Kansas
Corporation Commission

OIL & GAS REMEDIATION SITE STATUS

ANNUAL REPORT 2019

We serve the people of Kansas...

Abandoned Oil and Gas Well / Remediation Site Fund
Remediation Sites
Status Report

Introduction

During the 1996 legislative session, House Substitute for Senate Bill 755 was passed. K.S.A 55-192 and K.S.A. 55-193 created an Abandoned Oil and Gas Well / Remediation Fund with the expressed purpose of providing funds to the Kansas Corporation Commission to plug abandoned wells and remediate contamination sites (sites and wells having no responsible parties related to oil and gas exploration and production activities). K.S.A 55-194 also requires the Corporation Commission to prepare an annual Remediation Site Status Report for the office of the Governor and certain legislative committees. This report for the period January 1, 2018, through December 31, 2018, contains information for each of the sites with regard to the following: (1) A description and evaluation of the site; (2) the immediacy of the threat to public health and environment; (3) the level of remediation sought; (4) any unusual problems associated with the investigation or remediation; (5) any remedial efforts completed during the review period; (6) current contaminate level; (7) status of the site; (8) direct and indirect costs associated with remedial efforts; and (9) an estimate of the cost to achieve the recommended level of remediation or an estimate of the cost to conduct an investigation sufficient to determine the cost of remediation. The Site Remediation cash expenditures for FY2019 are projected to be approximately $50,000.

Site Inventory

The inventory of sites listed in the current Remediation Site Status Report consists of 49 sites. This report includes sites that were transferred to the control of the Kansas Corporation Commission (KCC) from the Kansas Department of Health and Environment (KDHE) by legislative action in 1995 and in-house sites already under KCC jurisdiction. Of the original 109 sites, four were combined with other sites. During previous evaluation periods, 79 sites have been resolved and 23 sites have been added. The current evaluation period, January 1, 2018, through December 31, 2018, ended without resolving or adding sites, resulting in a total of 49 active sites. Summary tables for site impacts and immediacy levels as well as estimated costs are found at the beginning of the report. The tables below provide an overview of distribution of sites with respect to both resources impacted and the range of immediacy levels for required remediation.

Distribution of Active Sites with Respect to Impacted Resources

Impacted Resources	Number of Sites
Groundwater, Surface Water, Soil and Well Problems (Cavity, Abandoned)	69
Public Water Supply	7
Domestic Supply	20
Stock Supply	14
Irrigation Supply	10

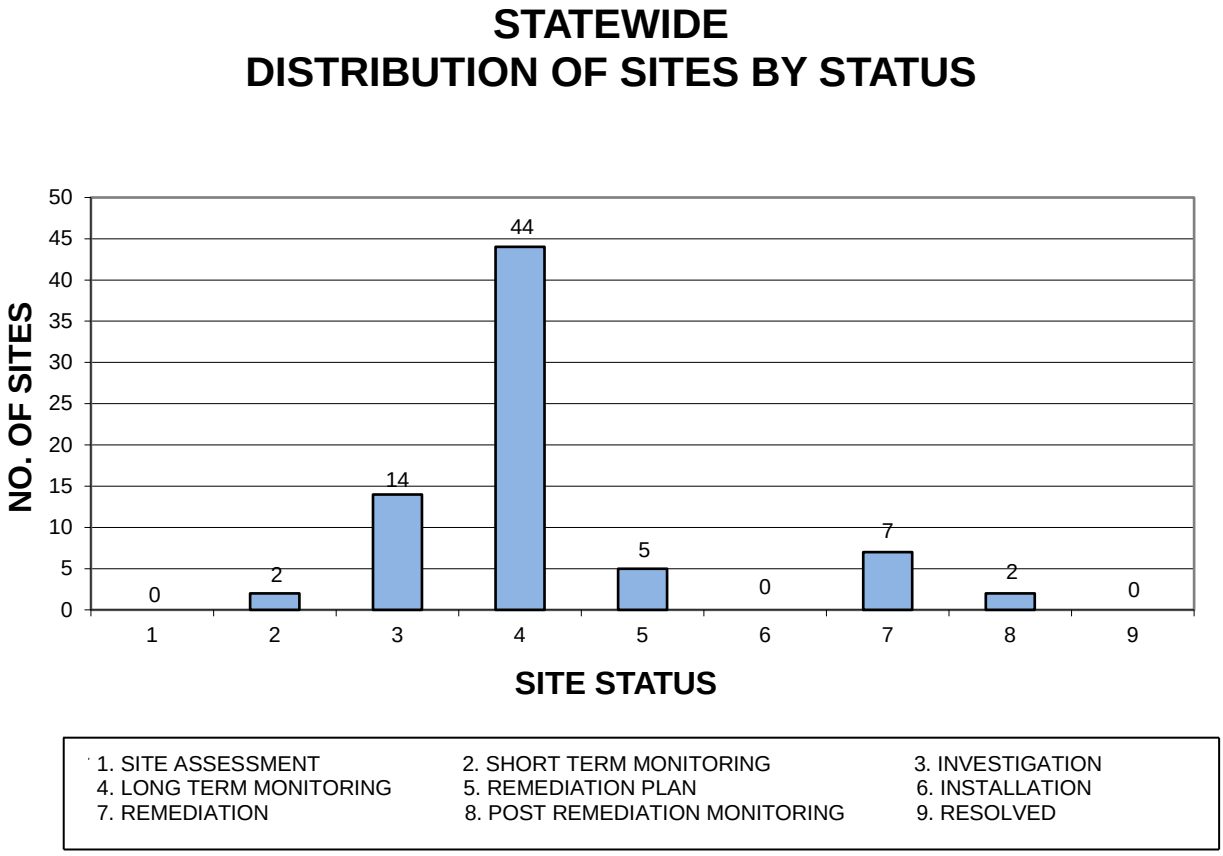
*Some sites have impacts to multiple resources

Distribution of Active Sites with Respect to Immediacy Levels

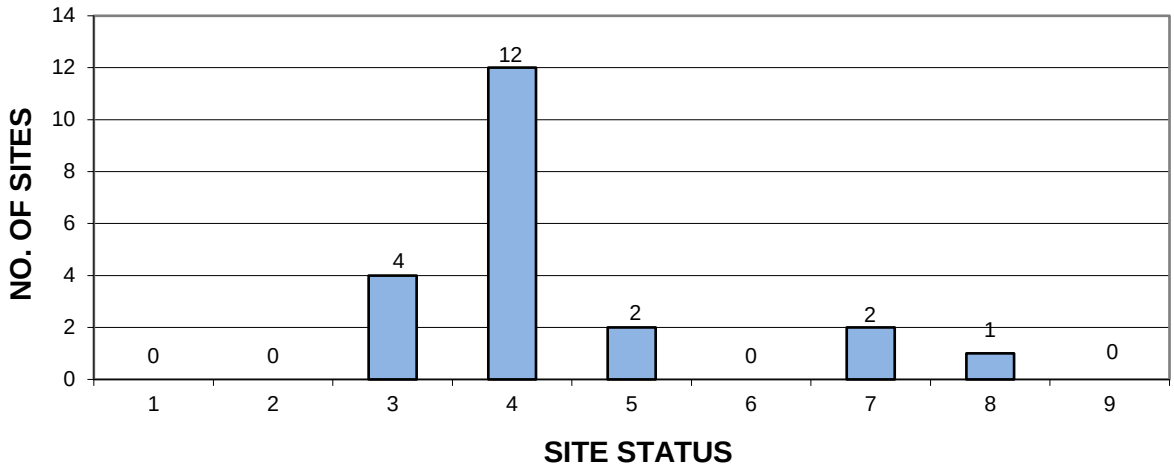
Range of Immediacy Level	No. of Sites
Low & Low to Moderate	23
Moderate	8
Moderate to High & High	11
Other (Under Remediation)	7
Total	49

Site Status

In general each contamination site has a definable life cycle. This cycle begins with, then follows a sequence of investigatory and possible remedial activities which move the site towards ultimate resolution. The first phase of the cycle is the site assessment. This phase defines general site parameters and conditions forming the basis for additional efforts at the site. Once the assessment is complete the site moves on to a new phase. This next phase may be short term or long term monitoring followed by resolution of the site. Another scenario might include an extensive investigation phase followed by the installation of a monitoring system whose sample results may indicate the necessity for certain remedial activities and additional post remediation monitoring prior to resolution of the site. The following graphs depict the current status of the 49 listed sites on a statewide and KCC District basis.

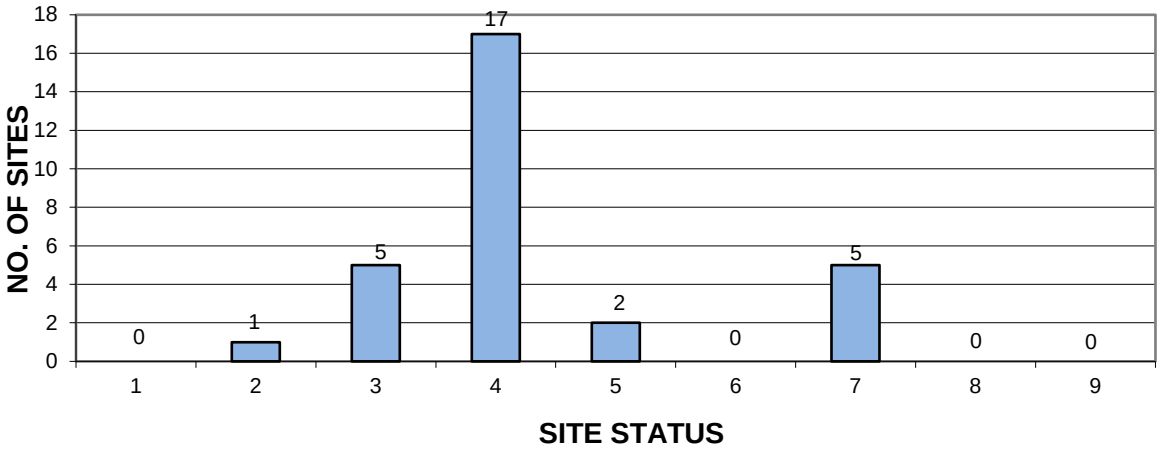


DISTRICT 1
DISTRIBUTION OF SITES BY STATUS



1. SITE ASSESSMENT	2. SHORT TERM MONITORING	3. INVESTIGATION
4. LONG TERM MONITORING	5. REMEDIATION PLAN	6. INSTALLATION
7. REMEDIATION	8. POST REMEDIATION MONITORING	9. RESOLVED

DISTRICT 2
DISTRIBUTION OF SITES BY STATUS



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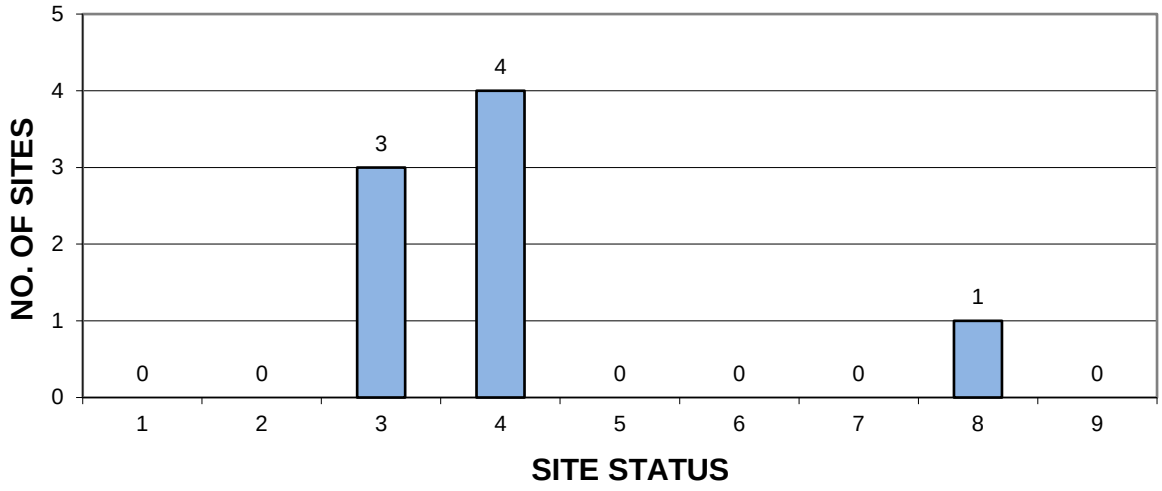
DISTRICT 3
DISTRIBUTION OF SITES BY STATUS



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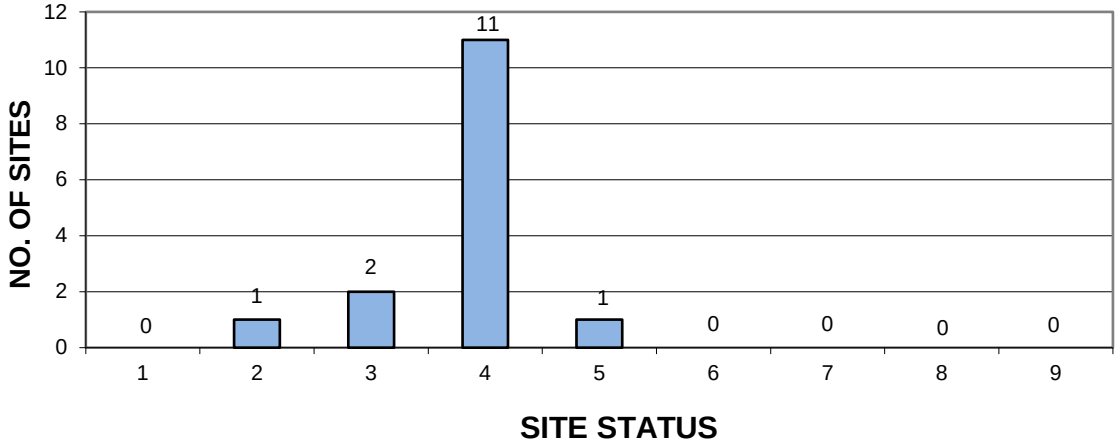
DISTRICT 4
DISTRIBUTION OF SITES BY STATUS



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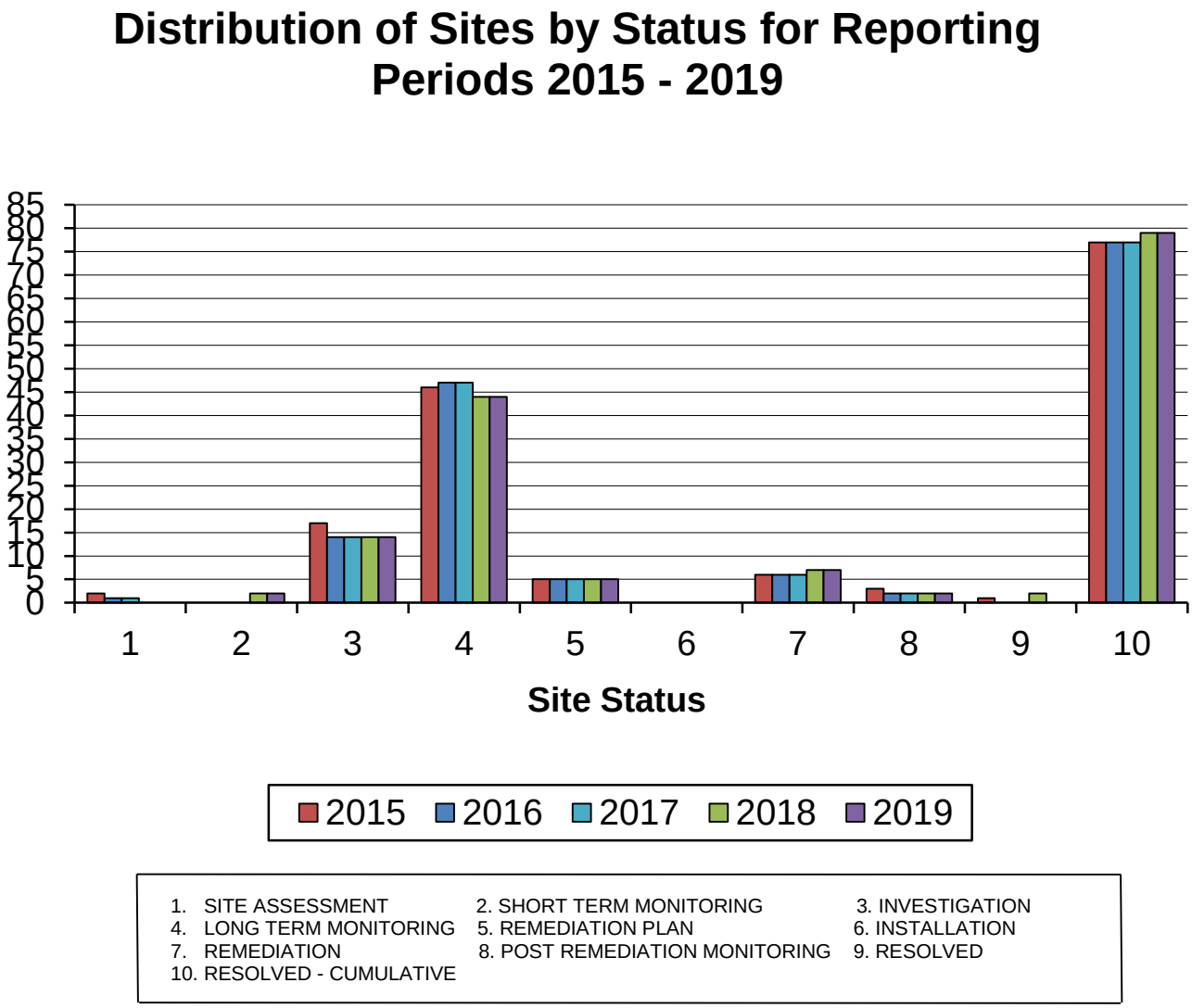
7. REMEDIATION	8. POST REMEDIATION MONITORING	9. RESOLVED

This graph depicts the distribution of sites by status for the reporting periods 2015 through 2019.



Conclusions

This report provides information concerning the location, resource impact, immediacy level, and site description and status for 49 listed contamination / remediation sites related to exploration and production activities in the state. In addition, data is presented with regard to staff expenditures for site management, administration, and inspections, as well as authorization and/or expenditures against the Abandoned Well / Remediation fund for investigatory and remedial activities at the sites.

The Conservation Division of the Corporation Commission is committed to work with the oil and gas industry of the state, other state agencies and the public to provide a scientifically sound and technically based remediation program.

Impacts, Immediacy and Target Remediation Levels
For
Kansas Corporation Commission Contamination Sites

Site Name	County	KCC District	Impact	Immediacy	Target Level Of Remediation	Unusual Problems	Estimated Total Cost
Arlington	Reno	2	GW / Soil / DM / IR / WSW	UR	250 ppm	Yes	$ 7,500*
Balthazor	Graham	4	GW / Domestic(Sole Source)	Low	250 ppm	No	$ 10,000
Brazil	Neosho	3	SW / GW / PWS / Soil	Low-Mod	500 ppm	No	$ 63,000
Brothers	Rice	2	Groundwater	Low	500 ppm	Yes	$ 4,000
Burrton	Harvey/Reno	2	GW / Domestic / Irrigation	High	Variable	Yes	$3,000,000+
Clawson(Mesa)	Haskell	1	Groundwater / Irrigation	Mod-High	500 ppm	Yes	$ 450(yr)*
Curtis	Stafford	1	Groundwater / Irrigation	Low-Mod	500-1000 ppm	Yes	$ 27,000
Dinkel	Ellis	4	GW / Domestic (SS)	Low	500 ppm	No	$ 30,000
EB-3C	Harvey/Reno	2	Groundwater	Low	No Free Liquid Hydrocarbon	Yes	$ 8,000
Elm Creek	Rooks	4	GW / Domestic / Stock Well	Mod-High	500 ppm	Yes	$ 300,000
Enoch-Thompson	Pawnee	1	Groundwater / Stock Well	Low-Mod	1000 ppm	No	$ 500(yr)*
Fink, Leon	Graham	4	Groundwater / Stock Well	Low	500 ppm	Yes	$ 2,000
Fowler	Montgomery	3	Soil	Low	300 ppm	Yes	$ 4,500
French Sink	Stafford	1	WP (Cavity)	Mod-High	NA	Yes	$ 3,000

Site Name	County	KCC District	Impact	Immediacy	Target Level Of Remediation	Unusual Problems	Estimated Total Cost
Galva City	McPherson	2	Groundwater	UR	500 ppm	Yes	$ 500,000
Harbaugh	Barber	1	GW / Domestic / Stock Well	UR	1000 ppm	Yes	$ 450,000*+
Hollow-Nikkel	Harvey	2	GW / Domestic / Irrigation	Moderate	500 ppm	Yes	$ 75,000
Hrencher	Barber	1	GW/ STK / Soil / SW	Mod-High	1000 ppm	No	$ 150,000
Irey - Hrabe	Rooks	4	Groundwater	Moderate	500 ppm	No	$ 15,000
Jennings	Decatur	4	Groundwater / PWSW	Low-Mod	500 ppm	No	$ 2,000
Knackstedt	McPherson	2	WP (Cavity)	Moderate	NA	Yes	$ 5,000
Korf	Hodgeman	1	GW / SW/ Soil / STK	Low	1000 ppm	Yes	$ 2,500*
Leesburg Sink	Stafford	1	WP (Cavity)	Mod-High	NA	Yes	$ 62,000*
Little River	Rice	2	Groundwater / PWS	High	300 ppm	Yes	$ 46,500
Macksville	Pawnee	1	Groundwater / IR / SW	Mod-High	300 ppm	Yes	$ 20,000(yr)*
Mantooth	Montgomery	3	GW / Domestic (SS) / SW	Moderate	500 ppm	Yes	$ 10,000+
Maupin	Russell	4	Groundwater / Stock Well	Low	500 ppm	No	$ 2,000
McDonald - East	Linn	3	Surface Water	Low	500 ppm	No	$ 1,500(yr)
McPherson LandFill	McPherson	2	GW / DM / SD / INDWSW	UR	500 ppm	No	$ 26,500*
Nikkel-Epps	McPherson	2	GW / Domestic (SS) / IR	Mod-High	500 ppm	Yes	$ 20,000

Site Name	County	KCC District	Impact	Immediacy	Target Level Of Remediation	Unusual Problems	Estimated Total Cost
Packard	Barber	1	GW / Water Well / STK	Moderate	1000 ppm	Yes	$ 10,000
Ruder	Ellis	4	Groundwater / SW	Moderate	500 ppm	Yes	$ 29,000
Running Turkey Ck	McPherson	2	DM/PWS/SW/SD/STK/IR	Mod-High	500 ppm	Yes	$ 125,000
Russell City	Russell	4	GW / Domestic / Irrigation	Low	1000 ppm	Yes	$ 400,000
Russell RWD #1	Russell	4	Groundwater / PWSW	Low-Mod	250 ppm	Yes	$ 33,000
Sample	Sedgwick	2	Groundwater	Low	500 ppm	Yes	$ 2,000
Sander	Russell	4	GW / Domestic / Stock Well	Low	1000 ppm	No	$ 300
Schraeder	Hodgeman	1	Groundwater / Stock Well	Low	350 ppm	No	$ 30,000
Schruben-Rogers	Rooks	4	GW / Domestic (SS)	Low	250 ppm	No	$ 2,000
Schulte Field	Sedgwick	2	GW / Domestic / PWSW	UR	500 ppm	Yes	$ 300,000
Selzer	McPherson	2	Groundwater / SW	Moderate	500-750 ppm	Yes	$ 20,000
Smith-Finn	Morton	1	Groundwater / Domestic	UR	500 ppm	Yes	$ 200,000*
South Spivey	Kingman	2	GW / DM / SW	Low	750 ppm	Yes	$ 5,000*
Stowe-Zaid	Rice	2	Groundwater / Soil	Low	350 ppm	Yes	$ 12,000
Trostle	Kingman	2	GW / Domestic / STK / Soil	Low	500 ppm	No	$ 2,500*
Voshell	McPherson	2	GW / SW / DM / IR / STK	Moderate	500 ppm	Yes	$ 20,000+

Site Name	County	KCC District	Impact	Immediacy	Target Level Of Remediation	Unusual Problems	Estimated Total Cost
Wildboy's	Barber	1	GW / SW / PWSW	Mod-High	500 ppm	No	$ **
Wingate	Wilson	3	Groundwater / Soil	Low	500 ppm	Yes	$ 15,000
Yoeman	Kingman	2	GW / DM /Stock Well	UR	NA	Yes	$ 56,000+
Total Estimated Cost							$6,109,750

ABDW=Abandoned Well DM=Domestic GW=Groundwater INDWSW=Industrial Water Supply Well IR=Irrigation Well
Mod=Moderate PWSW=Public Water Supply Well SD=Surface Damage STK=Stock Well SW=Surface Water
SS=Sole Source UR=Under Remediation WSW=Water Supply Well WP=Well Problem

*PRP – Potential Responsible Party involvement **See Harbaugh Site for costs +Actual costs have exceeded original estimate

CONTAMINATION SITE EXPENDITURES

SITE NAME	CONTROL NO.	STAFF HOURS	EXPENDITURE FOR STAFF HOURS	REMEDIATION FUND AUTHORIZATION / EXPENDITURE FY 2018/19	TOTAL
ARLINGTON	20030016-001	24.5	$761.07		
BALTHAZOR	970023-00	9	$270.10		
BRAZIL	990040-001	25.5	$749.66		$10,791.18
BROTHERS	970029-00	21	$592.45		$4.26
BURRTON	970003-00	28	$783.48	$4,187.00	$337,081.35
CLAWSON	970005-00	12	$346.84		
CURTIS	970034-00	10.5	$288.93		$4,199.17
DINKEL	970035-00	4	$128.52		
EB-3C	970042-00	25	$701.61		$2,350.00
ELM CREEK	970043-00	17	$495.26		$29,212.25
ENOCH THOMPSON	970044-00	11.5	$313.39		
FINK	970007-00	3	$101.23		
FOWLER	970046-00	7	$244.79		
FRENCH	990002-001	16	$422.04		$346.50
GALVA CITY AREA	980033-001	206	$5,731.40	$12,693.75	$296,190.12
HARBAUGH	970049-00	60	$1,818.46	$126,299.96	$688,743.03
HOLLOW NIKKEL	970009-00	12	$346.84	$2,460.00	$44,623.01
HRENCHER	970051-00	6	$186.10		$189.94
IREY-HRABE	970053-00	68	$1,919.54		
JENNINGS	970054-00	8	$244.52		
KNACKSTEDT	970060-00	35	$991.71		$153.39
KORF	20140017-001	3	$101.23		
LEESBURG SINK	20040003-001	3	$101.23		$6,266.00
LITTLE RIVER	20000057-001	18	$510.58		$3,112.20
MACKSVILLE	970066-00	11.5	$313.39	$1,268.98	$84,624.34
MANTOOTH	980058-001	40.5	$1,124.61		$17,349.00

SITE NAME	CONTROL NO.	STAFF HOURS	EXPENDITURE FOR STAFF HOURS	REMEDIATION FUND AUTHORIZATION / EXPENDITURE FY 2018/19	TOTAL
MAUPIN	970068-00	4	$131.94		
MC DONALD-EAST	970070-00	42	$1,199.94		
MCPHERSON LANDFILL	980034-001	18.5	$657.53	$604.00	$22,364.45
NIKKLE-EPPS	20100082-001	20	$565.16		$8,318.75
PACKARD	970075-00	12.5	$366.99		$310.09
RUDER	970082-00	53	$1,496.51		$12,960.00
RUNNING TURKEY CREEK	20010033-001	20.5	$578.81		$61,603.07
RUSSELL CITY	970083-00	3	$101.23		$1,192.60
RUSSELL RWD #1	970084-00	9	$270.10		
SAMPLE	970088-00	3	$101.23		
SANDER	970089-00	4	$130.23		
SCHRAEDER	970013-00	9.5	$264.47		$1,590.90
SCHRUBEN-ROGERS	970014-00	4	$130.23		
SCHULTE	970015-00	408	$11,897.58	$27,914.68	$177,954.55
SELZER	970093-00	23	$647.03		$12,133.50
SMITH-FINN	970095-00	3	$101.23		
SOUTH SPIVEY	970096-00	26	$728.90		
STOWE-ZAID	20000035-001	10.5	$323.11		$4,057.85
TROSTLE	980038-001	21.5	$606.10		
VOSHELL	20030059-001	45.5	$1,227.70	$302.00	$20,484.80
WILDBOY'S	970017-00	4	$129.52		
WINGATE	970107-00	4.5	$142.17		$8,296.00
YEOMAN	20060021-001	166.5	$5,025.59		$93,690.76
Totals:		1600.5	$46,412.21	$175,730.37	$1,950,193.06

REMEDIATION

SITES

REPORT

2019

Project: ***Arlington Site***

Site Location: The site is located approximately 5 miles west and 1 mile south of Arlington, Kansas. The brine spill, which was the source of the contamination at this site, took place on the Henson lease located in the NE/4 of Section 14, Township 25 South, Range 9 West, Reno County. Rama Operating Company is the Primary Responsible Party, and past operator of the Henson lease. The Henson lease has been plugged and abandoned for several years.

Impact/Immediacy: Impacts are to both soil and groundwater as a result of a large saltwater line leak from August 2000. Initially the spill impacted irrigation wells in the SE/4 of Section 11 and a domestic well on the lease in late 2001. The domestic well was abandoned and a new one was drilled, and the irrigation well was taken out of use for several seasons allowing the saltwater plume to migrate back to the southeast and be remediated in the NE/4 of Section 14. This site immediacy level should be classified as moderate.

Site Description: The south half of section 11 and northwestern section 13 is cultivated farmland with various crops grown. There is circle irrigation in both the SW/4 and SE/4 of section 11 and the northwest of section 13. The north half of section 14 is in CRP, and the topography is relatively flat with only eleven feet of total relief across the area. The subsurface strata consist of 3 to 4 feet of topsoil and brown clay grading into sands ranging in size from very fine to coarse mixed with clay layers down to the Harper Siltstone, which is the bedrock. Bedrock depths range from 47 to 56 feet. The highest chlorides have been found on the bedrock indicating the clay layers across the area are not contiguous forming aquitards. The only visible remnant of the line leak at the surface is a soil scar approximately 30 feet by 10 feet that is located near the center of the NE/4.

Unusual Problems: Water quality should be frequently monitored during summer because of offsetting irrigation wells to the north and east. This location is highly susceptible to plume movement due to large pump irrigation. Due to the age of the site it is difficult to determine the top of the surveyed casing and some well hydraulic data was thrown out if it looked erroneous.

Status of the Project: Since 2001 Rama Operating Company has installed 16 monitoring wells and 8 recovery wells within the area of the Arlington contamination Site. Rama installed a pump and lines to RW-8 and ran that recovery well during the summers of 2014-15 after chloride levels were found to remain high. Annual sampling by KCC has shown that the chloride plume has stayed mainly contained in the NE/4 of section 14, with the highest levels of chlorides found in MW #6 (9,500 mg/L). Chlorides have decreased in most of the monitoring wells surrounding that recovery well during the 2018 year. Side and down gradient delineation wells shows slight increases, especially MW-14 which rose to 100 mg/L Chlorides. Bedrock mapping of the Harper Siltstone indicates a slight depression along the bedrock at MW #6; this also contains the highest concentration of saltwater at the site. 2018 groundwater elevations indicate that the generalized flow is to the east-southeast with a hydraulic gradient between MW-5 and MW-11 of 0.001172414 ft/ft. During the 2018 water level gauging, it was apparent that RW-8 was in operation as coning from the recovery well affected multiple monitoring wells nearby. This is good sign for continued remediation. The overall water level increased an average of 1.90 feet since 2017, which could a contributor to the lower chlorides seen in the samples taken this year. All delineating wells to the north of the site have been destroyed or plugged over the years.

On September 12, 2018, KCC was onsite to sample the monitoring wells via air lift technology. Prior to sampling, groundwater levels were measured in each monitoring well using a Solnist electronic water level indicator. Air-lift technology was used to purge a minimum of three well volumes of groundwater from each well, save MW-15 which was not sampled during the 2018 year. Purge water was tested for conductivity and contained in a 250 gallon poly-tank if conductivity was high before being disposed of into a deep injection well located a quarter mile east of the site. Groundwater samples from each monitoring well were collected in one 250 (ml) polyurethane container for analysis at the KCC District #2 Laboratory. Each sample for this monitoring event was analyzed for the presence of Chloride by United States Environmental Protection Agency USEPA Silver Nitrate Buret Titration Method - Method 8225.

Level of Remediation Sought:

Ideal: 30 to 80 ppm (background)
Target: 250 ppm

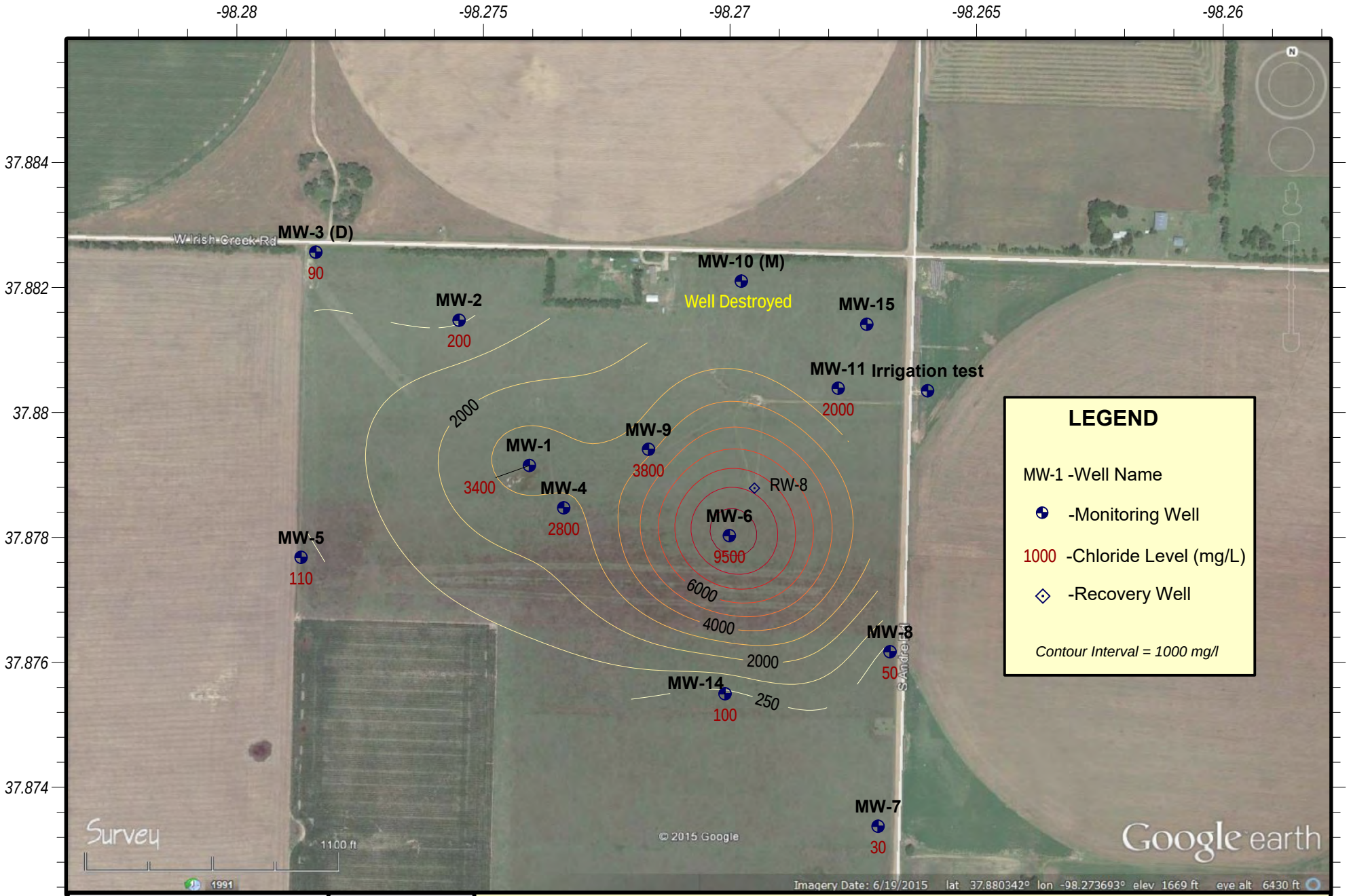
Recommendation for Future Work: 2018-19 KCC will require Rama Operating Company, to continue to run Recovery Well No. 8, and suggest the addition of utilizing other recovery wells adjacent to MW #6 in an effort to expedite the remediation efforts since natural attenuation will not likely occur anytime soon. RW-8 is the closest recovery well to the "hot spot" in the plume, but has limited amount of effectiveness in regard to chloride levels at MW-6. This year showed stable to lower chlorides surrounding the recovery well which could be the result of the recovery well pulling higher chloride fluids horizontally in the aquifer. KCC also recommends re-surveying the site and permanently marking the wells for measuring locations on each of the casing as more wells have become unusable for hydrologic studies due to bad top of casing data. This could be done utilizing the KCC's new survey grade equipment, or a licensed survey company. KCC recommends continued sampling of monitoring wells by the District #2 Office in 2018-19.

Estimated Total Cost: $2500 for Annual Groundwater sampling. Staff time will include performing reviews and research into reports remediating the Site.

Control No.	**Staff Hours/Expenditures**	**Fund Expenditures FY 2018/19 Total**
20030016-001	**24.5 Hrs. / $761.07**	

Current Contaminate Level: 9,500 mg/l in MW-6

☐ **1. Site Assessment**	☐ **2. Short Term Monitoring**	☐ **3. Investigation**
☐ **4. Long Term Monitoring**	☐ **5. Remediation Plan**	☐ **6. Installation**
☒ **7. Remediation**	☐ **8. Post Rem. Monitoring**	☐ **9. Resolved**



Kansas Corporation Commission

N W E S

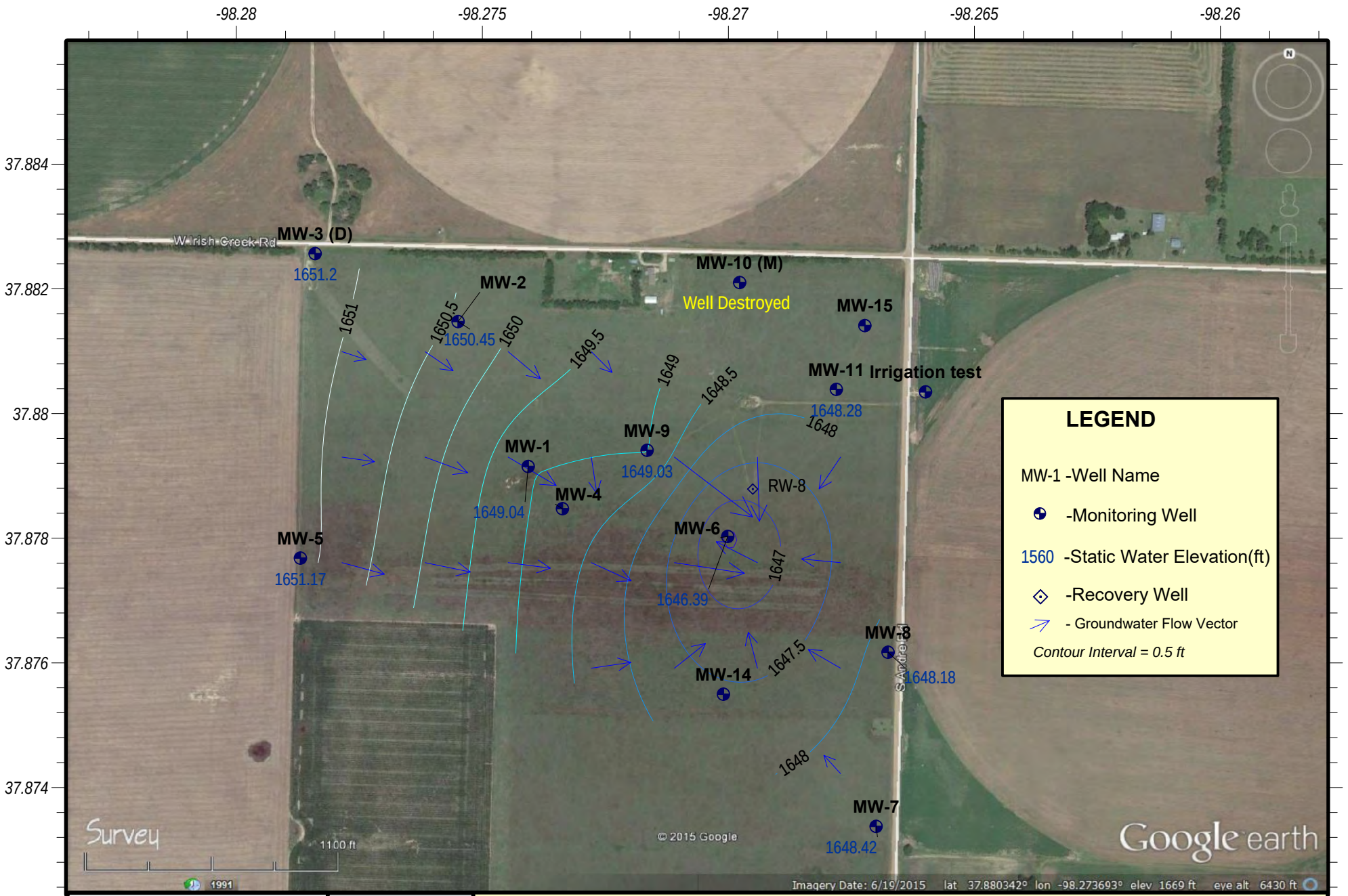
Arlington Contamination Site

Section 14 - Township 25 South - Range 9 West, Reno County, Kansas

2018 Chloride Levels

KCC Project code #20030016-001 - KCC District #2 Field Office

Well Sampled on 9/12/2018 - Map Drawn on 10/17/2018 by D. Bollenback



Kansas Corporation Commission

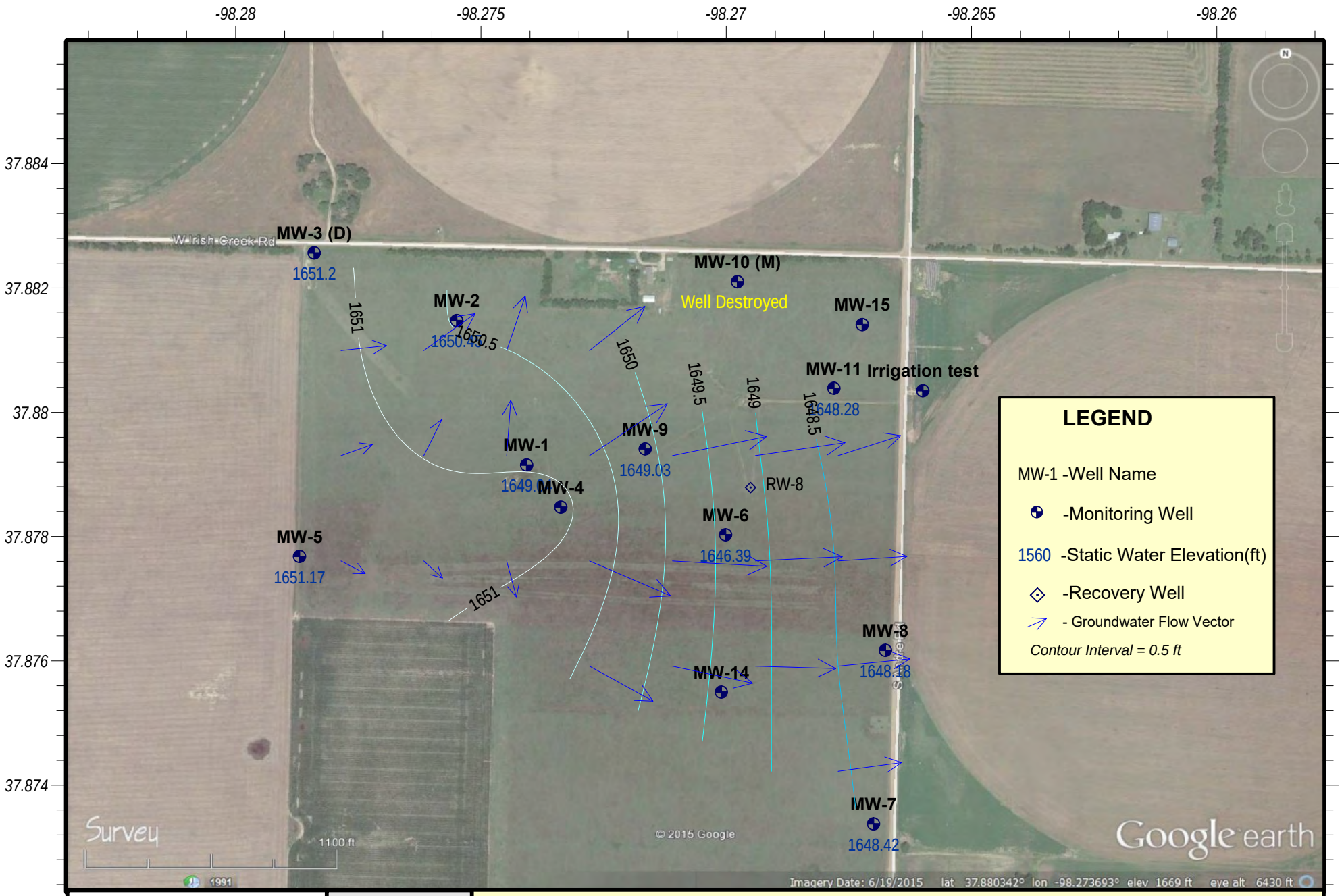
Arlington Contamination Site

Section 14 - Township 25 South - Range 9 West, Reno County, Kansas

2018 Static Groundwater Levels with RW-8 Running

KCC Project code #20030016-001 - KCC District #2 Field Office

Well gauged on 9/12/2018 - Map Drawn on 10/17/2018 by D. Bollenback



Kansas Corporation Commission

N W E S

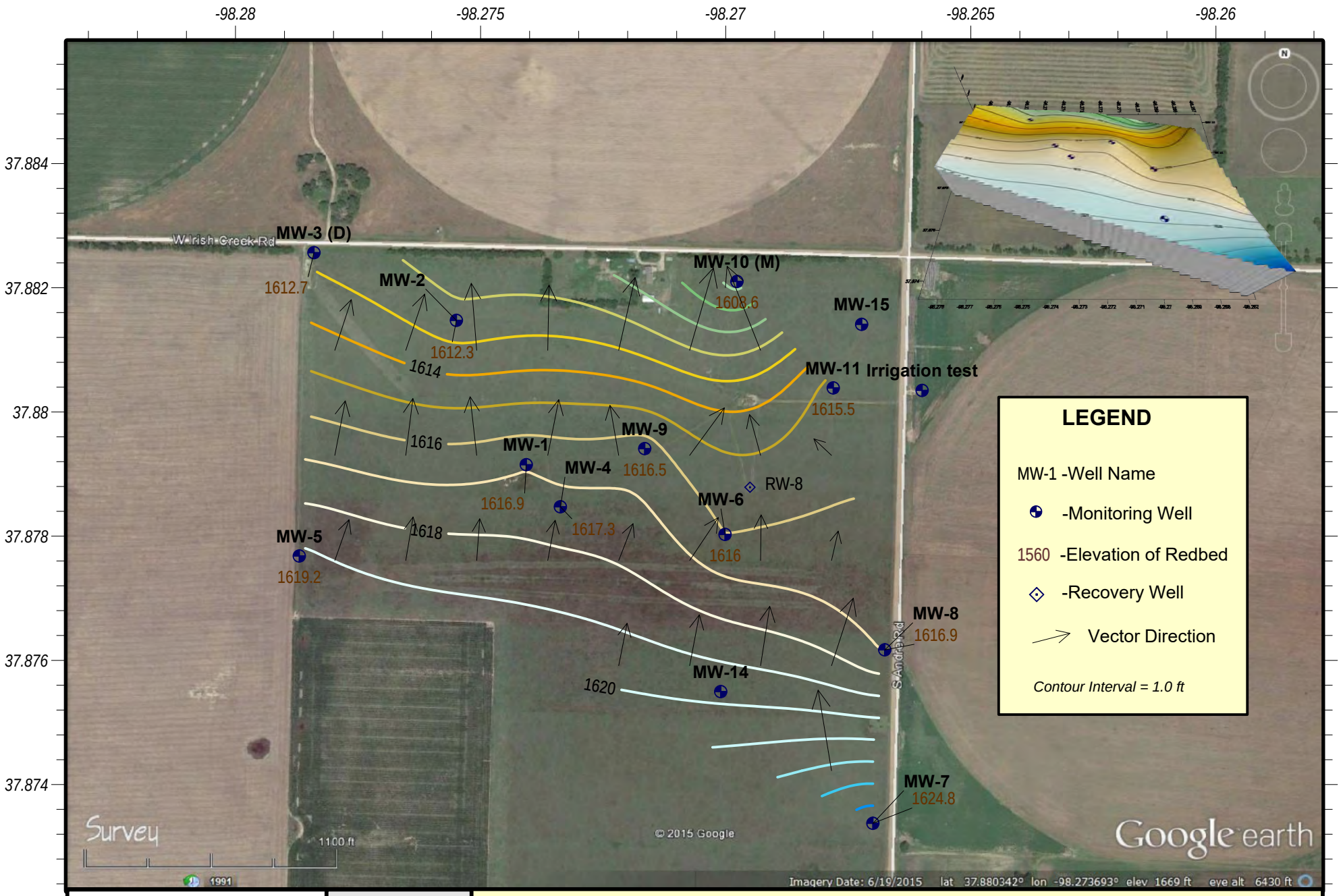
Arlington Contamination Site

Section 14 - Township 25 South - Range 9 West, Reno County, Kansas

2018 Static Groundwater Levels Adjusted for RW-8 Pull

KCC Project code #20030016-001 - KCC District #2 Field Office

Well gauged on 9/12/2018 - Map Drawn on 10/17/2018 by D. Bollenback



Kansas Corporation Commission

Arlington Contamination Site

Section 14 - Township 25 South - Range 9 West, Reno County, Kansas

Top of Permian Redbeds

KCC Project code #20030016-001 - KCC District #2 Field Office

Data from Drill logs- Map Drawn on 10/10/2017 by D. Bollenback

Project: ***Balthazor Contamination Site***

Site Location: Section 23 of Township 9 South, Range 21 West, Graham County.

Impact/Immediacy: Pollution from past oil field activity has impacted an aquifer which supplies domestic water to a homestead. The immediacy level is rated as low.

Site Description: At the time that the site was listed, a well in section 14 was the sole source of water for the residence. Though the chloride concentration was at 600 ppm when it was last tested in 2002, this well is no longer utilized by the landowner. The sole source of domestic water for the residence is a water well to the south in section 23. The quarter that the water well is located in has three oil wells that are dry and abandoned, four that are plugged and abandoned, and four producers. The majority of these wells were originally drilled in the 1940's

Unusual Problems: None.

Status of Project: When the new domestic well was drilled in 2011 the chloride level was 2,300 ppm. After an initial decline to 600 ppm, the concentration increased slightly in 2015 to 750 ppm. In 2016 and 2017, the concentration fell from 670 ppm to 320 ppm, but has since increased to 475 ppm. The three monitoring wells on the location have remained relatively stable with a subtle overall decrease in contamination. The contamination levels were 1,200 ppm, 1,450 ppm, and 140 ppm, respectively, in 2016, and in 2017, the concentrations were 1,500 ppm in MW #1, 1,450 ppm in MW #2, and 140 ppm in MW #3. The contamination level in 2018 has followed the trend of stability with only minor fluctuation. The wells were tested and found to be 1,300 ppm in MW #1, 1,400 in MW #2, and 30 ppm in MW #3.

Level of Remediation Sought:
Ideal: 250 ppm Chloride
Target: 250 ppm Chloride

Recommendations for Future Work: The source of the contamination is likely an old brine pit in the NW/4 of Section 23, T.9S. R.21W., and the feasibility of decreasing the contamination level through remediation will be considered, but needs to be weighed against the site parameters. The contamination level will continue to be monitored.

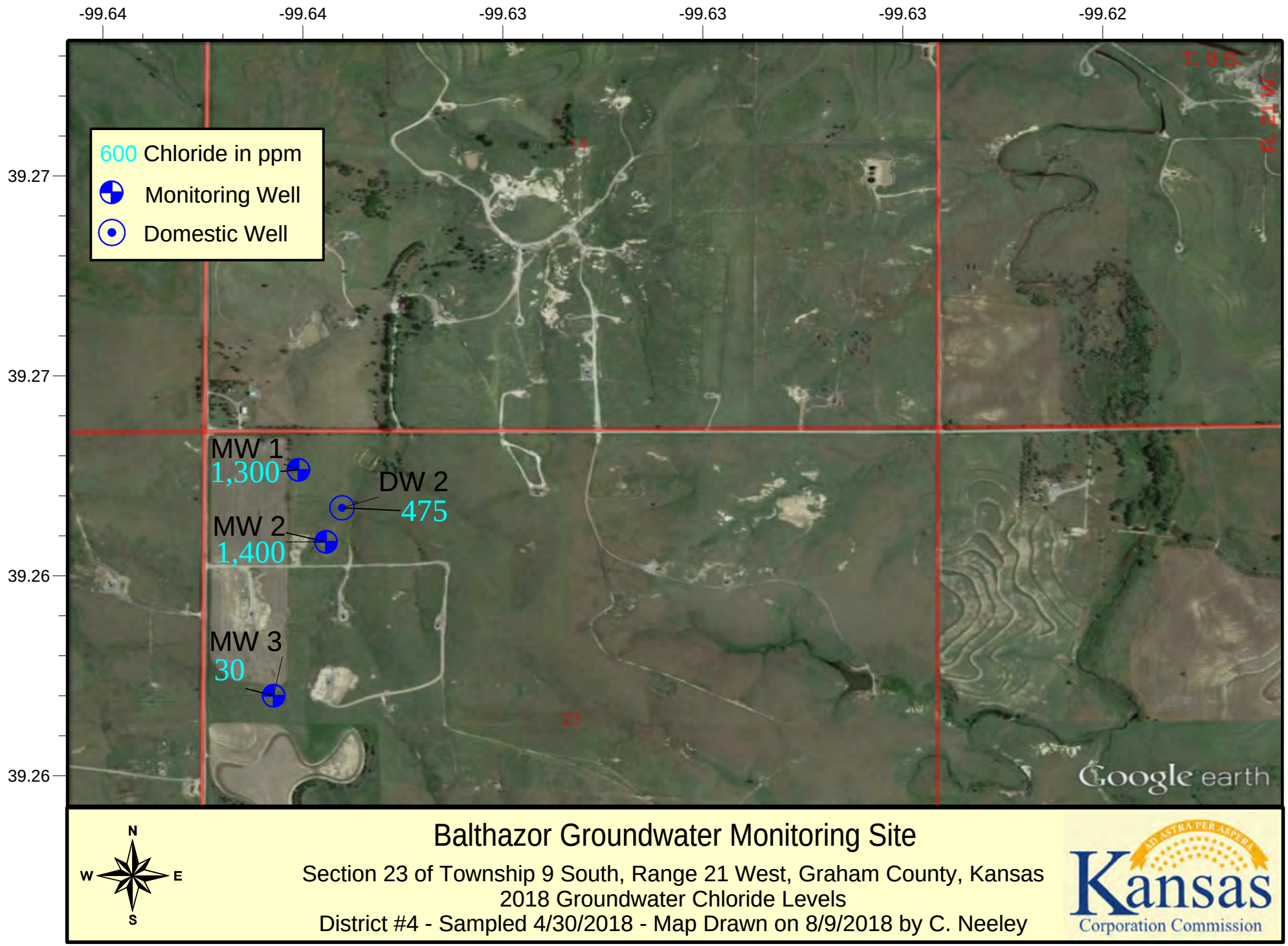
Estimated Total Costs: $10,000.00

Control No.	**Staff Hours/Expenditures**	**Fund Expenditures FY 2018/19 Total**
970023-00	**9 Hrs. / $270.10**	

Current Contaminate Level: 30 ppm to 1,400 ppm Cl^-

Status:

☐ **1. Site Assessment**	☐ **2. Short Term Monitoring**	☐ **3. Investigation**
☒ **4. Long Term Monitoring**	☐ **5. Remediation Plan**	☐ **6. Installation**
☐ **7. Remediation**	☐ **8. Post Rem. Monitoring**	☐ **9. Resolved**



Balthazor Groundwater Monitoring Site

Section 23 of Township 9 South, Range 21 West, Graham County, Kansas
2018 Groundwater Chloride Levels
District #4 - Sampled 4/30/2018 - Map Drawn on 8/9/2018 by C. Neeley

Kansas Corporation Commission

Project: ***Brazil Contamination Site***

Site Location: Section 27, Township 28 South, Range 18 East, Neosho County.

Impact/Immediacy: Chloride contamination at this site has verified impacts to both surface water and soil resources with a strong potential for ongoing impact to groundwater resources. The immediacy level is rated as low to moderate for water resources and low to moderate for soil resources.

Site Description: The site consisted of an abandoned oil lease with 30 abandoned wells. Surface runoff over areas of past brine spillage and near surface leakage from abandoned wells is affecting both surface water and soil resources. The surface drainage through this lease is a minor tributary to the Neosho River, which is a public water supply source.

Unusual Problems: None.

Status of Project: The Fee Fund Plugging Project for this lease was completed in early spring of 1999. Twenty-three wells were plugged while seven of the wells were determined to already have been plugged. River Rock is the current CBM gas Operator. Post Rock (previous Operator) plugged an additional break out well in 2006. Four new monitoring wells were constructed in early 2012. These wells were specifically located to further determine the extent and possible source area of the chlorides impacting the area groundwater and surface soils. This property was leased by Post Rock and six new gas wells have been drilled in this section since 2006. Two additional surface casing only wells cut off below surface were discovered in 2016. The following sample results were obtained this year on: ***10/2/2018***:

Well BRA1; 1,100 ppm Cl-; ***Well BRA2***; 1,100 ppm Cl-;
Well BRA3; 400 ppm Cl-; ***Well BRA4;*** 1,400 ppm Cl-;
Overall CL- concentrations continue to trend down for the year.

Level of Remediation Sought:
Ideal: 250 ppm Chloride
Target: 500 ppm Chloride

Recommendation for Future Work: Future work at the site will include plugging of OW57 and OW55, the two abandoned oil wells discovered in 2016 through the use of data collected from monitoring wells correlated with google earth imagery, historical documents and focused metal detector surveys. The sampling of constructed monitoring wells will continue and possible construction of additional monitoring wells may be necessary. Additional field work will be performed to locate possible unplugged abandoned wells or old wells in which the initial plugs have failed along with utilizing the new ability to download and overlay historic aerial imagery. This information will assist in determining the location and extent of the brine impact.

Estimated Total Cost: Plugging cost for this site totaled $57,697.10. Monitoring Well Construction completed in early 2012 totaled $8,196.00.

Control No.	**Staff Hours/Expenditures**	**Fund Expenditures FY 2018/19**	**Total**
990040-001	**25.5 Hrs. / $749.66**		**$10,791.18**

Current Contaminate Level: 400 ppm to 1,400 ppm Cl-

Status:

☐ **1. Site Assessment**	☐ **2. Short Term Monitoring**	☒ **3. Investigation**
☒ **4. Long Term Monitoring**	☐ **5. Remediation Plan**	☐ **6. Installation**
☐ **7. Remediation**	☐ **8. Post Rem. Monitoring**	☐ **9. Resolved**

KANSAS CORPORATION COMMISSION
Brazil Remediation Site
E1/2 27-T28S-R18E
Neosho County, Kansas
Project 990040-001

10/08/2018 District 3

Project: ***Brothers Contamination Site***

Site Location: This contamination site is located nine miles east, two and one half miles north of Sterling. The legal location is S/2 NE of Section 12, Township 21 South, Range 7 West, Rice County, Kansas.

Impact/Immediacy: Low immediacy. The only water wells within one mile are to the southwest and were drilled in the 1980s as oil field supply wells. There are residential wells over a mile to the southeast which is side gradient to groundwater flow.

Site Description: The site is located in the Sand Hills of Rice County. The contaminated groundwater aquifer is a shallow permeable zone consisting Pleistocene Dune Sand, consisting of poorly sorted medium to fine sands with silt lenses. Below this the Sandborn formation consisting of dark brown silty clay interbedded with coarser materials, which occurs as an aquatard at the site. The Sandborn changes into the Meade Formation, which is a good water baring coarse gravel and sand aquifer. The Meade Formation appears to not be contaminated at the Brothers site. The groundwater flow is to the south-southwest.

Unusual Problem: Monitoring wells in the Pleistocene Dune Sand onsite have shown that the aquifer has low deliverability in the upper aquifer and is limited especially during periods of drought. Hydrology in the upper perched aquifer is in direct connection with precipitation and has a varying aquatard elevation stopping penetration. This can create issues with entrapment of chlorides and movement of water not in line with true downward gradient.

Status of Project: KCC visited the site and collected water samples on April 12th, 2018. MW-1 has been destroyed and covered in a pile of cedar trees. KCC laboratory results of the two monitoring wells show that chloride levels have dropped in the wells and the pond. MW-2 is screened in the Meade Formation and lab results showed 20 ppm chlorides. This indicates that the lower aquifer is still unaffected at the Brothers site. A sample was taken at the pond and was tested at 353 ppm chlorides. Frogs, deer, turkey, turtles, and other biota were witnessed in or at the pond. KCC inspected the leases to the north of the site but could not find anything that currently is contributing to the chloride issues at the Brothers site. It should be noted that this site was visited in early 2018 before any heavy and sustained rain events that would occur later in the year.

