



September 22, 2008

Mr. Scott Pope
Colorado Interstate Gas
Two North Nevada Avenue
Colorado Springs, CO 80903

Re: Second Quarter 2008 Groundwater Monitoring Report, Colorado Interstate Gas
(CIG) Fort Morgan Compressor Station, Fort Morgan, Colorado

Dear Mr. Pope:

The Fort Morgan Long-Term Monitoring (LTM) program for 2008 is described in Section 6 of the Phase II Investigation Report (URS 2008). The results for the first quarterly sampling event, conducted in March 2008, have been included in the Phase II Report (URS 2008). This letter report summarizes the second quarter sampling results and describes additional field activities that were performed at the site during the second quarter 2008.

Overview of Second Quarter Field Activities

The following field activities were performed during the second quarter of 2008:

- Piezometer redevelopment
- Monitor well installation and development
- Surveying
- Groundwater sampling

All 28 piezometers included in the LTM program were redeveloped on June 16 and June 17 to remove sediment that had built up over the last year. A new monitor well was installed near H100 and CPT-57R on June 17; this well was subsequently developed on June 18. The second quarter groundwater monitoring event was conducted on June 24 through 26, and the new well and piezometers were surveyed on June 25. Figure 1 presents the locations included in the June 2008 sampling event.

The second quarter field activities are described in greater detail in the following sections.

Piezometer Redevelopment

Piezometers in the LTM program were redeveloped by URS to remove accumulated fine-grained sediment using the air lift method. Air lifting was conducted by surging and evacuating water from the piezometer with compressed air. The compressed air was

injected into the well through an air line to push water through the well screen. After injecting the compressed air, the well was given a chance to recharge so that water could flow back into the well casing. At set intervals, the air line was pulled up into a pipe string and water was pumped from the well using air as the lifting medium. This process was repeated until suspended sediment was no longer visible in the well discharge.

Results of the piezometer redevelopment work are summarized in Table 1. The table includes the following measurements: the original piezometer installation depth, the depth measured prior to redevelopment, and the depth measured immediately following redevelopment. The difference between the pre- and post-redevelopment depths has also been included to indicate the effect of the redevelopment process. As shown on the table, the differences ranged from 0.06 to 9.94 feet. These increases in total depth indicate that a significant volume of sediment was removed from many of the piezometers during redevelopment.

The depths shown in Table 1 that were measured post-redevelopment will be used as the standard piezometer depth measurement for comparison during future sampling events.

Monitor Well Installation and Development

In a letter dated April 4, 2008, the Colorado Oil and Gas Conservation Commission (COGCC) requested that CIG install one 2-inch polyvinyl chloride (PVC) monitor well near the location of CPT-57R. The COGCC specified that the new well should be completed at the same total depth as CPT-57R. The purpose of the well would be to allow low-flow sampling techniques to verify that methane and benzene, toluene, ethylbenzene, and total xylene (BTEX) concentrations were the same order of magnitude as the results obtained from piezometer samples. The new monitor well, designated MW-01, was installed on June 17, 2008 at a location near House 100 and across County Road 18 from CPT-57R. This newly installed monitoring point has been included in the LTM network.

MW-01 was installed to a depth of 55 feet below ground surface (bgs) using a hollow stem auger drill rig. During drilling, soil cores were collected from the borehole using a 5-foot-long continuous core barrel. A URS geologist was present on site to record the physical properties of the soil cores, including lithology, grain size, texture, sorting, color, strength, and moisture content. Groundwater was first encountered at approximately 26 feet bgs. The boring log and well construction log for MW-01 are presented as Figure 2.

The monitor well boring for MW-01 was originally intended to be 50 feet deep but was extended to 55 feet due to the presence of loose, saturated, “flowing” sands throughout the 40- to 50-foot interval. These sands were flowing into the hollow-stem augers, which prevented the well from being set at the desired depth of 50 feet. The well was installed with 40 feet of 2-inch inner diameter Schedule 40 PVC riser and 10 feet of 0.010-inch slot PVC screen that was set from 40 to 50 feet bgs. A 5-foot sump was placed at the

bottom of the well to elevate the well screen to the appropriate depth interval. The total depth of the well and the screened interval are similar to CPT-57R.

The monitor well construction was consistent with state regulations. As required in the Colorado Water Well Construction Rules, a silica sand filter pack was placed around the well screen from the bottom of the borehole to approximately 2 feet above the top of the screen. This corresponds to a depth interval of 38 to 55 feet bgs. Bentonite pellets were added above the filter pack from 38 feet to approximately 2 feet bgs. The remainder of the well completion consisted of a 2-foot-square concrete pad with a 4-inch by 4-inch above-grade steel well cover.

Monitor well MW-01 was developed on June 18, 2008. The well was developed by alternating surging and bailing until clear, sediment-free water was produced and water quality parameters stabilized to within 10 percent. The initial depth to water was 30.81 feet below the top of casing (TOC). Throughout well development, water quality parameters were measured every two to four gallons. The amount of water purged was approximately 26 gallons, which brought the depth to water to 40.86 feet below the TOC. Table 2 presents the well development summary for MW-01.

**Table 2
Well Development Summary for MW-01**

Volume gallons	Temperature °C	pH pH units	Conductivity mS/cm	Turbidity NTU	DTW feet BTOC	Comments
0.5	15.8	7.95	4.40	338	30.81	bailing/surging
1.0	15.3	7.85	4.44	>999	31.68	bailing- bentonite on bailer
4.0	14.5	7.83	4.46	>999	36.71	pumping
8.0	14.1	7.81	4.48	283	39.97	
12.0	14.0	7.80	4.49	612	41.65	
16.0	13.9	7.78	4.49	503	43.01	stopped pumping
17.0	--	--	--	--	38.63	bailing/ surging
20.0	13.8	7.73	4.50	>999	36.61	
22.0	13.9	7.71	4.51	716	38.26	
24.0	13.8	7.70	4.51	583	39.53	
26.0	13.8	7.71	4.52	423	40.86	

Notes:

-- = No measurement taken

°C = degrees Celsius

> = greater than

BTOC = below top of casing

DTW = depth to water

mS/cm = milliSiemens per centimeter

NTU = nephelometric turbidity units

Surveying

On June 25, 2008, the location and elevation of the new monitor well and the 28 piezometers were precisely measured and recorded by Flat Irons Surveying Company for URS. Each location was surveyed under the direction of a registered surveyor to acquire the northing, easting, ground surface elevation, and TOC elevation of the well or piezometer. The project database was updated with the new survey data, and the well and piezometer locations are posted on Figures 1, 3, and 4 of this report using the new coordinates.

Groundwater Sampling

The second quarter 2008 sampling event was conducted between June 24 and June 26, 2008. The sampling network (Figure 1) included the 28 piezometers, two active domestic wells, one inactive domestic well (i.e., H100), and the newly installed monitoring well MW-01.

Prior to sampling, the natural gas content in the headspace of each piezometer was checked using a QRAE™ Multi-Gas Monitor (QRAE). The domestic well locations were also screened prior to sampling by scanning the air around the wellhead with the QRAE. Once the air screening was complete, a water level meter was used to measure the static water level and total depth at each well location. These water level measurements were used to contour the potentiometric surface for the site (Figure 3). After measuring the static water level, the low-flow pump and dedicated polyethylene tubing were then lowered down the well to begin purging for low-flow sampling. Field parameter measurements were recorded during purging and prior to sample collection. Additional details on groundwater sampling procedures used at the site can be found in the Phase I Well Water and Air Sampling Report (CIG 2007) and the Interim Phase II Report (URS 2007).

