardous Decomposition Products	Oxygen which supports combustion; Sulfur oxides.

11. TOXICOLOGICAL INFORMATION

Product Information

Unknown acute toxicity 0% of the mixture consists of ingredient(s) of unknown toxicity

LD50 Oral 895 920 mg/kg (rat) (Sodium Persulfate)
LD50 Dermal > 10,000 mg/kg (rabbit) (Sodium Persulfate)
LC50 Inhalation > 5.1 mg/L (rat) (4-hr) (Sodium Persulfate)

Serious eye damage/eye irritation Irritating to eyes.
Skin corrosion/irritation Minimally irritating.

Sensitization Sensitizing to skin and respiratory system.

Component Information

Chemical name	LD50 Oral	LD50 Dermal	LC50 Inhalation	NOAEL Oral Value
Sodium Persulfate (7775-27-1)	895 mg/kg (Rat)	> 10000 mg/kg (Rabbit)	> 21.6 mg/L (Rat) 4 h	
Sodium sulfate (7757-82-6)	> 10000 mg/kg (Rat)			

Information on toxicological effects

Symptoms Symptoms of allergic reaction may include rash, itching, swelling and trouble breathing.

Delayed and immediate effects as well as chronic effects from short and long-term exposure

Irritation Irritating to eyes, respiratory system and skin.
corrosivity None.

Carcinogenicity Did not show carcinogenic effects in animal experiments.

Mutagenicity In vivo tests did not show mutagenic effects.

Reproductive toxicity This product is not recognized as reprotox by Research Agencies.

STOT - single exposure May cause respiratory irritation.
STOT - repeated exposure Not classified.
Subchronic toxicity Oral (NOAEL) = 131.5 mg/kg bw (Sodium Persulfate)
Inhalation (NOAEC) = 10.3 mg/m^3 (Ammonium Persulfate) Dermal: No data available

Target organ effects Eyes, Skin, Respiratory System.

Aspiration hazard Not applicable.

12. ECOLOGICAL INFORMATION

Ecotoxicity

Ecotoxicity effects

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 Selenastrum 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.
US EPA Waste Number	D001.
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

TDG

UN/ID no	UN 1505
Proper Shipping Name	SODIUM PERSULFATE
Hazard class	5.1
Packing Group	III

MEX

UN/ID no	UN 1505
Proper Shipping Name	SODIUM PERSULFATE
Hazard class	5.1
Packing Group	III

ICAO/IATA

UN/ID no	1505
Proper Shipping Name	SODIUM PERSULFATE
Hazard class	5.1
Packing Group	III

IMDG/IMO

UN/ID no	1505
Proper Shipping Name	SODIUM PERSULFATE
Hazard class	5.1
Packing Group	III

ADR/RID

UN/ID no	UN 1505
Proper Shipping Name	SODIUM PERSULFATE
Hazard class	5.1
Packing Group	III

ADN

Proper Shipping Name	SODIUM PERSULFATE
Hazard class	5.1
Packing Group	III

15. REGULATORY INFORMATION

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

This product has the following hazards that are reportable under The Emergency Planning and Community Right-to-Know rule (EPCRA Tier II):

- Oxidizer
- Acute toxicity
- Skin corrosion/irritation
- Serious eye damage/eye irritation
- Respiratory/skin sensitization
- Specific Target Organ Toxicity (STOT) - Single Exposure

Clean Water Act

This product does not contain any substances regulated as pollutants pursuant to the Clean Water Act (40 CFR 122.21 and 40 CFR 122.42)

CERCLA/EPCRA

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

US State Regulations

U.S. State Right-to-Know Regulations

This product contains the following substances regulated under state Right-to-Know laws:

Chemical name	Massachusetts	New Jersey	Pennsylvania	Illinois	Rhode Island
Sodium Persulfate		X			
Sodium sulfate	X		X		

California Proposition 65

This product does not contain any Proposition 65 chemicals

CANADA

Environmental Emergencies
This product contains no substances listed under Canada's Environmental Emergency regulations.

Canadian National Pollutant Release Inventory
This product contains no substances reportable under Canada's National Pollutant Release Inventory regulations.

International Inventories

Component	TSCA (United States)	DSL (Canada)	EINECS/ELINCS (Europe)	ENCS (Japan)	China (IECSC)	KECL (Korea)	PICCS (Philippines)	AICS (Australia)	NZIoC (New Zealand)
Sodium Persulfate 7775-27-1 (> 99)	X	X	X	X	X	X	X	X	X
Sodium sulfate 7757-82-6 (< 1)	X	X	X	X	X	X	X	X	X

Mexico

Mexico - Grade Slight risk, Grade 1

16. OTHER INFORMATION

NFPA	**Health Hazards** 1	**Flammability** 0	**Stability** 1	**Special Hazards** OX
HMIS	**Health Hazards** 1	**Flammability** 0	**Physical hazard** 1	**Special precautions** J

NFPA/HMIS Ratings Legend Severe = 4; Serious = 3; Moderate = 2; Slight = 1; Minimal = 0
OX = Oxidizer
Protection=J (Safety goggles, gloves, apron, combination dust and vapor respirator)

Revision date: 2018-07-13
Revision note SDS sections updated: 3.
Issuing Date: 2018-10-16

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Prepared By:

PeroxyChem

End of Safety Data Sheet

1 - PRODUCT IDENTIFICATION

PRODUCT NAME: CALCIUM HYDROXIDE
FORMULA: CA(OH)2
FORMULA WT: 74.09
CAS NO.: 01305-62-0
NIOSH/RTECS NO.: EW2800000
COMMON SYNONYMS: CALCIUM HYDRATE; SLAKED LIME
PRODUCT CODES: 1372,5143,5033,1374
EFFECTIVE: 09/26/85
REVISION #01

PRECAUTIONARY LABELLING

BAKER SAF-T-DATA(TM) SYSTEM

HEALTH - 1 SLIGHT
FLAMMABILITY - 0 NONE
REACTIVITY - 1 SLIGHT
CONTACT - 2 MODERATE

HAZARD RATINGS ARE 0 TO 4 (0 = NO HAZARD; 4 = EXTREME HAZARD).