Level of Remediation Sought:

Ideal: 250 mg/l Chloride
Target: 500 mg/l Chloride

Recommendations for Future Work: KCC recommends that the site remain in the monitoring phase due to the lack of priority of the site. There is now only one monitoring well in the upper aquifer, which severely limits hydrological studies of the site. A Geoprobe® rig could be used to probe the area surrounding the site to indicate whether or not the chloride contamination is still high in the old drilling pit area. A Geoprobe® rig can also drill and install shallow monitoring wells or very inexpensive 1' piezometers if deemed necessary. Probe work could show whether or not this chloride contamination is part of a larger chloride situation from past oil field activities. Data found from a probing event could be used to help plan on a time table for site closure.

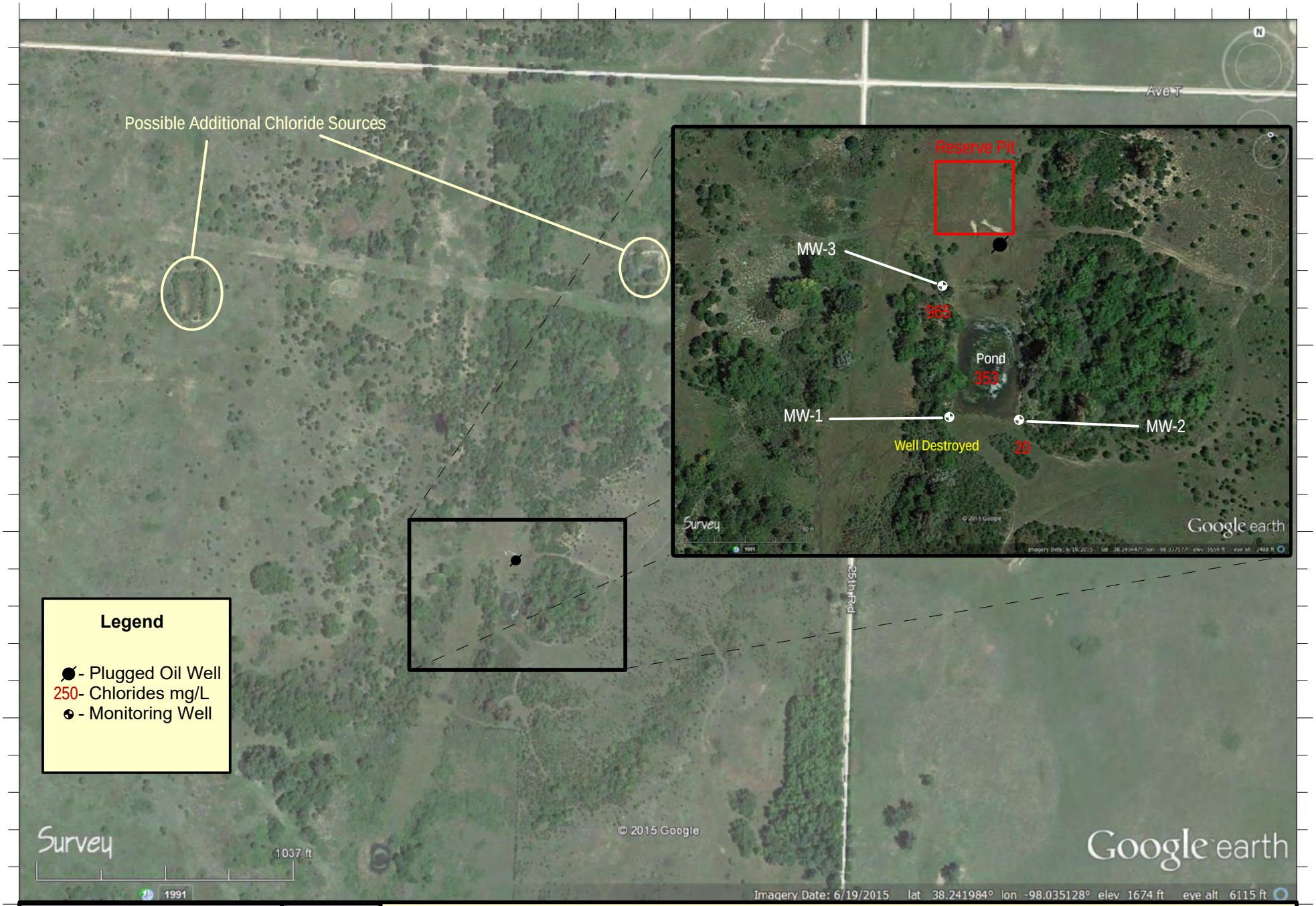
Estimated Total Costs: $750 for monitoring, research and report writing. Geoprobe work would cost around $4,000.

Control No.	**Staff Hours/Expenditures**	**Fund Expenditures FY 2018/19**	**Total**
970029-00	**21 Hrs / $592.45**		**$4.26**

Current Contaminate Level: 20 mg/l to 965 mg/l Chloride **4/12/2018**

Status:

☐ **1. Site Assessment**	☐ **2. Short Term Monitoring**	☐ **3. Investigation**
☒ **4. Long Term Monitoring**	☐ **5. Remediation Plan**	☐ **6. Installation**
☐ **7. Remediation**	☐ **8. Post Rem. Monitoring**	☐ **9. Resolved**



Kansas Corporation Commission

Brothers Chloride Monitoring Site

S/2 NE of Section 12 of Township 21 South & Range 7 West, Rice County, Kansas

2018 Chloride Levels and Site Map

KCC Code #970029-00 - KCC District #2 Field Office - Well Sampled on 4/12/2018 - Map Drawn on 10/15/2018 by D.Bollenback

Project: ***Burrton Contamination Site***

Site Location: The site is located in western Harvey County and eastern Reno County approximately 18 miles west of the city of Newton and 12 miles east of the city of Hutchinson. The site includes acreage in Townships 23 and 24 South, Ranges 3 and 4 West.

Impact/Immediacy: Presently the contamination site is affecting local domestic and irrigation wells. Hydrogeologic computer modeling shows portions of the plume will intercept parts of the Wichita Well Field within 50 years. The Equus Beds aquifer is a major source of public water supply for much of the population of Sedgwick County. This case is ranked at a very high level of immediacy based on the resource impacted and the size of the site.

Site Description: Total maximum area affected by the contamination covers approximately 25 to 30 square miles. In general, the contaminate plume is aligned in a northeast to southwest configuration parallel with the associated producing areas. A water quality-sampling network maintained by the local groundwater management district indicates oil field brine contamination of all three major zones within the Equus Beds Aquifer. Depth to groundwater ranges from 10 to 35 feet with saturated thickness in the order of 150 to 250 feet.

Unusual Problems: The need of suitable disposal facilities and the large area extent of the plume make the clean up of this site very costly. The physical day-to-day maintenance and monitoring of a withdrawal and disposal system of this size would require a large commitment of labor and resources. In addition, over pumping the aquifer as part of a remediation plan for oilfield brine could cause natural chlorides to migrate from the Arkansas River into the Equus Beds, thus impacting parts of the aquifer that are not contaminated. Considering the variable conditions within the aquifer different areas within the contaminate plume would need to be evaluated separately during cleanup to insure that fresh and usable water is not being disposed of needlessly.

Status of the Project: GMD #2 sampled the monitoring wells in the late summer of 2018. This site is currently in monitoring status with the KCC but other entities including the city of Wichita are actively attempting to remediate the contamination problem. In 2018 The Kansas Water Office proposed giving $50,000 for remedial efforts in the Burrton Field which is to be administered by GMD#2. The City of Wichita's ASR project, a multi-million dollar investment, is directly attempting to remediate/slow the Burrton brine plume. District #2 continues to investigate private groundwater wells and water quality in the area including a geoprobe investigation to the northwest of Burrton in 2015. In 2018, the A zone showed increases in chlorides in EB-2A, EB-10A, EB-14A, and EB-15A. Precipitation may be leaching salts in the soil zone above the water table which is possibly the source for the increase chlorides in those wells or due the process of slow hydraulic movement of chlorides along clay beds. Other areas showed decreases in the A zone, which alternatively could be due the lack of salts in the soils in those location allowing for the rains to help dilute the water table's shallowest zone or vertical movement of chlorides to the B zone. The B Zone wells EB-1B, EB-2B, EB-4B, EB-9B, EB-10B, EB-11B, EB-14B, EB-15B, P27A, and P28A all increased with the greatest being EB-1B with a gain of 130 mg/L. With the added influx of water from precipitation it could be that chlorides have been pushed past and over the upper aquatard and have entered the lower zone and moving chlorides along clay beds. Chlorides dropped in the B Zone within the middle and eastern potions of the site. The lower C zone had 70 mg/L drop in chlorides in EB-8C, where historically the highest chloride levels occur. Many wells were stable in Chloride levels. EB-11C, EB-13C, and EB-15C, which lie on the eastern side of the site rose slightly since 2017.

Level of Remediation Sought:

Ideal: 250 mg/L Chloride
Target: 300 mg/L

Recommendations for Future Work: Continue working with Groundwater Management District #2 including the funding of annual water well sampling and analysis of this critical data. KCC will continue to review data for locations for possible additional wells to help delineate the plume. KCC will continue to actively communicate with the USGS, City of Wichita, and GMD #2 regarding data exchange and future cooperation which is essential for the study and remediation of this problem. KCC will concentrate research into high level A Zone plumes to investigate the possibility of remedial action in smaller areas of contamination. KCC Plans to evaluate the high chlorides surrounding EB-3 which is high in all three zones.

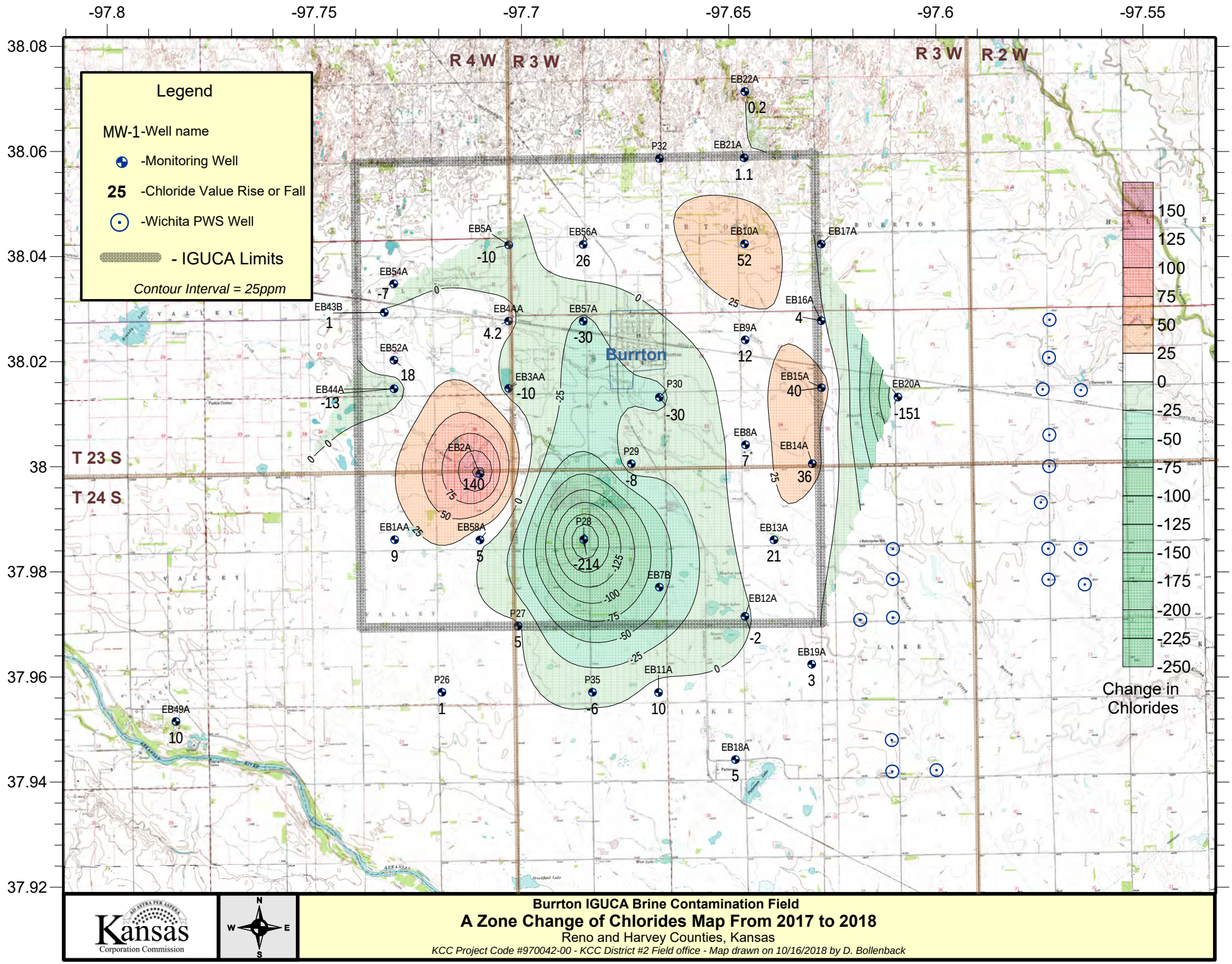
Estimated Total Cost: Cost associated with funding the sampling done by GMD #2, along with KCC staff research and report preparation. KCC Staff attends many meetings and conferences regarding the work being done regarding this site and will continue to do so. Installation of new wells along the eastern edge of the site to help delineate the plume movement could be needed in the future.

Control No.	**Staff Hours/Expenditures**	**Fund Expenditures**	
		FY 2018/19	**Total**
970003-00	**28 Hrs. / $783.48**	**$4,187**	**$337,081.35**

Current Contaminate Level: 2.1 mg/l to 1580 mg/l Cl^-

Status:

☐ **1. Site Assessment**	☐ **2. Short Term Monitoring**	☐ **3. Investigation**
☒ **4. Long Term Monitoring**	☒ **5. Remediation Plan**	☐ **6. Installation**
☐ **7. Remediation**	☐ **8. Post Rem. Monitoring**	☐ **9. Resolved**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37.96
37.94
37.92
R 4 W
R 3 W
R 3 W
R 2 W
T 23 S
T 24 S
Legend
MW-1-Well name
-Monitoring Well
25 -Chloride Value Rise or Fall
-Wichita PWS Well
- IGUCA Limits
Contour Interval = 25ppm
Burrton
EB22A 0.2
P32
EB21A 1.1
EB5A -10
EB56A 26
EB10A 52
EB17A
EB54A -7
EB43B 1
EB4AA 4.2
EB57A -30
EB16A 4
EB9A 12
EB52A 18
EB44A -13
EB3AA -10
P30 -30
EB15A 40
EB20A -151
EB8A 7
EB14A 36
EB2A 140
P29 -8
EB1AA 9
EB58A 5
P28 -214
EB13A 21
EB7B
EB12A -2
P27 5
EB19A 3
EB11A 10
P26 1
P35 -6
EB49A 10
EB18A 5
150
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Change in Chlorides
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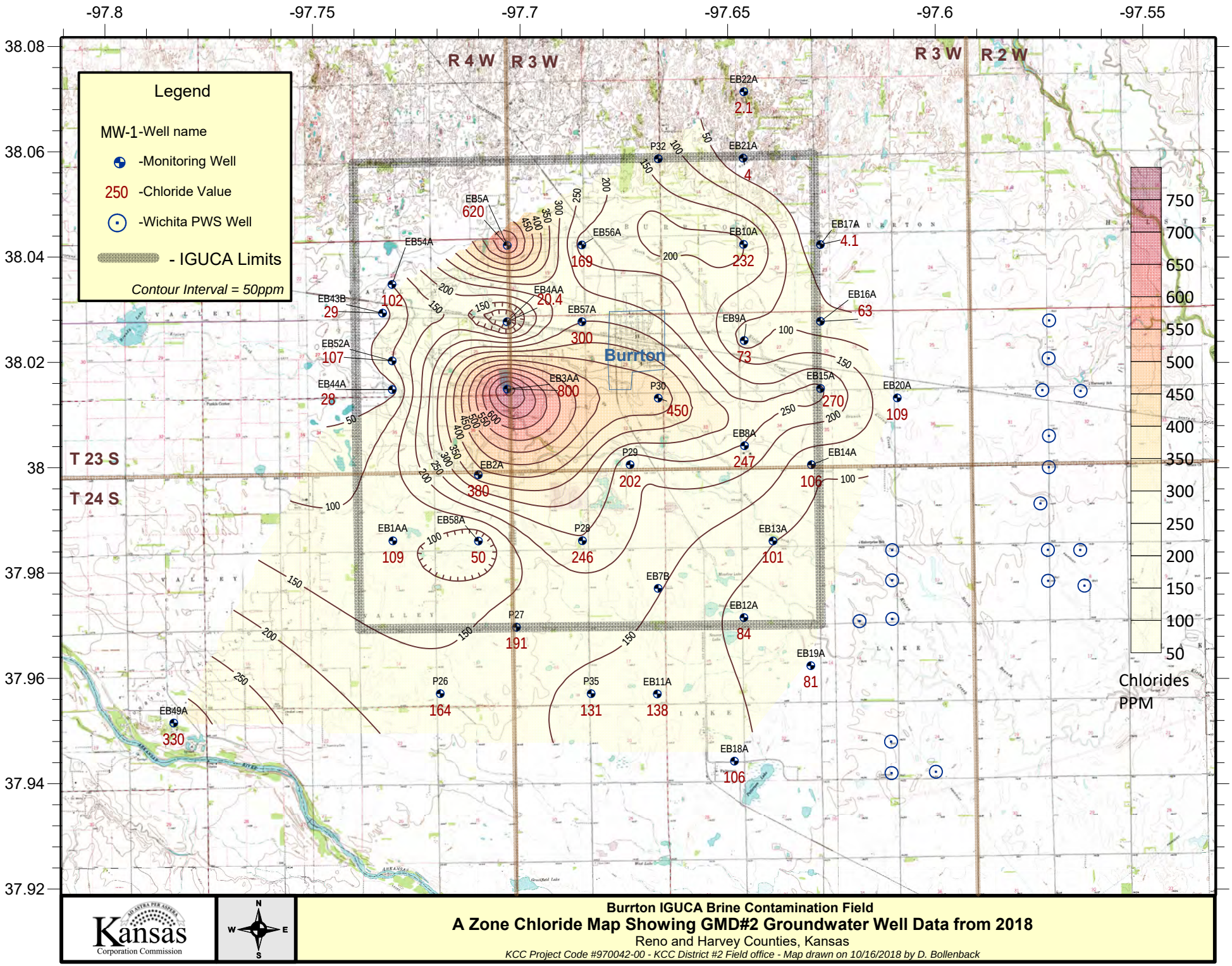
Burrton IGUCA Brine Contamination Field
A Zone Change of Chlorides Map From 2017 to 2018
Reno and Harvey Counties, Kansas
KCC Project Code #970042-00 - KCC District #2 Field office - Map drawn on 10/16/2018 by D. Bollenback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R 4 W
R 3 W
R 3 W
R 2 W
T 23 S
T 24 S
Legend
MW-1-Well name
-Monitoring Well
250 -Chloride Value
-Wichita PWS Well
- IGUCA Limits
Contour Interval = 50ppm
Burrton
EB22A 2.1
P32
EB21A 4
EB5A 620
EB56A 169
EB10A 232
EB17A 4.1
EB54A 102
EB43B 29
EB4AA 20.4
EB57A 300
EB16A 63
EB9A 73
EB52A 107
EB3AA 800
P30 450
EB15A 270
EB20A 109
EB44A 28
EB8A 247
P29 202
EB14A 106
EB2A 380
EB1AA 109
EB58A 50
P28 246
EB13A 101
EB7B
EB12A 84
P27 191
EB19A 81
P26 164
P35 131
EB11A 138
EB49A 330
EB18A 106
750
700
650
600
550
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450
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350
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150
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Chlorides
PPM
Kansas
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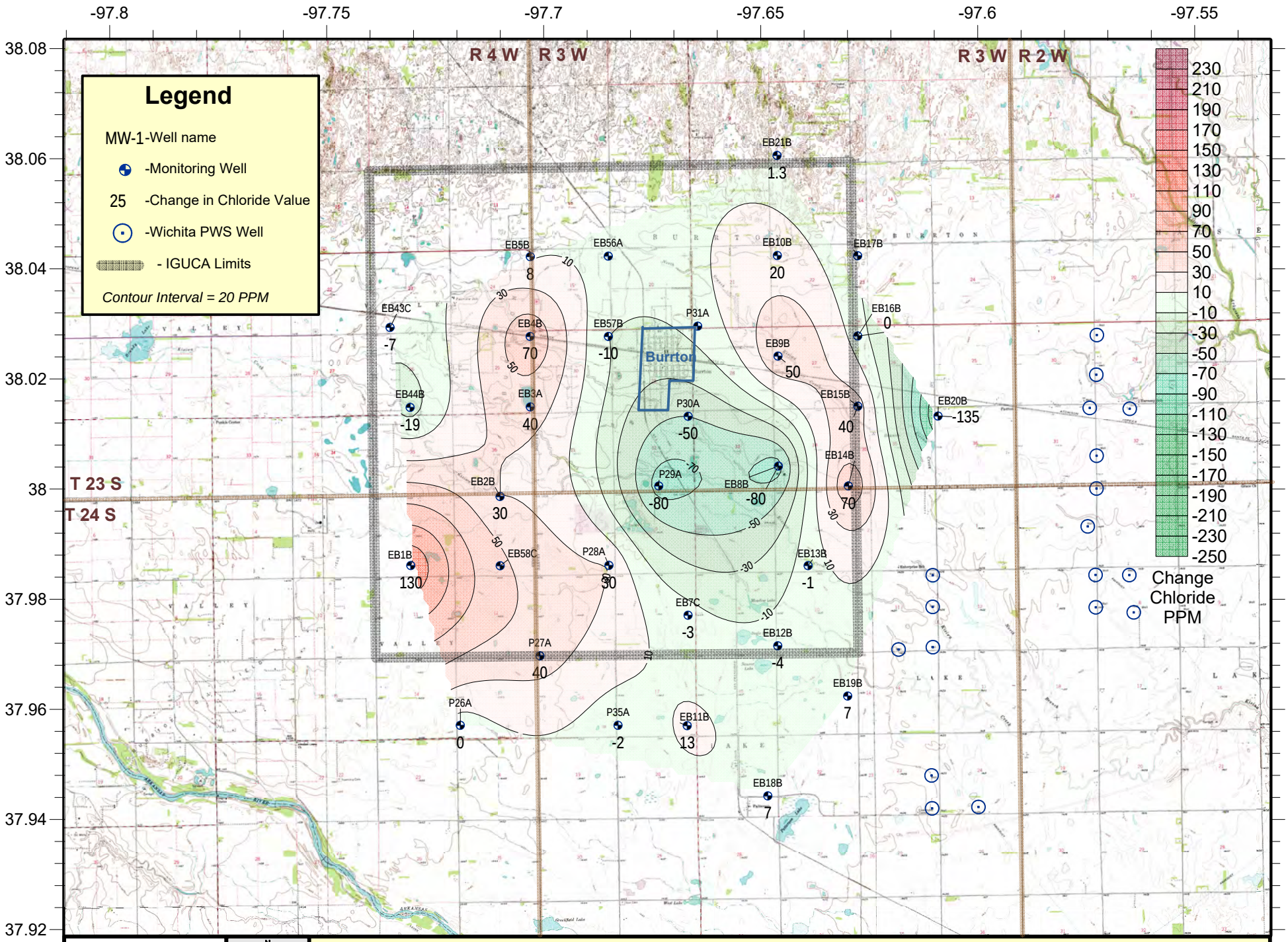
Burrton IGUCA Brine Contamination Field
A Zone Chloride Map Showing GMD#2 Groundwater Well Data from 2018
Reno and Harvey Counties, Kansas
KCC Project Code #970042-00 - KCC District #2 Field office - Map drawn on 10/16/2018 by D. Bollenback

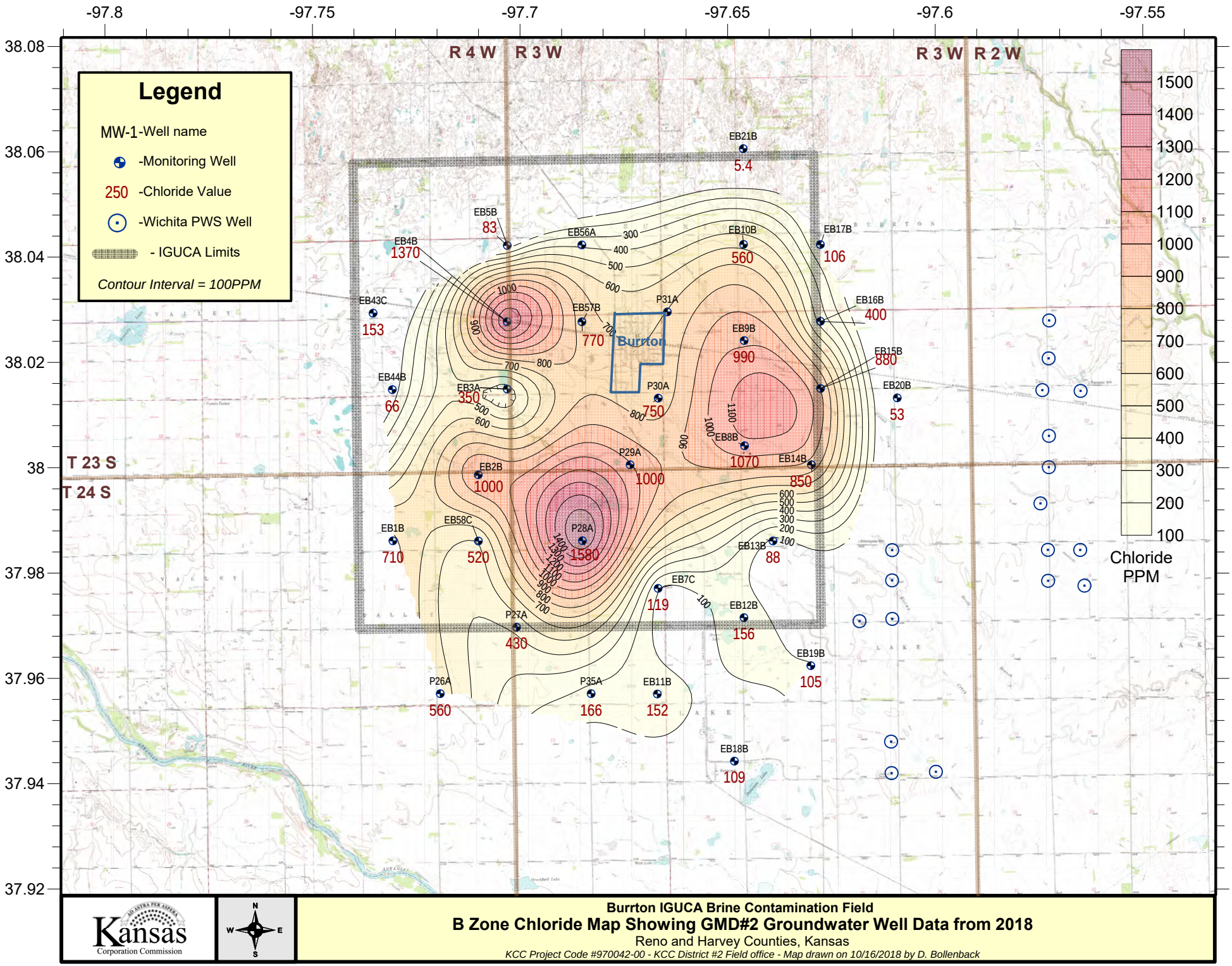


Burrton IGUCA Brine Contamination Field

B Zone Chloride Map Showing GMD#2 Groundwater Well Data Change from 2017 to 2018

Reno and Harvey Counties, Kansas

KCC Project Code #970042-00 - KCC District #2 Field office - Map drawn on 10/16/2018 by D. Bollenback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R 4 W
R 3 W
R 3 W
R 2 W
T 23 S
T 24 S
Legend
MW-1-Well name
-Monitoring Well
250 -Chloride Value
-Wichita PWS Well
- IGUCA Limits
Contour Interval = 100PPM
Burrton
EB21B 5.4
EB5B 83
EB4B 1370
EB56A
EB10B 560
EB17B 106
EB43C 153
EB57B 770
P31A
EB16B 400
EB9B 990
EB15B 880
EB44B 66
EB3A 350
P30A 750
EB20B 53
EB8B 1070
EB14B 850
P29A 1000
EB2B 1000
EB1B 710
EB58C 520
P28A 1580
EB13B 88
EB7C 119
EB12B 156
P27A 430
EB19B 105
P26A 560
P35A 166
EB11B 152
EB18B 109
1500
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Chloride PPM
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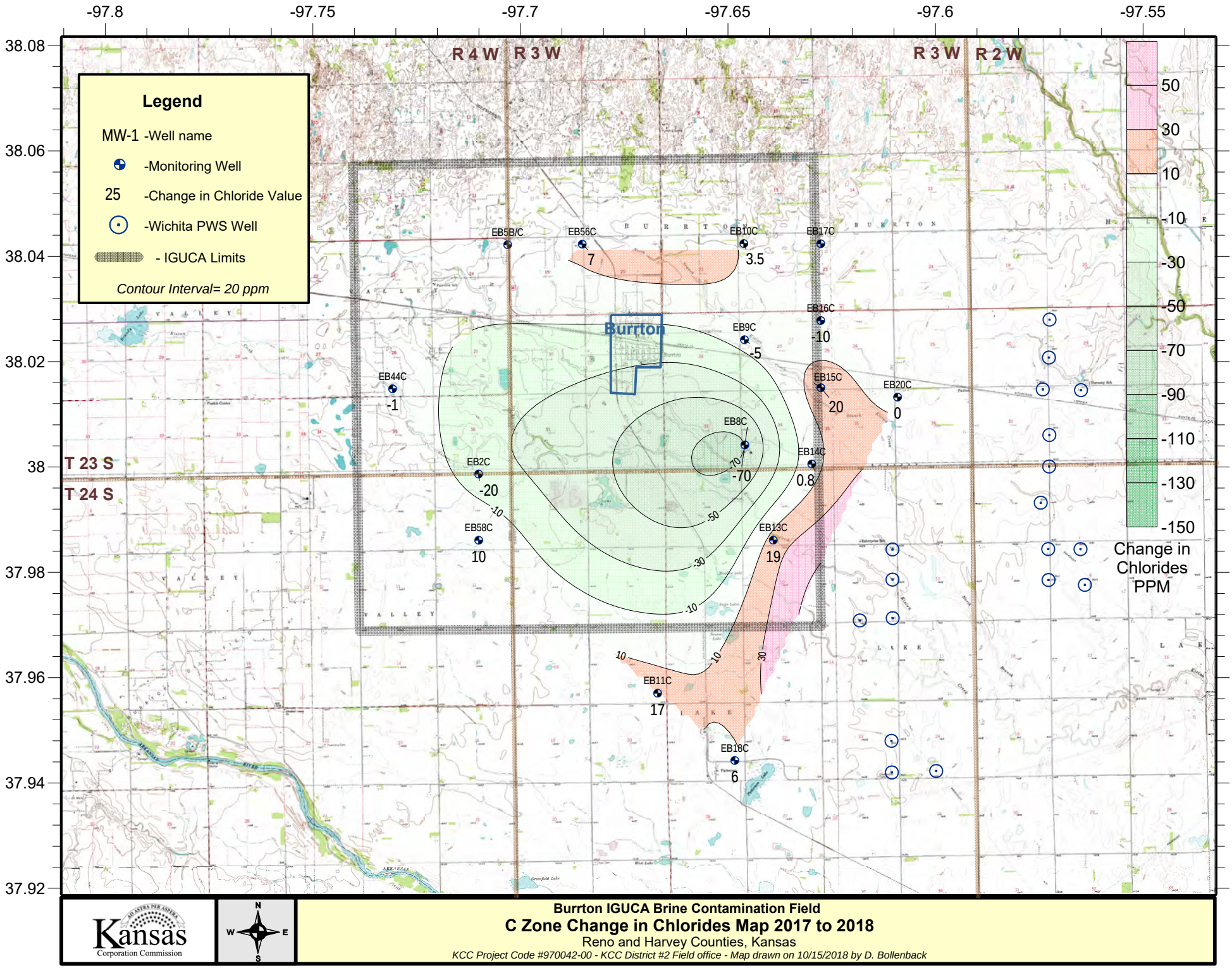
Burrton IGUCA Brine Contamination Field
B Zone Chloride Map Showing GMD#2 Groundwater Well Data from 2018
Reno and Harvey Counties, Kansas
KCC Project Code #970042-00 - KCC District #2 Field office - Map drawn on 10/16/2018 by D. Bollenback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37.98
37.96
37.94
37.92
R 4 W
R 3 W
R 3 W
R 2 W
T 23 S
T 24 S
Legend
MW-1 -Well name
-Monitoring Well
25 -Change in Chloride Value
-Wichita PWS Well
- IGUCA Limits
Contour Interval= 20 ppm
Burrton
EB5B/C
EB56C
7
EB10C
3.5
EB17C
EB16C
-10
EB9C
-5
EB44C
-1
EB15C
20
EB20C
0
EB8C
-70
EB14C
0.8
EB2C
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EB58C
10
EB13C
19
EB11C
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EB18C
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-110
-130
-150
Change in Chlorides PPM
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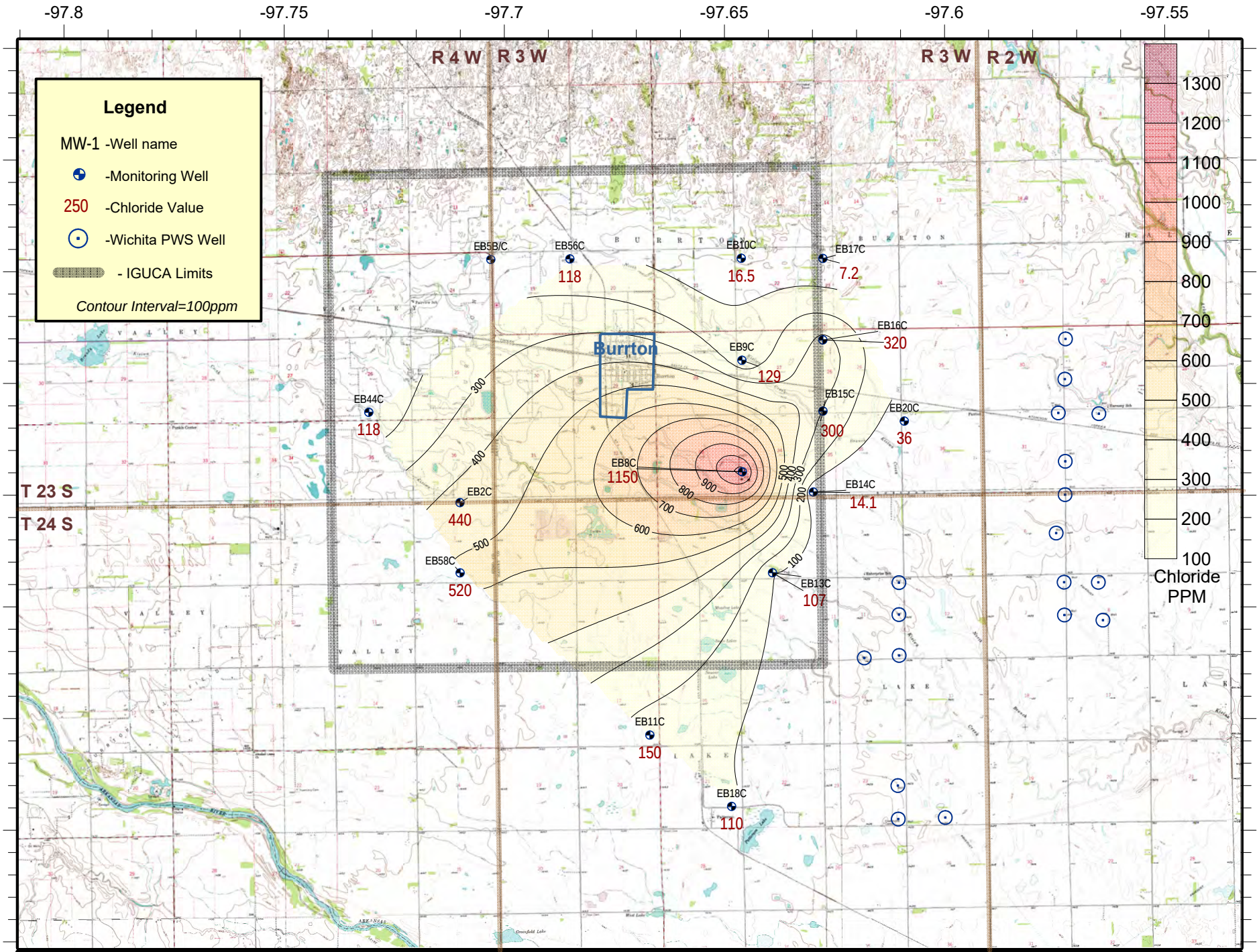
Burrton IGUCA Brine Contamination Field
C Zone Change in Chlorides Map 2017 to 2018
Reno and Harvey Counties, Kansas
KCC Project Code #970042-00 - KCC District #2 Field office - Map drawn on 10/15/2018 by D. Bollenback



Burrton IGUCA Brine Contamination Field

C Zone Chloride Map Showing GMD#2 Groundwater Well Data from 2018

Reno and Harvey Counties, Kansas

KCC Project Code #970042-00 - KCC District #2 Field office - Map drawn on 10/15/2018 by D. Bollenback

Project: ***Clawson Contamination Site***

Site Location: Legal location is East half of Section 33 and all of Section 34, Township 29 South, Range 34 West, Haskell County.

Impact/Immediacy: Irrigation well is contaminated and a pollution threat to other irrigation wells if contaminate is not contained to site. Site immediacy is rated at moderate to high and is under long term monitoring at the present time by the responsible party.

Site Description: The site consists of a plume of brine-contaminated groundwater moving in an easterly direction. Area is blanketed by 500 feet of Ogallala sand and gravel. Bedrock underlying the Ogallala is the Dakota/Cheyenne formation. There is a total of 600 feet of freshwater bearing strata. Pollution occurs along a clay layer 360 feet below the surface (in the upper part of the freshwater aquifer). No domestic wells in the affected area. One irrigation well is currently polluted to the extent it cannot be used for irrigation purposes. Depth to groundwater is 300 feet. Depth to Cretaceous bedrock is 510 feet in the center of the SW/4 of Section 34. The Red Beds underlie the three aquifers at a depth of 635 feet.

Unusual Problems: High yield rates of the Ogallala formation and ongoing severe drought.

Status of Project: On October 2, 2018 DBS&A sampled seven monitoring wells on the Clawson site. Samples ranged from 769mg/L chloride in well 05-03 to 3310mg/L chloride in well 05-02. Overall the historic chloride levels have have dropped throughout this site, but this year has shown an upward trend in concentrations.

Level of Remediation Sought:

Ideal: 250 ppm Chloride
Target: 500 ppm Chloride

Recommendations for Future Work: There have been ongoing discussions of groundwater modeling to see how starting up the irrigation well for agriculture use would affect the plume. It was discussed on site of a spring sampling event for next year as well as running a chloride-bromide ratio. The 7 wells continue to be monitored until target concentrations are met. All of these expenses will be covered by the PRP and will only happen with the consent of the KCC.

Estimated Total Costs: KCC - $450 a year. PRP – in excess of $2 million.

Control No.	**Staff Hours/Expenditures**	**Fund Expenditures FY 2018/19**
970005-00	**12 Hrs. / $346.84**	

Current Contaminate Level: 769 ppm Cl- to 3,310 ppm Cl-

Status:

☐ **1. Site Assessment**	☐ **2. Short Term Monitoring**	☐ **3. Investigation**
☒ **4. Long Term Monitoring**	☐ **5. Remediation Plan**	☐ **6. Installation**
☐ **7. Remediation**	☐ **8. Post Rem. Monitoring**	☐ **9. Resolved**

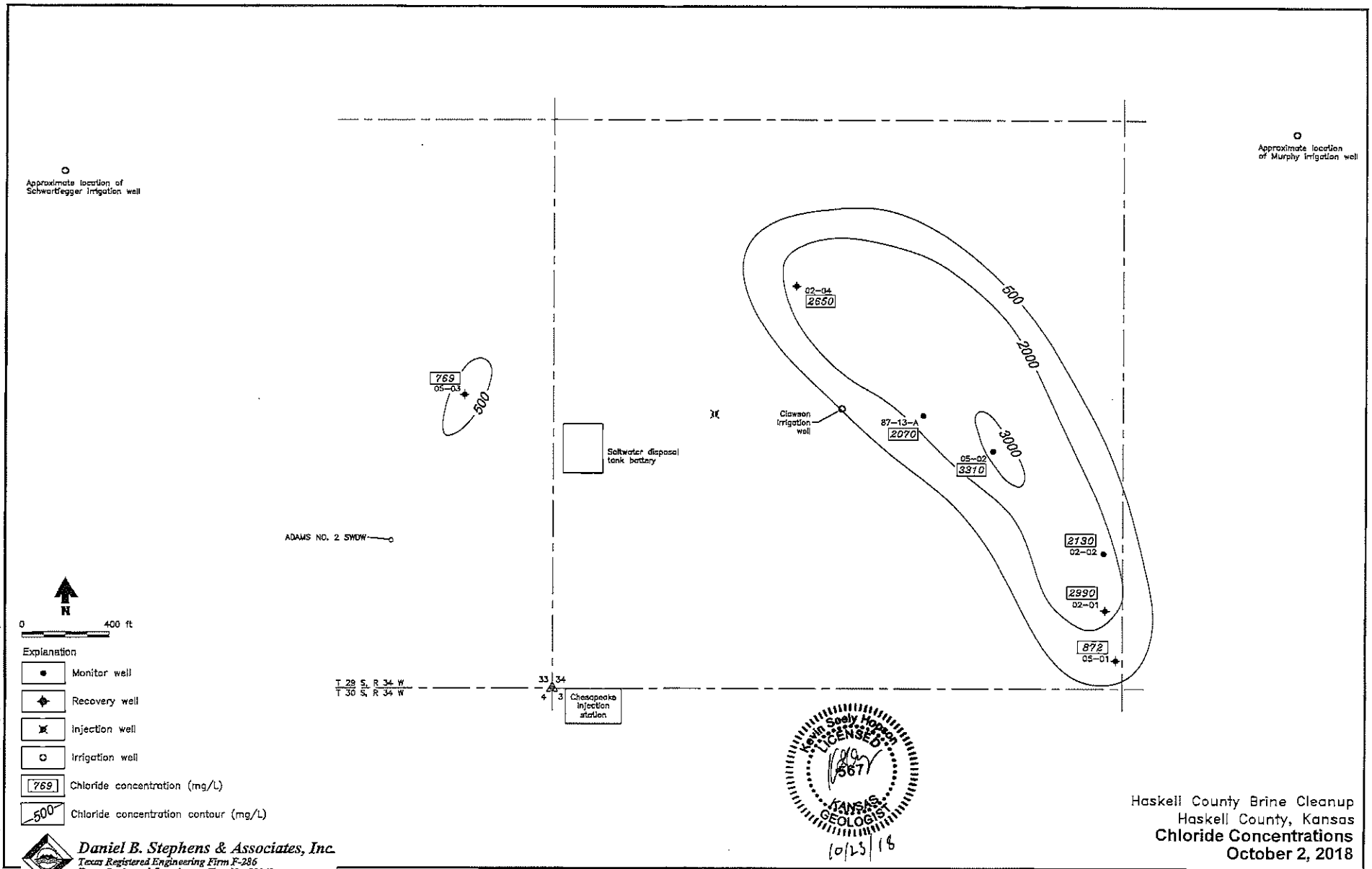


Figure 3

Project: ***Curtis Contamination Site***

Site Location: The legal location is Sections 23, 24, 25 & 26 of Township 24 South, Range 14 West, Stafford County.

Impact/Immediacy: The impact is to groundwater resources that have been contaminated by the flow of salt water from an old core drill hole. The core hole thought to be the source of contamination was plugged in 1988. This site has a low to moderate immediacy rating.

Site Description: This site was investigated after the Curtis irrigation well was reported salty. The aquifer in this area consists of unconsolidated material consisting mostly of sand and gravel, and is in general ninety feet thick. Several thin aquitards were encountered in the unconsolidated material. Bedrock consists of clay shale of various colors and was encountered at approximately 90 to 100 feet. The Curtis irrigation well tested salty upon completion and it was reportedly never used. It was also reported that no preliminary test boreholes were made before drilling the irrigation well. The irrigation well was probably drilled into the top of the bedrock and may have pumped chloride contaminated water from this zone.

Unusual Problems: The old core hole may have allowed cross flow of brine into the groundwater aquifer of the Rattlesnake Creek for more than forty years. The plume from this massive intrusion of brine extends to the northeast approximately two miles from the original source area.

Status of Project: Samples were collected from four monitoring wells in 2018. The chlorides have remained steady in the area. The plume remains confined around MW-1. Only two of the wells remain above the ideal level of 250ppm chloride.

Level of Remediation Sought:
Ideal: 250 ppm
Target: 500-1000 ppm

Recommendation for Future Work: MW-11 will need to be cleaned out in order to get a sample. Mapping of the coffining layer below the aquifer might reveal if there is a channel the brine is following, or electromagnetic induction profiling (EM) could be run to determine where the chlorides are, and pinpoint the highest impacted areas. This would give a better representation of the chlorides than the thin network of monitoring wells, and would help to pinpoint where future work would need to be focused. An EM survey would also help to identify if there is a current source of chloride intrusion.

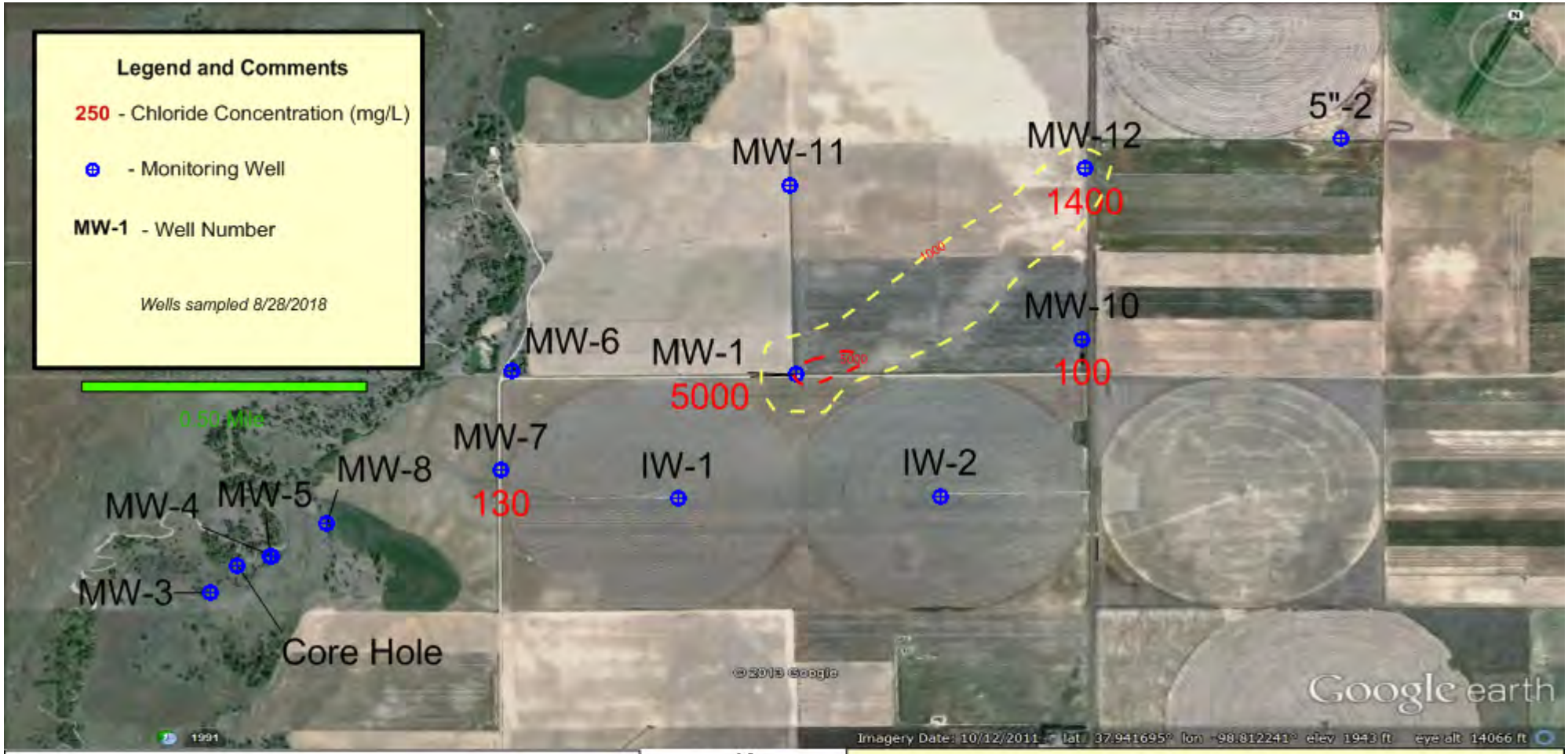
Estimated Total Costs: $27,000

Control No.	**Staff Hours/Expenditures**	**Fund Expenditures**	
		FY 2018/19	**Total**
970034-00	**10.5 Hrs. / $288.93**		**$4,199.17**

Current Contaminate Level: 100 ppm Cl- to 5000 ppm Cl-

Status:

☐ **1. Site Assessment**	☐ **2. Short Term Monitoring**	☒ **3. Investigation**
☒ **4. Long Term Monitoring**	☐ **5. Remediation Plan**	☐ **6. Installation**
☐ **7. Remediation**	☐ **8. Post Rem. Monitoring**	☐ **9. Resolved**



Kansas Corporation Commission

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Curtis Site

Sections 19/23/24/25/26-T24S-R14W
Stafford County, Kansas

2018 Area Map with Chlorides

KCC Control # 970034-00 District 1
K. Sullivan 9/24/2018

Project: ***Dinkel Contamination Site***

Site Location: SE/4 of Section 32, Township 13 South, Range 17 West, Ellis County.

Impact/Immediacy: Brine from oil field operations has impacted a shallow aquifer within the Big Creek drainage. The affected water was originally the sole source of domestic water for the farmstead, which is now on rural water. The immediacy level for this site is rated as low.

Site Description: This site is bounded on the north by I-70, positioned within the Younger oil field, and has active oil wells, enhanced recovery wells, and disposal wells in the vicinity. Possible contaminant sources include an evaporation pit (permit revoked July 1, 1958), a shallow injection well (injection authorization revoked September 3, 1969), or drilling pits associated with a nearby well.

Unusual Problems: None.

Status of Project: A total of 16 holes were drilled on the site in August and September of 2000, and three were completed as monitor wells. The household is on rural water, and the well water is now utilized for cattle. Pumping to waste may be utilized to remove contaminated water; however, the aquifer may not have the capacity to allow for appreciable gains when compared to the amount of water pumped. Because the house has a source of drinking water, and the chloride concentrations in the aquifer are not unsuitable for beef cattle, remediation is not warranted at this time.

Well ID	2014 Chlorides	2015 Chlorides	2016 Chlorides	2017 Chlorides	2018 Chlorides
5	1,300 ppm	1,400 ppm	1,400 ppm	900 ppm	1,250 ppm
7	900 ppm	900 ppm	750 ppm	875 ppm	1,000 ppm
9	1,200 ppm	1,100 ppm	1,050 ppm	800 ppm	800 ppm

Level of Remediation Sought:
Ideal: 100 ppm Chloride
Target: 500 ppm Chloride

Recommendations for Future Work: Annual sampling will continue at this site.

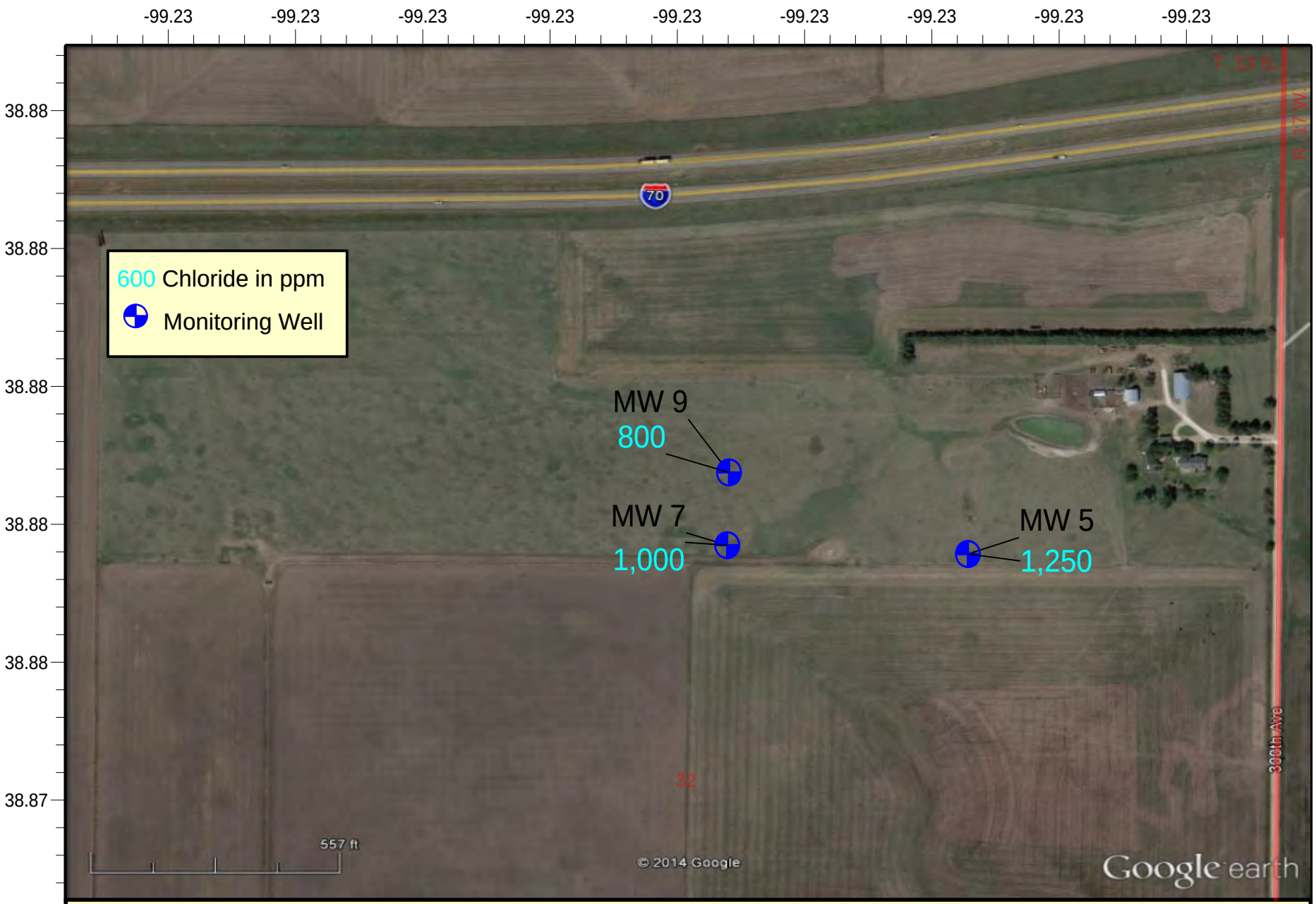
Estimated Total Costs: $28,000 to $30,000

Control No.	**Staff Hours/Expenditures**	**Fund Expenditures** FY 2018/19	Total
970035-00	**4 Hrs. / $128.52**		

Current Contaminate Level: 800 ppm to 1,250 ppm Cl^-

Status:

☐ **1. Site Assessment**	☐ **2. Short Term Monitoring**	☐ **3. Investigation**
☒ **4. Long Term Monitoring**	☐ **5. Remediation Plan**	☐ **6. Installation**
☐ **7. Remediation**	☐ **8. Post Rem. Monitoring**	☐ **9. Resolved**



Dinkel Groundwater Monitoring Site

Section 32 of Township 13 South, Range 17 West, Ellis County, Kansas
2018 Groundwater Chloride Levels
District #4 - Sampled 6/29/2018 - Map Drawn on 8/9/2018 by C. Neeley

Kansas Corporation Commission

Project: ***Burrton Crude Oil EB-3C***

Site Location: The EB-3C contamination site is located at a crossroads located at the convergence of Sections 25 and 36, Township 23 South, Range 4 West and Sections 30 and 31 of Township 23 South and Range 3 West, Harvey and Reno County. The site is one mile west and one mile south of Burrton, Kansas.

Impact/Immediacy: Low immediacy level. The spill affects a shallow groundwater aquifer with no residences within a half mile. The area extent of contamination is believed to be less than one acre. No domestic water wells or irrigation wells are immediately down gradient of the site.

Site Description: The site is located in rural Harvey and Reno County. The land use is agricultural. The depth to groundwater is less than ten feet. The affected groundwater is the Equus Beds. The A layer of the Equus Beds is very permeable, is very productive and contains good water quality but is severely brine impacted locally.

Unusual Problems: This site is a hydrocarbon impacted site with problems different than brine impaction. The clay above the Equus Sands deepens down gradient and is acting as a trap for the crude oil. Historical static water levels have intersected this clay layer to the south and east. KCC is not confident that this crude oil is from oil and gas production, historical research has indicated a now closed crude oil pumping station just west of the site. KCC feels there is a possibility that this historical crude oil contamination could be a result from a past pipeline spill in associated with this facility.

Status of Project: KCC has evaluated multiple remedial techniques from natural attenuation, new well installation and hydro-carbon absorbing aqua-socks, and oxygenating chemical injection into the aquifer. KCC District #2 feels that injection of an oxygenating chemical would help speed-up natural break-down of the hydrocarbons by increasing micro-bioremediation. Due to low priority the chemical injection was not done during the 2017 and 2018 year. KCC will be prepared to perform this remedial technique during the 2018-2019 term if funds become available.

Level of Remediation Sought:

Ideal: Non –detect of TPH (Aqueous-Phase)
Target: No Free Liquid-Phase Hydrocarbon

Recommendations for Future Work: KCC has put together a scope of work to inject oxygenating compounds throughout the known plume. This will accelerate bio-remediation of the small amount of crude oil that has persisted over the years. Once this is done, KCC recommends closure of this site.

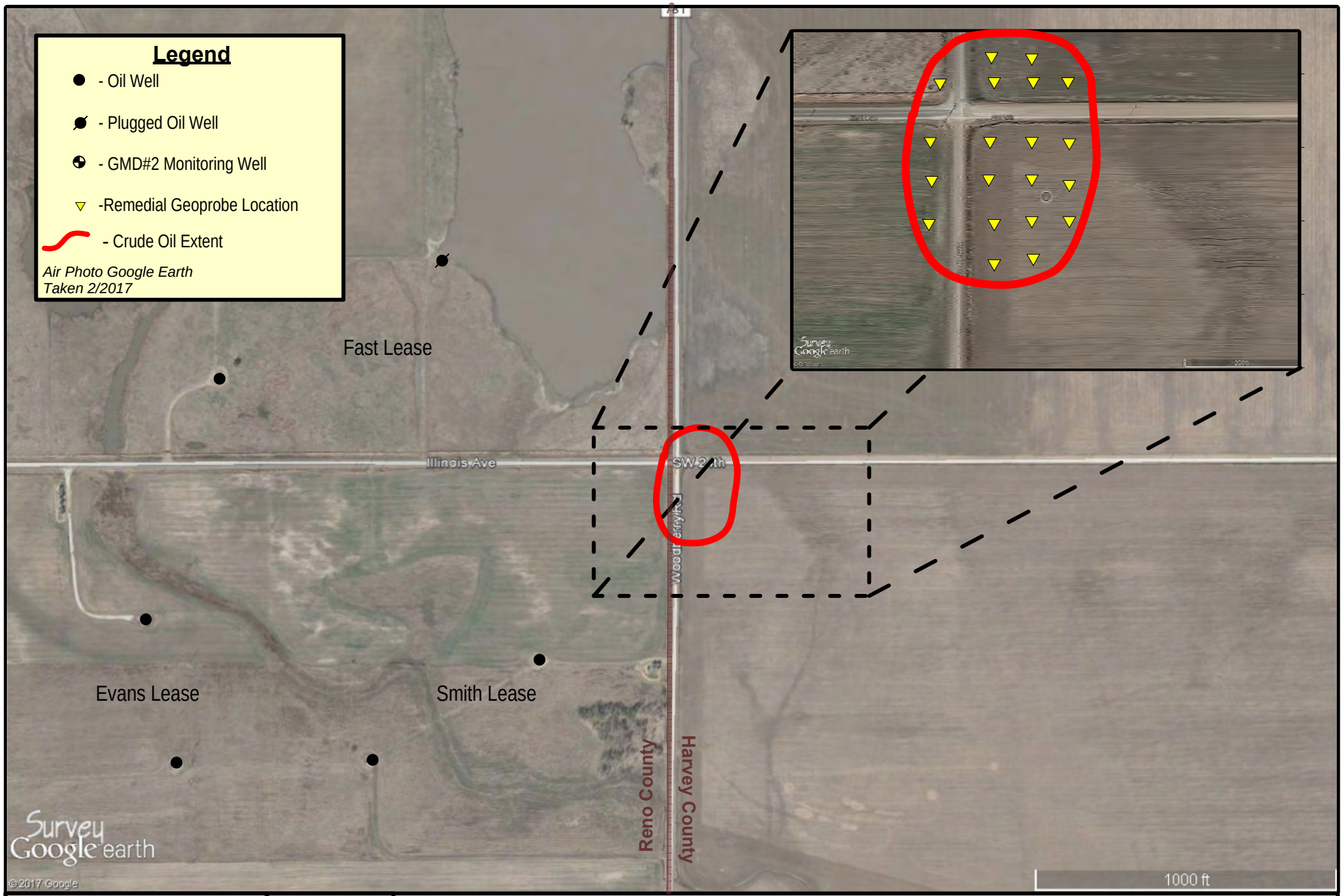
Estimated Total Costs: Approximately $2,500-$4,000 to inject the remedial compounds.

