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3.6 Groundwater

This section summarizes the regional and local groundwater hydrology, including hydrostratigraphy, groundwater flow patterns, hydraulic gradient and aquifer parameters. Data for this section of the report were obtained from the NRC Technical Report (LCI, 2010) and the WDEQ-LQD Permit to Mine (LCI, 2011b).

3.6.1 Regional Groundwater Hydrology

The Permit Area is located in the northeastern portion of the Great Divide Basin, a closed basin with all surface water flows toward the interior of the basin. Existing data suggest that groundwater flow within the Basin is also predominately toward the interior of the basin (Collentine et al., 1981; Welder and McGreevy, 1966; and Mason and Miller, 2005). The Green Mountains located to the northeast, the Rawlins Uplift, Rock Springs Uplift, and Creston Junction, located east, southwest, and southeast, respectively, from the Permit Area, were identified as major recharge areas for aquifers within the basin (Fisk, 1967). The main discharge area for the Battle Spring/Wasatch aquifer system is to a series of lakes, springs and playa lake beds near the center of the Basin.

Hydrologic units of interest within the northeast portion of the Basin are shown on the stratigraphic column in **Figure 3.6-1** and further described below, from deepest to shallowest:

- Lewis Shale (aquitard between Tertiary and Mesaverde aquifer systems);
- Fox Hills Formation (Cretaceous);
- Lance Formation (Tertiary aquifer system);
- Fort Union Formation (Tertiary aquifer system);
- Battle Spring Formation-Wasatch Formation (Tertiary aquifer system);
- Undifferentiated Tertiary Formations (Upper Tertiary aquifer system, including Bridger, Uinta, Bishop Conglomerate, Browns Park, and South Pass); and
- Undifferentiated Quaternary Deposits (Tertiary aquifer system).

The Tertiary aquifer system has been identified as “the most important and most extensively distributed and accessible groundwater source in the study area” (Collentine et al., 1981). The term Tertiary aquifer system is used herein as the shallow Undifferentiated Quaternary Deposits through the Lance Formation. Although the Lance Formation is Cretaceous in age, Collentine et al. included it with the Tertiary aquifer system in the 1981 report, “Occurrence and Characteristics of Ground Water in the Great Divide and Washakie Basins, Wyoming”, and that convention was adopted by LCI for the Project.

ERA	SYSTEM, SERIES AND OTHER SUBDIVISIONS			STRATIGRAPHIC UNIT	HYDROGEOLOGIC UNIT
Cenozoic	Quaternary			Unnamed Alluvium	Alluvial Aquifers
	Tertiary	Miocene	Upper	Browns Park, North Park, and South Pass Formations Bishop Conglomerate	UpperTertiary Aquifers (Not present near Lost Creek)
		Oligocene			
		Eocene	Lower	Bridger Formation Green River Formation	
				Wasatch Formation-Battle Spring Formation	Tertiary Aquifers
		Paleocene		Fort Union Formation	
Mesozoic	Cretaceous		Upper	Lance Formation Fox Hills Sandstone	
				Lewis Shale	Confining Unit
				Mesaverde Formation	Mesaverde Aquifer
				Steele Shale Cody Shale Niobrara Formation	Confining Unit
				Frontier Formation	Frontier Aquifer
			Lower	Mowry Shale Muddy Sandstone Thermopolis Shale	Confining Unit
				Cloverly Formation	Cloverly (Dakota) Aquifer
	Jurassic			Morrison Formation	Confining Unit
				Sundance Formation	Sundance/Nugget Aquifer
	Triassic			Nugget Sandstone	
				Chugwater Formation Dinwoody Formation	Confining Unit
Paleozoic	Permian			Phosphoria Formation	
	Pennsylvanian			Tensleep Sandstone Amsden Formation	Paleozoic Aquifers
	Mississippian			Madison Formation	
	Cambrian			Flathead Sandstone	

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Fort Collins, Colorado, USA

FIGURE 3.6-1
Regional Hydrostatigraphic Units of Interest, Great Divide Basin

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The Battle Spring Formation of the Tertiary aquifer system crops out over most of the northeast portion of the Basin; and the Quaternary deposits and Upper Tertiary aquifer systems are absent or minimal in extent. In the northeast portion of the Basin, the shallower aquifer systems (Quaternary and Upper Tertiary) are typically found along the margins of the Basin where the Battle Springs Formation is absent, and in localized areas can be a source of groundwater.

Aquifers in formations deeper than the Lewis Shale are generally too deep to economically develop for water supply or have elevated total dissolved solid (TDS) concentrations that render them unusable for human consumption. However in the northeast portion of the Basin, near structural highs such as the Rawlins Uplift, these aquifer systems can be sources of groundwater in the vicinity of outcrops.

3.6.1.1 Lewis Shale

The Lewis Shale a regionally extensive aquitard in the Basin underlies the Fox Hills Formation (Collentine et al., 1981). This unit is described by Welder and McGreevey (1966) as light to dark gray, carbonaceous shale with beds of siltstone and very fine-grained sandstone. The Lewis Shale is up to 2,700 feet thick, generally increasing in thickness toward the east side of the Basin. In the Permit Area, the Lewis Shale is 1,200 feet thick. Small quantities of water may be available from the thin sandstone beds within this unit near the margins of the Basin. The Lewis Shale acts as the confining unit between the Tertiary and Mesaverde aquifer systems (Collentine et al., 1981).

3.6.1.2 Fox Hills Formation

The Fox Hills Formation overlies the Lewis Shale and consists of very fine-grained sandstone, siltstone and coal beds. It is not considered to be an important aquifer in the Permit Area.

3.6.1.3 Lance Formation

Overlying the Fox Hills Formation is the Lance Formation, consisting predominately of very fine-to fine-grained lenticular, clayey, calcareous sandstone. Shale, coal and lignite beds are present within the formation, which reaches a maximum thickness of approximately 4,500 feet (Welder and McGreevy, 1966). In the Permit Area, the Lance Formation is approximately 3,000 feet thick.

Collentine et al. (1981) include the Lance Formation (Aquifer) as the lower-most aquifer within the Tertiary aquifer system. However, the Lance Aquifer is included as part of the Mesaverde aquifer system by Freethey and Cordy (1991). Several stock wells, located along the eastern outcrop area of the Basin, are completed in the Lance Aquifer. The stock wells have estimated yields of five to

30 gpm. Hydraulic conductivity for the Mesaverde aquifer system reported by Freethey and Cordy (1991) (which, by the authors' designation, includes the Fox Hills Sandstone, Lewis Shale, and Mesaverde Group, in addition to the Lance Aquifer) is reported to range from 0.0003 to 2.2 feet per day (ft/d).

3.6.1.4 Fort Union Formation

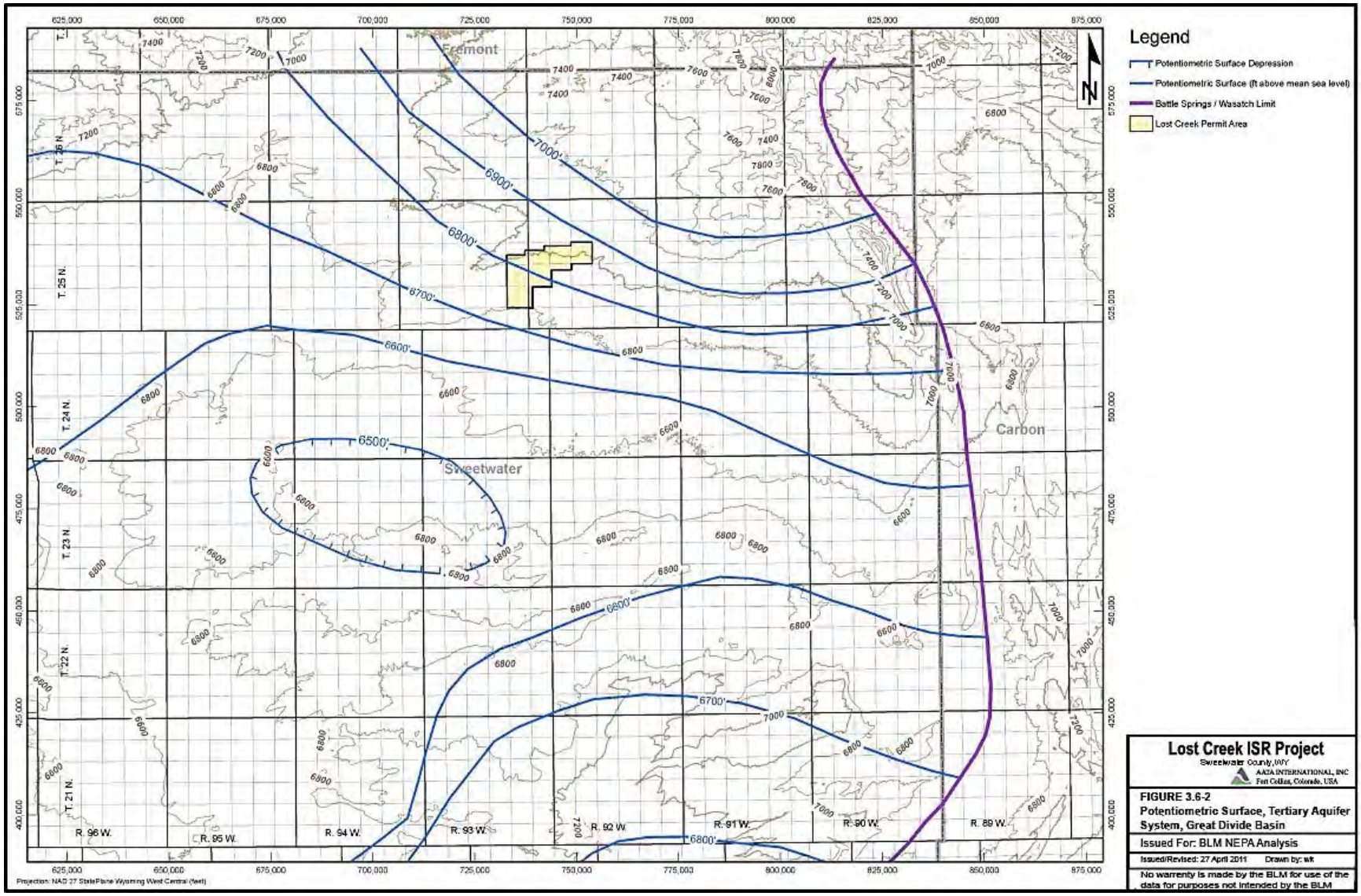
The Paleocene-age Fort Union Formation is between the Lance Formation and the overlying Wasatch and Battle Spring Formations, reaching a maximum thickness of approximately 6,000 feet within the Great Divide/Washakie Basin area. In the Permit Area, it is approximately 4,650 feet thick. The Fort Union Formation is present at or near land surface in a band around the Rock Springs Uplift and in the northeastern corner of the Basin (Mason and Miller, 2005). The Fort Union Formation is described as fine- to coarse-grained sandstone with coal and carbonaceous shale. Siltstone and claystone are present in the upper part of the formation (Welder and McGreevy, 1966).

A potentiometric surface map, prepared by Natfz (1996) that groups the Fort Union aquifer with the Battle Spring/Wasatch aquifers, shows inferred movement of groundwater toward the Basin's center (**Figure 3.6-2**).

The Fort Union aquifer is largely undeveloped and unknown as a source of groundwater supply except in areas where it occurs at shallow depths along the margins of the Basin. Well yields from the Fort Union aquifer within the Great Divide and Washakie Basins range from 3 to 300 gpm. Estimates of transmissivity for the Fort Union aquifer are highly variable, ranging from less than 3 square feet per day (ft^2/d) to325 ft^2/d (Ahern et al., 1981) and (Collentine et al., 1981).

3.6.1.5 Battle Spring Formation-Wasatch Formation

The most important water-bearing aquifers within the Basin are in the Wasatch Formation and the Battle Spring Formation. The Wasatch and Green River Formations grade into the Battle Spring Formation in the northeastern portion of the Basin. The Battle Spring Formation is absent along the eastern margin of the Basin, near the county line between Sweetwater and Carbon Counties. The termination of the Battle Spring Formation to the east and north is abrupt, controlled largely by structural features, including the Rawlins Uplift to the east and the Green Mountains to the north. A dry oil test in Section 14, Township 24 North, Range 90 West, located within a few miles of the eastern limit of the Battle Spring Formation, had a reported thickness of over 6,000 feet of fine- to coarse-grained sandstone that was interpreted by the American Stratigraphic Company as the Battle Spring Formation. Within the Permit Area, the Battle Spring Formation is over 6,200 feet thick. **Figure 3.3-1** shows the regional geology of the area.


Legend
Potentiometric Surface Depression
Potentiometric Surface (ft above mean sea level)
Battle Springs / Wasatch Limit
Lost Creek Permit Area
Fremont
Sweetwater
Carbon
T. 26 N.
T. 25 N.
T. 24 N.
T. 23 N.
T. 22 N.
T. 21 N.
R. 96 W.
R. 95 W.
R. 94 W.
R. 93 W.
R. 92 W.
R. 91 W.
R. 90 W.
R. 89 W.
7000'
6900'
6800'
6700'
6600'
6500'
Projection: NAD 27 State Plane Wyoming West Central (feet)
Lost Creek ISR Project
Sweetwater County, WY
AMIA INTERNATIONAL, INC
Fort Collins, Colorado, USA
FIGURE 3.6-2
Potentiometric Surface, Tertiary Aquifer System, Great Divide Basin
Issued For: BLM NEPA Analysis
Issued/Revised: 27 April 2011 Drawn by: wk
No warrenty is made by the BLM for use of the data for purposes not intended by the BLM

The Battle Spring Formation is described as an arkosic fine- to coarse-grained sandstone with claystone and minor conglomerates. There are typically several water-bearing sands within the Battle Spring Formation. The Battle Spring aquifers are included in the Tertiary aquifer system, as defined by Collentine et al. (1981).

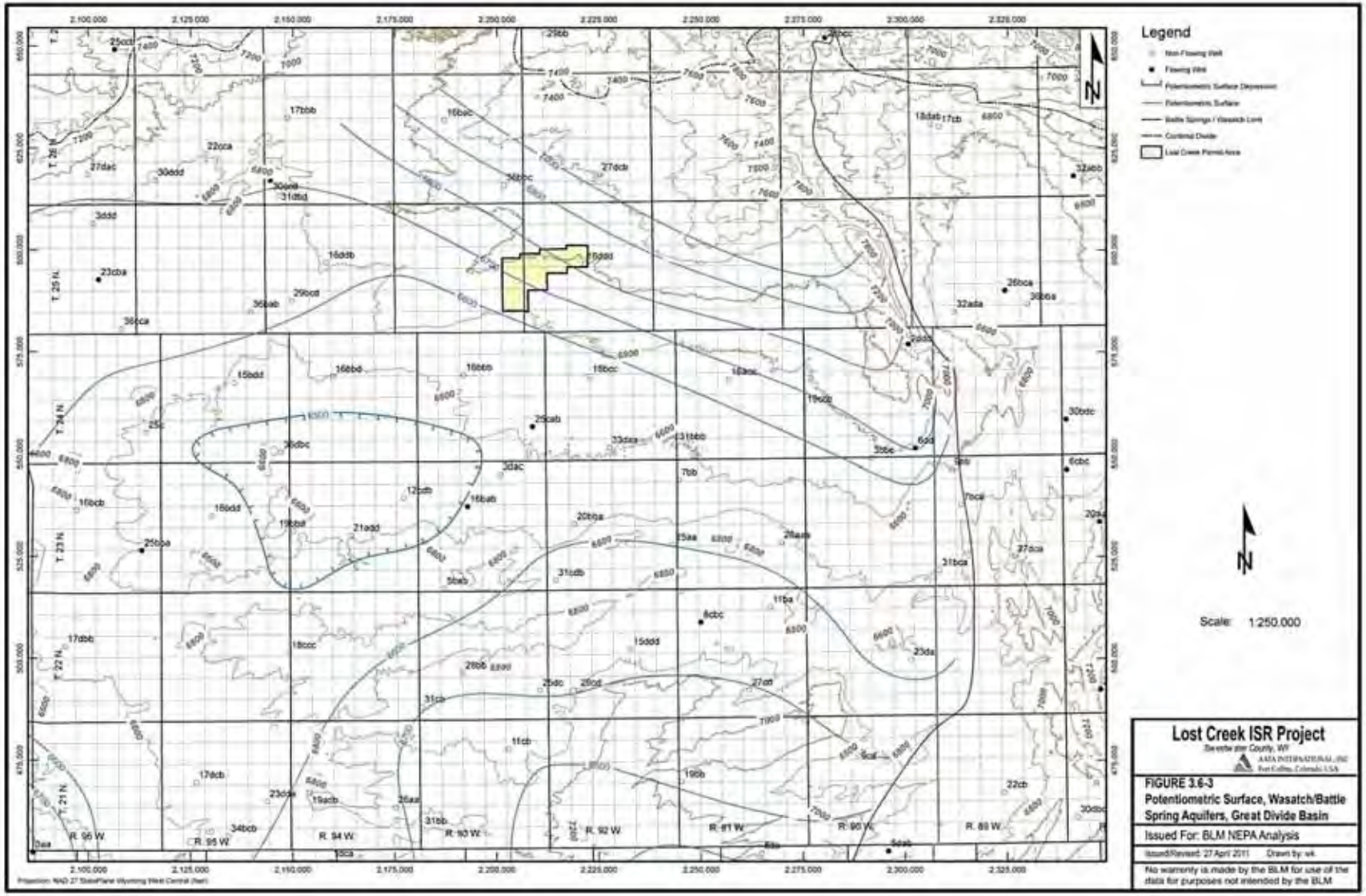
Groundwater within the Battle Spring aquifers is typically under confined conditions, although locally unconfined conditions exist. The potentiometric surface within the Battle Spring aquifers is usually within 200 feet of the ground surface (Welder and McGreevy, 1966). Most wells drilled for water supply in this unit are less than 1,000 feet deep. The potentiometric surface map of Wasatch and Battle Spring aquifers (**Figure 3.6-3**) indicates groundwater movement toward the center of the Basin (Welder and McGreevy, 1966). From the Permit Area, the potentiometric surface dips to the southwest at approximately 50 feet per mile (ft/mile) (a hydraulic gradient of 0.01 feet per foot [ft/ft]). The hydraulic gradient becomes steeper near the margins of the Basin, where recharge to the aquifer is occurring.

Wells completed in the Battle Spring aquifers typically yield 30 to 40 gpm; but yields as high as 150 gpm are possible. Pump tests conducted on 26 wells completed within the Battle Spring aquifers resulted in transmissivity values ranging from 3.9 to 423 ft^2/d, although most wells were less than 67 ft^2/d. Specific capacity was less than one gallon per minute per foot for 23 of the 26 wells tested (Collentine, et al., 1981).

3.6.1.6 Undifferentiated Tertiary and Quaternary Sediments

Undifferentiated Tertiary and Quaternary units above the Battle Spring/Wasatch Formations can be sources of water supply; but wells in the northeastern portion of the Basin are rare and generally limited to the margins of the Basin, where the Battle Spring Formation is not present. Commonly, along the margins of the Basin, hydrostratigraphic units younger than the Battle Spring/Wasatch have been deposited on rocks of Cretaceous age or older. Water supply wells along the margins of the Basin are often completed in both the older hydrostratigraphic units and Tertiary and Quaternary sediments. Water quality within these units tends to be variable and available resources of good quality water are limited.

The undifferentiated Tertiary units consist of interbedded claystone, sandstone and conglomerate, with the coarser grained facies providing suitable groundwater resources where present. The undifferentiated Tertiary units are absent within the Permit Area and are not discussed further.


Legend
Non-Flowing Well
Flowing Well
Potentiometric Surface Depression
Potentiometric Surface
Battle Springs / Wasatch Limit
Continental Divide
Lost Creek Permit Area
Scale: 1:250,000
Lost Creek ISR Project
Sweetwater County, WY
FIGURE 3.6-3
Potentiometric Surface, Wasatch/Battle Spring Aquifers, Great Divide Basin
Issued For: BLM NEPA Analysis
Issued/Revised: 27 April 2011 Drawn by: wk
No warranty is made by the BLM for use of the data for purposes not intended by the BLM

The undifferentiated Quaternary units consist of clay, silt, sand, gravel and conglomerates that are poorly consolidated to unconsolidated (Welder and McGreevy, 1966). These units represent windblown, alluvial and lake deposits. Where present, these deposits can provide acceptable yields of groundwater of relatively good quality. Thin deposits of Quaternary sediments are present within surface drainages in the Permit Area but are usually above the water table and unsaturated. Therefore, Quaternary sediments are not an important groundwater source in the vicinity of the Project and are not described further.

3.6.2 Site Groundwater Hydrology

LCI has collected lithologic, water level, water quality, and pump test data as part of its ongoing evaluation of hydrologic conditions for the Permit Area and, most recently, for MU1. In addition to LCI's data, historic data collected for Conoco were used to support this evaluation (Hydro-Search, Inc., 1982). Drilling and installation of borings and monitor wells would continue to provide additional data to further refine the site hydrologic conceptual model and provide detailed operating information for each mine unit. Water level measurements, both historic and recent, provide data to assess potentiometric surface, hydraulic gradients and inferred groundwater flow directions for the aquifers of interest at the Permit Area. Long-term pump test data conducted by LCI and several shorter-term pump tests (Hydro-Engineering, 2007), as well as the pump tests conducted for Conoco (Hydro-Search, Inc., 1982), were used to evaluate hydrologic properties of the aquifers of interest. The pump test data were used to assess hydraulic characteristics of the confining units, and to evaluate impacts to the hydrologic system of the Fault through the Permit Area.

Figure 3.6-4 shows the locations of the historic Conoco (or Texasgulf) monitor wells (the M-25-92 series), and it shows the locations of the existing monitor wells that were used for baseline data collection and in the LC16M and LC19M pump tests. **Table 3.6-1** provides completion data for the monitor wells currently in use. Attachment D6-3 of the WDEQ-LQD Permit to Mine (LCI, 2011b) includes well completion logs for those wells. Plate D5-3 in Appendix D5 of the WDEQ-LQD Permit to Mine shows the locations of all the existing monitor wells in the Permit Area. **Figure 3.6-5** shows the monitor well locations for MU1; and **Table 3.6-2** is a list of those wells.