LABORATORY PROTECTIVE EQUIPMENT

SAFETY GLASSES; LAB COAT

PRECAUTIONARY LABEL STATEMENTS

WARNING
CAUSES IRRITATION

AVOID CONTACT WITH EYES, SKIN, CLOTHING.
KEEP IN TIGHTLY CLOSED CONTAINER. WASH THOROUGHLY AFTER HANDLING.

SAF-T-DATA(TM) STORAGE COLOR CODE: ORANGE (GENERAL STORAGE)

2 - HAZARDOUS COMPONENTS

COMPONENT	%	CAS NO.
CALCIUM HYDROXIDE	90-100	1305-62-0
CALCIUM HYDROXIDE	90-100	1305-62-0

3 - PHYSICAL DATA

BOILING POINT: N/A

VAPOR PRESSURE(MM HG): N/A

MELTING POINT: 580 C (1076 F)

VAPOR DENSITY(AIR=1): 2.5

SPECIFIC GRAVITY: 2.24
(H2O=1)

EVAPORATION RATE: N/A
(BUTYL ACETATE=1)

SOLUBILITY(H2O): NEGLIGIBLE (LESS THAN 0.1 %) % VOLATILES BY VOLUME: 0

APPEARANCE & ODOR: SOFT, ODORLESS SOLID OR CRYSTALS.

4 - FIRE AND EXPLOSION HAZARD DATA

FLASH POINT (CLOSED CUP: N/A

FLAMMABLE LIMITS: UPPER - N/A % LOWER - N/A %

FIRE EXTINGUISHING MEDIA
USE EXTINGUISHING MEDIA APPROPRIATE FOR SURROUNDING FIRE.

5 - HEALTH HAZARD DATA

THRESHOLD LIMIT VALUE (TLV/TWA): 5 MG/M3 (PPM)

TOXICITY: LD50 (ORAL-RAT)(MG/KG) - 7340

CARCINOGENICITY: NTP: NO IARC: NO Z LIST: NO OSHA REG: NO

EFFECTS OF OVEREXPOSURE
DUST MAY IRRITATE NOSE AND THROAT.
CONTACT WITH SKIN OR EYES MAY CAUSE IRRITATION.

TARGET ORGANS
NONE IDENTIFIED

MEDICAL CONDITIONS GENERALLY AGGRAVATED BY EXPOSURE
NONE IDENTIFIED

ROUTES OF ENTRY
NONE INDICATED

EMERGENCY AND FIRST AID PROCEDURES
CALL A PHYSICIAN.
IN CASE OF CONTACT, IMMEDIATELY FLUSH EYES WITH PLENTY OF WATER FOR AT
15 MINUTES. FLUSH SKIN WITH WATER.

6 - REACTIVITY DATA

STABILITY: STABLE HAZARDOUS POLYMERIZATION: WILL NOT OCCUR

INCOMPATIBLES: STRONG ACIDS

7 - SPILL AND DISPOSAL PROCEDURES

STEPS TO BE TAKEN IN THE EVENT OF A SPILL OR DISCHARGE

WEAR SELF-CONTAINED BREATHING APPARATUS AND FULL PROTECTIVE CLOTHING. WITH CLEAN SHOVEL, CAREFULLY PLACE MATERIAL INTO CLEAN, DRY CONTAINER AND COVER; REMOVE FROM AREA. FLUSH SPILL AREA WITH WATER.

DISPOSAL PROCEDURE

DISPOSE IN ACCORDANCE WITH ALL APPLICABLE FEDERAL, STATE, AND LOCAL ENVIRONMENTAL REGULATIONS.

8 - PROTECTIVE EQUIPMENT

VENTILATION:	USE GENERAL OR LOCAL EXHAUST VENTILATION TO MEET TLV REQUIREMENTS.
RESPIRATORY PROTECTION:	RESPIRATORY PROTECTION REQUIRED IF AIRBORNE CONCENTRATION EXCEEDS TLV. AT CONCENTRATIONS ABOVE 2 PPM, A SELF-CONTAINED BREATHING APPARATUS IS ADVISED.
EYE/SKIN PROTECTION:	SAFETY GLASSES WITH SIDESHIELDS, UNIFORM, RUBBER GLOVES ARE RECOMMENDED.

9 - STORAGE AND HANDLING PRECAUTIONS

SAF-T-DATA(TM) STORAGE COLOR CODE: ORANGE (GENERAL STORAGE)

SPECIAL PRECAUTIONS

KEEP CONTAINER TIGHTLY CLOSED. SUITABLE FOR ANY GENERAL CHEMICAL STORAGE AREA.

10 - TRANSPORTATION DATA AND ADDITIONAL INFORMATION

DOMESTIC (D.O.T.)

PROPER SHIPPING NAME	CHEMICALS, N.O.S. (NON-REGULATED)

INTERNATIONAL (I.M.O.)

PROPER SHIPPING NAME	CHEMICALS, N.O.S. (NON-REGULATED)