Control No.	**Staff Hours/Expenditures**	**Fund Expenditures**	
		FY 2018/19	**Total**
970042-00	**25 Hrs. / $701.61**		**$2,350**

Current Contaminate Level: NDA

Status:

☐ **1. Site Assessment**	☒ **2. Short Term Monitoring**	☐ **3. Investigation**
☐ **4. Long Term Monitoring**	☒ **5. Remediation Plan**	☐ **6. Installation**
☐ **7. Remediation**	☐ **8. Post Rem. Monitoring**	☐ **9. Resolved**



Kansas Corporation Commission

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Burrton EB-3C - Crude Oil Spill

Sections 30 and 31of Township 23 South and Range 3 West, Reno County, Kansas

Annual Site Map 2018 - CoolOx© Injection Locations

KCC District #2 Field Office - Map Drawn by D. Bollenback on 10/22/2018

Project: ***Elm Creek Contamination Site***

Site Location: Sections 19, 20, 29, 30, 31, and 32 of Township 7 South, Range 17 West.
Sections 5, 6, 7, 8, 17, 18, 19, 20, 29, 30, 31, and 32 of Township 8 South, Range 17 West.
Sections 5 and 6 of Township 9 South, Range 17 West, Rooks County.

Impact/Immediacy: The Elm Creek alluvial aquifer has been contaminated by past oil field activity. Both domestic and stock wells are affected. The area is serviced by Rooks County Rural Water District #3, and the immediacy level for this site should be rated as moderate to high.

Site Description: Elm Creek is a tributary to the South Fork Solomon River, which it enters just downstream of Stockton, Kansas. Numerous complaints beginning in the 1950's led to wide-spread sampling, and the designation of approximately 20 square miles as the site. A series of monitoring wells were completed in the alluvial deposits of the drainage near the confluences of other streams with Elm Creek in an attempt to constrict the size of the contamination site by identifying the direction from which pollution originated. The installation of the monitor well net was completed in May of 1998, and sampled for 5 years by a third party. Following the sunset of the sampling contract, the well net was sampled quarterly for three years, and biannually for two years. Sampling is now performed annually by KCC staff.

Unusual Problems: The history of contamination in the Elm Creek area is extensive, and many of the possible sources of pollution were insufficiently documented. Additionally, the large areal extent of the site poses challenges for investigation and remediation.

Status of Project: Long-term monitoring has revealed that the chloride concentrations in the monitoring wells have remained the highest near the south end of the site. Presently, the chloride level in even the most severely impacted areas of the site do not preclude use of the water for stock use, irrigation of certain plants, or general non-potable use. Four monitoring wells contain chloride ions in concentrations which are above what is considered to be fresh water (500 ppm), four wells are below the freshwater threshold, but above drinking water standards (250 ppm), and six wells are below the chloride concentration threshold for water suitable for human consumption.

Level of Remediation Sought:
Ideal: 250 ppm Chloride
Target: 500 ppm Chloride

Recommendations for Future Work: While the trend in contamination distribution has remained relatively stable, long-term monitoring should continue until the target level is reached, or the site parameters change in such a way as to warrant further investigation and remedial efforts.

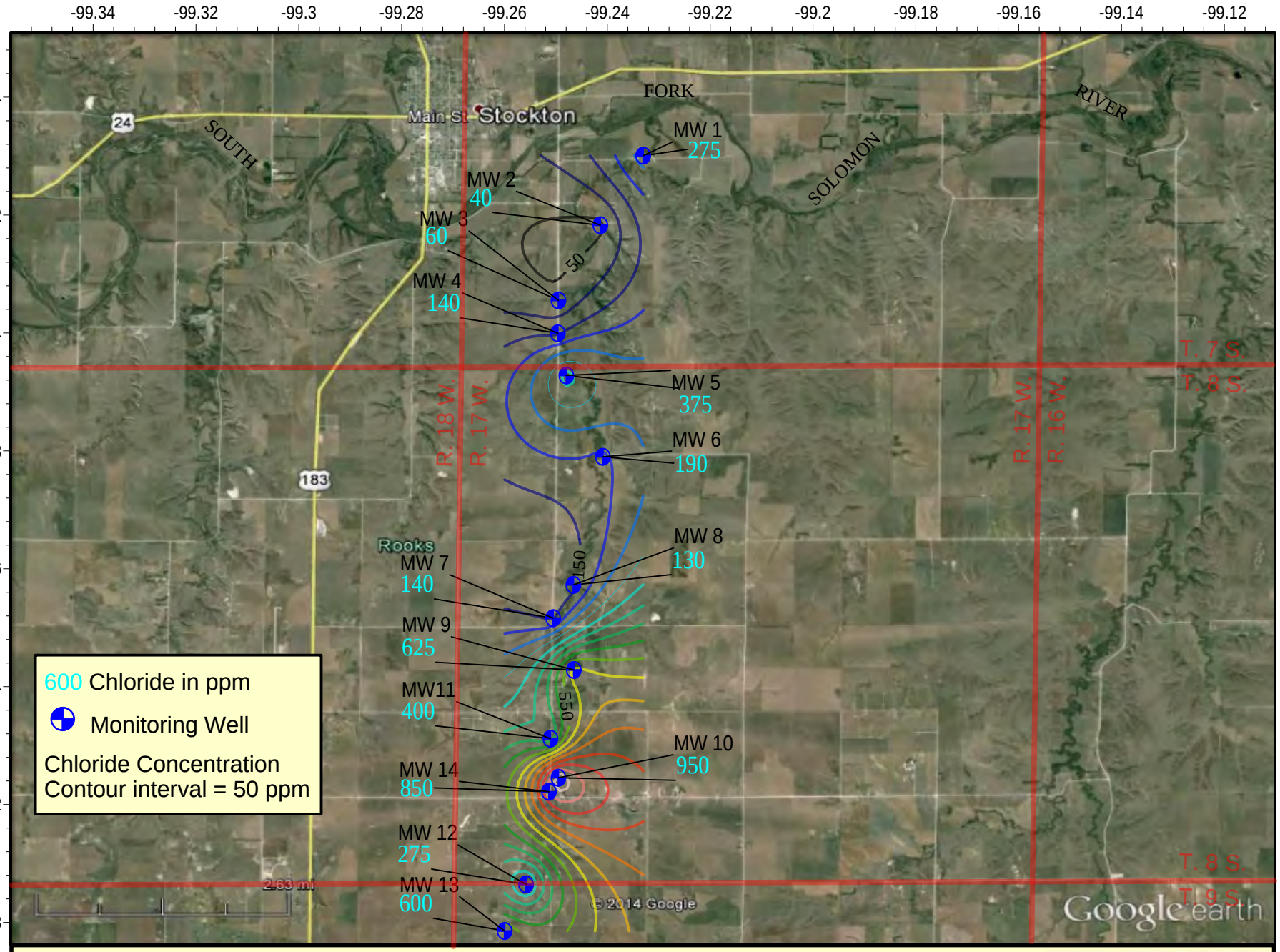
Estimated Total Cost: If warranted, remediation costs could reach a total of $250,000.

Control No.	**Staff Hours/Expenditures**	**Fund Expenditures**	
		FY 2018/19	**Total**
970043-00	**17 Hrs. / $495.26**		**$29,212.25**

Current Contaminate Level: 40 ppm to 950 ppm Cl^-

Status:

☐ **1. Site Assessment**	☐ **2. Short Term Monitoring**	☐ **3. Investigation**
☒ **4. Long Term Monitoring**	☐ **5. Remediation Plan**	☐ **6. Installation**
☐ **7. Remediation**	☐ **8. Post Rem. Monitoring**	☐ **9. Resolved**



Elm Creek Groundwater Monitoring Site

Multiple Sections of Townships 7, 8, and 9 South, Range 17 West, Rooks County, Kansas
2018 Groundwater Chloride Levels
District #4 - Sampled 08/16/2018 and 08/17/2018 - Map Drawn on 09/28/2018 by C. Neeley

Kansas Corporation Commission

Project: ***Enoch Thompson Contamination Site***

Site Location: Legal location is NW/4 Section 17, Township 21 South, Range 20 West, Pawnee County**.**

Impact/Immediacy: Stock well was damaged by chlorides from a line leak found near the SWDW. An irrigation well is located to the southwest of the site in the direction of the plume flow. Potential responsible parties drilled one recovery well and a replacement stock well in October 1988, thereafter the chlorides dropped through the years. The site is rated moderate to low in immediacy.

Site Description: The contamination is confined to a narrow alluvial scour channel filled with sandy gravel and silty clay. The high concentrate of brine water moved from the source area in the north to the south and contaminated Mr. Thompson's stock well.

Unusual Problems: None.

Status of Project: Two groundwater samples were collected in 2018. Chloride levels across the board have seen a decrease. The recovery system has been down since 2003 following P&A of the disposal well due to wellbore problems. KDHE-1, which has historically been the highest in terms of chlorides, was destroyed December 2003. The chloride plume continues to be localized in a relatively small area of alluvial scour between the recovery well and the plugged disposal well. It is unlikely that without the recovery well operational, the site will see any significant change in chlorides.

Level of Remediation Sought:

Ideal: 250 ppm Chloride
Target: 1000 ppm Chloride

Recommendation for Future Work: Continue groundwater sampling on an annual basis to monitor movement of chloride plume through the area. Should a disposal well be drilled nearby, the feasibility of restarting the recovery well should be evaluated.

Estimated Total Cost: $500 for yearly sampling.

Control No.	**Staff Hours/Expenditures**	**Fund Expenditures FY 2018/19**	**Total**
970044-00	**11.5 Hrs. / $313.39**		

Current Contaminate Level: 1900 ppm Cl- to 2100 ppm Cl-

Status:

☐ **1. Site Assessment**	☐ **2. Short Term Monitoring**	☐ **3. Investigation**
☒ **4. Long Term Monitoring**	☐ **5. Remediation Plan**	☐ **6. Installation**
☐ **7. Remediation**	☐ **8. Post Rem. Monitoring**	☐ **9. Resolved**

Kansas Corporation Commission

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Enoch Thompson Site

Section 17-T21S-R20W
Pawnee County, Kansas

2018 Area Map with Chlorides

KCC Control # 970044-00 District 1
K. Sullivan 9/24/18

Project: ***Leon Fink Contamination Site***

Site Location: SE/4 of Section 22, and NE/4 of Section 27, Township 8 South, Range 22 West, Graham County.

Impact/Immediacy: Stock well in the Codell Formation testing high in chlorides. Immediacy level is rated as low.

Site Description: The site encompasses a stock well and a now abandoned domestic well. Both were drilled into the Codell sandstone, which is a marginal aquifer in Graham County. The chloride in the stock well was initially very low, but rose sharply during the 1970's. Surface sources were considered, but due to the nature of the bedrock and the depth to the Codell aquifer, it is more likely that the pollution originated from a source below ground. The Fink #2 saltwater disposal well (SWD) was originally completed as an oil well in 1954 and converted to an enhanced oil recovery well before ultimately being converted back to a SWD. This well was long the subject of interest, but before the implementation of the Federal Underground Injection Control, there was little statutory authority to rigorously check the integrity of the well bore. For this reason, it was never proved or disproved that the well was the source. The construction of this well is highly suspect, and may or may not continue to be a conduit for saline water from brackish zones to enter the Codell despite the fact that the well was plugged in 1984.

Unusual Problems: The depth to the contaminated zone is approximately 250 to 300 feet, making investigation and remediation difficult.

Status of Project: The domestic well has been abandoned due to a water level that is inadequate for use by the owner, and the house has been abandoned as well. The last sample taken from this source in 2004 contained a chloride concentration of 200 ppm. Samples from the stock well continue to be tested, and the well is presently being utilized for livestock which will contribute to a reduction in chloride concentrations if the source has been eliminated. An overall downward trend has been observed over the history of the site, and the current contamination concentration is at 800 ppm.

Level of Remediation Sought:
Ideal: 250 ppm Chloride
Target: 500 ppm Chloride

Recommendations for Future Work: This site should be monitored long-term to ascertain if the source of chloride ions has been isolated from the useable water in the Codell Sandstone aquifer. An investigation of the Fink #2 and the water well should also be conducted.

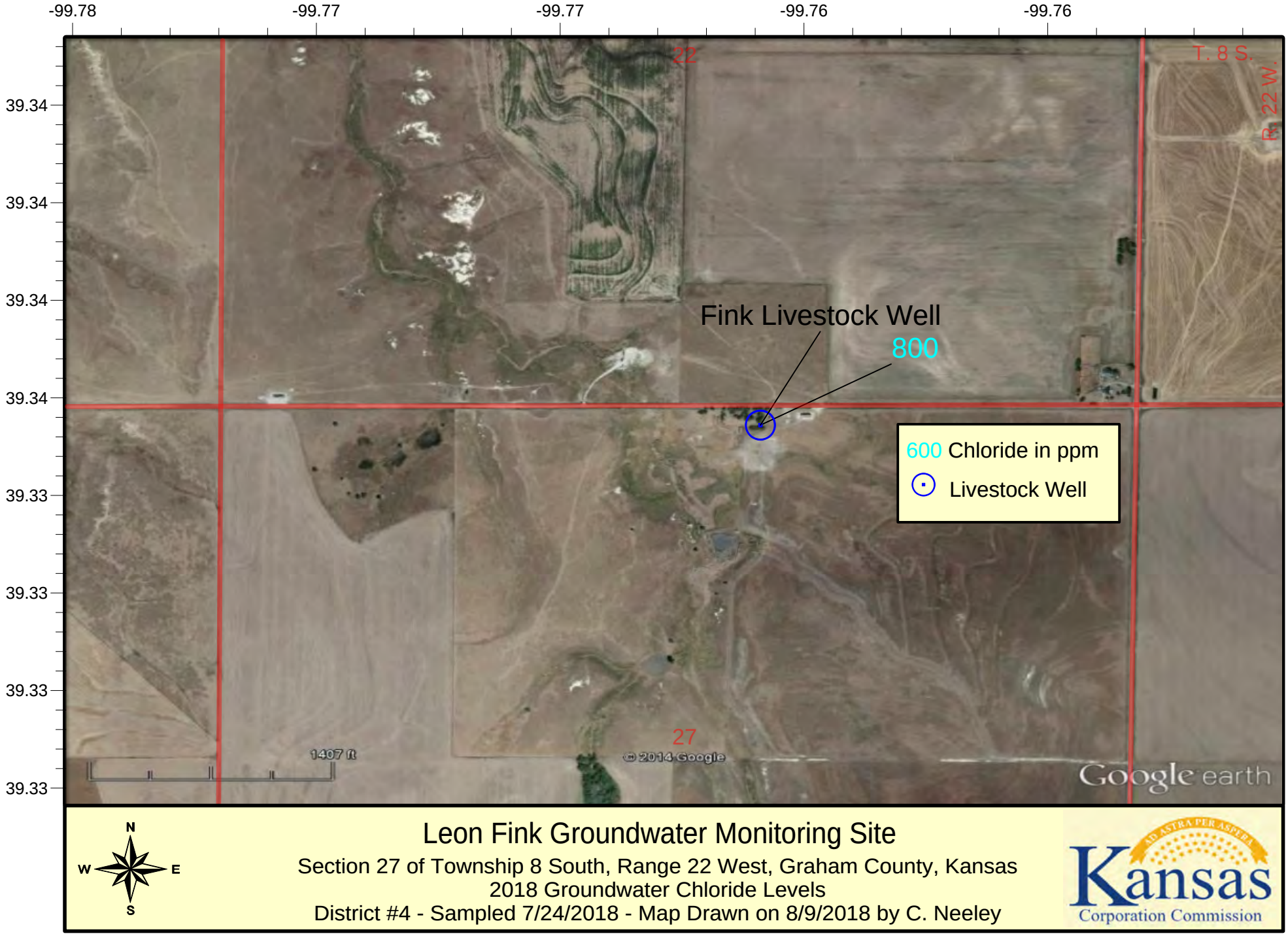
Estimated Total Costs: $2,000

Control No.	**Staff Hours/Expenditures**	**Fund Expenditures FY 2018/19**	**Total**
970007-00	**3 Hrs. / $101.23**		

Current Contaminate Level: 800 ppm Cl^-

Status:

☐ **1. Site Assessment**	☐ **2. Short Term Monitoring**	☐ **3. Investigation**
☒ **4. Long Term Monitoring**	☐ **5. Remediation Plan**	☐ **6. Installation**
☐ **7. Remediation**	☐ **8. Post Rem. Monitoring**	☐ **9. Resolved**



Leon Fink Groundwater Monitoring Site

Section 27 of Township 8 South, Range 22 West, Graham County, Kansas
2018 Groundwater Chloride Levels
District #4 - Sampled 7/24/2018 - Map Drawn on 8/9/2018 by C. Neeley

Kansas Corporation Commission

Project: ***Fowler Contamination Site***

Site Location: NE/4 of Section 19, Township 32 South, Range 14 East, Montgomery County.

Impact/Immediacy: Impact is to the soil. The immediacy is rated as low.

Site Description: Site is located below an old three-cell storage/settling pond.

Unusual Problems: Access to dependable sample locations and lack of monitoring wells.

Status of Project: Monitoring of small creek running through project area. The Fowler lease was approved for a Fee Fund Project in the fall of 2000. Approximately 112 wells were plugged in 2001. No samples were collected in 2018. Brine impacted areas continue to show significant improvement of vegetative growth as shown on 2015 aerial imagery (most current available).

Level of Remediation Sought:

Ideal: 200 ppm Chloride
Target: 300 ppm Chloride

Recommendation for Future Work: Future work on this site will consist of post remediation monitoring. Brine impacted area below old 3 cell storage pit has successfully been remediated and landowner has filled the eastern third with construction debris consisting of soil, rock, and asphalt.

Estimated Total Costs: Monitoring cost approximately $1,500.00 per year.

Control No.	**Staff Hours/Expenditures**	**Fund Expenditures FY 2018/19 Total**
970046-00	**7 Hrs. / $244.79**	

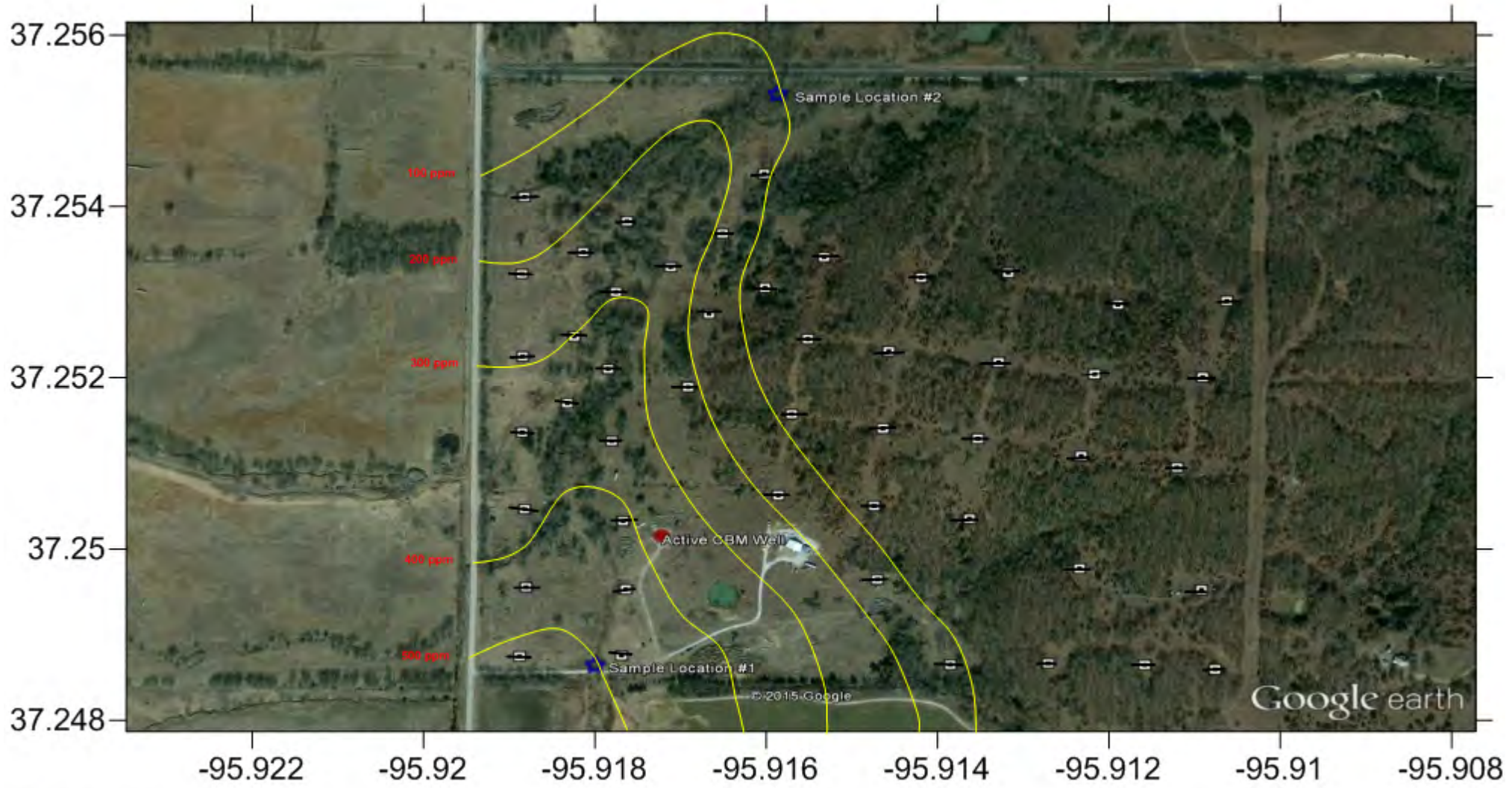
Current Contaminate Level: 100 ppm Cl- to 650 ppm Cl- (2016)

Status: Active

☐ **1. Site Assessment**	☐ **2. Short Term Monitoring**	☐ **3. Investigation**
☐ **4. Long Term Monitoring**	☐ **5. Remediation Plan**	☐ **6. Installation**
☐ **7. Remediation**	☒ **8. Post Rem. Monitoring**	☐ **9. Resolved**

KANSAS CORPORATION COMMISION
Fowler Remediation Site
NE19-T32S-R14E
Montgomery County, Kansas
Project 970046-00

10/26/2018 District 3



Contour Interval 100 ppm Cl-

Sample Locations

Fee Fund Plugged Well

Active CBM Well

Project: ***French Contamination Site***

Site Location: The site is located in Section 17, Township 23 South, Range 13 West, Stafford County.

Impact/Immediacy: Potential exists for impacts on stock and irrigation resources. Subsidence around the French "A" 1 has developed into a sinkhole. Worst-case scenario would be a catastrophic collapse taking part of an east-west county road and several acres of farm ground. Probable action is a gentle downward movement of the area until stable. The site has a moderate to high rating.

Site Description: The site consists of an unplugged saltwater disposal well whose operation led to the development of a solution cavity. The site is located in a rural setting 330' north of a county road. Land use is agricultural with oil activities in the area. The subsidence at the site now covers an area of approximately 600 x 1000' in size.

Unusual Problems: A solution cavity was determined to exist under the existing location by a seismic survey conducted by the KGS. The seismic survey indicates the cavity is approximately 60' thick.

Status of the Project: Elevations were shot on 10/26/2018. Abundant rainfall has occurred in 2018 in the area where the sinkhole is, therefore, most of it was underwater and some points couldn't be located. The majority of the drop is in the eastern part of the sinkhole, with the most dramatic drop to the northeast. The eastern part of the sinkhole is dropping quicker than in the recent past. The seismic that was shot over it would indicate that the sinkhole will continue to subside to the east. Survey point 'Old BM' was destroyed after a high line pole was replaced in late 2015 or early 2016.

Level of Remediation Sought:

Ideal: Stabilize cavity and plug well bore in accordance with KCC rules and regulations.

Target: Safely monitor site. Determine an acceptable plugging procedure, which will adequately address groundwater resources.

Recommendations for Future Work: Set a new bench mark located closer to the sinkhole for more accurate surveys. Look at adding a few more survey points. Monitor stock wells and irrigation wells to the southeast of the depression. Resume the annual survey of the site to establish a current rate of subsidence.

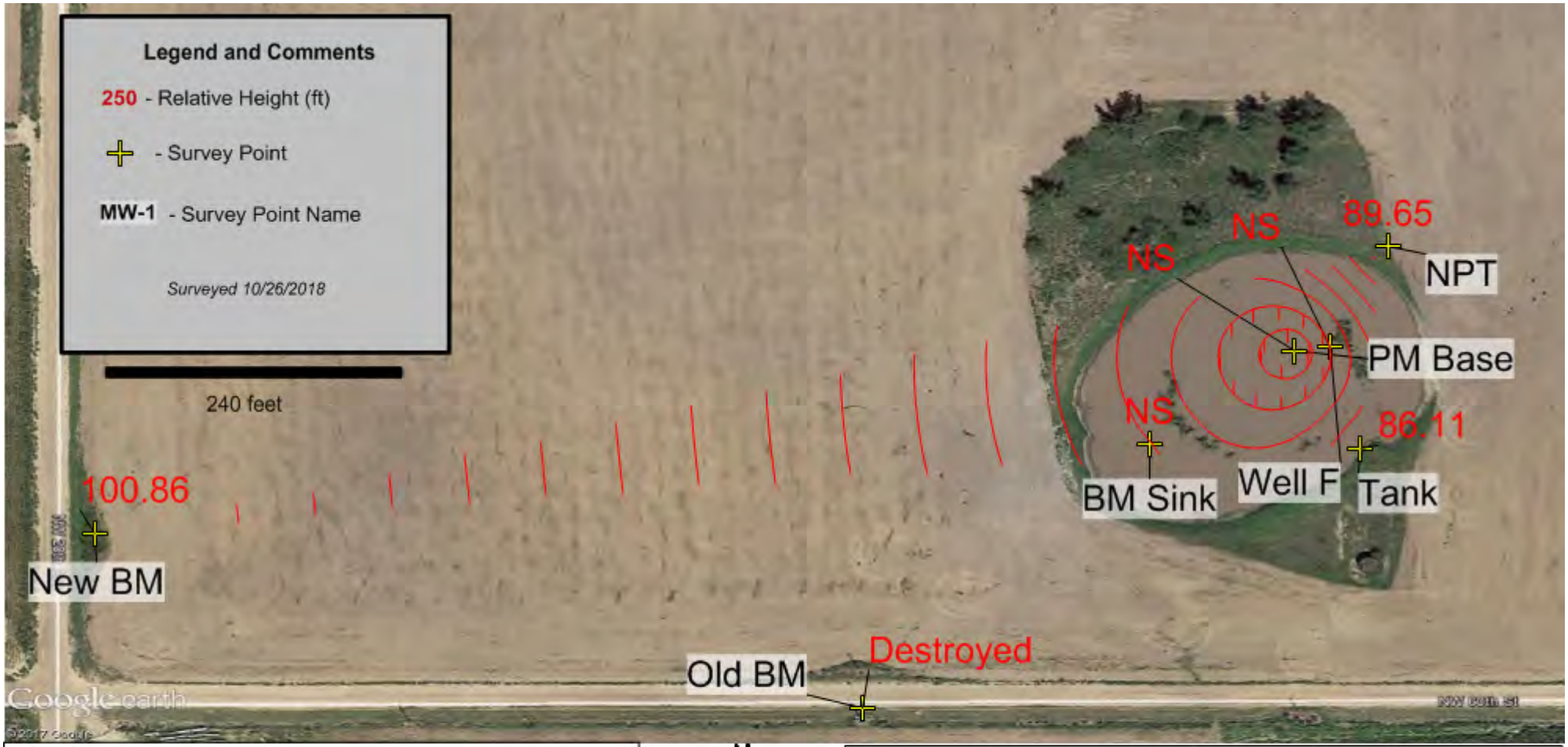
Estimated Total Costs: $3,000.00

Control No.	**Staff Hours/Expenditures**	**Fund Expenditures**	
		FY 2018/19	**Total**
990002-001	**16 Hrs. / $422.04**		**$346.50**

Current Contaminate Level: Unknown.

Status:

☐ **1. Site Assessment**	☐ **2. Short Term Monitoring**	☒ **3. Investigation**
☒ **4. Long Term Monitoring**	☐ **5. Remediation Plan**	☐ **6. Installation**
☐ **7. Remediation**	☐ **8. Post Rem. Monitoring**	☐ **9. Resolved**



Kansas
Corporation Commission

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French Sinkhole

SW 1/4 Section 17-T23S-R13W

Change in Elevation Map

KCC Control #970002-001 District #1

K. Sullivan 10/29/2018

Project: ***Galva City Area Contamination Site***

Site Location: This contamination site is located in Section 15 and 22 of Township 19 South, Range 2 West, which is half mile north and quarter mile east of Galva City in McPherson County.

Impact/Immediacy: This site has been up graded to a very high level of immediacy. Groundwater has been impacted and the potential for contamination to domestic and the **public water supply** at Galva City is very high. A water sample was taken from Galva City Well #3 in July 2006 and the chlorides tested 460 mg/l, 2007 tested 1170 mg/l and in July of 2008 tested 1200 mg/l. A Sample of the same public supply well was taken in 2011 and tested to be 670 mg/l.

Site Description: The site is located in a rural area with topography of gentle sloping fields with a small drainage stream located east and west of site with the flow from the north to the southwest. This site is in the Ritz-Canton oil field, which has a past history of utilizing brine pits for the disposal of brine from the wells. The depth to the ground water is 17 $^{+/-}$ feet. There are buried paleo-channels in the area where the bedrock is encountered at approximately 60-100 feet which usually hold the highest chloride levels close to the top of the Wellington Shale. KCC has operated a recovery system at this site since 2005. In August 2014 KCC completed Phase III with the installation of five monitoring wells and one recovery well. Data obtained from these additional wells shows a strong chloride source to the east/northeast of the remedial site in section 14. There are multiple suspected pits in that section, including the prior location of a distillation refinery and associated pits that were operational in the forties. It appears that chlorides are following along the paleo-valley slope (top of the Wellington Formation) that is located northeast of Galva and pooling. There is a paleo high directly below the City and its PWS wells. This is suggests to be the only reason that the public water supply is still viable, as brine water is settling in the lower zones of the aquifer.

Unusual Problems: The disposal well will not take the amount of fluid necessary run all four recovery wells at the same time. In order to run multiple wells at the same time the pumps would have to sample power so as to not overpower each other. High Chloride water deteriorates metal pumps, fittings, etc. Recovery pumps have short life spans and the local groundwater has high levels of iron which clog up lines and equipment. The age of the site requires constant vigilance into inspection as well proactive and reactive repairs/modifications in order to keep it online.

Status of Project: The hydraulic gradient between MW-214 and MW-401 was 0.001063917 ft/ft in 2018, and the average water level decrease was 0.75' from 2017. The extremely high chlorides across the site showed some substantial decrease during 2018 except for the monitoring wells along east to west line in the middle of the site. MW-114, MW-201, and MW-414 all went up during 2018. MW-601 also showed 500mg/L increase but it is relatively far from the remedial systems influence. The largest decreases were within the influence of the remedial system, especially near RW-2 which dropped by 14,000 mg/L. RW-2 was replaced and ran for a good part of 2018 before the sampling event. RW-3 was the main well run throughout 2018, as it is located within the site's highest chloride levels. RW-5 was flushed with acid and redeveloped by a hired KCC vendor, but due to the extreme iron bacteria build up, the pump and lines from the well were too plugged for use. KCC plans to install a new pump and water line in RW-5 during the winter of 2018-19. As of September 2018, RW-1 had chloride levels of 7,250 mg/L, RW-2 had 8,000 mg/L, and RW-3 had 16,500 mg/L. Meter readings show that at the beginning of October 2018 the Galva remedial system had recovered 22,412,100 gallons (533,621.4 bbls) of fluid for the year.

Level of Remediation Sought:

Ideal: 250 mg/l chlorides
Target 500 mg/l chlorides

Recommendations for Future Work: KCC plans to create a follow up scope of work to continue with the work started in 2014. The main focus of future work will be in the direction of the old refinery site, and to the east of the remedial system. Evidence has shown a strong possibility that the refinery and its associated pits are large sources of the brine contamination that is encroaching on the City of Galva. Bedrock orientation as well as chloride levels in MW-114 support this idea. KCC will be looking into the possibility of multiple monitoring and possible recovery well installations during the next phase. Immediate work that needs to be done at the Galva remedial site includes the installation of a new pump and line at RW-5. The site would benefit from its own disposal well but that is extremely cost prohibitive.

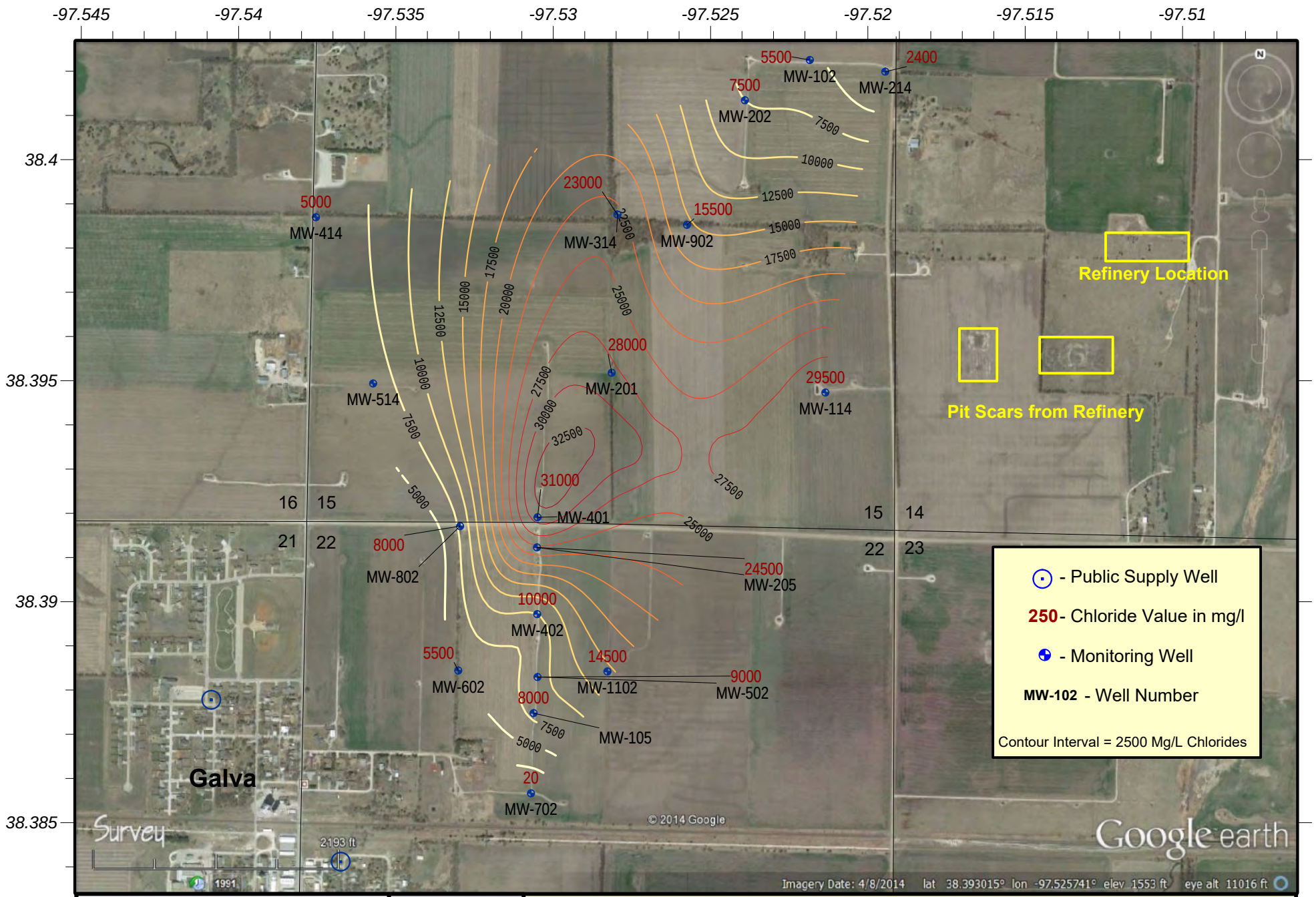
Estimated Total Costs: Regular annual costs are approximately $4,000-$6,000. This includes field work addressing, modifying, or repairing the remediation system, system inspection, groundwater sampling, research, and report writing. The continued Phase III work would cost in the $20,000-$30,000 range. The immediate work on RW-5, and the saltwater line would be in the $2,000-$3,000 range.

Control No.	Staff Hours/Expenditures	Fund Expenditures FY 2018/19	Total
980033-001	206 Hrs. / $5,731.40	$12,693.75	$296,190.12

Current Contaminate Level: 31,000 mg/L (MW 401) to 2,400 mg/L (MW 214) Cl- for 2018

Status:

☐ 1. Site Assessment	☐ 2. Short Term Monitoring	☒ 3. Investigation
☒ 4. Long Term Monitoring	☐ 5. Remediation Plan	☐ 6. Installation
☒ 7. Remediation	☐ 8. Post Rem. Monitoring	☐ 9. Resolved



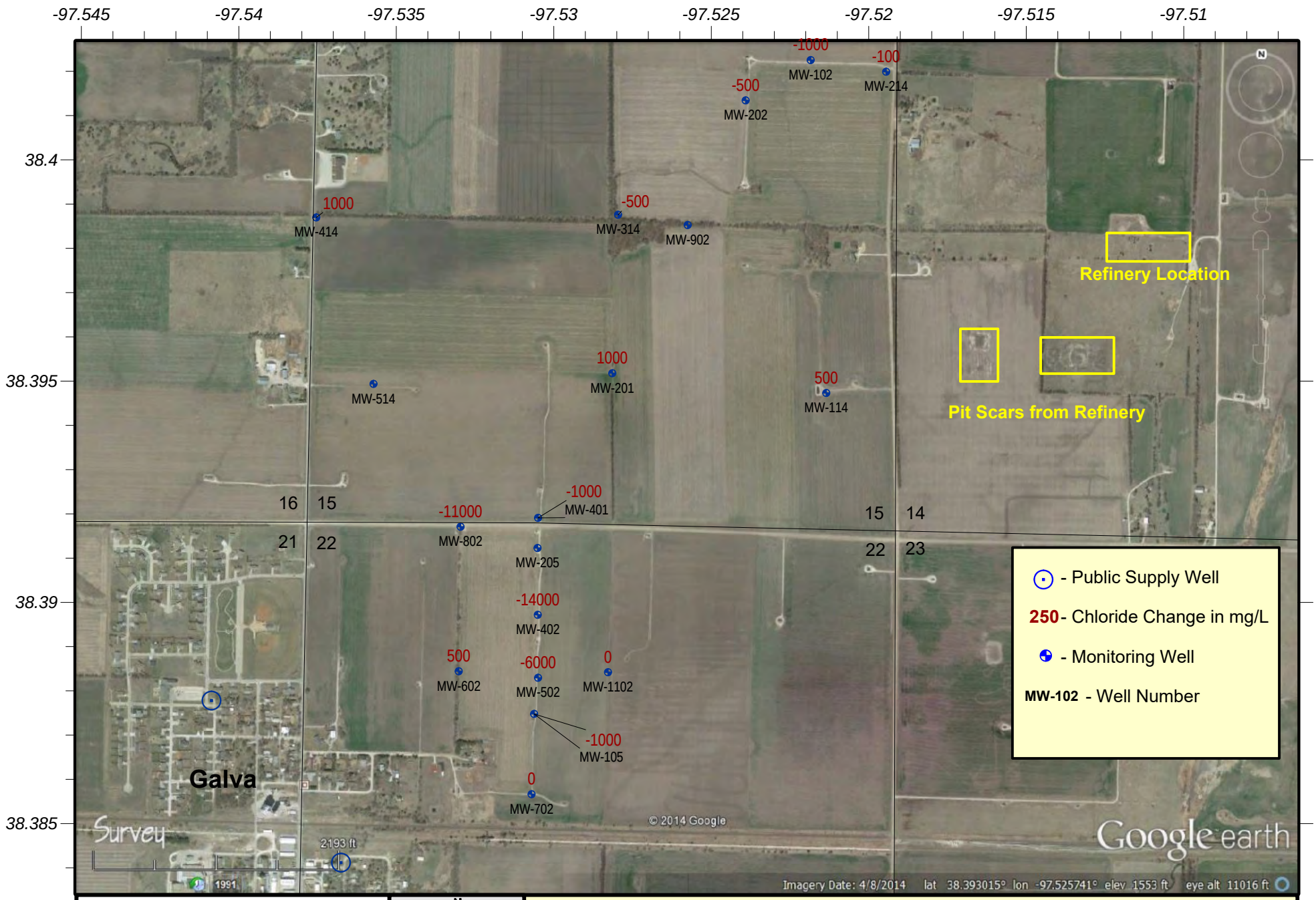
Kansas Corporation Commission

Galva City Brine Remediation Site

Sections 15, 16, 21,and 22 of Township 19 South and Range 2 West, McPherson County, Kansas

2018 Chloride Levels

KCC Control #980033-01 - KCC District #2 Field Office -Wells sampled July 2018 - Map Drawn on 10/5/2018 by D.Bollenback



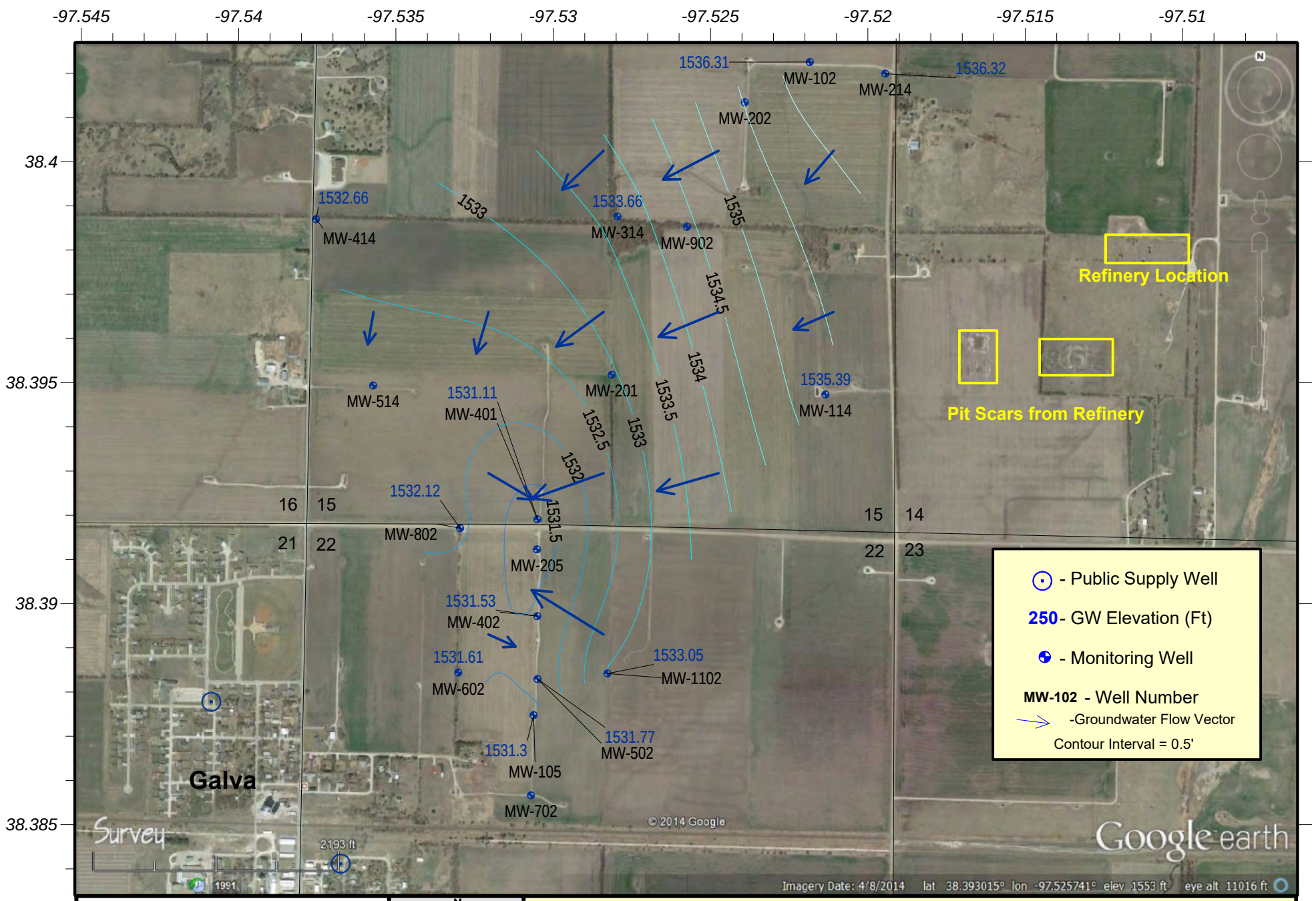
Kansas Corporation Commission

Galva City Brine Remediation Site

Sections 15, 16, 21,and 22 of Township 19 South and Range 2 West, McPherson County, Kansas

2018 Chloride Change in mg/L

KCC Control #980033-01 - KCC District #2 Field Office -Wells sampled July 2018 - Map Drawn on 10/30/2018 by D.Bollenback



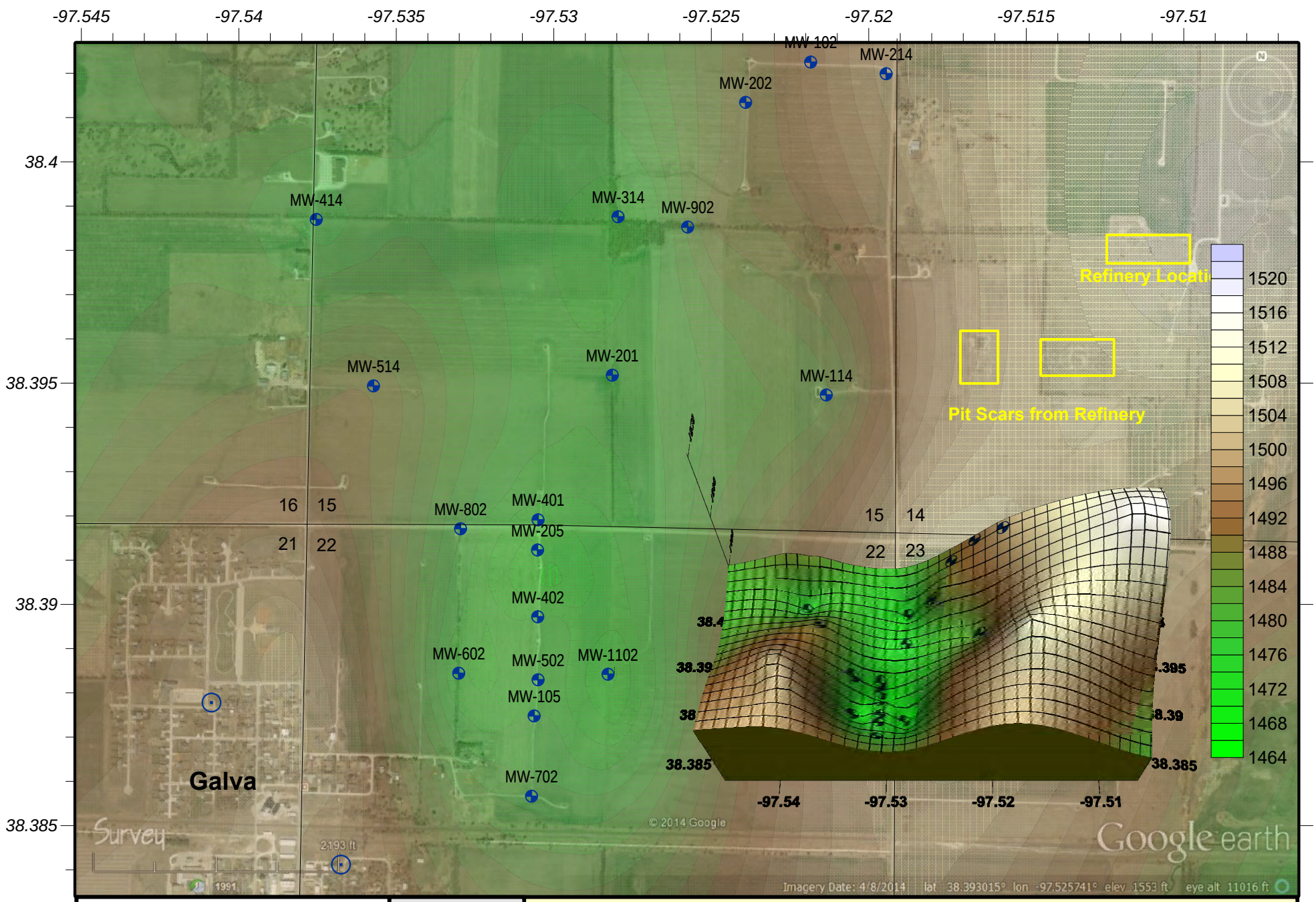
Kansas Corporation Commission

Galva City Brine Remediation Site

Sections 15, 16, 21,and 22 of Township 19 South and Range 2 West, McPherson County, Kansas

2018 Groundwater Elevations

KCC Control #980033-01 - KCC District #2 Field Office - Map Drawn on 10/8/2018 by D.Bollenback



Kansas Corporation Commission

Galva City Contamination Site

Sec. 15, 16, 21, &22 - T19S - R2W, McPherson County

Top of Wellington Formation

KCC Control #980033-01 - District #2 - D.Bollenback - 11/18/2015

Project: ***Albert Harbaugh Contamination Site***

Site Location: Legal location is the SE/4 Section 20 & NE/4 Section 29, Township 33 South, Range 11West, Barber County.

Impact/Immediacy: The groundwater for domestic and stock wells has been contaminated from several sources on this project. This site is rated as high immediacy and remediation of the groundwater began on November 1, 1999.

Site Description: The site is located in the alluvial valley on the flood plain of the Medicine River, in the Rhodes Pool, approximately nine miles south of Medicine Lodge. This site covers an area of approximately 1000 feet wide and 3500 feet long. This location and others sites in the area are continually increasing the chlorides in the groundwater aquifer of the Medicine River valley.

Unusual Problems: It is probable that all source areas of natural halite pollution into the aquifer have not been identified. Areas of suspected sources have not continued to contribute to the contamination since the remediation of the ground water has been implemented. These areas are suspected to have achieved a natural closure at this time. Unless all the source areas are located and plugged, the contamination will continue until there is natural closure.

Status of Project: On May 3rd, 2018 the recovery system was turned on. Only one monitoring well can be operational at a time as that is all the disposal well will tolerate. We have focused on the high chloride area in the northwest part of the plume and alternated RWs 1, 3, & 5. There were four monitoring wells plugged on the site in January. The site was mostly underwater due to flooding at the time of sampling, and the wells we could access were by foot only. There were some dramatic declines in the chloride concentration on the site this year, which is a result of the recovery system being operational as well as mixing of significant fresh rainwater. An unidentified flowing core hole near these wells is the probable source of these chlorides with other sources contributing additional contamination across the rest of the remediation site. Differences in chloride values of wells in close proximity to each other are attributed to different screening depths.

Level of Remediation Sought:

Ideal: 250 ppm Chloride
Target: 1000 ppm Chloride

Recommendation for Future Work: Monitor the recovery well system for effectiveness of chloride plume containment. Continue annual sampling of monitor wells and bimonthly sampling of the recovery wells when they are in use.

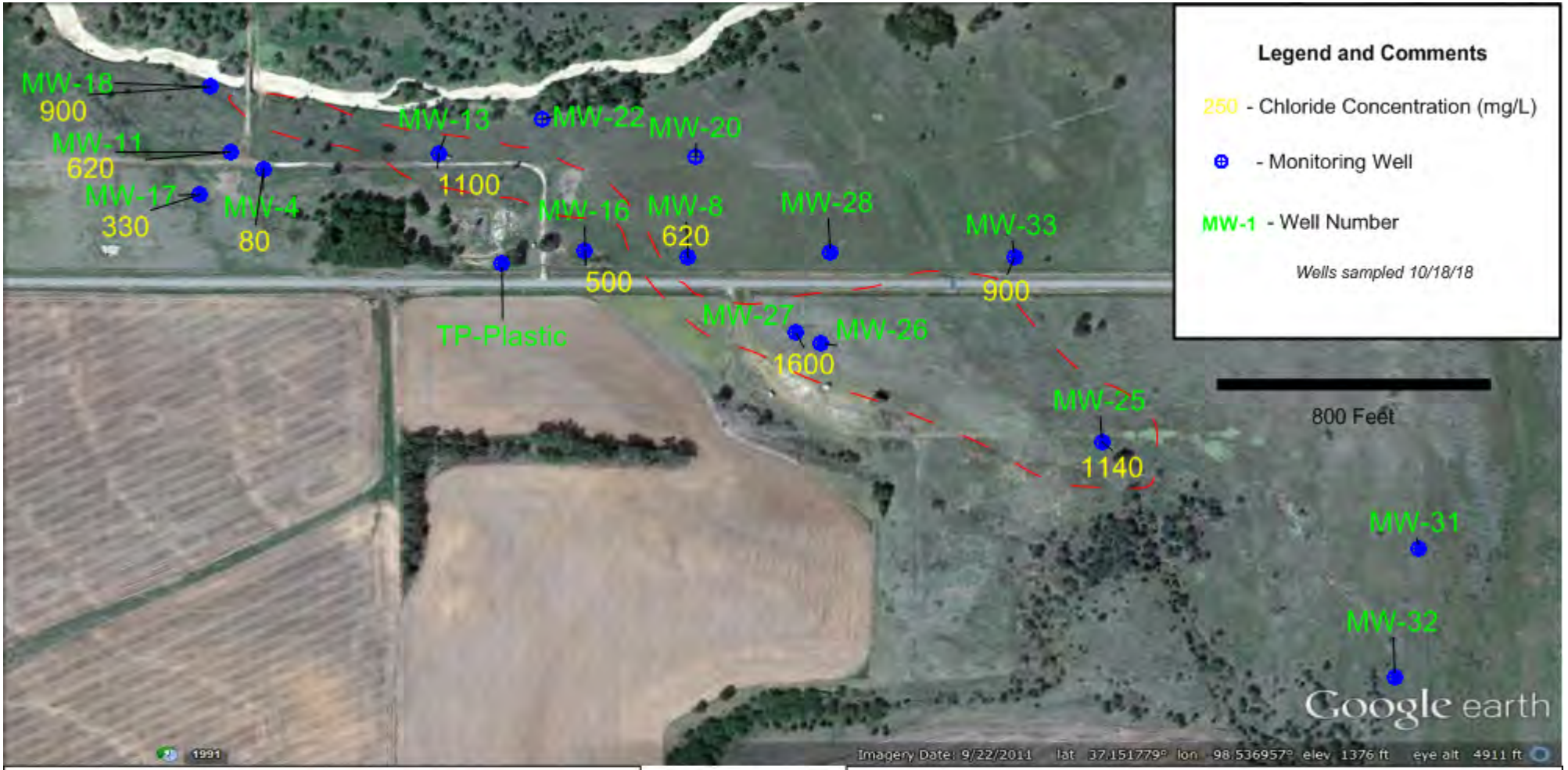
Estimated Total Cost: Total costs have exceeded the original estimate of $450,000. There will be additional costs for a pumper and maintenance.

Control No.	**Staff Hours/Expenditures**	**Fund Expenditures**	
		FY 2018/19	**Total**
970049-00	**60 Hrs. / $1,818.46**	**$126,299.96**	**$688,743.03**

Current Contaminate Level: 80 ppm Cl- to 2,200 ppm Cl-

Status:

☐ **1. Site Assessment**	☐ **2. Short Term Monitoring**	☒ **3. Investigation**
☒ **4. Long Term Monitoring**	☐ **5. Remediation Plan**	☐ **6. Installation**
☒ **7. Remediation**	☐ **8. Post Rem. Monitoring**	☐ **9. Resolved**



Kansas Corporation Commission

N
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Harbaugh Site

Sections 20/29-T-33S-R11W
Barber County, Kansas

2018 Area Map with Monitoring Well Chlorides

KCC Control # 970049-00 District 1
K. Sullivan 10/29/18

Kansas Corporation Commission

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Harbaugh Site

Sections 20/29-T-33S-R11W
Barber County, Kansas

2017 Area Recovery Well Map with Chlorides

KCC Control # 970049-00 District #1
K. Sullivan 10/29/18

Project: ***Hollow-Nikkel Contamination Site***

Site Location: The site is located in northwestern Harvey County approximately eighteen miles northwest of the city of Newton. The site includes parts of Sections 7, 8, 17, 18, 19, 20, 29, and 30 in Township 22 South, Range 3 West. This site is located within the Equus Beds Aquifer boundaries.

Impact: Potential impact is to irrigation and rural residential wells. Directly down gradient of the site there are nine domestic wells and irrigation well. This site should be rated at a moderate immediacy level. In the past two years the city of McPherson has investigated the possibility of the area as a public water supply.

Site Description: The project area covers approximately 700 acres. The contaminate plume is aligned in a north to south configuration and is approximately 0.5 miles wide and 2 miles in length. Plume morphology appears to be controlled by a bedrock channel, which has an alignment similar to that of the plume. Contamination mapped to date is primarily confined to the lower zone of the Equus Beds aquifer, which consists of McPherson Formation Pleistocene unconsolidated sand and gravel deposits and lies at a depth of 200 to 250 feet onto of the Permian aged Wellington Formation shales. The location near EB-34 is contaminated throughout all three zones of the aquifer.

Unusual Problems: In order to remediate this site, the planning, land access acquisition, and development of a good water disposal method would be very time and financially intensive.

Status of the Project: The Ground Water Management District #2 has been contracted to do annual water sampling with the KCC funding the analysis of the water samples. The City of McPherson, GMD#2, and the Kansas Water Office have done an investigation into utilizing the area for public water supply for the city of McPherson. Concerns over the chloride plume have stalled development of that project, and the KCC has not been contacted in over two years from any party regarding the project. A zone chloride levels varied overall, but none of the wells showed significant changes. B Zone Wells had some substantial changes, as EB-34B increased by 150 mg/L. EB-36B decreased 100 mg/L chlorides in the northern part of the site. C Zone wells decreased in 2018, with the largest change being the heart of the plume at EB-34C, which decreased by 200 mg/L. EB-37C was the only well in the C zone that increased, and had a change of 60 mg/L. Changes within the aquifer result from brine water moving horizontally along gradient as well as down vertically into areas that lack a clay aquatard. EB27C has been a focal point for this investigation by the KCC due to the past rise in chlorides, but it went down by 10 mg/L, which is so small of a change it is considered stable during 2018.

Level of Remediation Sought:

Ideal: 250 mg/l
Target: 500 mg/l

Recommendations for Future Work: KCC will continue to collect data from GMD #2 on an annual basis for monitoring purposes. Continue research and investigation into the northeastern area of this site especially in the area around EB27C. If the City of McPherson resumes their water project, KCC will allocate their professional expertise and similar resources to aid McPherson's research and planning. The highest level brine plume is centered on EB-34 in all of the vertical zones, a remedial system at that location may be able to remediate the brine contamination, but that would be very costly.

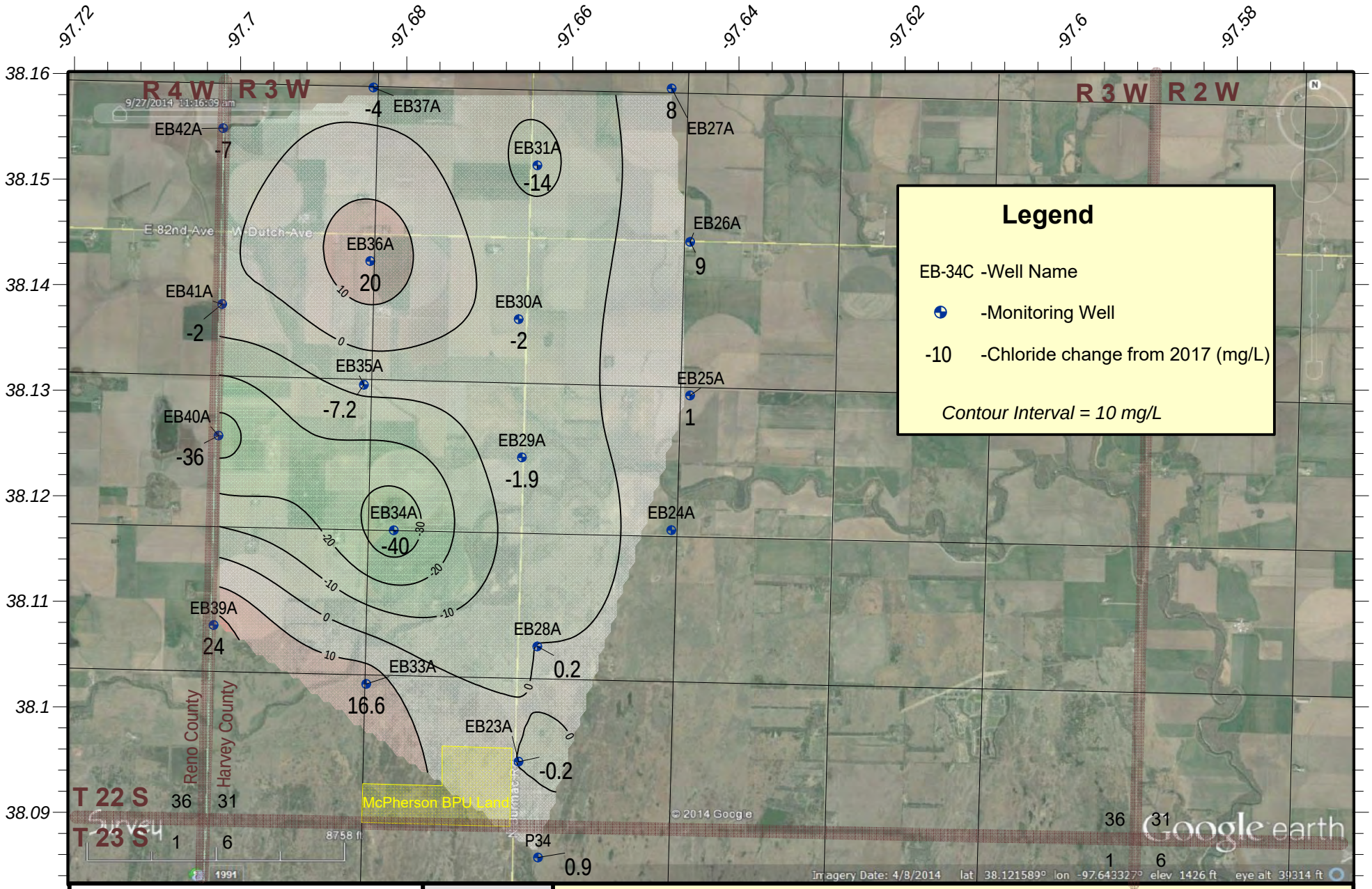
Estimated Total Costs: Time for district personnel to put together and analyze groundwater data obtained from GMD #2 plus research possible remediation avenues. Cost of staff time could increase substantially if the City of McPherson resumes their interest in obtaining a new source of water in the area.