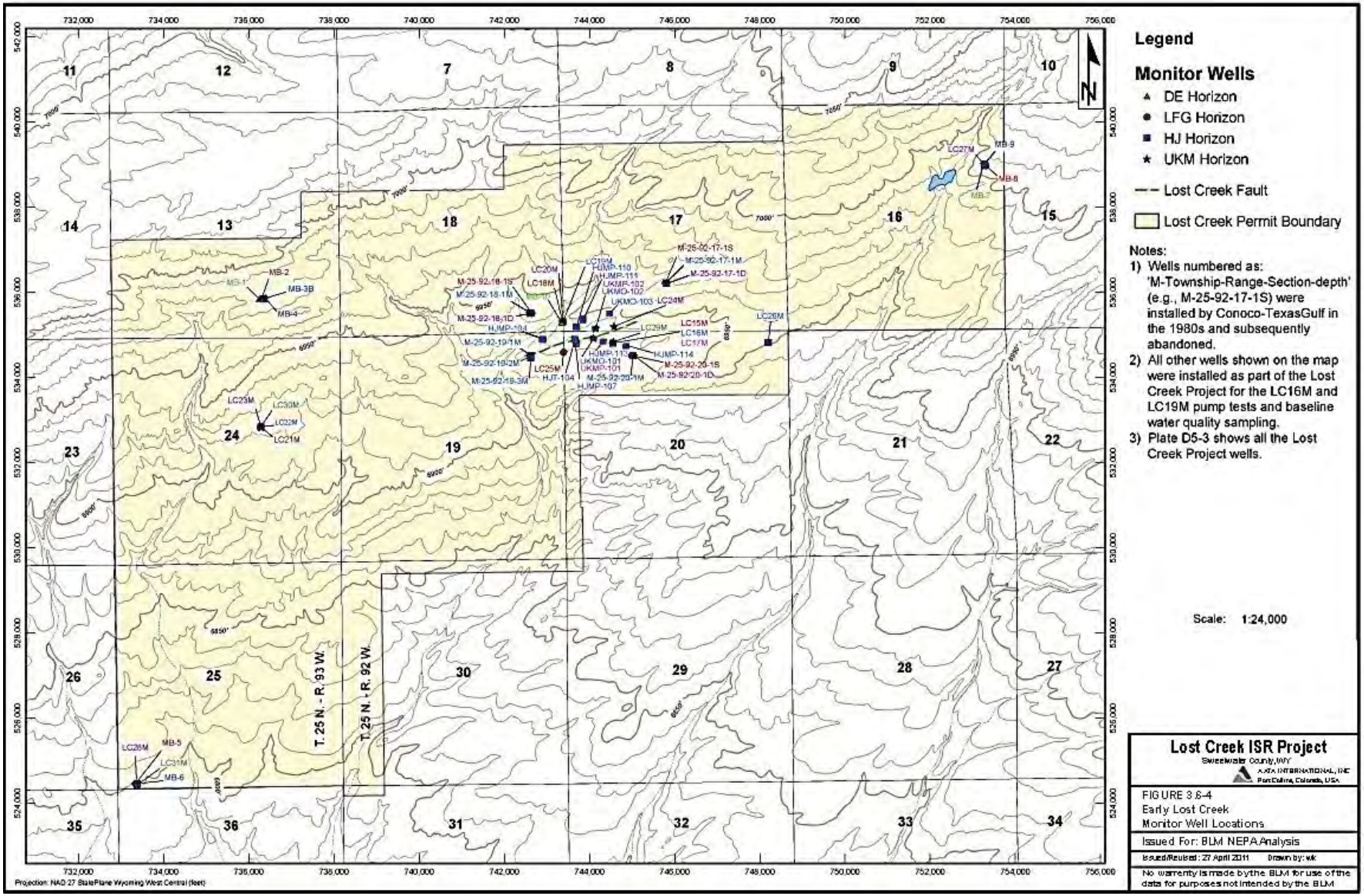

Legend
Monitor Wells
DE Horizon
LFG Horizon
HJ Horizon
UKM Horizon
Lost Creek Fault
Lost Creek Permit Boundary
Notes:
1) Wells numbered as: 'M-Township-Range-Section-depth' (e.g., M-25-92-17-1S) were installed by Conoco-TexasGulf in the 1980s and subsequently abandoned.
2) All other wells shown on the map were installed as part of the Lost Creek Project for the LC16M and LC19M pump tests and baseline water quality sampling.
3) Plate D5-3 shows all the Lost Creek Project wells.
Scale: 1:24,000
T. 25 N. - R. 93 W.
T. 25 N. - R. 92 W.
Lost Creek ISR Project
Sweetwater County, WY
KATA INTERNATIONAL, INC
Fort Collins, Colorado, USA
FIGURE 3.6-4
Early Lost Creek
Monitor Well Locations
Issued For: BLM NEPA Analysis
Issued/Revised: 27 April 2011 Drawn by: wk
No warranty is made by the BLM for use of the data for purposes not intended by the BLM
Projection: NAD 27 StatePlane Wyoming West Central (feet)

Table 3.6-1 Permit Area Monitor Well Data (Page 1 of 4)

Well Name	Easting (feet)	Northing (feet)	Completion Zone	Ground Surface Elevation (ft amsl)	Measure Point Elevation (ft amsl)	Total Depth (feet)	Top Underreamed Zone (ft bgs)	Bottom Underreamed Zone (ft bgs)	Total Underreamed thickness (feet)
HJT-106	744,221	534,573	DE	6933.14	6935.14	162	142	162	20
HJT-107	745,230	534,833	DE	6942.69	6944.34	163	133	163	30
LC29M	744,547	534,837	DE	6935.11	6936.86	171	140	164	24
LC30M	736,276	532,836	DE	6925.10	6927.40	236	196	236	40
LC31M	733,380	524,434	DE	6804.55	6805.83	191	150	190	40
MB-1	736,248	535,851	DE	6984.39	6985.89	300	240	280	40
MB-7	753,266	538,981	DE	6983.38	6984.88	140	80	125	45
MB-10	743,348	535,293	DE	6939.20	6940.70	190	130	160	30
HJMO-102	742,549	534,762	FG	6933.89	6934.56	330	290	330	40
HJMO-103	742,646	535,101	FG	6935.29	6936.29	330	296	326	30
HJMO-101	743,281	534,988	LFG	6904.24	6905.45	326	295	326	31
HJMO-104	742,897	534,899	LFG	6939.51	6940.76	328	296	326	30
HJMO-105	742,953	535,074	LFG	6936.84	6938.00	326	300	323	23
HJMO-106	743,168	535,258	LFG	6941.00	6941.75	336	296	326	30
HJMO-107	743,697	534,790	LFG	6936.86	6937.86	370	339	369	30
HJMO-108	743,461	535,298	LFG	6950.64	6951.64	333	305	333	28
HJMO-109	743,904	534,825	LFG	6937.79	6938.95	379	345	370	25
HJMO-110	743,675	535,194	LFG	6945.92	6947.13	330	300	330	30
HJMO-111	743,825	535,371	LFG	6949.38	6950.46	330	303	333	30
HJMO-112	744,375	534,674	LFG	6933.76	6935.51	350	305	350	45
HJMO-113	744,265	534,805	LFG	6936.06	6936.97	362	318	356	38
HJMO-114	744,979	534,676	LFG	6939.09	6940.75	360	324	360	36
LC15M	744,532	534,820	LFG	6935.13	6936.55	350	286	340	54
LC18M	743,368	535,316	LFG	6948.43	6949.03	350	290	332	42
LC21M	736,277	532,850	LFG	6925.00	6927.13	410	375	398	23
LC25M	743,397	534,601	LFG	6935.00	6936.52	380	316	369	53
MB-2	436,298	535,858	LFG	6985.42	6986.92	460	410	450	40

Table 3.6-1 Permit Area Monitor Well Data (Page 2 of 4)

Well Name	Easting (feet)	Northing (feet)	Completion Zone	Ground Surface Elevation (ft amsl)	Measure Point Elevation (ft amsl)	Total Depth (feet)	Top Underreamed Zone (ft bgs)	Bottom Underreamed Zone (ft bgs)	Total Underreamed thickness (feet)
MB-5	733,337	524,466	LFG	6803.54	6805.04	330	305	325	20
MB-8	753,316	538,987	LFG	6984.00	6985.50	280	230	260	30
HJMP-101	743,287	534,998	HJ	6903.70	6904.58	490	438	465	27
HJMP-102	742,559	534,755	HJ	6934.15	6936.15	440	405	435	30
HJMP-103	742,652	535,109	HJ	6935.08	6936.49	432	392	432	40
HJMP-104	742,886	534,897	HJ	6939.04	6941.04	430	402	430	28
HJMP-105	742,933	535,073	HJ	6936.84	6937.38	460	425	463	38
HJMP-106	743,166	535,267	HJ	6940.20	6941.29	480	430	480	50
HJMP-107	743,684	534,802	HJ	6936.81	6938.45	464	423	460	37
HJMP-108	743,466	535,311	HJ	6951.12	6952.20	436	400	434	34
HJMP-109	743,895	534,829	HJ	6937.89	6939.10	512	478	512	34
HJMP-110	743,682	535,184	HJ	6945.81	6947.01	476	431	476	45
HJMP-111	743,836	535,365	HJ	6948.99	6949.49	440	393	440	47
HJMP-112	744,385	534,668	HJ	6934.32	6935.48	400	370	400	30
HJMP-113	744,273	534,797	HJ	6935.26	6937.26	462	416	462	46
HJMP-114	744,976	534,687	HJ	6940.18	6941.01	460	408	460	52
HJT-101	742,561	534,610	HJ	6937.12	6937.56	478	437	477	40
HJT-102	742,886	534,696	HJ	6937.82	6939.15	430	390	417	27
HJT-103	743,180	534,670	HJ	6937.56	6938.22	450	423	450	27
HJT-104	743,653	534,892	HJ	6937.48	6940.15	460	410	460	50
HJT-105	744,423	535,024	HJ	6937.45	6938.87	850	407	438	31
LC16M	744,549	534,818	HJ	6934.73	6936.15	472	410	467	57
LC19M	743,383	535,317	HJ	6949.32	6950.52	463	412	463	51
LC22M	736,292	532,850	HJ	6924.01	6926.06	592	504	585	81
LC26M	748,203	534,832	HJ	6952.96	6955.67	436	376	431	55
UKMO-101	744,086	534,943	HJ	6940.19	6942.28	487.4	465	485	20
UKMO-102	744,205	535,134	HJ	6940.24	6940.79	420	377	408	31
UKMO-103	744,501	535,556	HJ	6949.28	6950.53	438	417	445	28

Table 3.6-1 Permit Area Monitor Well Data (Page 3 of 4)

Well Name	Easting (feet)	Northing (feet)	Completion Zone	Ground Surface Elevation (ft amsl)	Measure Point Elevation (ft amsl)	Total Depth (feet)	Top Underreamed Zone (ft bgs)	Bottom Underreamed Zone (ft bgs)	Total Underreamed thickness (feet)
MB-3B	736,348	535,854	HJ	6985.88	6987.38	600	540	552	12
							562	587	25
MB-6	733,376	524,466	HJ	6803.40	6804.90	440	380	405	25
MB-9	753,281	539,034	HJ	6984.82	6986.31	400	340	370	30
HJMU-101	743,277	531,997	UKM	6903.50	6904.71	535	499	535	36
HJMU-102	743,476	535,299	UKM	6934.72	6935.35	600	495	525	30
HJMU-103	742,657	535,098	UKM	6935.06	6936.06	850	500	540	40
HJMU-104	742,891	534,907	UKM	6939.01	6940.51	550	512	550	38
HJMU-105	742,942	535,076	UKM	6936.37	6937.58	548	502	542	40
HJMU-106	743,159	535,258	UKM	6940.59	6941.75	547	500	546	46
HJMU-107	743,686	534,788	UKM	6936.84	6937.88	855	550	580	30
HJMU-108	743,476	535,299	UKM	6949.97	6951.51	850	510	540	30
HJMU-109	743,905	534,835	UKM	6933.92	6939.38	850	524	574	50
HJMU-110	743,685	535,195	UKM	6945.97	6947.56	850	492	532	40
HJMU-111	743,841	535,374	UKM	6948.93	6950.08	853	507	545	38
HJMU-112	744,386	534,676	UKM	6934.18	6935.35	802	525	560	35
HJMU-113	744,277	534,807	UKM	6935.16	6936.99	800	524	555	31
HJMU-114	744,966	534,678	UKM	6939.10	6940.43	557	525	553	28
LC17M	744,548	534,838	UKM	6935.32	6936.90	575	529	565	36
LC20M	743,383	535,331	UKM	6949.27	6950.64	543	511	543	32
LC23M	736,292	532,835	UKM	6924.41	6926.80	634	595	630	35
LC24M	744,566	535,200	UKM	6942.33	6944.33	542	478	531	53
LC27M	753,260	539,018	UKM	7010.00	7012.16	477	433	456	23
LC28M	733,364	524,437	UKM	6804.15	6805.19	563	502	557	55
UKMP-101	744,090	534,929	UKM	6940.18	6941.74	575	540	572	32
UKMP-102	744,204	535,145	UKM	6940.51	6942.10	498	485	505	20

Table 3.6-1 Permit Area Monitor Well Data (Page 4 of 4)

Well Name	Easting (feet)	Northing (feet)	Completion Zone	Ground Surface Elevation (ft amsl)	Measure Point Elevation (ft amsl)	Total Depth (feet)	Top Underreamed Zone (ft bgs)	Bottom Underreamed Zone (ft bgs)	Total Underreamed thickness (feet)
UKMP-103	744,487	535,558	UKM	6949.73	6950.84	537	496	537	41
MB-4	736,398	535,868	UKM	6985.77	6987.27	680	610	640	30
UKMU-101	744,101	534,931	MKM	6939.87	6941.87	850	608	630	22
UKMU-102	744,191	535,143	MKM	6940.62	6942.62	583	545	570	25
UKMU-103	744,488	535,546	MKM	6948.75	6950.92	850	558	590	32

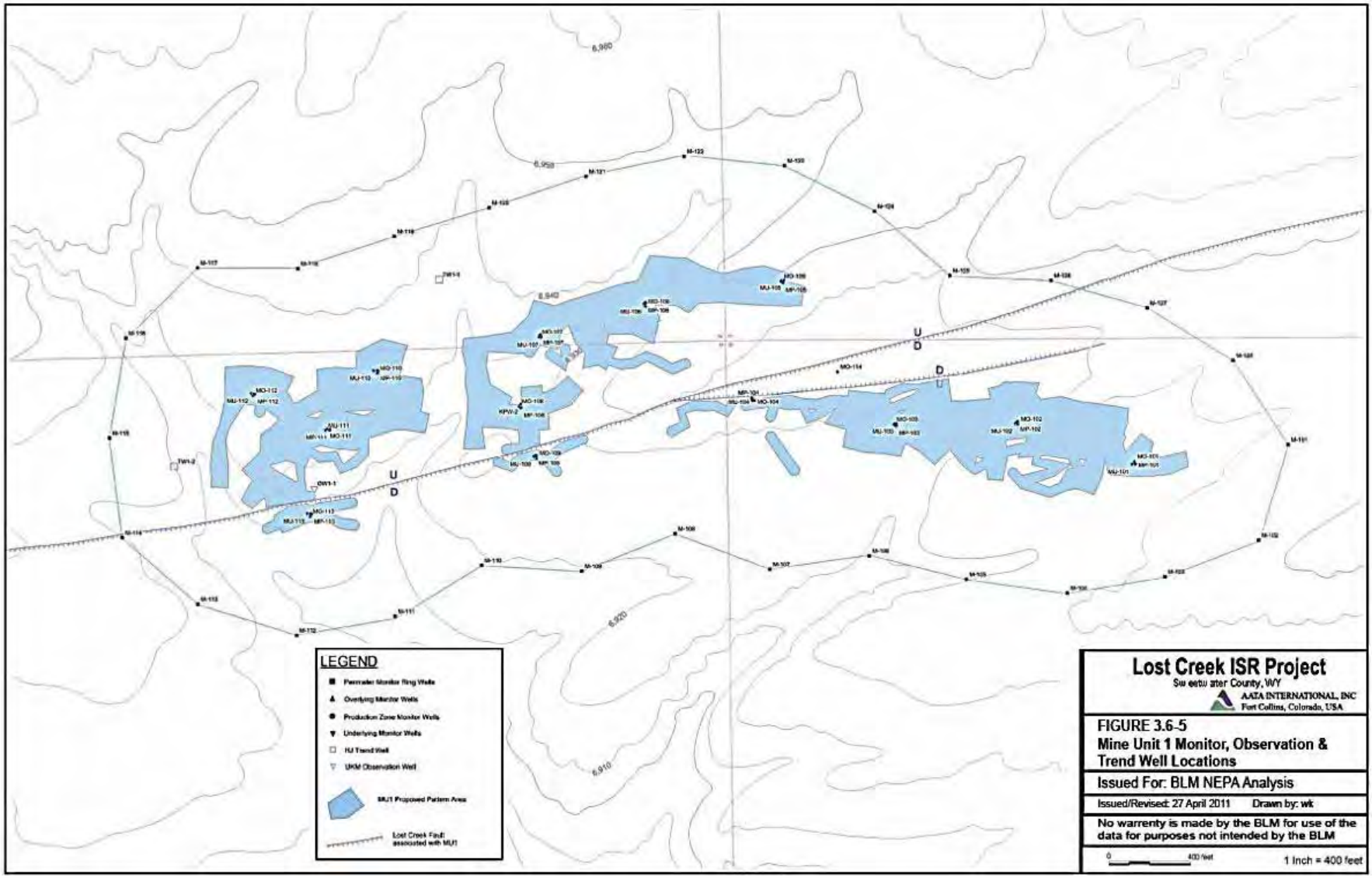

LEGEND
Perimeter Monitor Ring Wells
Overlying Monitor Wells
Production Zone Monitor Wells
Underlying Monitor Wells
HJ Trend Well
UKM Observation Well
MU1 Proposed Pattern Area
Lost Creek Fault associated with MU1
Lost Creek ISR Project
Sweetwater County, WY
AATA INTERNATIONAL, INC
Fort Collins, Colorado, USA
FIGURE 3.6-5
Mine Unit 1 Monitor, Observation & Trend Well Locations
Issued For: BLM NEPA Analysis
Issued/Revised: 27 April 2011
Drawn by: wk
No warrenty is made by the BLM for use of the data for purposes not intended by the BLM
0
400 feet
1 Inch = 400 feet

Table 3.6-2 Mine Unit 1 Monitor, Observation and Trend Wells

Monitor Ring (M) Wells and Trend Well (TW) [1]		Overlying Aquifer Monitor (MO) Wells	Underlying Aquifer Monitor (MU) Wells and Observation Well (OW)	Production Zone Monitor (MP) Wells
M-101	M-116	MO-101	MU-101	MP-101
M-102	M-117	MO-102	MU-102	MP-102
M-103	M-118	MO-103	MU-103	MP-103
M-104	M-119	MO-104	MU-104	MP-104
M-105	M-120A [2]	MO-105	MU-105	MP-105
M-106	M-121	MO-106	MU-106	MP-106
M-107	M-122	MO-107	MU-107	MP-107
M-108	M-123	MO-108	KPW-2 [4]	MP-108
M-109	M-124	MO-109	MU-109	MP-109
M-110	M-125	MO-110	MU-110	MP-110
M-111	M-126	MO-111	MU-111	MP-111
M-112	M-127	MO-112	MU-112	MP-112
M-113	M-128	MO-113	MU-113	MP-113
M-114	TW1-1	MO-114 [3]	OW1-1	---
M-115	---	---	---	---

[1] Detailed monitor well information (e.g., well depths, screened intervals) provided in Attachment MU1 2-1 of the WDEQ-LQD MU1 documents (LCI, 2011b).

[2] Well M-120 failed the MIT, was properly abandoned and was replaced with well M-120A.

[3] Well MO-114 was added to this list to ensure adequate monitoring near the Fault and associated splinter fault.

[4] Well MU-108 failed the MIT, was properly abandoned and replaced with well KPW-2, which was originally used as a pump test well within the same horizon as and 17 feet from well MU-108.

3.6.2.1 Hydrostratigraphic Units

As previously discussed in **Section 3.3**, the primary uranium production zone is identified as the HJ Horizon in the Battle Springs Formation. The HJ Horizon is subdivided into the Upper (UHJ), Middle (MHJ) and Lower (LHJ) Sands. The HJ Horizon is bounded above and below by aerially extensive confining units identified as the Lost Creek Shale and the Sage Brush Shale, respectively. Overlying the Lost Creek Shale is the FG Horizon. The deepest sand in the FG Horizon, the Lower FG (LFG) Sand, is the overlying aquifer to the HJ Horizon. Beneath the Sage Brush Shale is the KM Horizon. The uppermost sand within the KM Horizon, designated the Upper KM (UKM) sand, is a secondary production zone and also the underlying aquifer to the HJ Horizon. The No Name Shale unit

separates the UKM and Middle KM (MKM) Sand. The shallowest occurrence of groundwater within the Permit Area occurs within the DE Horizon, which is above the FG Horizon. A brief description of each hydrostratigraphic unit, from deepest to shallowest, is provided below and illustrated on a geophysical log on **Figure 3.3-3**.

DE Horizon

The DE Horizon is the shallowest occurrence of groundwater within the Permit Area, although the horizon is not saturated in all portions of the Permit Area. The depth to groundwater in the DE horizon has been measured from approximately 155 feet to 257 feet below ground surface; however some of the monitor wells were occasionally dry during the monitoring events. The DE Horizon consists of a sequence of sands and discontinuous clay/shale units. In the southern portion of the Permit Area, sands of the DE Horizon coalesce with sands of the FG Horizon. The top of the unit ranges from 100 to 200 ft bgs (**Figure 3.3-3**).