During the June sampling event, URS personnel were unable to lower pumps down eight of the wells due to an apparent constriction of the well casing at the uppermost PVC joint. Two other difficulties were also encountered during the sampling event: anomalous pH readings were recorded at three monitoring locations, and a local landowner expressed concern at the location of a permanent monitoring well on his property. These situations are summarized in greater detail below.

During April 2008, surface completions were constructed at the 28 monitoring network piezometers, at the direction of the Colorado Water Well Construction Board of Examiners (BOE). The surface completions consist of an aboveground steel protective cover and a 2-foot-square concrete well pad. Unfortunately, this construction work caused sampling difficulties at eight of the piezometers (CPT-10S, CPT-36S, CPT-44S, CPT-50S, CPT-53S, CPT-62S, CPT-84S, and CPT-85S). Constructing the concrete pad and cover caused slight deformations of the piezometer riser pipes, which interfered with lowering a pump and/or bailer down the well. As a result of the constrictions in the riser

pipes, bailers were accidentally stuck in CPT-84S and CPT-85S. Two bailers are now stuck in CPT-84S.

Unusually high pH readings of 10, 13 and 17 (actual instrument reading) were obtained at CPT locations CPT-9S, CPT-11S, and CPT-10S, respectively, which are higher than the historic range of 7.2 to 8.2. At this time, instrument malfunction is the suspected cause of the anomalous readings. Another possible cause could be grout contamination that might have occurred when the surface completions were installed. Field parameters that will be measured during the next round of sampling (September 2008) will help confirm the source of the anomalous pH readings. Whatever the cause, high pH values are not expected to interfere with either the BTEX or natural gas monitoring.

The resident who farms the field south of CPT-85S expressed concern at the location of the permanent well. The resident informed CIG personnel that the well presented an inconvenience to his farming operations. CIG has since initiated a dialogue with the resident to explain why the well is an integral part of the LTM network and to discuss other possible options for the remainder of the LTM program.

During the June 2008 sampling event, water level measurements were taken at the 28 piezometers and the new monitor well and were used to develop the potentiometric surface map shown on Figure 3. This map indicates that groundwater is flowing generally to the north, and the hydraulic gradient is approximately 0.01 feet per foot. Pumping from several irrigation wells located north-northeast of the plant influences groundwater flow toward the north and east, which appears to influence migration of the dissolved methane plume in the same direction (Figure 4).

Groundwater samples collected during the June event were analyzed for dissolved gases and BTEX. The samples were submitted to the project laboratory (Microseeps in Pittsburgh, Pennsylvania) for analysis of dissolved gases by method AM-20Gax. The dissolved gases analyte list includes methane and other significant natural gas constituents. The samples for BTEX analysis were submitted to Southern Petroleum Laboratory (SPL) in Houston, Texas. The analytical data received from these laboratories were subject to the same data validation and database management protocols that were previously established for the Phase I and Phase II investigations.

Data obtained during the June 2008 sampling event were entered into the project database. This includes headspace gas measurements, water levels, field parameters, concentration data, and data validation qualifiers. Table 3 presents a summary of field parameters and concentration results for the June 2008 monitoring event. The associated data validation reports have been included as Attachments 1 (Dissolved Gases) and 2 (BTEX). Tables 4 and 5 present summaries of the laboratory results obtained to date for dissolved methane and benzene for sample locations in the current LTM network. The June 2008 concentrations are shown in the table for comparison purposes. Finally, Figure 4 presents the most recent interpretation of the dissolved methane groundwater plume based on June 2008 reported concentrations.

For the June 2008 samples, benzene was reported above the detection limit at two locations, CPT-11S and H100 (Table 3). The benzene concentrations at these wells were both below the Colorado drinking water standard of 5 micrograms per liter ($\mu\text{g/L}$), with reported concentrations of 3.0 $\mu\text{g/L}$ at CPT-11S and 0.90 $\mu\text{g/L}$ at H100. As shown in Table 3, the remaining BTEX constituents (i.e., toluene, ethylbenzene, and xylenes) were reported as *Not Detected* for every sample collected during the June event.

The June 2008 dissolved methane concentrations in groundwater from the alluvial aquifer ranged from 0.00007 to 25 mg/L (Table 3). Methane is a major component of natural gas and is used as an indicator parameter to delineate the presence of dissolved natural gas in groundwater. In June 2008, dissolved methane concentrations in groundwater from the alluvial aquifer increased at 15 locations compared to the March 2008 event (Table 4), and reached the highest concentrations noted to date at eight sample locations (CPT-15S, CPT-35D, CPT-35S, CPT-36S, CPT-41S, CPT-62S, H66, and H98). In addition, the dissolved methane concentrations at 15 locations exceeded the COGCC dissolved methane action level of 2 mg/L.

Since March 2008, reported methane concentrations have increased by more than an order of magnitude at three sampling locations: CPT-15S, CPT-41S, and H66 (Table 4). Between March and June 2008, the reported methane concentration increased from less than 0.00092 mg/L to 0.032 mg/L at CPT-15S; from 0.083 mg/L to 4.6 mg/L at CPT-41S; and from 0.0045 mg/L to 0.30 mg/L at H66. These concentration increases may be due to an expansion of the plume that typically occurs during irrigation season. Of these three significant increases, only CPT-41S, located on CIG's property, increased above 2 mg/L. A similar phenomenon was observed in 2007, when the methane plume expanded between the March and June 2007 sampling events as a result of irrigation pumping.

The newly installed well, MW-01, had a reported methane concentration of 18 mg/L. This well is located between H100 and CPT-57R. Respectively, H100 and CPT-57R had dissolved methane concentrations of 25 and 7.4 mg/L. This trend in the data suggests that dissolved methane concentrations in groundwater decrease with distance downgradient from the surface releases of methane gas. This decrease occurs in a west-northwesterly direction.

Figure 4, Dissolved Methane in Groundwater, June 2008, shows the areal distribution of dissolved methane at the site. This figure shows that areas of elevated methane concentrations (above 10,000 $\mu\text{g/L}$) continue to persist in groundwater to the south and east of the gas plant. Groundwater methane concentrations have also remained elevated in a small area southwest of the plant centered on CPT-11S.

Summary

Despite seasonal fluctuations in groundwater levels caused by irrigation pumping, the groundwater methane plume has generally remained stable and of similar extent. The plume has even decreased in some areas, such as near CPT-85S. These findings do not



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differ substantially from the concentration maps and other data presented in the Phase II Investigation Report (URS 2008). However, the most recent monitoring results indicate notable increases in methane concentrations at locations CPT-15S, CPT-41S, and H66. Of the three locations, only CPT-41S had methane concentrations above 2 mg/L in June 2008.

Future Work

As directed by COGCC, two more quarterly sampling events are required for 2008. The first of these events was conducted between September 9 and September 11, 2008. Results from this sampling event will be summarized in the Third Quarter 2008 Ground Monitoring Report. The final event this year will likely take place in early December. The same sample collection and analysis protocols will be followed during future monitoring events.

References

- Colorado Interstate Gas (CIG). 2007. *Phase I Well Water and Air Sampling Report*. February.
- URS. 2007. *Interim Phase II Report, Fort Morgan Compressor Station, Fort Morgan, Colorado*. August.
- URS. 2008. *Phase II Investigation Report, Fort Morgan Natural Gas Storage Facility, Fort Morgan, Colorado*. August.

