ATTACHMENT I-4

MEMORANDUM REGARDING PETROLEUM COMPOUNDS IN GROUNDWATER, HALEY & ALDRICH

Haley & Aldrich, Inc.
One Arizona Center
400 E. Van Buren St., Suite 545
Phoenix, AZ 85004
602.760.2450

TECHNICAL MEMORANDUM

8 July 2015
File No.: 38681

TO: Rebecca Sawyer, Vice President - Sustainability
Excelsior Mining Corporation

FROM: Pejman Eshraghi, P.E., Project Manager
Haley & Aldrich, Inc.

SUBJECT: Presence of Petroleum Hydrocarbons in Groundwater at Gunnison Copper Project Located in Dragoon, Arizona

The purpose of this technical memorandum (tech memo) is to document the presence of dissolved petroleum hydrocarbons and petroleum free product (light non-aqueous phase liquid [LNAPL]) floating on top of groundwater at the referenced site (Figure 1).

Free Product Recovery and Groundwater Monitoring

In December 2014, Excelsior Mining Corporation (Excelsior) discovered that some of the existing core holes drilled onsite may be impacted by petroleum hydrocarbons. Excelsior cited detection of petroleum odor in groundwater and petroleum residue on monitoring equipment that was lowered into core holes CS-09, CS-10, CS-14, DC-09, and NSM-003.

On 26 January 2015, Haley & Aldrich provided Excelsior with a plan to conduct groundwater monitoring and, if necessary, a free product recovery test on the core holes. Subsequently, Haley & Aldrich mobilized to the site on 5 February and 11 February 2015 to implement the approved plan. On 5 February 2015, Haley & Aldrich measured the free product thickness in core holes CS-10 and CS-14 to be 1.47 and 1.93 feet, respectively (Table I). There was no measurable free product in core holes NSM-003, CS-09, and DC-09. However, a greasy substance was detected in CS-09 that appeared to be consistent with lubricant used for drilling operations.

On 11 February 2015, Haley & Aldrich removed 8 gallons of free product and oily water, using a bailer, from core holes CS-10 and CS-14. Haley & Aldrich estimates that approximately 1.25 gallons of the recovered liquid was free product, while the rest was oily water beneath the floating free product (Table I). The recovered liquid was dropped off at a recycling facility (Appendix A). Following recovery of free product, Haley & Aldrich continued periodic monitoring of the two core holes, through 26 February 2015, to monitor the return of free product. On 26 February 2015, the free product thickness in core hole CS-10 was measured to be approximately 0.25 feet, while no free product was measured in CS-14.

Following removal of the free product from core holes CS-10 and CS-14, Haley & Aldrich collected investigative (no purging) samples of the groundwater using a bailer to determine the concentrations of dissolved volatile organic compounds (VOCs) and polynuclear aromatic hydrocarbons (PAHs). Haley & Aldrich also collected an investigative sample of groundwater from core hole NSM-003, but was unable to collect a sample from core hole CS-09 as the bailer became fouled by the greasy substance in the core hole. Haley & Aldrich did not collect a sample from DC-09, because the well had been purged using air lifting, and collection of a representative water sample was not possible due to development activities. The three groundwater samples were analyzed for VOCs and PAHs using U.S. Environmental Protection Agency (USEPA) Test Methods 8260B and 8310, respectively.

The water samples from the wells containing free product (CS-10 and CS-14) contained elevated concentrations of benzene, toluene, ethylbenzene, and xylenes (BTEX). However, only benzene concentrations exceeded its Arizona Aquifer Water Quality Standard (AWQS) of 5 micrograms per liter (µg/L) with concentrations of 7.3 and 310 µg/L in CS-10 and CS-14, respectively. The water samples also contained other volatile hydrocarbons and PAHs. Table II presents a summary of the detected petroleum hydrocarbons in the groundwater samples collected from CS-10 and CS-14. Table III provides the chemical categories with which each detected compound is associated.