FG Horizon

The top of the FG Horizon occurs at depths of approximately 250 to 300 ft bgs on the north side of the Fault and 275 to 350 ft bgs on the south side of the Fault within the Permit Area. The FG Horizon is subdivided into the Upper (UFG), Middle (MFG) and Lower (LFG) Sands (**Figure 3.3-3**). The total thickness of the FG Horizon is approximately 100 feet. The basal unit in the FG Horizon, the LFG Sand, ranges from 20 to 50 feet thick within the Permit Area. The LFG Sand is designated as the overlying aquifer for the HJ Horizon.

Lost Creek Shale

Underlying the FG Sands is the Lost Creek Shale. The Lost Creek Shale appears continuous across the Permit Area, ranging from five to 45 feet in thickness. Typically, this unit has a thickness of ten to 25 feet. The Lost Creek Shale is the confining unit between the overlying aquifer (LFG Sand) and the HJ Horizon (**Figure 3.3-3**). An isopach of the shale thickness is included as Plate D5-2a in the WDEQ-LQD Permit to Mine (LCI, 2011b). The confining characteristics of the Lost Creek Shale have been demonstrated with a pump test.

HJ Horizon

The HJ Horizon is the primary target for uranium production at the Project. For purposes of uranium ISR operations, the HJ Horizon has been subdivided into three Sands: the Upper HJ (UHJ), Middle HJ (MHJ) and the Lower (LHJ) Sand (**Figure 3.3-3**). These sands are generally composed of coarse-grained arkosic sands with thin lenticular intervals of fine sand, mudstone and siltstone. The bulk of the uranium mineralization is present in the MHJ Sand. The total thickness of the HJ Horizon ranges from 100 to 160 feet, averaging approximately 120 feet.

The top of the HJ Horizon ranges from approximately 300 to 450 ft bgs within the Permit Area. The three sands are generally separated by thin clayey units that are not laterally extensive and, based on pump test results, do not act as confining units to prevent groundwater movement vertically between the HJ Sands. The underlying aquifer to the HJ Horizon is the UKM Sand. An isopach of the shale thickness is included as Plate D5-2b in the WDEQ-LQD Permit to Mine (LCI, 2011b).

Sage Brush Shale

Beneath the HJ Horizon is the Sage Brush Shale, at depths ranging from 450 to 550 ft bgs. The Sage Brush Shale is laterally extensive and ranges from five to 75 feet in thickness (**Figure 3.3-3**). An isopach of the shale thickness is included as Plate D5-2c in the WDEQ-LQD Permit to Mine (LCI, 2011b). The Sage Brush Shale is the lower confining unit to the HJ Production Zone. The confining characteristics of this unit have been demonstrated through pump tests.

UKM Sand

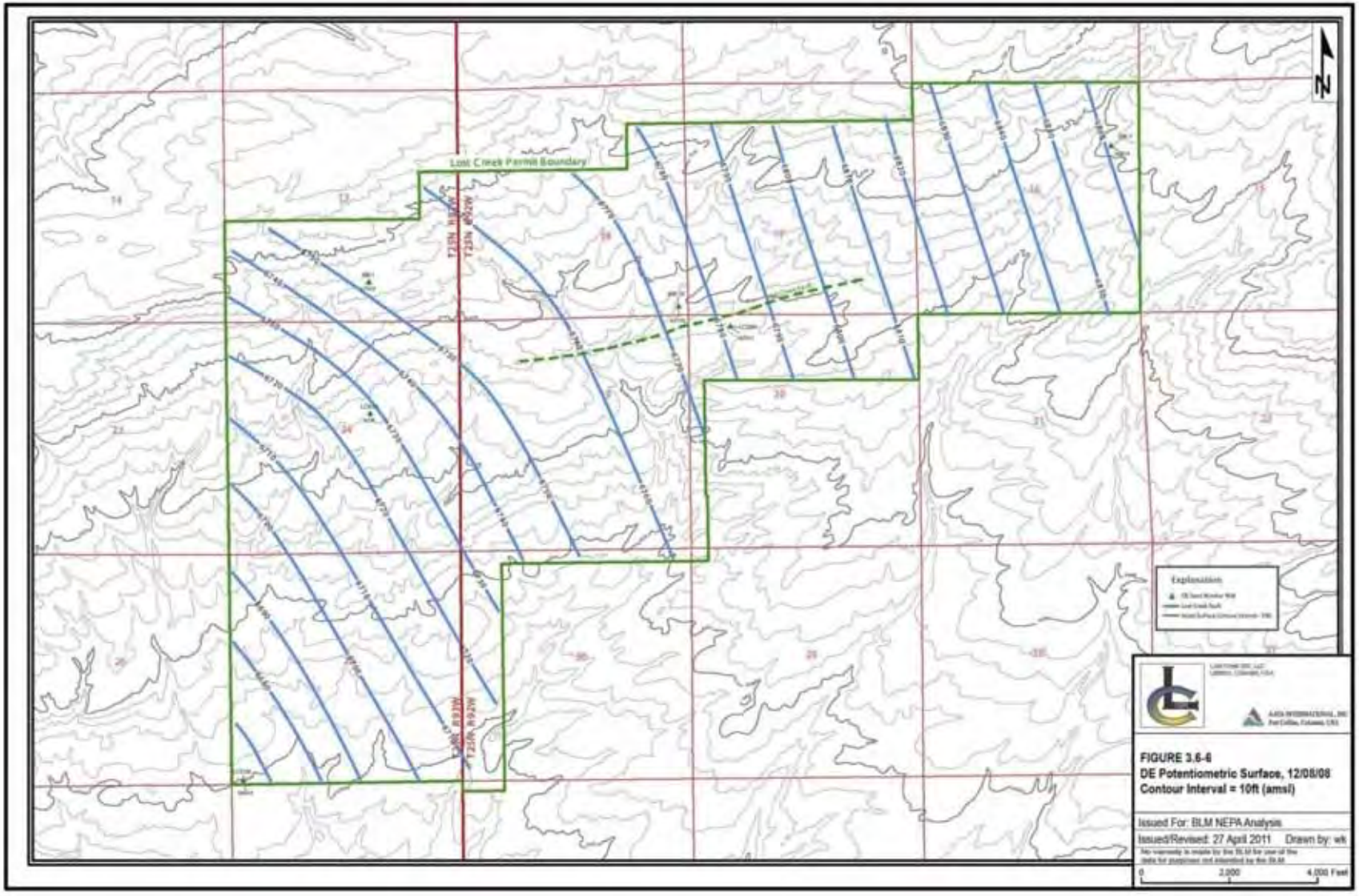
The UKM Sand is present beneath the Sage Brush Shale. The UKM Sand is the upper member of the KM Horizon and is generally a massive coarse sandstone with lenticular fine sandstone intervals. The UKM Sand is the underlying aquifer to the HJ Horizon but is also a potential production zone within the Permit Area. The UKM Sand is typically 30 to 60 feet thick but can reach over 75 feet in thickness (**Figure 3.3-3**). An isopach of the shale thickness is included as Plate D5-2d in the WDEQ-LQD Permit to Mine (LCI, 2011b). The top of the UKM Sand is usually between 450 and 600 ft bgs within the Permit Area.

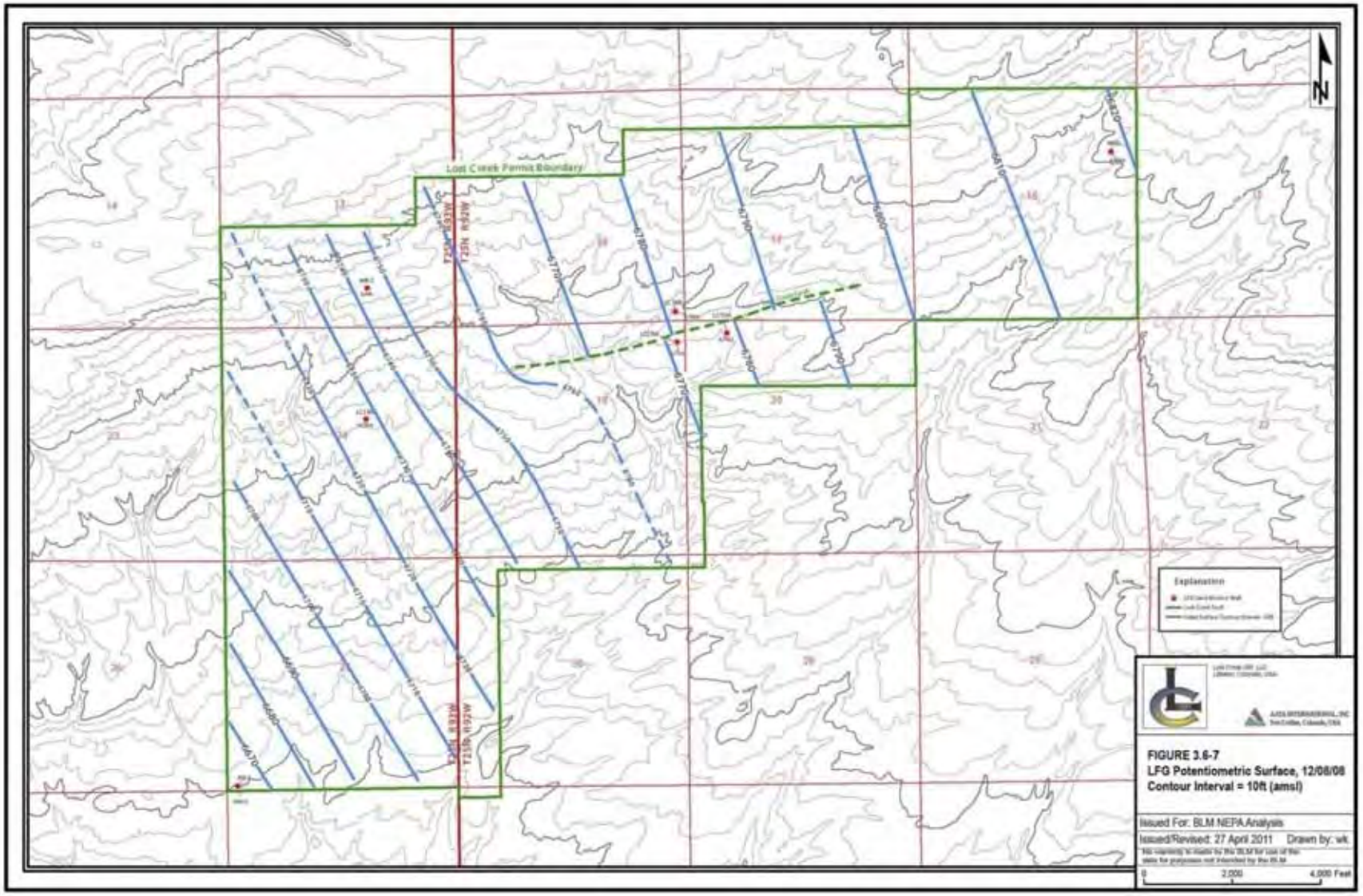
No Name Shale

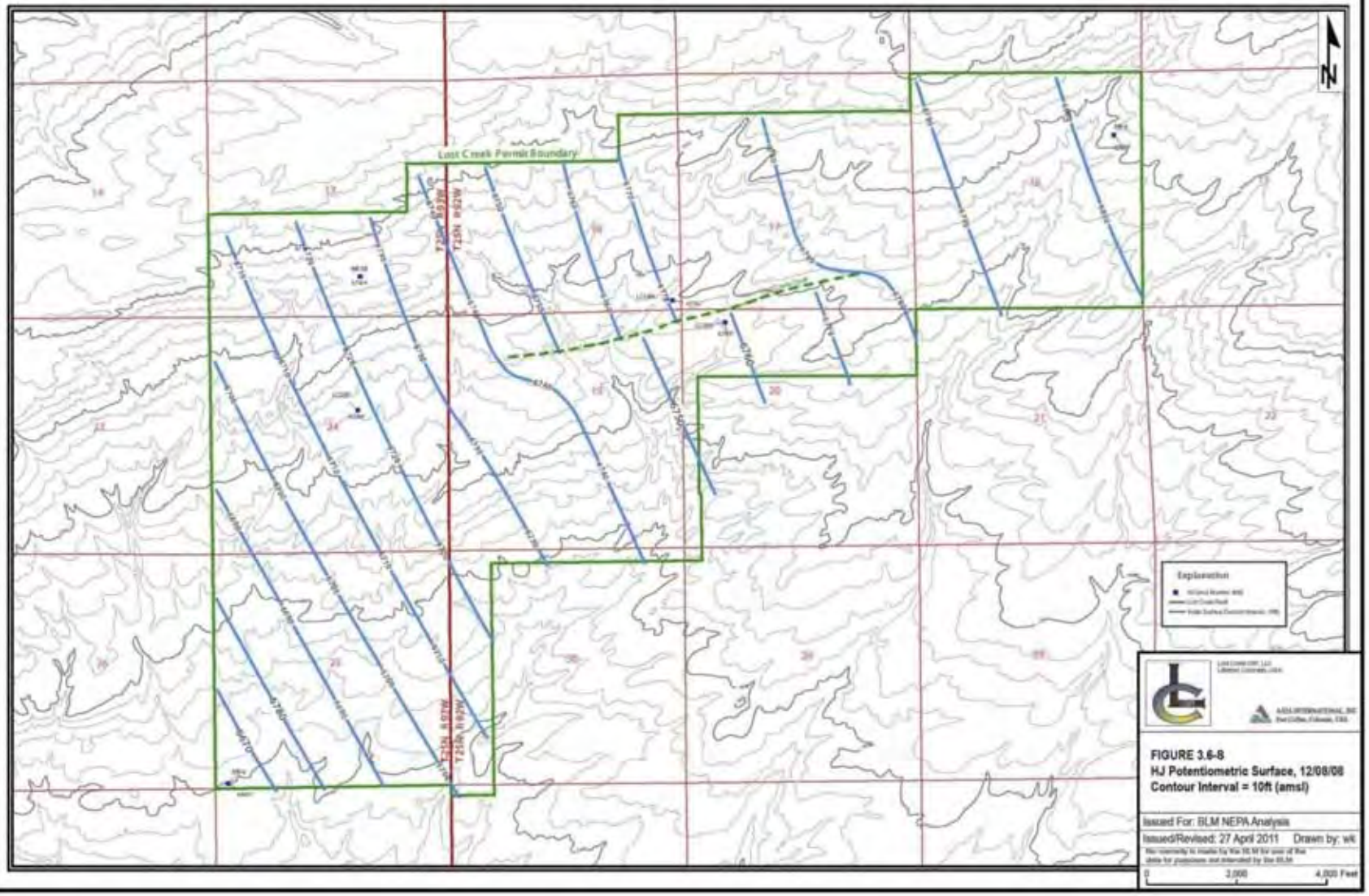
The No Name Shale at the base of the UKM Sand has not yet been fully characterized. The top of the unit is approximately 480 to 650 ft bgs. This unit is generally 10 to 30 feet thick (**Figure 3.3-3**).

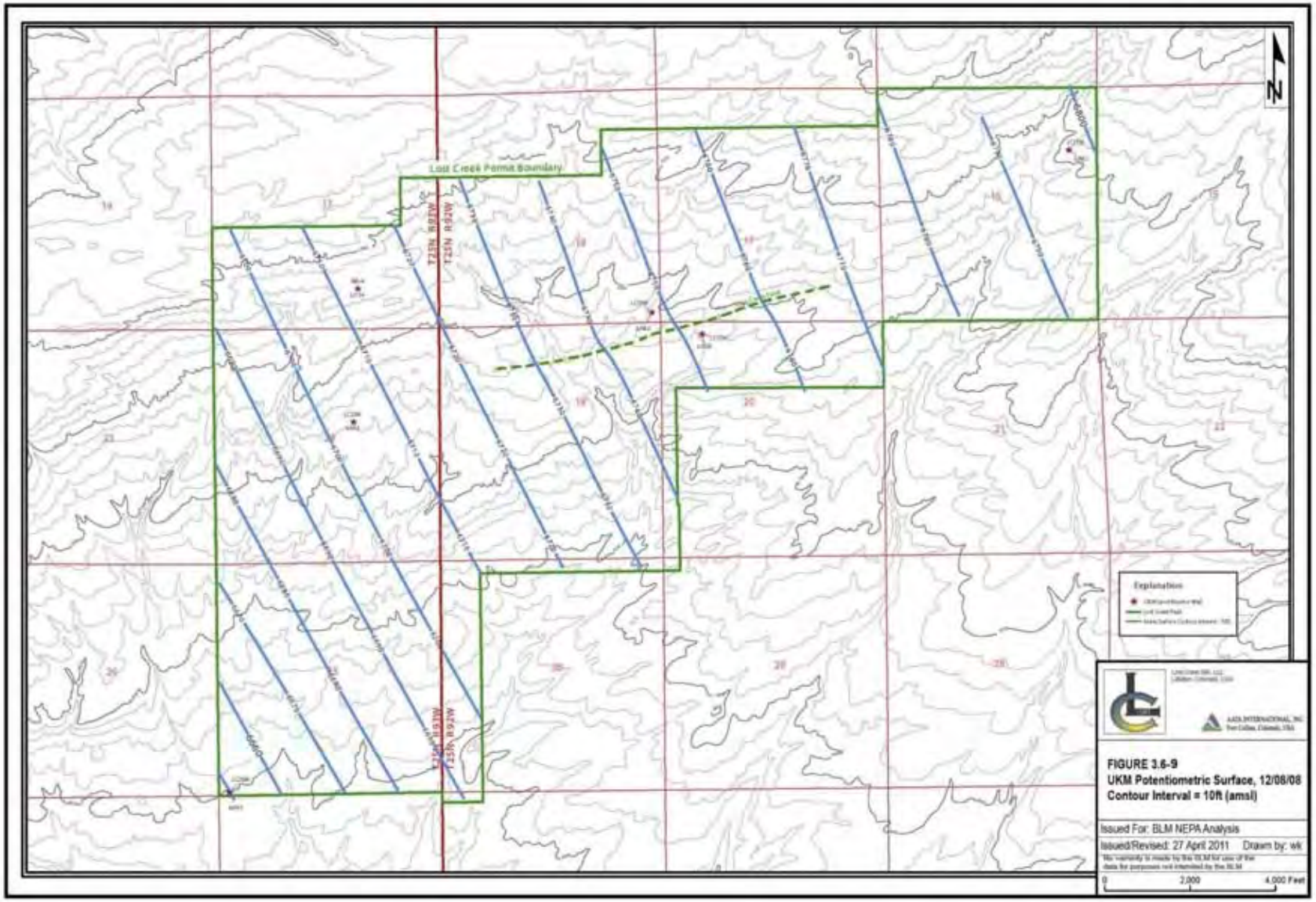
3.6.2.2 Potentiometric Surfaces

Potentiometric surfaces for the DE, LFG, HJ, and UKM Horizons in 2008 are illustrated as contour maps in **Figure 3.6-6** through **Figure 3.6-9**. Table D6-6 in Appendix D6 of the WDEQ-LQD Permit to Mine (LCI, 2011b) lists static water level data recorded in 1982, 2006, 2007, and 2008. Based on the potentiometric surface maps, groundwater flow is to the west-southwest within the Permit Area, generally consistent with the regional flow system.


Lost Creek Permit Boundary
Explanation
FIGURE 3.6-6
DE Potentiometric Surface, 12/08/08
Contour Interval = 10ft (amsl)
Issued For: BLM NEPA Analysis
Issued/Revised: 27 April 2011 Drawn by: wk
0 2,000 4,000 Feet


N
Lost Creek Permit Boundary
T23N R92W
T23N R91W
Explanation
FIGURE 3.6-7
LFG Potentiometric Surface, 12/08/08
Contour Interval = 10ft (amsl)
Issued For: BLM NEPA Analysis
Issued/Revised: 27 April 2011 Drawn by: wk
0
2,000
4,000 Feet


N
Lost Creek Permit Boundary
Explanation
FIGURE 3.6-8
HJ Potentiometric Surface, 12/08/08
Contour Interval = 10ft (amsl)
Issued For: BLM NEPA Analysis
Issued/Revised: 27 April 2011 Drawn by: wk
0
2,000
4,000 Feet


N
Lost Creek Permit Boundary
T25N R92W
T25N R93W
Explanation
FIGURE 3.6-9
UKM Potentiometric Surface, 12/08/08
Contour Interval = 10ft (amsl)
Issued For: BLM NEPA Analysis
Issued/Revised: 27 April 2011 Drawn by: wk
0
2,000
4,000 Feet

Based on the water level data collected for the HJ Horizon in the vicinity of the Fault, it is evident that the Fault provides a significant hydraulic barrier to groundwater flow. The potentiometric surface on the north side of the Fault is 5 to 15 feet higher than on the south side. The difference in hydraulic head across the Fault becomes less to the northeast. HJ Horizon water level data from 1982 and 2006 are shown on **Figure 3.6-10**. There are an insufficient number of data points to accurately represent the potentiometric surface for both those measurement periods. However, the data illustrate the difference in water levels within the HJ Horizon across the Fault.

The steep gradient observed in the potentiometric surface from the north to the south side of the Fault is most likely a manifestation of a lower permeability transition area associated with a fault smear zone and/or secondary faulting and fracturing near the Fault. This is consistent with regional groundwater flow impacted by lower permeability zones studied and modeled by Freeze (1969). Although limited groundwater leakage occurs across the Fault (as demonstrated during the long-term pump tests), the majority of groundwater flow on both sides of the Fault appears to be generally parallel to the Fault, to the west-southwest. Based on the potentiometric surface map, groundwater is inferred to flow to the west-southwest, generally consistent with the regional flow system.

The potentiometric surface for the overlying (LFG) aquifer indicates a similar groundwater flow direction as in the HJ aquifer, towards the west-southwest (**Figure 3.6-7**). The barrier effect of the Fault is also evident within this shallower hydrostratigraphic unit, with an observed difference of six to eight feet of hydraulic head across the Fault. Potentiometric surface data for the underlying (UKM) aquifer also indicate a generally west-southwest direction of groundwater flow (**Figure 3.6-9**). However, the impacts of the Fault are not as evident in this hydrostratigraphic unit, with little, if any, difference in hydraulic head across the Fault.