If you have any questions or comments regarding this report, please feel free to contact me at 303-740-2648.

Sincerely,


Stacey Malerba
Project Manager

- cc: John Axelson, COGCC
- Mr. Bob Williamson, CIG (Fort Morgan)
- Mr. Kevin Lively, CIG (Fort Morgan)
- URS Project File 22240408

Tables

Table 1
Summary of Piezometer Redevelopment

Piezometer Number	Original Piezometer Total Depth (ft bgs)	Top of Screen (ft bgs)	Base of Screen (feet bgs)	Date Airlifted	Initial Depth (ft BTOC)	Final Depth (ft BTOC)	Difference ¹ (ft)	Development and Sampling Comments
CPT- 09S	30	25	30	6/17/08	27.89	28.39	0.50	Well screen damaged near top. Air line advanced to 33 feet, water level tape did not.
CPT- 10S	35	30	35	6/17/08	37.69	37.91	0.22	Pump would not advance in well. Had to purge and sample with a bailer No cap on well.
CPT- 11S	25	20	25	6/17/08	29.87	30.11	0.24	
CPT- 15S	40	35	40	6/17/08	42.48	43.46	0.98	
CPT- 17S	50	45	50	6/17/08	47.94	48.27	0.33	
CPT- 18S	58	53	58	6/16/08	52.41	55.42	3.01	Groundwater is extremely silty even after redevelopment. Pump would not function due to silt. Had to purge and sample with a bailer.
CPT- 26S	50	45	50	6/16/08	52.09	52.83	0.74	
CPT- 34S	55	50	55	6/16/08	56.31	58.34	2.03	
CPT- 35D	83	78	83	6/16/08	75.21	80.29	5.08	
CPT- 35S	60	55	60	6/16/08	58.64	59.66	1.02	
CPT- 36S	45	40	45	6/16/08	46.90	48.07	1.17	No cap on well. Pump would not advance past 2 feet. Had to purge and sample with a bailer.
CPT- 41D	84	79	84	6/16/08	82.33	82.68	0.35	
CPT- 41S	55	50	55	6/16/08	53.66	54.82	1.16	
CPT- 43S	45	40	45	6/16/08	46.54	47.87	1.33	
CPT- 44S	45	40	45	6/16/08	38.03	47.97	9.94	Well damaged in screen, allowing sediment to enter. Pump would not advance beyond 4 feet. Had to purge and sample with a bailer. Low-flow development does not work; sample collection process modified to purging the well dry and sampling the next day.
CPT- 46D	85	80	85	6/16/08	85.47	87.58	2.11	
CPT- 46S	45	40	45	6/16/08	43.36	44.38	1.02	
CPT- 49S	55	50	55	6/17/08	57.54	58.17	0.63	
CPT- 50S	50	45	50	6/16/08	52.21	53.58	1.37	Pump would not advance past 4 feet. Had to purge and sample with a bailer.
CPT- 53S	50	45	50	6/16/08	51.47	52.62	1.15	Pump would not advance past 15 feet. Had to purge and sample with a bailer. Native concentration of dissolved methane >4x spike level; do not collect MS/MSD at this location.
CPT- 54S	45	40	45	6/17/08	47.24	47.84	0.60	
CPT- 57R	45	40	45	6/17/08	46.94	48.22	1.28	
CPT- 58S	50	45	50	6/17/08	51.98	52.42	0.44	
CPT- 60S	45	40	45	6/16/08	47.80	47.98	0.18	
CPT- 62S	50	45	50	6/17/08	50.90	52.28	1.38	No cap on well. Pump would not advance past 4 feet. Had to purge and sample with a bailer.
CPT- 63S	55	50	55	6/17/08	55.65	58.69	3.04	
CPT- 84S	50	45	50	6/17/08	48.03	48.09	0.06	Well pipe bent in upper 20 feet. Could not get the bailer out that is stuck in the well bottom. No cap in well. A second bailer was lost in the well due to a bend in the piping. Pump would not advance past 4 feet. Had to purge and sample with a bailer.
CPT- 85S	45	40	45	6/17/08	47.29	48.38	1.09	A bailer was lost in this well.

Notes:

bgs = below ground surface

BTOC = below top of casing

DTW = depth to water

ft = feet

MS/MSD = matrix spike/matrix spike duplicate

¹ This value reflects amount of sediment removed by redevelopment

Table 3
Summary of June 2008 Physical and Chemical Data

	Locations	CPT-09S	CPT-10S	CPT-11S	CPT-15S	CPT-17S	CPT-18S	CPT-26S	CPT-34S	CPT-35D	CPT-35S	CPT-36S	CPT-41D	CPT-41S	CPT-43S
	Sample Date	6/24/2008	6/24/2008	6/24/2008	6/24/2008	6/26/2008	6/24/2008	6/26/2008	6/24/2008	6/25/2008	6/25/2008	6/26/2008	6/25/2008	6/25/2008	6/25/2008
Field Parameters	Units														
Carbon monoxide	ppm	ND	ND	ND	1.0	ND	4.0	ND	2.0	ND	ND	ND	ND	ND	ND
Combustible gas	percent LEL	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Conductivity	µS/cm	1678	3387	686	751	2934	2640	2953	3551	1765	1605	2546	2582	3473	3864
Dissolved oxygen	mg/L	1.0	2.6	1.9	4.3	4.1	7.6	6.4	8.7	1.1	8.0	2.8	4.0	8.5	2.4
H ₂ S	ppm	ND	1.0	ND	ND	ND	ND	ND	ND	1.0	1.0	ND	1.0	1.0	ND
ORP	mV	-321.2	-475.8	-284.2	-177.7	113	239	102	196	89	88	146	102	87	171
Oxygen	percent	21	21	21	21	21	21	21	21	20	20	21	21	21	21
pH	pH Units	10 (a)	17 (a)	13 (a)	7.3	7.0	6.6	6.9	7.0	7.2	7.1	7.2	7.1	7.3	7.1
Temperature	Celsius	15	14	20	16	17	16	20	18	19	15	15	18	19	15
Dissolved Gasses	Units														
Ethane	mg/L	0.53	0.00001 J	0.79	0.0088	0.00009	0.000006 J	0.000096	0.00002 J	0.037	0.000013 J	2.2	0.000026 J	0.20	1.1
Ethene	mg/L	0.000014	0.000061	<0.000025	0.00012	0.00019	0.000011 J	0.00024	0.000021 J	<0.000025	<0.000025	<0.000025	<0.000025	0.00002 J	0.00037
iso-Butane	mg/L	0.00038	<0.00005	0.011	0.000082	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005
Methane	mg/L	3.5	0.00018	11	0.032	0.00073	0.00007	0.00067	0.00016	6.7	0.39	14	5.6	4.6	12
n-Butane	mg/L	0.00028	<0.00005	0.013	0.000082	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005
Propane	mg/L	0.038	<0.00005	0.24 J	0.0014	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	0.0024
Propene	mg/L	0.000092	<0.00005	0.00035	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005
Volatile Organics	Units														
Benzene	µg/L	<1.0	<1.0	3.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Ethylbenzene	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
m,p-Xylene	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
o-Xylene	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Toluene	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Xylenes (total)	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0

Notes:

Less than (<) symbol indicates the concentration listed is below the reporting limit for the specific sample, analytical method, and analyte.

Bold values highlight detections.

