1R - 427-03

WORKPLANS

Date:

8-6-13

ARCADIS
Infrastructure, environment, buildings

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Mr. Ed Hansen
New Mexico Energy, Minerals, & Natural Resources Dept.
Oil Conservation Division, Environmental Bureau
1220 S. St. Francis Drive
Santa Fe, New Mexico 87505

Subject:

Corrective Action Plan (CAP)
EME G-11
Unit G, SEC. 11, T20S, R36E, Monument, Lea County, New Mexico
NMOCD CASE # 1R427-03

Date:
August 6, 2013

Contact:
Sharon E. Hall

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Our ref:
MT001085.0001

Mr. Hansen:

On behalf of Rice Operating Company (ROC), ARCADIS U.S., Inc. (ARCADIS) respectfully submits this Corrective Action Plan (CAP) for the above-referenced site.

BACKGROUND

The site is located approximately four miles southwest of Monument, New Mexico. Groundwater at the site occurs at an approximate depth of 46 feet below ground surface (bgs).

The junction box, located directly south of an abandoned production facility, was eliminated. Initial delineation began on January 30, 2003 and was completed on February 25, 2003. Soil samples were collected at regular intervals and analyzed in the field for chlorides using field-adapted Standard Method 4500-Cl^-B and screened in the field using a photoionization detector (PID).

A backhoe was used to excavate soils from an excavation around the former junction box measuring 30 feet by 30 feet by 18 feet deep. A four-point wall composite sample was collected and a five-point composite sample was collected from the bottom of the excavation and submitted to Environmental Lab of Texas for analysis of gasoline range organics (GRO), diesel range organics (DRO), benzene, toluene, ethylbenzene and xylenes (BTEX) and chloride analysis. DRO was detected at a concentration of 36.6 milligrams per kilo gram (mg/kg) in the five-point bottom composite sample. Chlorides were detected at a concentration of 656 mg/kg in the four-point composite sidewall sample and at a

concentration of 1,440 mg/kg in the five-point composite bottom sample. GRO and BTEX were not detected in either of the samples.

Based on the results of the soil sampling analytical results, elevated chloride concentrations are present at the subject site.

A 20-mil poly liner was installed at the base of the excavation and up the sidewalls of the excavation. Excavated soils were backfilled into the excavation. The area was contoured to the surrounding landscape and seeded with native vegetation.

ROC disclosed potential groundwater impact at the site to New Mexico Oil Conservation Division (NMOCD) via e-mail on February 24, 2003. A disclosure report was submitted to NMOCD with all the ROC 2003 junction box closures and disclosures.

ROC submitted an Investigation Characterization Plan (ICP) to NMOCD on August 9, 2010 and was approved by NMOCD on August 24, 2010. Five soil borings (SB-1 through SB-5) were drilled at the site on October 4 and 5, 2010 and samples were collected every three feet.

A near-source monitoring well (MW-1) and an up-gradient monitoring well (MW-2) were installed at the site on December 7, 2010, to assess groundwater quality. Sampling results from MW-2 confirm that free product is present in groundwater up-gradient of the site. Based on the fact that soil chloride concentrations, as confirmed by laboratory analysis, decrease with depth to below or near 250 mg/kg in all of the soils borings except SB-1 (304 mg/kg at 42 feet) and that free product occurs in the upgradient monitor well, we believe there is an upgradient source at this site.

On May 11, 2012, an ICP Report and CAP was submitted to the NMOCD. The plan proposed plugging and abandonment of both monitoring wells (MW-1 and MW-2) and installing a 50 foot by 50 foot 20-mil reinforced poly liner to a depth of 4-5 feet bgs. NMOCD approved the report on June 4, 2012, with the condition that ROC continue monitoring MW-1 and check for NAPLs in MW-2.

In June 2012, a 50x50 ft 20-mil reinforced liner was installed and properly seated at a depth of 4.5 ft bgs. The excavation was then backfilled and the site was seeded with a blend of native vegetation. On October 15, 2012, ROC requested soil closure at this site. NMOCD approved the request on October 15, 2012.

CORRECTIVE ACTION PLAN FOR GROUNDWATER

ROC proposes to remove chloride impacted groundwater for the EME G-11 site using existing groundwater recovery systems at EME K-6 and EME L-6 (see attached figure for site locations) to maximize environmental benefit of the chloride mass removal effort. Our

estimate conservatively reflects the impact to groundwater at the site resulting from the former junction box. It does not take into account other sources or regional groundwater conditions.

