

SUBSURFACE ASSESSMENT FINDINGS

Bonanza Creek Water Flood Facility & Praxair CO₂ Facility

Stakeholder Meeting – October, 22 2013



LT Environmental, Inc.
COMPLIANCE / ENGINEERING / REMEDIATION

- ASSESSMENT ACTIVITIES (2012-2013)
 - Monitoring Well Installation/Replacement
 - Free Product Levels and Characterization
 - Line Pressure Tests
- SITE CHARACTERIZATION
- GROUNDWATER ANALYTICAL RESULTS/TRENDS
- SITE FIGURES
 - Utility Location Map
 - Site Map with Benzene Isocontours
 - Groundwater Elevation and Gradient
- KEY ASSESSMENT FINDINGS
- RECOMMENDATIONS

- ASSESSMENT ACTIVITIES (2012)
 - June 2012 pressure test revealed breach of return line on Praxair facility
 - Sixteen assessment soil borings (SB01 – SB16) advanced between the facilities in August 2012
 - Stained soil (smear zone 8 -10' bgs) in 8 borings
 - No source area discovered
 - Soil borings completed as monitoring wells (MW01 – MW16)
- ASSESSMENT ACTIVITIES (2013)
 - Lines pressure tested in April 2013 - DAK-LAK dumpline and injection well #57 lines held

- ASSESSMENT ACTIVITIES (2013) Cont'd
 - Five new wells (MW17 – MW21) installed between facilities in July 2013
 - MW03 and MW08 replaced with MW03R and MW08R (2") to allow for product recovery
 - Plume extent (East of Praxair) defined to North, South, and East
 - Product samples collected from pump jack (shallow oil), MW08, and separator at BC water flood facility in July 2013
 - Free product in MW08R (0.01') in Sept 2013



SITE CHARACTERIZATION

- Hydraulic gradient was 0.0089 ft/ft in May 2013 (MW07 to PMW05)
- Depth to groundwater ranged from 8.04 ft to 10.70 ft bgs in August 2013
- Groundwater flow is typically to the northwest, but data on file with CDPHE indicates periods of southerly and westerly flow (Praxair well data)
- Annual groundwater level fluctuation of 1 to 2 feet
- Soil lithology generally consists of silty/sandy clay (0-5' bgs), sand/gravel/clay mixtures with sand and gravel lenses (5-10' bgs), and silty/sandy-clay (10-15' bgs)



- AUGUST 2013 QUATERLY SAMPLING RESULTS
 - Benzene exceeded CGWQS in 9 of the 21 wells sampled (19 – 6,700 ppb)
 - No measurable product in August 2013
 - Highest benzene concentrations (>1,000 ppb) in MW03R, MW06, and MW08R
- TRENDS
 - Benzene concentration increased in 2 wells and decreased in 7 wells from May to August 2013 sampling events
 - BTEX concentrations are steady or declining across the site over the first year of monitoring