"J" flag indicates an estimated value.

Sample was a field duplicate.

(a) High pH readings could be due to grout contamination or instrument malfunction.

µg/L = micrograms per liter

µS/cm = microSiemens per centimeter

H₂S = hydrogen sulfide

LEL = Lower Explosive Limit

mg/L = milligrams per liter

mV = millivolt

NA = Not Applicable

ND = Not Detected

ORP = oxygen reducing potential

ppm = parts per million

Table 3
Summary of June 2008 Physical and Chemical Data

	Locations	CPT-44S	CPT-46D	CPT-46S	CPT-49S	CPT-50S	CPT-50S FD	CPT-53S	CPT-54S	CPT-54S FD	CPT-57R	CPT-58S	CPT-60S	CPT-62S	CPT-63S
	Sample Date	6/24/2008	6/25/2008	6/25/2008	6/25/2008	6/24/2008	6/24/2008	6/25/2008	6/26/2008	6/26/2008	6/25/2008	6/25/2008	6/25/2008	6/25/2008	6/25/2008
Field Parameters	Units														
Carbon monoxide	ppm	ND	1.0	1.0	2.0	2.0	NA	ND	ND	NA	ND	1.0	ND	ND	ND
Combustible gas	percent LEL	ND	ND	ND	ND	ND	NA	ND	ND	NA	ND	ND	ND	ND	ND
Conductivity	µS/cm	3632	2080	3866	2185	4188	NA	2849	3760	NA	4237	3105	3233	4014	2628
Dissolved oxygen	mg/L	9.5	8.6	4.2	1.3	6.8	NA	3.6	2.6	NA	5.6	0.99	6.7	5.3	5.2
H ₂ S	ppm	ND	ND	ND	ND	ND	NA	ND	ND	NA	ND	ND	ND	ND	ND
ORP	mV	144	78	76	156	150	NA	123	126	NA	140	163	149	179	140
Oxygen	percent	21	21	21	21	21	NA	21	21	NA	21	21	21	21	21
pH	pH Units	6.7	7.2	7.0	7.1	6.6	NA	7.1	6.6	NA	6.9	7.1	7.0	7.2	7.1
Temperature	Celsius	14	18	14	18	16	NA	14	17	NA	16	17	14	15	17
Dissolved Gasses	Units														
Ethane	mg/L	0.062	0.50	1.2	0.00017	0.00023 J	0.000005 J	0.31	<0.000025	<0.000025	1.0	0.49	0.000048 J	0.22	0.00004 J
Ethene	mg/L	0.000026 J	0.000023 J	<0.000025	0.00077	0.000036 J	0.000039 J	0.000073	<0.000025	<0.000025	0.000044 J	<0.000025	0.00029	0.000042 J	0.00035
iso-Butane	mg/L	0.000022 J	0.00014	<0.00005	<0.00005	<0.00005	<0.00005	0.00002 J	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005
Methane	mg/L	0.39	6.6	8.2	0.0051	0.0014 J	0.0020 J	3.8	4.0	4.7	7.4	16	0.0012	1.2	0.00079
n-Butane	mg/L	<0.00005	0.00029	<0.00005	<0.00005	<0.00005	<0.00005	0.000017 J	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005
Propane	mg/L	0.00024	0.036	<0.00005	<0.00005	0.000031 J	<0.00005	0.00060	<0.00005	<0.00005	0.0032	0.000041 J	<0.00005	<0.00005	<0.00005
Propene	mg/L	<0.00005	0.00041	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005
Volatile Organics	Units														
Benzene	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Ethylbenzene	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
m,p-Xylene	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
o-Xylene	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Toluene	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Xylenes (total)	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0

Notes:

Less than (<) symbol indicates the concentration listed is below the reporting limit for the specific sample, analytical method, and analyte.

Bold values highlight detections.

"J" flag indicates an estimated value.

Sample was a field duplicate.

(a) High pH readings could be due to grout contamination or instrument malfunction.

µg/L = micrograms per liter

µS/cm = microSiemens per centimeter

H₂S = hydrogen sulfide

LEL = Lower Explosive Limit

mg/L = milligrams per liter

mV = millivolt

NA = Not Applicable

ND = Not Detected

ORP = oxygen reducing potential

ppm = parts per million

Table 3
Summary of June 2008 Physical and Chemical Data

	Locations	CPT-84S	CPT-85S	H100	H100 FD	H66	H98	MW01	MW01 FD
	Sample Date	6/24/2008	6/25/2008	6/25/2008	6/25/2008	6/25/2008	6/25/2008	6/26/2008	6/26/2008
Field Parameters	Units								
Carbon monoxide	ppm	1.0	1.0	ND	NA	ND	ND	1.0	NA
Combustible gas	percent LEL	ND	ND	ND	NA	ND	ND	>100	NA
Conductivity	µS/cm	4240	3791	3862	NA	3264	3632	4371	NA
Dissolved oxygen	mg/L	6.9	6.5	1.1	NA	2.8	1.7	1.5	NA
H ₂ S	ppm	ND	ND	ND	NA	ND	ND	ND	NA
ORP	mV	153	147	178	NA	178	158	71	NA
Oxygen	percent	21	21	21	NA	21	21	7.9	NA
pH	pH Units	6.8	6.9	7.4	NA	7.1	7.2	7.0	NA
Temperature	Celsius	14	14	16	NA	15	14	22	NA
Dissolved Gasses	Units								
Ethane	mg/L	0.000004 J	0.000084	6.2	5.5	0.066	0.074	4.3	4.1
Ethene	mg/L	0.000046 J	0.000026 J	<0.000025	<0.000025	0.000063	0.000030	0.000023 J	0.000038 J
iso-Butane	mg/L	<0.00005	<0.00005	<0.00005	<0.00005	0.00053	<0.00005	0.0071	0.0074
Methane	mg/L	0.00020	0.00077	25	24	0.30	0.47	18	18
n-Butane	mg/L	<0.00005	<0.00005	<0.00005	<0.00005	0.00054	<0.00005	0.0066	0.0068
Propane	mg/L	<0.00005	<0.00005	0.00076	0.00075	0.0069	0.00010	0.19 J	0.19 J
Propene	mg/L	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005
Volatile Organics	Units								
Benzene	µg/L	<1.0	<1.0	0.90	1.0	<1.0	<1.0	<1.0	<1.0
Ethylbenzene	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
m,p-Xylene	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
o-Xylene	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Toluene	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Xylenes (total)	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0

Notes:

Less than (<) symbol indicates the concentration listed is below the reporting limit for the specific sample, analytical method, and analyte.

Bold values highlight detections.

"J" flag indicates an estimated value.

Sample was a field duplicate.

(a) High pH readings could be due to grout contamination or instrument malfunction.