The following worst-case scenario estimate of chloride mass was calculated based on mass balance equations which are explained as follows:

Estimate of chloride mass in the vadose zone

An area of 2,500 ft^2 is the estimated area of impact. A value of 10 ft is used for the vadose zone thickness, which represents the 10 ft of vadose above the water table. The total area multiplied by the vadose zone thickness gives us a 25,000 ft^3 of impacted area. The volume of impacted vadose zone multiplied by the mass density gives us a value of 1,250,000 kilograms (kg). The average chloride concentration in the soils is 326 mg/kg. This results in a total chloride mass of 408 kg. These calculations are shown in the following table:

Estimate of Chloride Mass in Vadose Zone:

Vadose Zone			
Parameter	**Unit**	**Value**	**Description**
Release Area	ft^2	2500	Estimated Area of Impact Based on the 50 x 50-ft 20-mil reinforced liner
Vadose Zone Thickness	ft	10	10 ft of vadose above the water table
Zone	Ft^3	25,000	Impacted Area x Vadose Zone Thickness
Mass of Impacted Vadose Zone	kg	1,250,000	Volume of Impacted Vadose Zone x Mass Density (1 ft^3 of soil weighs approximately 50 kg or 110 lb/ft^3)
Chloride Concentration Added to Soil From Source	L	326	Average chloride concentration in the 10 ft of soil above the water table from SB-1. SB-2. SB-3, SB-4, SB-5 and MW-1
Total Chloride Mass	**kg**	**408**	Volume of Impacted Groundwater Below Site x Chloride Concentration Added to GW from Source

Estimate of chloride mass in groundwater

An area of 2,500 ft^2 is the estimated area of impact. The aquifer thickness is estimated to be 15 ft. The total area multiplied by the thickness of the aquifer and its porosity (0.25) results in a saturated pore space volume of 9,375 cubic ft (ft^3) or 265,470.44 liters (L). The average chloride concentration in groundwater in MW-1 is 620 milligrams per liter. This chloride concentration multiplied by the saturated pore space volume results in a chloride mass of 165 kilograms (kg). These calculations are shown in the following table:

Estimate of Chloride Mass in Groundwater:

Groundwater			
Parameter	**Unit**	**Value**	**Description**
Release Area	ft^2	2500	Estimated Area of Impact Based on the 50 x 50-ft 20-mil reinforced liner
Aquifer Thickness	ft	15	NMOCD Approved Estimation
Porosity	%	0.25	Professional estimate for water saturated pore volume
Volume of Impacted Groundwater Below Site	ft^3	9,375	Impact Area x Aquifer Thickness x Porosity
Volume of Impacted Groundwater Below Site	L	265,470.44	Conversion from ft^3 to Liter
Total Chloride Mass	**kg**	**165**	Volume of Impacted Groundwater Below Site x Chloride Concentration Added to GW from Source

Estimate of Groundwater Recovery System Removal

The estimated chloride mass in both the vadose zone and the groundwater results in a representative chloride mass of 573 kg.

The volume of water required to remove the 573 kgs of chloride is estimated using recent concentrations observed at EME L-6, as opposed to using the higher K-6 concentration, providing a more conservative estimate. The actual volume of groundwater to be removed may fluctuate depending on pumping rates and changes in chloride concentrations of the recovery wells. The groundwater recovery system, located at EME L-6, extracting water with chloride concentration of 9,400 mg/L, could extract about 21 kg/day, assuming an

average pumping rate of 1 gallon per minute (gpm) can be achieved. At that rate, it would take approximately 27 days, the equivalent of 383 barrels, to remove 573 kg of chloride mass. These calculations are shown in the following table:

Estimated Groundwater Recovery System Removal:

Groundwater Recovery System Removal			
Parameter	**Unit**	**Value**	**Description**
Groundwater Concentration	mg/L	9,400	Groundwater Concentration from Recovery Well at EME L-6
Groundwater Concentration	kg/gal	0.0355	Conversion from mg/L to kg/gal
Pumping Rate	gal/min	1	Given
Extraction Rate	kg/min	0.0355	Pumping Rate x groundwater concentration (kg/gal)
Extraction Rate	kg/day	21.34	Conversion from kg/min to kg/day
Representative Total Chloride Mass	kg	573	From above
Volume Removal	gal	16,078	Pumping Rate x Estimated Removal Time x 60 min/hour x 10 hour/day
Volume Removal	bbl	383	Conversion from gal to bbl
Estimated Removal Time	**day**	**27**	Representative Total Chloride Mass / Extraction Rate

The design and specifications of the groundwater recovery system include a recovery well submersible pump capable of discharging at a minimum of 1 gpm. Water from the recovery well will be utilized in pipeline and well maintenance operations.