Control No.	**Staff Hours/Expenditures**	**Fund Expenditures**	
		FY 2018/19	**Total**
970009-00	**12 Hrs. / $346.84**	**$2,460**	**$44,623.01**

Current Contaminate Level: Varies; There are hot spots in each zone.

Status:

☐ **1. Site Assessment**	☐ **2. Short Term Monitoring**	☐ **3. Investigation**
☒ **4. Long Term Monitoring**	☐ **5. Remediation Plan**	☐ **6. Installation**
☐ **7. Remediation**	☐ **8. Post Rem. Monitoring**	☐ **9. Resolved**



Kansas Corporation Commission

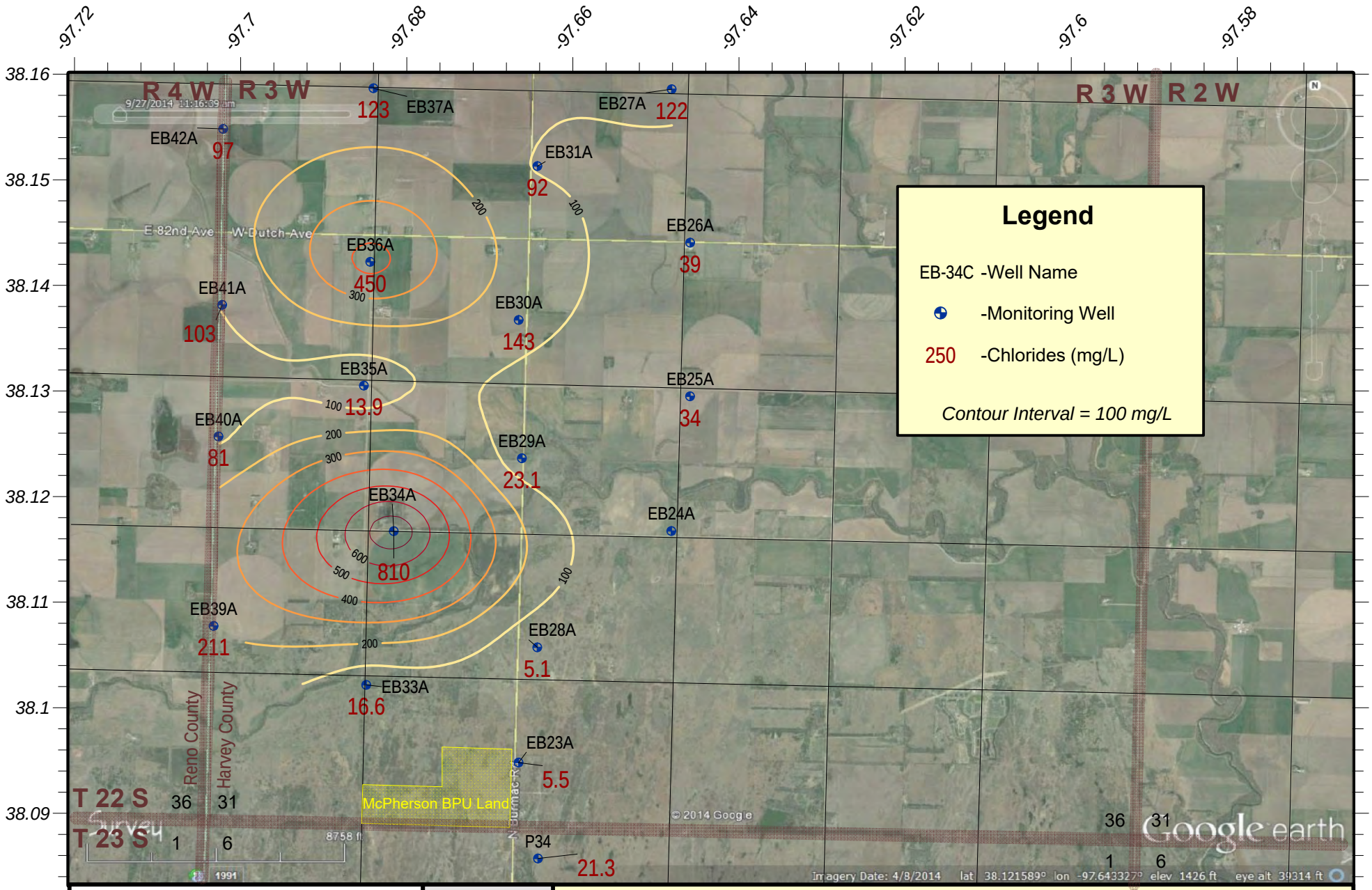
N W E S

Hollow-Nikkel Brine Contamination Site - KCC Control #970009-00

Multiple sections of Townships 22 & 23 South and Range 3 West, Harvey County, Kansas

2018 Chloride Level Changes in the Equus Beds A Zone from 2017

KCC District #2 Field Office - Wells sampled Summer of 2018 by GMD #2 - Map Drawn on 10/16/2018 by D. Bollenback



Kansas Corporation Commission

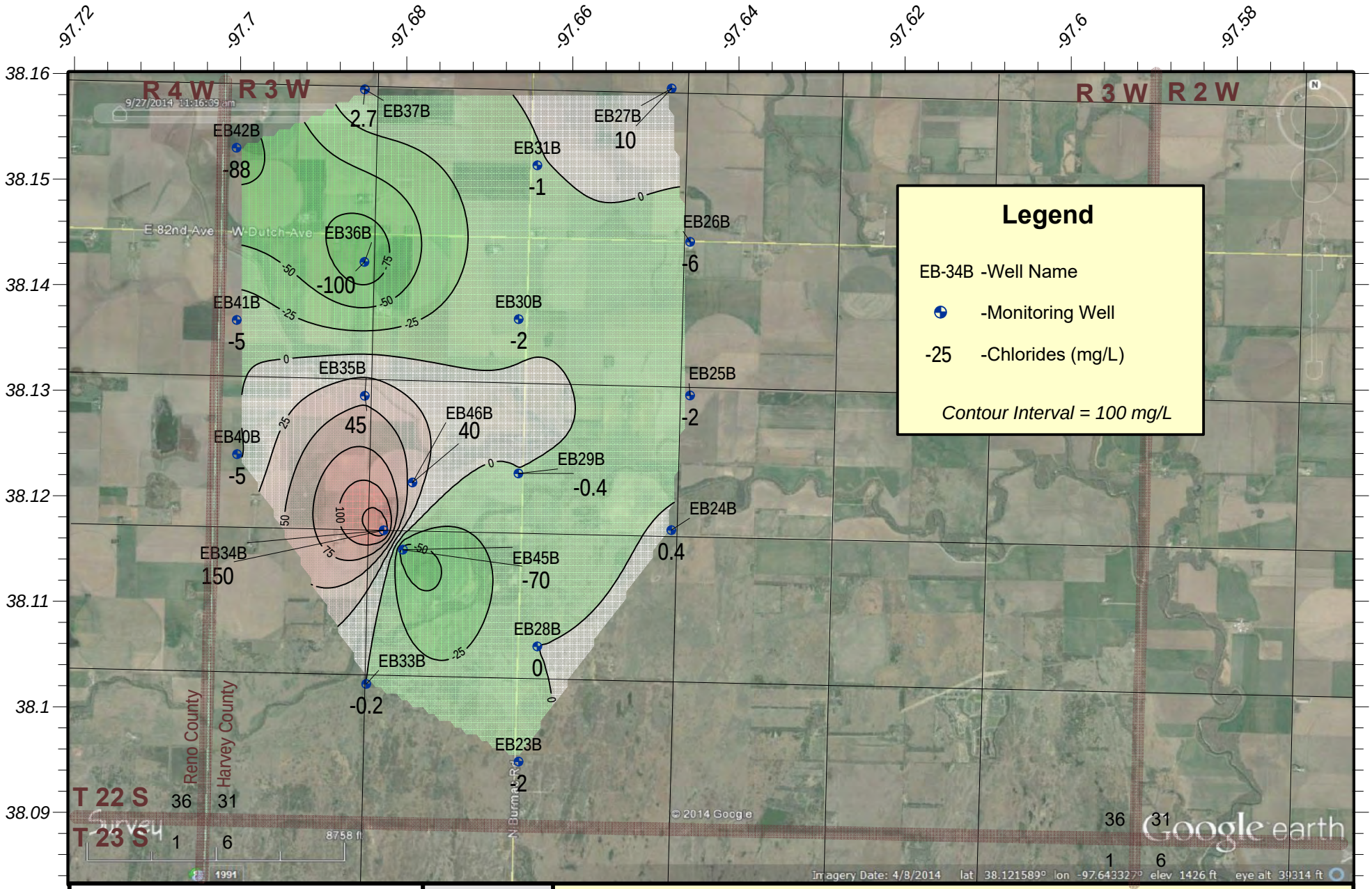
N W E S

Hollow-Nikkel Brine Contamination Site - KCC Control #970009-00

Multiple sections of Townships 22 & 23 South and Range 3 West, Harvey County, Kansas

2018 Chloride Levels in the Equus Beds A Zone

KCC District #2 Field Office - Wells sampled Summer of 2018 by GMD #2 - Map Drawn on 10/16/2018 by D. Bollenback



Kansas Corporation Commission

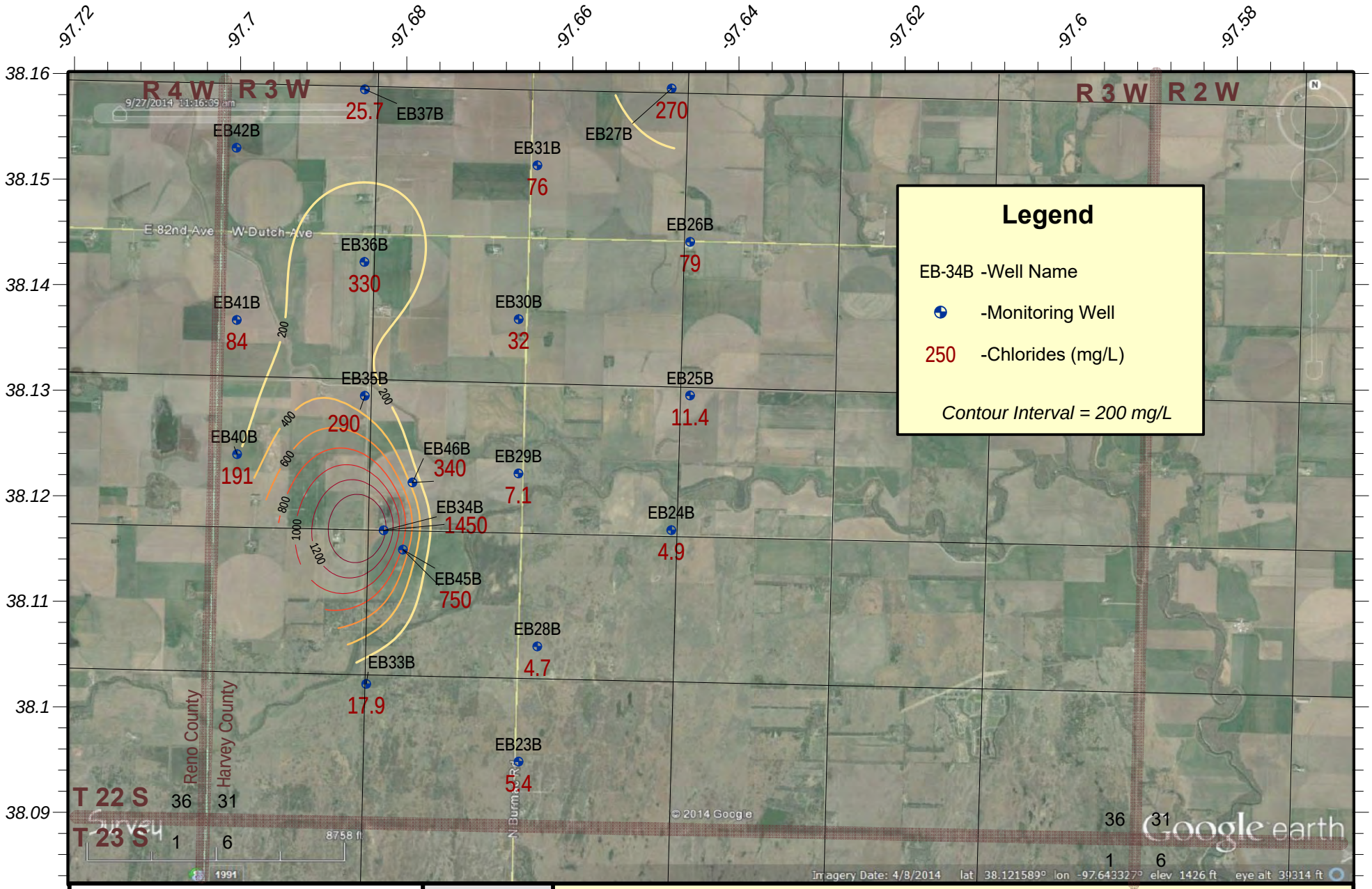
N W E S

Hollow-Nikkel Brine Contamination Site - KCC Control #970009-00

Multiple sections of Townships 22 & 23 South and Range 3 West, Harvey County, Kansas

2018 Chloride Levels Change in the Equus Beds B Zone from 2018

KCC District #2 Field Office - Wells sampled Summer of 2018 by GMD #2 - Map Drawn on 10/16/2018 by D. Bollenback



Kansas Corporation Commission

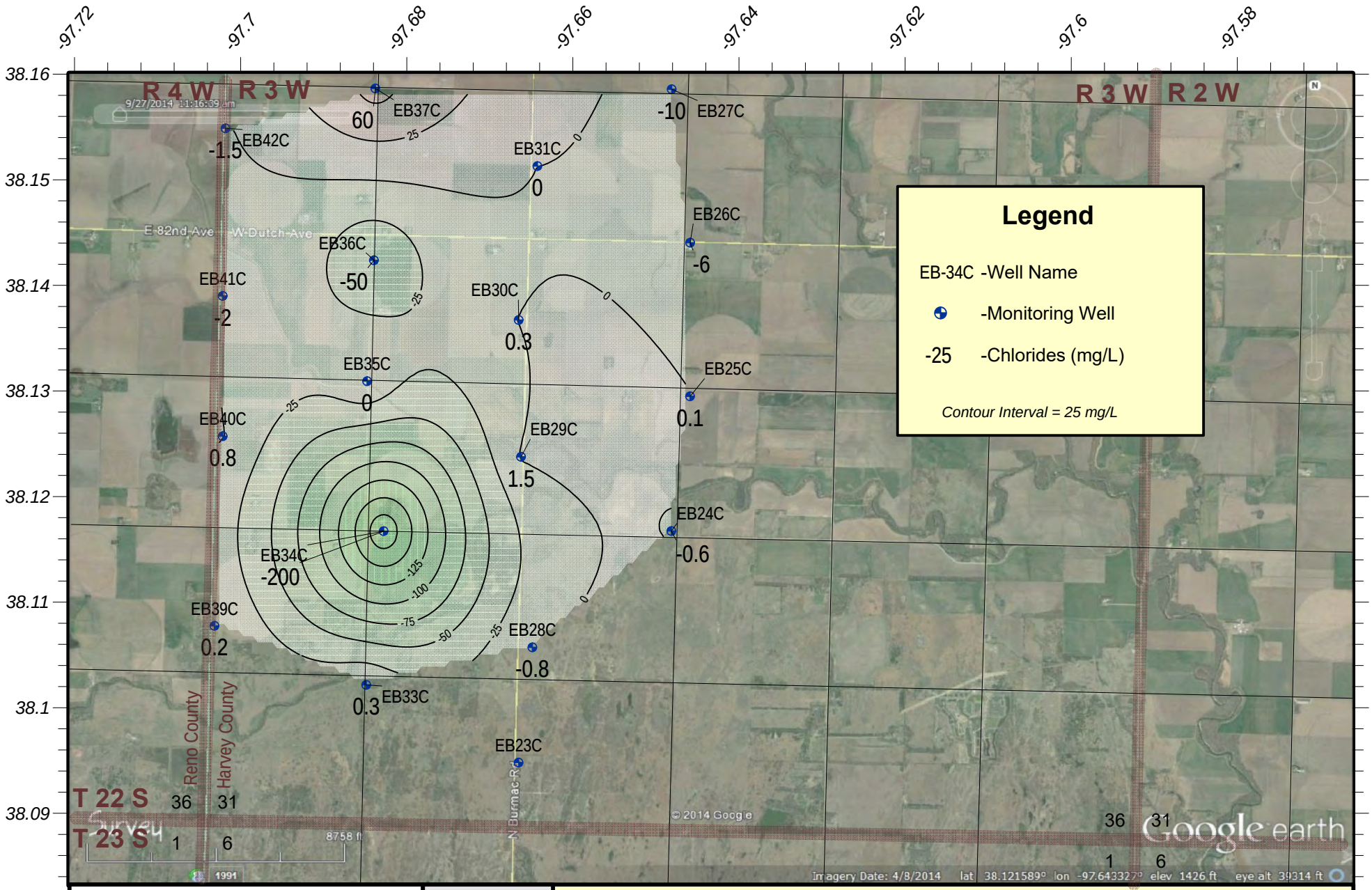
N W E S

Hollow-Nikkel Brine Contamination Site - KCC Control #970009-00

Multiple sections of Townships 22 & 23 South and Range 3 West, Harvey County, Kansas

2018 Chloride Levels in the Equus Beds B Zone

KCC District #2 Field Office - Wells sampled Summer of 2018 by GMD #2 - Map Drawn on 10/16/2018 by D. Bollenback



Kansas Corporation Commission

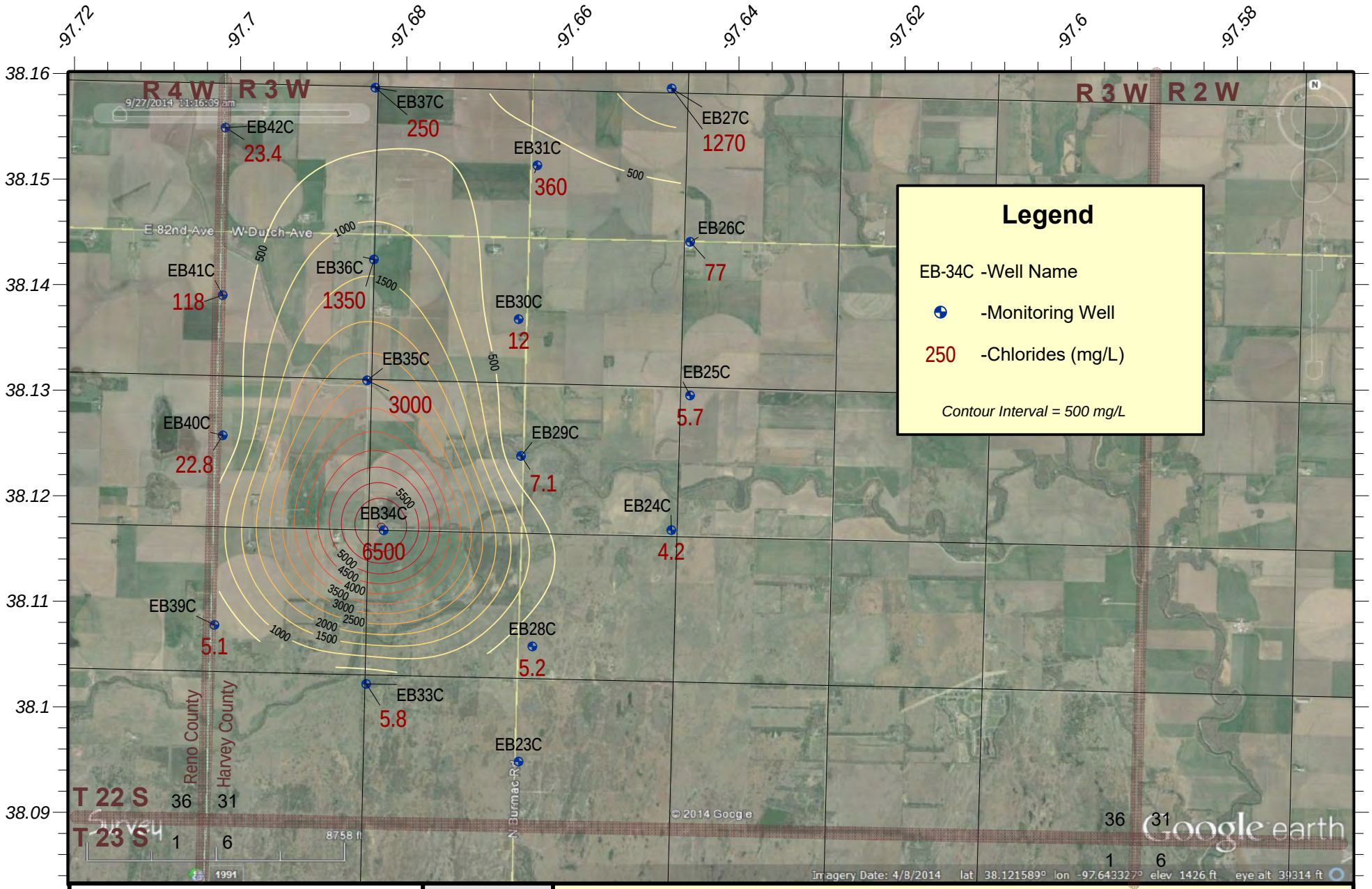
N W E S

Hollow-Nikkel Brine Contamination Site - KCC Control #970009-00

Multiple sections of Townships 22 & 23 South and Range 3 West, Harvey County, Kansas

2018 Chloride Level Changes in the Equus Beds C Zone from 2017

KCC District #2 Field Office - Wells sampled Summer of 2018 by GMD #2 - Map Drawn on 10/16/2018 by D. Bollenback



Kansas Corporation Commission

Hollow-Nikkel Brine Contamination Site - KCC Control #970009-00

Multiple sections of Townships 22 & 23 South and Range 3 West, Harvey County, Kansas

2018 Chloride Levels in the Equus Beds C Zone

KCC District #2 Field Office - Wells sampled Summer of 2018 by GMD #2 - Map Drawn on 10/16/2018 by D. Bollenback

Project: ***Hrencher Contamination Site***

Site Location: Legal location is W/2 Section 36, Township 32 South, Range 12 West, Barber County**.**

Impact/Immediacy: The salt-water intrusion in the area affected the groundwater, small pond, stock wells and there is a salt scar near the pond. This site is classified as moderate to high for remediation.

Site Description: The surface area is predominately "red beds" of lower Permian age. The area is dissected by small drainage patterns and the alluvial channels filled with local parent material shale and gypsum. The area of high chlorides (1000 ppm +) is a narrow channel 300 feet wide and approximately 8,000 feet long near the present stream. This small stream flows into the Medicine Lodge River within a half-mile.

Unusual Problems: None.

Status of Project: The site area has dealt with plentiful rainfall this year, and as a result only two groundwater samples were collected by foot in 2018. Chloride levels overall in the project area have remained consistent with previous years. Since 2003 when the last full sampling event has taken place, MW-5, MW-7, and MW-11 have been destroyed. MW-5 was originally drilled to provide a profile of the chlorides in the main channel, whereas MW-7 was drilled to eliminate additional sources of contamination and has historically been fresh. MW-11 was drilled in order to evaluate the down gradient concentration of chlorides, but since it has been destroyed, the leading edge of the plume is left undefined.

Level of Remediation Sought:

Ideal: 250 ppm Chloride
Target: 1000 ppm Chloride

Recommendation for Future Work: Continue sampling on an annual basis. As chloride levels have continued to increase down gradient, it may be necessary to design and install a remedial system for this site. Additional monitoring wells need to be drilled to define the toe of the plume. Further investigation and sampling will continue to determine if a remedial system is appropriate for this site.

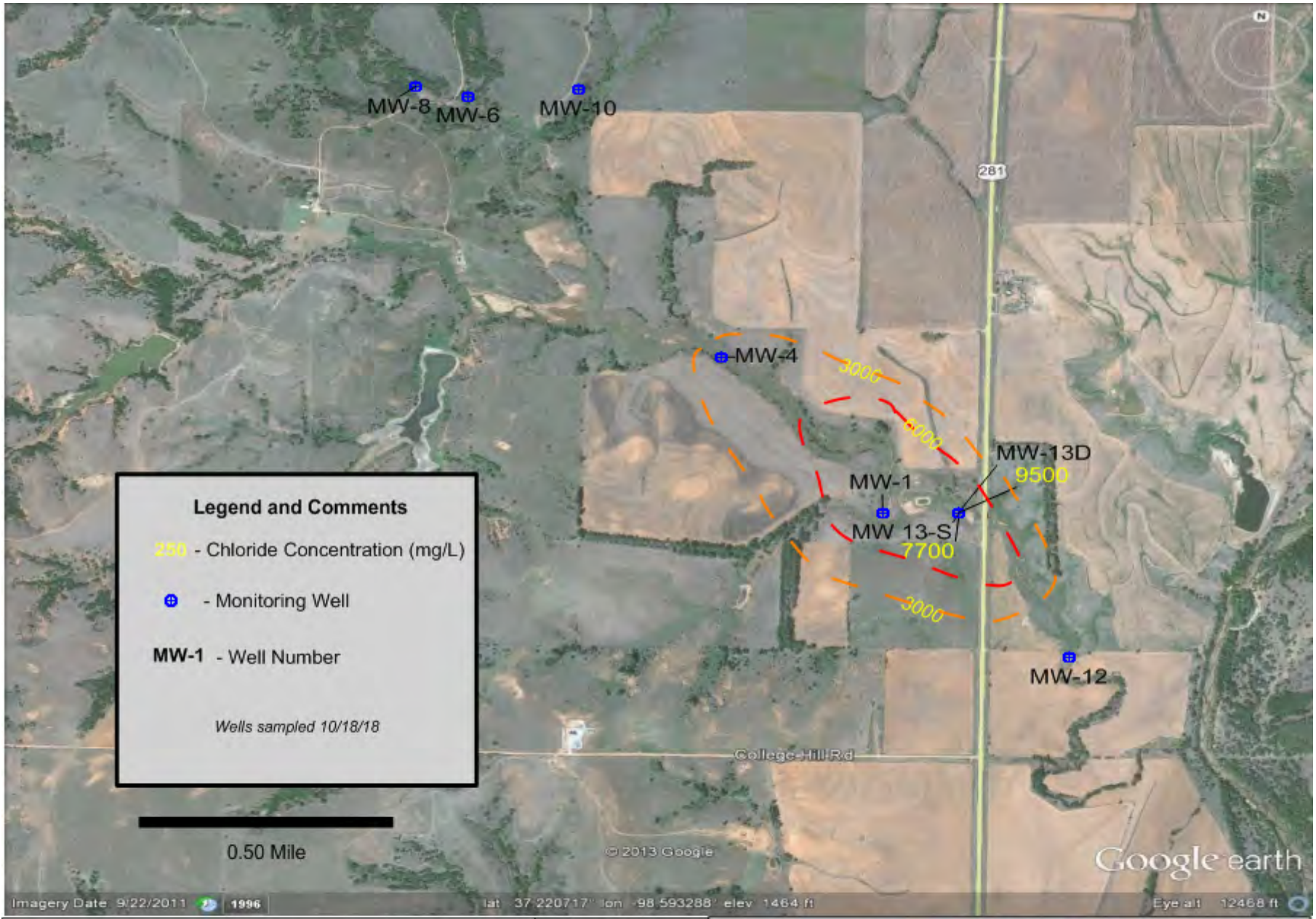
Estimated Total Cost: $150,000 if necessary to install a remediation system.

Control No.	**Staff Hours/Expenditures**	**Fund Expenditures**	
		FY 2018/19	**Total**
970051-00	**6 Hrs. / $186.10**		**$189.94**

Current Contaminate Level: 7700 ppm Cl- to 9500 ppm Cl-

Status:

☐ **1. Site Assessment**	☐ **2. Short Term Monitoring**	☐ **3. Investigation**
☒ **4. Long Term Monitoring**	☐ **5. Remediation Plan**	☐ **6. Installation**
☐ **7. Remediation**	☐ **8. Post Rem. Monitoring**	☐ **9. Resolved**



Kansas Corporation Commission

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Hrencher Site

Sections 26/35/36-T-32S-R12W
Barber County, Kansas

2018 Area Map with Chlorides

KCC Control # 970051-00 District 1
K. Sullivan 10/29/18

Project: ***Irey-Hrabe Contamination Site***

Site Location: Section 1 and Section 12 of Township 9 South, Range 17 West, Rooks County.

Impact/Immediacy: The groundwater near a former homestead has been impacted by repeated releases of brine on the surface and in the subsurface. The immediacy for this site is rated as moderate.

Site Description: A subtle drainage runs through the site from south to north, and an old farmstead is situated near this draw. Up to six water wells were drilled into the Codell Sandstone and terminated in the Blue Hill Shale, and one hand dug well that is likely completed in alluvium overlying the Fort Hays Limestone. Contamination at the site can be attributed to an injection well which had pressurized a number of near-surface formations through failed casing, over pressurization, the numerous spills that have occurred over a period of 50 years, as well as multiple surface pits.

Unusual Problems: None.

Status of Project: The site assessment has been completed, and an investigatory phase began in earnest in 2015. The open wells were sampled early in 2017, and the concentrations of chlorides have dramatically increased to 44,000 ppm in one, and 7,500 ppm in another. The well closest to the abandoned farmstead was 1,150 ppm. The open wells with the highest chlorides were pumped out, and the water was taken to a SWD well. The groundwater coming into the south well was sampled and determined to be approximately 3,500 ppm. Test holes were hand augured to a depth of 6' to 10' in 2018, and the concentrations ranged from 1,100 ppm to 17,000 ppm. These tests conform to the known site history, and will be used to plan future exploratory and remedial work.

Level of Remediation Sought:
Ideal: 250 ppm Chloride
Target: 500 ppm Chloride

Recommendations for Future Work: While samples have been collected through existing wells, these do not meet quality control standards for groundwater sampling. A network of monitoring wells and exploratory test holes should be drilled at this site to delineate the extent of the pollution. The open wells will be pumped out on a periodic basis.

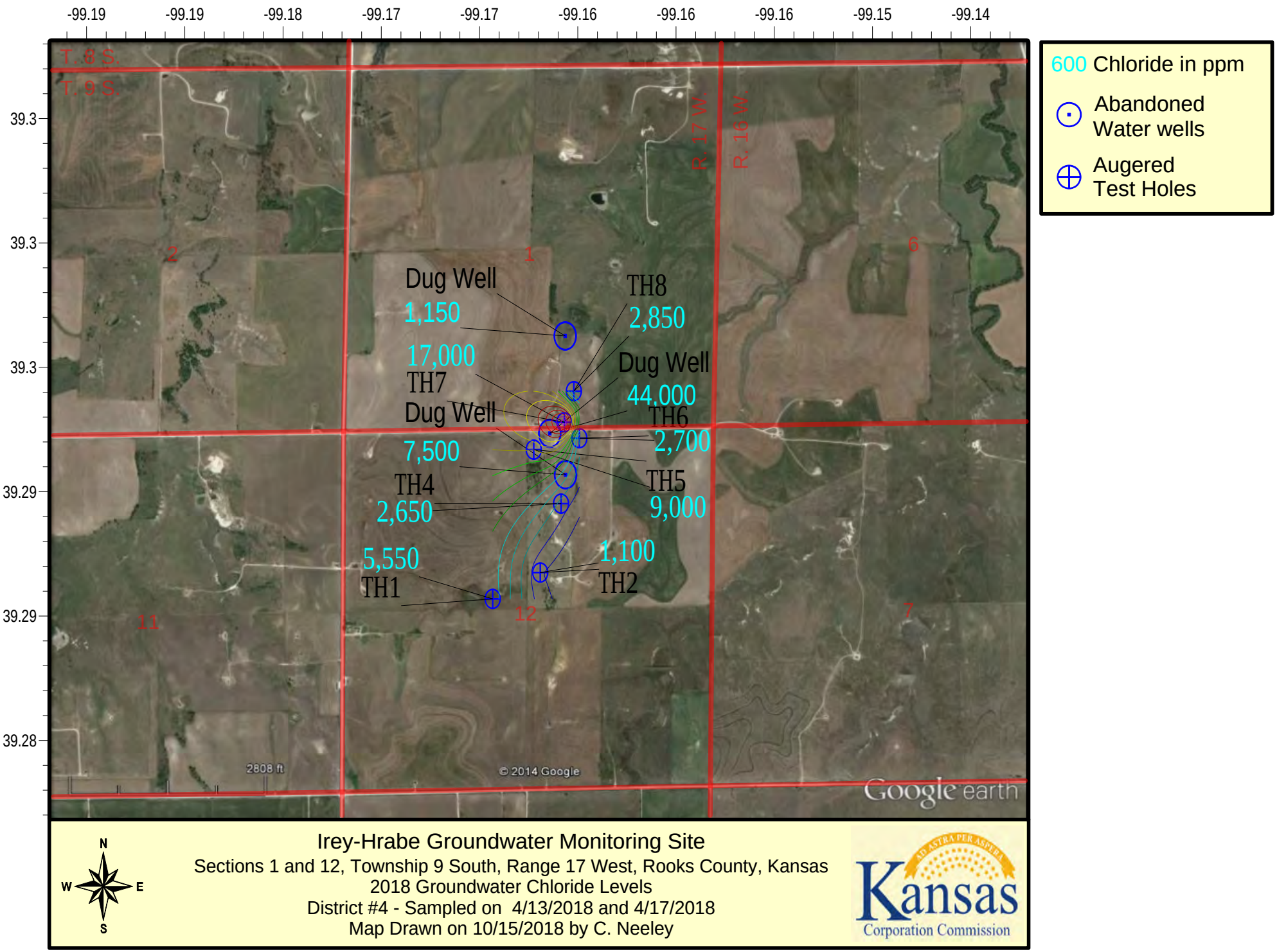
Estimated Total Costs: $15,000.00

Control No.	**Staff Hours/Expenditures**	**Fund Expenditures FY 2018/19 Total**
970053-00	**68 Hrs. / $1,919.54**	

Current Contaminate Level: 1,100 to 17,000 ppm / Dug Well 44,000 ppm Cl-

Status:

☐ **1. Site Assessment**	☐ **2. Short Term Monitoring**	☒ **3. Investigation**
☒ **4. Long Term Monitoring**	☐ **5. Remediation Plan**	☐ **6. Installation**
☐ **7. Remediation**	☐ **8. Post Rem. Monitoring**	☐ **9. Resolved**


-99.19
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39.3
39.3
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39.29
39.28
T. 8 S.
T. 9 S.
R. 17 W.
R. 16 W.
2
1
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11
12
7
Dug Well
1,150
17,000
TH7
Dug Well
7,500
TH4
2,650
5,550
TH1
TH8
2,850
Dug Well
44,000
TH6
2,700
TH5
9,000
1,100
TH2
2808 ft
© 2014 Google
Google earth
600 Chloride in ppm
Abandoned Water wells
Augered Test Holes
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Irey-Hrabe Groundwater Monitoring Site
Sections 1 and 12, Township 9 South, Range 17 West, Rooks County, Kansas
2018 Groundwater Chloride Levels
District #4 - Sampled on 4/13/2018 and 4/17/2018
Map Drawn on 10/15/2018 by C. Neeley
Kansas
Corporation Commission

Project: ***Jennings Contamination Site***

Site Location: NW/4 of Section 25, Township 4 South, Range 27 West, Decatur County.

Impact/Immediacy: Groundwater contaminated by poor oil field practices including discharges at the injection pump site and brine line leaks since the 1950's. Two public water supply wells inside the city limits have experienced elevated chloride levels of varying intensity. Immediacy level is rated as low to moderate.

Site Description: The current city water supply well is located west and upstream of the tank battery and injection plant area, and has not been impacted by oil field pollution. The contaminated wells within the city limits are used for purposes other than human consumption, such as lawn and garden, and bulk water load-out. The site is situated within the stream valley of Prairie Dog Creek. The monitoring well has been drilled into this alluvium, and the soils are Munjor sandy loam. This allows rapid infiltration of spilled fluids into the groundwater, and spikes in the chloride level seem to correlate to reported spills at the tank battery area.

Unusual Problems: None.

Status of Project: Sampling in early 2017 yielded water with 1,400 ppm chloride concentration. The site was sampled again in October 2017, and the contaminant level had decreased to 100 ppm. In 2018, the contamination level remained stable, at 125 ppm.

Level of Remediation Sought:
Ideal: 250 ppm Chloride
Target: 500 ppm Chloride

Recommendations for Future Work: Monitor on an annual basis. Additional data needs to be acquired through the sampling of additional wells down gradient of the existing monitoring well. District staff will work to establish a cooperative relationship with the operator regarding lease practices, and the implementation of safeguards to prevent pollution of the aquifer.

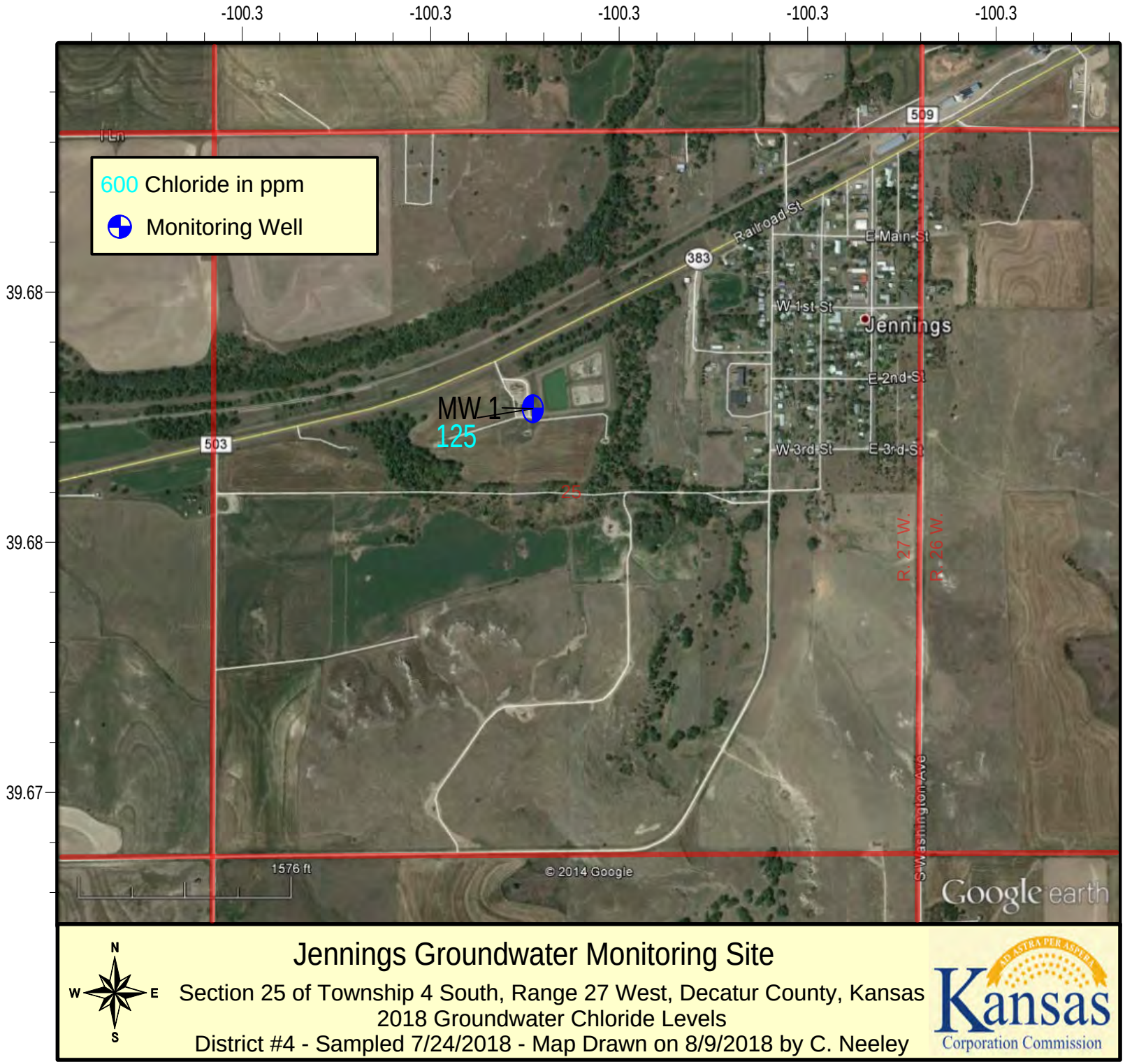
Estimated Total Costs: $2,000

Control No.	**Staff Hours/Expenditures**	**Fund Expenditures FY 2018/19**	**Total**
970054-00	**8 Hrs. / $244.52**		

Current Contaminate Level: 125 ppm Cl^-

Status:

☐ **1. Site Assessment**	☐ **2. Short Term Monitoring**	☐ **3. Investigation**
☒ **4. Long Term Monitoring**	☐ **5. Remediation Plan**	☐ **6. Installation**
☐ **7. Remediation**	☐ **8. Post Rem. Monitoring**	☐ **9. Resolved**



Jennings Groundwater Monitoring Site

Section 25 of Township 4 South, Range 27 West, Decatur County, Kansas
2018 Groundwater Chloride Levels
District #4 - Sampled 7/24/2018 - Map Drawn on 8/9/2018 by C. Neeley

Kansas Corporation Commission

Project: ***Knackstedt Site***

Site Location: The site is located eight miles west and four miles north of Inman. The legal location is N/2 N/2 NW NW of Section 30, Township 20 South, and Range 5 West, in McPherson County.

Impact/Immediacy: Potential exists for impacts on both rural domestic and stock water resources. Public safety issues have been mitigated with the re-routing of the local roadway affected by this site, the site is still ranked as moderate immediacy level due to the unknown extent of the dissolution.

Site Description: The site consists of an unplugged saltwater disposal well whose operation led to the development of an air filled underground void at an approximate depth of 430 feet within the Hutchinson Salt Member. KCC attempted to delineate the extents with remote cameras, but the size of the cavity could not be determined. The site is located immediately southeast of the intersection of Plum Street and Saxman Road. Land use is agricultural with oil and gas activities in the area.

Unusual Problems: The air filled nature of the cavity makes the design of an acceptable plugging project more difficult. The air filled nature of the cavity also restricts the nature and kind of investigatory methods applicable to this site. There is a farmstead near the sink which could be affected if the subduction rate accelerates from current levels.

Status of the Project: The cavity is in the salt section of the Wellington Formation, but has been stable with only slight indication of any downward surface movement. The site was and will be under periodic monitoring of surface elevations with respect to possible surface movement. [Survey was made of the control points in July of 2013.] The results of that survey indicated that the control points and/or benchmark have been compromised and are in need of replacement. District Staff purchased professional survey markers in the summer of 2018 to install throughout the site, including placing a new benchmark for future surveys. KCC plans to install these during the fall-winter of 2018.

Level of Remediation Sought:

Ideal: Stabilize cavity and plug well bore in accordance with KCC rules and regulations.

Target: Study results indicate a reduced need for further or complete cavity stabilization beyond the original well bore and an acceptable plugging procedure can be developed which adequately addresses both fresh water resources and public safety issues.

Recommendations for Future Work: KCC may discuss with the Kansas Geological Survey regarding the future surveying and other investigative techniques that could be used to delineate the cavern. Re-establish good control points and have them initially surveyed by a licensed surveyor and perform a quarterly survey of the site using the KCC hi-accuracy GPS survey system.

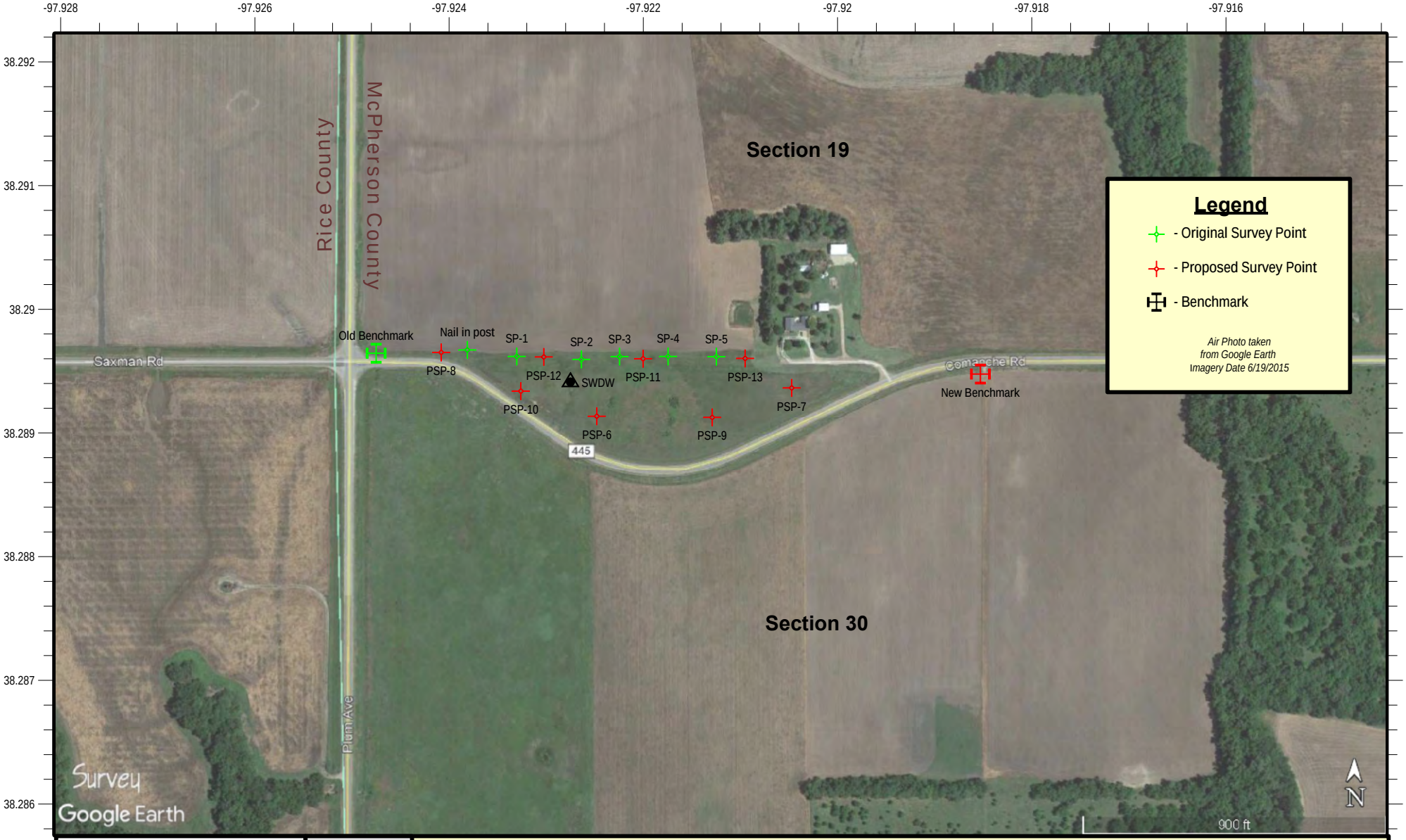
Estimated Total Costs: $500-$750 to have the benchmark/points resurveyed by a licensed surveyor. Staff time for install of benchmark and points.

Control No.	**Staff Hours/Expenditures**	**Fund Expenditures**	
		FY 2018/19	**Total**
970060-00	**35 Hrs. / $991.71**		**$153.39**

Current Contaminate Level: Unstable well cavity

Status:

☐ **1. Site Assessment**	☐ **2. Short Term Monitoring**	☐ **3. Investigation**
☒ **4. Long Term Monitoring**	☐ **5. Remediation Plan**	☐ **6. Installation**
☐ **7. Remediation**	☐ **8. Post Rem. Monitoring**	☐ **9. Resolved**



Kansas Corporation Commission

N W E S

Knackstedt Depression Site

NW of Section 30 of Township 20 South and Range 5 West, McPherson County, Kansas

2018 Site Map

KCC Project Code #970060-00 - KCC District #2 Field Office - Map Drawn on 10/16/2018 by D.Bollenback

Project: ***Korf Contamination Site***

Site Location: Legal location is the SE/4 of the SE/4 of the NE/4, Section 7, Township 23 South, Range 22 West.

Impact/Immediacy: There is a very slight chance of the plume impacting the area to the northeast. The site has a low rating.

Site Description: There are currently six monitoring wells on the site which are sampled on an annual basis. Land use is agricultural with oil activities to the south. The site is located at the bottom of a small valley carved by an intermittent stream. The aquifer is a mixture of weathered shale, clay, and some clayey sand sitting on top of the Cretaceous Dakota shale.

Unusual Problems: The aquifer is composed of weathered shale, shale, with some clayey sand. Due to this, water does not flow quickly through the area. This makes normal methods of treating the aquifer difficult to accomplish.

Status of Project: The project is currently in a monitoring phase. The saltwater plume is moving very slowly to the north northeast along the draw. The samples from the monitoring wells continue to remain erratic from each sampling event. MW-3 had water and was sampled this year. The other five wells were sampled and chlorides ranged from 46ppm-2,900ppm. The area has seen abundant rainfall this year, and the ponds were unable to be accessed during the time of sampling.

Level of Remedation Sought:

Ideal: 250 ppm
Target: 1000 ppm

Recommendations for Future Work: Continue monitoring work until the aquifer reaches the target level.

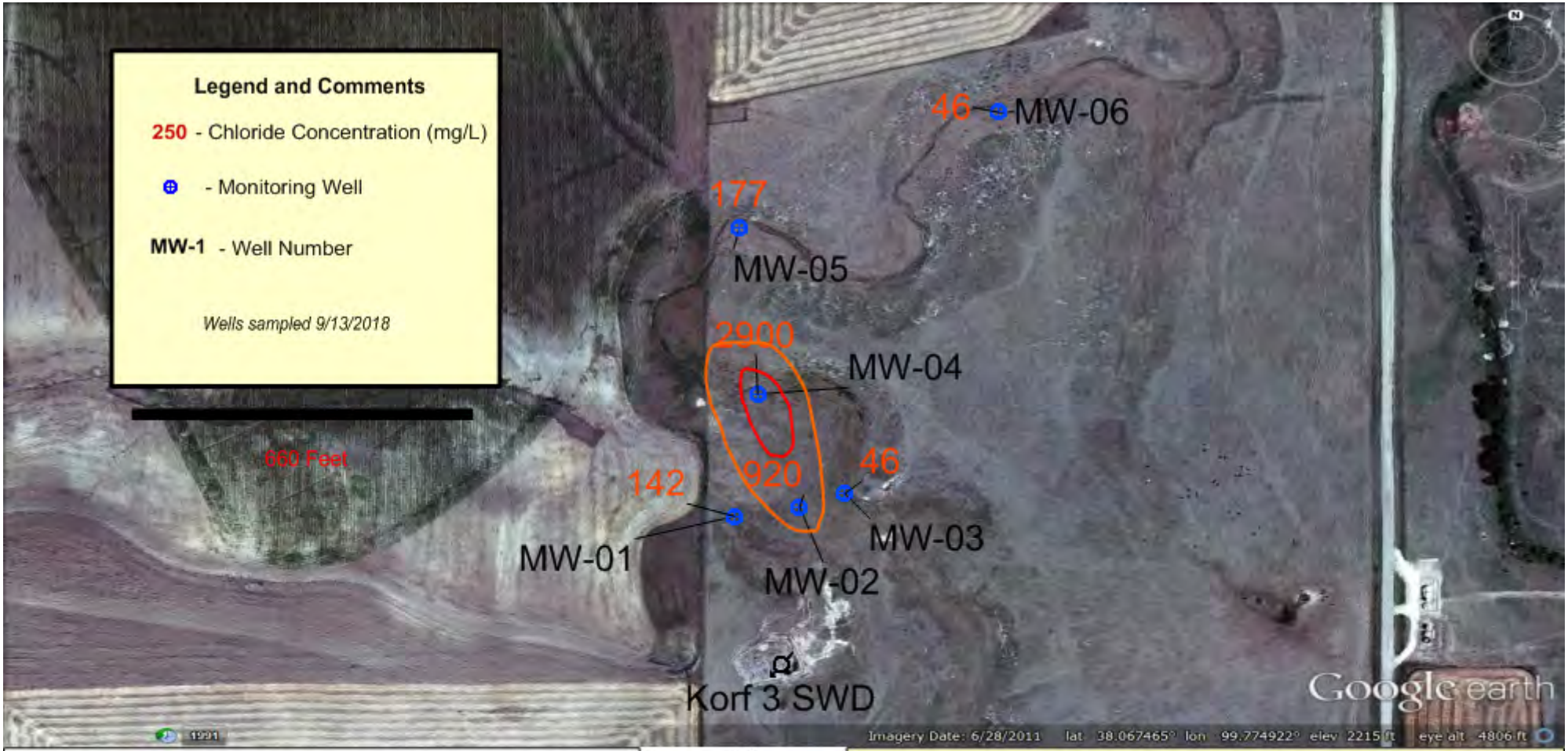
Estimated Total Costs: Costs covered by PRP.

Control No.	**Staff Hours/Expenditures**	**Fund Expenditures FY 2018/19**	**Total**
20140017-001	**3 Hrs. / $101.23**		

Current Contaminate Level: 46 ppm Cl- to 2900 ppm Cl-

Status:

☐ **1. Site Assessment**	☐ **2. Short Term Monitoring**	☐ **3. Investigation**
☒ **4. Long Term Monitoring**	☒ **5. Remediation Plan**	☐ **6. Installation**
☐ **7. Remediation**	☐ **8. Post Rem. Monitoring**	☐ **9. Resolved**



Kansas Corporation Commission

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Korf Site

Sections 7-T-23S-R22W
Hodgeman County, Kansas

2018 Area Map with Chlorides

KCC Control # 20140017 District 1
K. Sullivan 9/24/18

Project: ***Leesburg Sink Hole Site***

Site Location: The site is located in Section 12, Township 25 South, Range 13 West, Stafford County.

Impact/Immediacy: Potential exists for impacts on stock and irrigation resources. Subsidence around the Leesburg #302 and Leesburg #303 may develop into a sinkhole. Worst-case scenario would be a catastrophic collapse taking several acres of farm ground. Probable action is a gentle downward movement of the area until stable. The site has a moderate to high rating.

Site Description: The site consists of a plugged saltwater disposal well whose operation led to the probable development of a solution cavity. The site is located in a rural setting approximately 990' FEL and 2310' FSL of section 12. Land use is agricultural with oil activities in the area. The subsidence at the site now covers an area of approximately 350'x400' in size.

Unusual Problems: A solution cavity is thought to exist under the existing location.

Status of the Project: Elevation was shot on 9/11/2018. There was a 0.2' increase in elevation since the previous survey in 2017. Other points were under water and unable to be surveyed.

Recommendations for Future Work: It is recommended the site continue to be surveyed annually to establish a subsidence rate. The ground level at the stake on the east side should be surveyed in addition to the Leesburg 302 if it is accessible (low/no water). Additional points on the north and south edges of the sink, as well as a point in the center of the sink should be added in order to more thoroughly describe the movement.

Level of Remediation Sought:

Ideal: Stabilize cavity.

Target: Safely monitor site.

Estimated Total Costs: RP -$62,000, plugging costs, seismic and installation of monitor wells.

Control No.	**Staff Hours/Expenditures**	**Fund Expenditures**	
		FY 2018/19	**Total**
2004003-001	**3 Hrs. / $101.23**		**$6,266**

Current Contaminate Level: Unknown

Status:

☐ **1. Site Assessment**	☐ **2. Short Term Monitoring**	☒ **3. Investigation**
☒ **4. Long Term Monitoring**	☐ **5. Remediation Plan**	☐ **6. Installation**
☐ **7. Remediation**	☐ **8. Post Rem. Monitoring**	☐ **9. Resolved**

ADVANTAGE ELEVATIONS
OIL FIELD SURVEYORS
BOX 8604 - PRATT, KS 67124
(620) 672-6491

911181
INVOICE NO.

LYONS & LYONS INC — OPERATOR
SINKHOLE — NO.
SAUNDERS LEASE — FARM

STAFFORD — COUNTY
12 — S
25s — T
13w — R
Approx. NW NE SE — LOCATION

ELEVATION: 1900.9 GR

LYONS & LYONS INC
1519 S. Baltimore
TULSA, OK 74119

N

AUTHORIZED BY: _____

SCALE: 1" = 1000'

SHOT GROUND ELEVATION AT WEST STEEL T-POST AT WEST EDGE OF SINKHOLE.

Elevation Record at same point.

3/13/06	1904.9 gr.
5/15/08	1903.6 gr.
5/13/09	1903.4 gr.
4/27/12	1901.5 gr.
9/27/13	1901.5 gr.
11/21/14	1900.9 gr.
9/13/15	1900.9 gr.
9/14/16	1900.9 gr.
10/20/17	1900.7 gr.
9/11/18	1900.9 gr.

1 2

SINKHOLE

DATE STAKED: 9/11/18

Taylor Printing Inc. • Pratt, KS 67124 • 620-672-3656

Project: ***Little River Site***

Site Location: The site is located 4 miles north and one east of the southwest edge of the city of Little River. The area of contamination is in the SE/4 of section 29 and NE/4 of section 32 T 18S R6W, Rice County.

Impact/Immediacy: The impact is to the ground water supply for the city of Little River from unknown oil field source. The immediacy level is rated as high because of its potential impact to the existing public water supply wells.

Site Description: The Little River water well field is located in part of the Odessa Oil Field. The ground water table in this area is at a depth of thirty feet in the Dakota Sandstone with an aquatard of Kiowa Shale at a depth of fifty to sixty feet. The sandstone has its highest increase in conductivity (chlorides) at a depth of 47 to 50 feet as indicated by a conductivity test in MW# 1. The source for the contamination may be from old core soundings, spills, pits or leaking lines.

Unusual Problems: Unknown sources and probably multiple sources for the contamination.

Status of Project: KCC sampled the Public Water Supply Wells and Monitoring Wells on September 11th, 2018. Chloride values were found to be lower overall than the 2017 event. One well, MW#1 did increase in chloride level.

Level of remediation Sought:

Ideal: 60 mg/l
Target: 300 mg/l

Recommendation for Future Work: Due to the threat to public water supply, KCC recommends continued annual sampling of the public water supply and monitoring wells for 2019.

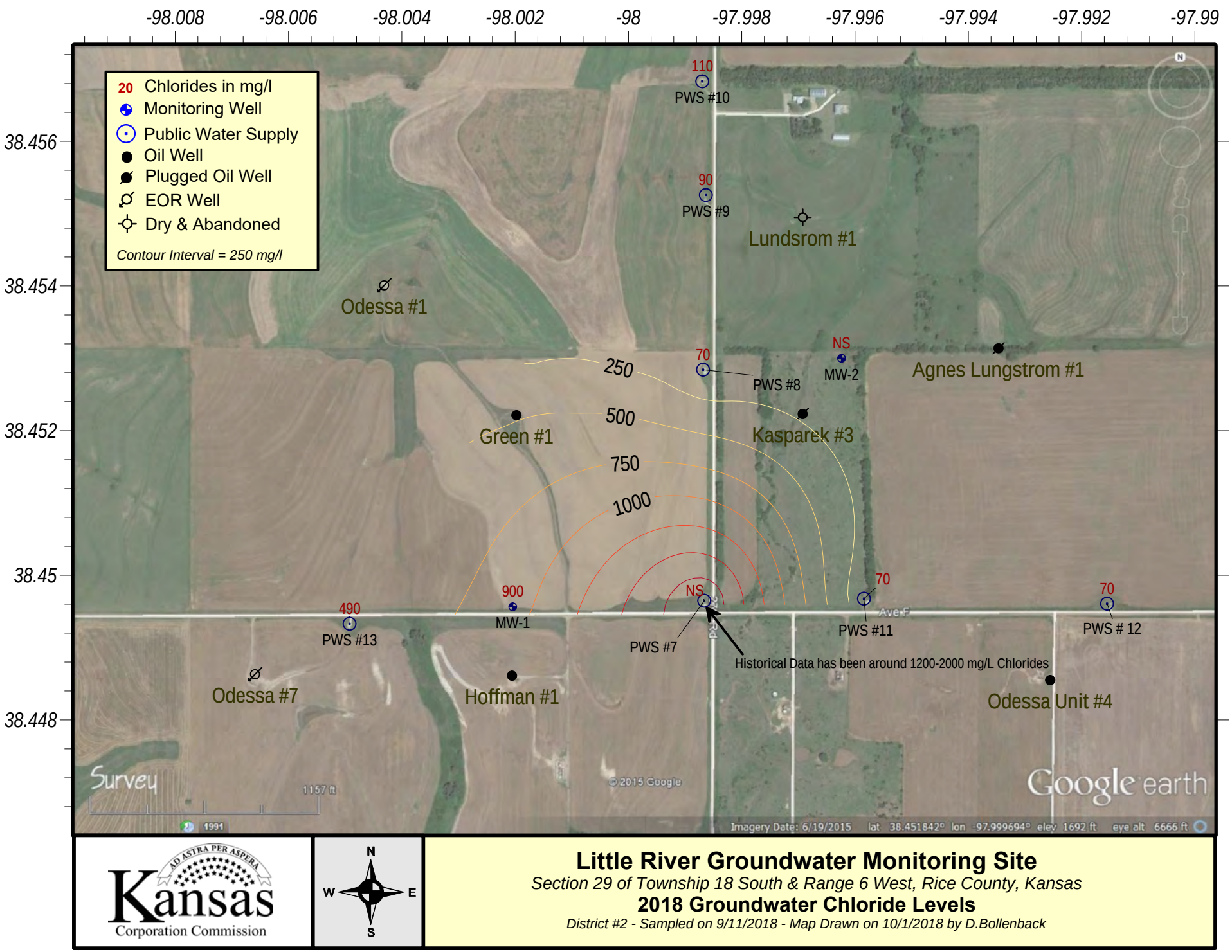
Estimated Total Costs: Time for staff to mobilize to site and sample the wells once over the next year, perform the laboratory work, data entry, mapping, and report creation.