µg/L = micrograms per liter

µS/cm = microSiemens per centimeter

H₂S = hydrogen sulfide

LEL = Lower Explosive Limit

mg/L = milligrams per liter

mV = millivolt

NA = Not Applicable

ND = Not Detected

ORP = oxygen reducing potential

ppm = parts per million

Table 4
Summary of Dissolved Methane Results for LTM Locations

Location	Historic Data					LTM 2008	
	Pre-Irrigation Sampling	Post-Irrigation Sampling #1	Post-Irrigation Sampling #2	Supplemental Sampling	Supplemental Sampling	LTM Q1	LTM Q2
	Mar-07	Jun-07	Aug-07	Sep-07	Nov-07	Mar-08	Jun-08
CPT-09S	23	6.3	0.24	0.37	0.55	4.8	3.5
CPT-10S	0.0047	0.0011	0.0013	NS	NS	0.0016	0.00018
CPT-11S	12	13	0.55	7.8	11	6.0	11
CPT-15S	0.0025	0.00084	0.0019	NS	NS	0.00092	0.032
CPT-17S	0.0050	0.00054	0.0029	NS	NS	0.0010	0.00073
CPT-18S	0.0016	0.00093	NS	NS	NS	0.00062	0.000070
CPT-26S	0.0050	0.0054	0.00051	0.0016	0.0038	0.0048	0.00024
CPT-34S	0.0052	0.0011	NS	0.0021	0.0013	0.0032	0.00016
CPT-35D	2.5	1.2	1.7	1.0	1.6	2.2	6.7
CPT-35S	0.011	0.026	0.0045	0.010	0.32	0.22	0.39
CPT-36S	14	9.7	11	7.0	8.9	8.4	14
CPT-41D	2.4	15	13	0.31	8.6	4.9	5.6
CPT-41S	0.011	0.032	0.25	0.15	0.11	0.083	4.6
CPT-43S	12	14	11	13	9.5	10	12
CPT-44S	12	10	8.4	10	11	14	0.39
CPT-46D	15	15	29	16	20	13	6.6
CPT-46S	11	5.4	19	6.4	18	11	8.2
CPT-49S	0.0063	0.0066	0.00088	0.0013	0.0021	0.0048	0.0051
CPT-50S	0.0034	0.0036	0.0011	0.0016	0.0020	0.00048	0.0014
CPT-53S	8.0	10	10	11	11	6.0	3.8
CPT-54S	11	14	5.5	8.1	9.1	9.4	4.7
CPT-57R	20	18	19	13	13	14	7.4
CPT-58S	0.0060	18	24	4.6	5.0	7.8	16
CPT-60S	0.0042	0.0041	0.0054	0.0024	0.0020	0.0023	0.0012
CPT-62S	0.017	0.0069	0.00033	0.028	0.13	0.33	1.2
CPT-63S	0.0054	0.0022	0.00069	0.00080	0.0015	0.0023	0.00079
CPT-84S	0.0059	0.00072	0.031	0.0026	0.0010	0.0023	0.00020
CPT-85S	3.2	5.0	1.2	2.3	0.17	1.2	0.00077
MW-01	NA	NA	NA	NA	NA	NA	18
H100	26	19	26	30	25	24	25
H66	0.000020	0.011	0.017	0.000089	0.00028	0.0045	0.30
H98	0.0037	0.013	0.00056	0.00010	0.0021	0.072	0.47

Notes:

Less than (<) symbol indicates result was not detected at the associated detection limit.

Units are milligrams per liter (mg/L)

Bold value	Highest detected value at each sample location
Value	Exceeds COGCC limit of 2 mg/L

COGCC = Colorado Oil and Gas Conservation Commission

LTM = long-term monitoring

NA = Not applicable

NS = Not sampled

Table 5
Summary of Benzene Results for LTM Locations

Location	Historic Data				LTM 2008	
	Post-Irrigation Sampling #1	Post-Irrigation Sampling #2	Supplemental Sampling	Supplemental Sampling	LTM Q1	LTM Q2
	Jun-07	Aug-07	Sep-07	Nov-07	Mar-08	Jun-08
CPT-09S	<1	<1	<1	<1	<1	<1
CPT-10S	NS	NS	NS	NS	<1	<1
CPT-11S	3	2	<1	5 / 5	3	3
CPT-15S	NS	NS	NS	NS	<1	<1
CPT-17S	NS	NS	NS	NS	<1	<1
CPT-18S	NS	NS	NS	NS	<1	<1
CPT-26S	NS	NS	<1	<1	<1	<1
CPT-34S	NS	NS	<1	<1	<1	<1
CPT-35D	<1	<1	<1	<1	<1	<1
CPT-35S	NS	NS	<1	<1	<1	<1
CPT-36S	<1	<1	<1	<1	<1	<1
CPT-41D	6	3	<1	<1	<1	<1
CPT-41S	NS	NS	<1	<1	<1	<1
CPT-43S	<1	<1	<1	<1	<1	<1
CPT-44S	<1	<1	<1	<1	<1	<1
CPT-46D	4	4	2	2	<1	<1
CPT-46S	<1	<1	<1	<1	<1	<1
CPT-49S	NS	NS	<1 / <1	<1	<1	<1
CPT-50S	NS	NS	<1	<1	<1	<1
CPT-53S	<1	<1	<1	<1	<1	<1
CPT-54S	<1	<1	<1	<1	<1	<1
CPT-57R	<1	<1	<1	<1	<1	<1
CPT-58S	NS	NS	<1	<1	<1	<1
CPT-60S	NS	NS	<1	<1	<1	<1
CPT-62S	NS	NS	<1	<1	<1	<1
CPT-63S	NS	NS	<1	<1	<1	<1
CPT-84S	NS	NS	<1	<1	<1	<1
CPT-85S	<1	<1	<1	<1	<1	<1
MW-01	NA	NA	NA	NA	NA	<1
H100	3 / 3	2 / 2	2 / 2	2 / 2	<1 / 1.0	0.9 / 1.0
H66	NS	NS	<1	<1	<1	<1
H98	NS	NS	<1	<1	<1	<1

Notes:

Less than (<) symbol indicates result was not detected at the associated detection limit.

Units are micrograms per liter (µg/L).

Bold value	Highest detected value at each sample location
Value	Exceeds Colorado Basic Groundwater Standard of 5 ug/l.