ROC is the service provider (agent) for the EME Salt Water Disposal (SWD) System and has no ownership of any portion of pipeline, well or facility. The EME SWD System is owned by a consortium of oil producers, System Parties, who provide all operating capital on a percentage ownership/usage basis.

Thank you for your consideration concerning this proposed chloride mass removal for this site. If you have any questions, do not hesitate to contact me or Hack Conder.

Sincerely,
ARCADIS U.S., Inc.

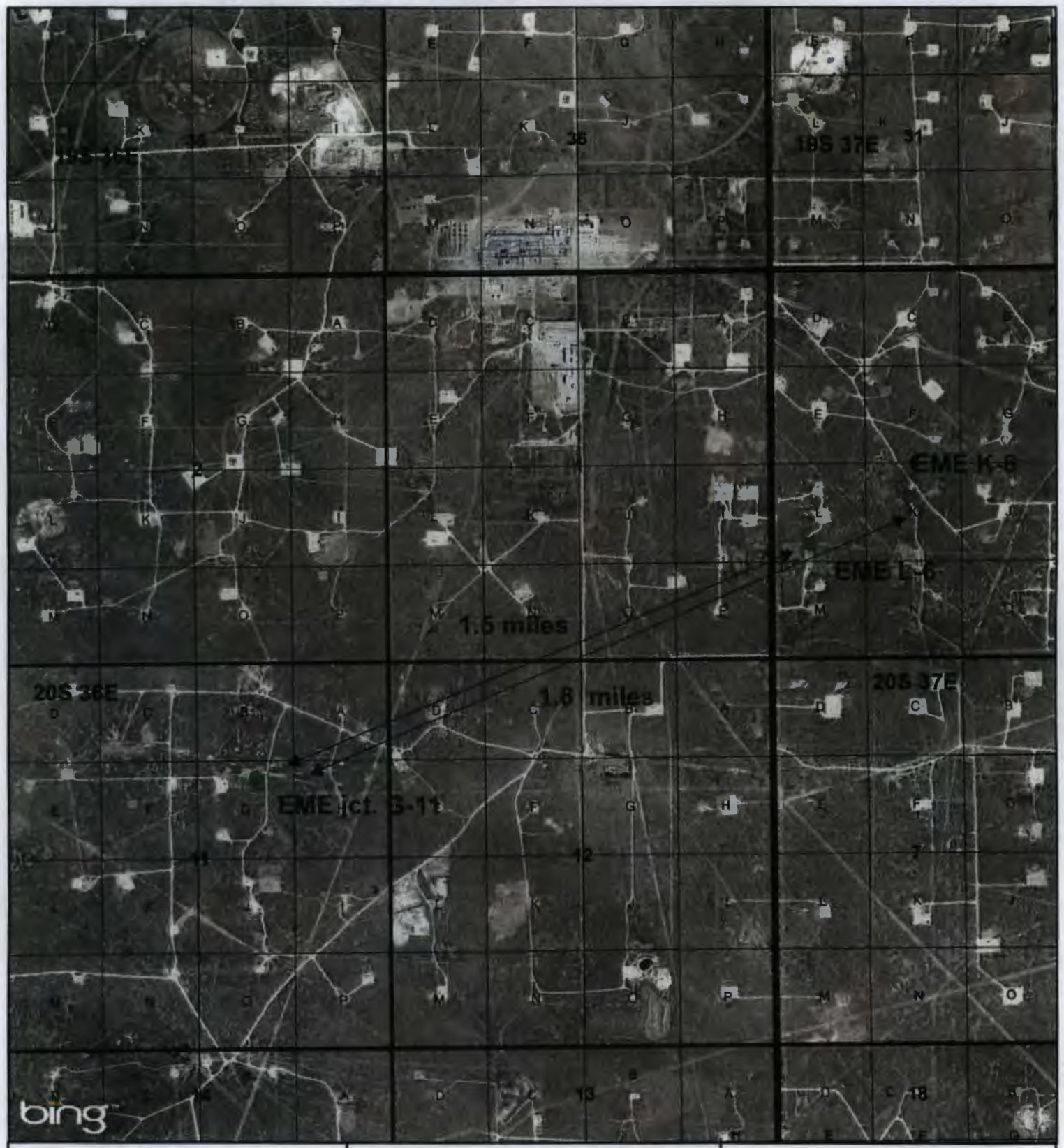
Jeffrey W. Kindley, P.G.
Senior Geologist