Recognizing that the fuels detected at the site are highly degraded, Haley & Aldrich performed a series of ratio calculations with BTEX, which represents the most volatile aromatic hydrocarbons. The calculated ratios (Table IV) are compared to the published values[1] of gasoline residues in groundwater. The elevated concentrations of BTEX and the results of the comparison suggest that the detected concentrations of BTEX in the groundwater samples collected from CS-10 and CS-14 are consistent with degraded gasoline or a mixture of petroleum products including gasoline.

The groundwater sample collected from NSM-003 contained detectable concentrations of tert-butyl alcohol (TBA), a gasoline additive that is added to gasoline as an oxygenate and an engine anti-knock compound. TBA is more soluble in groundwater than BTEX, tends to partition from the vapor phase and dissolves into groundwater, and is not significantly slowed by subsurface sorptive processes[2]. Therefore, its detection alone is not indicative of a release of pure TBA. Rather, it is a more reasonable scenario that TBA originally entered the environment as a constituent of the gasoline detected in groundwater in CS-10 and CS-14.

Since the original groundwater sampling, VOCs and PAHs have been detected in groundwater samples collected from new core holes (NSH-007, NSH-009, NSH-015, and NSH-22), which were drilled under the oversight of Haley & Aldrich. The detected concentrations are summarized in Table II. Of particular interest were the detection of 1,2-dichloroethane (1,2-DCA) at concentrations of 0.96 and 0.36 µg/L in groundwater samples collected from NSH-15 and NSH-22, respectively; and the detection of the highest toluene concentration of 2,080 µg/L in the groundwater sample collected from NSH-22. The compound 1,2-DCA is a lead scavenger and is specifically added to leaded gasoline as an additive to prevent build-up of lead oxide deposits inside internal combustion engines. The presence of 1,2-DCA in groundwater along with other VOCs and PAHs, although in low concentrations below AWQS, is further evidence that groundwater impact is likely due to a gasoline release.

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[1] Kaplan, I. R., Galperin, Y., Lu, S-T. & Lee, R-P., 1997. "Forensic Environmental Geochemistry: Differentiation of Fuel Types, Their Sources and Release Time". *Organic Geochemistry* 27:289– 317. Table 8.
[2] ITRC, February 2005. *Overview of Groundwater Remediation Technologies for MTBE and TBA*.

The toluene concentration of 2,080 µg/L in NSH-022 exceeds its established AWQS of 1,000 µg/L. Toluene is used as a solvent, used to manufacture benzene, and added to gasoline to improve its octane rating. Similar to TBA, detection of toluene in NSH-22 alone does not indicate a pure toluene release. Rather, it is a more reasonable scenario that toluene entered the environment as a constituent of gasoline.

Source(s) of Contamination

At this time, the source(s) of the gasoline impact and or the location(s) where the impact may have occurred are unknown. Haley & Aldrich reviewed the Arizona Department of Environmental Quality's (ADEQ's) readily available Leaking Underground Storage Tank (LUST) public record and identified The Thing Dairy Queen Travel Center (The Thing; Facility ID 0-000748 | LUST ID 4387) as a potential off-site source. On 27 March 1996, this facility permanently closed (via removal) three gasoline USTs. Soil samples collected beneath the USTs at 12 feet below ground surface (bgs) were tested for BTEX. The maximum concentrations of BTEX detected in the soil samples collected from the tank pit were 21, 500, 170, and 850 milligrams per kilogram (mg/kg), respectively. Soil that was removed during tank removal was placed in the tank pit[3]. Bedrock was reportedly observed at less than 2 feet below the tanks. The ADEQ's UST Programs unit opened three LUST case files and requested the facility to begin site characterization.

On 7 February 2000, the facility conducted site characterization of the shallow soils by installation of six soil borings to total depths ranging from 2 to 10 feet bgs, the depth at which bedrock was encountered. The concentrations of BTEX compounds were mostly below the laboratory's minimum reporting limits (MRLs), although detectable concentrations of ethylbenzene and xylenes of 0.28 and 1.8 mg/kg, respectively, were detected at 10 feet bgs in one boring (SB-1). However, soil boring SB-1 was drilled in the tank pit, 2 feet shallower than and more than 20 feet away from, the area where elevated concentrations of BTEX were detected during tank closure.