< = less than

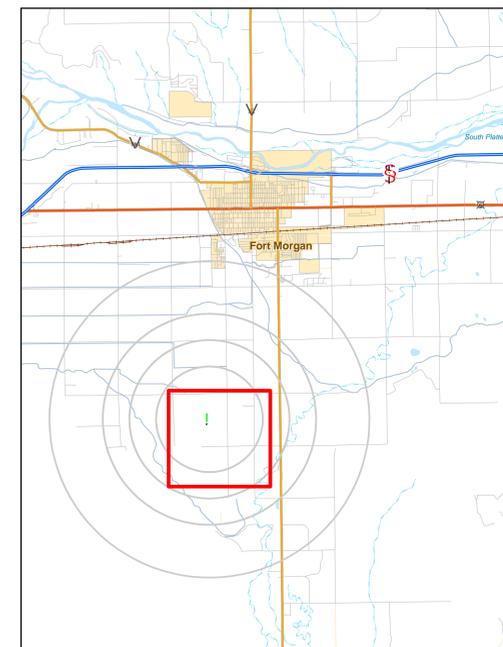
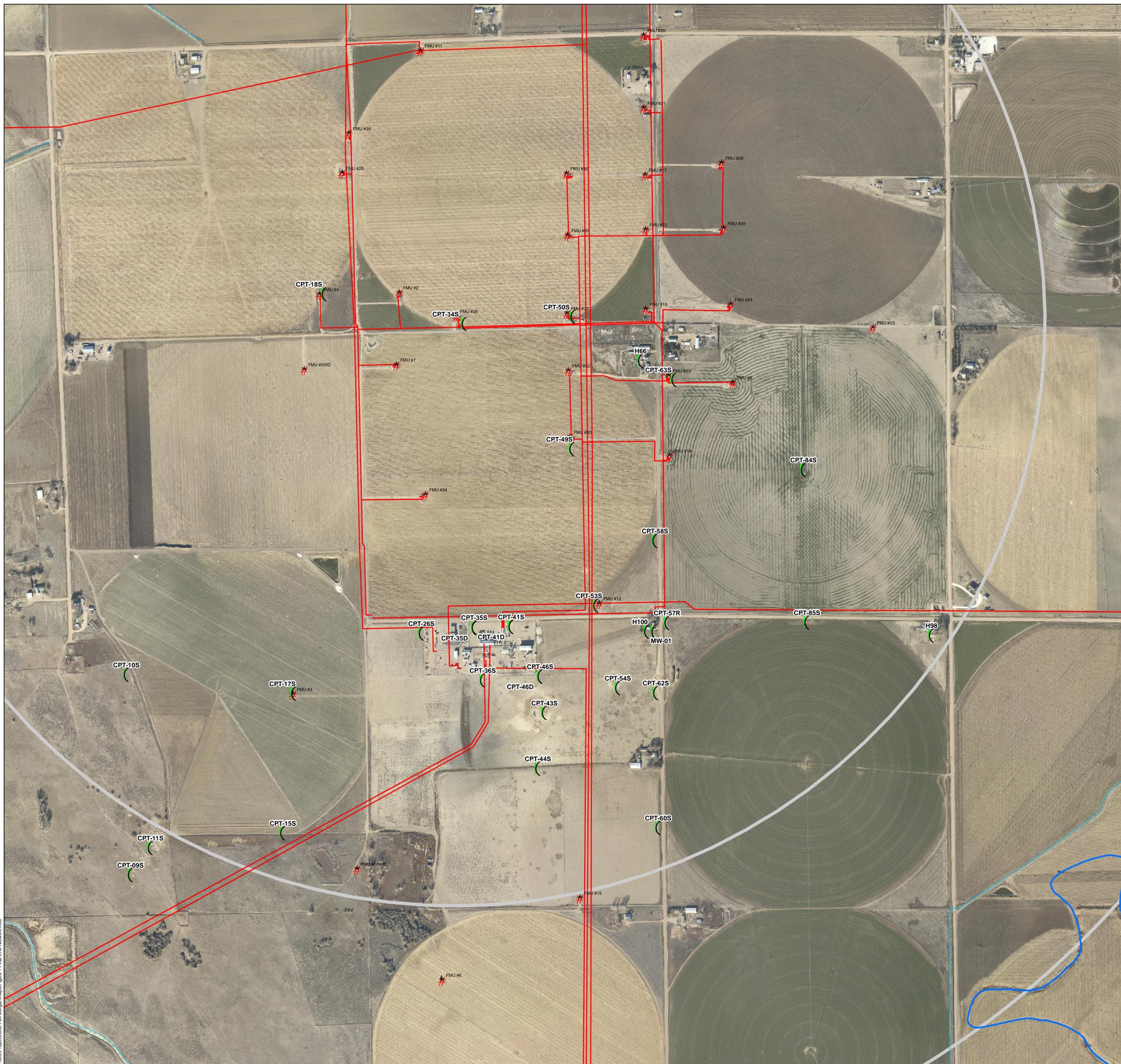
0.90 / 1.0 = primary sample/ field duplicate

LTM = long-term monitoring

NA = Not applicable

NS = Not sampled

Figures



Legend

- ⊗ Groundwater Sampling Location
- * CIG Gas Storage Wells
- Natural Gas Pipeline (El Paso)
- Hydrologic Features (National Hydrography Dataset)
 - Canal or Ditch
 - Stream or River
- Buffers 1, 1.5, and 2 miles from Gas Storage Well #26

3



Figure 1
Long Term Monitoring
Sample Locations

CIG Fort Morgan
Gas Storage Field



Figure 2. Boring and Well Installation Log for MW-01



URS Corporation
 8181 East Tufts
 Avenue
 Denver, CO 80237

Borehole ID: MW-01

Project Name: CIG Fort Morgan

Hydrogeologist: Matt Spansky

Drilling Equipment: CME 55

Borehole Diameter: 8.5"

Date/Time Drilling Started: 6/17/08

Vertical Datum: NAVD 88

Horizontal Datum: NAD 83/92 CO North (Ground)

Water Level (ft bgs): 29

Location: Fort Morgan, CO

Project Number: 22239403.00700

Drilling Company/Driller: Drilling Engineers/R. Gehry

Drilling Method: Hollow Stem Auger

Date/Time Total Depth Reached: 6/17/08

Total Depth Drilled: 55'

Ground Elevation: 1325.203

Easting: 601209.516

Northing: 4449342.093

Permit No.: 278560

Depth (ft)	Recovery	Lithologic Symbol	Lithologic Description	USCS Code	Well Construction Diagram	Remarks
0.0 - 2.0			SILTY CLAY dark brown, silty clay, very stiff, dry to damp, root traces in upper 6"	CL		0-2.8' Soil Horizon
2.0 - 4.0			SILTY SAND brown, silty sand, fine to very fine grained, very loose, damp, well sorted	SM		
4.0 - 6.0			SILTY SAND gray brown, silty sand, very fine grained, medium dense, dry to damp, minor clay	CL		
6.0 - 8.0			SILTY CLAY gray brown, silty clay, very stiff, damp	SM		
8.0 - 10.0			SAND yellow brown, sand, fine to medium grained, sub-rounded, very loose, damp, well sorted, some mica	SW		
10.0 - 12.0			SAND yellow brown, sand, fine to medium grained, sub-rounded, very loose, moist, well sorted, some mica	SW		
12.0 - 14.0			SANDY CLAY gray brown, sandy clay with red mottling, damp to moist, sand is fine to very fine grained and represents 10% of interval	CL		
14.0 - 16.0			SAND tan to orange, medium to coarse grained, sub-rounded, very loose, damp, well sorted, quartz, visually apparent lithics	SW		
16.0 - 18.0			SAND tan, orange coloration in upper 6", sand, medium to coarse grained, sub-rounded, very loose, damp to moist, well sorted, quartz, visually apparent lithics	SW		
18.0 - 20.0						

Figure 2. Boring and Well Installation Log for MW-01



URS Corporation
8181 East Tufts
Avenue
Denver, CO 80237

Borehole ID: MW-01

Project Name: CIG Fort Morgan

Hydrogeologist: Matt Spansky

Drilling Equipment: CME 55

Borehole Diameter: 8.5"

Date/Time Drilling Started: 6/17/08

Vertical Datum: NAVD 88

Horizontal Datum: NAD 83/92 CO North (Ground)

Water Level (ft bgs): 29

Location: Fort Morgan, CO

Project Number: 22239403.00700

Drilling Company/Driller: Drilling Engineers/R. Gehry

Drilling Method: Hollow Stem Auger

Date/Time Total Depth Reached: 6/17/08

Total Depth Drilled: 55'

Ground Elevation: 1325.203

Easting: 601209.516

Northing: 4449342.093

Permit No.: 278560

Depth (ft)	Recovery	Lithologic Symbol	Lithologic Description	USCS Code	Well Construction Diagram	Remarks
22.0			SAND tan gray, sand, slight orange mottling, fine to medium grained, sub-rounded, very loose, moist, well sorted, quartz, feldspar, lithics, 4" sandy clay seam from 20.4-20.7', clay is soft, moist	SW	<p>Sch 40 PVC Riser</p>	
24.0			SAND tan gray, sand, slight orange mottling, fine to medium grained, sub-rounded, very loose, wet becoming saturated at 26.2', well sorted, quartz, feldspar, lithics, 2" clay seam at top of interval, clay is medium, moist	SW		
26.0						
28.0						
30.0						
32.0						
34.0			SANDY CLAY gray brown, sandy clay, orange red mottling, stiff, moist, significant fraction of fine sand (~25%), especially in upper 1.5'	SW		
36.0						
38.0						
40.0			CLAY dark gray, clay, blocky texture, very stiff, damp to moist	CL		