Hydraulic Gradients

The horizontal hydraulic gradients across the Permit Area were estimated from the December 2008 potentiometric surface maps and are summarized in **Table 3.6-3**. The gradients are similar in all the aquifers and range from about 0.003 to 0.007 ft/ft on both sides of the Fault.

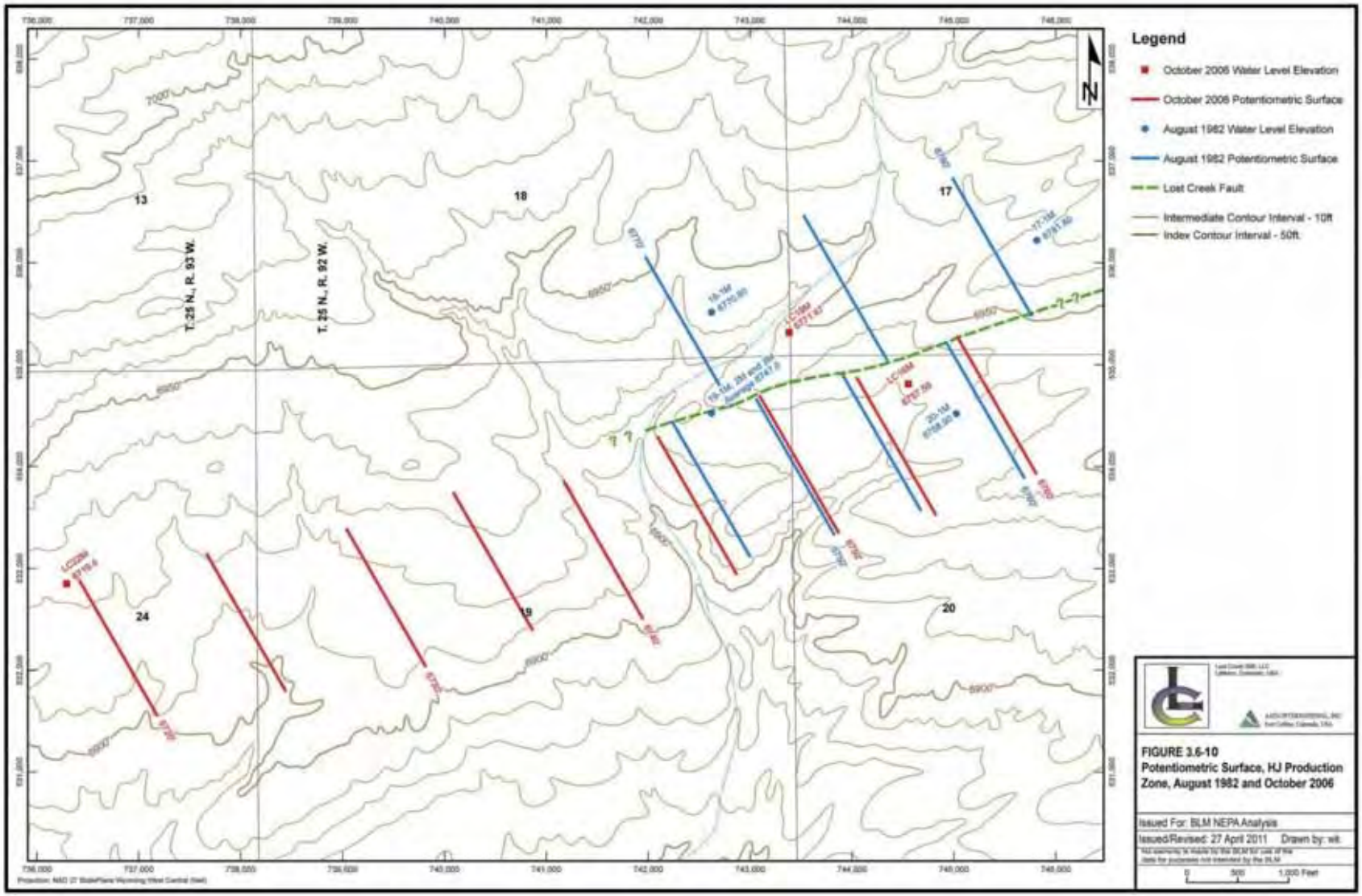

Legend
October 2006 Water Level Elevation
October 2006 Potentiometric Surface
August 1982 Water Level Elevation
August 1982 Potentiometric Surface
Lost Creek Fault
Intermediate Contour Interval - 10ft
Index Contour Interval - 50ft.
T. 25 N., R. 93 W.
T. 25 N., R. 92 W.
13
18
17
24
19
20
N
7000'
6950'
6900'
6850'
6800'
6750'
6700'
6650'
6600'
6550'
6500'
LC29M
6719.4
LC18M
6707.59
20-1M
6708.00
17-1M
6751.80
19-1M
6770.80
LC19M
6771.67
19-1M, 2M and 3M
Average 6747.3
Projection: NAD 27 State/Plane Wyoming West Central (feet)
FIGURE 3.6-10
Potentiometric Surface, HJ Production Zone, August 1982 and October 2006
Issued For: BLM NEPA Analysis
Issued/Revised: 27 April 2011 Drawn by: wlt
0 500 1,000 Feet

Table 3.6-3 Horizontal Hydraulic Gradients

	Distance (feet)	Head Upgradient	Head Downgradient	Head Difference (feet)	Hydraulic Gradient (foot/foot)
DE North Side of Fault	21000	6860	6710	150	0.0071
DE South Side of Fault	12500	6780	6690	90	0.0072
LFG North Side of Fault	21500	6820	6710	110	0.0051
LFG South Side of Fault	14000	6780	6680	100	0.0071
HJ North Side of Fault	20500	6800	6700	100	0.0049
HJ South Side of Fault	13500	6760	6680	80	0.0059
UKM North Side of Fault	20500	6790	6680	110	0.0054
UKM South Side of Fault	12700	6750	6670	80	0.0063

Vertical hydraulic gradients were determined in December 2008 by measuring water levels in closely grouped wells completed in different hydrostratigraphic units, and the results are summarized in **Table 3.6-4**. Vertical hydraulic gradients range from -0.04 to 0.37 ft/ft between the DE, LFG, HJ and UKM aquifers and consistently indicate decreasing hydraulic head with depth. The vertical gradients indicate the potential for groundwater flow is downward. A downward potential is indicative of an area of recharge, as opposed to an upward potential that is normally indicative of an area of groundwater discharge. A downward gradient is consistent with the structural and stratigraphic location of the Project with regard to Great Divide Basin.

3.6.2.3 Aquifer Testing

Aquifer properties for the Battle Spring aquifers within the Permit Area have been calculated from tests conducted for Conoco in the early 1980s and more extensive tests conducted for LCI in 2006, 2007, and 2008. The aquifer characteristics calculated from these tests are summarized in **Table 3.6-5**. The primary purpose of the tests conducted prior to 2008 was to determine aquifer characteristics, including transmissivity, storativity, hydraulic conductivity, and the potential for communication between aquifers. In addition to determining aquifer characteristics, the 2008 test collected information specific to operation of MU1, including: hydrologic communication between the HJ pumping well and the surrounding HJ monitor wells; the influence of the Fault within MU1, and the degree of hydrologic communication between the production zone and the overlying and underlying aquifers in MU1. Testing similar to that conducted in 2008 for MU1 would be conducted for each of the other mine units.

Table 3.6-4 Vertical Hydraulic Gradients (Page 1 of 4)

Well ID	Easting (feet)	Northing (feet)	Completion Zone	Measure Point Elevation (ft msl) [1]	Top Underreamed Interval (ft bgs) [2]	Bottom Underreamed Interval (ft bgs) [2]	Midpoint Underreamed Interval (ft bgs) [3]	Date of Measurement	Depth to Water (ft bgs)	Water Level Elevation (ft msl)	Vertical Hydraulic Gradient (foot/foot)
West Central Well Group (North side of Fault)											
MB-10	743347.83	535293	DE	6942.66	130	170	150	NM	NM	NM	- [4]
LC18M	743368	535316	LFG	6948.97	290	332	311	10/25/2006	167.32	6781.65	-
LC19M	743383	535317	HJ	6950.02	412	463	438	10/25/2006	179.05	6770.97	0.08
LC20M	743383	535331	UKM	6950.52	511	543	527	10/25/2006	202.84	6747.68	0.26
MB-10	743347.83	535293	DE	6942.66	130	170	150	NM	NM	NM	-
LC18M	743368	535316	LFG	6948.97	290	332	311	6/27/2007	168.04	6780.93	-
LC19M	743383	535317	HJ	6950.02	412	463	438	6/27/2007	180.08	6769.94	0.09
LC20M	743383	535331	UKM	6950.52	511	543	527	6/27/2007	202.36	6748.16	0.24
MB-10	743347.83	535293	DE	6942.66	130	170		NM	NM	NM	-
LC18M	743368	535316	LFG	6948.97	290	332	311	11/21/2007	168.11	6780.86	-
LC19M	743383	535317	HJ	6950.02	412	463	438	11/21/2007	181.41	6768.60	0.10
LC20M	743383	535331	UKM	6950.52	511	543	527	11/21/2007	204.2	6746.31	0.25
MB-10	743347.83	535293	DE	6942.66	130	170	150	12/8/2008	168.75	6,773.91	-
LC18M	743368	535316	LFG	6948.97	290	332	311	12/8/2008	168.15	6,780.82	-0.04
LC19M	743383	535317	HJ	6950.02	412	463	438	12/8/2008	179.85	6,770.17	0.08
LC20M	743383	535331	UKM	6950.52	511	543	527	12/8/2008	201.69	6,748.83	0.24

Table 3.6-4 Vertical Hydraulic Gradients (Page 2 of 4)

Well ID	Easting (feet)	Northing (feet)	Completion Zone	Measure Point Elevation (ft msl) [1]	Top Underreamed Interval (ft bgs) [2]	Bottom Underreamed Interval (ft bgs) [2]	Midpoint Underreamed Interval (ft bgs) [3]	Date of Measurement	Depth to Water (ft bgs)	Water Level Elevation (ft msl)	Vertical Hydraulic Gradient (foot/foot)
East Central Well Group (South of Fault)											
LC29M	744547	534837	DE	6937.55	140	164	152	10/25/2006	154.87	6,782.68	-
LCM15	744546	534823	LFG	6936.55	286	340	313	10/25/2006	160.34	6,776.21	0.04
LCM16	744562	534820	HJ	6936.15	410	467	438.5	10/25/2006	178.79	6,757.36	0.15
LCM17	744562	534840	UKM	6936.90	529	565	547	10/25/2006	185.34	6,751.56	0.05
LC29M	744547	534837	DE	6937.55	140	164	152	11/21/2007	155.14	6,782.41	-
LCM15	744546	534823	LFG	6936.55	286	340	313	11/21/2007	157.94	6,778.61	0.02
LCM16	744562	534820	HJ	6936.15	410	467	438.5	11/21/2007	178.78	6,757.37	0.17
LCM17	744562	534840	UKM	6936.90	529	565	547	11/21/2007	186.96	6,749.94	0.07
LC29M	744547	534837	DE	6937.55	140	164	152	12/8/2008	155.94	6,781.61	-
LCM15	744546	534823	LFG	6936.55	286	340	313	12/8/2008	158.06	6,778.49	0.02
LCM16	744562	534820	HJ	6936.15	410	467	438.5	12/8/2008	177.45	6,758.70	0.16
LCM17	744562	534840	UKM	6936.90	529	565	547	12/8/2008	185.03	6,751.87	0.06
West Well Group (South of Fault; Projected)											
LC30M	736276	532836	DE	6927.40	196	236	216	10/25/2006	199.02	6,728.38	-
LC21M	736277	532850	LFG	6927.13	375	398	387	10/25/2006	199.05	6,728.08	0.00
LC22M	736292	532850	HJ	6926.06	504	585	544.5	10/25/2006	206.66	6,719.40	0.06
LC23M	736292	532835	UKM	6926.80	595	630	612.5	10/25/2006	220.33	6,706.47	0.19
LC30M	736276	532836	DE	6927.40	196	236	216	12/8/2008	199.40	6,728.00	-
LC21M	736277	532850	LFG	6927.13	375	398	387	12/8/2008	198.78	6,728.35	0.00
LC22M	736292	532850	HJ	6926.06	504	585	544.5	12/8/2008	207.15	6,718.91	0.06
LC23M	736292	532835	UKM	6926.80	595	630	612.5	12/8/2008	221.00	6,705.80	0.19

Table 3.6-4 Vertical Hydraulic Gradients (Page 3 of 4)

Well ID	Easting (feet)	Northing (feet)	Completion Zone	Measure Point Elevation (ft msl) [1]	Top Underreamed Interval (ft bgs) [2]	Bottom Underreamed Interval (ft bgs) [2]	Midpoint Underreamed Interval (ft bgs) [3]	Date of Measurement	Depth to Water (ft bgs)	Water Level Elevation (ft msl)	Vertical Hydraulic Gradient (foot/foot)
Northwest Well Group (North of Fault)											
MB-1	736245.85	535848.56	DE	6985.90	240	280	260	12/8/2008	233.01	6,752.89	-
MB-2	736301.85	535855.26	LFG	6986.92	410	450	430	12/8/2008	241.92	6,745.00	0.05
MB-3	736348.85	535849.86	HJ	6987.38	540	580	560	12/8/2008	259.00	6,728.38	0.13
MB-4	736395.85	535867.36	UKM	6987.27	630	660	645	12/8/2008	273.90	6,713.37	0.18
Southwest Well Group (South of Fault)											
LC31M	733380	524434	DE	6806.05	150	190	170	12/8/2008	143.65	6,662.40	-
MB-5	733337.91	524460.9	LFG	6805.04	305	325	315	12/8/2008	142.85	6,662.19	0.00
MB6	733380.91	524464.1	HJ	6804.90	380	405	392.5	12/8/2008	141.22	6,663.68	-0.02
LC28M	733364	524437	UKM	6805.56	502	557	529.5	12/8/2008	155.04	6,650.52	0.10
East Well Group (North of Fault; Projected)											
MB-7	753265.78	538975.75	DE	6984.88	80	125	102.5	11/17/2008	123.33	6,861.55	-
MB-8	753316.78	538979.75	LFG	6985.50	240	270	255	12/8/2008	167.19	6,818.31	0.28
MB-9	753280.78	539026.25	HJ	6986.32	340	370	355	12/8/2008	182.38	6,803.94	0.14
LC27M	753260	539018	UKM	6987.38	433	456	444.5	12/8/2008	191.15	6,796.23	0.09
Conoco Northeast Wells											
M-25-92-17-1S	745785	536224	LFG	6966.20	* [5]	*	334	8/18/1982	*	6792.90	-
M-25-92-17-1M	745813	536223	HJ	6966.70	*	*	422	8/18/1982	*	6781.80	0.13
M-25-92-17-1D	745837	536222	UKM	6967.40	*	*	516	8/18/1982	*	6761.60	0.21

Table 3.6-4 Vertical Hydraulic Gradients (Page 4 of 4)

Well ID	Easting (feet)	Northing (feet)	Completion Zone	Measure Point Elevation (ft msl) [1]	Top Underreamed Interval (ft bgs) [2]	Bottom Underreamed Interval (ft bgs) [2]	Midpoint Underreamed Interval (ft bgs) [3]	Date of Measurement	Depth to Water (ft bgs)	Water Level Elevation (ft msl)	Vertical Hydraulic Gradient (foot/foot)
Conoco Central Wells											
M-25-92-18-1S	742648	535513	LFG	6939.30	*	*	340	8/18/1982	*	6778.00	-
M-25-92-18-1M	742623	535515	HJ	6940.00	*	*	413	8/18/1982	*	6770.80	0.10
M-25-92-18-1D	742596	535517	UKM	6938.70	*	*	608	8/18/1982	*	6740.60	0.15
Conoco Southeast Wells											
M-25-92-20-1S	744998	534521	LFG	6934.50	*	*	341	8/18/1982	*	6776.40	-
M-25-92-20-1M	745023	534520	HJ	6934.90	*	*	388	8/18/1982	*	6758.90	0.37
M-25-92-20-1D	745048	534519	UKM	6935.00	*	*	522	8/18/1982	*	6751.80	0.05

[1] ft amsl - feet above mean sea level

[2] ft bgs - feet below ground surface

[3] Vertical hydraulic gradient is calculated from middle of underreamed interval in overlying aquifer to middle of underreamed interval in underlying aquifer. A positive number indicates a downward potential.

[4] Dash (-) indicates no overlying aquifer.

[5] Asterisk (*) indicates values were not reported by HydroSearch, Inc (1982)

Table 3.6-5 Summary of Aquifer Characteristics

Hydrostratigraphic Unit	Thickness (feet) [typical]	Porosity [1]	Transmissivity [2] (gpd/ft)		Transmissivity [2] (ft^2/d)		Storativity		Horizontal Hydraulic Conductivity [3] (feet/day)		Vertical Hydraulic Conductivity [4]	
			N of Fault [5]	S of Fault [5]	N of Fault	S of Fault	N of Fault	S of Fault	N of Fault	S of Fault	cm/sec	ft/day
DE	0 to 120 [40]	0.28	NM [6]	10 to 1100	NM [6]	1.3 to 147	NM	ND [7]	NM	0.03 to 3.7	- [8]	- [8]
Upper No Name Shale	0 to 50 [5 to 15]	NA [9]	NA	NA	NA	NA	NA	NA	NA	NA	-	-
FG Horizon (includes LFG, MFG and UFG)	30 to 150 [50]	0.28	30 to 90	120 to 300	4 to 12	16 to 40	ND	ND	0.08 to 0.24	0.3 to 0.8	-	-
Lost Creek Shale	5 to 45 [10 to 25]	NA	NA	NA	NA	NA	NA	NA	NA	NA	5.6E-06 to 5.4E-05	0.016 to 0.15
HJ Horizon (includes LHJ, MHJ and UHJ)	100 to 160 [120]	0.28	220 to 2700	365 to 1820	29 to 361	49 to 243	6.6E-05 to 1.5E-04	3.5E-05 to 9.1E-04	0.2 to 3.0	0.4 to 2.0	-	-
Sage Brush Shale	5 to 75 [20 to 30]	NA	NA	NA	NA	NA	NA	NA	NA	NA	3.1E-07 to 1.4E-06	0.0009 to 0.004
UKM	20 to 75 [50]	0.28	520 to 860	195 to 700	70 to 115	26 to 94	ND	ND	1.4 to 2.3	0.5 to 1.9	-	-

1982 Testing

In 1982, Hydro-Search, Inc. conducted two 25-hour tests within the HJ Horizon. Both pump tests were conducted at a rate of 30 gpm and on the south side of the Fault. There was no reported response in the HJ aquifer north of the Fault. Monitor wells in the overlying (LFG) and underlying (UKM) aquifers did not show any effects from the pump test. The monitor well locations are shown on **Figure 3.6-4**.

2006 Testing

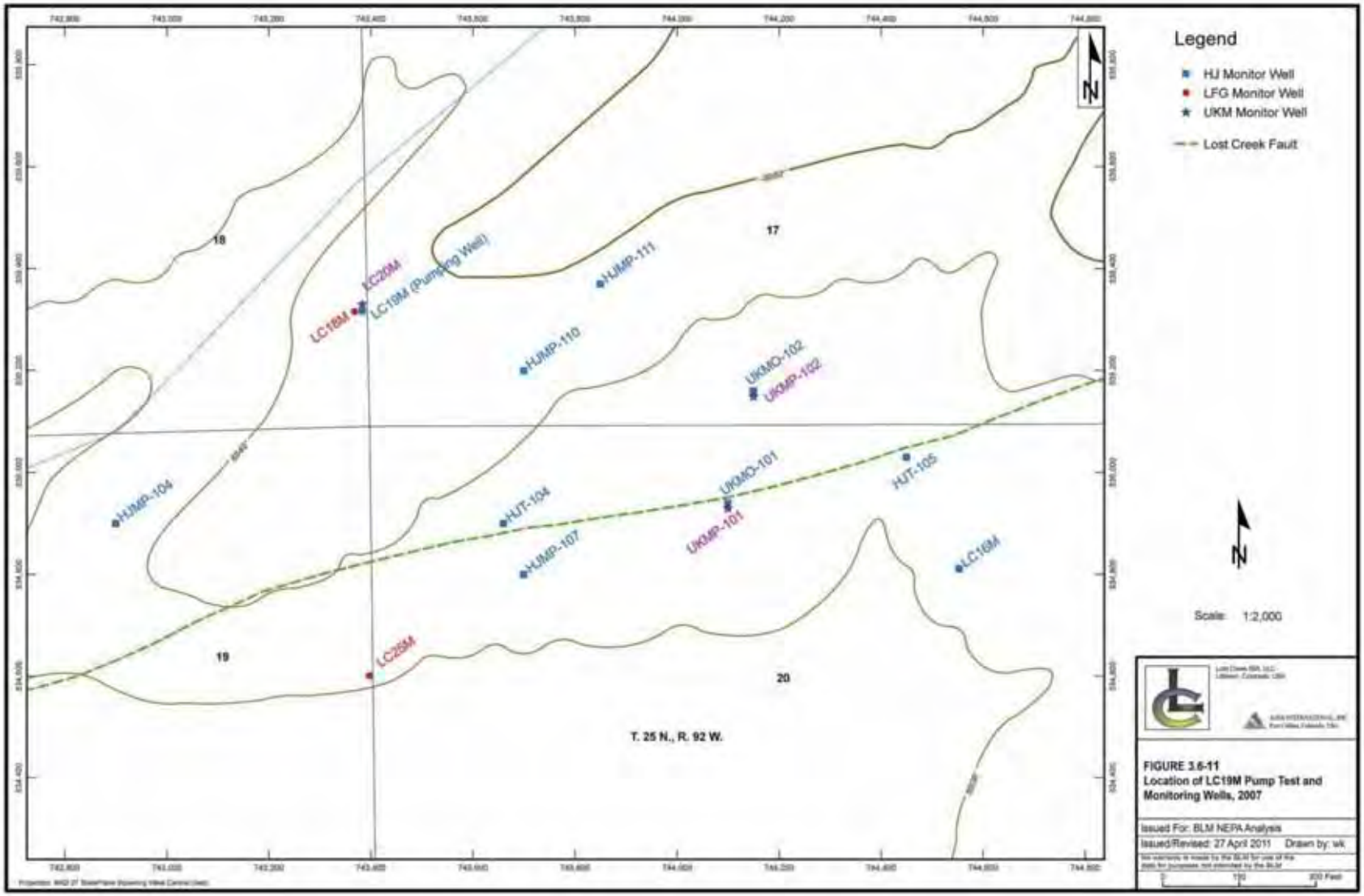
Hydro-Engineering (2007) conducted several short-term single-well pump tests and three longer multi-well pump tests in October 2006. The single-well tests ranged from 30 minutes to five hours in duration at rates from 0.67 to 14 gpm. The long-term tests were from 20 to 45 hours long at rates of 15 to 19 gpm. Each of the long-term tests was conducted in HJ well completions. The monitor well locations are shown on **Figure 3.6-4**. None of the HJ tests indicated significant communication (less than 0.2 feet draw down) with the overlying or underlying aquifers. The slope inflection point at approximately 150 minutes after the pump start indicated that a boundary (the Fault) was encountered and that the Fault is generally acting as a barrier to flow. There was also no indication of hydraulic communication across the Fault in any of the pump tests. Hydro-Engineering concluded that the Fault acts as a hydraulic barrier.