Control No.	**Staff Hours/Expenditures**	**Fund Expenditures**	
		FY 2018/19	**Total**
20000057-001	**18 Hrs. / $510.58**		**$3,112.20**

Current Contaminate Level: 900 mg/l Cl^- in MW #1

Status:

☐ **1. Site Assessment**	☐ **2. Short Term Monitoring**	☐ **3. Investigation**
☒ **4. Long Term Monitoring**	☐ **5. Remediation Plan**	☐ **6. Installation**
☐ **7. Remediation**	☐ **8. Post Rem. Monitoring**	☐ **9. Resolved**



Little River Groundwater Monitoring Site

Section 29 of Township 18 South & Range 6 West, Rice County, Kansas

2018 Groundwater Chloride Levels

District #2 - Sampled on 9/11/2018 - Map Drawn on 10/1/2018 by D.Bollenback

Project: ***Macksville Contamination Site***

Site Location: Legal location of the site is in the S/2 SW Section 30, Township 23 South, Range 15 West, in Pawnee County.

Impact/Immediacy: An irrigation well is located in the NE/4 of this section which is in direct line with the natural flow of the groundwater. A new irrigation well was drilled and is being used to irrigate corn. Sampling shows that while the water in the well has been impacted, the water is below drinking water standards. The sinkhole itself seems to be growing to the north. Immediacy level is rated at Moderate-High due to the growing sinkhole.

Site Description: A sinkhole developed around an abandoned salt-water disposal well on July 21, 1988. Brine from the old well and possibly other sources entered the fresh water aquifer. The aquifer consists of sand and gravel overlying the Wellington Formation of Permian age. The salt-water plume is being monitored by thirty-seven wells. The plume is moving to the northeast from the sinkhole area towards an irrigation well.

Unusual Problems: Ground usage is lost over several acres due to the development of the sink. The depression is still increasing in size.

Status of Project: Samples were collected from six monitoring wells in 2018. Chlorides mostly declined compared to 2017. Chlorides at this site are below ideal water level standards in all except one well. The last remaining above ideal level well is MW-16d, where the chlorides are 1500ppm. Overall, the chlorides at this site have been steadily declining due to natural attenuation, but will likely remain elevated over background chlorides due to the higher chlorides that still reside in the pond formed by the sink, which are at 1,500ppm, a slight increase from last year. The only recovery well that is operational on this site is #1, and it is outside of the fugitive plume that is found in MW-16d.

Level of Remediation Sought:

Ideal: 250 ppm Chloride
Target: 300 ppm Chloride

Recommendations for Future Work: Chlorides, overall, have been stable for several years with a couple exceptions. Since only one well currently remains above the usable water standards it is recommended to begin plugging a majority of the wells at the site, starting with well in the SW/Q, and working back towards the fleeting plume. The feasibility of purchasing a new pump to drain the pond will be considered. The site should also continue to be surveyed on an annual basis to track the current rate of subsidence.

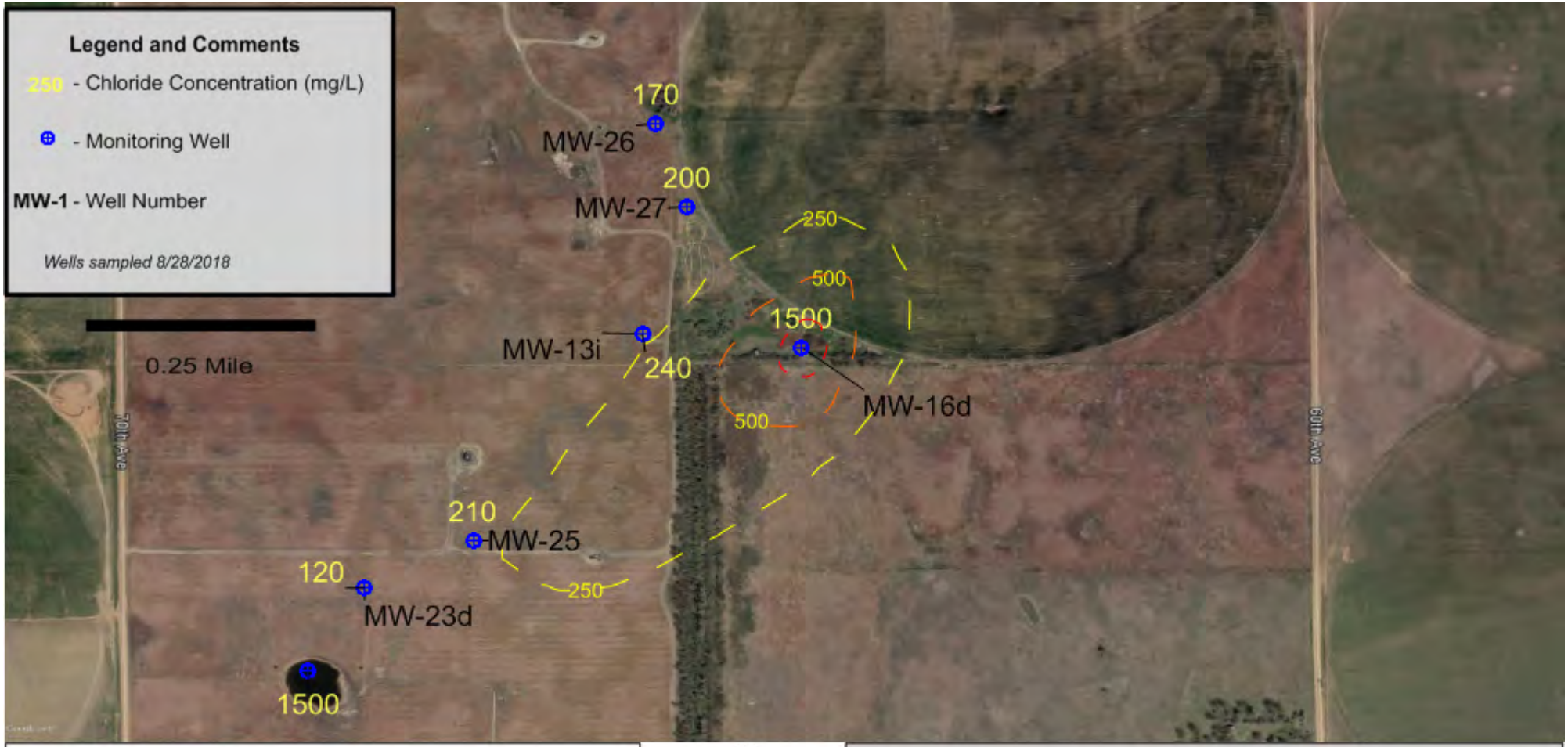
Estimated Total Cost: Costs to plug the wells have not yet been explored.

Control No.	**Staff Hours/Expenditures**	**Fund Expenditures**	
		FY 2018/19	**Total**
970066-00	**11.5 Hrs. / $313.39**	**$1,268.98**	**$84,624.34**

Current Contaminate Level: 1500 ppm Cl-

Status:

☐ **1. Site Assessment**	☐ **2. Short Term Monitoring**	☐ **3. Investigation**
☐ **4. Long Term Monitoring**	☐ **5. Remediation Plan**	☐ **6. Installation**
☐ **7. Remediation**	☒ **8. Post Rem. Monitoring**	☐ **9. Resolved**



Kansas
Corporation Commission

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Macksville Site

Section 30-T-23S-R15W
Pawnee County, Kansas

2018 Area Map with Chlorides

KCC Control # 970066-00 District 1
K. Sullivan 9/24/18

Project: ***Mantooth Contamination Site***

Site Location: Section 20 & 29, Township 33 South, Range 14 East, Montgomery County.

Impact/Immediacy: Impact is to surface water and groundwater. The immediacy level is rated as moderate.

Site Description: The initial investigation began in May of 1996 by personnel from the Chanute Office, in response to a complaint of brine in Deer Creek. At that time the site consisted of an abandoned oil lease with as many as 41 abandoned well locations, some of which were leaking brine at or near the surface and effecting both surface water and groundwater resources. The site is situated immediately north of Deer Creek, a tributary of the Caney River in the Verdigris River Basin. In the spring of 1999 funds were approved for the excavation of abandoned well sites on this property. During that investigation 25 abandoned wells were confirmed and referenced by GPS.

Unusual Problems: Lack of detailed lease data concerning the number and location of wells drilled in the area is a significant problem in properly and completely assessing potential contaminate source areas for this site. However, to date there have been 25 wells plugged in 1999 and an additional 10 wells in 2013. There are also several potential sources being investigated outside the physical lease boundaries of this site.

Status of Project: The Primary Fee Fund Project for this site was completed in the summer of 2000. Twenty-five abandoned wells were plugged. In 2012 the area of interest was expanded resulting in the discovery and plugging of an additional 10 wells in 2013. Data gathered from the well plugging operations and monitoring well sampling indicates that the source of the salt water plume is most likely located in the south half of the project. Leases immediately bordering this site are being inventoried and referenced by GPS to identify further environmental threats outside the original area of concern. The overall Cl- concentrations are still trending down, but MWE 04 continues to show noticeable fluctuations in Cl- concentration ranges. Six additional monitoring wells were completed in early 2012 to further evaluate the extent and to help determine the possible brine source. The following are the Cl- concentrations of this year's sampling taken on: ***3/2/2018***

MWE 01: 4,100 (4,500) ppm Cl- ***MWE 02***: 2,400 (4,000) ppm Cl- ***MWE 03:*** 2,400 (4,600) ppm Cl-
MWE 04: 500 (4,000) ppm Cl- ***MWE 05***: 500 (500) ppm Cl- ***MWE 06***: 600 (600) ppm Cl-
MWE07: 400 (500) ppm Cl-
The Cl- concentration averages for the life of each monitoring well are in parenthesis.

Level of Remediation Sought:
Ideal: Less than 250 ppm Chloride
Target: 500 ppm Chloride

Recommendation for Future Work: Continue monitoring in order to verify whether plugging of the existing abandoned wells eliminates the current source of saltwater contamination within the ground and surface water in the project area. Future work will be based upon the results of the sample analysis of the monitoring wells and Deer Creek. There have been 20 new CBM wells and associated SWD wells drilled in the last few years in sections 20 & 29. The new ability to download and overlay historic aerial imagery will be utilized to help identify undocumented well locations within and near the site boundary. Numerous possible well locations that are referenced on a recently discovered historical lease map of the site area will be investigated in the following year.

Estimated Total Costs: Fee Fund Plugging of 10 abandoned wells cost $77,926.

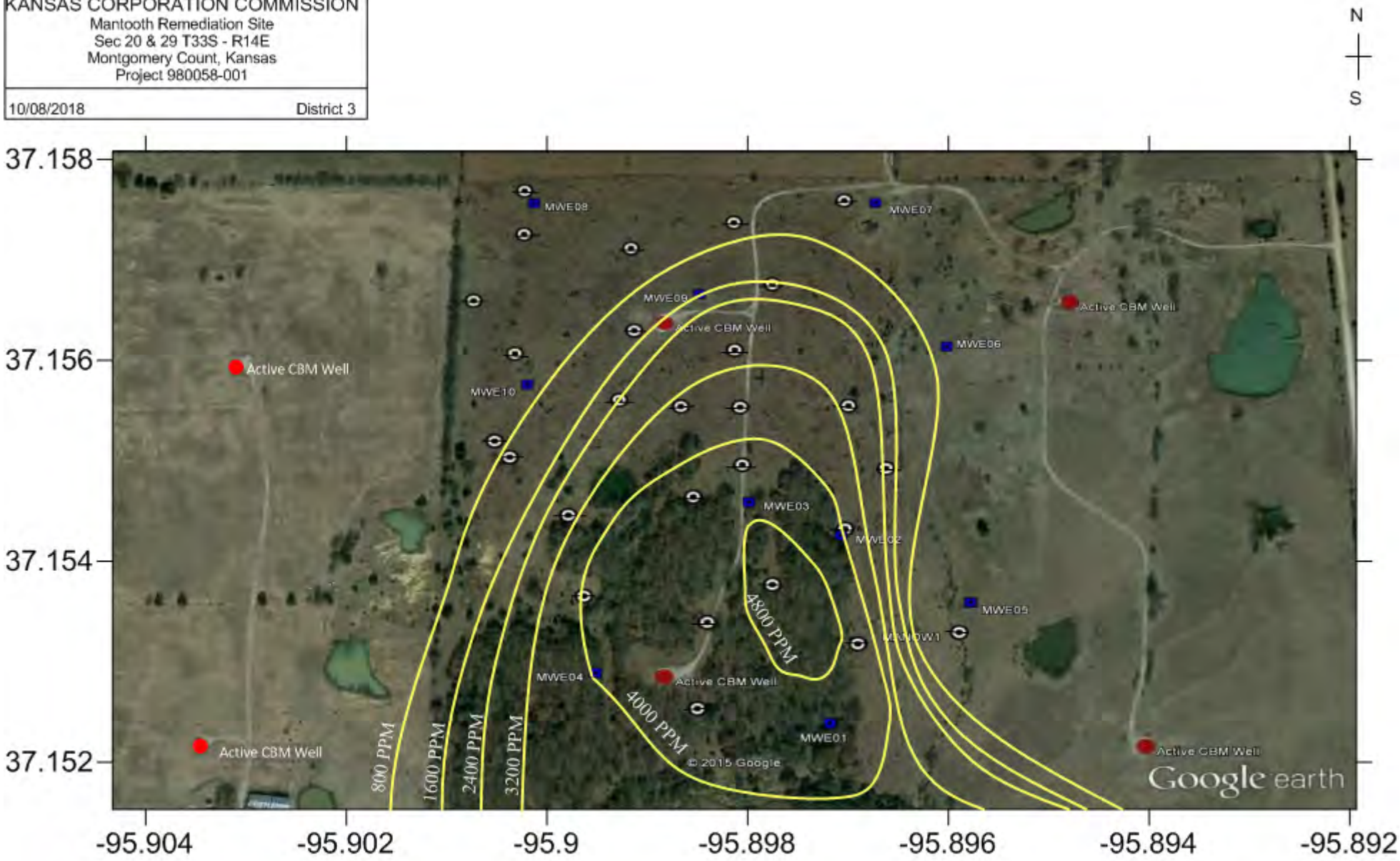
Control No.	**Staff Hours/Expenditures**	**Fund Expenditures**	
		FY 2018/19	**Total**
980058-001	**40.5 Hrs. / $1,124.61**		**$17,349**

Current Contaminate Level: 400 ppm to 4,100 ppm Cl-
Status: Active

☐ **1. Site Assessment**	☐ **2. Short Term Monitoring**	☒ **3. Investigation**
☒ **4. Long Term Monitoring**	☐ **5. Remediation Plan**	☐ **6. Installation**
☐ **7. Remediation**	☐ **8. Post Rem. Monitoring**	☐ **9. Resolved**

KANSAS CORPORATION COMMISSION
Mantooth Remediation Site
Sec 20 & 29 T33S - R14E
Montgomery Count, Kansas
Project 980058-001

10/08/2018 District 3



Contour Interval 800 ppm Cl-

Monitoring Well

Fee Fund Plugged Well

Active CBM Well

Contour Map Showing Average Lifetime Cl- Concentrations of Mantooth Monitoring Wells

Project: ***Maupin Contamination Site***

Site Location: SE/4 of Section 9, Township 11 South, Range 15 West, Russell County.

Impact/Immediacy: Brine contamination of a shallow aquifer and a spring which is utilized for cattle. Immediacy level is rated as low.

Site Description: The site is rangeland at the head of a drainage within the Saline River Basin. Originally, the primary source of water for cattle in the pasture was a spring which had been developed by diverting its water to an open stock tank. Nearby water wells and ponds were experiencing increases in chloride concentration by 1956, and a complaint regarding high chlorides in this spring was made in 1991. Following an investigation, five monitoring wells were drilled on the location, and the waters of this basin ranged in chlorides, including the spring, from 200 ppm to 3,400 ppm throughout the history of sampling. While the pollution has never caused the water to become unusable, the concentration of chloride in the spring is near the upper limit for stock use if it is the sole source of water for the cattle. The pasture is now served by Ellsworth Rural Water District #1, and an additional stock tank filled by this source is available for the cattle to consume.

Unusual Problems: None.

Status of Project: The chloride concentrations in the monitoring wells are 650 ppm at monitoring well 3, and 1,150 ppm at monitoring well 5. The concentration of the spring-fed stock tank is 1,050 ppm. At this time, these levels do not warrant additional action.

Level of Remediation Sought:
Ideal: 250 ppm Chloride
Target: 500 ppm Chloride

Recommendations for Future Work: This site will continue to be monitored on an annual basis until closure.

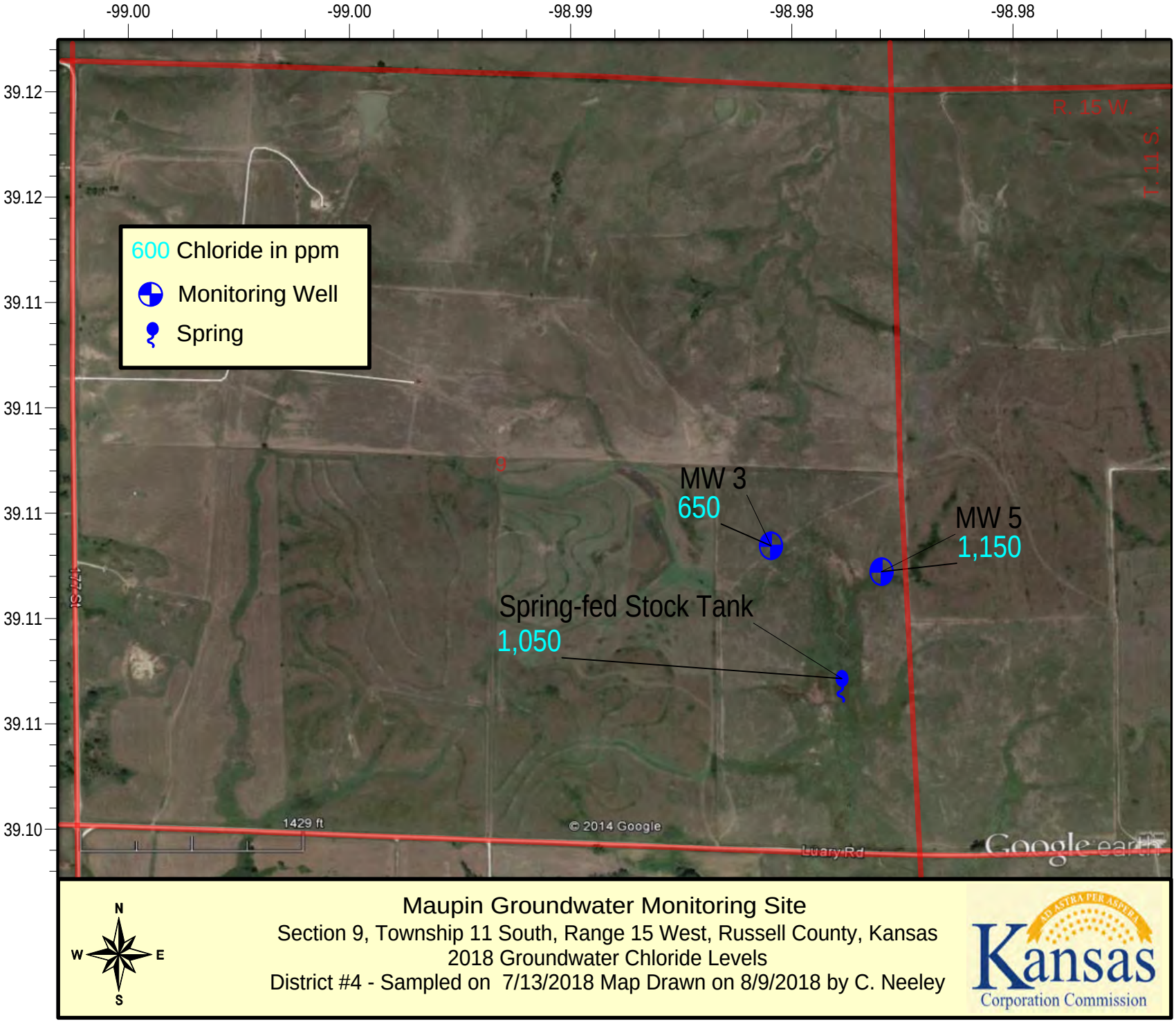
Estimated Total Costs: $2,000.00

Control No.	**Staff Hours/Expenditures**	**Fund Expenditures FY 2018/19 Total**
970068-00	**4 Hrs. / $131.94**	

Current Contaminate Level: 650 ppm to 1,150 ppm Cl^-

Status:

☐ **1. Site Assessment**	☐ **2. Short Term Monitoring**	☐ **3. Investigation**
☒ **4. Long Term Monitoring**	☐ **5. Remediation Plan**	☐ **6. Installation**
☐ **7. Remediation**	☐ **8. Post Rem. Monitoring**	☐ **9. Resolved**


-99.00
-99.00
-98.99
-98.98
-98.98
39.12
39.12
39.11
39.11
39.11
39.11
39.11
39.10
R. 15 W.
T. 11 S.
600 Chloride in ppm
Monitoring Well
Spring
9
MW 3
650
MW 5
1,150
Spring-fed Stock Tank
1,050
1429 ft
© 2014 Google
Luary Rd
Google earth
N
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E
S
Maupin Groundwater Monitoring Site
Section 9, Township 11 South, Range 15 West, Russell County, Kansas
2018 Groundwater Chloride Levels
District #4 - Sampled on 7/13/2018 Map Drawn on 8/9/2018 by C. Neeley
Kansas
Corporation Commission

Project: ***McDonald-East Contamination Site***

Site Location: NW/4 of Section 27, Township 19 South, Range 22 East, Linn County.

Impact/Immediacy: Impact is to the surface water. Immediacy level is rated as low.

Site Description: This site is located at the bottom of a small, fairly steep drainage in the Cherryvale Shale. A seep originating from this drainage tested 3,300 ppm chloride in 1991, 6,500 ppm chloride in 1992, 750 ppm chloride on September 26, 1995 and 380 ppm chloride on January 26, 1998. Seepage within the drainage is intermittent based on precipitation in the area.

Unusual Problems: None.

Status of Project: The State has made an agreement with a local operator to put this lease back into production and plug several of the injection wells and older oil wells. There are six monitoring wells located on the McDonald East Site in the NW ¼ of section 27–T19S–R22E. The following Cl- concentrations of sample results were obtained on ***04/04/2018***:

Monitoring well#2 (MCDE02): 500 ppm Cl-
Monitoring well#3 (MCDE03): 500 ppm Cl-
Monitoring well#4 (MCDE04): 900 ppm Cl-
Monitoring well#5 (MCDE05): 600 ppm Cl-
Monitoring well#6 (MCDE06): 500 ppm Cl-

Cl- levels spiked during 2010 and since have been trending down. Further monitoring on an annual basis is recommended for this site. The lease operator continues to produce this lease and future monitoring will determine if production activity has any impact on site.

Level of Remediation Sought:

Ideal: 200 ppm Chloride
Target: 500 ppm Chloride

Recommendation for Future Work: Continue sampling annually and monitoring injection activity on this lease. The new ability to download and overlay historic aerial imagery will be utilized to help identify undocumented well locations within and near the site boundary.

Estimated Total Costs: $1,500.00 yearly.

Control No.	**Staff Hours/Expenditures**	**Fund Expenditures FY 2018/19**	**Total**
970070-00	**42 Hrs. / $1,199.94**		

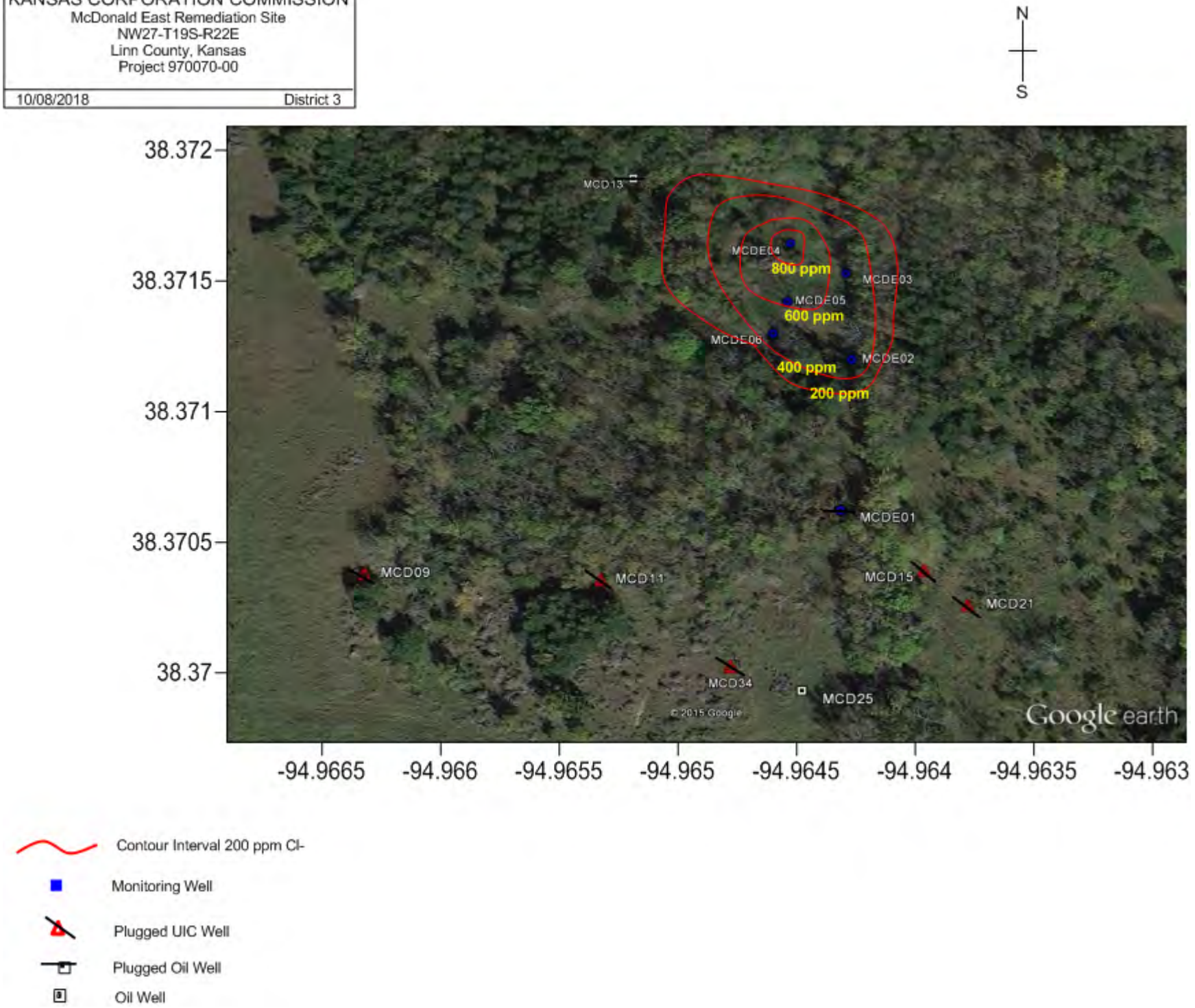
Current Contaminate Level: 500 ppm Cl- to 900 ppm Cl-

Status: Active

☐ **1. Site Assessment**	☐ **2. Short Term Monitoring**	☐ **3. Investigation**
☒ **4. Long Term Monitoring**	☐ **5. Remediation Plan**	☐ **6. Installation**
☐ **7. Remediation**	☐ **8. Post Rem. Monitoring**	☐ **9. Resolved**

KANSAS CORPORATION COMMISSION
McDonald East Remediation Site
NW27-T19S-R22E
Linn County, Kansas
Project 970070-00

10/08/2018 District 3



Project: ***McPherson Landfill-Johnson Oil Field Contamination Site***

Site Location: The McPherson Landfill itself is located in Section 34, Township 19 South, Range 3 West, in McPherson County, approximately .75 miles southeast of the city of McPherson. The affected areas include Sections 33 & 34, Township 19 South, Range 3 West, and Sections 3, 4 & 5, Township 20 South, Range 3 West.

Impact/Immediacy: The contamination has impacted industrial water supply wells for the CHS Refinery formerly the National Cooperative Refinery Association (NCRA), as well as domestic rural water wells. This site has a moderate immediacy level.

Site Description: The site is located in rural McPherson County near the old landfill and the CHS refinery. The area of contamination lies on the west side of the Johnson Oil Field, which is the probable source of the high salinity in the ground water.

Unusual Problems: None.

Status of Project: Since 2003 CHS has annually provided a report on their East Refinery Groundwater Quality Improvement Project, and the Groundwater Monitoring Plan. A full report from the consulting company, Trihydro Corporation is on file with the KCC. The goals for this project include mitigating chloride impacted oil field brine water migrating from the Johnson Oil field east of the refinery, and preventing lateral movement of the identified hydrocarbon plume beneath the refinery toward the chloride remediation system. The remediation system consists of 12 recovery wells, RW-7 through RW-18, which are all screened in the lower portion of the Equus Beds aquifer. In 2017 a total of 546 acre-feet of chloride impacted water was recovered from 7 of the recovery wells (RW). The RW wells utilized (RW7, 8, 11, 12, 13, 14, & 18) ranged from an average of 499 to 871 mg/l for 2017. According to the 2017 annual report, recovered water is treated on-site using a reverse osmosis system and used as refinery process water. The processed water not meeting standards is injected into a Class I non-hazardous disposal well.

Overall, the June 2018 sampling of the 16 deep screened CHS monitoring wells showed some decrease in chloride values (350 – 2,330mg/L). KCC sampled MW 7D and MW 8D at the old landfill on August 30, 2018, and have included that data along with data collected by GMD2. The two areas that continue to exhibit very elevated chlorides are around EB 402C (4,790 mg/L), and MW 114D (2,610 mg/l). Both of these monitoring wells increased in chloride levels in 2018. MW 114D is adjacent to the refinery and most likely affected by the recovery wells pulling in higher chloride waters. EB 402C sits off in Section 3, SE of the refinery and appears to be trapped chlorides along the bedrock, as those values have always fluctuated between 4,000 to 5,000 mg/L since 2005.

Level of Remediation Sought:

Ideal: 250 ppm chlorides
Target: 500 ppm chlorides.

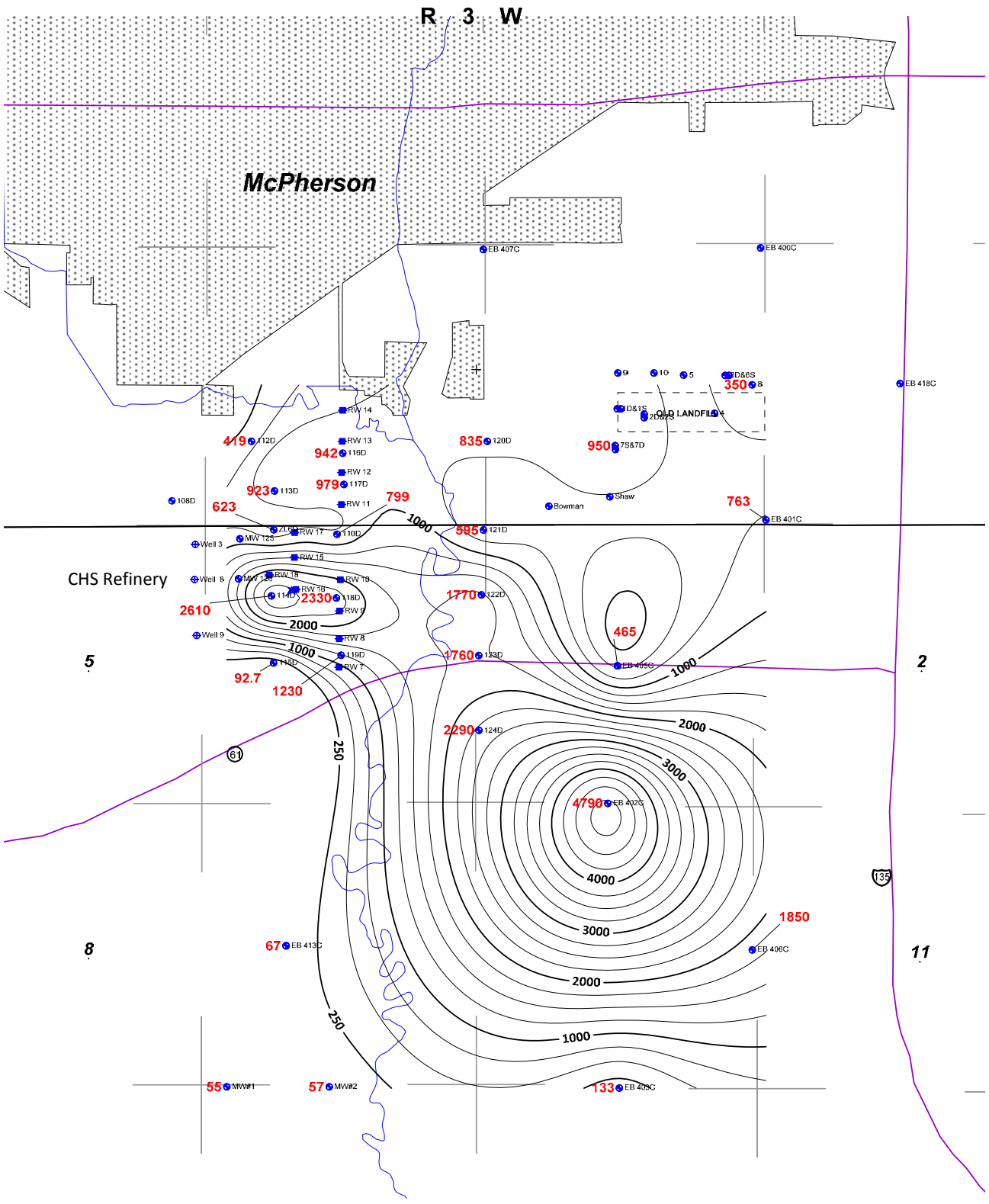
Recommendations for Future Work: Collect data on an annual basis from CHS, GMD2 and the old landfill.

Estimated Total Costs: KCC provides funding to GMD2 for sampling surrounding monitoring wells.

Control No.	Staff Hours/Expenditures	Fund Expenditures FY 2018/19	Fund Expenditures Total
980034-001	18.5 Hrs. / $$657.53	$604.00	$22,364.45

Current Contaminate Level: 55 mg/l (MW-1) to 4,790 mg/l (EB 402C) - 2018
Recovery wells averaged 499 to 871 mg/l chlorides in 2017
Status:

☐ 1. Site Assessment	☐ 2. Short Term Monitoring	☐ 3. Investigation
☒ 4. Long Term Monitoring	☐ 5. Remediation Plan	☐ 6. Installation
☒ 7. Remediation (CHS)	☐ 8. Post Rem. Monitoring	☐ 9. Resolved



LEGEND

- Monitoring Well
- NCRA Recovery Well
- NCRA Water Supply Well

1880 118D *Numbers in RED are Chloride Values*
Numbers in BLACK are Monitoring Well Numbers

Contour Interval = 250 mg/l

KANSAS CORPORATION COMMISSION
McPherson Landfill-Johnson Oil Field 2018
2018 CHLORIDE MAP
T19S & T20S-R3W, McPheron County, KS

Dist. 2	Control No. 980034-01	10-4-2018	J. Klock

SCALE
0 0.25 0.5 0.75 1
MILES

Project: ***Nikkel-Epps***

Site Location: The Nikkel-Epps contamination site is located in the NE/4 of Section 18, Township 20 South, Range 1 West, in McPherson County.

Impact/Immediacy: Medium-high immediacy level. Chlorides here affect a shallow groundwater aquifer with multiple residences within a half mile, some of which use the aquifer as the sole source of water. There is crop irrigation in the area side and down gradient as well.

Site Description: The aquifer resides in the McPherson Formation which consists of two to three sand units separated by clay layers. At the base of the aquifer lies the Wellington Shale. The aquifer appears to contain several possible aquitards, which could be impermeable clays separating the sands. It is unknown if these clays are continuous throughout the area. Due to the depth that the saltwater has been found it is assumed that a potential pathway/s down to the Wellington Formation exist. The land surface is flat irrigated farmland. Chlorides seem to be settling along the Wellington Shale contact. The top of the Wellington is an erosional disconformity which can allow for high relief channels and bumps within the shallow aquifer.

Unusual Problems: Like many other chlorides problems in the area, the chlorides can be hit and miss and contained in 'hot spots' down-gradient of old evaporation pits and settling in deeper pockets within the aquifer. Farming practices have destroyed half of the monitoring wells installed by the KCC.

Status of Project: The Nikkel-Epps site has historically known brine water contamination since at least the late 1960's when a local homestead complained that the domestic well had turned unusable due to saltwater intrusion. KCC first investigated the issue in 2007 when an irrigation well battery was drilled in the northeast corner of section 18 and killed the soybean crop planted that year. The irrigation and local domestic well were sampled and showed varying degrees of brine contamination. In 2011-12 KCC drilled and installed 7 monitoring wells surrounding the investigated wells in the northwest corner of section 18. In 2013, the tenant farmer struck and destroyed all of the northern monitoring wells while discing the agricultural field. The wells were either broken and buried or snapped to far below ground surface to be repaired. KCC has been sampling the southern wells and the domestic well near MW-2 to date.

On September 25th, 2018, MW-2, MW-3, MW-3S, and MW-5 groundwater monitoring wells were gauged and sampled for chloride levels. Chloride levels have risen at MW-5 (310ppm) and in MW-2 (1,550ppm) from the 2017 sampling event. The middle well, MW-3 (400ppm), lab results were slightly lower than 2017. The domestic well at the Ratslaff Homestead rose to 1,190 ppm which is alarming as the homestead is not on rural water and still utilizes the well for non-drinking purposes. KCC during the 2018 year has performed research for the development of a Phase II investigation including the drilling and installation of more monitoring wells, performing soil borings, and a comprehensive surrounding water well sampling program.

Level of Remediation Sought:

Ideal: <250 ppm
Target: 500 ppm

Recommendations for Future Work: KCC has not replaced or added new wells to the Nikkel-Epps investigation. Without the northern monitoring wells, the site is currently hard to interpret in regards to chloride migration. The Ratslaff domestic well has tested over 1,000 ppm the last few years (not used for drinking purposes). For these reasons, the Nikkel-Epps Site is now higher on the priority list. Evidence suggests that the main brine plume has a source(s) in section 7 up gradient to the site. Currently there is no delineation to the north or down gradient south of the site. At the minimum, five wells are recommended to be installed as a Phase II study, which will enable the KCC to devise a suitable remediation plan if feasible and assist the Ratslaff homestead in finding a new water source. There are other domestic and irrigation wells in the next section south of the site which could be affected in the future.

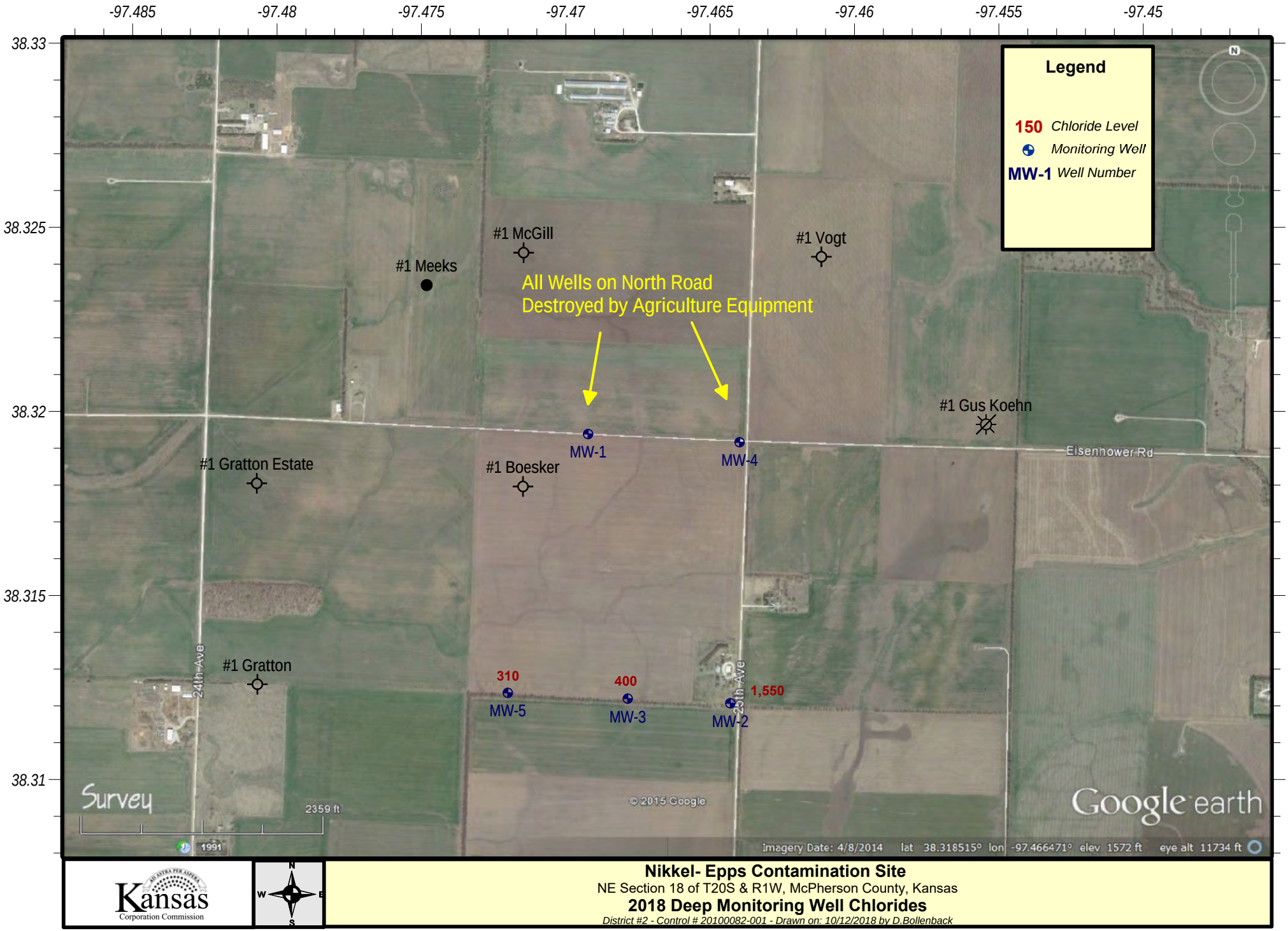
Estimated Total Costs: $10,000 to $30,000 to drill the new wells and repair broken wells during a Phase II investigation. The KCC District #2 will also need funding for sampling, research, and report preparation.

Control No.	**Staff Hours/Expenditures**	**Fund Expenditures**	
		FY 2018/19	**Total**
20100082-001	**20 Hrs. / $565.16**		**$8,318.75**

Current Contaminate Level: MW-5 310 ppm to MW-2 1550 ppm.

Status:

☐ **1. Site Assessment**	☐ **2. Short Term Monitoring**	☒ **3. Investigation**
☒ **4. Long Term Monitoring**	☐ **5. Remediation Plan**	☐ **6. Installation**
☐ **7. Remediation**	☐ **8. Post Rem. Monitoring**	☐ **9. Resolved**


-97.485
-97.48
-97.475
-97.47
-97.465
-97.46
-97.455
-97.45
38.33
38.325
38.32
38.315
38.31
Legend
150 Chloride Level
Monitoring Well
MW-1 Well Number
#1 McGill
#1 Vogt
#1 Meeks
All Wells on North Road
Destroyed by Agriculture Equipment
#1 Gus Koehn
MW-1
MW-4
Eisenhower Rd
#1 Gratton Estate
#1 Boesker
24th Ave
#1 Gratton
310
MW-5
400
MW-3
1,550
MW-2
28th Ave
Survey
2359 ft
1991
© 2015 Google
Google earth
Imagery Date: 4/8/2014 lat 38.318515° lon -97.466471° elev 1572 ft eye alt 11734 ft
Kansas
Corporation Commission
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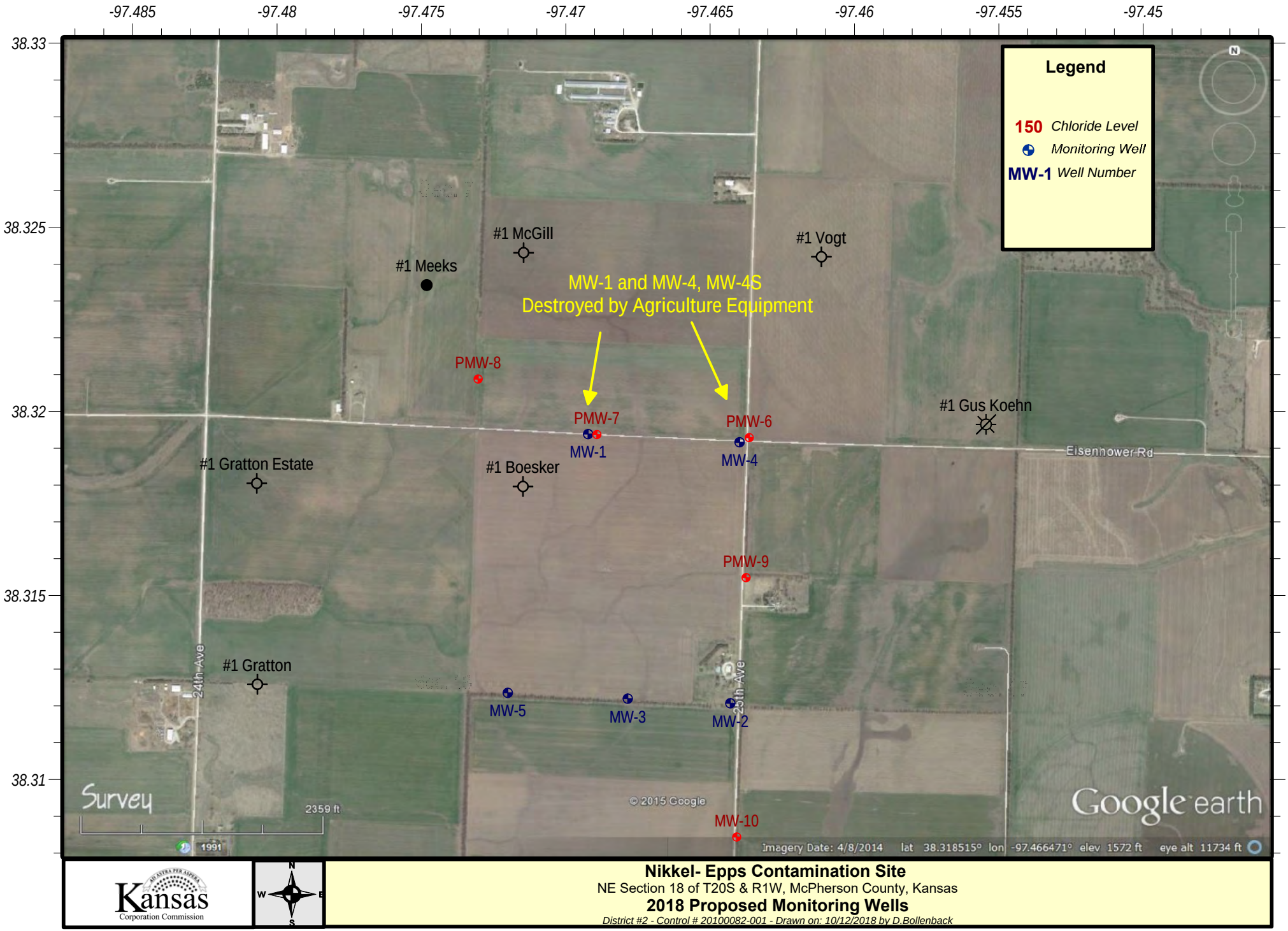
Nikkel- Epps Contamination Site
NE Section 18 of T20S & R1W, McPherson County, Kansas
2018 Deep Monitoring Well Chlorides
District #2 - Control # 20100082-001 - Drawn on: 10/12/2018 by D.Bollenback



Kansas Corporation Commission

Nikkel- Epps Contamination Site

NE Section 18 of T20S & R1W, McPherson County, Kansas

2018 Proposed Monitoring Wells

District #2 - Control # 20100082-001 - Drawn on: 10/12/2018 by D.Bollenback

Project: ***Packard Contamination Site***

Site Location: Legal location is Section 15, 22, 23 Township 31 South, Range 13 West, in Barber County. 7 miles west of Medicine Lodge on River Road.

Impact/Immediacy: The groundwater has been contaminated and a very good water well has been contaminated with chlorides. Immediacy level is rated as moderate.

Site Description: The salt-water plume is moving to the south away from the Packard #1 oil well. It has contaminated the water supply well and could possibly damage the domestic well at the abandoned house, the supply well in the SE/4 of section 23, and the spring to the southwest.

Unusual Problems: The contamination could be from multiple sources.

Status of Project: A total of four samples were taken in 2018. Three monitoring wells samples were taken in addition to a house well. Chloride data shows the plume remains confined. Chlorides historically have decreased, but over the past several years have remained consistent.

Level of Remediation Sought:

Ideal: 250 ppm Chloride
Target: 1000 ppm Chloride

Recommendation for Future Work: Monitoring will continue on an annual basis as the area continues to be remediated by natural attenuation. As the groundwater in this area is relatively shallow, several holes may be augured in order to gather more comprehensive data on the size and whereabouts of the chlorides. Depending on the information gathered, additional permanent monitoring wells may need to be installed. Analytical may need to be run on the new south supply well in order to determine if the chlorides are of a natural source, or from oilfield activities.

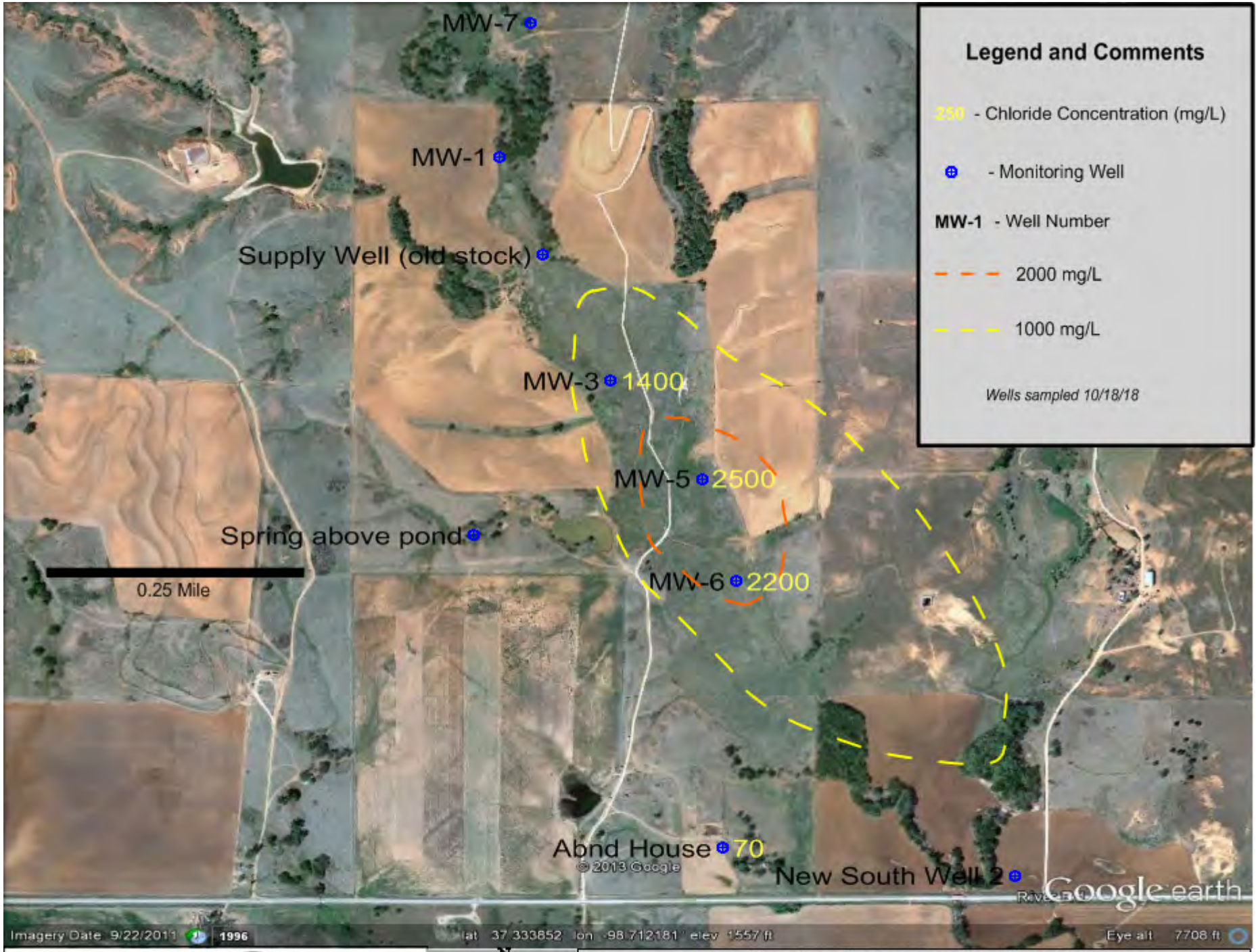
Estimated Total Costs: $10,000

Control No.	**Staff Hours/Expenditures**	**Fund Expenditures**	
		FY 2018/19	**Total**
970075-00	**12.5 Hrs. / $366.99**		**$310.09**

Current Contaminate Level: 70ppm CL- 2500 ppm CL-

Status:

☐ **1. Site Assessment**	☐ **2. Short Term Monitoring**	☐ **3. Investigation**
☒ **4. Long Term Monitoring**	☐ **5. Remediation Plan**	☐ **6. Installation**
☐ **7. Remediation**	☐ **8. Post Rem. Monitoring**	☐ **9. Resolved**


MW-7
MW-1
Supply Well (old stock)
MW-3 1400
MW-5 2500
Spring above pond
MW-6 2200
0.25 Mile
Abnd House 70
New South Well 2
© 2013 Google
Google earth
Imagery Date 9/22/2011 1996
Legend and Comments
250 - Chloride Concentration (mg/L)
- Monitoring Well
MW-1 - Well Number
2000 mg/L
1000 mg/L
Wells sampled 10/18/18
Kansas
Corporation Commission
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Packard Contamination Site
Sections 15/22/23-T31S-R13W
Barber, County Kansas
2018 Area Map with Chlorides
KCC Control # 970075-00 District1-K. Sullivan 10-29-18

Project: ***Ruder Contamination Site***

Site Location: Sections 17, 20, and 28 of Township 15 South, Range 18 West, Ellis County.

Impact/Immediacy: The Ruder Creek Alluvial Aquifer has been impacted by brine intrusion due to surface ponds, shallow disposal wells in the Cheyenne Sandstone, and numerous leaks. The Immediacy level for this site is rated as moderate.

Site Description: Ruder Creek runs southwest of US 183 from near Hays to the Smoky Hill River near Schoenchen. North of the site, Ruder Creek is divided into east and west branches, which come together into the main trunk in the northern section of the site. The area is almost exclusively range land with a subtle relief from the uplands to the bed of the stream. Documented oil field pollution has existed in the drainage since the 1930's, and correspondence made during 1954 states that the west branch was fresh while the east branch and the main trunk of the stream were heavily impacted by brine. Historical aerial photographs show many pits and tank battery locations directly adjacent to the stream. The sources of pollution in this area have been numerous, and geographically as well as temporally wide spread, complicating the investigation and remediation of the overall issue.

Unusual Problems: Proximity to the City of Hays' public water supply well field.

Status of Project: Presently, the chloride concentrations in the monitoring wells range from 1,050 ppm in the northern end of the site, to 250 ppm in the southern monitoring well near the Smoky Hill River. This north-south chloride gradient has persisted for many years. Appreciable decreases in chloride contamination have not been observed throughout the duration of sampling, and it is unknown if the input of additional contaminants has been halted by the closure of surface pits, plugging of flowing wells, and general improvement of lease practices. A test hole augured in 2018 approximately 100' north east of the northern monitoring well (MW1) produced water with a concentration of only 600 ppm. It is not yet known if this is representative of the groundwater north of this well, and further work will be conducted to determine if MW1, which was not completed in alluvium, is anomalous.

Level of Remediation Sought:
Ideal: 250 ppm Chloride
Target: 500 ppm Chloride

Recommendations for Future Work: Conspicuous potential sources of pollution have been identified on a historical aerial photograph, and a conductivity survey will be carried out and combined with additional groundwater sampling. This site will continue to be monitored on an annual basis, and resources will be compiled to identify other possible sources of pollution.

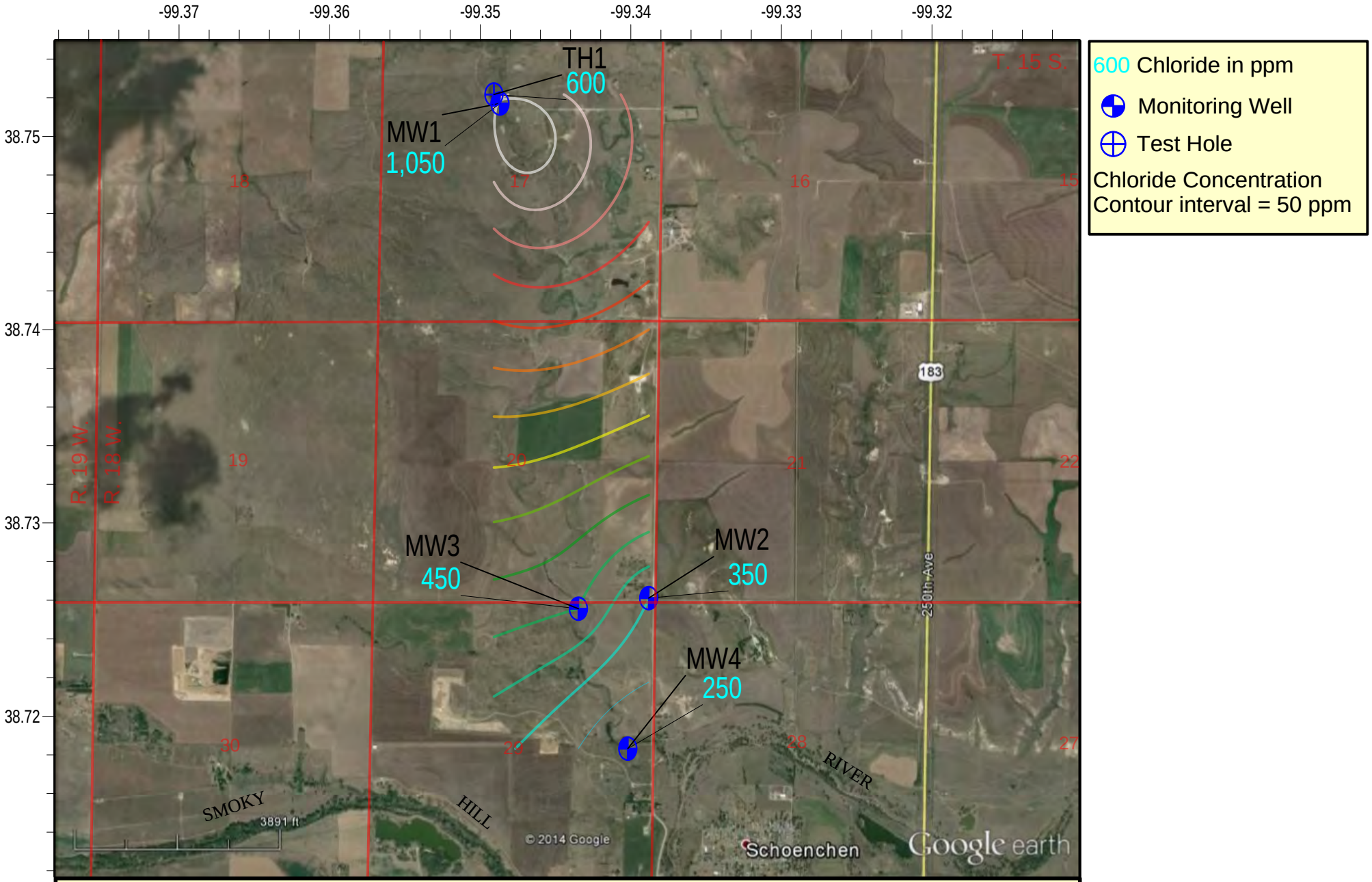
Estimated Total Costs: $29,000

Control No.	**Staff Hours/Expenditures**	**Fund Expenditures FY 2018/19**	**Total**
970082-00	**53 Hrs. / $1,496.51**		**$12,960**

Current Contaminate Level: 250 ppm to 1,050 ppm Cl^-

Status:

☐ **1. Site Assessment**	☐ **2. Short Term Monitoring**	☒ **3. Investigation**
☒ **4. Long Term Monitoring**	☐ **5. Remediation Plan**	☐ **6. Installation**
☐ **7. Remediation**	☐ **8. Post Rem. Monitoring**	☐ **9. Resolved**



Ruder Creek Groundwater Monitoring Site

Sections 17, 20, and 29 of Township 15 South, Range 18 West, Ellis County, Kansas
2018 Groundwater Chloride Levels
District #4 - Sampled 8/6/2018 - Map Drawn on 8/9/2018 by C. Neeley

Kansas Corporation Commission

Project*: Running Turkey Creek*

Site Location: The area of contaminated surface and ground water is in the Running Turkey drainage pattern and appears to start in the N/2 of 26-19S-2W. This area is within the Ritz Canton oil field, east of Galva, and extends south of Highway 56.