Figure 2. Boring and Well Installation Log for MW-01



URS Corporation
 8181 East Tufts
 Avenue
 Denver, CO 80237

Borehole ID: MW-01

Project Name: CIG Fort Morgan

Hydrogeologist: Matt Spansky

Drilling Equipment: CME 55

Borehole Diameter: 8.5"

Date/Time Drilling Started: 6/17/08

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Horizontal Datum: NAD 83/92 CO North (Ground)

Water Level (ft bgs): 29

Location: Fort Morgan, CO

Project Number: 22239403.00700

Drilling Company/Driller: Drilling Engineers/R. Gehry

Drilling Method: Hollow Stem Auger

Date/Time Total Depth Reached: 6/17/08

Total Depth Drilled: 55'

Ground Elevation: 1325.203

Easting: 601209.516

Northing: 4449342.093

Permit No.: 278560

Depth (ft)	Recovery	Lithologic Symbol	Lithologic Description	USCS Code	Well Construction Diagram	Remarks
42.0			SAND gray brown, sand, little clay, fine grained, very loose, sub-rounded, saturated, well sorted, muscovite mica visually apparent	SW	<p>Sand Pack</p> <p>0.010" PVC Screen</p> <p>Sch 40 PVC Sump</p>	Drilled last segment 6'; still only 2.5' of recovery
44.0			SANDY CLAY light gray, sandy clay (40% very fine sand), very soft, moist to wet	CL SW		
46.0			SAND tan to light gray, sand, medium grained, sub-rounded, well sorted, very loose, wet, quartz, feldspar, lithics	SW		
48.0			SAND tan to light gray, sand, medium grained, sub-rounded, well sorted, very loose, saturated, quartz, feldspar, lithics			
50.0			End of Boring Log			Drilled 5 feet to advance past flowing sands. Total Depth= 55'
52.0						
54.0						
56.0						
58.0						
60.0						