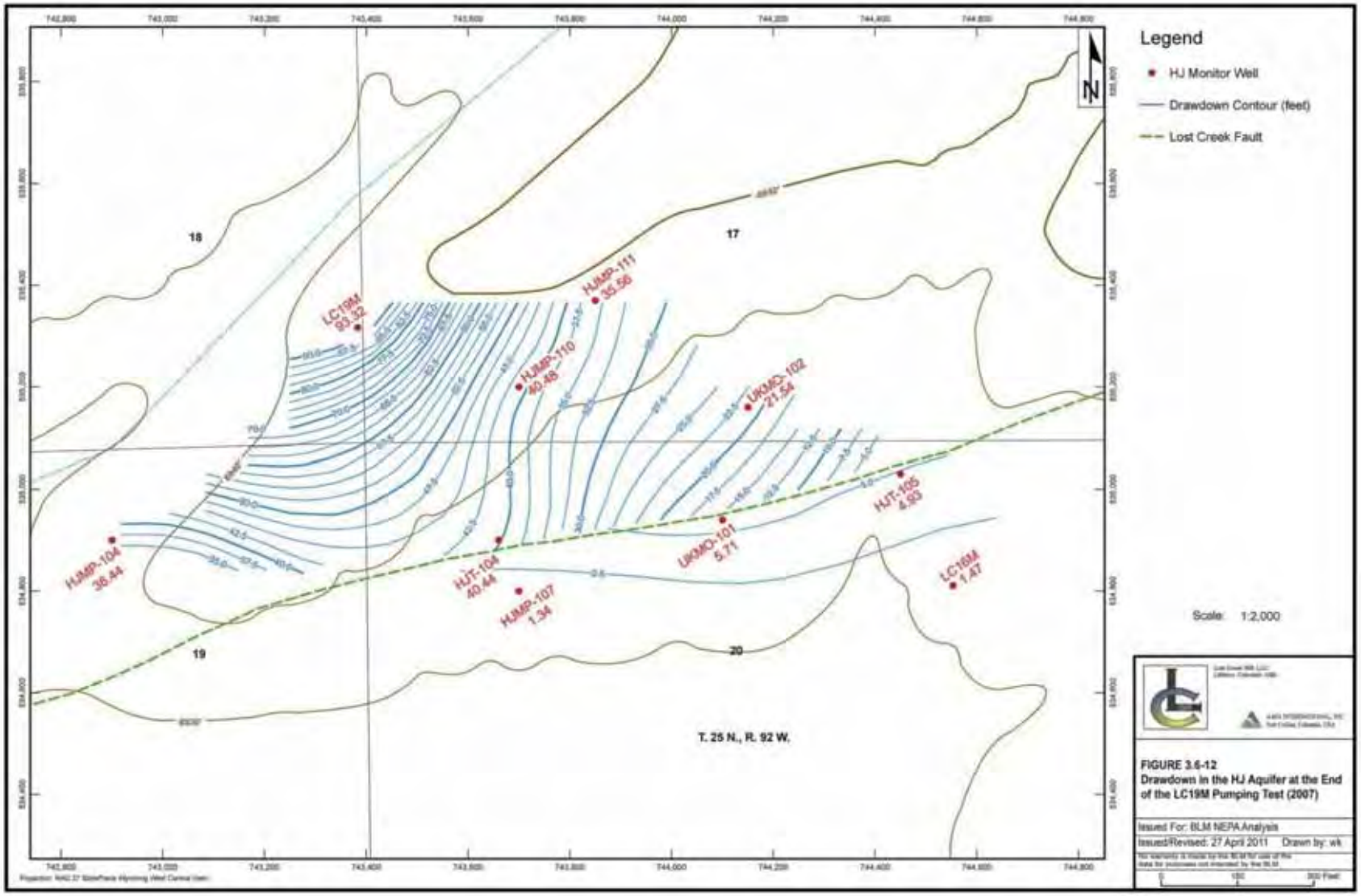
2007 Testing

In 2007, Petrotek Engineering Corporation conducted two long-term pump tests in the HJ aquifer at Wells LC19M and LC16M, one located on each side of the Fault. Pre-pumping monitoring was performed several days in advance of the tests to establish baseline conditions and to evaluate barometric effects. HJ monitor wells on both sides of the Fault and within distances likely to be impacted by the pump tests were included as observation wells. Observation wells in the overlying (LFG) and underlying (UKM) aquifers near the pumping wells and across the Fault were also monitored during the tests.

LC19M Test

The first pump test, with LC19M as the pumping well, was conducted to evaluate aquifer properties on the north side of the Fault. The locations of the wells monitored during the test are shown on **Figure 3.6-11**. The average pumping rate during the test was 42.9 gpm. Maximum drawdown in the pumping well was 93.3 feet. Monitoring was continued after pump shut-in to record recovery from the LC19M test. Drawdown at the end of the test in the HJ aquifer is shown on **Figure 3.6-12**. A detailed discussion of the LC19M test is included in Attachment D6-2a of Appendix D6 of the WDEQ-LQD Permit to Mine (LCI, 2011b).


Legend
HJ Monitor Well
LFG Monitor Well
UKM Monitor Well
Lost Creek Fault
Scale: 1:2,000
FIGURE 3.6-11
Location of LC19M Pump Test and Monitoring Wells, 2007
Issued For: BLM NEPA Analysis
Issued/Revised: 27 April 2011 Drawn by: wk
T. 25 N., R. 92 W.
18
17
19
20
LC20M
LC19M (Pumping Well)
LC18M
LC25M
HJMP-111
HJMP-110
HJMP-104
HJT-104
HJMP-107
UKMO-102
UKMP-102
UKMO-101
UKMP-101
HJT-105
LC19M


Legend
HJ Monitor Well
Drawdown Contour (feet)
Lost Creek Fault
Scale: 1:2,000
N
18
17
19
20
T. 25 N., R. 92 W.
LC19M 93.92
HJMP-111 35.56
HJMP-110 40.48
UKMD-102 21.54
HJT-105 4.93
HJMP-104 36.44
HJT-104 40.44
HJMP-107 1.34
UKMD-101 5.71
LC16M 1.47
FIGURE 3.6-12
Drawdown in the HJ Aquifer at the End of the LC19M Pumping Test (2007)
Issued For: BLM NEPA Analysis
Issued/Revised: 27 April 2011 Drawn by: wk

The response of the overlying and underlying aquifers during the pump test was small (e.g., on the order of 0.2 to 0.5 feet); but the water level responses did correspond to the start and stop of pumping from LC19M in the HJ Horizon. The underlying/overlying responses appear to be relatively consistent, regardless of distance from the pumping well, the hydrostratigraphic interval monitored, or the location relative to the Fault. These water level changes suggest potential impacts from off-site pumping or background trends that, because of distance from the monitor wells, are manifested at multiple locations at the same or similar times. As previously stated, a declining trend in water level elevations was observed prior to the start of the test. Most of the wells showed an initial inverted response (increase in water level) at the start of the test and then resumed a gradual downward trend during the test. This phenomenon was also observed and noted by Hydro-Engineering during the 2006 pump tests. It is possible that some of the drawdown response could be caused by: 1) pumping in the drilling water well (LC1) that is completed in both the DE and FG Horizons; 2) communication across multiple sands due to the nature of the Fault distance from the pumping well location; 3) communication due to juxtapositioning of hydrostratigraphic units across the Fault; or 4) leakage through the confining shale, or any combination of these. While LCI has aggressively pursued re-plugging of historic wells and continues to do so, it is also possible that some of the communication could be related to abandoned wells.

Responses in observation wells across the Fault were negligible relative to the magnitude of drawdown observed in monitor wells located on the same side of the Fault as the pumping well. The impact of the Fault on groundwater flow can be clearly seen from the responses recorded in a pair of observation wells that were placed on either side of the Fault, within 100 feet of each other. Well HJT104, located on the north side of the Fault and completed in the HJ Horizon, had a maximum drawdown of 40.5 feet at the end of the LC19M test. Well HJMP107 (south of the Fault) in the HJ Horizon had a net decrease of 1.4 feet from the beginning of the test to the end of pumping at LC19M. At least a portion of that change is attributable to a declining trend in water levels that was observed in all monitor wells prior to the start of the test. The reason for the background trend observed has not been identified; however, it might be a result of offset pumping (e.g., LCI's first two water supply wells that are screened over multiple sands).

LC16M Test

A second long-term pump test was conducted to evaluate aquifer properties on the south side of the Fault. The locations of the wells monitored during the test are shown on **Figure 3.6-13**. The average pumping rate during the test was 37.4 gpm. Maximum drawdown in the pumping well was 69.3 feet. Monitoring was continued after pump shut-in to record recovery from the test. Drawdown near the end of the test in the HJ aquifer is shown on **Figure 3.6-14**. A detailed

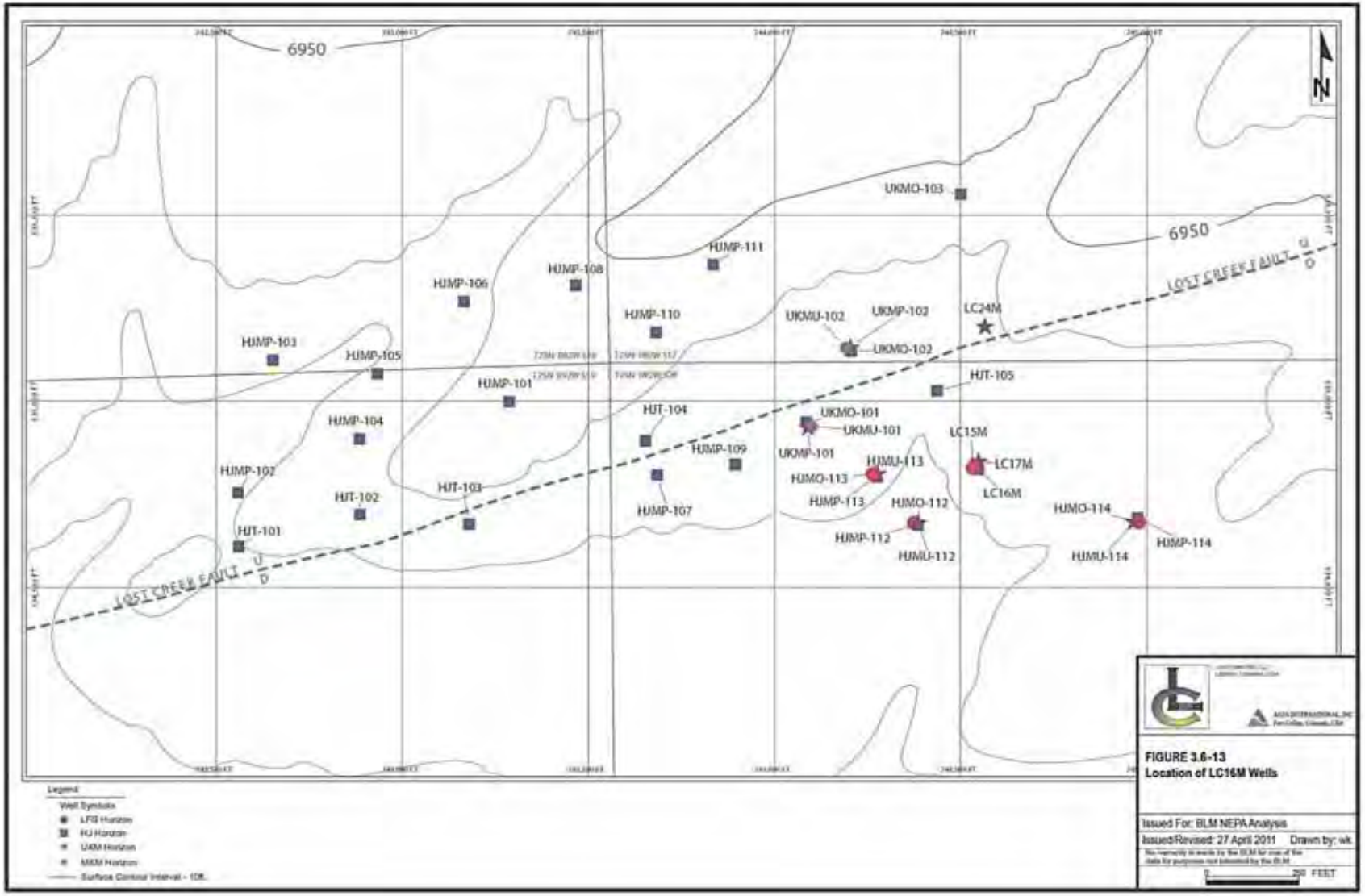
discussion of the LC16M test is included in Attachment D6-2b of Appendix D6 of the WDEQ-LQD Permit to Mine (LCI, 2011b).

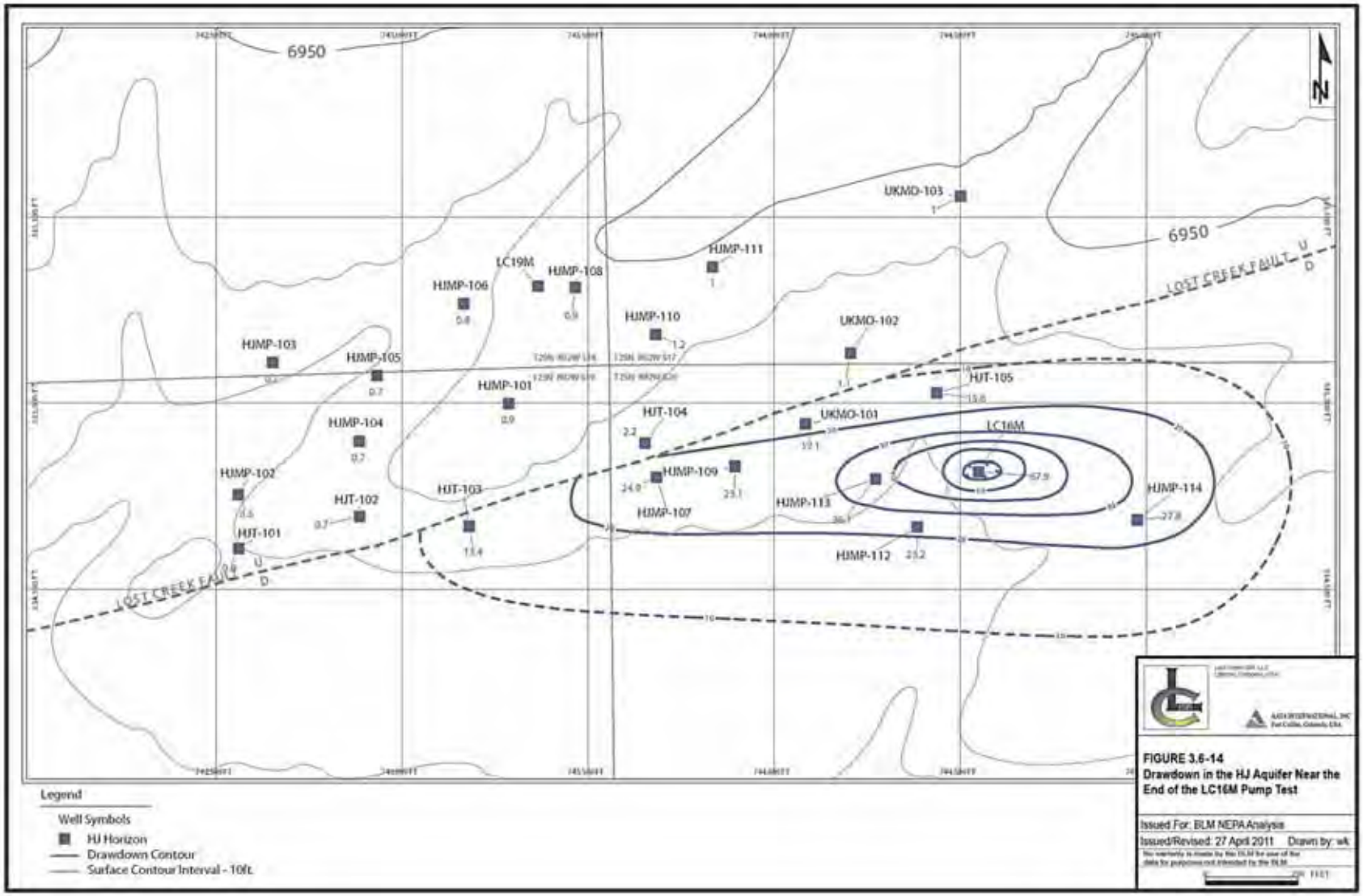
As in the LC19M pump test, the response of the overlying and underlying aquifers during the LC16M pump test was small (e.g., less than one foot in the LFG and less than two feet in the UKM); but the water level responses were coincident with the start and stop of pumping from LC16M. The response was slightly more pronounced in the UKM and occurred on both sides of the Fault.

The data from this test appear consistent with the first pump test, showing that the Fault, while not impermeable, is a significant barrier to groundwater flow. The same wells, located about 100 feet apart and across the Fault from one another (HJMP107 and HJT104), that were evaluated during the LC19M test were evaluated during the LC16M test. Well HJMP107, located on the same side of the Fault as the pumping well, had nearly 25 feet of drawdown near the end of the test. Well HJT104, located approximately 100 feet north of Well HJMP107 and north of the Fault, had approximately 2.2 feet of drawdown at the end of pumping.

2008 Testing

Two pump tests were conducted within MU1 due to the faulting that bisects the mine unit from west-southwest to east-northeast. The north pump test was conducted on the north side of the Fault (and associated splinter fault) in November 2008, and the south pump test was conducted on the south side of the Fault (and associated splinter fault) in December 2008. Both pump tests were conducted in the HJ Horizon, with monitoring of the overlying and underlying aquifers as well. The locations of the wells monitored during the 2008 testing are shown on **Figure 3.6-5**. The additional information collected from the two pump tests did not significantly alter the information on the aquifer characteristics attained from previous pump tests. This information is discussed in detail in Attachment MU1 2-1 of the WDEQ-LQD MU1 documents (LCI, 2011b).


6950
6950
N
UKMO-103
HJMP-111
HJMP-108
HJMP-106
HJMP-110
UKMU-102
UKMP-102
LC24M
UKMO-102
HJMP-103
HJMP-105
HJMP-101
HJT-105
HJT-104
UKMO-101
UKMU-101
LC15M
HJMP-104
HJMP-109
UKMP-101
HJMU-113
LC17M
HJMO-113
LC16M
HJMP-102
HJT-103
HJT-102
HJMP-113
HJMO-112
HJMO-114
HJMP-107
HJT-101
HJMP-112
HJMP-114
HJMU-112
HJMU-114
LOST CREEK FAULT
U
D
Legend
Well Symbols
LFG Horizon
HJ Horizon
UKM Horizon
MKM Horizon
Surface Contour Interval - 10ft.
FIGURE 3.6-13
Location of LC16M Wells
Issued For: BLM NEPA Analysis
Issued/Revised: 27 April 2011 Drawn by: wk
FEET


6950
6950
UKMO-103
HJMP-111
LC19M
HJMP-108
HJMP-106
HJMP-110
UKMO-102
HJMP-103
HJMP-105
HJMP-101
HJT-105
HJT-104
UKMO-101
LC16M
HJMP-104
HJMP-109
HJMP-107
HJMP-113
HJMP-114
HJMP-102
HJT-103
HJT-102
HJT-101
HJMP-112
LOST CREEK FAULT
U
D
Legend
Well Symbols
HJ Horizon
Drawdown Contour
Surface Contour Interval - 10ft.
FIGURE 3.6-14
Drawdown in the HJ Aquifer Near the End of the LC16M Pump Test
Issued For: BLM NEPA Analysis
Issued/Revised: 27 April 2011 Drawn by: wk

3.6.3 Groundwater Use

The majority of the groundwater-use permits filed in the vicinity of the Permit Area is for monitoring or miscellaneous mining-related purposes. Many of those permits are associated with the Kennecott Sweetwater Mine (formerly owned by Minerals Exploration Co.), which has been reclaimed (**Section 3.1.2.4**).

Groundwater permits with legal descriptions inside and within three miles of the Permit Area were queried using the WSEO Water Rights Database (WSEO, 2010). **Table 3.6-6** list permits within one-half mile and three miles of the Permit Area, respectively, and the locations are shown on **Figure 3.6-15**. The lists include potentially active permits as well as abandoned and cancelled permits, which were issued by WSEO to parties other than LCI or its affiliates. The permit information includes, but is not limited to, location, uses, priority dates, status, yield, total depth, and static water depth.

3.6.3.1 BLM Wells

The groundwater permits within one mile unrelated to mining are those of the BLM. In 1968 and 1980, the BLM Rawlins District was granted three permits by the WSEO. Each of these permits is associated with a well that supplies a stock pond or tank (**Figure 3.6-15**). These wells and associated stock ponds are located outside of the Permit Area. The permit numbers and names of these BLM wells are:

- WSEO Permit 13834, Battle Spring Draw Well No. 4451;
- WSEO Permit 55112, Boundary Well No. 4775; and
- WSEO Permit 55113, Battle Spring Well No. 4777.