Although, it does not appear that the petroleum release(s) were adequately investigated, ADEQ closed the LUST case files on 23 May 2005. ADEQ's primary rationale for LUST case file closure was the presence of bedrock and lack of groundwater beneath the facility. The LUST facility, however, is generally hydrologically upgradient from the gasoline-impacted wells at the site.

The Johnson Camp mining facility is another potential upgradient source of hydrocarbon contamination, but previous Phase I Environmental Site Assessments conducted by Haley & Aldrich did not reveal evidence of widespread gasoline use at the facility. In fact, most mobile equipment, powered haulage, and beneficiation processes are not using gasoline.

[3] Souder, Miller & Associates, 9 April 1996. *Release Confirmation and 14 Day Report Form, Bowlin's The Thing Dairy Queen Travel Center Near Benson, Arizona*.

Corrective Action Requirements

The Resource Conservation and Recovery Act requires owners and operators to undertake corrective actions in response to releases of petroleum and hazardous waste to the environment. If the source of gasoline is impact from LUSTs, such as an off-site impact from The Thing's LUSTs, then it is the responsibility of the owners and operators of those LUSTs to undertake corrective actions, even if those LUSTs received a prior closure letter from the ADEQ. If the source(s) of impact did not originate from LUSTs, then the applicability of innocent landowner defense under the Comprehensive Environmental Response Compensation and Liability Act should be evaluated.

Pejman Eshraghi, P.E. #34771

Registered Professional Engineer (Civil)
CERTIFICATE NO.
34771
PEJMAN
ESHRAGHI
Date Signed 7/8/15
ARIZONA U.S.A.
Expires: 3/31/2018

Enclosures:
- Table I: Summary of Free Product Recovery
- Table II: Summary of Detected Analytical Results - Groundwater
- Table III: Summary of Chemical Types
- Table IV: Summary of BTEX Ratios in Altered Gasoline in Groundwater
- Figure 1: Site Plan
- Appendix A: Recovered Liquid Disposal Documentation

TABLE I
SUMMARY OF FREE PRODUCT RECOVERY
EXCELSIOR MINING CORP.
GUNNISON COPPER PROJECT
DRAGOON, AZ

Location	Date	Time	Depth to Product (feet bgs)	Depth to Water (feet bgs)	Thickness (feet)	Volume[1] (gallons)
CS-10	2/5/2015	1718	616.95	618.42	1.47	0.54
	2/11/2015	1450	618.25	618.3	0.05	0.02
	2/12/2015	0838	617.08	617.1	0.02	0.01
	2/12/2015	1530	617.03	617.1	0.07	0.03
	2/13/2015	0715	617.29	617.35	0.06	0.02
	2/26/2015	1508	617.2	617.8	0.6	0.22
CS-14	2/6/2015	1009	428.98	430.91	1.93	0.71
	2/11/2015	1123	433.15	433.16	0.01	0.00
	2/12/2015	0838	415.68	415.72	0.04	0.01
	2/12/2015	1530	409.09	409.1	0.01	0.00
	2/13/2015	0715	402.19	402.2	0.01	0.00
	2/26/2015	1508	No Product Measured	446	0	0.00

NOTES

1. Assumes corehole diameter is 3 inches and the entire volume of free product is trapped within the corehole.
bgs = below ground surface