GROUNDWATER ANALYTICAL

TABLE 1
GROUNDWATER SAMPLE ANALYTICAL DATA
WALDEN WATER FLOOD FACILITY
BONANZA CREEK ENERGY OPERATING COMPANY LLC

SAMPLE ID	SAMPLE DATE	DTW (feet bgs)	BENZENE (ug/L)	TOLUENE (ug/L)	ETHYLBENZENE (ug/L)	XYLENES (Total) (ug/L)
MW01	8/22/2012	9.03	810	1.3	400	840
	11/7/2012	10.30	810	<1.0	160	910
	2/28/2013	10.16	790	<1.0	210	570
	5/21/2013	8.96	620	<1.0	160	440
	8/13/2013	9.90	360	<1.0	150	240
MW02	8/22/2012	9.46	2,100	1.7	870	5,400
	11/7/2012	10.00	2,400	<1.0	700	5,400
	2/28/2013	10.15	3,200	<1.0	740	4,300
	5/21/2013	9.33	790	<1.0	150	960
	8/13/2013	10.09	650	<1.0	210	1,100
MW03	8/22/2012	8.96	560	100	480	2,500
	11/7/2012	9.84	Product	Product	Product	Product
	2/28/2013	Frozen	-	-	-	-
	5/21/2013	Destroyed	-	-	-	-
	8/13/2013	10.37	1,900	25	290	1,500
MW04	8/22/2012	9.13	6.6	7.9	200	410
	11/7/2012	10.50	2.5	<1.0	62	60
	2/28/2013	9.85	4.1	<1.0	66	58
	5/21/2013	8.88	<1.0	<1.0	6.4	6.1
	8/13/2013	9.82	1.6	<1.0	19	13
MW05	8/22/2012	14.13	<1.0	<1.0	<1.0	2.2
	11/7/2012	8.00	<1.0	<1.0	<1.0	<1.0
	2/28/2013	10.18	<1.0	<1.0	<1.0	<1.0
	5/21/2013	9.40	<1.0	<1.0	<1.0	<1.0
	8/13/2013	10.16	<1.0	<1.0	<1.0	<1.0
MW06	8/22/2012	10.16	1,200	4.9	300	1,200
	11/7/2012	10.72	9.8	1.6	200	540
	2/28/2013	10.76	1,100	1.2	170	360
	5/21/2013	10.01	1,300	3.0	210	710
	8/13/2013	10.70	1,400	5.2	280	1,200
MW07	8/22/2012	9.74	1.5	1.2	4.6	33
	11/7/2012	9.90	2.0	<1.0	1.2	8.7
	2/28/2013	10.44	2.3	<1.0	<1.0	<1.0
	5/21/2013	9.77	2.6	<1.0	1.0	5.4
	8/13/2013	10.44	7.8	<1.0	1.1	2.3
MW08	8/22/2012	10.09	7,000	13,000	830	7,800
	11/7/2012	10.43	Product	Product	Product	Product
	2/28/2013	10.66	Product	Product	Product	Product
	5/21/2013	9.76	8,000	11,000	440	6,700
	8/13/2013	10.50	6,700	8,600	520	4,900
MW09	8/22/2012	9.47	1,400	1,700	200	1,700
	11/7/2012	11.41	4,100	4,600	430	3,500
	2/28/2013	10.01	7,200	6,700	680	5,100
	5/21/2013	9.09	5,100	5,000	440	3,900
	8/13/2013	9.96	720	470	67	360
MW10	8/22/2012	7.88	100	<1.0	3.5	14
	11/7/2012	8.66	120	5.2	5.1	30
	2/28/2013	10.75	120	<1.0	2.0	<1.0
	5/21/2013	7.38	70	2.6	<1.0	3.0
	8/13/2013	8.18	19	<1.0	<1.0	<1.0



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MW11	8/22/2012	14.18	<1.0	<1.0	<1.0	<1.0
	11/7/2012	9.75	<1.0	<1.0	<1.0	<1.0
	2/28/2013	6.87	10	<1.0	2.8	16
	5/21/2013	6.63	<1.0	<1.0	<1.0	<1.0
	8/13/2013	8.04	<1.0	<1.0	<1.0	<1.0
MW12	8/22/2012	Dry	Dry	Dry	Dry	Dry
	11/7/2012	7.42	<1.0	<1.0	<1.0	<1.0
	2/28/2013	7.52	<1.0	<1.0	<1.0	<1.0
	5/21/2013	6.62	<1.0	<1.0	<1.0	<1.0
	8/13/2013	9.02	<1.0	<1.0	<1.0	<1.0
MW13	8/22/2012	Dry	Dry	Dry	Dry	Dry
	11/7/2012	9.01	<1.0	<1.0	<1.0	<1.0
	2/28/2013	9.27	<1.0	<1.0	<1.0	<1.0
	5/21/2013	7.86	<1.0	1.2	<1.0	<1.0
	8/13/2013	8.27	<1.0	<1.0	<1.0	<1.0
MW14	8/22/2012	Dry	Dry	Dry	Dry	Dry
	11/7/2012	10.12	1.1	<1.0	<1.0	<1.0
	2/28/2013	10.01	<1.0	<1.0	<1.0	<1.0
	5/21/2013	7.74	<1.0	<1.0	<1.0	<1.0
	8/13/2013	8.84	<1.0	<1.0	<1.0	<1.0
MW15	8/22/2012	10.51	4.7	<1.0	<1.0	<1.0
	11/7/2012	8.37	16	<1.0	<1.0	<1.0
	2/28/2013	9.04	19	<1.0	<1.0	<1.0
	5/21/2013	7.79	5.9	<1.0	<1.0	<1.0
	8/13/2013	9.09	3.9	<1.0	<1.0	<1.0
MW16	8/22/2012	8.67	<1.0	<1.0	<1.0	<1.0
	11/7/2012	9.16	2.9	<1.0	<1.0	<1.0
	2/28/2013	8.99	2.6	<1.0	<1.0	<1.0
	5/21/2013	7.87	2.1	<1.0	<1.0	<1.0
	8/13/2013	9.08	<1.0	<1.0	<1.0	<1.0
MW17	8/13/2013	11.62	<1.0	<1.0	<1.0	<1.0
MW18	8/13/2013	11.31	<1.0	<1.0	<1.0	<1.0
MW19	8/13/2013	10.09	1,900	41	470	1,500
MW20	8/13/2013	8.43	<1.0	<1.0	<1.0	<1.0
MW21	8/13/2013	9.31	520	<1.0	47	18
The Basic Standards for Groundwater			5	560	700	1,400