In addition, there is a fourth BLM well (East Eagle Nest Draw Well), also supplying a stock pond, for which no water-use permit was found.

Battle Spring Draw Well No. 4451 pumps water into a stock tank east of the Permit Area. The well depth is 900 feet deep, with a static water level of 104 feet. A yield of 19 gpm is permitted. The screened interval is unknown, but given the well depth, it may be significantly deeper than the sands targeted by LCI. **Figure 3.6-10** shows photographs of this well and associated stock tank. Although Well No. 4451 is outside of the Permit Area, two groundwater samples, one pond water sample, one algae sample, and one soil sample were collected and analyzed (**Table 3.6-7**). The results indicate that the water, algae, and soil all have high levels of radionuclides. In addition, the algae sample had a high selenium concentration.

Table 3.6-6 Groundwater-Use Permits within a 3-Mile Radius, WSEO Records, December 2008 (Page 1 of 6)

ID [1]	Well or Use Point	Permit Number	Applicant [2]	Township	Range	Section	¼ of the ¼ [3]	Uses	Priority	Status	Permit Facility Name	Yield [4] (gpm)	Well Depth (ft)	Static Well Depth (ft)
1	Well	P9742W	Kennecott Uranium Company	24 N	94 W	34	NENE	Stock, Industrial	7/15/1971	Adjudicated	J E S No. 1	25	170	104
2	Well	P13834P	USDI BLM, Rawlins District	25 N	92 W	21	NENW	Stock	9/21/1968	Good Standing	Battle Spring Draw Well No. 4451	19	900	104
3	Well	P34708W	USDI, BLM -- Minerals Exploration Co.	24 N	93 W	10	SESW	Monitoring	8/16/1976	Cancelled	RDW-5	INP	INP	INP
4	Well	P35721W	USDI, BLM -- Texasgulf Inc.	25 N	93 W	14	SWSE	Stock, Miscellaneous	12/8/1976	Abandoned	TE 24	INP	INP	INP
5	Well	P35772W	USDI BLM, Rawlins District -- Minerals Exploration Co.	24 N	93 W	9	NESE	Miscellaneous	11/24/1976	Cancelled	RDW - 8	INP	INP	INP
6	Well	P35773W	USDI BLM, Rawlins District -- Minerals Exploration Co.	24 N	93 W	9	NESE	Monitoring	11/24/1976	Abandoned	RDW - 6	0	452	60
7	Well	P35774W	USDI BLM, Rawlins District -- Minerals Exploration Co.	24 N	93 W	10	SWSW	Industrial	11/24/1976	Abandoned	RDW - 7	Unknown	450	60
8	Well	P37637W	USDI, BLM -- Texasgulf Inc.	25 N	93 W	24	NENW	Miscellaneous	5/5/1977	Cancelled	TE 38	25	380	220
9	Well	P39744W	USDI, BLM -- Apexco Inc.	25 N	93 W	22	SWNE	Miscellaneous	8/26/1977	Cancelled	Battle Springs No. 1	25	640	60
10	Well	P41699W	Kennecott Uranium Company	24 N	93 W	10	NESW	Reservoir Supply, Industrial, Miscellaneous	7/28/1977	Unadjudicated	24-93W10CA-DW1	400	600	106.83
11	Well	P41700W	Kennecott Uranium Company	24 N	93 W	10	NESW	Reservoir Supply, Industrial, Miscellaneous	7/28/1977	Unadjudicated	24-93W10CA-DW2	400	600	118.4
12	Well	P41701W	Kennecott Uranium Company	24 N	93 W	10	NESW	Reservoir Supply, Industrial, Miscellaneous	7/28/1977	Unadjudicated	24-93W10CA-DW3	400	620	111.7
13	Well	P41702W	Kennecott Uranium Company	24 N	93 W	10	NESW	Reservoir Supply, Industrial, Miscellaneous	7/28/1977	Unadjudicated	24-93W10CA-DW4	400	620	113.8
14	Well	P41703W	Kennecott Uranium Company	24 N	93 W	10	NWSW	Reservoir Supply, Industrial, Miscellaneous	7/28/1977	Unadjudicated	24-93W10CB-DW5	400	600	119

Table 3.6-6 Groundwater-Use Permits within a 3-Mile Radius, WSEO Records, December 2008 (Page 2 of 6)

ID [1]	Well or Use Point	Permit Number	Applicant [2]	Township	Range	Section	¼ of the ¼ [3]	Uses	Priority	Status	Permit Facility Name	Yield [4] (gpm)	Well Depth (ft)	Static Well Depth (ft)
15	Well	P41704W	Kennecott Uranium Company	24 N	93 W	10	NWSW	Reservoir Supply, Industrial, Miscellaneous	7/28/1977	Unadjudicated	24-93W10CB-DW6	400	600	117.5
16	Well	P41705W	Kennecott Uranium Company	24 N	93 W	10	NWSW	Reservoir Supply, Industrial, Miscellaneous	7/28/1977	Unadjudicated	24-93W10CB-DW7	400	600	116.8
17	Well	P41706W	Kennecott Uranium Company	24 N	93 W	10	SWSW	Reservoir Supply, Industrial, Miscellaneous	7/28/1977	Unadjudicated	24-93W10CC-DW18	100	201	100
18	Well	P41707W	Kennecott Uranium Company	24 N	93 W	9	SESE	Reservoir Supply, Industrial, Miscellaneous	7/28/1977	Unadjudicated	24-93W9DD-DW9	400	600	113.1
19	Well	P41708W	Kennecott Uranium Company	24 N	93 W	10	SWSW	Reservoir Supply, Industrial, Miscellaneous	7/28/1977	Unadjudicated	24-9310CC-DW19	100	250	100
20	Well	P41709W	Kennecott Uranium Company	24 N	93 W	9	SESE	Reservoir Supply, Industrial, Miscellaneous	7/28/1977	Unadjudicated	24-939DD-DW28	300	600	152
21	Well	P41710W	Kennecott Uranium Company	24 N	93 W	9	SESE	Reservoir Supply, Industrial, Miscellaneous	7/28/1977	Unadjudicated	24-93DD-DW29	179	465	179
22	Well	P41711W	Kennecott Uranium Company	24 N	93 W	10	SWSW	Reservoir Supply, Industrial, Miscellaneous	7/28/1977	Unadjudicated	24-93W15BB-DW13	400	600	103.5
23	Well	P41712W	Kennecott Uranium Company	24 N	93 W	10	SWSW	Reservoir Supply, Industrial, Miscellaneous	7/28/1977	Unadjudicated	24-93W15BB-DW14	400	600	105.8
24	Well	P41713W	Kennecott Uranium Company	24 N	93 W	10	SESW	Reservoir Supply, Industrial, Miscellaneous	7/28/1977	Unadjudicated	24-93W10CD-DW15	400	600	101.1
25	Well	P41714W	Kennecott Uranium Company	24 N	93 W	10	SESW	Reservoir Supply, Industrial, Miscellaneous	7/28/1977	Unadjudicated	24-93W10CD-DW16	400	600	101
26	Well	P41715W	Kennecott Uranium Company	24 N	93 W	10	SESW	Reservoir Supply, Industrial, Miscellaneous	7/28/1977	Unadjudicated	24-93W10CD-DW17	400	600	103.3

Table 3.6-6 Groundwater-Use Permits within a 3-Mile Radius, WSEO Records, December 2008 (Page 3 of 6)

ID [1]	Well or Use Point	Permit Number	Applicant [2]	Township	Range	Section	¼ of the ¼ [3]	Uses	Priority	Status	Permit Facility Name	Yield [4] (gpm)	Well Depth (ft)	Static Well Depth (ft)
27	Well	P41716W	Kennecott Uranium Company	24 N	93 W	10	SWSW	Dewatering, Reservoir Supply, Miscellaneous	7/28/1977	Unadjudicated	24-93W10CC-S1	300	16	2
28	Well	P47137W	Kennecott Uranium Company	24 N	93 W	10	NWNW	Reservoir Supply, Stock, Miscellaneous	12/7/1977	Unadjudicated	Blue No. 5	INP	INP	INP
29	Well	P48386W	Kennecott Uranium Company	24 N	93 W	3	SWNE	Monitoring, Dewatering, Miscellaneous	5/31/1979	Unadjudicated	24-93W-3AC-M-1	0	450	135.8
30	Well	P53849W	USDI, BLM -- Kennecott Uranium Company	24 N	93 W	9	SESE	Dewatering, Industrial, Miscellaneous	9/4/1980	Unadjudicated	24 93 9DD - DW 30	250	460	170
31	Well	P54883W	Kennecott Uranium Company -- WSBLC	24 N	93 W	16	NWNE	Dewatering, Industrial, Miscellaneous	11/24/1980	Good Standing	DW31	190	600	152
32	Well	P54884W	Kennecott Uranium Company -- WSBLC	24 N	93 W	16	NENE	Dewatering, Industrial, Miscellaneous	11/24/1980	Unadjudicated	DW 32	200	600	147
33	Well	P54885W	Kennecott Uranium Company -- WSBLC	24 N	93 W	16	NENE	Dewatering, Industrial, Miscellaneous	11/24/1980	Unadjudicated	DW 33	190	560	141
34	Well	P54886W	Kennecott Uranium Company -- WSBLC	24 N	93 W	16	NENE	Dewatering, Industrial, Miscellaneous	11/24/1980	Good Standing	DW 34	200	450	140
35	Well	P54887W	Minerals Exploration Company -- WSBLC	24 N	93 W	15	SWNW	Dewatering, Industrial, Miscellaneous	11/24/1980	Cancelled	DW 35	INP	INP	INP
36	Well	P54888W	Minerals Exploration Company -- WSBLC	24 N	93 W	15	SWNW	Dewatering, Industrial, Miscellaneous	11/24/1980	Cancelled	DW 36	INP	INP	INP
37	Well	P54889W	Minerals Exploration Company -- WSBLC	24 N	93 W	15	NWNW	Dewatering, Industrial, Miscellaneous	11/24/1980	Cancelled	DW 37	INP	INP	INP
38	Well	P54890W	Minerals Exploration Company -- WSBLC	24 N	93 W	15	NWNW	Dewatering, Industrial, Miscellaneous	11/24/1980	Cancelled	DW 38	INP	INP	INP

Table 3.6-6 Groundwater-Use Permits within a 3-Mile Radius, WSEO Records, December 2008 (Page 4 of 6)

ID [1]	Well or Use Point	Permit Number	Applicant [2]	Township	Range	Section	¼ of the ¼ [3]	Uses	Priority	Status	Permit Facility Name	Yield [4] (gpm)	Well Depth (ft)	Static Well Depth (ft)
39	Well	P54891W	USDI BLM -- Kennecott Uranium Company	24 N	93 W	15	NWNW	Dewatering, Industrial, Miscellaneous	11/24/1980	Good Standing	DW 39	200	600	169
40	Well	P54892W	USDI BLM -- Kennecott Uranium Company	24 N	93 W	15	NWNW	Dewatering, Industrial, Miscellaneous	11/24/1980	Good Standing	DW 40	200	600	155
41	Well	P54893W	Kennecott Uranium Company -- WSBLC	24 N	93 W	16	NENE	Dewatering, Industrial, Miscellaneous	11/24/1980	Good Standing	DW 41	190	600	157
42	Well	P54894W	Kennecott Uranium Company -- WSBLC	24 N	93 W	16	NENE	Dewatering, Industrial, Miscellaneous	11/24/1980	Good Standing	DW 42	200	600	166
43	Well	P54896W	USDI, BLM -- Kennecott Uranium Company	24 N	93 W	9	NESE	Dewatering, Industrial, Miscellaneous	6/11/1980	Unadjudicated	24 93 9 DA-DW20	200	575	178
44	Well	P54897W	USDI, BLM -- Kennecott Uranium Company	24 N	93 W	9	NESE	Dewatering, Industrial, Miscellaneous	6/11/1980	Unadjudicated	24 93 9 DA-DW21	200	580	170
45	Well	P54898W	USDI, BLM -- Kennecott Uranium Company	24 N	93 W	9	SESE	Dewatering, Industrial, Miscellaneous	6/11/1980	Unadjudicated	24 93 9 DA-DW22	150	480	159
46	Well	P54899W	USDI, BLM -- Kennecott Uranium Company	24 N	93 W	9	SESE	Dewatering, Industrial, Miscellaneous	6/11/1980	Unadjudicated	24 93 9 DA-DW23	150	525	154
47	Well	P54900W	USDI, BLM -- Kennecott Uranium Company	24 N	93 W	9	SWSE	Dewatering, Industrial, Miscellaneous	6/11/1980	Unadjudicated	24 93 9 DC-DW24	150	540	151
48	Well	P54901W	USDI, BLM -- Kennecott Uranium Company	24 N	93 W	9	SWSE	Dewatering, Industrial, Miscellaneous	6/11/1980	Unadjudicated	24 93 9 DD-DW25	150	660	145
49	Well	P54902W	USDI, BLM -- Kennecott Uranium Company	24 N	93 W	9	SESE	Dewatering, Industrial, Miscellaneous	6/11/1980	Unadjudicated	24 93 9 DD-DW26	150	560	159
50	Well	P54903W	USDI, BLM -- Kennecott Uranium Company	24 N	93 W	9	SESE	Dewatering, Industrial, Miscellaneous	6/11/1980	Unadjudicated	24 93 9 DD-DW27	200	600	164

Table 3.6-6 Groundwater-Use Permits within a 3-Mile Radius, WSEO Records, December 2008 (Page 5 of 6)

ID [1]	Well or Use Point	Permit Number	Applicant [2]	Township	Range	Section	¼ of the ¼ [3]	Uses	Priority	Status	Permit Facility Name	Yield [4] (gpm)	Well Depth (ft)	Static Well Depth (ft)
51	Well	P55112W	USDI BLM, Rawlins District	25 N	92 W	10	SESE	Stock	12/24/1980	Good Standing	Boundary	5	280	155
52	Well	P55113W	USDI BLM, Rawlins District	25 N	92 W	30	NWSE	Stock	12/24/1980	Good Standing	Battle Springs	5	220	109
53	Well	P55114W	BLM - Rawlins District	25 N	92 W	35	SENE	Stock	12/24/1980	Good Standing	Sooner	5	320	237
54	Well	P60051W	USDI, BLM -- Kennecott Uranium Company	24 N	93 W	10	SESW	Monitoring	2/20/1982	Good Standing	PH1	0	350	100
55	Well	P60052W	USDI, BLM -- Kennecott Uranium Company	24 N	93 W	10	NESW	Monitoring	2/20/1982	Good Standing	PH2	0	350	100
56	Well	P60053W	USDI, BLM -- Kennecott Uranium Company	24 N	93 W	10	NESW	Monitoring	2/20/1982	Good Standing	PH3	0	350	100
57	Well	P60054W	USDI, BLM -- Kennecott Uranium Company	24 N	93 W	10	NWSW	Monitoring	2/20/1982	Good Standing	PH4	0	350	100
58	Well	P60055W	USDI, BLM -- Kennecott Uranium Company	24 N	93 W	10	NWSW	Monitoring	2/20/1982	Good Standing	PH5	0	350	100
59	Well	P60056W	USDI, BLM -- Kennecott Uranium Company	24 N	93 W	10	NWSW	Monitoring	2/20/1982	Good Standing	PH6	0	350	100
60	Well	P60057W	USDI, BLM -- Kennecott Uranium Company	24 N	93 W	9	SWSE	Monitoring	2/20/1982	Good Standing	PH7	0	350	100
61	Well	P60058W	USDI, BLM -- Kennecott Uranium Company	24 N	93 W	9	SWSE	Monitoring	2/20/1982	Good Standing	PH8	0	350	100
62	Well	P60059W	USDI, BLM -- Kennecott Uranium Company	24 N	93 W	9	SWSE	Monitoring	2/20/1982	Good Standing	PH9	0	350	100
63	Well	P61528W	Texasgulf Inc.	25 N	92 W	20	NWNW	Monitoring	6/11/1982	Abandoned	M25 92 20 1S	0	355	155.8
64	Well	P61529W	Texasgulf Inc.	25 N	92 W	20	NWNW	Monitoring	6/11/1982	Abandoned	M25 92 20 1M	0	440	173.8
65	Well	P61530W	Texasgulf Inc.	25 N	92 W	20	NWNW	Monitoring	6/11/1982	Abandoned	M25 92 20 1D	0	534	181.2
66	Well	P61531W	Texasgulf Inc.	25 N	92 W	19	NENE	Monitoring	6/11/1982	Abandoned	M25 92 19 3M	0	460	176.5
67	Well	P61532W	Texasgulf Inc.	25 N	92 W	19	NENE	Monitoring	6/11/1982	Abandoned	M25 92 19 2M	0	460	175.9
68	Well	P61533W	Texasgulf Inc.	25 N	92 W	19	NENE	Monitoring	6/11/1982	Abandoned	M25 92 19 1M	0	460	174.4
69	Well	P61534W	Texasgulf Inc.	25 N	92 W	18	SESE	Monitoring	6/11/1982	Abandoned	M25 19 18 1M	0	465	166.7
70	Well	P61535W	Texasgulf Inc.	25 N	92 W	18	SESE	Monitoring	6/11/1982	Abandoned	M25 19 18 1S	0	355	159.5
71	Well	P61536W	Texasgulf Inc.	25 N	92 W	18	SESE	Monitoring	6/11/1982	Abandoned	M25 92 18 1D	0	615	195.7
72	Well	P61537W	Texasgulf Inc.	25 N	92 W	17	SESW	Monitoring	6/11/1982	Abandoned	M25 92 17 1S	0	340	170.53
73	Well	P61538W	Texasgulf Inc.	25 N	92 W	17	SESW	Monitoring	6/11/1982	Abandoned	M25 92 17 1M	0	480	182.7
74	Well	P61539W	Texasgulf Inc.	25 N	92 W	17	SESW	Monitoring	6/11/1982	Abandoned	M25 92 17 1D	0	529	204.5

Table 3.6-6 Groundwater-Use Permits within a 3-Mile Radius, WSEO Records, December 2008 (Page 6 of 6)

ID [1]	Well or Use Point	Permit Number	Applicant [2]	Township	Range	Section	¼ of the ¼ [3]	Uses	Priority	Status	Permit Facility Name	Yield [4] (gpm)	Well Depth (ft)	Static Well Depth (ft)
75	Well	P63128W	USDI, BLM -- Kennecott Uranium Company	24 N	93 W	11	SWSW	Monitoring	1/28/1983	Good Standing	TMW-14	0	INP	INP
76	Well	P66110W	Kennecott Uranium Company	24 N	93 W	9	NENW	Monitoring	12/8/1983	Good Standing	BRE 944	0	185	109
77	Well	P66111W	USDI, BLM -- Minerals Exploration Company	24 N	93 W	5	NESE	Monitoring	12/8/1983	Cancelled	REB 1390			
78	Well	P66112W	USDI, BLM --Kennecott Uranium Company	24 N	93 W	10	SWSW	Monitoring	12/8/1983	Abandoned & Cancelled	PH 13	0	210	100
79	Well	P66113W	USDI, BLM -- Kennecott Uranium Company	24 N	93 W	10	SWSW	Monitoring	12/8/1983	Abandoned & Cancelled	PH 12	0	140	100
80	Well	P66114W	USDI, BLM -- Kennecott Uranium Company	24 N	93 W	10	SWSW	Monitoring	12/8/1983	Abandoned & Cancelled	PH 11	0	140	100
81	Well	P66115W	USDI, BLM -- Kennecott Uranium Company	24 N	93 W	10	SWSW	Monitoring	12/8/1983	Abandoned & Cancelled	PH 10	0	210	100
82	Well	P68449W	USDI, BLM -- Texasgulf Inc.	25 N	93 W	24	NENW	Miscellaneous	8/10/1984	Cancelled	TE 38	25	380	220
83	Well	P95601W	Kennecott Uranium Company	24 N	93 W	9	NESE	Monitoring	5/31/1994	Good Standing	RDW-8	0	450	60
84	Well	P97709W	Kennecott Uranium Company	24 N	93 W	10	SWSW	Miscellaneous, Reservoir Supply	2/8/1994	Unadjudicated	SWEETWATER PIT #1	130	225	113.6
85	Well	P147594W	Kennecott Uranium Company	24 N	93 W	1	SWNE	Monitoring	10/22/2002	Good Standing	TMW-90	INP	55	36.13
86	Well	P147595W	Kennecott Uranium Company	24 N	93 W	1	SENW	Monitoring	10/22/2002	Good Standing	TMW-91	INP	110	100.17
87	Well	[5]	USDI BLM, Rawlins District	25 N	93 W	13	NWNW	Stock			East Eagle Nest Draw Well	5	370	269

[1] Each number represents a well. Well locations are shown on Plate D6-1b. A number followed by a letter(s) is a point of use related to the well.

[2] USDI BLM = United States Department of Interior's Bureau of Land Management; WSBLC = Wyoming State Board of Land Commissioners

[3] INP = Information not provided by the online WSEO database.

[4] LCS = Part of the on-going Lost Creek Project study. Information will be provided when it becomes available.

[5] This well does not currently have an associated WSEO permit number.