TABLE II
SUMMARY OF DETECTED ANALYTICAL RESULTS - GROUNDWATER
EXCELSIOR MINING CORP.
GUNNISON COPPER PROJECT
DRAGOON, AZ

Location	Sample Date	Volatile Organic Compounds (USEPA Test Method 8260B)									Polynuclear Aromatic Hydrocarbons (USEPA Test Method 8310)											
		1,2-Dichloroethane	Benzene	Toluene	Ethylbenzene	Xylenes	n-propylbenzene	tert-Butyl Alcohol	1,2,4-Trimethylbenzene	1,3,5-Trimethylbenzene	Anthracene	Acenaphthene	Acenaphthylene	Benzo (g,h,i) perylene	Chrysene	Fluoranthene	Fluorene	Naphthalene	Phenanthrene	Pyrene	1-Methylnaphthalene	2-Methylnaphthalene
CS-10	2/11/2015	<50	**7.3**	**44**	**30**	**90**	**7.1**	<25	**60**	**12**	**12**	**13**	**3.5**	<0.050	**0.21**	<0.050	**27**	**510**	**86**	**1.6**	**690**	**1000**
CS-14	2/11/2015	<5	**310**	**680**	**110**	**500**	<50	<250	**110**	<50	**4.8**	**6.6**	**1.7**	**0.052**	**0.067**	**0.15**	**16**	**330**	**34**	**0.96**	**330**	**460**
NSH-007	2/26/2015	<0.50	<0.50	**0.59**	<0.50	<0.50	<0.50	NA	<0.50	<0.50	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	NA	<0.0050
NSH-009	3/12/2015	<0.50	<0.50	**3.93**	<0.50	<0.50	<0.50	NA	<0.50	<0.50	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	NA	<0.010
NSH-015	3/26/2015	**0.96**	**4.56**	**0.71**	<0.10	<0.10	<0.10	NA	<0.10	<0.10	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	**0.268**	<0.0050	<0.0050	NA	**0.0262**
NSH-022	04/02/15	<5.0	<5.0	**2,080**	<5.0	<5.0	<5.0	NA	<5.0	<5.0	<0.0050	<0.0050	<0.0050	**0.00614**	<0.0050	<0.0050	**0.00781**	<0.0050	**0.00662**	<0.0050	NA	**0.00776**
	05/04/15	**0.36**	**0.33**	NA	**0.38**	NA	**0.35**	NA	**0.37**	**0.39**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
NSM-003	2/11/2015	<1	<1	<5	<1	<3	<1	**29**	<1	<1	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.25	<0.05	<0.05	<0.25	<0.25
Arizona AWQS		**5**	**5**	**1000**	**700**	**10,000**	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**

Notes:

bold *= compound was detected*
Concentrations are in micrograms per liter.
AWQS = aquifer water quality standard
EPA = Environmental Protection Agency
NA = sample was not analyzed for the presence of this compound.
NE = standard has not been established for this compound.
USEPA = U.S. Environmental Protection Agency

TABLE III
SUMMARY OF CHEMICAL TYPES
EXCELSIOR MINING CORP.
GUNNISON COPPER PROJECT
DRAGOON, AZ

Detected Compound	Type	Typical Host Fuel
1,2-Dichloroethane	Lead Scavenger	Leaded Gasoline
tert-Butyl Alcohol	Anti-knock/Oxygenate	Unleaded Gasoline
Benzene	Monoaromatic	Gasoline[1]
Toluene		
Ethylbenzene		
Xylenes		
n-propylbenzene		
1,2,4-Trimethylbenzene		
1,3,5-Trimethylbenzene		
Anthracene	Polynuclear Aromatic	Gasoline and Diesel[2]
Acenaphthene		
Acenaphthylene		
Benzo (g,h,i) perylene		
Chrysene		
Fluoranthene		
Fluorene		
Naphthalene		
Phenanthrene		
Pyrene		
1-Methylnaphthalene		
2-Methylnaphthalene		

NOTES

1. Monoaromatics exist, in varying concentrations, in most petroleum fuels. However, their concentrations are most elevated in gasoline.

2. Polynuclear Aromatics exist, varying concentrations, in most petroleum fuels. However, their detection at the site is likely to be attributed to gasoline or diesel.