Copies:
Hack Conder, ROC

Attachments:

Figure – Site in Relationship to EME L-6 and K-6
Appendix A – Monitoring Well Sampling Data

Site in Relation to EME L-6 and K-6



RICE ENVIRONMENTAL RECS CONSULTING & SAFETY, LLC

EME jct. G-11

Legals: UL/G sec. 11
T20S R36E

Case #: 1R427-03

N W E S

0 0.15 0.3 0.6 Miles

Drawing date: 5/6/13
Drafted by: L. Weinheimer

ROC EME G-11													
MW	Depth to Water	Total Depth	Well Volume	Volume Purged	Sample Date	Cl	TDS	Benzene	Toluene	Ethyl Benzene	Total Xylenes	Sulfate	Comments
1	46.32	68.28	14.3	50	2/22/2011	348	1210	<0.001	<0.001	<0.001	<0.003	41.7	Clear No odor
1	46.48	68.28	14.2	50	5/31/2011	670	1620	0.003	0.005	0.002	0.032	47.6	Clear Slight odor
1	46.71	68.28	14	50	8/26/2011	760	1830	0.01	0.003	0.003	0.026	56.6	Clear Slight odor
1	46.8	68.28	14	50	12/1/2011	770	1920	0.01	0.002	<0.001	0.021	71.2	Clear Slight odor
1	46.78	68.28	14	50	2/15/2012	650	1760	0.002	0.003	<0.001	0.005	71.9	Clear Slight odor
1	46.82	68.28	13.9	50	5/17/2012	640	1620	0.003	<0.001	<0.001	<0.003	66.7	Clear Slight odor
1	46.78	68.28	14	50	7/13/2012	670	1860	<0.001	<0.001	<0.001	<0.003	59.2	Clear Slight odor
1	46.91	68.28	13.9	50	11/8/2012	790	1960	0.003	0.001	<0.001	<0.003	73.5	Clear with heavy sheen with strong odor
1	46.93	68.28	13.9	50	2/7/2013	S00	1420	0.003	<0.001	<0.001	<0.003	52.6	Clear with heavy sheen with strong odor
1	46.98	68.28	13.8	50	S/23/2013	400	1230	0.002	<0.001	<0.001	<0.003	52.4	Clear with heavy sheen with strong odor.

MW	Depth to Water	Total Depth	Well Volume	Volume Purged	Sample Date	Cl	TDS	Benzene	Toluene	Ethyl Benzene	Total Xylenes	Sulfate	Comments
2	48.92	55.02	1	5	2/22/2011	176	695	0.006	0.059	0.042	0.192	59.6	Clear Product present Strong hydrocarbon odor
2	49.05	55.02	1	0	5/31/2011	XXX	XXX	XXX	XXX	XXX	XXX	XXX	Product measurable/no sample heavy product made sample inconclusive
2	49.26	55.02	0.9	0	8/26/2011	XXX	XXX	XXX	XXX	XXX	XXX	XXX	Product measurable Clear Product present Strong hydrocarbon odor
2	49.35	55.02	0.9	0	12/1/2011	XXX	XXX	XXX	XXX	XXX	XXX	XXX	Product measurable Clear Product present Strong hydrocarbon odor
2	49.32	55.02	0.9	0	2/15/2012	XXX	XXX	XXX	XXX	XXX	XXX	XXX	Product measurable Clear Product present Strong hydrocarbon odor
2	49.37	55.02	0.9	0	5/17/2012	XXX	XXX	XXX	XXX	XXX	XXX	XXX	Product measurable Clear Product present Strong hydrocarbon odor
2	49.33	55.02	0.9	0	7/13/2012	XXX	XXX	XXX	XXX	XXX	XXX	XXX	Product measurable oil Sampled Sock placed in well
2	49.47	55.02	0.9	0	11/8/2012	XXX	XXX	XXX	XXX	XXX	XXX	XXX	Product Measurable Oil sampled Sock placed in well
2	49.41	55.02	0.9	0	2/7/2013	XXX	XXX	XXX	XXX	XXX	XXX	XXX	Product Measurable No sample taken Sock placed in well
2	49.48	55.02	0.9	0	5/23/2013	XXX	XXX	XXX	XXX	XXX	XXX	XXX	Product Measurable No sample taken Sock placed in well