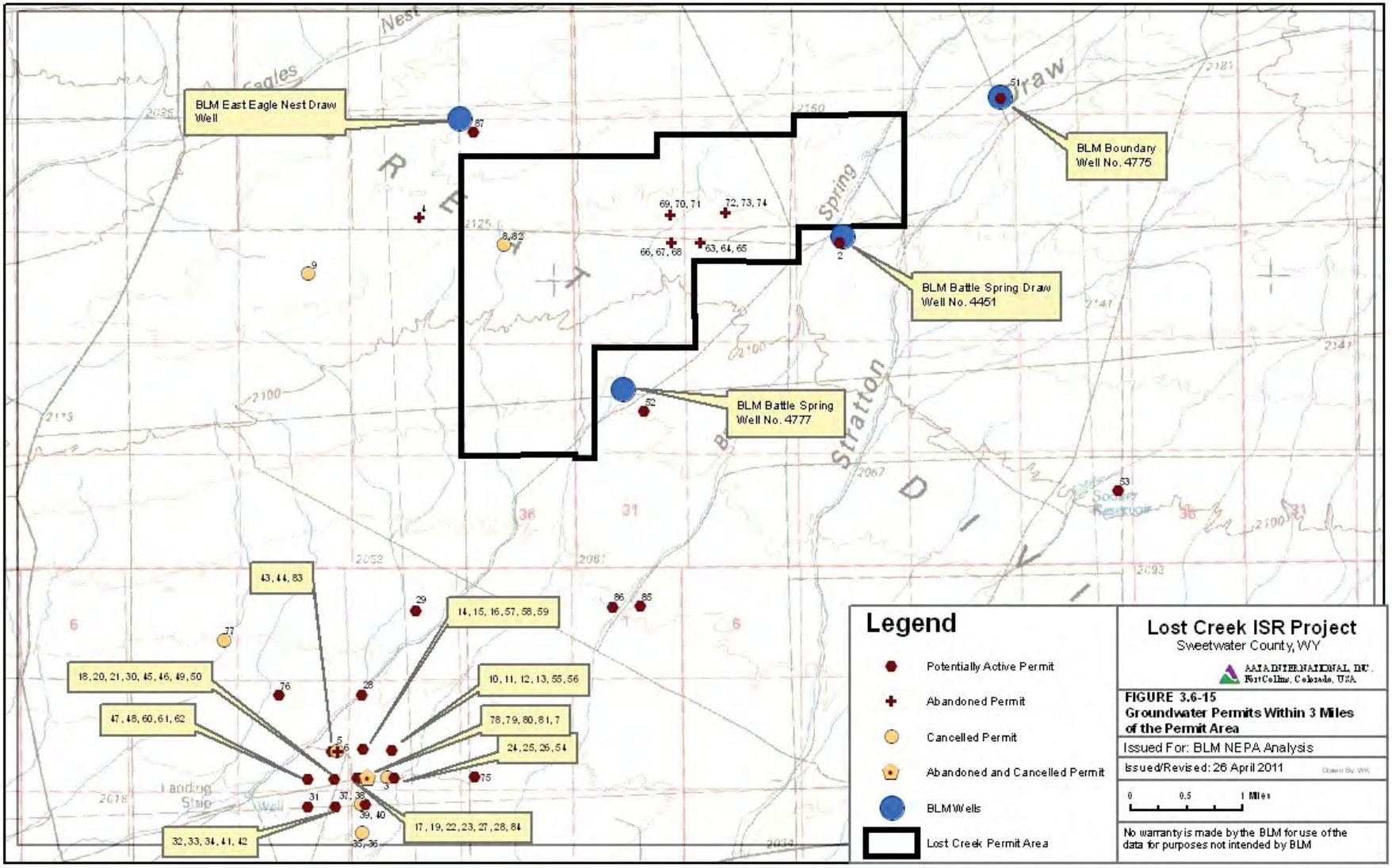

BLM East Eagle Nest Draw Well
BLM Boundary Well No. 4775
BLM Battle Spring Draw Well No. 4451
BLM Battle Spring Well No. 4777
43, 44, 83
14, 15, 16, 57, 58, 59
18, 20, 21, 30, 45, 46, 49, 50
10, 11, 12, 13, 55, 56
47, 48, 60, 61, 62
78, 79, 80, 81, 7
24, 25, 26, 54
17, 19, 22, 23, 27, 28, 84
32, 33, 34, 41, 42
Legend
Potentially Active Permit
Abandoned Permit
Cancelled Permit
Abandoned and Cancelled Permit
BLM Wells
Lost Creek Permit Area
Lost Creek ISR Project
Sweetwater County, WY
AATA INTERNATIONAL, INC.
Fort Collins, Colorado, USA
FIGURE 3.6-15
Groundwater Permits Within 3 Miles of the Permit Area
Issued For: BLM NEPA Analysis
Issued/Revised: 26 April 2011
0 0.5 1 Miles
No warranty is made by the BLM for use of the data for purposes not intended by BLM

Table 3.6-7 BLM Battle Springs Draw Well No. 4451 Laboratory Results (Page 1 of 2)

Parameter (mg/L unless otherwise noted)				Well Water		Pond Water	Algae (mg/kg)	Soil (mg/kg)
				8/27/2009	6/29/2010	7/13/2010	7/13/2010	7/13/2010
Major Cations and Anions	Na (mg/L)			30	31	36	-	-
	K (mg/L)			3	3	8	-	-
	Ca (mgL)			167	170	166	-	-
	Mg (mg/L)			8	8	10	-	-
	Cl (mg/L)			7	7	9	-	-
	HCO_3 (mg/L)			206	200	200	-	-
	CO_3 (mg/L)			ND	ND	ND	-	-
	SO_4 (mg/L)			340	353	379	-	-
	SiO_2 (mg/L)			16.9	16.5	18.7	-	-
	NO_3+NO_2 (mg/L)			0.01	ND	ND	-	-
General Water Quality	TDS (mg/L)			698	694	786	-	-
	Specific Conductivity			929	948	983	-	-
	Lab pH (SU)			7.94	8	7.61	-	-
	Alkalinity (mg/L)			169	164	164	-	-
Trace Parameters (Dissolved unless otherwise noted.)	Al (mg/L)			ND	ND	ND	-	-
	NH_3-N (mg/L)			0.1	ND	0.13	-	-
	As (mg/L)			ND	ND	0.003	-	-
	Ba (mg/L)			ND	ND	ND	-	-
	B (mg/L)			ND	ND	ND	-	-
	Cd (mg/L)			ND	ND	ND	-	-
	Cr (mg/L)			ND	ND	ND	-	-
	Cu (mg/L)			ND	ND	ND	-	-
	F (mg/L)			0.1	ND	0.1	-	-
	Fe (mg/L)	Dissolved		ND	ND	ND	-	-
		Total		0.11	0.11	1.45	-	-
	Hg (mg/L)			ND	N	ND	-	-
	Mn (mg/L)	Dissolved		0.02	0.01	0.27	-	-
		Total		0.02	0.01	0.36	-	-
	Mo (mg/L)			ND	ND	ND	-	-
	Ni (mg/L)			ND	ND	ND	-	-
	Pb (mg/L)			ND	ND	ND	-	-
	Se (mg/L)			0.015	0.025	0.008	2.3	ND
	V (mg/L)			ND	ND	ND	-	-
	Zn (mg/L)			0.02	0.03	ND	-	-

Table 3.6-7 BLM Battle Springs Draw Well No. 4451 Laboratory Results (Page 2 of 2)

Parameter (mg/L unless otherwise noted)			Well Water		Pond Water	Algae (mg/kg)	Soil (mg/kg)
			8/27/2009	6/29/2010	7/13/2010	7/13/2010	7/13/2010
Radionuclides	Gross Alpha (pCi/L)		1230	1190	932	-	-
	Gross Beta (pCi/L)		313	249	239	-	-
	Ra-226 (pCi/L)		11	7.9	1.9	-	-
	Ra-228 (pCi/L)		8.0	5.4	1.6	-	-
	Ra-226 + Ra-228 (pCi/L)		19.0	13.3	3.5	-	-
	Uranium (mg/L)		0.91	1.10	1.02	112	11.8

ND – Concentration was below the laboratory detection limit.
(-) Not analyzed

Boundary Well No. 4775 and Battle Spring Well No. 4777 were drilled as stock wells to a depth of approximately 280 feet and 220 feet, respectively. These wells are shallower than the sands targeted by LCI. A water use of 25 gpm is permitted at each of these wells. Boundary Well No. 4775 apparently is not being used every year, but water has been pumped in the last few years. The electrical cord for the pump and the pipe to deliver water to the troughs are shown in the photos (**Figure 3.6-16**).

Figure 3.6-16 BLM Boundary Well No. 4775

November 2007

October 2011

The windmill on Battle Spring Well No. 4777 was not in working order in June 2007, but it was removed and replaced with an electrical submersible pump (**Figure 3.6-17**).

Figure 3.6-17 BLM Battle Spring Well No. 4777

June 2007

October 2011

The East Eagle Nest Draw Well is located north of the Permit Area, in the NW¼, NW¼, NW¼ of Section 13, Township 25 North and Range 93 West. From mid-May through mid-September, an electric submersible pump in the well is used to pump water into a livestock watering pond at an average rate of five gpm for six to eight hours each day. The total depth of this well is 370 feet, with a static water level of 269 feet. **Figure 3.6-18** shows the East Eagle Nest Draw Well in June 2007 and in October 2011.

Figure 3.6-18 BLM East Eagle Nest Draw Well

June 2007

October 2011

3.6.3.2 LCI Wells

There are seven existing or planned water supply wells and numerous monitor wells permitted and bonded by WSEO and WDEQ, respectively, to LCI and its affiliates. The existing and planned water supply wells and their completion horizons include:

- In the FG horizon, well LC1W would be used for dust suppression and drill water. An additional potable water well (not yet named) is planned for the FG also.
- Well LC28M is completed in the middle HJ horizon and would be used for drill water and dust suppression. The M horizon has three drill water and dust suppression wells completed in it; they are LC32W, LC229W and LC606W.
- The final on-site well for drill water and dust suppression is LC33W, which is completed in the N horizon.

The existing monitor wells include 27 wells that were used to establish baseline conditions in the Permit Area and 63 wells that were used for aquifer testing and water quality sampling for MU1. All of these wells are completed in the DE, FG, HJ, and KM Horizons.

Five deep UIC Class I wells are planned for injection of waste water from the Plant (**Section 2.1.4**), and one of the five was installed in the southwest portion of the Permit Area to obtain subsurface information to ensure the feasibility of this disposal option. The well was completed in the Fort Union Formation.

3.6.4 Groundwater Quality

This section summarizes the regional and Permit Area groundwater quality. The groundwater quality in the Permit Area is separated on the basis of: site-wide characteristics of the ore-bearing and associated aquifers; characteristics within MU1 in the ore-bearing and associated aquifers; and characteristics of the deeper formations evaluated for the UIC Class I wells.

3.6.4.1 Regional Groundwater Quality

Water quality within the Basin ranges from very poor to excellent. Groundwater in the near surface, more permeable aquifers is generally of better quality than groundwater in deeper and less permeable aquifers. Groundwater with TDS less than 3,000 mg/L can generally be found at depths less than 1,500 feet within the Tertiary aquifer system, which includes the Battle Spring/Wasatch, Fort Union and Lance aquifers (Collentine et al., 1981).

Water quality within the shallow Tertiary aquifers generally represents sodium-bicarbonate to sodium-sulfate water types. TDS levels within the Wasatch aquifer

in the west and south parts of the Basin tend to be high relative to the EPA's Secondary Drinking Water Standard (SDWS) of 500 mg/L, even at shallower depth. TDS levels within the Battle Spring/Wasatch aquifers are generally below 500 mg/L along the northern flank of the Basin (which includes the Permit Area). Elevated TDS levels (greater than 3,000 mg/L) are present within the Wasatch aquifer along the eastern edge of the Washakie Basin and within the Fort Union and Lance aquifers along the east side of the Rock Springs uplift. Elsewhere within the Great Divide and Washakie Basins, TDS levels in the Tertiary aquifer system are typically between 1,000 and 3,000 mg/L (Collentine et al., 1981).

Low-TDS waters within the Battle Spring aquifer are predominately sodium-bicarbonate type waters. With increasing salinity, the water type tends to become more calcium-sulfate dominated. However, this trend is not exhibited in the Wasatch, Fort Union and Lance aquifers within the Great Divide and Washakie Basins. The Wasatch and Lance aquifers are characterized by predominately sodium-sulfate type waters, particularly near outcrop areas. The Fort Union is more variable in composition.

Water quality within the Battle Spring aquifer is generally good in the northeast portion of the Basin, with TDS levels usually less than 1,000 mg/L and frequently less than 200 mg/L. The water type of the Battle Spring aquifer is typically sodium-bicarbonate to sodium-sulfate. Mason and Miller (2005) reviewed eighteen groundwater samples collected from the Battle Spring aquifer and observed that those samples represented some of the best overall quality of those studied in Sweetwater County. Sulfate levels can be elevated in Tertiary aquifers, but are generally low in the shallow aquifers of the Battle Spring Formation. Out of 18 samples included in the Mason and Miller (2005) study, only one sample exceeded the WDEQ Class I Drinking Water Standard for sulfate of 250 mg/L. Most of the samples were also below the WDEQ TDS Class I Drinking Water Standard of 500 mg/L. Nitrate, fluoride and arsenic levels were below WDEQ and EPA standards for all of the samples.

Notable exceptions to the relatively good water quality included waters with elevated radionuclides. Uranium and radium-226 (Ra-226) concentrations exceeded their respective EPA Maximum Contaminant Levels (MCLs) of 0.03 mg/L and 5 pCi/L in some samples; radon-222 (Rn-222) concentrations were also relatively high in some samples (Mason and Miller, 2005). The presence of high levels of uranium in Tertiary sediments and groundwater of the Basin has been well documented. The Lost Creek Shroeckingerite deposit located northwest of the Permit Area is noted for high uranium levels in groundwater. Uranium-bearing coals are also present in the Basin. Sediments of the Battle Spring Formation were derived from the Granite Mountains and contain from 0.0005 to 0.001 percent uranium (Masursky, 1962). Based on historical exploration results, certain areas of the Battle Spring Formation (e.g., Lost Creek) contain much higher uranium concentrations. The BLM Battle Spring Draw Well No. 4551 is an example of the higher radium and uranium concentrations (**Table 3.6-7**).

3.6.4.2 Site Groundwater Quality, Ore-Bearing and Associated Aquifers

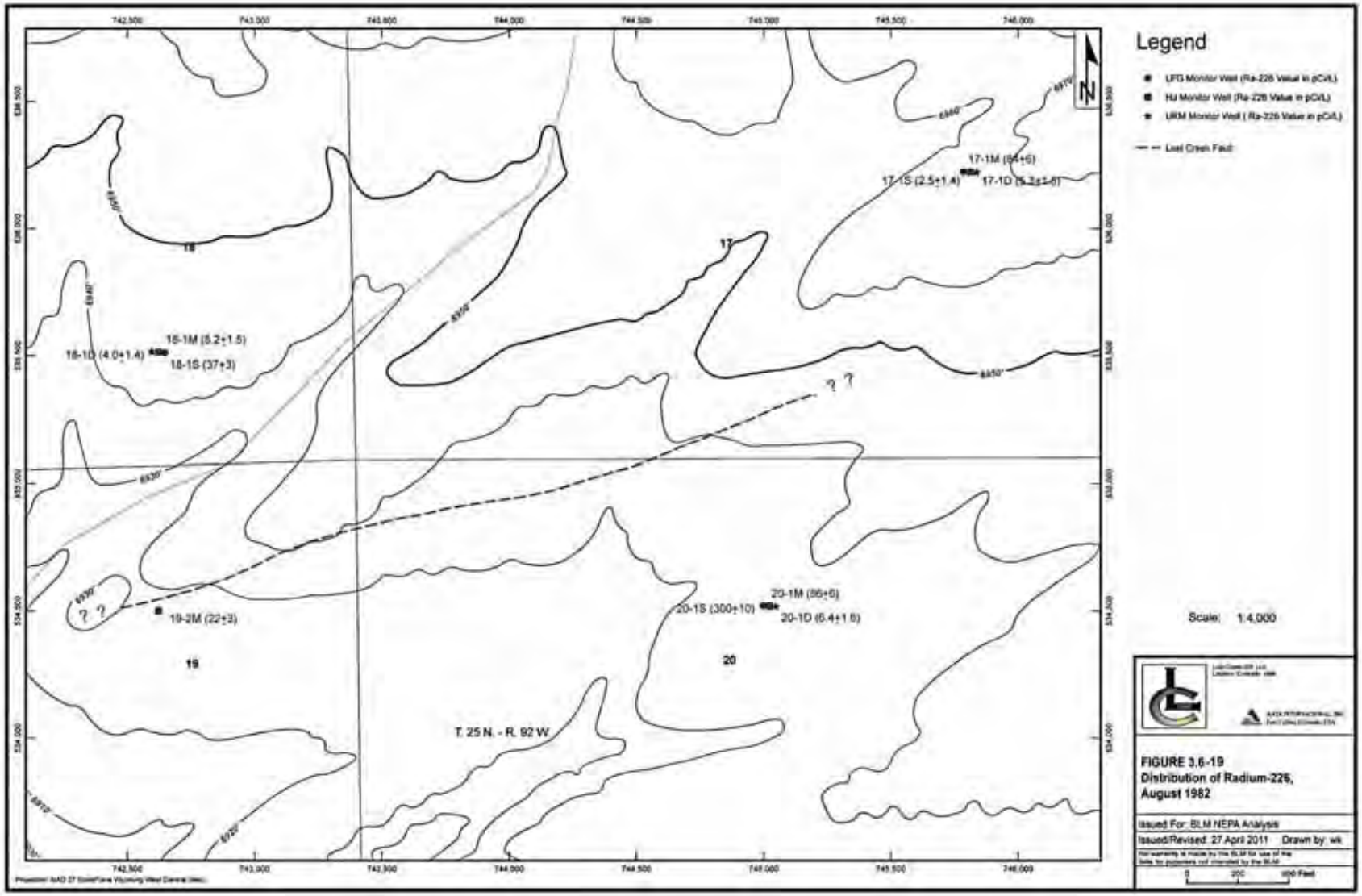
Information on the Permit Area groundwater quality is primarily derived from reconnaissance studies conducted by Conoco (Hydro-Search, Inc., 1982) and more detailed studies by LCI. The historical well locations were generally closer to the ore trend (**Figure 3.6-4**), while the wells installed by LCI include locations close to and well away from the ore trend.

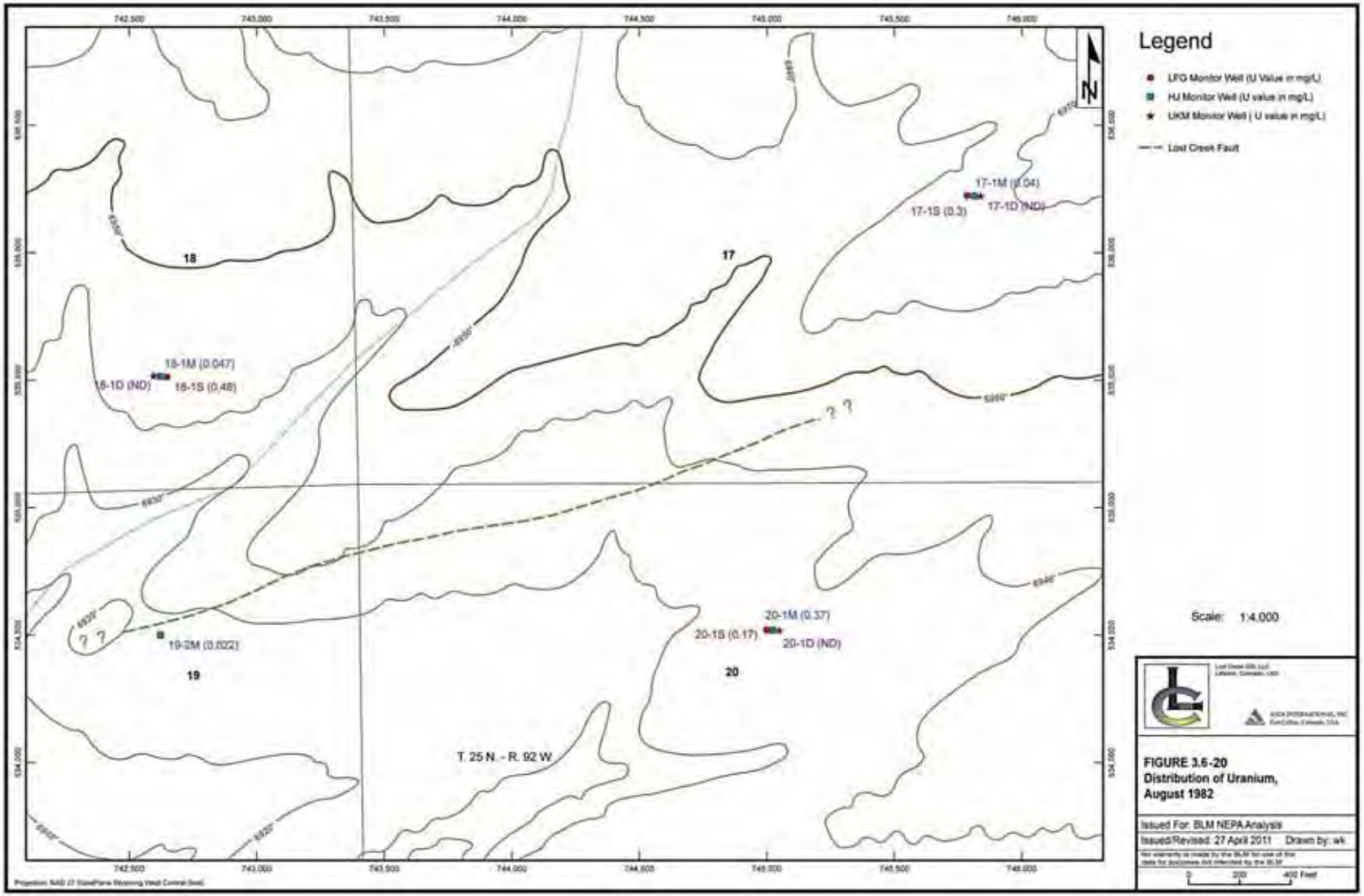
Historical Data

Conoco installed 12 wells, separated into four groups, to evaluate aquifer properties and water quality of the uranium ore-bearing sands and overlying and underlying aquifers within the Permit Area. Three of the groups included wells completed within the HJ Horizon aquifer and the overlying (LFG) and underlying (UKM) aquifers. The fourth group included three wells completed within the HJ Horizon aquifer. The location of the wells is shown on **Figure 3.6-4**. These 12 wells were installed as part of a joint venture between Conoco and Texasgulf Inc. The twelve wells were abandoned as documented in a September 16, 1987 letter from Texasgulf Inc. to WSEO.