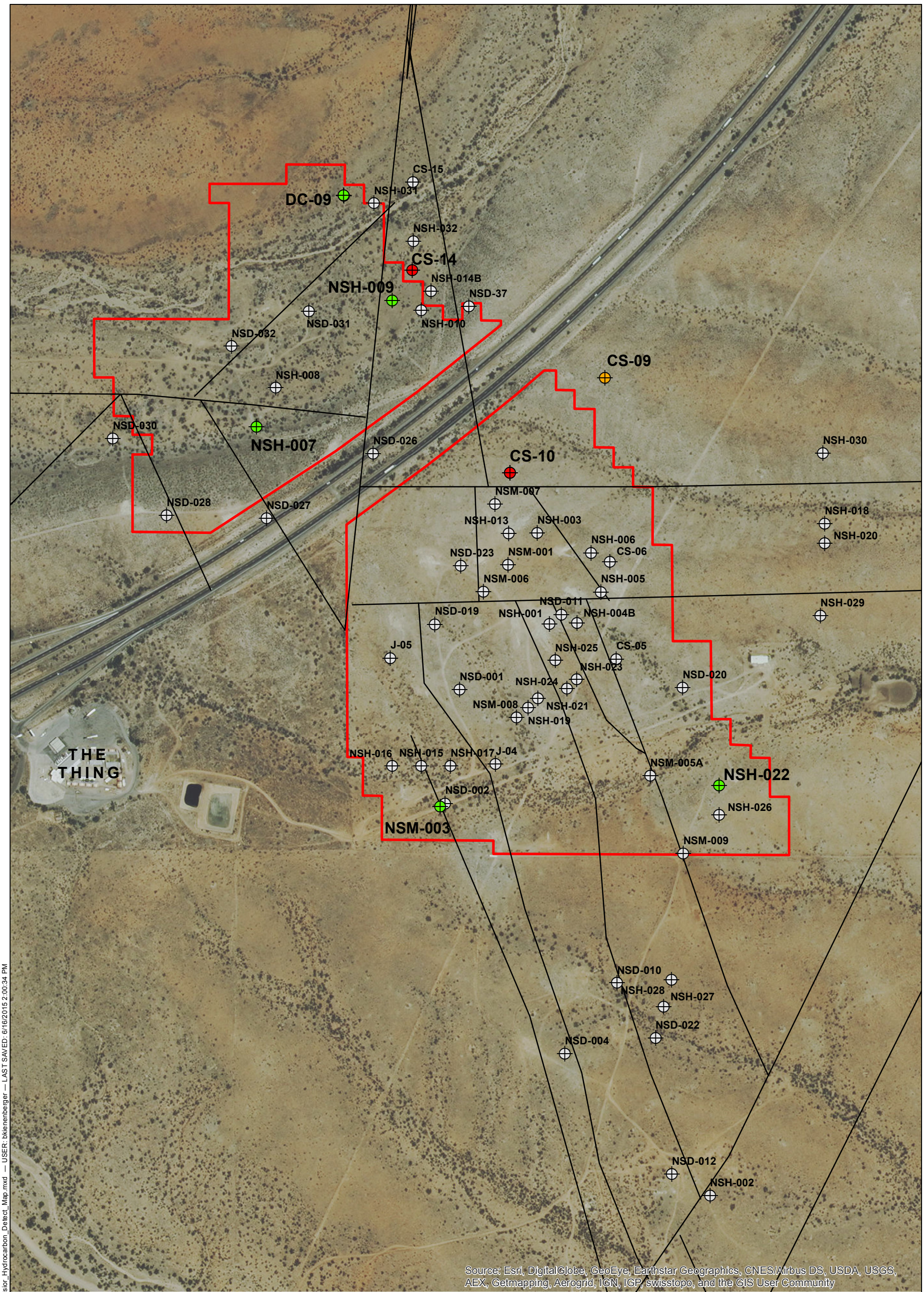
TABLE IV
SUMMARY OF BTEX RATIOS IN ALTERED GASOLINE IN GROUNDWATER
EXCELSIOR MINING CORP.
GUNNISON COPPER PROJECT
DRAGOON, AZ

Compound	Wells		Ratio in Groundwater[1]
	CS-10	CS-14	
B/T	0.46	0.17	0.09 - 21.6
B/E	2.82	0.24	0.13 - 10.9
B/X	0.62	0.08	0.01 - 3.5
T/E	6.18	1.47	0.1 - 9.6
T/X	1.36	0.49	0.04 - 4.2
E/X	0.22	0.33	0.08 - 0.55
B+T/E+X	1.62	0.43	0.11 - 3.4

NOTES

1. Kaplan, I. R., Galperin, Y., Lu, S-T. & Lee, R-P. 1997. Forensic environmental geochemistry: Differentiation of fuel types, their sources and release time. Organic Geochemistry 27:289– 317.Table 8.