Impact/Immediacy: Oil field impact to the soil can be seen through out the area of the oil fields along the drainage basin. Due to the age of the area oil fields, many spills, line leaks and old brine pits have caused damage to soil and water resources. Ground water used for domestic, irrigation and potential public water supplies is the largest and problematic resource affected by the contamination zones. The immediacy rating is moderate to high.

Site Description: The topography of the area is flat to gently rolling hills. Most of the land is under cultivation. The ground water also flows generally in a south to southwest direction with minor hydrologic anomalies. The ground water contamination is highest near the bedrock contact. Local geology consists of fine textured soils that exhibit strong clay-pan development. These soils are underlain by loess deposits of Quaternary Age which lay on top of McPherson Formation sands and gravels. Depth to sands in the area ranges from as little as 5 feet to 60 feet. The Wellington Shale forms the bedrock in the area. The Wellington had been eroded prior to deposition of the McPherson and has erosional contact along with various paleo-valley and related structures.

Unusual Problems: In order to delineate this site a monitoring well matrix may have to spread for a large distance. Ritz-Canton Oil Field brine contamination can have multiple sources which will complicate delineation. It is unclear if direct connection of the north and far south (South of Highway 56) wells is occurring or if they are separate plumes.

Status of the Project: This site is in a monitoring phase, though investigations are warranted in order to delineate the plume. The monitoring wells are sampled using submersible pumps or air-lift technology depending on the depth of the well. Overall the plume within this site has remained stable over 2017. MW-202 had a small increase in chlorides from 2016. All wells were sampled on September 25th and 26th, 2018. Lab results from the 2018 samples show stable chlorides in the heart of the plume, with a decrease on the up gradient northern edge. Heavy Precipitation may be the reason for the changes up gradient from the higher chlorides. This area is now within the GMD#2 boundaries.

Level of Remediation Sought:

Ideal: 250 mg/l mg/l
Target: 500 mg/l

Recommendation for Future Works: Continue with the annual monitoring program of the site as the highest chlorides are still over 20,000 mg/L chlorides. KCC District #2 plans to put together a scope of work which would entail the plugging/repair of certain wells within the site as well as the drilling and installation of no fewer than 10 new monitoring wells in order to delineate the very highly contaminated area in the east-northeast of the plume, and define the down gradient plume. It is unclear if the down gradient plume is related, or if there are more sources south of the main plume. A Galva-like remedial set up could be designed but would cost upward of $350,000 or even more if a disposal well was needed to be drilled or washed-down.

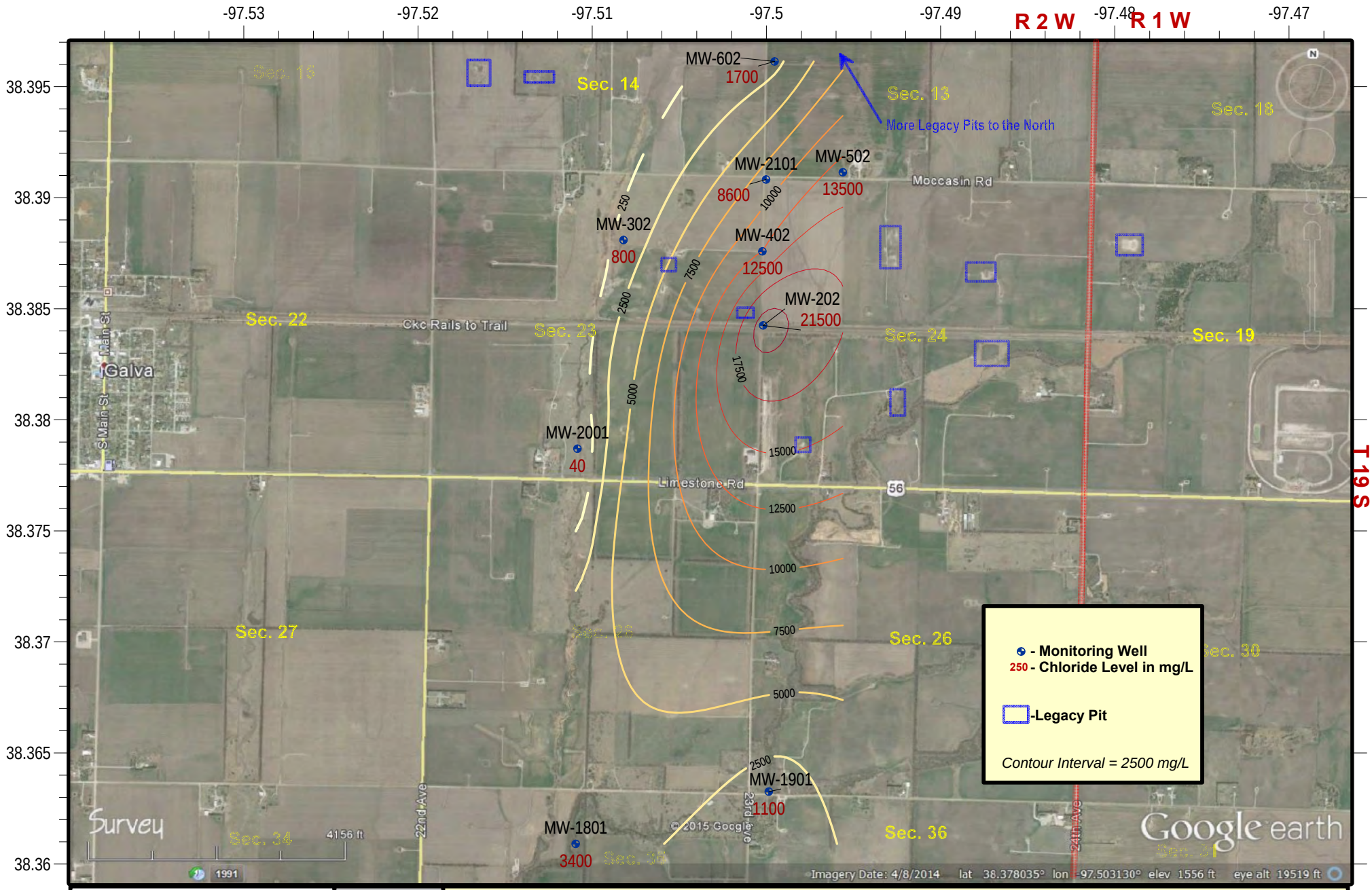
Estimated Total Cost: $1,000 for annual sampling and research. If a new investigation is begun, cost will rise as a sizable amount of time and research will be needed to plan the next phase of this site. Installation of more monitoring wells would range from $20,000 to $30,000.

Control No.	**Staff Hours/Expenditures**	**Fund Expenditures FY 2018/19**	**Total**
20010033-001	**20.5 Hrs. / $578.81**		**$61,603.07**

Current Contaminate Level: 40 mg/l Cl^- MW-2001 to 21,500 mg/l Cl^- MW-202 (Aquifer)

Status:

☐ **1. Site Assessment**	☐ **2. Short Term Monitoring**	☒ **3. Investigation**
☒ **4. Long Term Monitoring**	☐ **5. Remediation Plan**	☐ **6. Installation**
☐ **7. Remediation**	☐ **8. Post Rem. Monitoring**	☐ **9. Resolved**



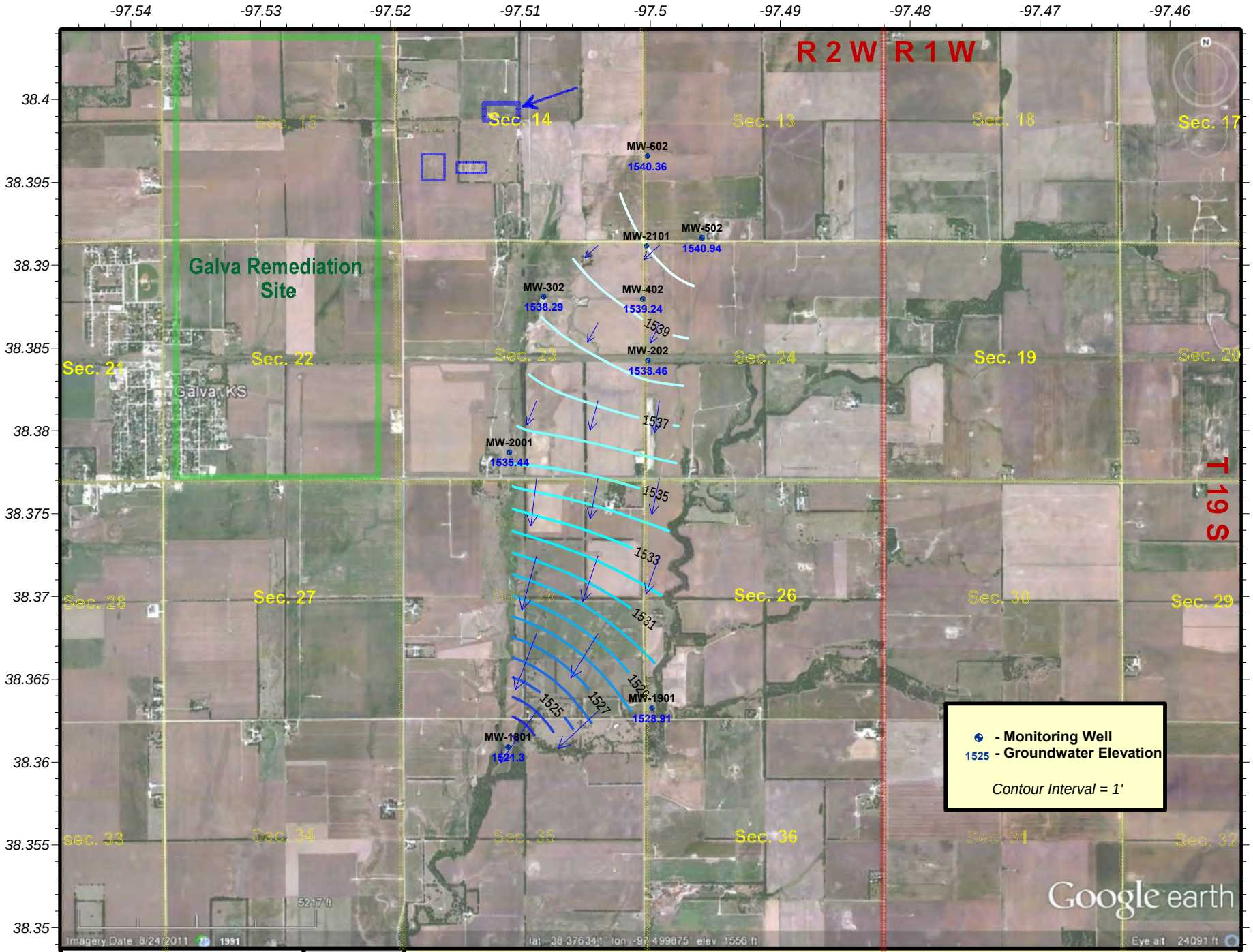
Kansas Corporation Commission

Northern Running Turkey Creek Contamination and Monitoring Site - KCC Control #20030059-001

Multiple sections in Township 19 & 20 South and Range 2 West, McPherson County, Kansas

2018 Groundwater Chloride Levels

District #2 - Sampled 9/25-26/2018 - Map Drawn on 10/15/2018 by D.Bollenback



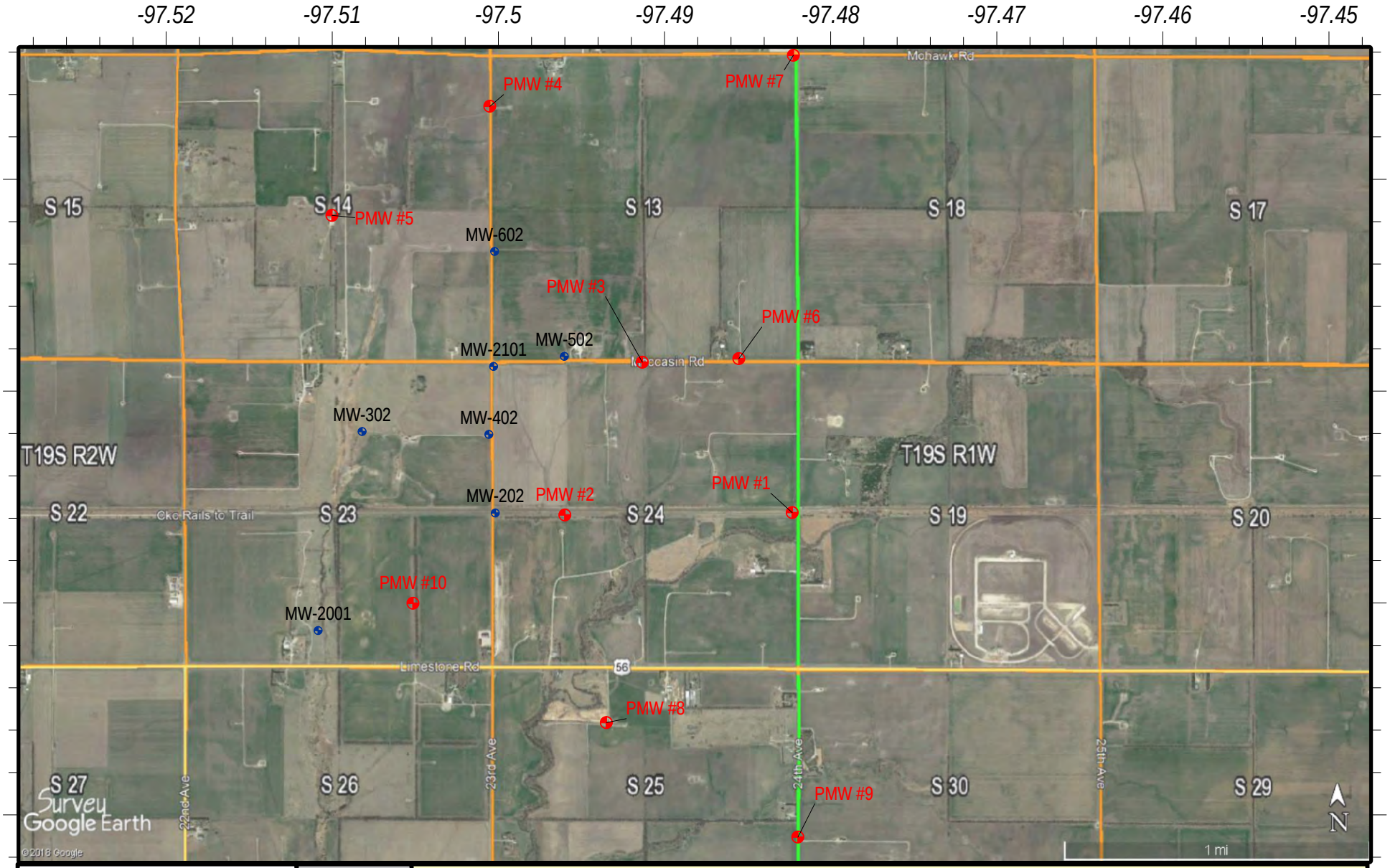
Kansas Corporation Commission

Northern Running Turkey Creek Contamination and Monitoring Site

Multiple sections in Township 19 & 20 South and Range 2 West, McPherson County, Kansas

2018 Groundwater Elevation Map

KCC Control #20030059-001 - District #2 - Levels gauged 9/25-26/2018 - Map Drawn on 10/15/2018 by D.Bollenback



Kansas Corporation Commission

N W E S

Running Turkey Creek Contamination and Monitoring Site

Multiple sections in Township 19 & 20 South and Range 2 West, McPherson County, Kansas

2018 Proposed New Monitoring Wells

KCC Control #20030059-001 - District #2 - Map Drawn on 10/15/2018 by D.Bollenback

Project: ***City of Russell Contamination Site***

Site Location: Within and around the City of Russell, in Parts of Township 13 South, Range 14 West and Township 14 S, Range 14 W, Russell County.

Impact/Immediacy: Brine contamination of a shallow aquifer utilized primarily for lawn and garden purposes such as irrigation of lawns. Immediacy level is rated as low.

Site Description: Potential sources include the approximately 334 wells drilled either in the city limits or in close proximity to the city limits, and the associated drill pits, lead lines, tank battery sites, brine tanks, brine lines, and emergency pits. In addition, there are 36 oil wells and UIC wells within this site that are either abandoned or have little or no documentation to confirm that they have been plugged. Test holes were drilled in the area during the summer of 2001 in an effort to delineate the source of the contamination. Data collected through the test holes, and other research indicated that the major contributor of chloride ions may be a former brine pit located to the northwest of the city. However, there has been extensive oil and gas development in the same vicinity, and the contribution from old drill pits and old line leaks has not been determined.

Unusual Problems: The investigation of all potential contamination sources would be costly and not without challenges. If remediation is initiated, the disposal of contaminated water would incur severe costs and logistical problems.

Status of Project: In September of 2004, the monitor well tested at 2,200 ppm chloride. No samples were taken between 2004 and 2014 due to the well being inaccessible. In 2014, the well was accessed, and the chloride concentration was 1,250 ppm and 1,500 in 2015. The well has been inaccessible since 2016, though in 2018 access restrictions have been resolved, and annual sampling will resume in spring 2019.

Level of Remediation Sought:
Ideal: 500 ppm Chloride
Target: 1000 ppm Chloride

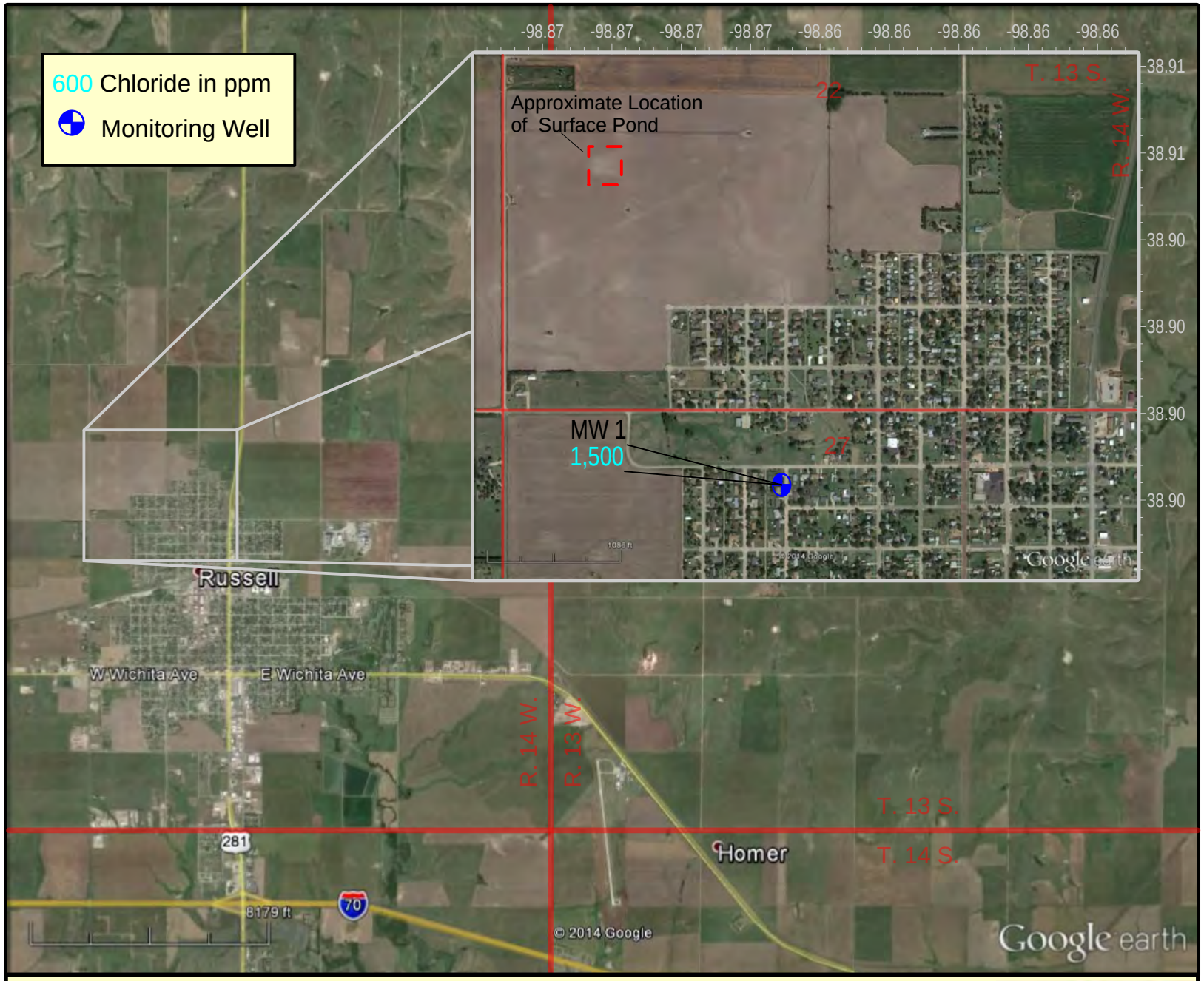
Recommendations for Future Work: Further research may be needed to determine whether remediation is justifiable, and what action should be taken. Additional samples may be collected in the future to determine the configuration of the brine plume, and if the chloride concentration in our monitoring well is characteristic for the entire area.

Estimated Total Costs: $400,000.

Control No.	**Staff Hours/Expenditures**	**Fund Expenditures**	
		FY 2018/19	**Total**
970083-00	**3 Hrs. / $101.23**		**$1,192.60**

Current Contaminate Level: 1,500 ppm Cl^-
Status:

☐ **1. Site Assessment**	☐ **2. Short Term Monitoring**	☐ **3. Investigation**
☒ **4. Long Term Monitoring**	☒ **5. Remediation Plan**	☐ **6. Installation**
☐ **7. Remediation**	☐ **8. Post Rem. Monitoring**	☐ **9. Resolved**



City of Russell Groundwater Monitoring Site

Sections 22 and 27, Township 13 South, Range 14 West, Russell County, Kansas
2018 Groundwater Chloride Levels
District #4 - Sampled 10/28/2015 - Map Drawn on 10/30/2018 by C. Neeley

Kansas Corporation Commission

Project: ***Russell Rural Water District #1***

Site Location: Section 34 and 35, Township 14 South, Range 14 West, Russell County.

Impact/Immediacy: A public water supply well is producing water with elevated chloride content. The immediacy level is rated as low to moderate.

Site Description: The hydrology of the area is complicated through the interaction of a shallow drainage mantled with alluvium, the Smoky Hill aquifer, and the Dakota Sandstone aquifer. The public water supply well was drilled to the north of the river, in hope of utilizing the alluvium. However, the well is sufficiently deep to be drawing water directly from either the Smoky Hill aquifer, or the Dakota. Additionally, the geology of the area may not provide a seal between the otherwise fresh shallow aquifers and the Dakota aquifer. Although the area has undergone significant oil and gas development, no active sources for pollution have been identified. Furthermore, the Dakota Sandstone was an early disposal formation in the area.

Unusual Problems: Research conducted by the Kansas Geological Survey in 1991 and 1992 showed that the chloride content of the Smoky Hill River in the vicinity of this site ranged from 843 ppm to 1,879 ppm, with oil field brines contributing 11% to 29% of the total concentration. The major natural chloride source is the dissolution of halite in Permian strata, which migrates into and through the Dakota Sandstone into the alluvium and river itself. Because of the difficulty in locating the source of the oil field brines, and the natural input of saline water, remediation of this site would not be feasible; however, each household served by the RWD is utilizing a reverse osmosis filtration system, mitigating the problem to some degree.

Status of Project: Over the previous 5 years, the chloride concentrations of the monitoring wells have remained steadily between 500 ppm and 900 ppm. Presently, the wells contain chloride concentrations of 400 ppm in MW 1, and 800 ppm in MW 3, and 600 in MW 5.

Level of Remediation Sought:
Ideal: 100 ppm Chloride
Target: 250 ppm Chloride

Recommendations for Future Work: This site should be monitored on an annual basis.

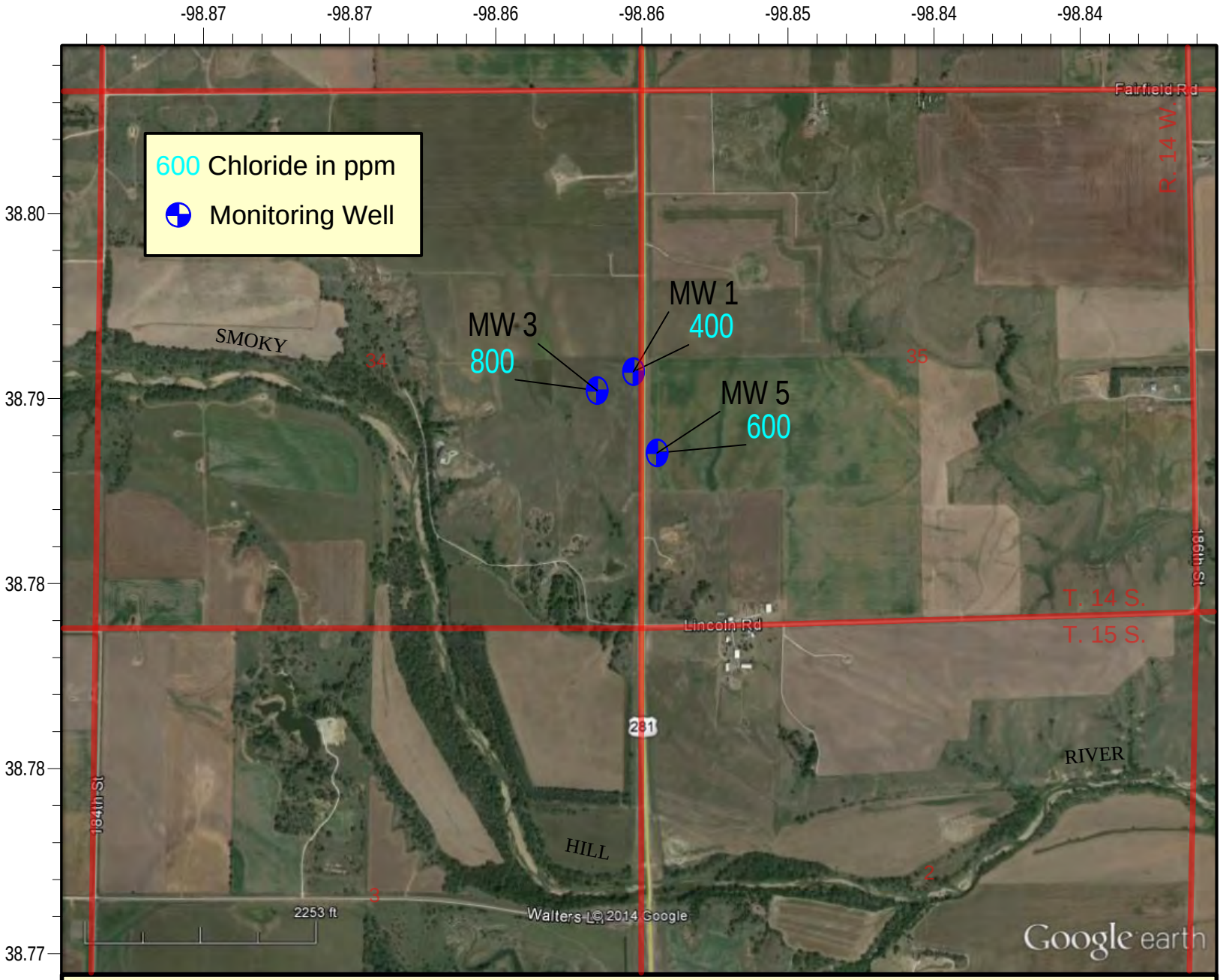
Estimated Total Costs: The estimated costs to KCC and KDHE for extensive studies in the past have been $30,000 or greater. Continued monitoring costs will be $3,000.00.

Control No.	**Staff Hours/Expenditures**	**Fund Expenditures FY 2018/19 Total**
970084-00	**9 Hrs. / $270.10**	

Current Contaminate Level: 400 ppm to 800 ppm Cl^-

Status:

☐ **1. Site Assessment**	☐ **2. Short Term Monitoring**	☐ **3. Investigation**
☒ **4. Long Term Monitoring**	☐ **5. Remediation Plan**	☐ **6. Installation**
☐ **7. Remediation**	☐ **8. Post Rem. Monitoring**	☐ **9. Resolved**



Russell Rural Water District #1 Groundwater Monitoring Site

Sections 34 and 35, Township 14 South, Range 14 West, Russell County, Kansas

2018 Groundwater Chloride Levels

District #4 - Sampled 7/6/2018 - Map Drawn on 8/9/2018 by C. Neeley

Kansas Corporation Commission

Project: ***Sample Contamination Site***

Site Location: The contamination area is located at the intersection of 45th Street North and Rock Road in Wichita. The legal location is the NW of the NW of Section 29 Township 26 South Range 2 East, Sedgwick County.

Impact/Immediacy: This site is very low immediacy. The chloride intrusion affects a groundwater aquifer that is very low volume. Housing development in the area could see rise in water well installation for domestic and heating/cooling systems.

Site Description: The site is located on the outskirts of a metropolitan housing development, but is being encroached on from all sides. The topsoil is hard clay (Wellington formation). The underlying aquifer is a thin low volume zone that is directly affected by precipitation. Total depth of the monitor well is nineteen feet.

Unusual problems: A portion of the chlorides is natural and could not readily be remediated. The aquifer is low volume and difficult to clean up. The urban setting logistically makes remediation difficult. Continued residential development could see increased attempts of use of the groundwater in the area.

Status of Project: A water sample collected in 2018 tested 5,000 mg/L chlorides. The chlorides have increased from 2017 by 2,350 mg/L. The change in chlorides could be from multiple factors including more precipitation in 2018 and high water levels. Historical data shows that chlorides this high occur when static water level is higher. This could be due to more groundwater moving through the Wellington which can contain a large amount of mineralization.

Level of Remediation Sought:

Ideal: 250 mg/l Chloride
Target: 500 mg/l Chloride

Recommendations for Future Work: KCC recommends continuation of monitoring the site for chlorides. Site is located only one mile north of the District #2 Field Office so limited resources are needed to continue monitoring this site. Remediation of this site could be started by pumping fluid from the monitoring well to the oil field salt-water tank located on site. Poor recovery and permeability in the local aquifer would hamper remedial efforts. Research, map, and investigate any new domestic wells in the area for contamination and begin sampling domestic wells in the area for annual report if contamination is found.

Estimated Total Costs: $300 per year for site inspection, sample collection, and research.

Control No.	**Staff Hours/Expenditures**	**Fund Expenditures FY 2018/19 Total**
970088-00	**3 Hrs. / $101.23**	

Current Contaminate Level: 5,016 mg/L Chlorides

Status:

☐ **1. Site Assessment**	☐ **2. Short Term Monitoring**	☐ **3. Investigation**
☒ **4. Long Term Monitoring**	☐ **5. Remediation Plan**	☐ **6. Installation**
☐ **7. Remediation**	☐ **8. Post Rem. Monitoring**	☐ **9. Resolved**

Kansas Corporation Commission

Sample 'A' Groundwater Monitoring Site

NW NW Section 29 of Township 26 South & Range 2 East, Sedgwick County, Kansas

2018 Area Map with Chloride Level of MW-1

KCC Project Code #970088-00 - District #2 Field Office - Site Sampled on 10/130/2018- Map Drawn on 10/30/2018 by D.Bollenback

Project: ***Sander Contamination Site***

Site Location: Section 03, Township 14 South, Range 15 West, Russell County.

Impact/Immediacy: A shallow aquifer and small drainage have been impacted by poor oil field practices. A stock well serves as the monitoring well. The immediacy level for this site is rated as low.

Site Description: The site is situated near the head of a small, intermittent tributary to Big Creek. The soils are Harney and Roxbury silt loam, and the area is divided equally between pasture along the creek, and cultivation in the higher portions of the location. Near-surface geological information is limited to data obtained through a few water well records covering many square miles; however, a reasonable hypothesis would be to expect topsoil to a depth of approximately six feet, atop a sand about ten feet thick. Shale bed rock is likely to be encountered at a depth of 15 to 20 feet below the surface, and a common depth for the area water wells is roughly 30 feet. The site is located within the Gorham oil field, which was discovered in 1926, and multiple water flood projects have been implemented within the field.

Unusual Problems: None.

Status of Project: Chloride levels were at 1,650 ppm in the stock well when it was tested in October 2005. Chloride concentrations dropped to 1,500 ppm in 2007 and again to 1,250 ppm in 2008. Samples were not collected between 2008 and 2014, due to the pump on the well being in disrepair, and incapable of lifting a sample. The sample gathered in 2014 was obtained from a domestic water well to the north in Sec. 34, T. 13 S., R. 15 W. The sample from this well was tested and contained 300 ppm chloride. Neither well was available to district staff in 2015. The well is now equipped with an electric pump and float switch which will enable sampling to be carried out. A sample collected from a stock tank set at the pump was 675 ppm in 2016 and 975 ppm in 2017. In 2018, the sample was collected directly from the well, and was 900 ppm. The site will transition to short-term monitoring, and if the water remains below the target level, the site will be closed.

Level of Remediation Sought:
Ideal: 500 ppm Chloride
Target: 1000 ppm Chloride

Recommendations for Future Work: Continue to monitor in the short term.

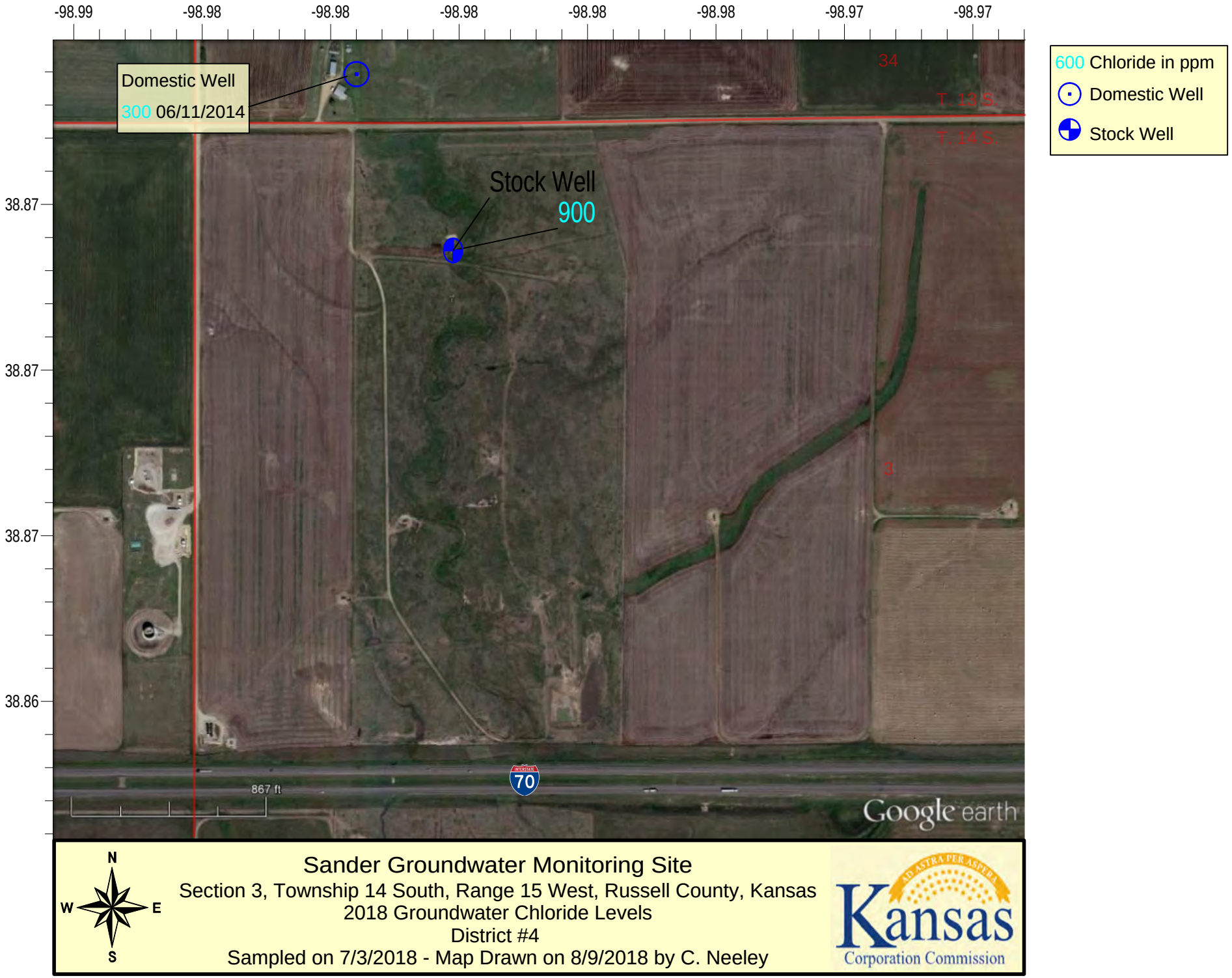
Estimated Total Costs: $300.00

Control No.	**Staff Hours/Expenditures**	**Fund Expenditures FY 2018/19 Total**
970089-00	**4 Hrs. / $130.23**	

Current Contaminate Level: 900 ppm

Status:

☐ **1. Site Assessment**	☒ **2. Short Term Monitoring**	☐ **3. Investigation**
☐ **4. Long Term Monitoring**	☐ **5. Remediation Plan**	☐ **6. Installation**
☐ **7. Remediation**	☐ **8. Post Rem. Monitoring**	☐ **9. Resolved**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-98.98
-98.98
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-98.98
-98.97
-98.97
38.87
38.87
38.87
38.86
Domestic Well
300 06/11/2014
Stock Well
900
34
T. 13 S.
T. 14 S.
3
867 ft
70
Google earth
600 Chloride in ppm
Domestic Well
Stock Well
N
W
E
S
Sander Groundwater Monitoring Site
Section 3, Township 14 South, Range 15 West, Russell County, Kansas
2018 Groundwater Chloride Levels
District #4
Sampled on 7/3/2018 - Map Drawn on 8/9/2018 by C. Neeley
Kansas
Corporation Commission

Project: ***Schraeder Contamination Site***

Site Location: Legal location is E/2 of Section 3 and W/2 of Section 2, Township 24 South, Range 24 West, Hodgeman County.

Impact/Immediacy: Contamination to groundwater, stock wells and possibly an irrigation well in the future. Immediacy level is rated as low.

Site Description: The chloride concentration of the Ogallala formation water supplying a stock well has been high in chlorides.

Unusual Problems: None.

Status of Project: Six groundwater samples were taken in 2018. Chlorides in these samples ranged from 90ppm chlorides at Well K, to 1100ppm chlorides in Well L. These values overall have remained consistent from the previous sample years. There has been a slow decline in the chlorides at this site due to natural attenuation; this trend is expected to continue in the future. Irrigation well B and Irrigation well J were unable to be sampled due to the electricity not being hooked up. Windmill F is damaged and not capable of pumping so no sample was taken. Windmill D, at the landowner's residence, was running and was sampled this year.

Level of Remediation Sought:

Ideal: 250 ppm Chloride
Target: 350 ppm Chloride

Recommendations for Future Work: Continue annual monitoring of the site.

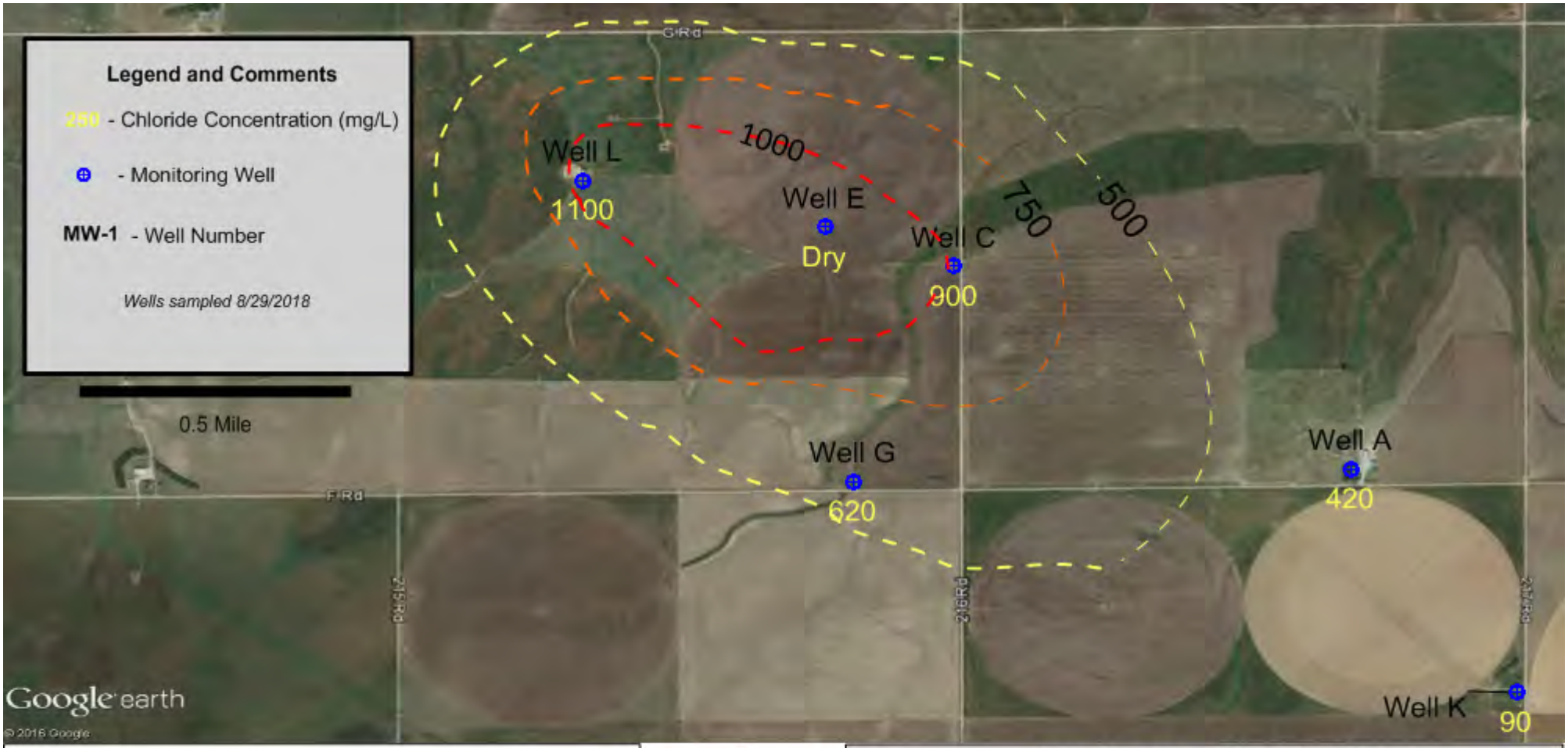
Estimated Total Costs: $30,000.00.

Control No.	**Staff Hours/Expenditures**	**Fund Expenditures**	
		FY 2018/19	**Total**
970013-00	**9.5 Hrs. / $264.47**		**$1,590.90**

Current Contaminate Level: 90ppm Cl- to 1100 ppm Cl-

Status:

☐ **1. Site Assessment**	☐ **2. Short Term Monitoring**	☐ **3. Investigation**
☒ **4. Long Term Monitoring**	☐ **5. Remediation Plan**	☐ **6. Installation**
☐ **7. Remediation**	☐ **8. Post Rem. Monitoring**	☐ **9. Resolved**



Kansas Corporation Commission

N
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Schraeder Site

Sections 2/3/11-T-24S-R24W
Hodgeman County, Kansas

2018 Area Map with Chlorides

KCC Control # 970013-00 District 1
K. Sullivan 9/24/18

Project: ***Schruben-Rogers Contamination Site***

Site Location: SE/4 of Section 18, Township 7 South, Range 17 West, Rooks County.

Impact/Immediacy: Groundwater contained in an alluvial aquifer has been impacted by oil field brine. The immediacy for this site is rated as low.

Site Description: This site is located on the eastern edge of the City of Stockton, approximately one-third of a mile from the South Fork Solomon River. The water wells in the area are used primarily for lawn and garden and stock purposes, and draw water from an alluvial terrace. The soil in the area of the impacted wells is rapidly permeated by contaminants, making the water quality sensitive to lease practices. Extensive past studies failed to identify a primary source for the brine, but a number of potential causes of the pollution were noted. These potential sources are generalized as oil field practices rather than delineated definitively, and contribute to an accumulative effect. Remediation was not initiated because a significant reduction of the chlorides in the area wells was observed, and the availability of other methods for obtaining water, i.e. municipal sources and reverse osmosis treatments.

Unusual Problems: None.

Status of Project: Several potential sources of pollution in the area have been removed over the last several years. The chloride concentration in the well on the Rogers' property has fallen appreciably since 1986, when the chloride concentration was 8,450 ppm. Since 2008, the chloride levels have remained relatively stable in the range of 500 ppm to 750 ppm. In 2015, the chloride concentration was determined to be 550 ppm, 525 ppm in 2016, 500 ppm in 2017, and 400 ppm in 2018.

Level of Remediation Sought:
Ideal: 100 ppm Chloride
Target: 250 ppm Chloride

Recommendations for Future Work: This site will be monitored annually to determine if the removal of potential sources has contributed to the reduction in contaminant levels. If additional work is warranted due to a rise in contaminant levels, additional geophysical and field research may be conducted in an effort to better delineate a source.

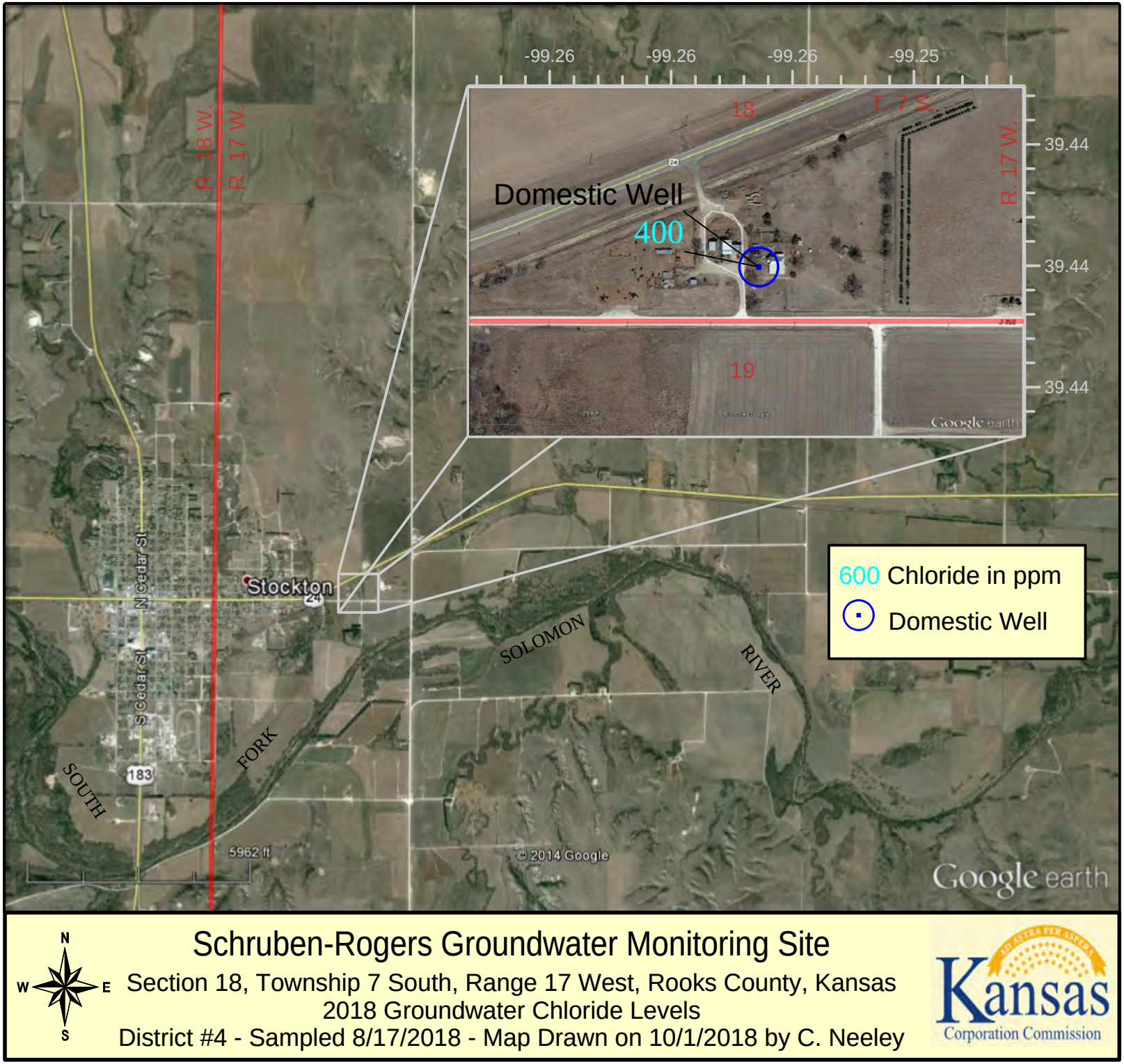
Estimated Total Costs: $2,000.

Control No.	**Staff Hours/Expenditures**	**Fund Expenditures FY 2018/19**	**Total**
970014-00	**4 Hrs. / $130.23**		

Current Contaminate Level: 400 ppm Cl^-

Status:

☐ **1. Site Assessment**	☐ **2. Short Term Monitoring**	☐ **3. Investigation**
☒ **4. Long Term Monitoring**	☐ **5. Remediation Plan**	☐ **6. Installation**
☐ **7. Remediation**	☐ **8. Post Rem. Monitoring**	☐ **9. Resolved**


-99.26
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18
T. 7 S.
R. 17 W.
Domestic Well
400
19
Google earth
R. 18 W.
R. 17 W.
Stockton
24
N Cedar St
S Cedar St
183
SOUTH
FORK
SOLOMON
RIVER
5962 ft
© 2014 Google
Google earth
600 Chloride in ppm
Domestic Well
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S
Schruben-Rogers Groundwater Monitoring Site
Section 18, Township 7 South, Range 17 West, Rooks County, Kansas
2018 Groundwater Chloride Levels
District #4 - Sampled 8/17/2018 - Map Drawn on 10/1/2018 by C. Neeley
Kansas
Corporation Commission

Project: ***Schulte Brine Remediation Site***

Site Location: The legal description is eastern half of sections 7 & 18, and all of Sections 8 and 17, Township 28 South, and Range 1 West of Sedgwick County, Kansas. To the northeast lies the Wichita Mid-Continent Airport. The site is in the drainage systems of the Cowskin Creek and Dry Creek. Dry Creek is a tributary of Cowskin Creek and flows in an easterly direction across the southern part of the site. The confluence of the two creeks is approximately three miles to the southeast of Schulte.

Impact/Immediacy: The impact is to groundwater resources including public supply wells and domestic water wells. The immediacy level is rated as moderate.

Site Description: Regionally, the site is located in the Arkansas River valley. This valley is filled with unconsolidated alluvial deposits ranging in age from late Pleistocene to Holocene. The Permian aged Wellington Shale underlies these deposits and is reportedly at a depth of approximately 120 feet. The apparent source for the contamination is salt-water disposal ponds that were associated with activities in the Schulte oil field in sections 6 and 7. The site is situated between Wichita Mid-Continent Airport to the northeast and the unincorporated town of Schulte to the west. The land use is a combination of light industrial, agricultural and residential. The aquifer consists of Pleistocene unconsolidated sand, clay and gravel deposits. New construction of commercial/industrial complexes have occurred directly east of the recovery wells at the site as well as a new industrial building between the two recovery wells in section 7. Local geology consists of topsoil underlain by a brown to reddish clay to silty clay intermixed with sand lenses. Upper clay thickness ranges from 8.5 feet to 33 feet from east to west. Below the top clay are poorly sorted sand and gravel beds intermixed with thin clay and silt lenses. This sand unit thins to the west unlike the clays above. Under that top sand unit is a brown to red clay/silty-clay aquitard that can be up to 60 feet in thickness near the west end of the site. Below the middle clay aquitard is another sand unit. This sand unit is poorly sorted fine to coarse grained with gravel and inter-bedded clay and silt layers. A bottom clay layer separates the sand from the blue Wellington Formation bedrock.
Local hydrology is based within the two sand units that reside above the Permian Wellington Formation bedrock but in between substantial clay layers. The middle clay aquitard separates the two aquifers and historical investigations suggest that the brine plume has in the past migrated along the top of this aquitard. Groundwater below the aquitard in the area of the plume has been tested and appears to be historically uncontaminated. The groundwater movement is to the east south-east, with almost easterly movement along the eastern edge of the site.

Unusual Problems: The construction of new structures over the possible plume down-gradient of the recovery system limits future recovery in that direction. Much of the area is for sale for future industrial expansion and could complicate continuance of the remediation of the site.

Status of Project: Remediation by the KCC began at this site on November 1, 2001. The site currently consists of 2 recovery wells, 11 monitoring wells, and one saltwater disposal well that is used to dispose of brine impacted water. During 2018, ten groundwater monitoring wells (MW-1, MW-6, MW-7, MW-8, MW-9, MW-15, MW-101, MW-201, MW-301, MW-401) were gauged and sampled. MW-4 was not sampled due to tree roots and poison ivy that have worked their way into the well blocking the casing and approach. It is doubtful that this well will be repaired and could be plugged at this time.
A 2" broken ball valve in the North Well meter vault was repaired and new plumbing was installed by KCC staff at the beginning of 2018. Due to local development, the electrical and water lines for the Schulte recovery system were moved into a KCC platted easement. The East Recovery well was tested during restarting of the system post line relocation and the pump was found to be seized. A new 25 gpm pump was installed at the East Recovery well. The North Recovery well was run intermittently early 2018, until the power line was cut by local development. On July 21, 2018, both recovery wells were online and the system was operational. Startup chlorides were tested and found to be in the 1400 to 1800 mg/L range but trail off with time as the wells began to cone, allowing less impacted water located higher in the water table to enter the pump. The Schulte recovery wells never showed chlorides lower than 1100 mg/L during 2018. A total of approximately 1,500,000 gallons of water were recovered by October of 2018.

Groundwater levels below the ground surface ranged from approximately 10 to 29 feet in the sampled wells during this year's event, and decreased an average of 1.35 feet since the 2017 gauging event. Groundwater flow direction flows to the east-southeast or east along the southern site border towards the center of the site before turning to an east direction toward the Cowskin Creek. The western hydraulic gradient was found to be 0.001693342 ft/ft between MW-1 and MW-101, and the eastern gradient was 0.002782895 ft/ft from MW-401 to MW-301. This indicates a slower water movement from the west side before the gradient increases to the east as it approaches the Cowskin Creek.
The data resulting from the 2018 groundwater sampling event show chloride level increasing in the monitoring wells located in and down gradient of the center of the plume. These suggest chlorides are moving down gradient as expected.

Level of Remediation Sought:
Ideal: 250 mg/l Chloride
Target: 500 mg/l Chloride

Recommendations for Future Work: KCC has set up the system to automatically shut down if temperatures drop below 38 degrees. This will allow for the system to run during the milder weather of the fall/winter/spring of 2018-19. The system controls have been upgraded to shut down on weekends, and restart on Monday morning. Fiberglass line markers will be installed along the KCC easement to mark line locations. KCC recommends that 4-5 new monitoring wells be installed to replace MW-4 and delineate the plume. Remedial work could be ending soon, but the monitoring phase at the Schulte site will continue, and plume delineation will be key to tracking potential brine impaction down gradient.

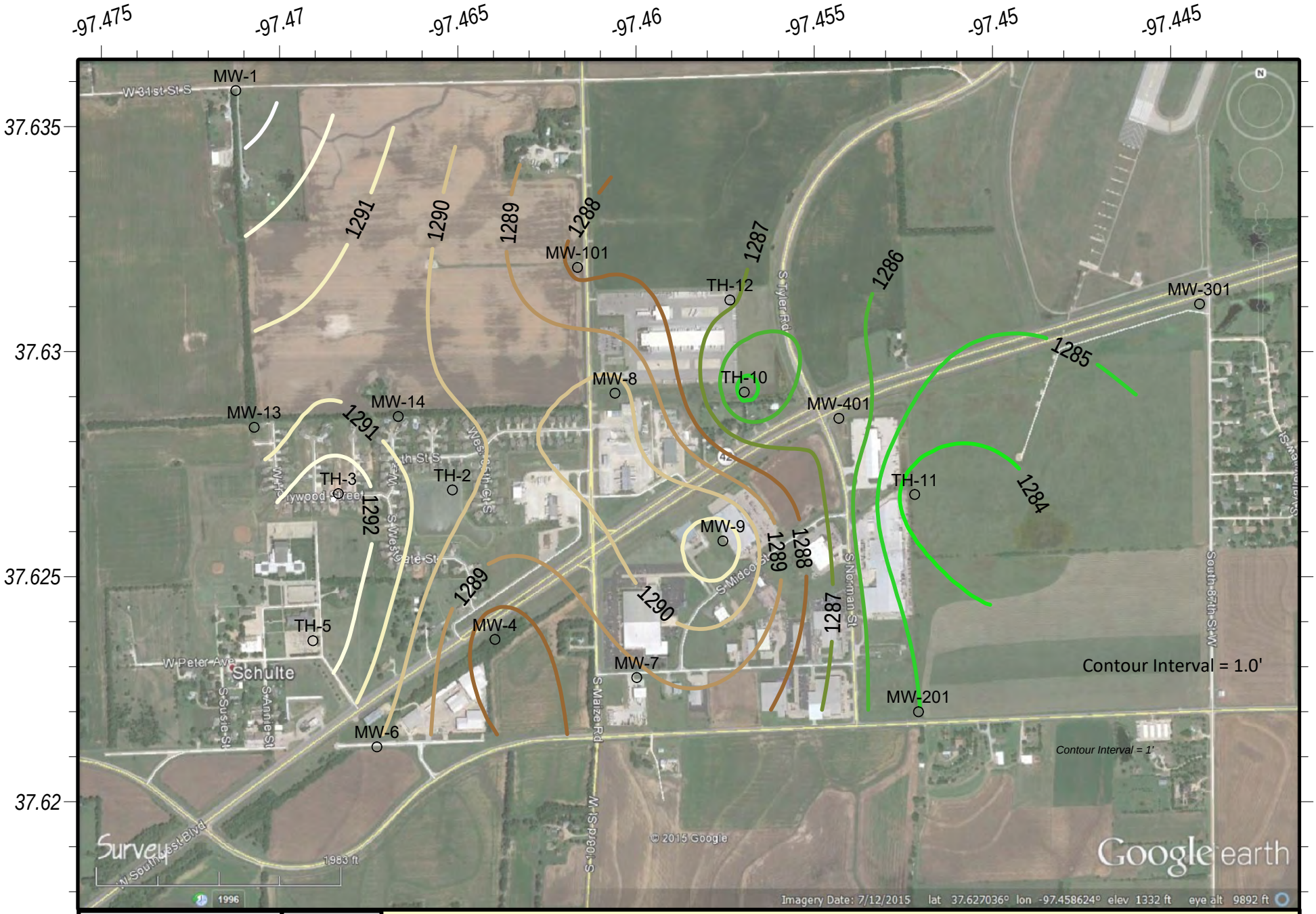
Estimated Total Costs: $2,000 to upkeep the remediation system, perform annual groundwater sampling, and continue investigation of new domestic water wells currently being installed inside the known plume. $10,000 to drill and install 4-5 new monitoring wells.