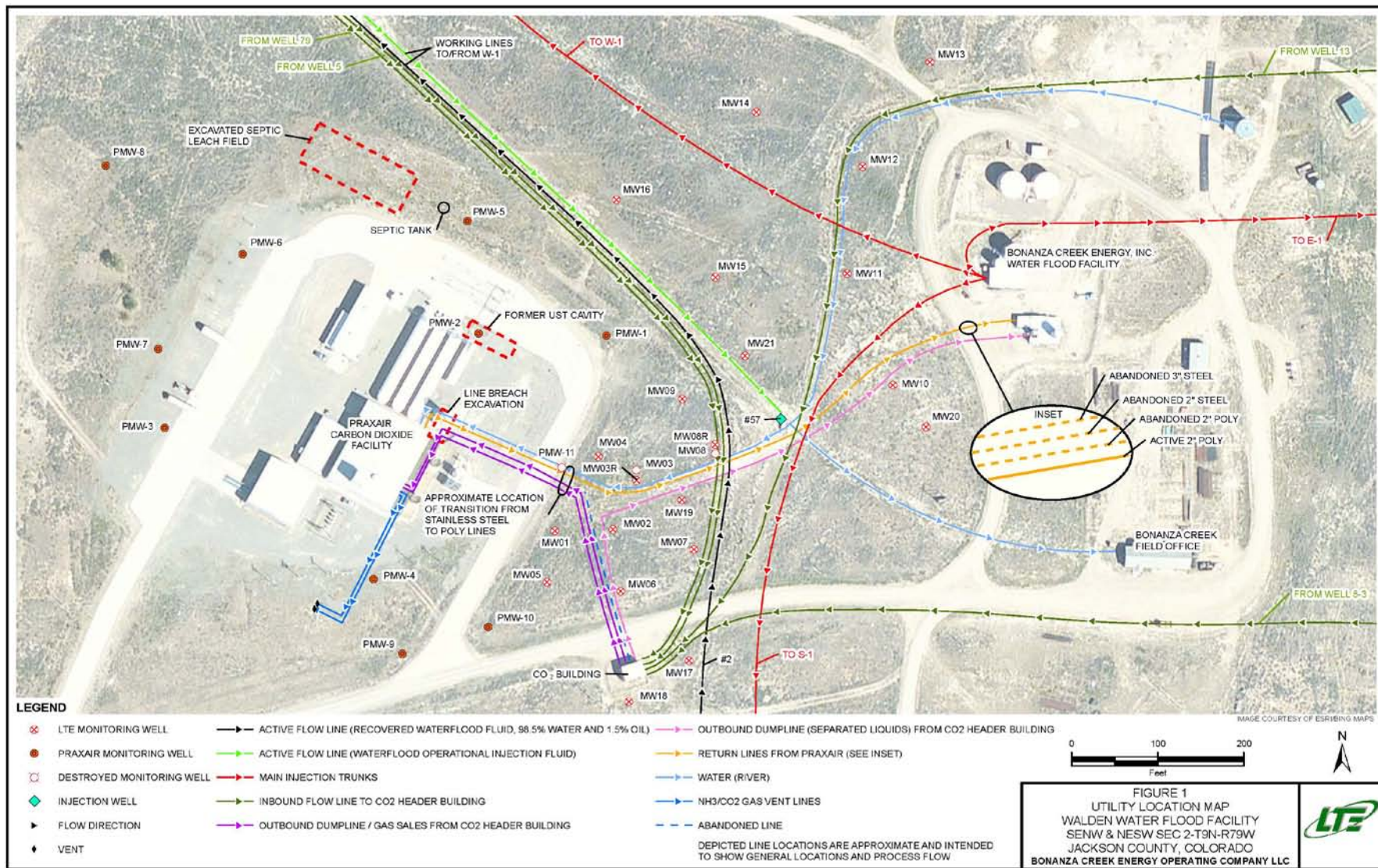
Notes:

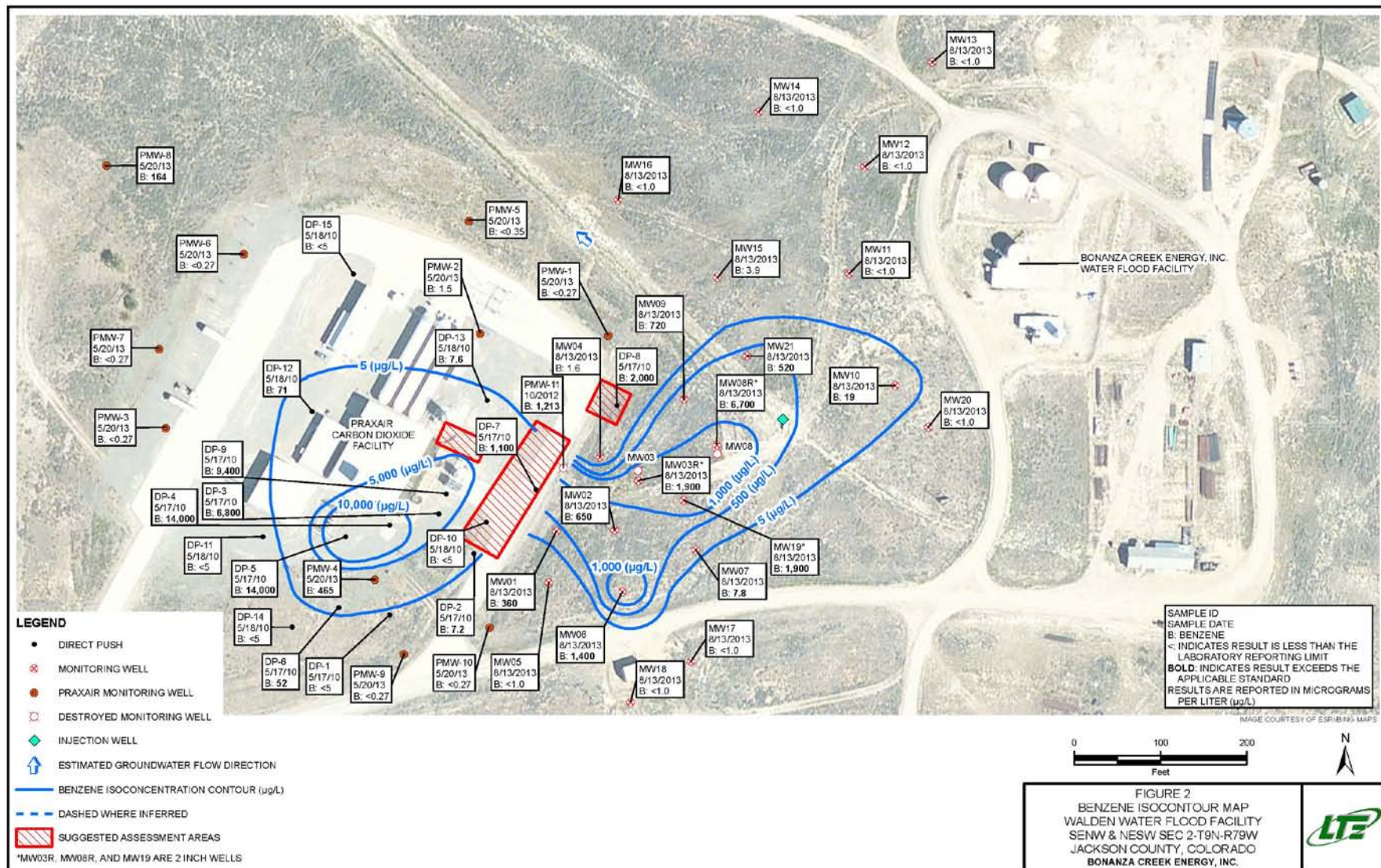
DTW - Depth to Water

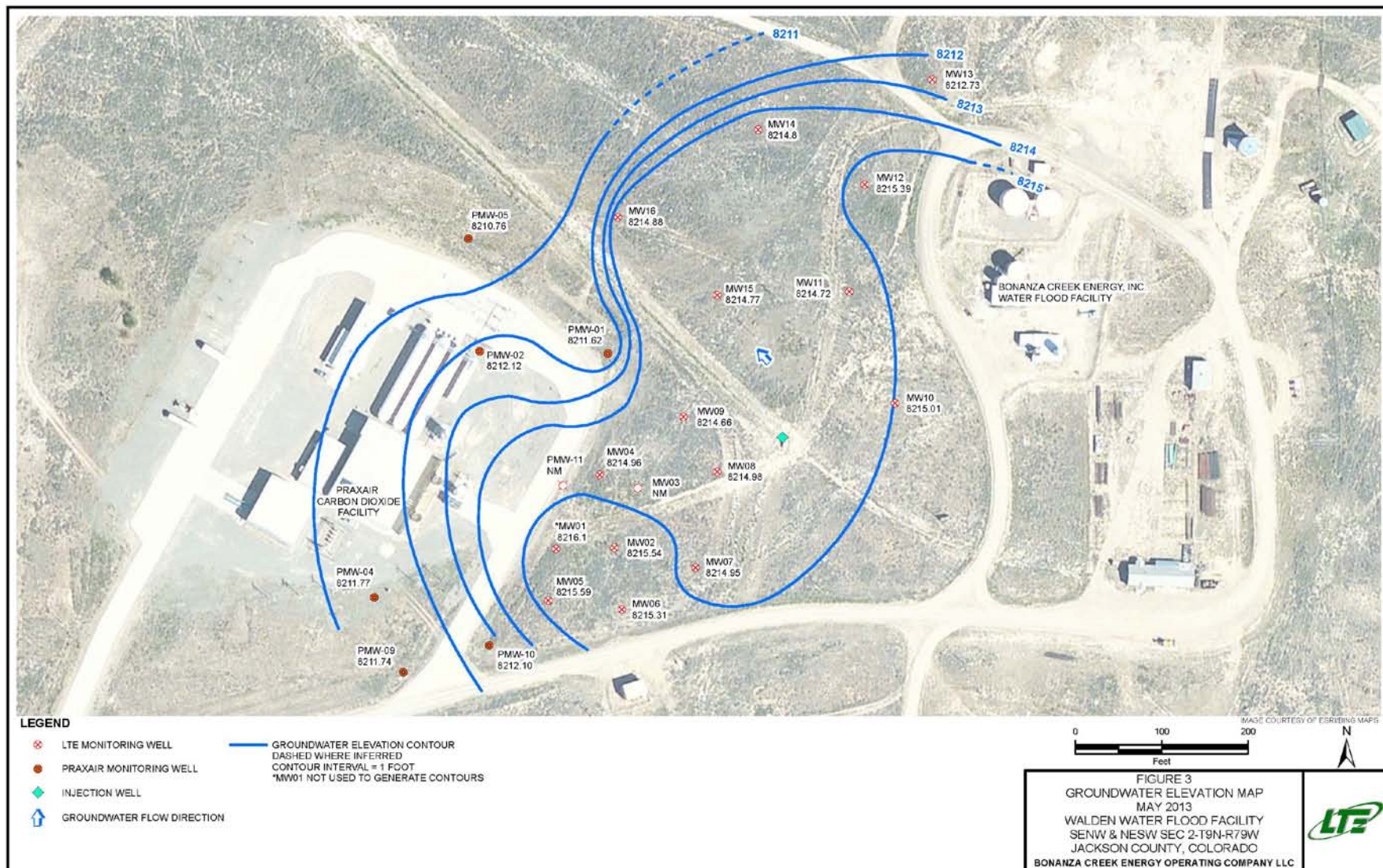
ug/L - Micrograms per liter

bgs - below ground surface

Results noted in bold exceed Colorado Department of Public Health and Environment (CDPHE)-Water Quality Control Commission (WQCC) Regulation 41-The Basic Standards for Groundwater









KEY ASSESSMENT FINDINGS

- Current groundwater flow is to the NW, but CBI reports on file with CDPHE indicate flows to W (4th Qtr 1998), W-SW (3rd Qtr 1998), SW (May 2010 and May 2011), and S (June 1999) have been recorded
- Based on currently available data, there appears to be four distinct source areas:
 - MW06 – Outbound Dumplines (separated liquids & gas sales line)
 - MW03/MW08 – Return Line from Praxair
 - PMW05/PMW06/PMW08 – Praxair Leach Field
 - PMW04/DP-3/DP-4/DP-5/DP-9 – Praxair Utility Corridor
- Historical BTEX concentrations/composition in PMW04 (16,600 ppb benzene in May '08) indicate impacts in PMW04 likely associated/contiguous with plume to the north of PMW04





KEY ASSESSMENT FINDINGS

- Plume extent has been defined on BC lease
- BTEX concentrations on BC lease steady or declining, source areas likely the result of historical releases from subsurface lines



- BC and Praxair Continue Respective Groundwater Monitoring Programs
- Passive Product Recovery in MW08R
- Additional Assessment Areas
 - Return line utility corridor in vicinity of 2012 line breach/excavation
 - Praxair lease west of PMW-11, MW04 and MW01
 - Re-assess area near DP-8 groundwater sample (2,000 ppb benzene)
- Evaluate Remedial Options