B = benzene
E = ethylbenzene
T = toluene
X = xylenes



LEGEND

- WELL/COREHOLE WITH DETECTION OF PETROLEUM HYDROCARBONS
- COREHOLE IMPACTED WITH UNKNOWN GREASY SUBSTANCE
- COREHOLE CONTAINING FREE PRODUCT
- WELL/COREHOLE
- EXPLORATION BOUNDARY
- FAULTS

N

0 480 960
SCALE IN FEET

NOTE

1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE.

HALEY ALDRICH

GUNNISON COPPER PROJECT
EXCELSIOR MINING CORPORATION
DRAGOON, ARIZONA

Excelsior MINING CORP

SITE PLAN

JUNE 2015

FIGURE X

GIS FILE PATH: G:\Projects\Excelsior Mining Corp\GIS\MXDs\Excelsior_Hydrocarbon_Detect_Map.mxd — USER: bkienenberger — LAST SAVED: 6/16/2015 2:00:34 PM

APPENDIX A

Recovered Liquid Disposal Documentation

ATTENTION SHIPPERS! FREIGHT CHARGES ARE PREPAID ON THIS BILL OF LADING UNLESS MARKED COLLECT.

STRAIGHT BILL OF LADING

ORIGINAL — NOT NEGOTIABLE

Shipper No. _____

Carrier No. _____

Page 1 of 1 ENVIRONMENTAL RESPONSE INC. (Name of carrier) (SCAC) Date 2/13/15

On Collect on Delivery shipments, the letters "COD" must appear before consignee's name or as otherwise provided in Item 430, Sec.1.

TO:
Consignee MESA OIL
Street 209 S. 57TH AVE
City PHOENIX State AZ Zip Code 85043

FROM:
Shipper GUNNISON COPPER PROJECT
Street EXCELSIOR MINING CORP
City State Zip Code
24 hr. Emergency Contact Tel. No. 800-535-5053 CHEMTREC

Route

Vehicle Number

No. of Units & Container Type	HM	BASIC DESCRIPTION Proper Shipping Name, Hazard Class, Identification Number (UN or NA), Packing Group, per 172.101, 172.202, 172.203	TOTAL QUANTITY (Weight, Volume, Gallons, etc.)	WEIGHT (Subject to Correction)	RATE	CHARGES (For Carrier Use Only)
1 DM	X	UN1203, GASOLINE, 3, PG II (PRODUCT FOR RECYCLE)	8 gal	50#s		
		Manuel Lares (Mesa Oil)	2/13/15			

PLACARDS TENDERED: YES ☐ NO ☒

Note — (1) Where the rate is dependent on value, shippers are required to state specifically in writing the agreed or declared value of the property, as follows: "The agreed or declared value of the property is hereby specifically stated by the shipper to be not exceeding _____ per _____."
(2) Where the applicable tariff provisions specify a limitation of the carrier's liability absent a release or a value declaration by the shipper and the shipper does not release the carrier's liability or declare a value, the carrier's liability shall be limited to the extent provided by such provisions. See NMFC Item 172.
(3) Commodities requiring special or additional care or attention in handling or stowing must be so marked and packaged as to ensure safe transportation. See Section 2(e) of Item 360, Bills of Lading, Freight Bills and Statements of Charges and Section 1(a) of the Contract Terms and Conditions for a list of such articles.

I hereby declare that the contents of this consignment are fully and accurately described above by the proper shipping name and are classified, packed, marked and labelled/placarded, and are in all respects in proper condition for transport according to applicable international and national governmental regulations.

Signature

REND C.O.D. TO: ADDRESS

COD Amt: $

C.O.D. FEE: PREPAID ☐ COLLECT ☐ $

Subject to Section 7 of the conditions, if this shipment is to be delivered to the consignee without recourse on the consignor, the consignor shall sign the following statement:
The carrier shall not make delivery of this shipment without payment of freight and all other lawful charges.