Control No.	Staff Hours/Expenditures	Fund Expenditures FY 2018/19	Fund Expenditures Total
970015-00	408 Hrs. / $11,897.58	$27,914.68	$177,954.55

Current Contaminate Level: 50 mg/L in MW #1 to 3,250 mg/L in MW# 101

Status:

☐ 1. Site Assessment	☐ 2. Short Term Monitoring	☐ 3. Investigation
☒ 4. Long Term Monitoring	☐ 5. Remediation Plan	☐ 6. Installation
☒ 7. Remediation	☐ 8. Post Rem. Monitoring	☐ 9. Resolved



Kansas Corporation Commission

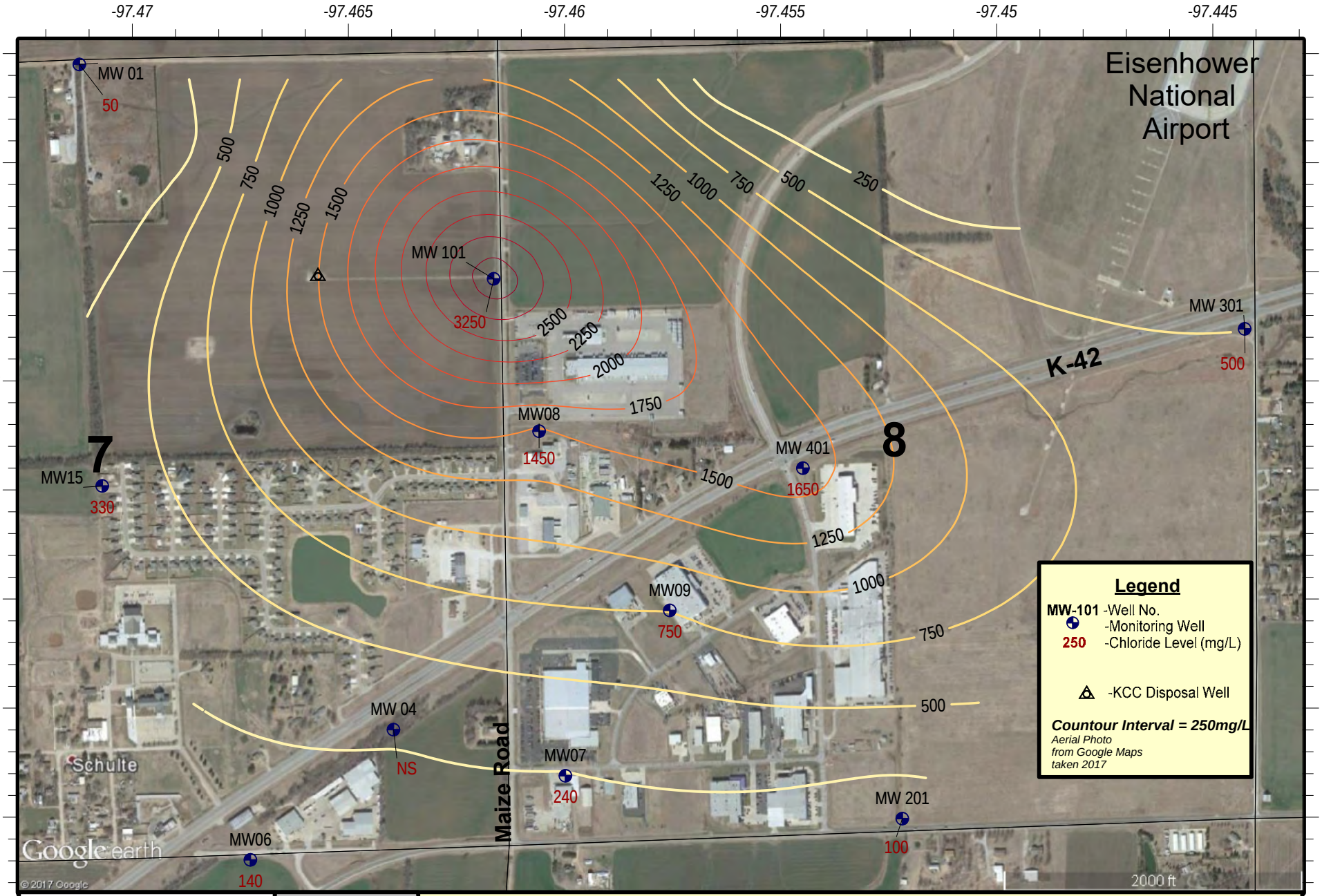
Schulte Remediation Site

Sections 7 & 8 of Township 28 and Range 1 West, Sedgwick County, Kansas

2016 Top of Aquatard

KCC Project Code #970015-00 - KCC District #2 Field Office

-Map Drawn 8/5/2016 by D. Bollenback



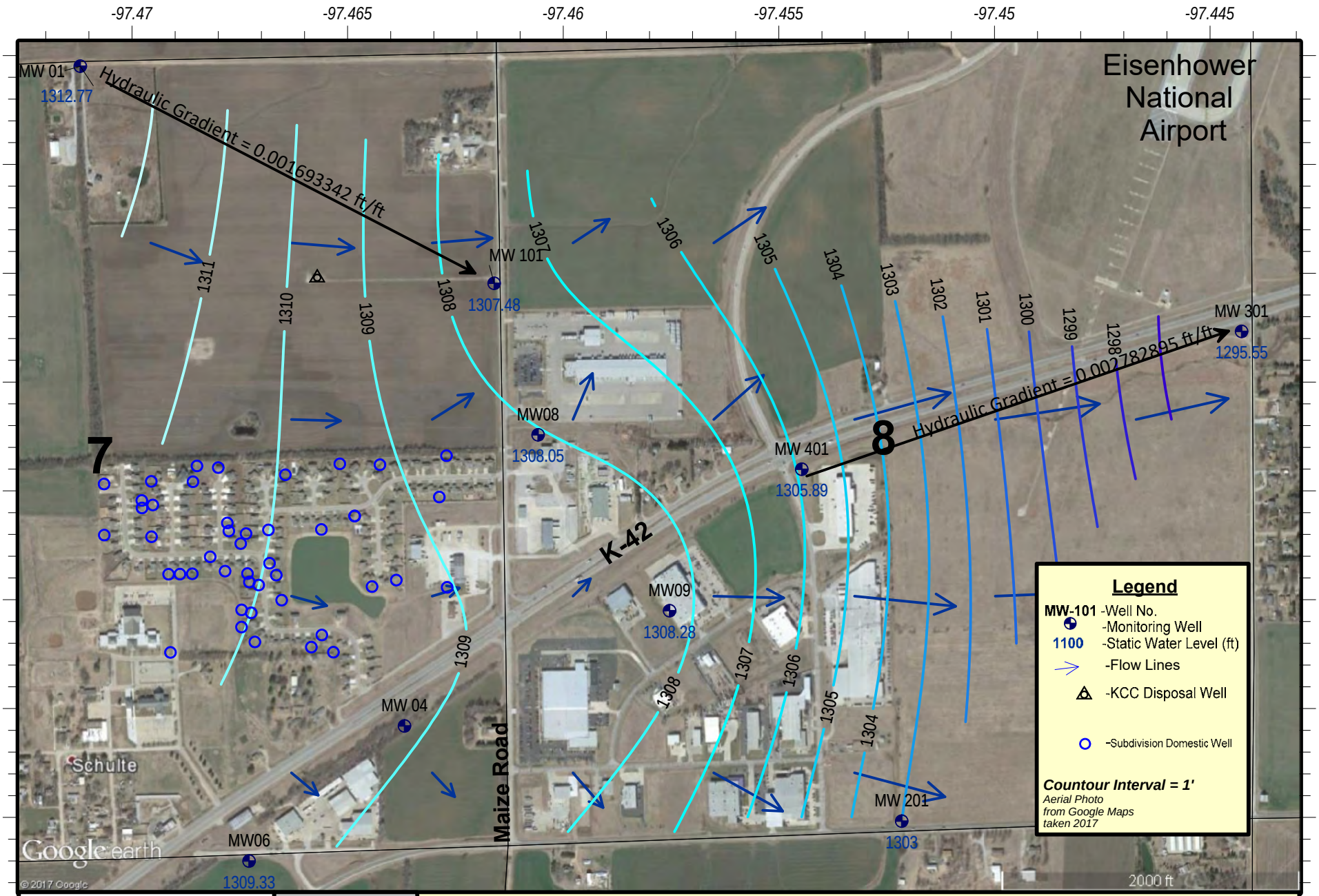
Kansas Corporation Commission

Schulte Remediation Site

Sections 7 & 8 of Township 28 South and Range 1 West, Sedgwick County, Kansas

2018 Chloride Levels

KCC Control # 970015-00 - KCC District #2 Field Office -Well sampled in June 2018 - Map drawn on 10/4/2017 by D. Bollenback, P.G.



Kansas Corporation Commission

N W E S

Schulte Remediation Site

Sections 7 & 8 of Township 28 South and Range 1 West, Sedgwick County, Kansas

2018 Groundwater Elevations

KCC Control # 970015-00 - KCC District #2 Field Office - Wells Gauged on 9/20/2018 - Map drawn on 10/4/2018 by D. Bollenback, P.G.

Kansas Corporation Commission

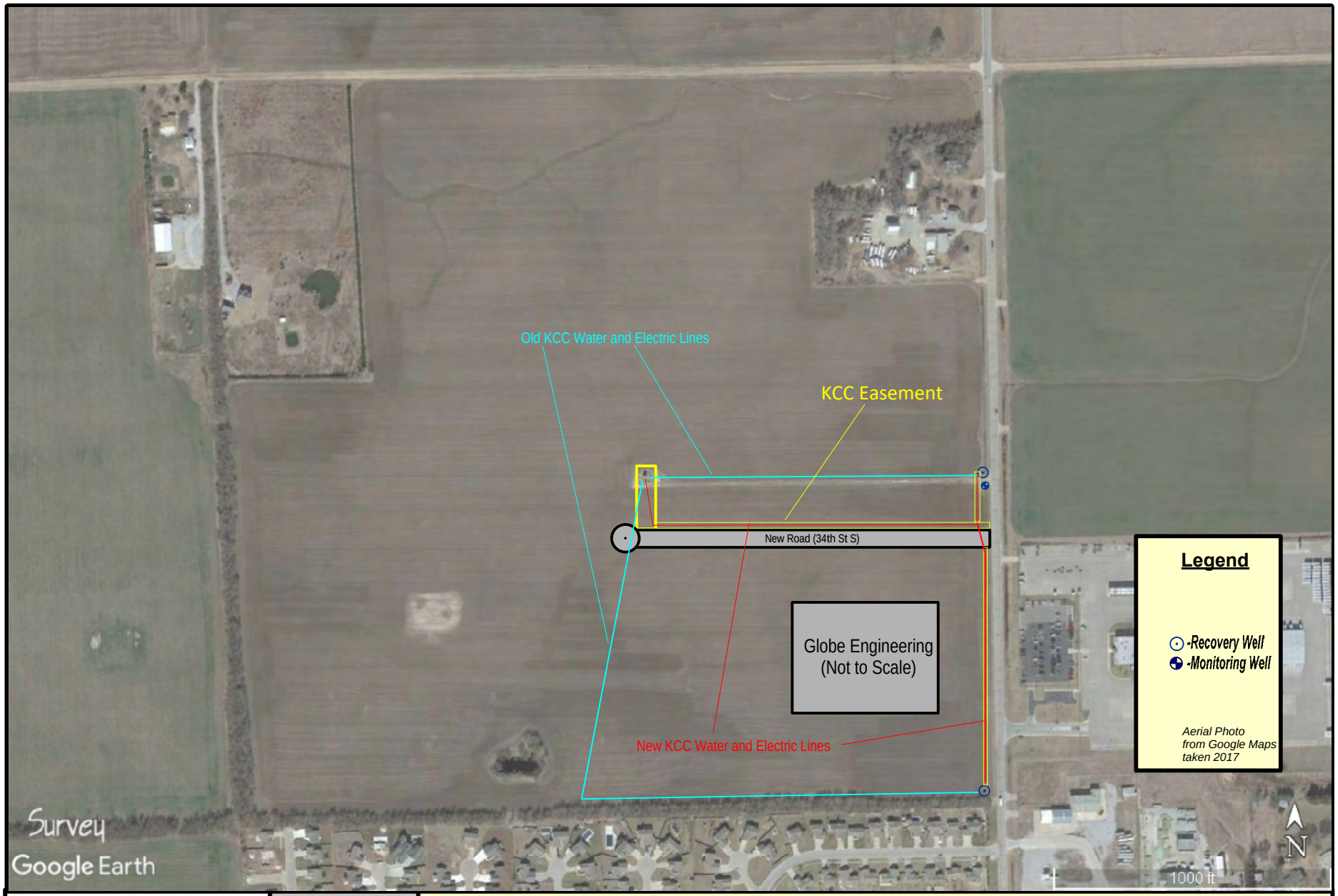
N W E S

Schulte Remediation Site

Sections 7 & 8 of Township 28 South and Range 1 West, Sedgwick County, Kansas

2018 Proposed Future Monitoring Wells

KCC Control # 970015-00 - KCC District #2 Field Office - Map drawn on 10/4/2018 by D. Bollenback, P.G.



Kansas Corporation Commission

N W E S

Schulte Remediation Site

Sections 7 & 8 of Township 28 South and Range 1 West, Sedgwick County, Kansas

2018 Site Development and Line Changes

KCC Control # 970015-00 - KCC District #2 Field Office - Map drawn on 10/4/2018 by D. Bollenback, P.G.

Project: ***Selzer -Bitikofer Contamination Site***

Site Location: The Selzer-Bitikofer Site is two miles east and two miles south of Canton, McPherson County, Kansas, centered approximately at the corner of Iron Horse Road and 29th Avenue, in Sections 35 and 36, Township 19 South, Range 1 West and Sections 1 and 2, Township 20 South, Range 1 West. The Selzer-Bitikofer Site is currently comprised of agricultural fields, pastures, and residences.

Impact/Immediacy: The site affects West Emma Creek and local groundwater. The immediacy level of the site is listed as moderate.

Site Description: Geologically, the site is located in far eastern edge of the Lower Arkansas River basin, and is characterized by fine textured soil with a silty clay loam surface soil and a strong clay pan development. Sediments at the site consist mainly of unconsolidated Pleistocene deposits of the McPherson Formation (KGS bulletin 79). The immediate area is topographically flat, with slopes ranging from 0-3 percent. Based on the site evaluation to date, the underlying material to a depth of approximately 35 feet was found to consist primarily of stiff clay and/or sandy clay, overlying fine to coarse sands of varying thickness. The sand member is underlain by an impermeable dense clay layer that is consistent throughout the site. Bedrock in the area consists of the Kiowa Shale Formation and lies approximately 50-70' below ground surface (KGS Bulletin 79). Bedrock was never encountered during site activities for verification. Based on groundwater data from the present site investigation, shallow groundwater is found at depths ranging from approximately 8 to 13 feet below ground surface at the site, and groundwater flow within the surface aquifer is to the south and southwest and nearly west approaching West Emma Creek. The principal water-bearing formation in the subject site area is a thin unconsolidated sand of varying thickness that lies between clay layers. This sand varies from fine to coarse grained and pinches off in some locations. Based on information obtained from the Kansas Rural Water Association, the subject site area is serviced by Marion Rural Water District (RWD) #4. Based on information obtained from the KGS WWC5 Database, there no public water supply (PWS) wells located within one mile from the subject site. There are three domestic wells (Bitikofer, Selzer and Huebert) located within ¼-mile from the subject site, but there could be unknown, unregistered, and other water wells in the area.

Unusual Problems: An aggressive withdrawal system could render the local water wells and West Emma Creek dry.

Status of Project: On September 18th, 2018, seven groundwater monitoring wells (MW-1, MW-4, MW-5, MW-6, MW-7, Klaassen East, and Klaassen West) were gauged and sampled. Each sample for this monitoring event was analyzed for the presence of Chloride by United States Environmental Protection Agency Silver Nitrate Buret Titration Method 8225. All monitoring wells were found to be above 250 mg/L chlorides, ranging from 300 to 3,800 mg/L. There are currently no monitoring wells capable of delineating the multiple plumes. Chlorides appear to be lower due to the heavy precipitation over 2018. The West Emma Creek was extremely high during sampling and results reflect this high amount of precipitation influx with greatly lower chlorides than in recent years. The northern stream sample was 1,000 mg/L, which is just over 3,000 mg/L drop from 2017. The southern creek tested 1,200 mg/L. The Bitikofter domestic water well was tested to be 600 mg/L, which is higher than last year but has historically occurred. The Selzer Dairy Well was sampled in 2018 and tested to be 100 mg/L chlorides.

Level of Remediation Sought:

Ideal: 250 mg/l Chloride
Target: 500 to 750 mg/l Chloride

Recommendations for Future Work: In 2017, MW-3 was found to be broken and full of sediment. MW-2 was found by the landowner after many years of not being sampled, but was also found to be full of sediment. MW-4 cannot be sampled below 15' and also needs to be replaced in order to collect a representative sample at the base of the aquifer. Delineation of the multiple plumes to the north and east needs to be done. KCC plans to produce another phase of work with the installation of multiple monitoring wells and investigatory borings. KCC also plans to perform a surface water survey of West Emma creek in order to delineate the chloride extents up stream once water levels decrease. It is believed that chlorides are flowing out of the groundwater into the creek where the aquifer intersects the surface. Chlorides are exceptionally high in northern section 1 and with the possibility of plume movement into section 2, KCC feels that the Bitikofer Farm is endangered of losing its only water source. KCC feels that new monitoring wells to the north and east of the current well matrix are necessary to delineate and predict the future for the chloride migration at the Selzer Site. A deep soil boring down to the Kiowa Shale is also needed to increase our knowledge of the local geology. There are some questionable historical oil and gas wells in section 36, north of the site, which may need to be investigated for plug integrity.

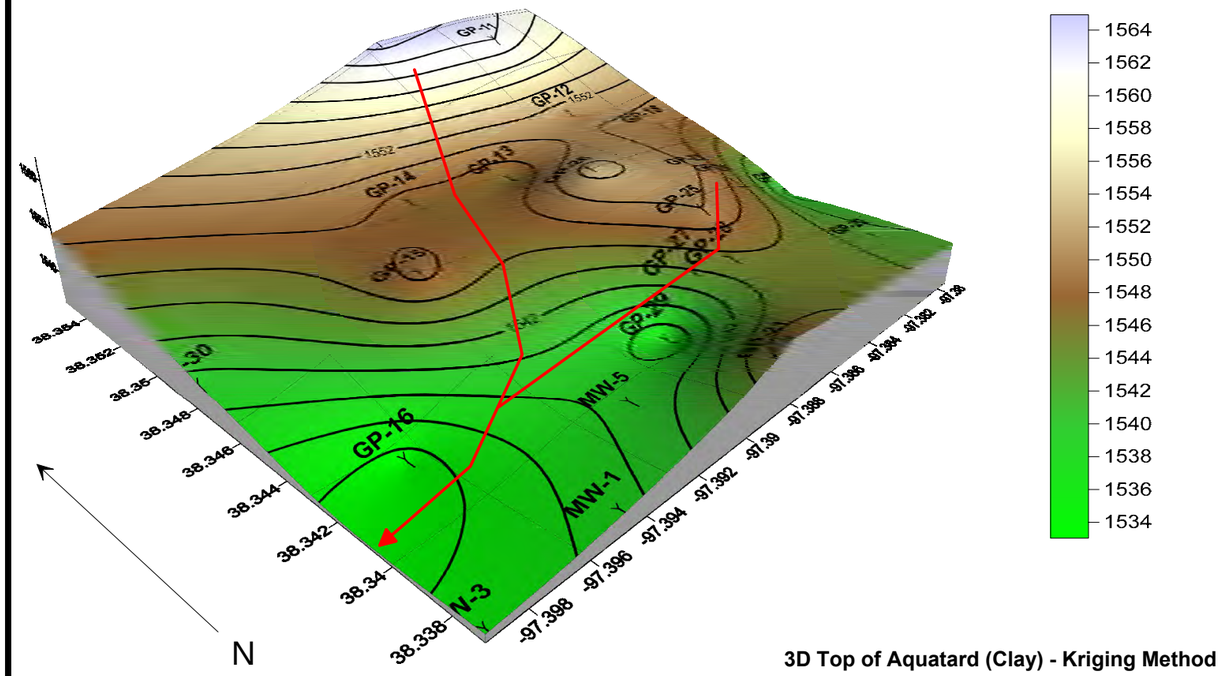
Estimated Total Cost: This site will require multiple visits during the next year. If additional monitoring wells are installed the cost for the 2018-19 year could be as high as $20,000 to $40,000 depending on the amount of new wells installed.

Control No.	**Staff Hours/Expenditures**	**Fund Expenditures**	
		FY 2018/19	**Total**
970093-00	**23 Hrs / $647.03**		**$12,133.50**

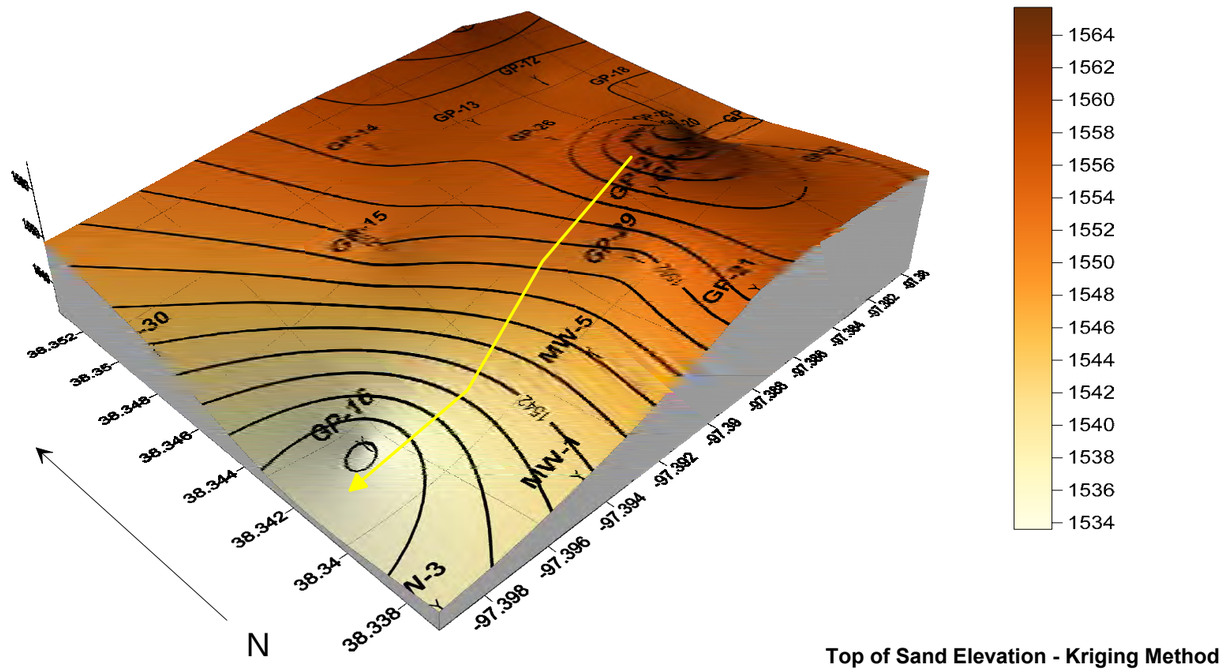
Current Contaminate Level: 300 mg/l (MW-7) to 3,800 mg/l Cl (Klaassen East)

Status:

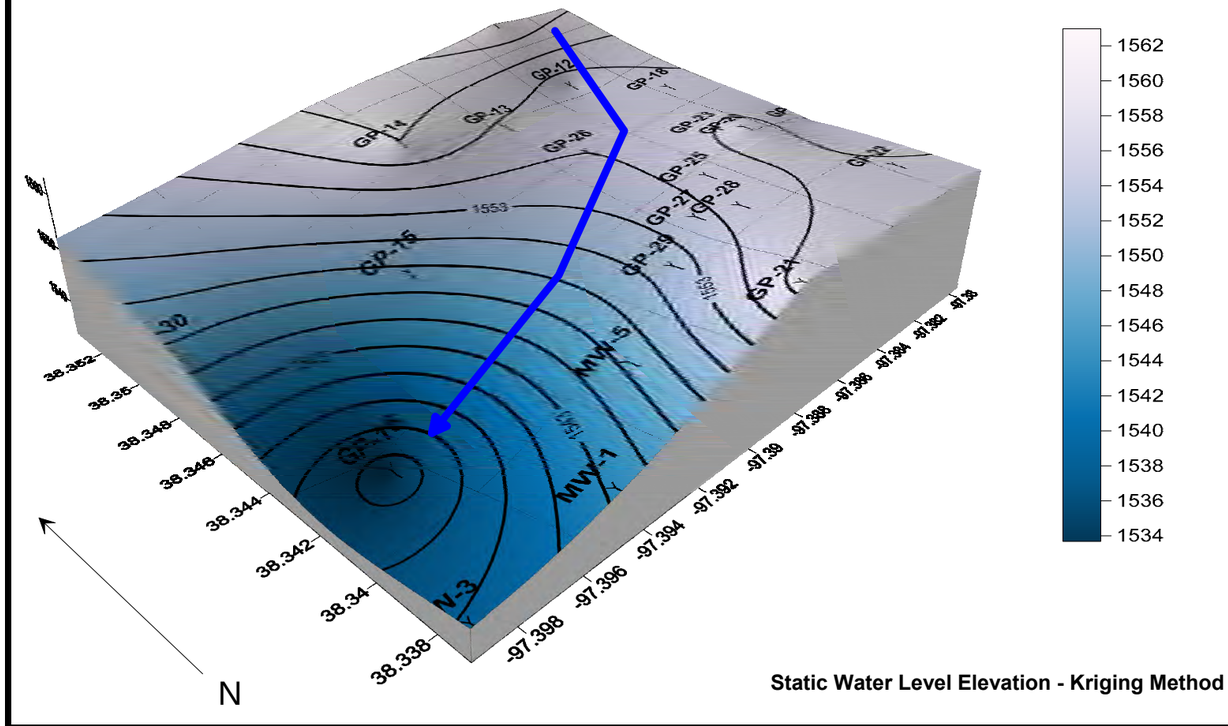
☐ **1. Site Assessment**	☐ **2. Short Term Monitoring**	☒ **3. Investigation**
☒ **4. Long Term Monitoring**	☐ **5. Remediation Plan**	☐ **6. Installation**
☐ **7. Remediation**	☐ **8. Post Rem. Monitoring**	☐ **9. Resolved**



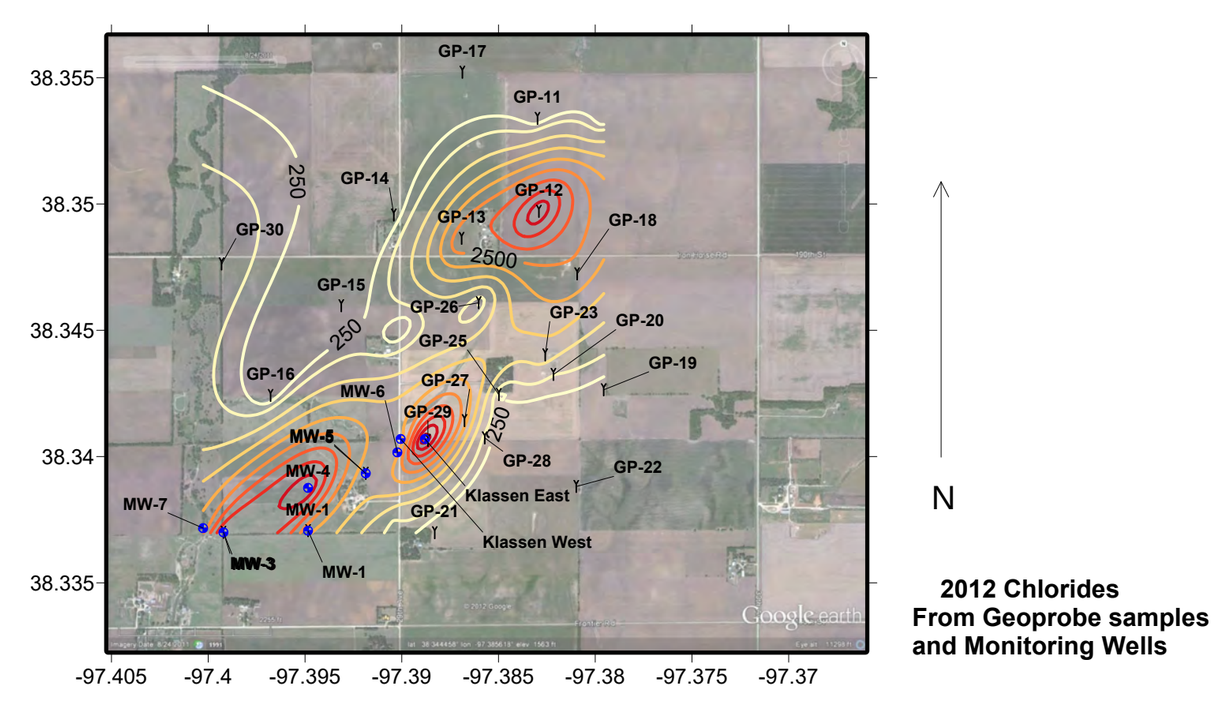
3D Top of Aquatard (Clay) - Kriging Method



Top of Sand Elevation - Kriging Method



Static Water Level Elevation - Kriging Method



2012 Chlorides
From Geoprobe samples
and Monitoring Wells

Kansas Corporation Commission

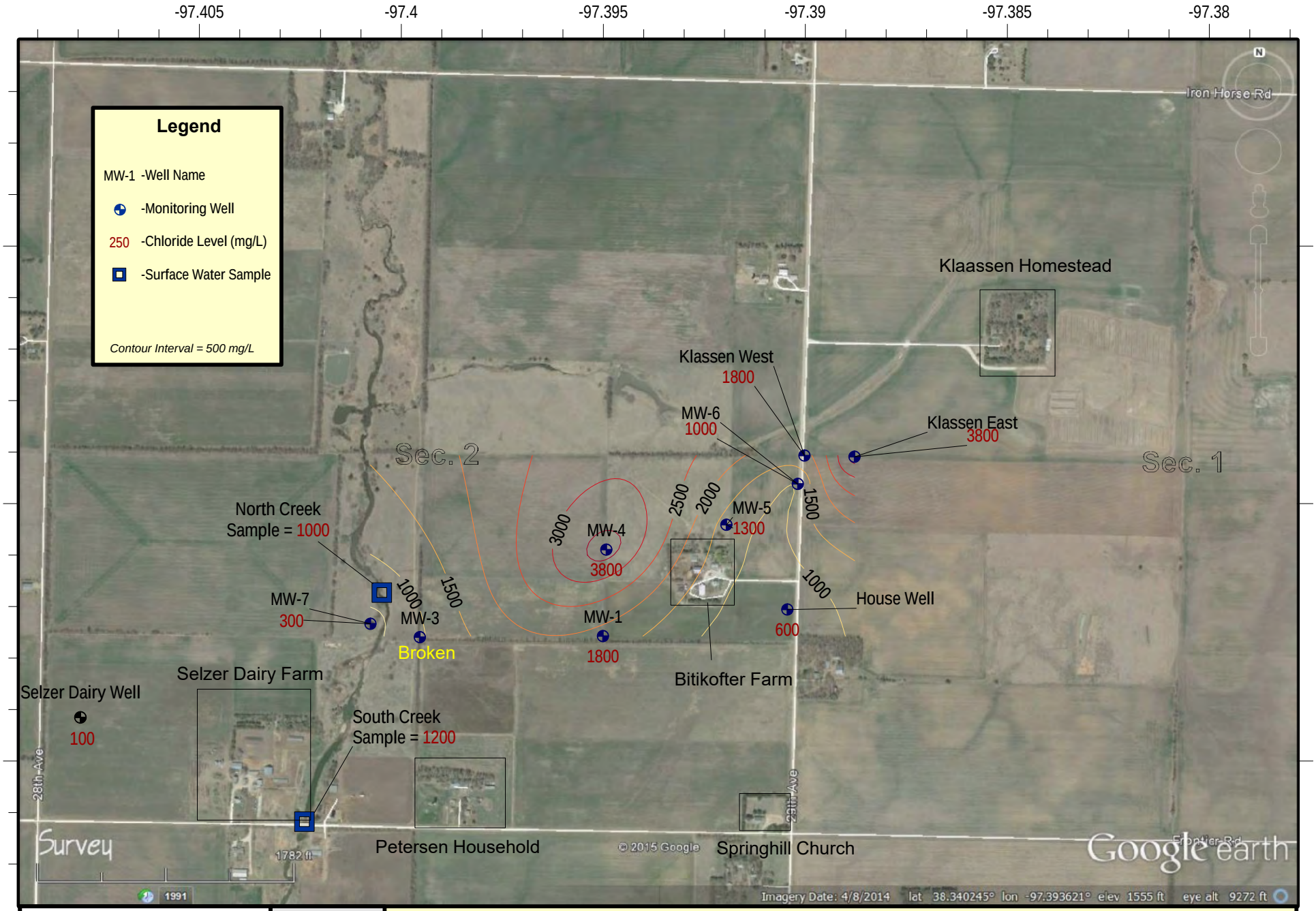
Selzer-Bitikofer Phase II Geoprobe Investigation

Sections 1&2 of T20S & R1W - Sections 35 & 36 of T19S & R1W

3D Interpretation of Data Aquired During Phase II

KCC District #2 Field Office - Drawn on:7/17/2012 - D.Bollenback

Figure 9



Kansas Corporation Commission

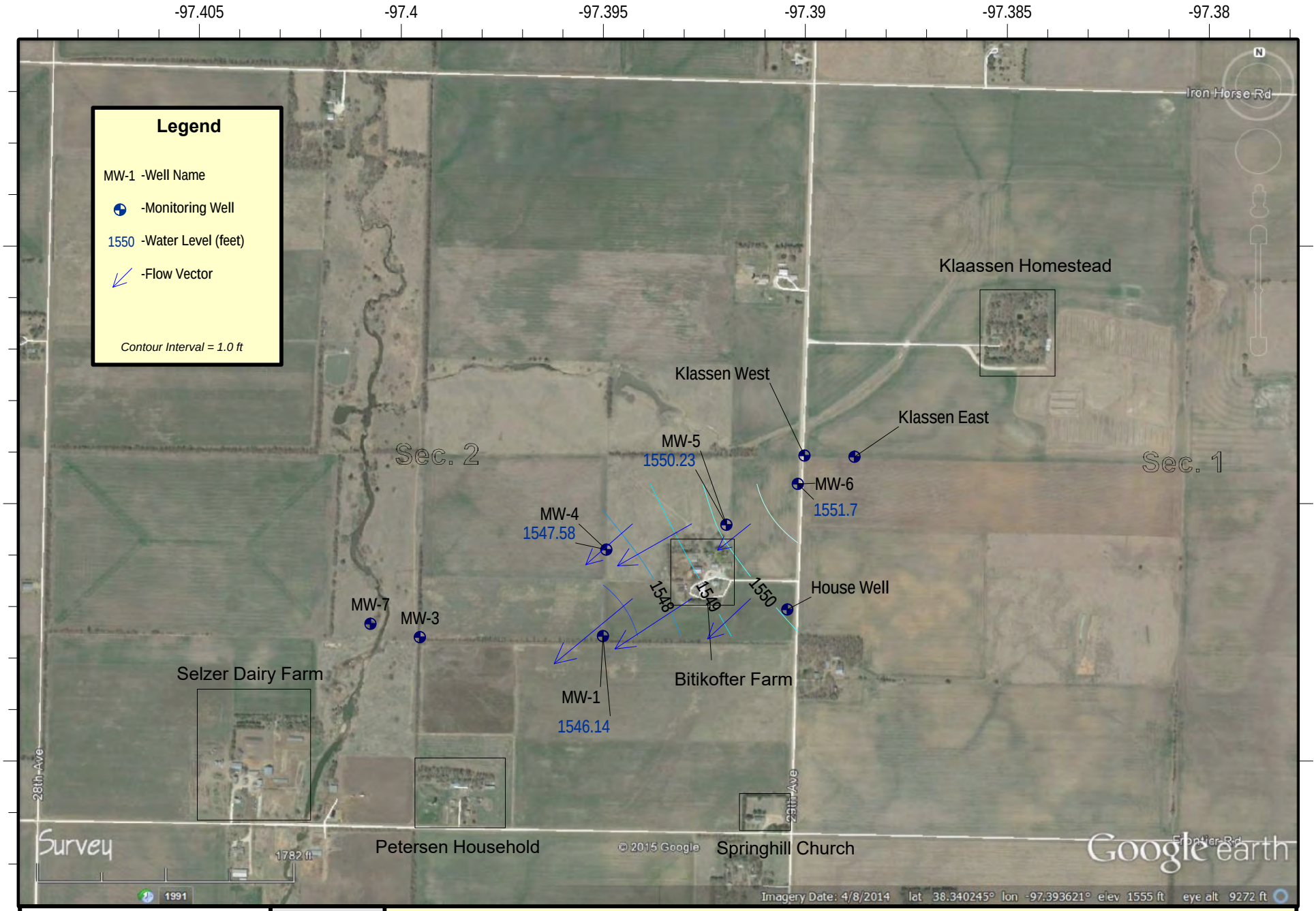
N W E S

Seltzer-Bitikofter Brine Contamination Site

Sections 1 and 2 of Township 20 South and Range 1 West, McPherson County, Kansas

2018 Chloride Levels

KCC Project Code #970093-00 - KCC District #2 Field Office - Wells Sampled on 9/18/2018 - Map Drawn on 10/9/2018 by D.Bollenback



Kansas Corporation Commission

N W E S

Seltzer-Bitikofter Brine Contamination Site

Sections 1 and 2 of Township 20 South and Range 1 West, McPherson County, Kansas

2018 Static Groundwater Levels

KCC Project Code #970093-00 - KCC District #2 Field Office - Wells Gauged on 9/18/2018 - Map Drawn on 109/2018 by D.Bollenback

Project: ***Smith Finn Contamination Site***

Site Location: Legal location is SE/4 of Section 8, Township 34 South, Range 43 West, in Morton County.

Impact/Immediacy: The impact is to a house domestic well, which has exhibited high chloride levels. The PRP **(**Anadarko) drilled a new domestic well in January of 1989**.** This site has a moderate immediacy level.

Site Description: The project consists of a localized pollution of the groundwater in the Ogallala Formation. The area is on the south edge of the high plains as the terrain begins to break downward to the Cimarron River valley, which is located one and one-half miles to the south.

Unusual Problems: The threat of contaminated groundwater moving from the Smith-Finn property to land owned by the BLM. Multiple sand layers with different levels of contamination.

Status of Project: Progress continues to be made towards closure of the site. Chlorides continue to decrease overall throughout the site. Much of the current work is to find the small areas that are problematic and remediate those areas.

Level of Remediation Sought:

Ideal: 250 ppm Chloride
Target: 500 ppm Chloride

Recommendation for Future Work: It is likely that MW 10-8, MW 11-8, and MW 12-8 will be plugged in the near future. PW-4 will remain operational until chlorides have dropped close to or into the fresh water standard. As the site has continued to make significant progress in the removal of chlorides, the project will begin to transition out of a remedial phase, into a monitoring phase.

Estimated Total Costs: $200,000 for PRP.

Control No.	**Staff Hours/Expenditures**	**Fund Expenditures FY 2018/19**	**Total**
970095-00	**3 Hrs. / $101.23**		

Current Contaminate Level: 7.61 ppm Cl- to 10,400 ppm Cl-

Status:

☐ **1. Site Assessment**	☐ **2. Short Term Monitoring**	☐ **3. Investigation**
☒ **4. Long Term Monitoring**	☒ **5. Remediation Plan**	☐ **6. Installation**
☒ **7. Remediation**	☐ **8. Post Rem. Monitoring**	☐ **9. Resolved**

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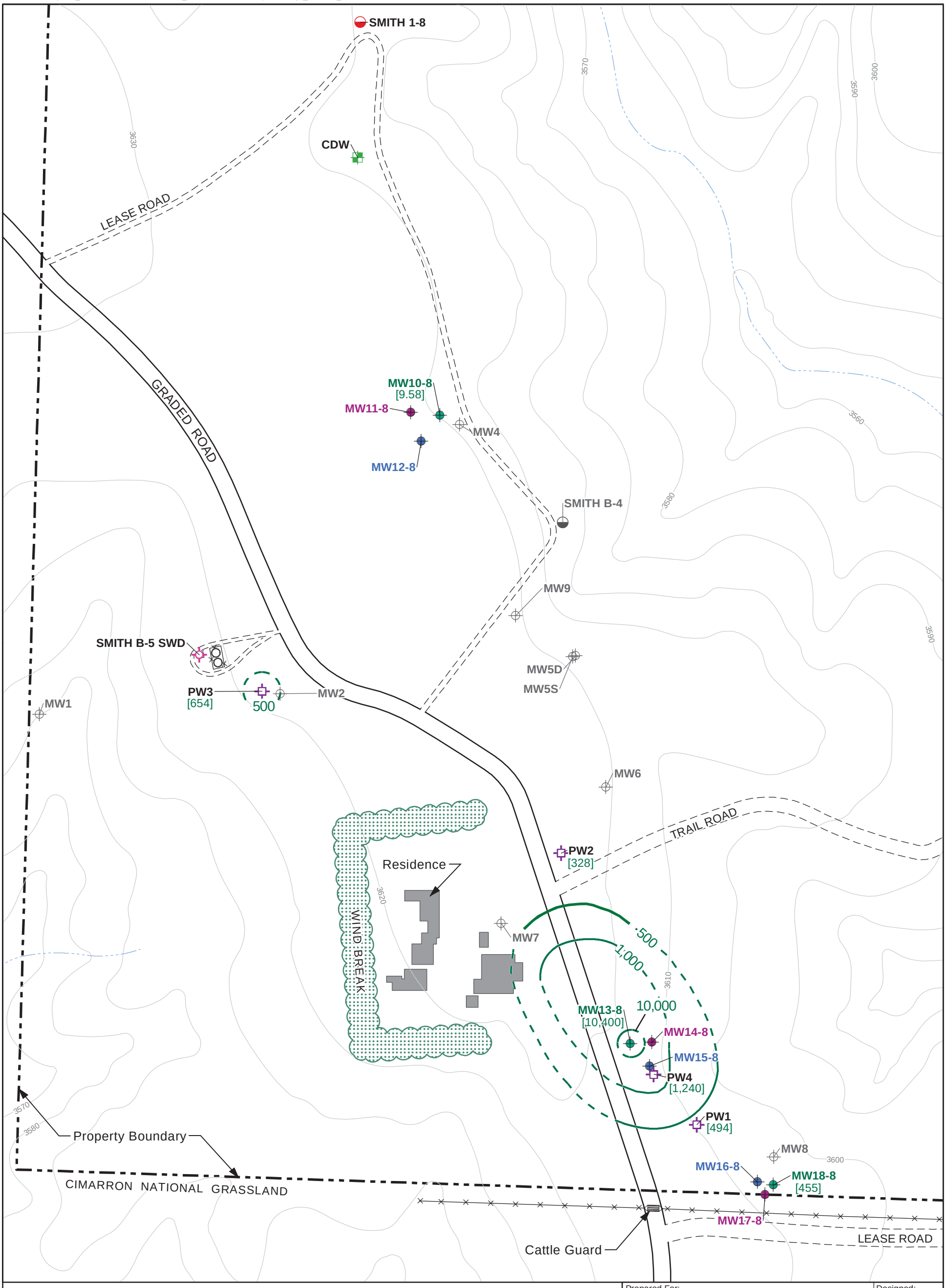

LEGEND

- Shallow Zone Monitoring Well
- Intermediate Zone Monitoring Well
- Deep Zone Monitoring Well
- Plugged and Abandoned Monitoring Well
- Current Domestic Well
- Recovery Well
- Salt Water Disposal Well
- Oil & Gas Well
- Plugged and Abandoned Oil & Gas Well

500 — Chloride isoconcentration contour for shallow wells, dashed where inferred

[440] — Shallow well chloride concentration (mg/L)

NOTE

1. Extraction wells PW1 and PW2 screen both the shallow and intermediate zones. Extraction well PW3 and PW4 screen the shallow, intermediate, and deep zones.
2. All values are in milligrams per liter (mg/L).
3. Chloride isoconcentration maps are interpreted from groundwater analytical results and the geophysical electrical resistivity survey.

N W E S

0 200 400 Feet

Prepared For: **Merit Energy Company**		Designed: **KM**
Title: **Chloride Isoconcentration Map for Shallow Wells May 2018** Smith Finn - Elkhart, Kansas		Drawn: **KK**
		Checked: **AH**
	Morton County, Kansas	Revised: **NA**
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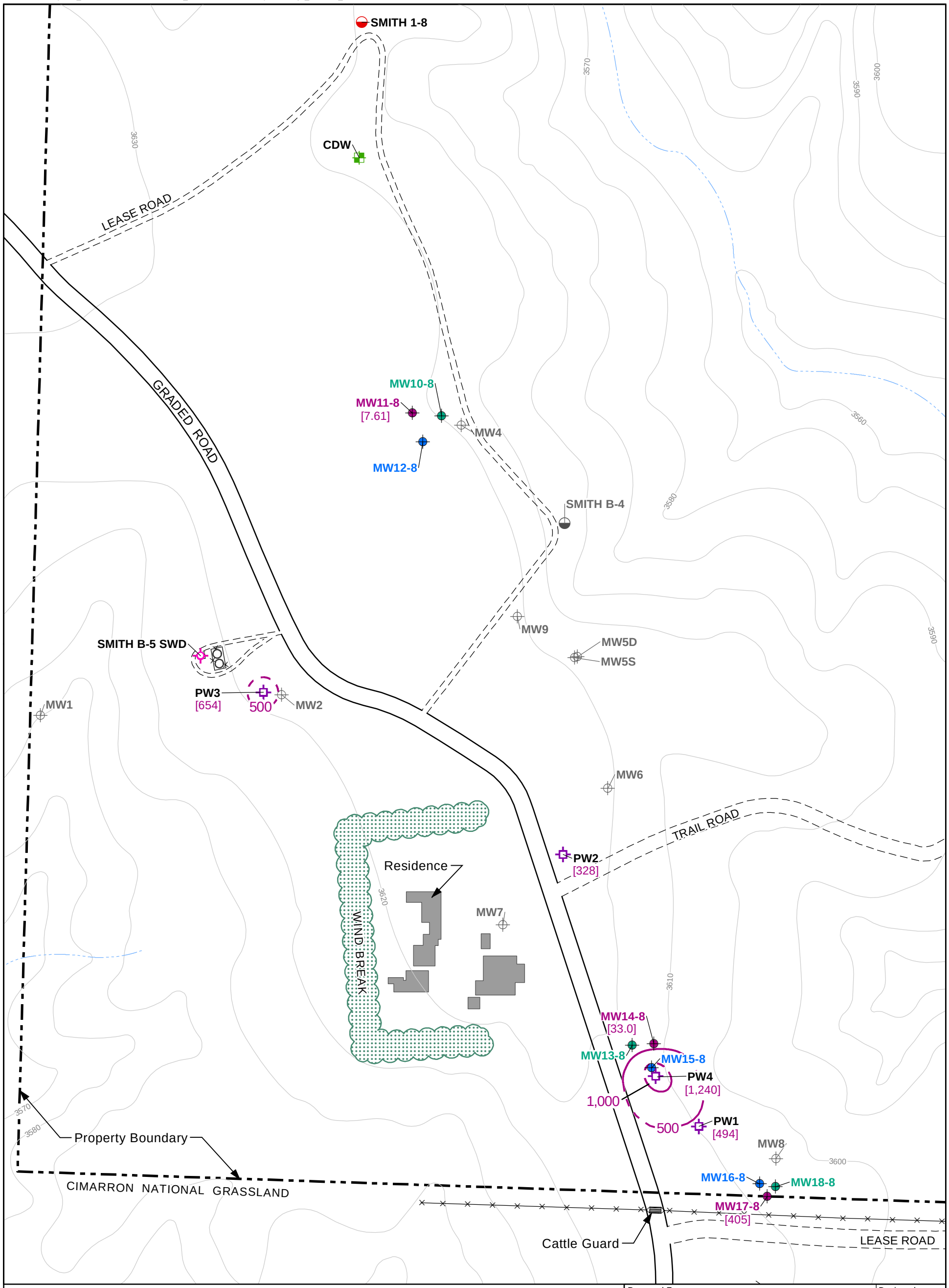

LEGEND

- Shallow Zone Monitoring Well
- Intermediate Zone Monitoring Well
- Deep Zone Monitoring Well
- Plugged and Abandoned Monitoring Well
- Current Domestic Well
- Recovery Well
- Salt Water Disposal Well
- Oil & Gas Well
- Plugged and Abandoned Oil & Gas Well

500 — Chloride isoconcentration contour for intermediate wells, dashed where inferred

[452] Intermediate well chloride concentration (mg/L)

NOTE

1. Extraction wells PW1 and PW2 screen both the shallow and intermediate zones. Extraction well PW3 and PW4 screen the shallow, intermediate, and deep zones.
2. All values are in milligrams per liter (mg/L).
3. Chloride isoconcentration maps are interpreted from groundwater analytical results and the geophysical electrical resistivity survey.

N W E S

0 200 400 Feet

Prepared For: **Merit Energy Company**		Designed: **KM**
Title: **Chloride Isoconcentration Map for Intermediate Wells May 2018** Smith Finn - Elkhart, Kansas		Drawn: **KK**
		Checked: **AH**
	Morton County, Kansas	Revised: **NA**
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ARCADIS

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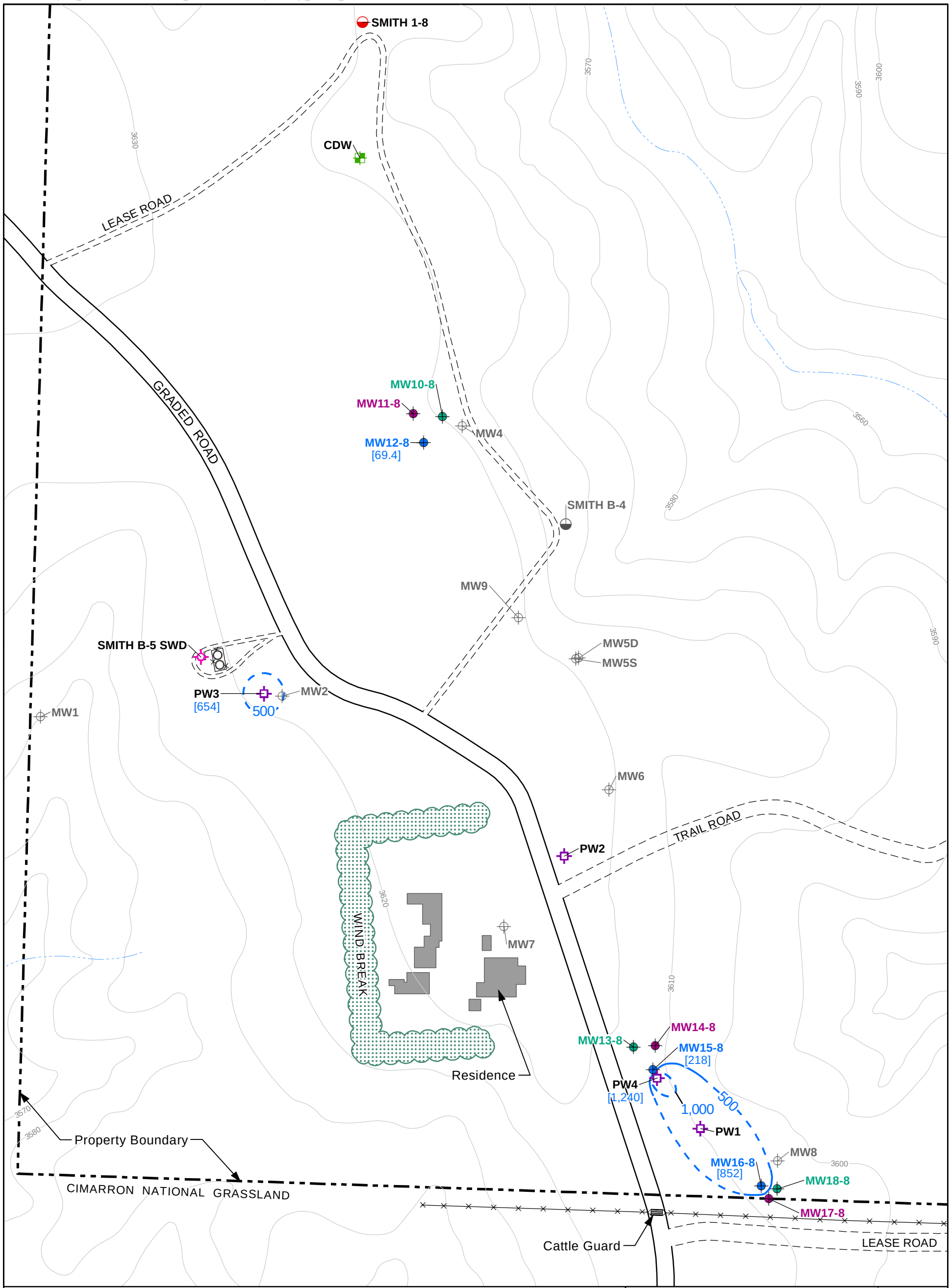


LEGEND

- Shallow Zone Monitoring Well
- Intermediate Zone Monitoring Well
- Deep Zone Monitoring Well
- Plugged and Abandoned Monitoring Well
- Current Domestic Well
- Recovery Well
- Salt Water Disposal Well
- Oil & Gas Well
- Plugged and Abandoned Oil & Gas Well

500 — Chloride isoconcentration contour for deep wells, dashed where inferred

[841] — Deep well chloride concentration (mg/L)

NOTE

1. Extraction wells PW1 and PW2 screen both the shallow and intermediate zones. Extraction well PW3 and PW4 screen the shallow, intermediate, and deep zones.
2. All values are in milligrams per liter (mg/L).
3. Chloride isoconcentration maps are interpreted from groundwater analytical results and the geophysical electrical resistivity survey.

N W E S

0 200 400 Feet

Prepared For: **Merit Energy Company**		Designed: **KM**
Title: **Chloride Isoconcentration Map for Deep Wells May 2018** Smith Finn - Elkhart, Kansas		Drawn: **KK**
		Checked: **AH**
	Morton County, Kansas	Revised: **NA**
File: Q:\GC002026\Fig9_Chloride_DZ.mxd	Date: **10/17/2018**	Figure: **9**

ARCADIS

Project: ***South Spivey Contamination Site***

Site Location: The site area is located 3.5 miles south of the city of Spivey, near an unnamed tributary of the Chikaskia River. The legal location is in Sections 27 and 34 of Township 30 South, Range 8 West, in Kingman County.

Impact: The impacts are to groundwater resources associated with local domestic wells. The site is rated as low immediacy level.

Site Description: The project area lies within an intermittently flowing creek bed within the large Spivey-Grabs oil and gas field. The area is remote and the surface use is primarily the grazing of cattle, oil and gas production, and wind turbines. The geology in the area is unconsolidated Tertiary and Quaternary deposits overlaying the Permian, Nippewalla Group Shale. This Shale can be found exposed along valleys of the Chikaskia River system and its tributaries. The unconsolidated sediments usually consist of poorly sorted sands, silts, and gravels and can be up to 60 feet thick. The Permian erosional surface dips to the north towards the Chikaskia River. Most locations that are overlain with unconsolidated sediments, show good infiltration from precipitation but can vary in horizontal permeability due to poor sorting or heavy silt development. Ground water tends to follow the slope of the Permian erosional surface. This site has been monitored since 1993 when an oil and gas lead line broke and flowed for a period of time. It was unknown at the time how much brine water was lost. There were remedial operations in the past in attempt to remove the brine, but it has been many years since operations ceased.

Unusual problems: Withdrawal rate can be low due to low permeability of the aquifer if it lies outside the well sorted paleo-channels especially in the south end of the site. Some monitoring wells will flow while others will pump dry. This can allow brine plumes to move in an erratic way.

Status of Project: South Spivey Site is an annual sampling program. Natural attenuation of the site is occurring but chloride readings have varied somewhat over the years with the annual precipitation amounts. The contaminated aquifer is so shallow that chlorides levels seem to be in direct correlation with precipitation. All the wells within the South Spivey Site had big drops in chlorides in 2018, which is thought to be influenced by the recent rains. The highest chloride concentration was from well OB with 1,457 ppm chlorides in 2018. The pond tested 50 ppm chlorides.

Level of Remediation Sought:

Ideal: 250 mg/l Chloride
Target: 750 mg/l Chloride

Recommendations for Future Work: Continue sampling all monitoring wells and surface waters on an annual basis. Two wells still remain over the target level of 750 mg/L Chlorides. MW-A1 is dry most years and could be plugged. No other action is needed at this time as this site has a low immediacy rating.

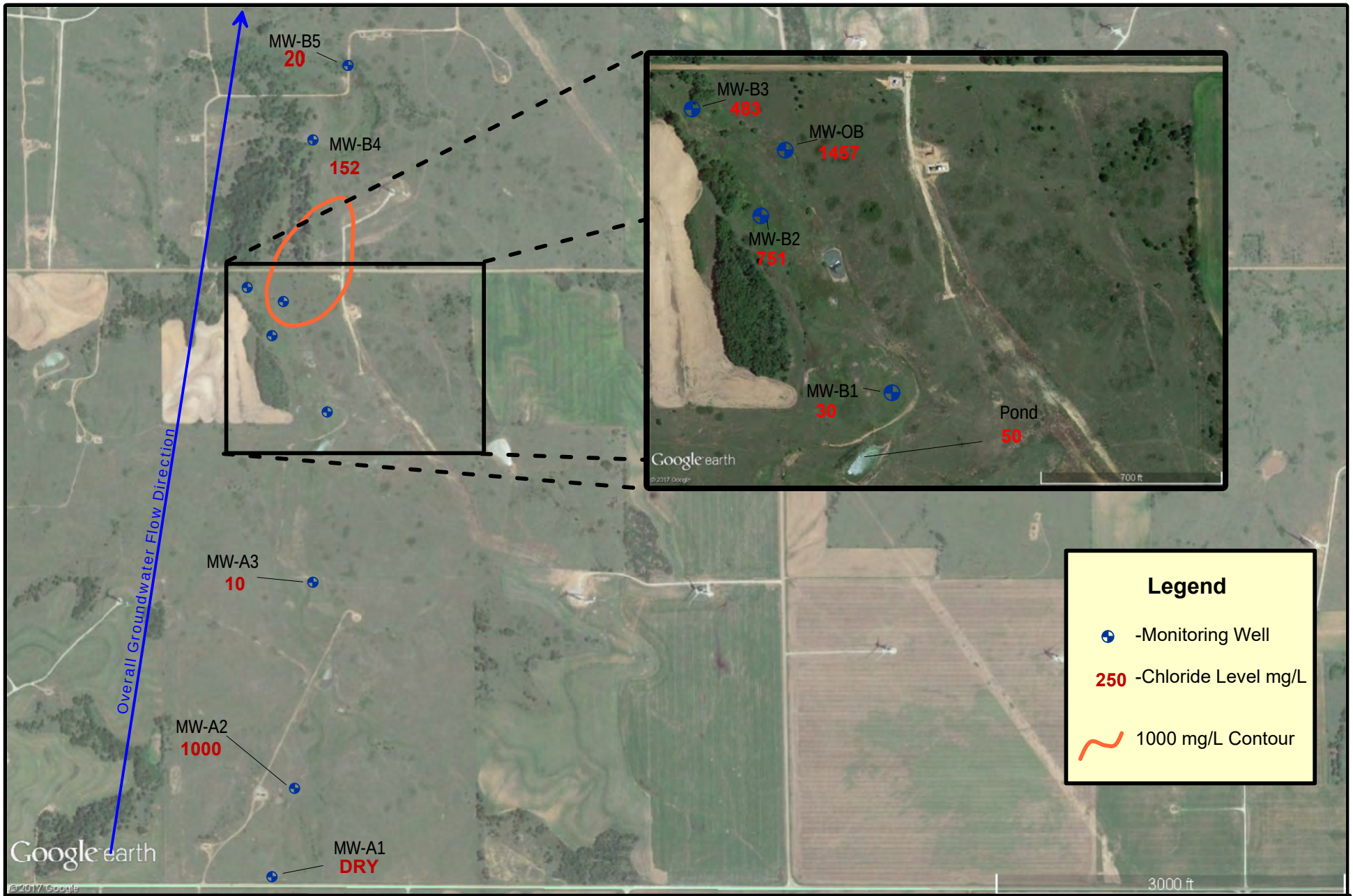
Estimated Total Costs: $1,000 per year for sampling, testing, and research.

Control No.	**Staff Hours/Expenditures**	**Fund Expenditures FY 2018/19 Total**
970096-00	**26 Hrs. / $728.90**	

Current Contaminate Level: 10 mg/L to 1457 mg/L Cl^-

Status:

☐ **1. Site Assessment**	☐ **2. Short Term Monitoring**	☐ **3. Investigation**
☒ **4. Long Term Monitoring**	☐ **5. Remediation Plan**	☐ **6. Installation**
☐ **7. Remediation**	☐ **8. Post Rem. Monitoring**	☐ **9. Resolved**


MW-B5
20
MW-B4
152
MW-A3
10
MW-A2
1000
MW-A1
DRY
Overall Groundwater Flow Direction
MW-B3
483
MW-OB
1457
MW-B2
751
MW-B1
30
Pond
50
Google earth
700 ft
Google earth
3000 ft
Legend
-Monitoring Well
250 -Chloride Level mg/L
1000 mg/L Contour
Kansas
Corporation Commission
N
W
E
S
South Spivey Brine Monitoring Site
Sections 27 & 34 of Township 30 South and Range 8 West, Kingman County, Kansas
Site Chloride Levels 2018
KCC District #2 Field Office - Site well sampled on 5/16/2018 - 8/31/2018 - Map Drawn on 10/22/2018 by D.Bollenback - Air Photo: Google Earth 2016

Project: ***Stowe- Zaid Contamination Site***

Site Location: The site is five miles south of the intersection of US 56 and Plum Avenue on the east side of Rice County. This site is in northwest part of Welch-Bornholdt oil field, and the lease has no production at the present time. The location is the SE/4 NE/4 Section 24, Township 20 South, Range 6 West, Rice County.

Impact/Immediacy: Impact is to the soil and groundwater. This site should be classified as low immediacy with the possibly of effecting domestic and stock wells and the aquifer of the Little Arkansas River. There is a rural water line in the area, which can provide service to the homes.

Site Description: There is a Permian contact with the Quaternary sediments that transects this site from northwest to south east. Ninnescah Shale has been eroded by the Little Arkansas River which has filled the floodplain with Alluvium. There is approximately 40-50 feet of elevation change in the direction of the northeast corner of the section. There has been a historical scar in the alluvium just south and west of this contact. A 1954 air photo shows that when there was oil and gas production in the northeast of Section 24, that a tank battery was located on the west side of Plum Road and northeast of the scar. The battery was positioned within the Ninnescah Shale beds and at a higher elevation to the scar. This suggests that possible spills and leaks from the tank battery may have entered the subsurface and flowed down gradient on top of the shale or through fractures and bedding planes until entering the Floodplain Alluvium at the location of the scar.