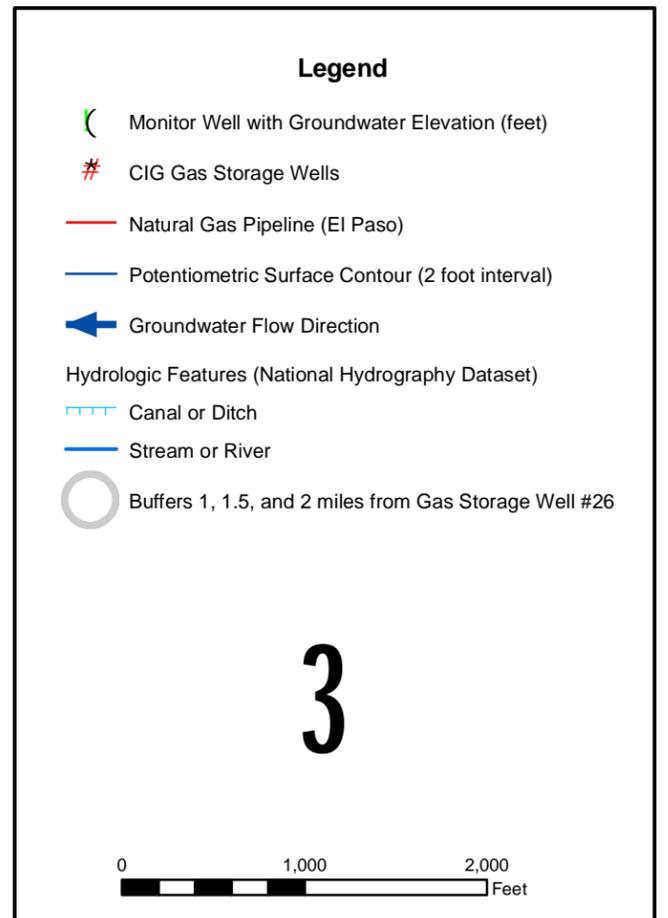
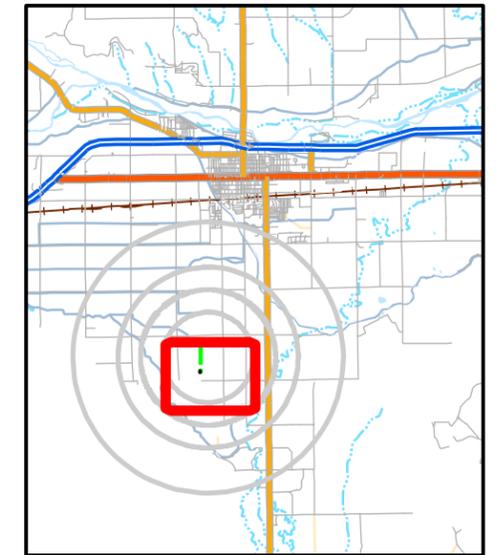
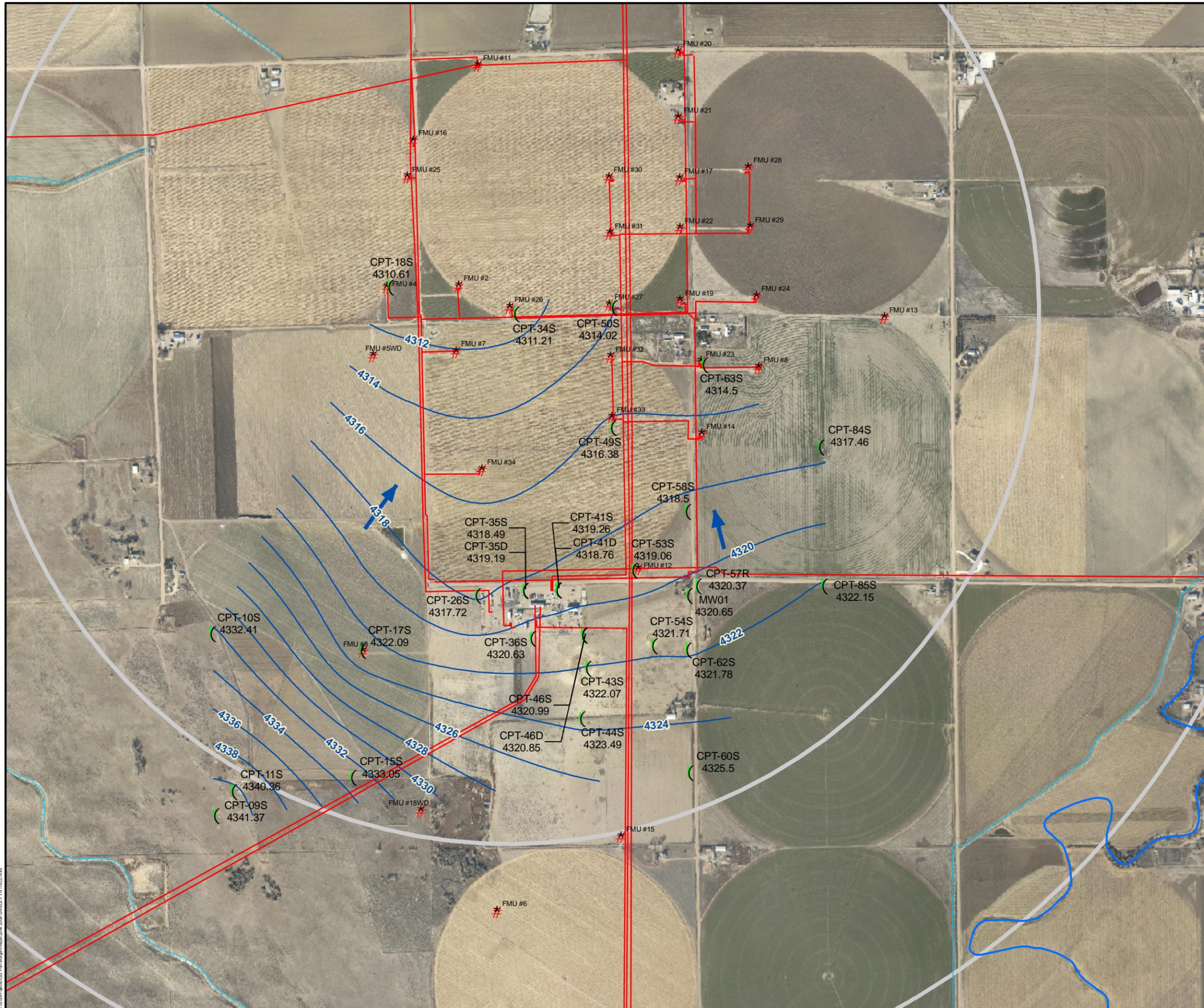
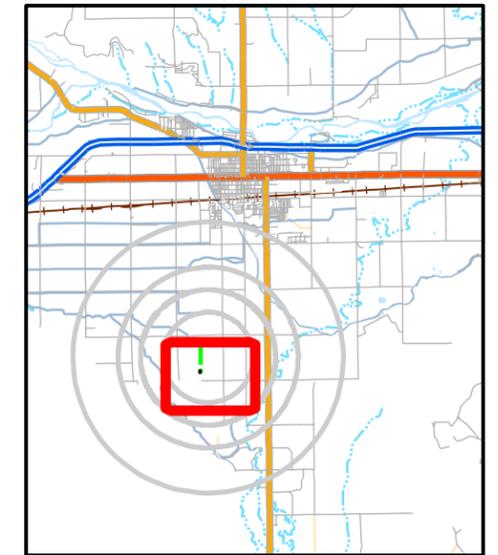
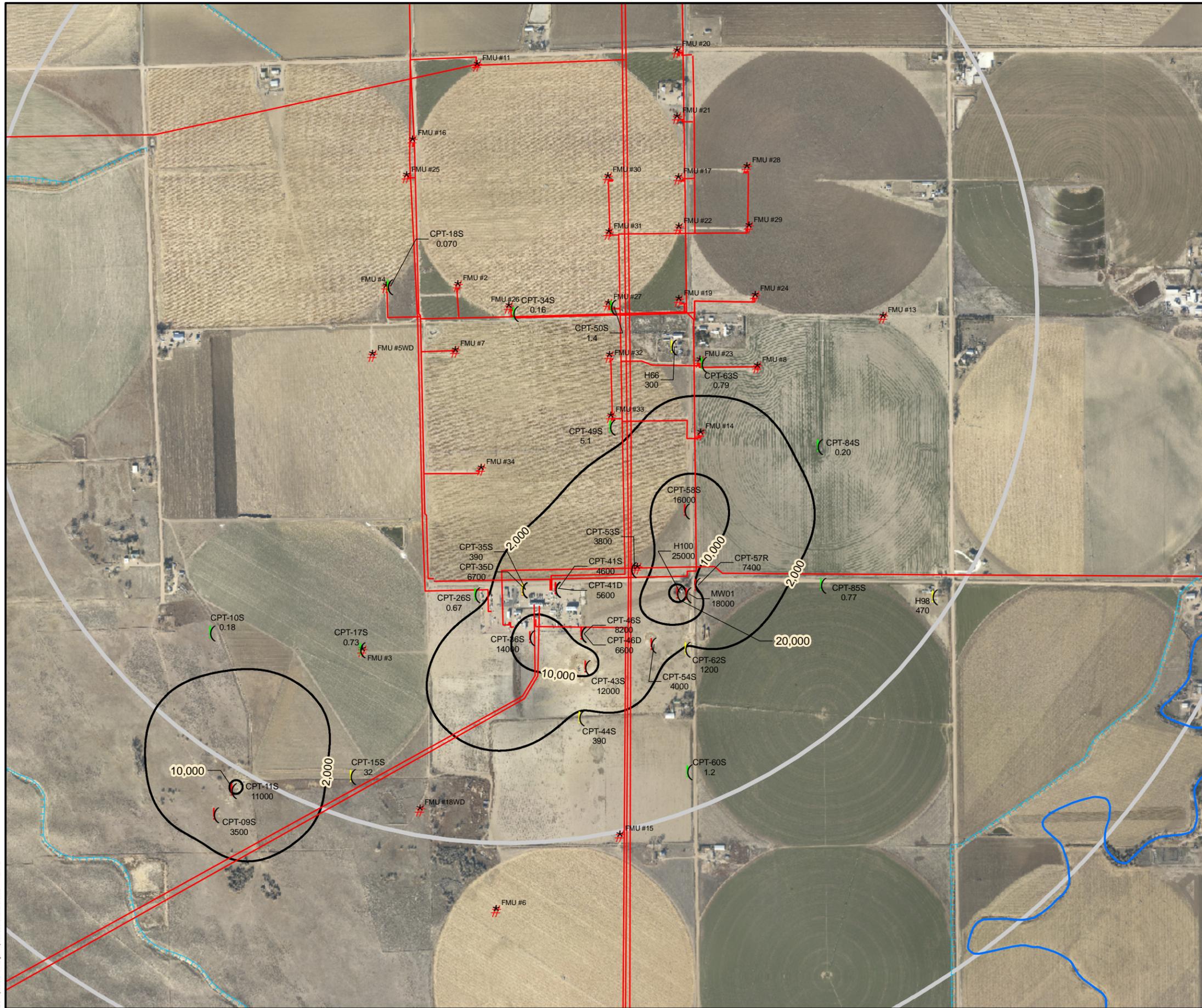


Figure 3
Groundwater Potentiometric Surface
June 2008
CIG Fort Morgan
Gas Storage Field





Legend

Dissolved Methane in Groundwater

- () ≤ 6.7 ug/L (Background UTL)
- () > 6.7 ug/L and ≤ 2000 ug/L
- () > 2000 ug/L (COGCC Action Level)
- * CIG Gas Storage Wells
- Methane Concentration Contour, June 2008 (µg/L)
- Natural Gas Pipeline (El Paso)

Hydrologic Features (National Hydrography Dataset)

- ▬▬▬ Canal or Ditch
- Stream or River
- Buffers 1, 1.5, and 2 miles from Gas Storage Well #26

Note:
At nested well locations, the higher of the two concentrations was used for contouring.

3

0 1,000 2,000
Feet

Figure 4
Dissolved Methane in Groundwater
June 2008
CIG Fort Morgan
Gas Storage Field



V:\GIS\Project\COG Fort Morgan\June 2008 methane results 11x1712.mxd