(Signature of Consignor)

TOTAL CHARGES $

FREIGHT CHARGES
FREIGHT PREPAID except when box at right is checked ☐ Check box if charges are to be collect

RECEIVED, subject to the classifications and tariffs in effect on the date of the issue of this Bill of Lading, the property described above in apparent good order, except as noted (contents and condition of contents of packages unknown), marked, consigned, and destined as indicated above which said carrier (the word carrier being understood throughout this contract as meaning any person or corporation in possession of the property under the contract) agrees to carry to its usual place of delivery at said destination, if on its route, otherwise to deliver to another carrier on the route to said destination. It is mutually agreed as to each carrier of all or any of, said property over all or any portion of said route to destination and as to each party at any time interested in all or any said property, that every service to be performed hereunder shall be subject to all the bill of lading terms and conditions in the governing classification on the date of shipment.
Shipper hereby certifies that he is familiar with all the lading terms and conditions in the governing classification and the said terms and conditions are hereby agreed to by the shipper and accepted for himself and his assigns.

SHIPPER GUNNISON COPPER PROJECT / EXCELSIOR MINING CORP
PER

CARRIER ENVIRONMENTAL RESPONSE INC.
PER
DATE 2/13/15

1

Permanent post-office address of shipper.

STYLE CF2604

LABELMASTER® (800) 621-5808 www.labelmaster.com

MESA ENVIRONMENTAL

A DIVISION OF MESA OIL, INC.

RECYCLING MANIFEST / RECEIPT

135043

DATE 2·13·15 SERVICE CALL #

GENERATOR

Generator Name Environmental Response Contact Paul Runyan

Pickup Address Phone #

City Tempe State AZ Zip 85281

Mailing Address 2202 W. Medtronic way Ste. 108

City State Zip

RECYCLING SERVICE	Price / Unit	Quantity	Total
USED OIL REMOVAL	Ø/dr	5	N/C
OILY WATER REMOVAL			
USED ANTIFREEZE REMOVAL			
USED OIL FILTER REMOVAL			
FREIGHT			

SPECIAL INSTRUCTIONS

SALES TAX

TOTAL DUE MESA OIL. $

FORM OF PAYMENT

PAID CASH: CREDIT APP.# MC / VISA

PAID CHECK: APPROVED BY P.O.#

GENERATORS CERTIFICATION: This material is described to the best of my ability. This material has not been mixed with PCB's or hazardous waste identified in 40 CFR Part 261. Used oil filters meet the exclusion requirements of 40 CFR Part 261.4. I acknowledge the accuracy of the total due on this receipt. If to be charged on account I understand that an invoice will follow with terms of NET 30 DAYS.

Jose Soto 2-13-15

Printed / Typed Name Signature Date

TRANSPORTER, STORER AND RECYCLER

MESA OIL, INC. - PLANT
Belen, NM
EPA# NM 0000096024
TEXAS TNRCC ID# A85467

MESA OIL, INC. - PLANT
Phoenix, AZ
EPA# AZR000033381

MESA OIL, INC. - PLANT
Golden, CO
EPA# COD 982581993

Mailing Address:
Mesa Oil, Inc.
7239 Bradburn Blvd.
Denver, CO 80030
(303) 426-4777

IN CASE OF SPILL CONTACT: MESA OIL, INC. 1-800-USED-OIL

D.O.T. REQUIREMENT - MAXIMUM LOAD 7000 GALLONS USED PETROLEUM OIL N.O.S.

TRANSPORTER ACKNOWLEDGMENT OF RECEIPT OF MATERIALS:
I certify materials have been tested and are below 1,000 PPM halogens.

Manuel Cares 2·13·15

Printed / Typed Name Signature Date

TREATMENT FACILITY OPERATOR:
The described materials were handled by me, the treatment facility named above, and were accepted.

Printed / Typed Name Signature Date

White - Return to Generator Green - Records Pink - Office Goldenrod - Generator Copy