Unusual Problems: The ground water table is very shallow due to the close proximity to the Arkansas River.

Status of the Project: The 2018 water sampling was done August 25th. The lower aquifer tested at 181 mg/l chlorides, which is slightly higher than last year. MW-1S in the upper water horizon was found last year to be filled with sediment and is no longer a viable well. MW-2 at the toe of the scar showed no real change from 2017 at 1,235 mg/l. Evidence appears to show that an aquatard is preventing the chlorides from moving down to the lower aquifer at least at a substantial rate.

Recommendation for Future Work: KCC recommends the continued sampling of the monitoring wells. Up gradient and down gradient delineation has not been achieved to this date, but the site is listed as low priority. There are large remnants of evaporation pits in the section north and the section east of the site. If the immediacy of this site increases due to increased chloride levels, the first step would be to drill and install more monitoring wells in order to delineate the plume. Due to the shallow nature of the contaminated aquifer it maybe possible to recover chloride polluted water via shallow recovery wells or trench system, but there is no disposal scenario available near by to dispose of the fluids. In light of those facts long term monitoring is suggested for the site. Increases in lower aquifer chlorides could require further investigation into the lower aquifer.

Level of Remediation Sought:

Ideal: 50 mg/l
Target: 350 mg/l

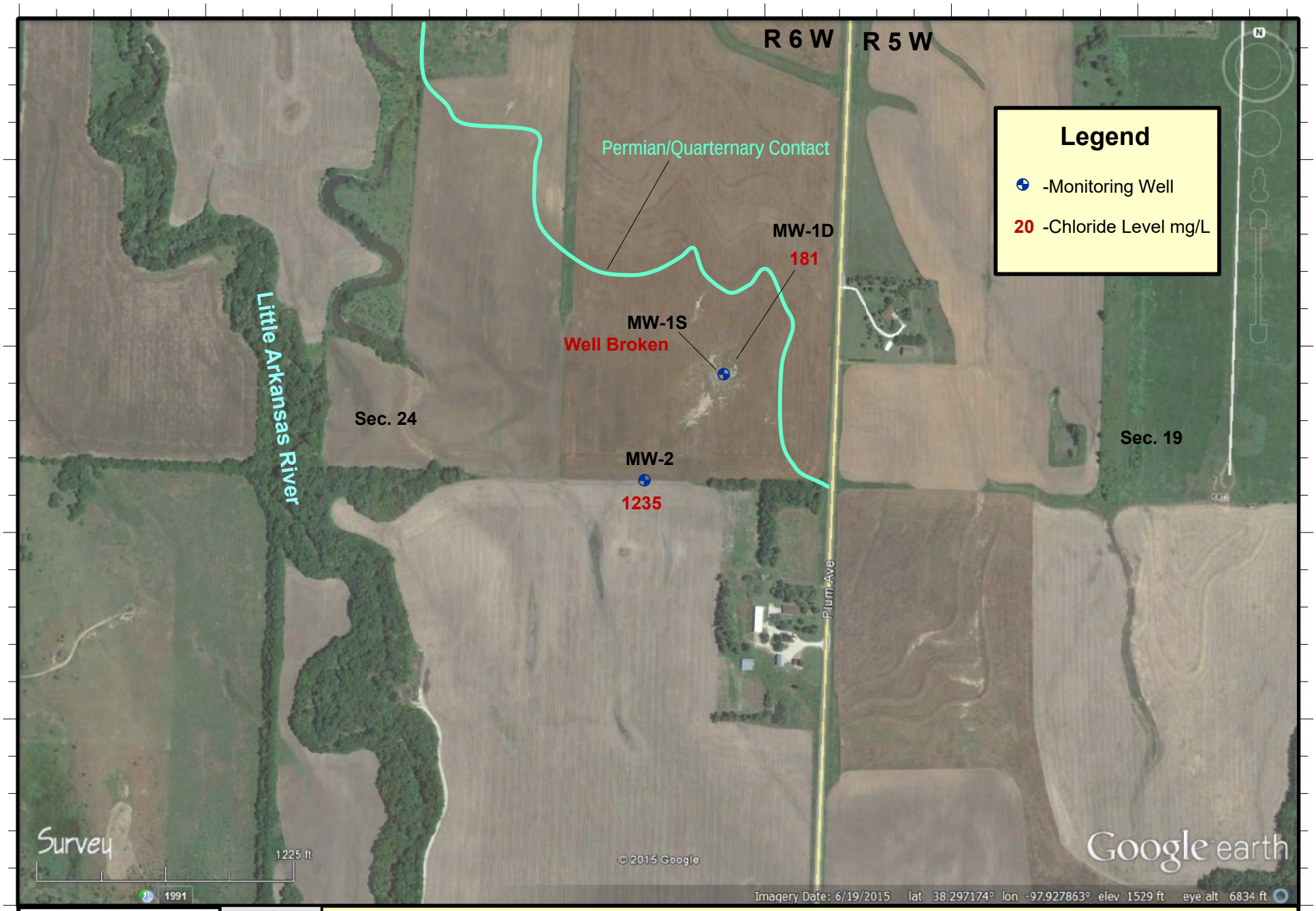
Estimated Total Costs: $800 annually for field inspection and monitoring, and research into ideas/alternatives to remediating the site or at least expediting the attenuation.

Control No.	**Staff Hours/Expenditures**	**Fund Expenditures FY 2018/19**	**Total**
20000035-001	**10.5 Hrs. / $323.11**		**$4,057.85**

Current Contaminate Level: 1235 mg/l, MW #2, 7/25/2018
181 mg/l Cl- MW-1 Deep Aquifer 7/25/2018

Status:

☐ **1. Site Assessment**	☐ **2. Short Term Monitoring**	☐ **3. Investigation**
☒ **4. Long Term Monitoring**	☐ **5. Remediation Plan**	☐ **6. Installation**
☐ **7. Remediation**	☐ **8. Post Rem. Monitoring**	☐ **9. Resolved**



Kansas Corporation Commission

Stowe-Zaid Shallow Brine Monitoring Site

Section 24 of Township 20 South and Range 6 West, Rice County, Kansas

2018 Chloride Levels

KCC District #2 Field Office - Wells sampled on 7/25/2018 - Map drawn on 10/22/2018 by D.Bollenback

Project: ***Trostle Contamination Site***

Site Location: The site area is 2.3 miles west and 2.75 miles south of the town of Murdock, Kansas. The legal description is northeastern quarter of Section 33, Township 28 South, and Range 6 West of Kingman County, Kansas. The site is in the drainage systems of Sand Creek which is located 1 mile north of the site. Sand Creek is a tributary of the South Fork Ninnescah River.

Impact\Immediacy: The high chlorides could impact the ground water affecting stock wells in the immediate area, as well as low lying draws which are usually dry, but containing water with high chlorides after a rainfall. The aquifer is very low yielding. There are erosion effects to the terrain where there is no vegetation. Site is classified as low immediacy.

Site Description: The area most affected historically is around the Trostle salt-water disposal well battery. There are seven monitoring wells below the Trostle salt-water disposal well that also have elevated chlorides. The most likely cause was something related to the salt-water tank such as discharges. This site was historically remediated via an interceptor trench but the system was abandoned after the holding tanks failed and the site was placed into the monitoring phase of investigation. There has only been one reported spill at the SWDW since 2005. Local hydrology is a perched aquifer system. Precipitation that infiltrated the Pleistocene Alluvium moves downward until it hits the impermeable red Ninnescah shale. Groundwater then flows down gradient on top of the shale. The general movement of fluids in the perched water table flows to the northwest-west.

Unusual Problems: None.

Status of Project: On July 23rd, 2018, eleven groundwater monitoring wells were sampled. A polyethylene disposable bailer was used to attempt purge a minimum of three well volumes of groundwater from each well before sampling. Almost all wells bailed dry before 3 well volumes could be purged, and those wells were sampled after recharge had taken place. Purge water was tested for conductivity and contained in a 250 gallon poly-tank if conductivity was high. All contained water was disposed into an authorized SWDW. Groundwater samples from each monitoring well were collected in one 250 (ml) polyurethane container for analysis at the KCC District #2 Laboratory. Laboratory results show a mix of changes in chlorides from 2017. There was increases chlorides in the down gradient toe of the plume, as well as a slight increase on the east side of the tank battery at MW-1. There were decreases on the west side of the battery, and fairly stable chloride results in the other well onsite.

Level of Remediation Sought:

Ideal: 250 mg/l Chloride
Target: 500 mg/l Chloride

Recommendations for Future Work: Due to the limited amount of water resources affected and with the recent data, KCC recommends continuing sampling the Trostle on an annual basis.

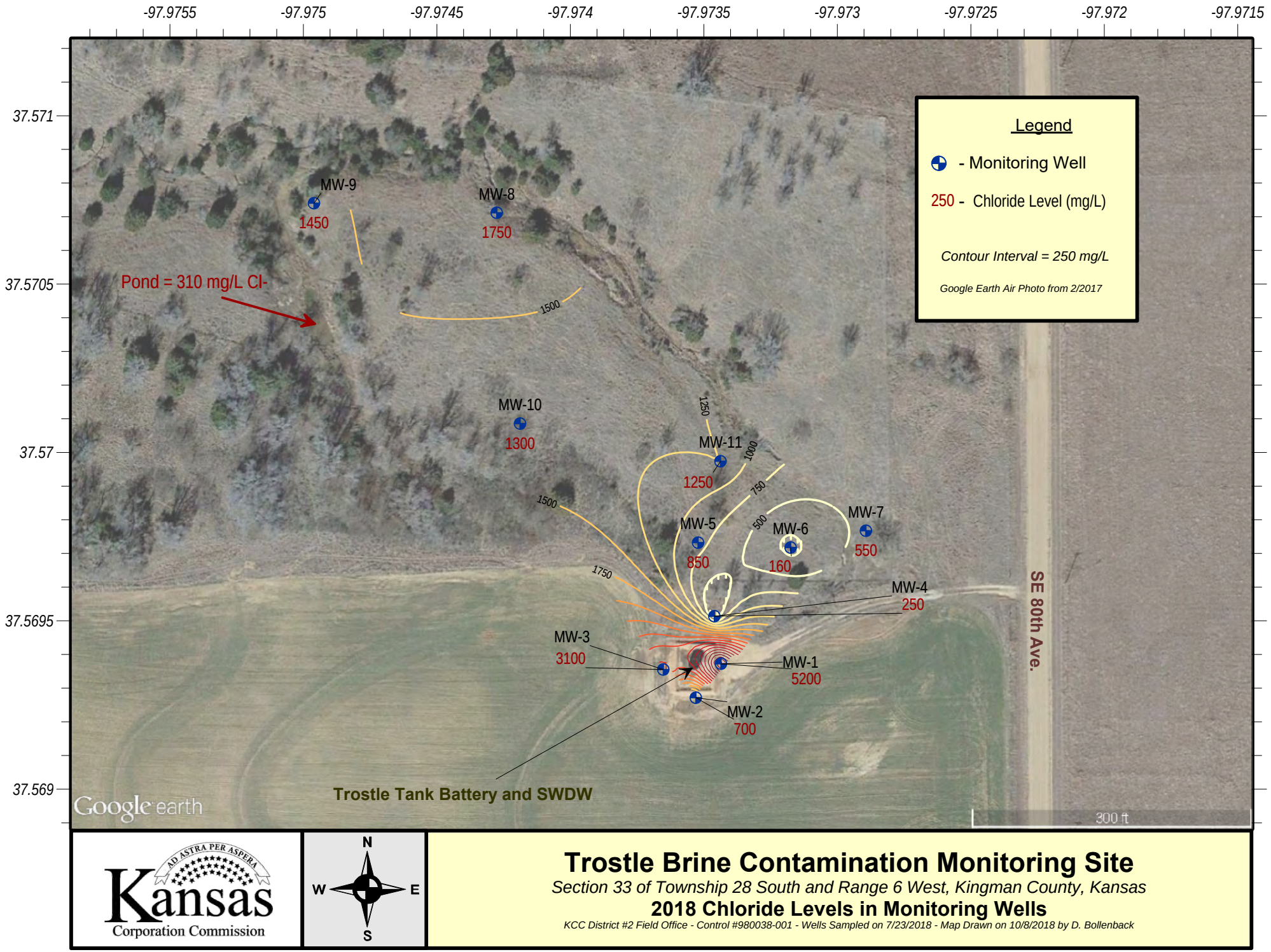
Estimated Long Term Cost: The estimated cost to the KCC will be $800 per year for inspection of site, running an analysis of the water, and data and report preparation.

Control No.	**Staff Hours/Expenditures**	**Fund Expenditures FY 2018/19**	**Total**
980038-001	**21.5 Hrs. / $606.10**		

Current Contaminate Level: 160 mg/L in MW-6 to 5,200 mg/L chlorides in MW-1

Status:

☐ **1. Site Assessment**	☐ **2. Short Term Monitoring**	☐ **3. Investigation**
☒ **4. Long Term Monitoring**	☐ **5. Remediation Plan**	☐ **6. Installation**
☐ **7. Remediation**	☐ **8. Post Rem. Monitoring**	☐ **9. Resolved**



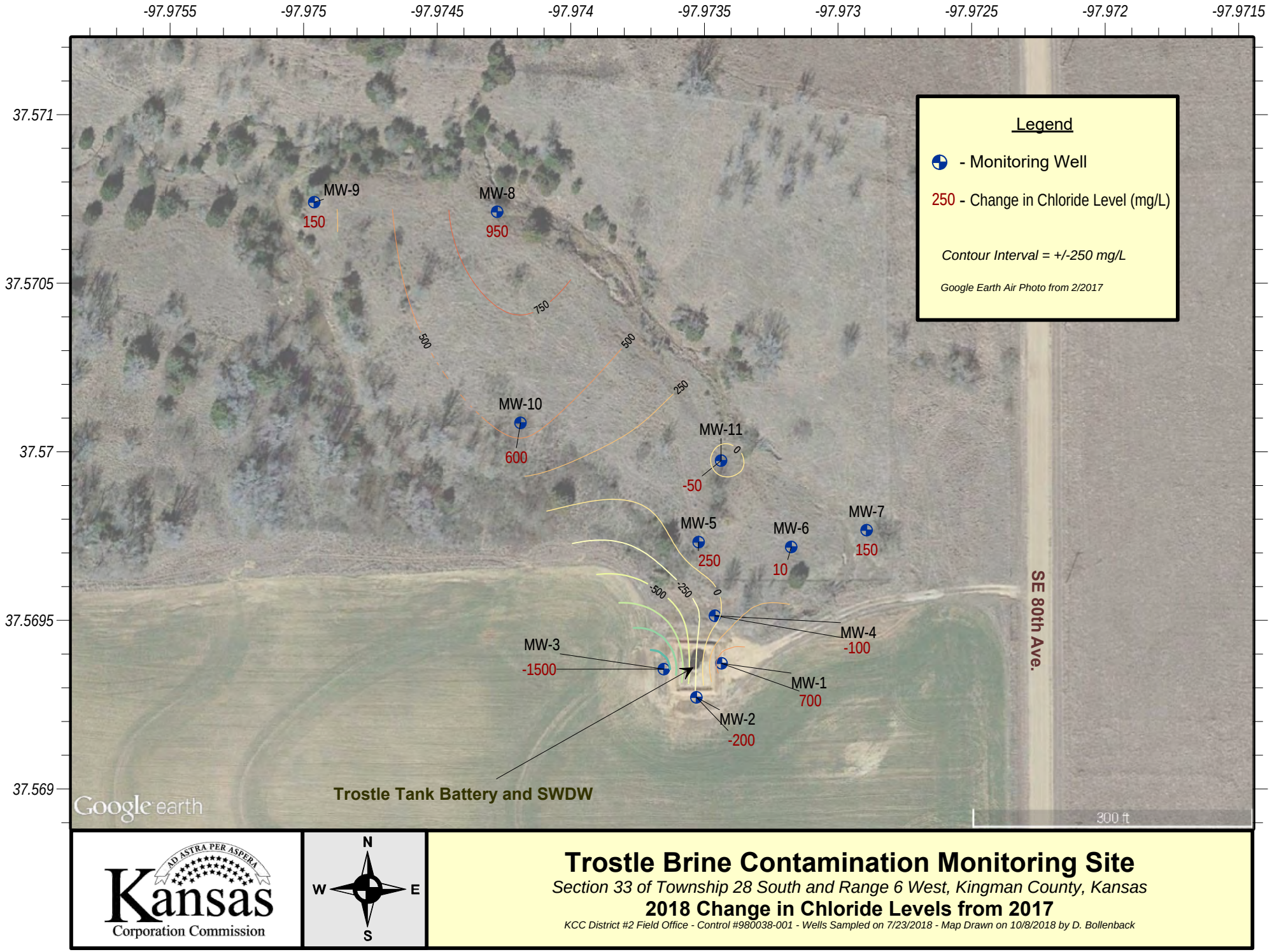
Kansas Corporation Commission

Trostle Brine Contamination Monitoring Site

Section 33 of Township 28 South and Range 6 West, Kingman County, Kansas

2018 Chloride Levels in Monitoring Wells

KCC District #2 Field Office - Control #980038-001 - Wells Sampled on 7/23/2018 - Map Drawn on 10/8/2018 by D. Bollenback



Kansas Corporation Commission

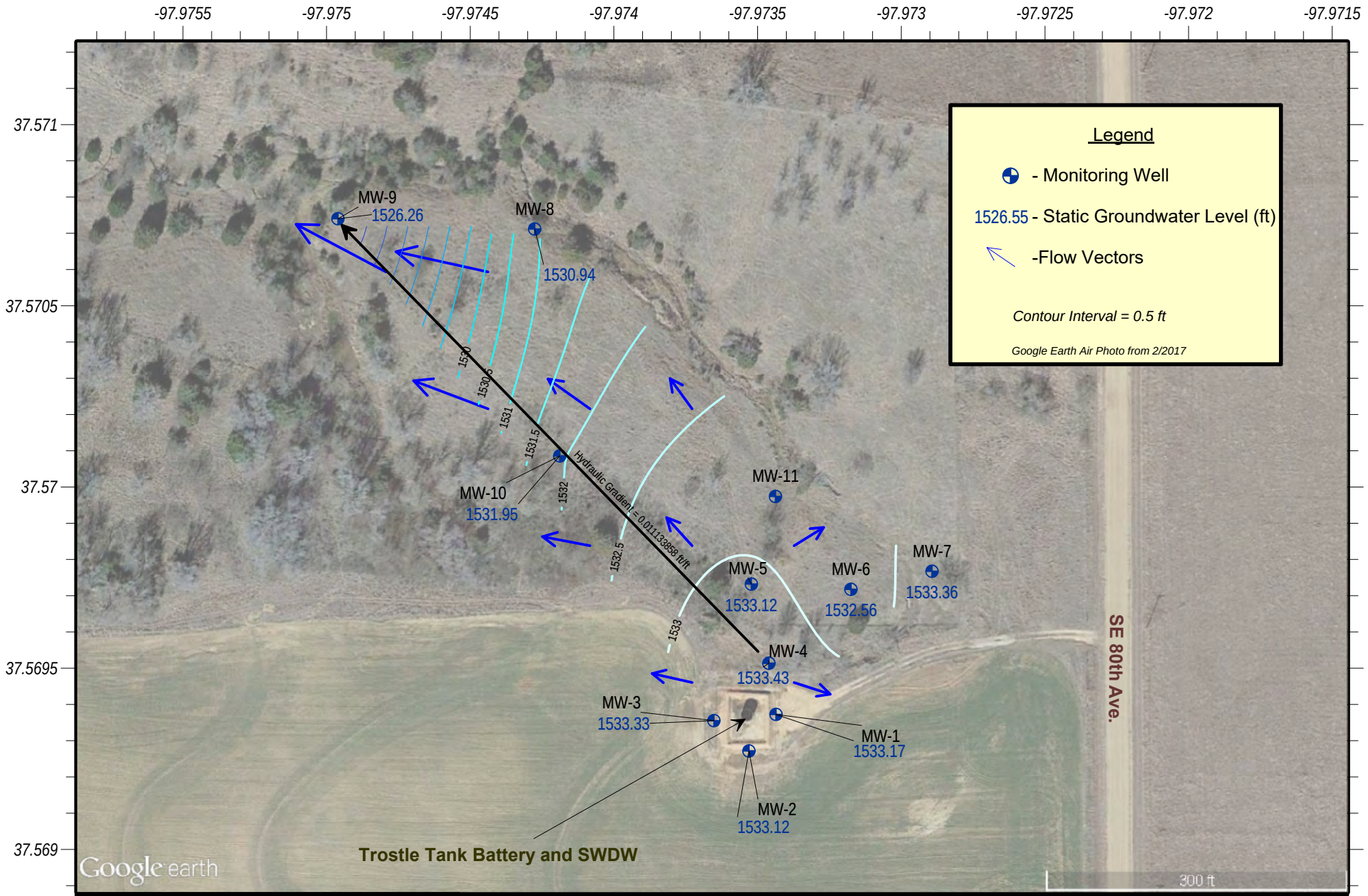
N W E S

Trostle Brine Contamination Monitoring Site

Section 33 of Township 28 South and Range 6 West, Kingman County, Kansas

2018 Change in Chloride Levels from 2017

KCC District #2 Field Office - Control #980038-001 - Wells Sampled on 7/23/2018 - Map Drawn on 10/8/2018 by D. Bollenback



Kansas Corporation Commission

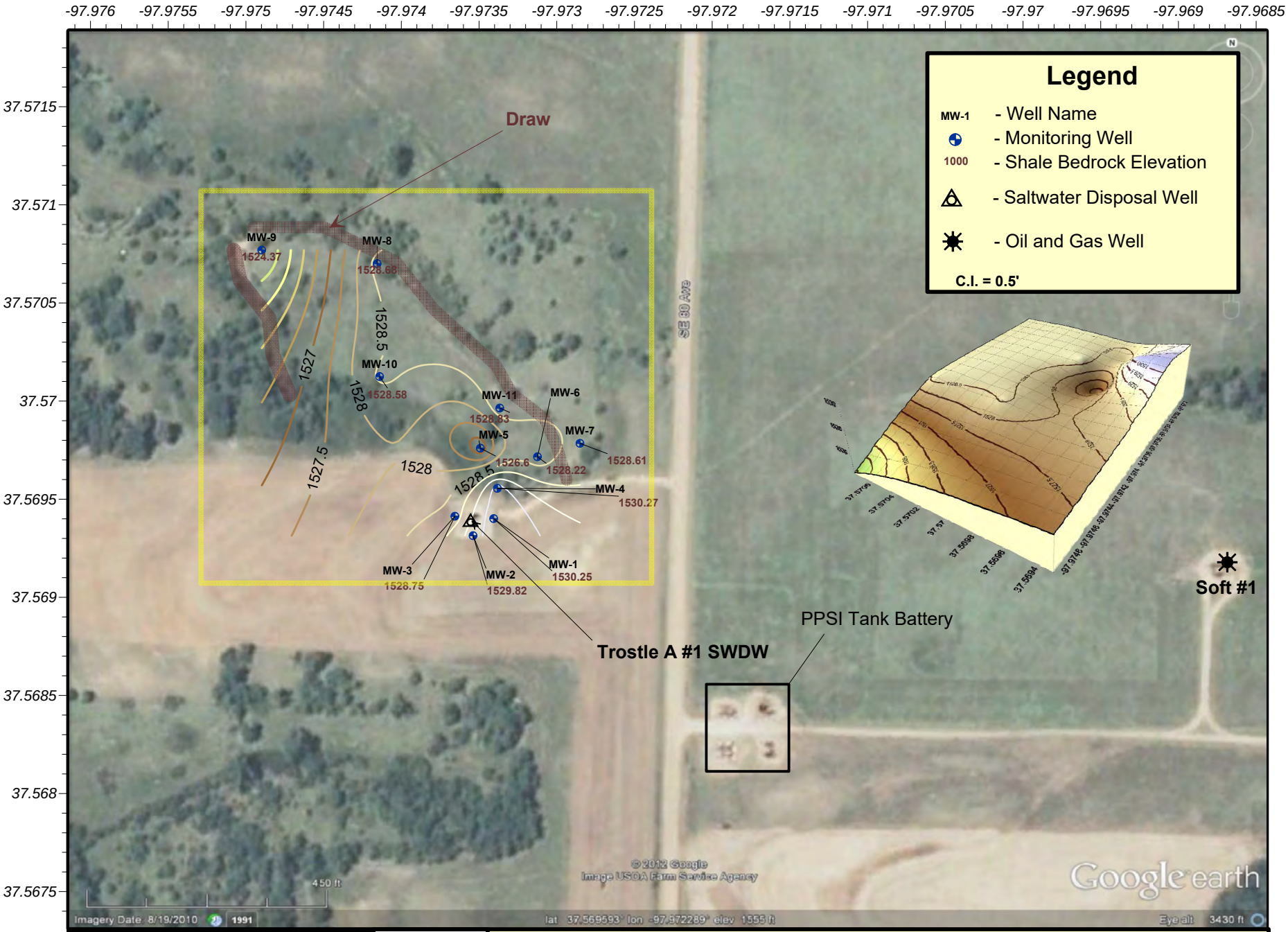
N W E S

Trostle Brine Contamination Monitoring Site

Section 33 of Township 28 South and Range 6 West, Kingman County, Kansas

2018 Groundwater Elevation Map

KCC District #2 Field Office - Control #980038-001 - Wells Gauged on 7/23/2018 - Map Drawn on 10/8/2018 by D. Bollenback



Kansas Corporation Commission

N W E S

Trostle Contamination and Monitoring Site
Shale Bedrock Elevation

Section 33 of T28S and R6W, Kingman County, Kansas

KCC District #2 Field Office - KCC Control Number:#980038-001 - Map Drawn 9/4/2012 by D. Bollenback reproduced for 2018 Report

Project: ***Voshell Site***

Site Location: The Voshell site includes a portion of the Voshell Oil Field, and a large area between Elyria and Moundridge, Kansas. Parts of Townships 20 and 21 South and Ranges 2 and 3 West are within the Site boundaries.

Impact/Immediacy: Impact is to the shallow Equus Beds underlying the Voshell Oil Field, which has been affected by elevated chloride levels. Resources impacted include domestic and irrigation wells. The site is classified as moderate immediacy level.

Site Description: The land surface is flat irrigated farmland, which is dissected by Dry Turkey Creek and Running Turkey Creek. The aquifer ranges in thickness from eighty feet in the east of the site area to approximately two hundred feet in the west. The axis of the relatively thick McPherson channel can be mapped from the center of Section 31, T21S, R3W to the NW corner of Section 19 to the center of Section 5, and then northward from that point. The aquifer appears to contain several aquitards, which may or may not be continuous throughout the area. In May of 2004, a cooperative agreement between the Kansas Corporation Commission (KCC) and the Equus Beds Groundwater Management District No. 2 (GMD 2) was entered into for the drilling of 10 groundwater monitoring wells in the Voshell Oil Field. The GMD 2 is responsible for water sampling and providing water quality data to the KCC of those wells. The initial seven wells were drilled north to south through the project area, and were drilled down to the Wellington shale bedrock. Approximately 21 wells associated with the Running Turkey Creek site monitored by the KCC have been moved under the control number of the Voshell site since 2012.

Unusual Problems: Movement of the chloride plume toward irrigation wells can be somewhat accelerated by the effect of large irrigation well pumping. The plume will continue to migrate toward the McPherson channel located to the west of the Voshell Oil Field as long as there is deep pumping of the Equus Bed aquifer. New irrigations wells are drilled every year in the immediate area, and can cause erratic hydraulic movements of the plumes.

Status of the Project: The Voshell wells were sampled by KCC staff in Late September and early October of 2018. The GMD#2 EB wells were sampled on July 28th, 2018. The known plumes appear to be slowly moving to the southwest. The KCC started a major water record research into the area west of the site during the 2014 year which continues through 2018. New irrigation wells are being drilled nearly every year. The western monitoring wells sampled by GMD2 have risen in chloride levels over the last two years but have remained stable in 2018. Most areas seem to be stable or slightly lower which could be due to the recent heavy precipitation in the region. The small plume southeast of the town Elyria has decreased substantially which is most likely due to fact that they are shallow and have a direct correlation with precipitation events. MW-901 was unlike most wells onsite and tested higher this year. KCC will monitor this and if a trend is discovered may put resources toward the source of the increase.

Level of Remediation Sought:

Ideal: 250 ppm Chloride
Target: 500 ppm Chloride

Recommendation for Future Work: KCC has discussed with GMD #2 about adding additional monitoring wells on the west edge of the site, and both KCC and GMD could join resources in achieving this. Some detail delineating within the site boundaries is also recommended especially near the high chloride plume within the field, and to the north near MW-101. KCC will continue to sample the Voshell monitoring wells, and fund the sampling of the GMD2 EB monitoring wells. KCC will begin putting together a multiple well installation scope of work after discussion with GMD #2. A remedial system could be installed in the southern plume, but costs seem to be too high for the current chloride levels at the Voshell site. Due to the large presence of irrigation wells down gradient of the plumes, reevaluation of potential remedial system installation may be warranted it if these wells show signs of being impacted.

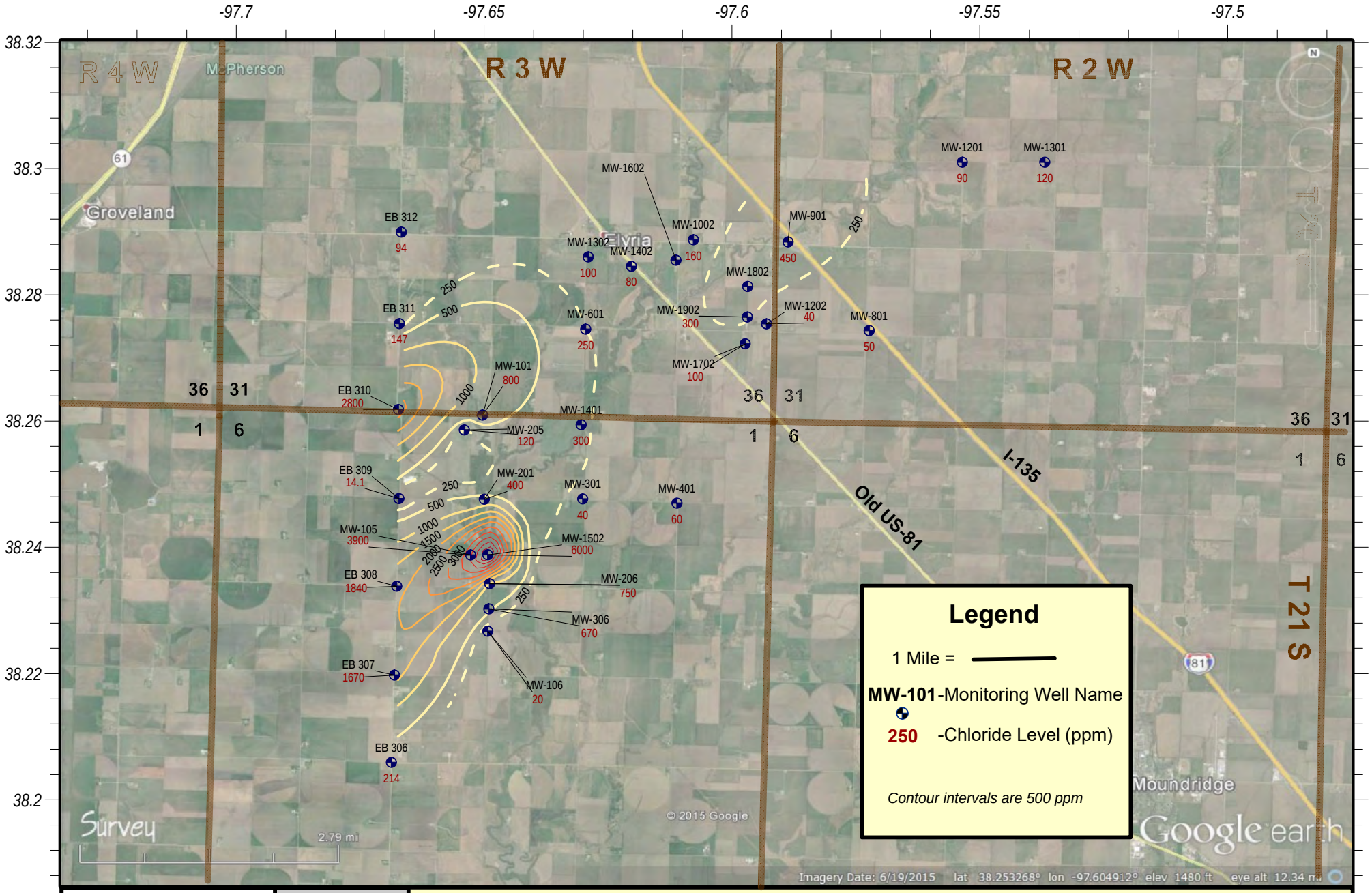
Estimated Total Costs: Cost of funding field work on repairs and sampling should be approximately $700-$1,000. Office research into the expansion of the monitoring well network will cost in staff time only. KCC believes a cost estimate of $20,000-$40,000 dollars will be needed for the installation of new monitoring wells to delineate the site depending on the number of wells to be installed. Remedial system installation could cost over $350,000, for disposal well and system install.

Control No.	**Staff Hours/Expenditures**	**Fund Expenditures FY 2018/19**	**Total**
20030059-001	**45.5 Hrs. / $1,227.70**	**$302.00**	**$20,484.80**

Current Contaminate Level: MW 1502 – 6,000 mg/l.

Status:

☐ **1. Site Assessment**	☐ **2. Short Term Monitoring**	☒ **3. Investigation**
☒ **4. Long Term Monitoring**	☐ **5. Remediation Plan**	☐ **6. Installation**
☐ **7. Remediation**	☐ **8. Post Rem. Monitoring**	☐ **9. Resolved**



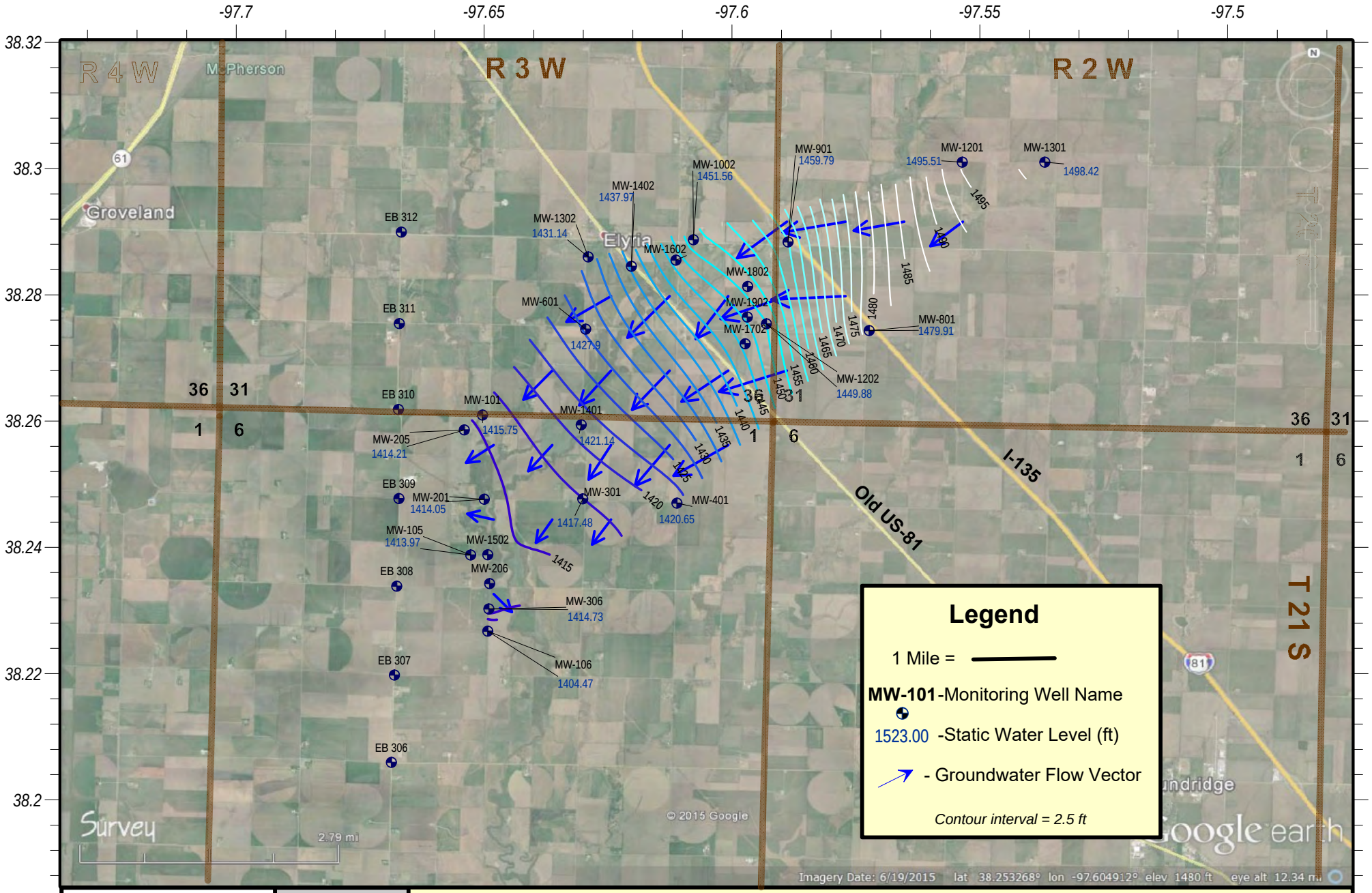
Kansas Corporation Commission

Voshell Contamination Site

Multiple Section of Townships 20 & 21 South and Range 2 & 3 West, McPherson County, Kansas

2018 Groundwater Chloride Level Map

District #2 - Control Number #20030059-001 - Sampled on 9/28/2018 & 10/2/2018 - Drawn on 10/19/18 by D.Bollenback



Legend

1 Mile = ——

MW-101 -Monitoring Well Name

1523.00 -Static Water Level (ft)

- Groundwater Flow Vector

Contour interval = 2.5 ft

Kansas Corporation Commission

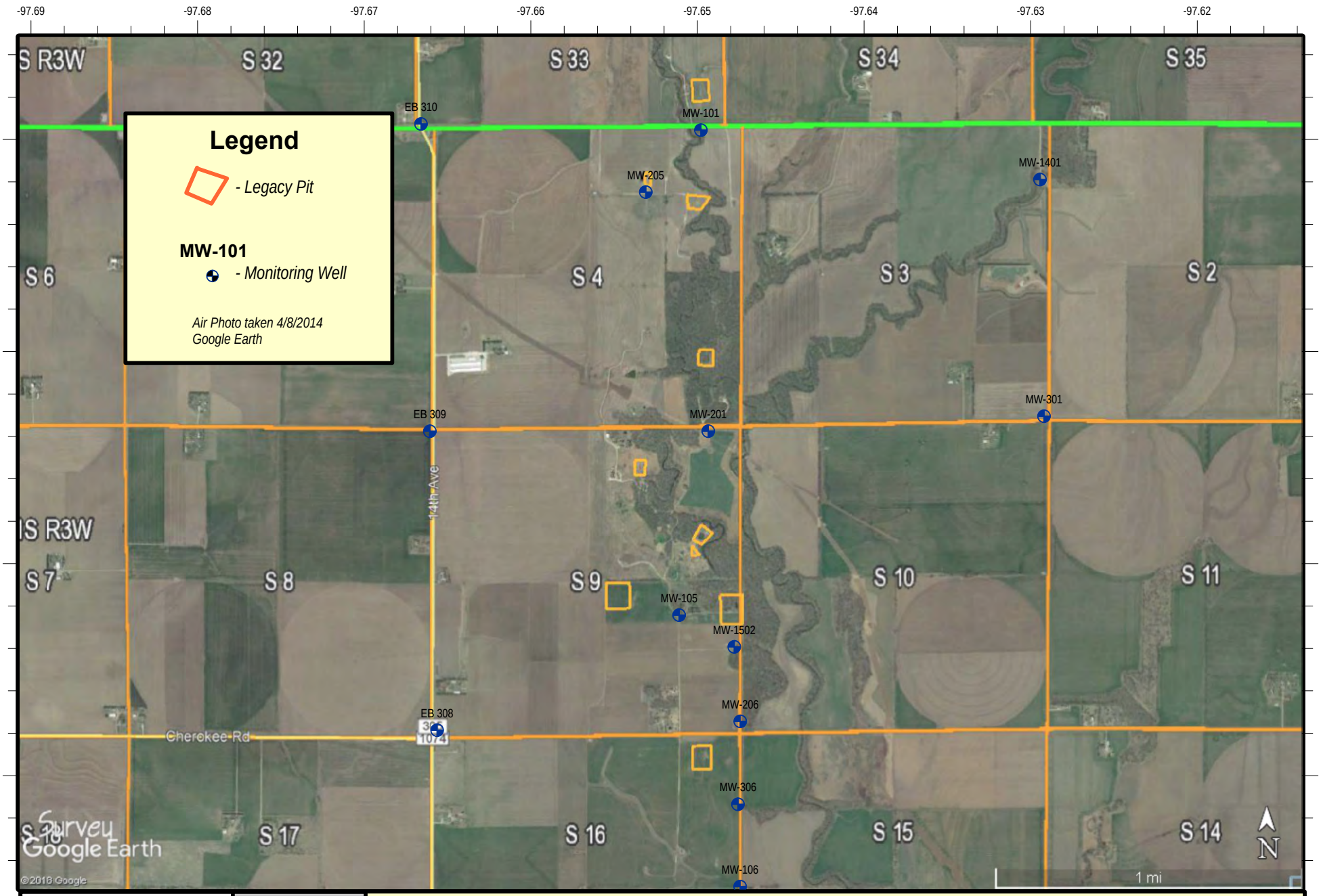
N W E S

Voshell Contamination Site

Multiple Section of Townships 20 & 21 South and Range 2 & 3 West, McPherson County, Kansas

2018 Groundwater Elevation Map

District #2 - Control Number #20030059-001 - Gauged on 9/28/2018 & 10/2/2018 - Drawn on 10/19/18 by D.Bollenback



Kansas Corporation Commission

N W E S

Voshell Contamination Site

Multiple Section of Townships 20 & 21 South and Range 3 West, McPherson County, Kansas

2018 Legacy Pits Location Map spotted using Historical Air Photos

District #2 - Control Number #20030059-001 - Drawn on 10/22/18 by D.Bollenback

Project: ***Wildboy's Land & Cattle Contamination Site***

Site Location: Legal location is NE/4 of Section 28, Township 33 South, Range 11 West, Barber County, 9 miles S of Medicine Lodge on Hwy 281, 1E, 1S, 1E into farmstead.

Impact/Immediacy: The impact is to the groundwater and surface water of the area. Immediacy level is rated at moderate to high.

Site Description: The site is located within the Medicine Lodge River Valley.

Unusual Problems: None.

Status of Project: During 2018, only one well was accessible to sample. In general, the chlorides at this site have been quite variable. The only determination that can be made from the one sample is that the plume doesn't appear to be moving westward.

Level of Chloride Sought:

Ideal: 250 ppm Chloride
Target: 500 ppm Chloride

Recommendations for Future Work: There are several oilfield supply wells downstream to the south that will be sampled in 2019 to help delineate the plume. Should chloride levels continue to elevate significantly in future sampling, implementation of a remedial system will be investigated.

Estimated Total Cost: Installation of recovery system and disposal facility with long term monitoring. Costs associated with the installation of the disposal well are attached to the Harbaugh site.

Control No.	**Staff Hours/Expenditures**	**Fund Expenditures FY 2018/19 Total**
970017-00	**4 Hrs. / $129.52**	**See Harbaugh**

Current Contaminate Level: 210ppm Cl- 3100ppm Cl-

Status:

☐ **1. Site Assessment**	☐ **2. Short Term Monitoring**	☐ **3. Investigation**
☒ **4. Long Term Monitoring**	☐ **5. Remediation Plan**	☐ **6. Installation**
☐ **7. Remediation**	☐ **8. Post Rem. Monitoring**	☐ **9. Resolved**

Kansas Corporation Commission

N W E S

Wildboys Site

2018 Area Map with Chlorides

Sections 28/33-T-33S-R11W

Barber County, Kansas

KCC Control # 970017-00 District 1

K. Sullivan 10/29/18

Project: ***Wingate Contamination Site***

Site Location: NE/4 of Section 17, Township 29 South, Range 17 East, Wilson County.

Impact/Immediacy: Impact is to the groundwater and soil. Immediacy level is rated as low.

Site Description: This site is located on gently sloping land used for agriculture. Much of the scar is located in a low-lying drainage area next to or within a waterway. Brine seepage originates from the Thayer coal bed or Cottage Grove Sandstone Member, which overlies the Chanute Shale in the higher areas.

Unusual Problems: This property is leased by River Rock. The Mary Douglas property located in the next ¼ section east contained 22 abandoned wells, many of which had high fluid levels and were old style completions. These abandoned wells are contributing to the source of the brine commingling with the shallow aquifer impacting the Wingate property. These wells were plugged by the State and the project was completed in February of 2009.

Status of Project: Four new monitoring wells were constructed on this project in early 2012. These wells were sampled on 09/13/2018. Statistical analysis of samples collected from these four new monitoring wells indicates Cl- concentrations are directly impacted to precipitation events and oil & gas producing activities within the immediate vicinity. The sample results for 2018 are as follows:

WIN1: 1,800 ppm Cl- ***WIN2***: 1,200 ppm Cl-
WIN3: 3,200 ppm Cl-: ***WIN4***: 2,100 ppm Cl-

Level of Remediation Sought:
Ideal: 250 ppm Chloride
Target: 500 ppm Chloride

Recommendation for Future Work: Sample site quarterly. This site should possibly be expanded to include the Mary Douglas property located in NW 16-T29S-R17E WL Co. and the SE 17-T29S-R17E. Sampling in 2017 indicates that the primary source of brine is coming from the SSE of this project. Graphical analysis of the Cl- concentrations in these four wells indicates that chlorides are at the lowest level since the project was initiated. Factors such as an increase in flood and or disposal fluids from active operations completed within the same zone or CBM wells that have been shut in or pumping at reduced rates can temporarily increase formation pressures allowing greater communication with possible undiscovered open bore holes and an increase in chloride levels. Further monitoring of existing wells and possible additional monitoring wells will help to delineate the extent and condition of this aquifer. Further review of KGS well data and GIS information along with the new ability to download and overlay historic aerial imagery may provide information on additional possible locations of abandoned wells for further field investigation.

Estimated Total Costs: Four new monitoring wells were completed at a cost of $8,196 in 2012.

Control No.	**Staff Hours/Expenditures**	**Fund Expenditures FY 2018/19**	**Total**
970107-00	**4.5 Hrs. / $142.17**		**$8,296**

Current Contaminate Level: 1,200 ppm Cl- to 3,200 ppm Cl-

Status:Active

☐ **1. Site Assessment**	☐ **2. Short Term Monitoring**	☒ **3. Investigation**
☒ **4. Long Term Monitoring**	☐ **5. Remediation Plan**	☐ **6. Installation**
☐ **7. Remediation**	☐ **8. Post Rem. Monitoring**	☐ **9. Resolved**

KANSAS CORPORATION COMMISSION
Wingate Remediation Site
NW 17-T29S-R17E
Wilson County, Kansas
Project 970170-00
10/08/2018 District 3

N
S

Contour Interval 800 ppm Cl-
Monitoring Well
Fee Fund Plugged Well

Project: ***Yeoman Site***

Site Location: The Yeoman site is located in the center of the Southeast quarter of Section 35 T 28S R7W. This area is five miles South and three miles East of the city of Kingman in Kingman County.

Impact/Immediacy: The abandoned Yeoman #1 located in the center of the SE/4 may have contributed to the charged up shallow zones in the Permian Red Beds with gas, but was found as an abandoned unplugged well with gas coming to surface. The site classification is high due to the remaining gas in place even after producing the gas from 5 monitoring / recovery wells for 12 years.

Site Description: The Yeoman #1 is located in pasture used for grazing cattle. The Permian Red Beds are encountered at a depth of 50' consisting of very soft, sandy weathered red shale. The unconsolidated alluvium above the Red Beds consists of a fine to medium grain sand that is the primary shallow aquifer for this area. There are five monitoring /recovery wells offsetting the abandoned Yeoman #1 that were drilled in December 2005 to a total depth of 150 feet with gas encountered as shallow as 110 feet. Each monitoring / recovery well has approximately 90 feet of 7 inch surface casing set.
In April 2010 the KCC District 2 office drilled an additional 6 monitoring wells around the perimeter of section 36 in the section east of the Yeoman site. This was done in an attempt to delineate the escaped gas, and follow the upward trend of the Permian red beds to the northeast. Gas was found at all 6 locations with small initial shut-in pressures from 15 to 37 psi at the wellhead.

Unusual Problems: In early 2009, KCC staff became aware of gas coming up an abandoned water well in the SW corner of Sec. 30-28-6W over a mile away from the Yeoman #1. The property owner is Harold Reida, and the water well is referred to as the Reida water well. Gas was still present in the Reida water well as of October 2017.

Status of the Project: Currently the five monitoring / recovery wells directly offsetting the Yeoman #1 are being produced by Don Graber (Gra Ex LLC, KCC Lic. #33921) under an agreement with the KCC. Mr. Graber has been producing the recovery wells since November 2009 and has recovered a total of 193,747 Mcf as of July 1, 2018. For the first 6 months of 2018 the five monitoring / recovery wells averaged 8.8 Mcf per day into the sales line. This is a huge drop from 73 Mcf per day for the prior 12 months. A total cumulative amount of 258,594 Mcf of gas has been recovered from these 5 recovery wells beginning in April 2006. (From KGS Production Data)

Since August of 2017 the gas production from the 5 recovery wells has continued to drop, which has made it uneconomical to run the compressor full time. As shown on the pressure map attached to this report, the recovery wells currently maintain 31.5 psi of wellhead pressure while free flowing gas through the system (no compressor). When the compressor is running the wellhead pressure will drop to <5 psi and the system will go on a vacuum within a day. The system is not run on a vacuum due to the risk of pulling water into the gathering lines. The monthly expenses of the system are: $250 in fees & adjustments from the purchaser, a minimum $30 electric connection fee plus $10-15/day when the compressor is ran intermittently, and approximately $92 per month in taxes, pumper fees, and royalty payments. As of October 2018, the system is flowing 6 Mcf per day into the sales line, and at the current gas price of $3.00+ per Mcf, Mr. Graber is able to break even or be slightly in the black.

In 2017 staff suggested to Mr. Graber that he connect MW 7 to the system based on: 1) The well always maintained an average pressure of 30 psi, and had a strong blow when opened to the atmosphere, and 2) MW 7 was drilled next to the compressor making the cost to connect very low. Mr. Graber connected MW 7 turning it into Recovery Well 7 (RW 7), but within several days the wellhead pressure dropped to 2 psi and he saw no increase in production rate. RW 7 has remained shut-in maintaining around 25 psi wellhead pressure.

In an effort to evaluate the potential of the 5 original recovery wells, KCC staff flow tested wells on July 16, 2018, along with MW 6. Testing each individually would show which ones were good producers, and which ones were not (RW 5 not tested due to stuck ball valve that will be replaced). The wells were tested for approximately 1 hour (based on blow-down rate), with all of them flowing through a 0.25" choke plate. Staff observed MW 6, RW East, and RW North as the best producers with flow rates of 7.85, 8.89 and 9.2 mcfpd respectively. RW South and RW West were recorded at a near zero rate production after 30 minutes and were subsequently shut-in after the test.

Yeoman 1: With the system not on a vacuum by running the compressor full time, staff have observed small amounts of gas bubbling up the backside of the Yeoman surface casing, and therefore have delayed the plugging of the well.

Level of Remediation Sought:

Ideal: N/A

Target: N/A Complete the plugging of the Yeoman #1 once escaped gas has been depleted from the Red Beds.

Project: ***Yeoman Site*** **(Cont'd)**

Recommendation for Future Work: Continue to monitor gas production very closely with Don Graber as he will continue to produce the gas. The original recovery wells were drilled in 2005, and have never been re-entered. Staff recommends that the best producers, RW North, RW East, RW 5 and MW 6, be re-entered and cleaned out to total depth (150'). If the wells have become silted in over time, it may increase their capability to produce the gas, and further mitigate the stray gas problem in the immediate area.

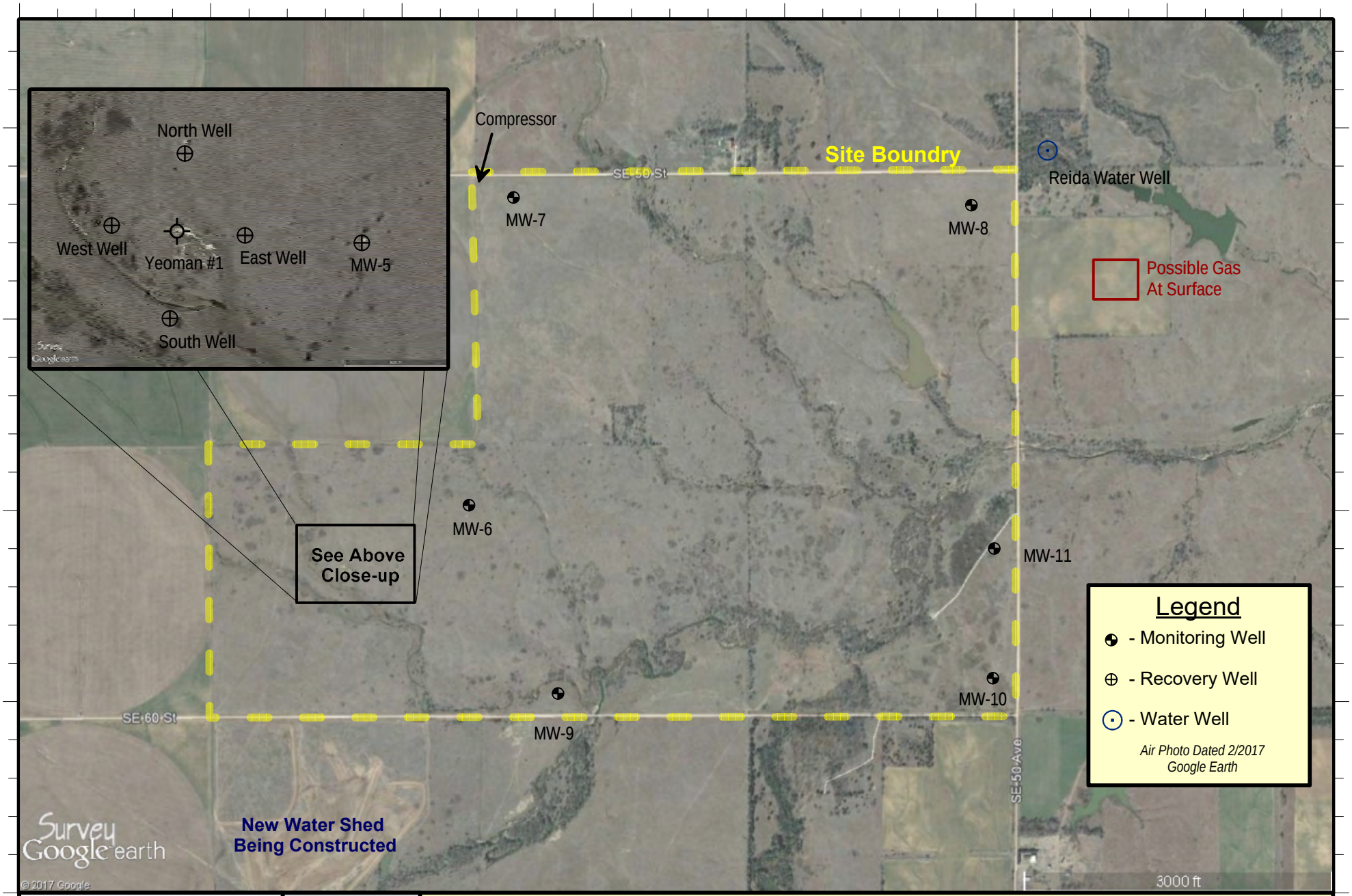
Estimated Total Costs: Plugging of the Yeoman #1 will be less than $25,000 and can be done through KCC fee fund.

Control No.	**Staff Hours/Expenditures**	**Fund Expenditures**	
		FY 2018/19	**Total**
20060021-001	**166.5 Hrs. / $5,025.59**		**$93,690.76**

Current Contaminate Level: Shallow Aquifer <70 ppm Cl-
Water from Permian Red Beds tested 625 ppm Cl- in well #5 at 150' TD
Total Gas Produced to date: 258,594 Mcf (KGS Production Data)

Status:

☐ **1. Site Assessment**	☐ **2. Short Term Monitoring**	☐ **3. Investigation**
☒ **4. Long Term Monitoring**	☐ **5. Remediation Plan**	☐ **6. Installation**
☒ **7. Remediation**	☐ **8. Post Rem. Monitoring**	☐ **9. Resolved**



Kansas Corporation Commission

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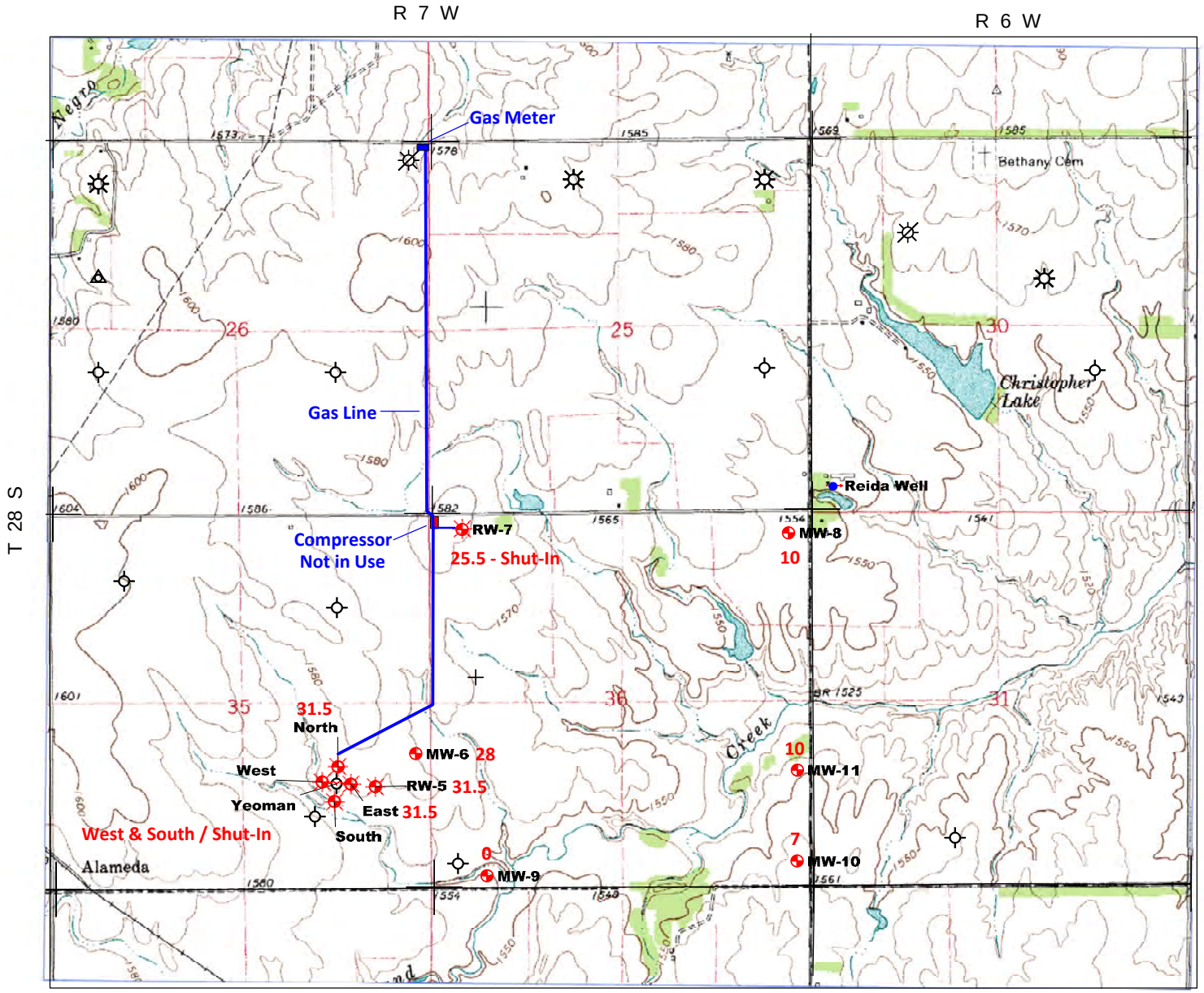
Yeoman Escaped Shallow Gas Site

SE/4 of Seciton 35 and all of section 36 of Township 28 South and Range 7 West, Kingman County, Kansas

Site Map

KCC District #2 Field Office - Control #20060021-001 - Map Drawn by D.Bollenback on 10/19/2017



KANSAS CORPORATION COMMISSION

YOEMAN SITE
SE/4 of Section 35-28-7W
All of Section 36-28-7W
Kingman County, KS

Dist. 2 | Project #20060021-00 | 10-12-2018

N W E S

LEGEND

- GAS
- P&A GAS
- DRY HOLE
- SWD
- EXISTING RECOVERY WELL
- MONITORING WELL

September 2018 Pressure Readings

Recovery Well Readings are free flowing pressure as the Compressor is not in use.

Measurements in psi

Ryan Hoffman, Director of Conservation

266 N. Main St., Ste. 220 | Wichita, Kansas 67202-1513 | http://kcc.ks.gov/