Ten of the 12 monitor wells installed by Conoco were sampled in August 1982. Hydro-Search, Inc. reported that there were no major differences in water quality between the HJ Horizon aquifer and the overlying and underlying aquifers (1982). The predominant ions were calcium and sulfate. TDS values were all below the WDEQ Class I Standard of 500 mg/L, ranging from 200 to 490 mg/L. The pH of the waters ranged from 7.1 to 8.5, indicating slightly alkaline conditions. Chloride levels were very low, ranging from seven to 18 mg/L.

Most trace constituents were below the detection limits. Selenium was present in two samples at 0.023 mg/L, which was above the WDEQ and EPA drinking water standards at that time (0.01 mg/L). The WDEQ Class I Standard and the EPA MCL are currently 0.05 mg/L. Ra-226 was detected in all of the samples, with a range of 2.5 to 300 pCi/L. Only two samples, one collected from the overlying aquifer and one from the underlying aquifer, were below the WDEQ Class I Standard and EPA MCL of 5.0 pCi/L for Ra-226 (**Figure 3.6-19**). Uranium levels ranged from below detection (less than 0.005 mg/L) to 0.48 mg/L. Six of the ten samples exceeded the current EPA MCL for uranium of 0.03 mg/L (**Figure 3.6-20**).


Legend
UFG Monitor Well (Ra-226 Value in pCi/L)
HJ Monitor Well (Ra-226 Value in pCi/L)
URM Monitor Well (Ra-226 Value in pCi/L)
Lost Creek Fault
Scale: 1:4,000
FIGURE 3.6-19
Distribution of Radium-226,
August 1982
Issued For: BLM NEPA Analysis
Issued/Revised: 27 April 2011 Drawn by: wk
17-1M (54±6)
17-1S (2.5±1.4)
17-1D (5.3±1.6)
16-1M (5.2±1.5)
16-1D (4.0±1.4)
16-1S (37±3)
19-2M (22±3)
20-1M (86±6)
20-1S (300±10)
20-1D (6.4±1.6)
T. 25 N. - R. 92 W.
16
17
19
20
N


Legend
LFG Monitor Well (U Value in mg/L)
HJ Monitor Well (U value in mg/L)
UKM Monitor Well (U value in mg/L)
Lost Creek Fault
Scale: 1:4,000
FIGURE 3.6-20
Distribution of Uranium,
August 1982
Issued For: BLM NEPA Analysis
Issued/Revised: 27 April 2011 Drawn by: wk
17-1M (0.04)
17-1D (ND)
17-1S (0.3)
18-1M (0.047)
18-1D (ND)
18-1S (0.48)
19-2M (0.022)
20-1M (0.37)
20-1S (0.17)
20-1D (ND)
18
17
19
20
T. 25 N. - R. 92 W.
742,500
743,000
743,500
744,000
744,500
745,000
745,500
746,000
0
200
400 Feet

Current Data

LCI has conducted baseline sampling since September 2006. Per WDEQ-LQD requirements, at least four quarters of baseline data are required to determine variability and if there are any trends in the variability fluctuations (e.g., seasonal changes). The baseline sampling locations, which cover all portions of the Permit Area and are completed in different Sands, are shown in **Figure 3.6-4**, and the sampling results are summarized in **Table 3.6-8**. The raw laboratory data are presented in Attachment D6-4 of Appendix D6, of the WDEQ-LQD Permit to Mine (LCI, 2011b).

In **Table 3.6-8**, those analytical results which exceed specific WDEQ or EPA criteria are highlighted, and the WDEQ and EPA criteria used for the comparison are included in **Table 3.6-9**. The table shows that the WDEQ TDS Class I standard is exceeded at one well in each of the DE, HJ and UKM aquifers, Wells LC31M, LC26M, and LC23M, respectively. Twenty-two out of the 25 wells have TDS levels below the Class I Standard. Sulfate exceeds the WDEQ Class I Standard (250 mg/L) in one DE monitor well (LC31M) and one HJ monitor well (LC26M). As with the Conoco monitoring results, chloride values are low with all but five samples at 10 mg/L or lower.

Piper diagrams have been developed to compare groundwater quality between individual wells (**Figure 3.6-21**) and between different aquifers (**Figure 3.6-22**). The individual well comparison plots the average value for each of the wells for all of the samples analyzed. The Piper diagram comparing different aquifers represents the average water quality for all wells sampled within individual aquifers (DE, LFG, HJ and UKM). Groundwater within the shallow Battle Springs aquifers beneath the Permit Area is a calcium sulfate to calcium bicarbonate type water. There is some variability in water chemistry when the wells are compared individually.

With the exception of four UKM monitor wells (LC17M, LC23M, LC27M, and LC28M), one LFG monitor well (MB-5), and one HJ monitor well (MB-6), every well exceeded the EPA uranium MCL of 0.03 mg/L in at least one quarter. Similarly, with the exception of one DE monitor well (MB-1), one LFG monitor well (MB-2), one HJ monitor well (MB-3B), and one UKM monitor well (MB-4), every well exceeded the WDEQ Class I Standard and EPA MCL for radium-226+228 of 5.0 pCi/L. The distributions of radium and uranium in the DE, FG, HJ, and UKM Horizons are shown on **Figures 3.6-23 and 3.6-24**.

Table 3.6-8 Analytical Results of Baseline Monitoring (Page 1 of 17)

Major Cations and Anions												
Well ID	Completion Zone	Sample Date	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	Cl (mg/L)	HCO_3 (mg/L)	CO_3 (mg/L)	SO_4 (mg/L)	SiO_2 (mg/L)	NO_3+NO_2 (mg/L)
LC29M	DE	9/20/06	26.0	2.0	57.0	4.0	6.0	137.0	ND	108.0	12.0	ND
LC29M	DE	11/26/06	26.0	3.0	64.0	4.0	4.0	98.0	ND	131.0	17.2	ND
LC29M	DE	3/1/07	24.0	2.0	57.0	3.0	4.0	205.0	ND	54.0	18.1	ND
LC29M	DE	5/4/07	27.0	2.0	47.0	3.0	10.0	183.0	ND	21.0	15.3	0.90
LC30M	DE	9/20/06	29.0	2.0	33.0	2.0	6.0	122.0	ND	31.0	14.7	1.40
LC30M	DE	11/26/06	25.0	1.0	31.0	2.0	5.0	124.0	ND	26.0	13.7	1.20
LC30M	DE	3/1/07	51.0	2.0	33.0	2.0	6.0	156.0	ND	51.0	17.4	0.60
LC30M	DE	5/3/07	62.0	2.0	28.0	2.0	6.0	176.0	ND	55.0	17.7	ND
LC31M	DE	9/21/06	40.0	3.0	140.0	9.0	7.0	140.0	ND	***316.0***	15.0	0.80
LC31M	DE	11/26/06	39.0	3.0	120.0	8.0	7.0	145.0	ND	***280.0***	13.9	0.40
LC31M	DE	2/28/07	64.0	3.0	108.0	7.0	8.0	156.0	ND	***277.0***	17.0	0.30
LC31M	DE	5/3/07	71.0	3.0	99.0	6.0	6.0	159.0	ND	***279.0***	15.9	0.20
MB-1	DE	8/27/09	22.0	3.0	10.0	ND	12.0	ND	18.0	22.0	15.7	1.55
MB-1	DE	1/4/10	23.0	2.0	11.0	ND	8.0	59.0	ND	21.0	14.4	1.60
MB-1	DE	3/30/10	29.0	3.0	19.0	1.0	6.0	108.0	ND	21.0	14.2	1.80
MB-1	DE	6/29/10	28.0	3.0	20.0	1.0	6.0	112.0	ND	20.0	14.3	1.60
MB-7	DE	8/26/09	Insufficient water to sample.									
MB-10	DE	8/26/09	Insufficient water to sample.									

Table 3.6-6 Groundwater-Use Permits within a 3-Mile Radius, WSEO Records, December 2008 (Page 4 of 6)

ID [1]	Well or Use Point	Permit Number	Applicant [2]	Township	Range	Section	¼ of the ¼ [3]	Uses	Priority	Status	Permit Facility Name	Yield [4] (gpm)	Well Depth (ft)	Static Well Depth (ft)
39	Well	P54891W	USDI BLM -- Kennecott Uranium Company	24 N	93 W	15	NWNW	Dewatering, Industrial, Miscellaneous	11/24/1980	Good Standing	DW 39	200	600	169
40	Well	P54892W	USDI BLM -- Kennecott Uranium Company	24 N	93 W	15	NWNW	Dewatering, Industrial, Miscellaneous	11/24/1980	Good Standing	DW 40	200	600	155
41	Well	P54893W	Kennecott Uranium Company -- WSBLC	24 N	93 W	16	NENE	Dewatering, Industrial, Miscellaneous	11/24/1980	Good Standing	DW 41	190	600	157
42	Well	P54894W	Kennecott Uranium Company -- WSBLC	24 N	93 W	16	NENE	Dewatering, Industrial, Miscellaneous	11/24/1980	Good Standing	DW 42	200	600	166
43	Well	P54896W	USDI, BLM -- Kennecott Uranium Company	24 N	93 W	9	NESE	Dewatering, Industrial, Miscellaneous	6/11/1980	Unadjudicated	24 93 9 DA-DW20	200	575	178
44	Well	P54897W	USDI, BLM -- Kennecott Uranium Company	24 N	93 W	9	NESE	Dewatering, Industrial, Miscellaneous	6/11/1980	Unadjudicated	24 93 9 DA-DW21	200	580	170
45	Well	P54898W	USDI, BLM -- Kennecott Uranium Company	24 N	93 W	9	SESE	Dewatering, Industrial, Miscellaneous	6/11/1980	Unadjudicated	24 93 9 DA-DW22	150	480	159
46	Well	P54899W	USDI, BLM -- Kennecott Uranium Company	24 N	93 W	9	SESE	Dewatering, Industrial, Miscellaneous	6/11/1980	Unadjudicated	24 93 9 DA-DW23	150	525	154
47	Well	P54900W	USDI, BLM -- Kennecott Uranium Company	24 N	93 W	9	SWSE	Dewatering, Industrial, Miscellaneous	6/11/1980	Unadjudicated	24 93 9 DC-DW24	150	540	151
48	Well	P54901W	USDI, BLM -- Kennecott Uranium Company	24 N	93 W	9	SWSE	Dewatering, Industrial, Miscellaneous	6/11/1980	Unadjudicated	24 93 9 DD-DW25	150	660	145
49	Well	P54902W	USDI, BLM -- Kennecott Uranium Company	24 N	93 W	9	SESE	Dewatering, Industrial, Miscellaneous	6/11/1980	Unadjudicated	24 93 9 DD-DW26	150	560	159
50	Well	P54903W	USDI, BLM -- Kennecott Uranium Company	24 N	93 W	9	SESE	Dewatering, Industrial, Miscellaneous	6/11/1980	Unadjudicated	24 93 9 DD-DW27	200	600	164

Table 3.6-6 Groundwater-Use Permits within a 3-Mile Radius, WSEO Records, December 2008 (Page 5 of 6)

ID [1]	Well or Use Point	Permit Number	Applicant [2]	Township	Range	Section	¼ of the ¼ [3]	Uses	Priority	Status	Permit Facility Name	Yield [4] (gpm)	Well Depth (ft)	Static Well Depth (ft)
51	Well	P55112W	USDI BLM, Rawlins District	25 N	92 W	10	SESE	Stock	12/24/1980	Good Standing	Boundary	5	280	155
52	Well	P55113W	USDI BLM, Rawlins District	25 N	92 W	30	NWSE	Stock	12/24/1980	Good Standing	Battle Springs	5	220	109
53	Well	P55114W	BLM - Rawlins District	25 N	92 W	35	SENE	Stock	12/24/1980	Good Standing	Sooner	5	320	237
54	Well	P60051W	USDI, BLM -- Kennecott Uranium Company	24 N	93 W	10	SESW	Monitoring	2/20/1982	Good Standing	PH1	0	350	100
55	Well	P60052W	USDI, BLM -- Kennecott Uranium Company	24 N	93 W	10	NESW	Monitoring	2/20/1982	Good Standing	PH2	0	350	100
56	Well	P60053W	USDI, BLM -- Kennecott Uranium Company	24 N	93 W	10	NESW	Monitoring	2/20/1982	Good Standing	PH3	0	350	100
57	Well	P60054W	USDI, BLM -- Kennecott Uranium Company	24 N	93 W	10	NWSW	Monitoring	2/20/1982	Good Standing	PH4	0	350	100
58	Well	P60055W	USDI, BLM -- Kennecott Uranium Company	24 N	93 W	10	NWSW	Monitoring	2/20/1982	Good Standing	PH5	0	350	100
59	Well	P60056W	USDI, BLM -- Kennecott Uranium Company	24 N	93 W	10	NWSW	Monitoring	2/20/1982	Good Standing	PH6	0	350	100
60	Well	P60057W	USDI, BLM -- Kennecott Uranium Company	24 N	93 W	9	SWSE	Monitoring	2/20/1982	Good Standing	PH7	0	350	100
61	Well	P60058W	USDI, BLM -- Kennecott Uranium Company	24 N	93 W	9	SWSE	Monitoring	2/20/1982	Good Standing	PH8	0	350	100
62	Well	P60059W	USDI, BLM -- Kennecott Uranium Company	24 N	93 W	9	SWSE	Monitoring	2/20/1982	Good Standing	PH9	0	350	100
63	Well	P61528W	Texasgulf Inc.	25 N	92 W	20	NWNW	Monitoring	6/11/1982	Abandoned	M25 92 20 1S	0	355	155.8
64	Well	P61529W	Texasgulf Inc.	25 N	92 W	20	NWNW	Monitoring	6/11/1982	Abandoned	M25 92 20 1M	0	440	173.8
65	Well	P61530W	Texasgulf Inc.	25 N	92 W	20	NWNW	Monitoring	6/11/1982	Abandoned	M25 92 20 1D	0	534	181.2
66	Well	P61531W	Texasgulf Inc.	25 N	92 W	19	NENE	Monitoring	6/11/1982	Abandoned	M25 92 19 3M	0	460	176.5
67	Well	P61532W	Texasgulf Inc.	25 N	92 W	19	NENE	Monitoring	6/11/1982	Abandoned	M25 92 19 2M	0	460	175.9
68	Well	P61533W	Texasgulf Inc.	25 N	92 W	19	NENE	Monitoring	6/11/1982	Abandoned	M25 92 19 1M	0	460	174.4
69	Well	P61534W	Texasgulf Inc.	25 N	92 W	18	SESE	Monitoring	6/11/1982	Abandoned	M25 19 18 1M	0	465	166.7
70	Well	P61535W	Texasgulf Inc.	25 N	92 W	18	SESE	Monitoring	6/11/1982	Abandoned	M25 19 18 1S	0	355	159.5
71	Well	P61536W	Texasgulf Inc.	25 N	92 W	18	SESE	Monitoring	6/11/1982	Abandoned	M25 92 18 1D	0	615	195.7
72	Well	P61537W	Texasgulf Inc.	25 N	92 W	17	SESW	Monitoring	6/11/1982	Abandoned	M25 92 17 1S	0	340	170.53
73	Well	P61538W	Texasgulf Inc.	25 N	92 W	17	SESW	Monitoring	6/11/1982	Abandoned	M25 92 17 1M	0	480	182.7
74	Well	P61539W	Texasgulf Inc.	25 N	92 W	17	SESW	Monitoring	6/11/1982	Abandoned	M25 92 17 1D	0	529	204.5

Table 3.6-6 Groundwater-Use Permits within a 3-Mile Radius, WSEO Records, December 2008 (Page 6 of 6)

ID [1]	Well or Use Point	Permit Number	Applicant [2]	Township	Range	Section	¼ of the ¼ [3]	Uses	Priority	Status	Permit Facility Name	Yield [4] (gpm)	Well Depth (ft)	Static Well Depth (ft)
75	Well	P63128W	USDI, BLM -- Kennecott Uranium Company	24 N	93 W	11	SWSW	Monitoring	1/28/1983	Good Standing	TMW-14	0	INP	INP
76	Well	P66110W	Kennecott Uranium Company	24 N	93 W	9	NENW	Monitoring	12/8/1983	Good Standing	BRE 944	0	185	109
77	Well	P66111W	USDI, BLM -- Minerals Exploration Company	24 N	93 W	5	NESE	Monitoring	12/8/1983	Cancelled	REB 1390			
78	Well	P66112W	USDI, BLM --Kennecott Uranium Company	24 N	93 W	10	SWSW	Monitoring	12/8/1983	Abandoned & Cancelled	PH 13	0	210	100
79	Well	P66113W	USDI, BLM -- Kennecott Uranium Company	24 N	93 W	10	SWSW	Monitoring	12/8/1983	Abandoned & Cancelled	PH 12	0	140	100
80	Well	P66114W	USDI, BLM -- Kennecott Uranium Company	24 N	93 W	10	SWSW	Monitoring	12/8/1983	Abandoned & Cancelled	PH 11	0	140	100
81	Well	P66115W	USDI, BLM -- Kennecott Uranium Company	24 N	93 W	10	SWSW	Monitoring	12/8/1983	Abandoned & Cancelled	PH 10	0	210	100
82	Well	P68449W	USDI, BLM -- Texasgulf Inc.	25 N	93 W	24	NENW	Miscellaneous	8/10/1984	Cancelled	TE 38	25	380	220
83	Well	P95601W	Kennecott Uranium Company	24 N	93 W	9	NESE	Monitoring	5/31/1994	Good Standing	RDW-8	0	450	60
84	Well	P97709W	Kennecott Uranium Company	24 N	93 W	10	SWSW	Miscellaneous, Reservoir Supply	2/8/1994	Unadjudicated	SWEETWATER PIT #1	130	225	113.6
85	Well	P147594W	Kennecott Uranium Company	24 N	93 W	1	SWNE	Monitoring	10/22/2002	Good Standing	TMW-90	INP	55	36.13
86	Well	P147595W	Kennecott Uranium Company	24 N	93 W	1	SENW	Monitoring	10/22/2002	Good Standing	TMW-91	INP	110	100.17
87	Well	[5]	USDI BLM, Rawlins District	25 N	93 W	13	NWNW	Stock			East Eagle Nest Draw Well	5	370	269

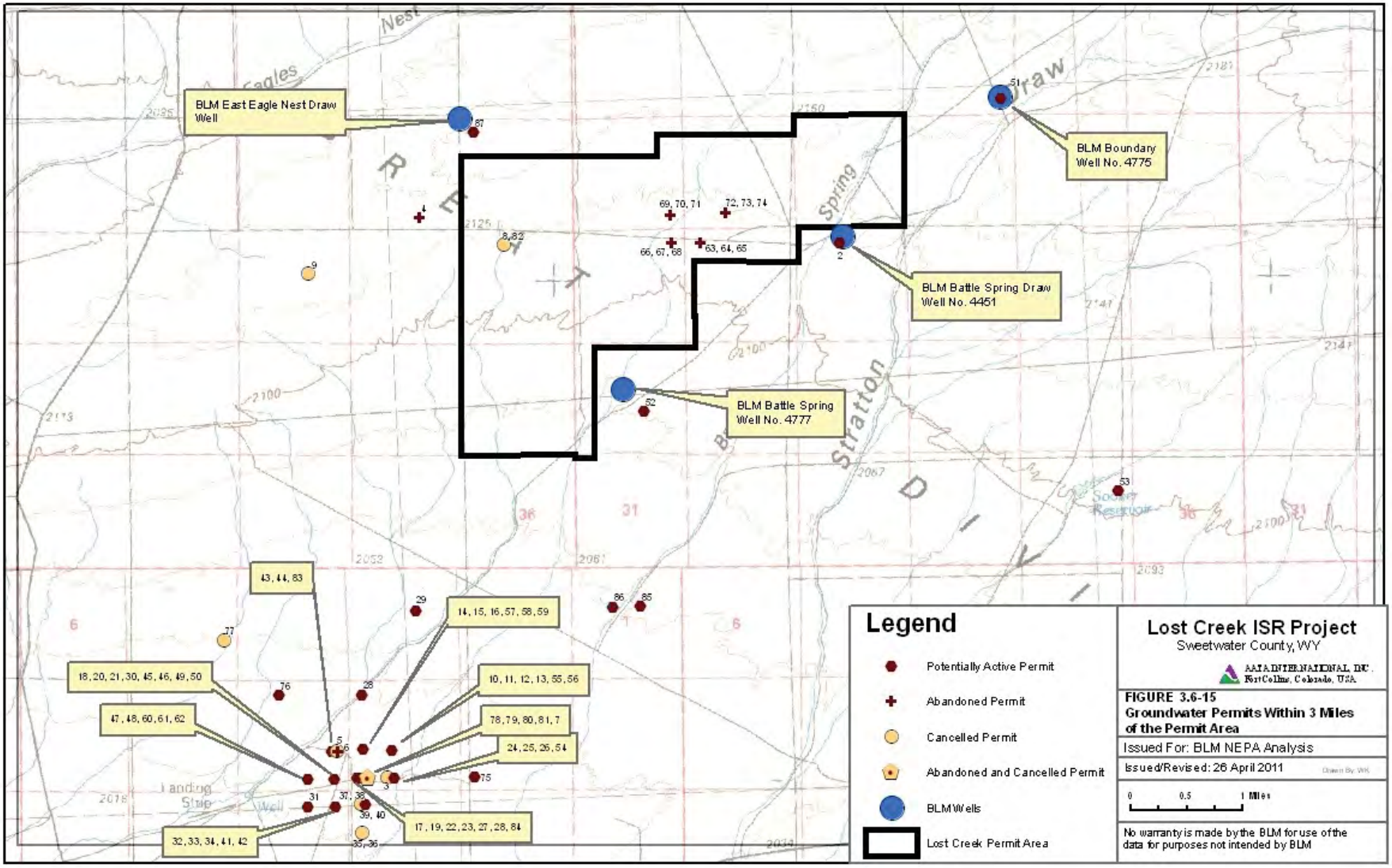
[1] Each number represents a well. Well locations are shown on Plate D6-1b. A number followed by a letter(s) is a point of use related to the well.

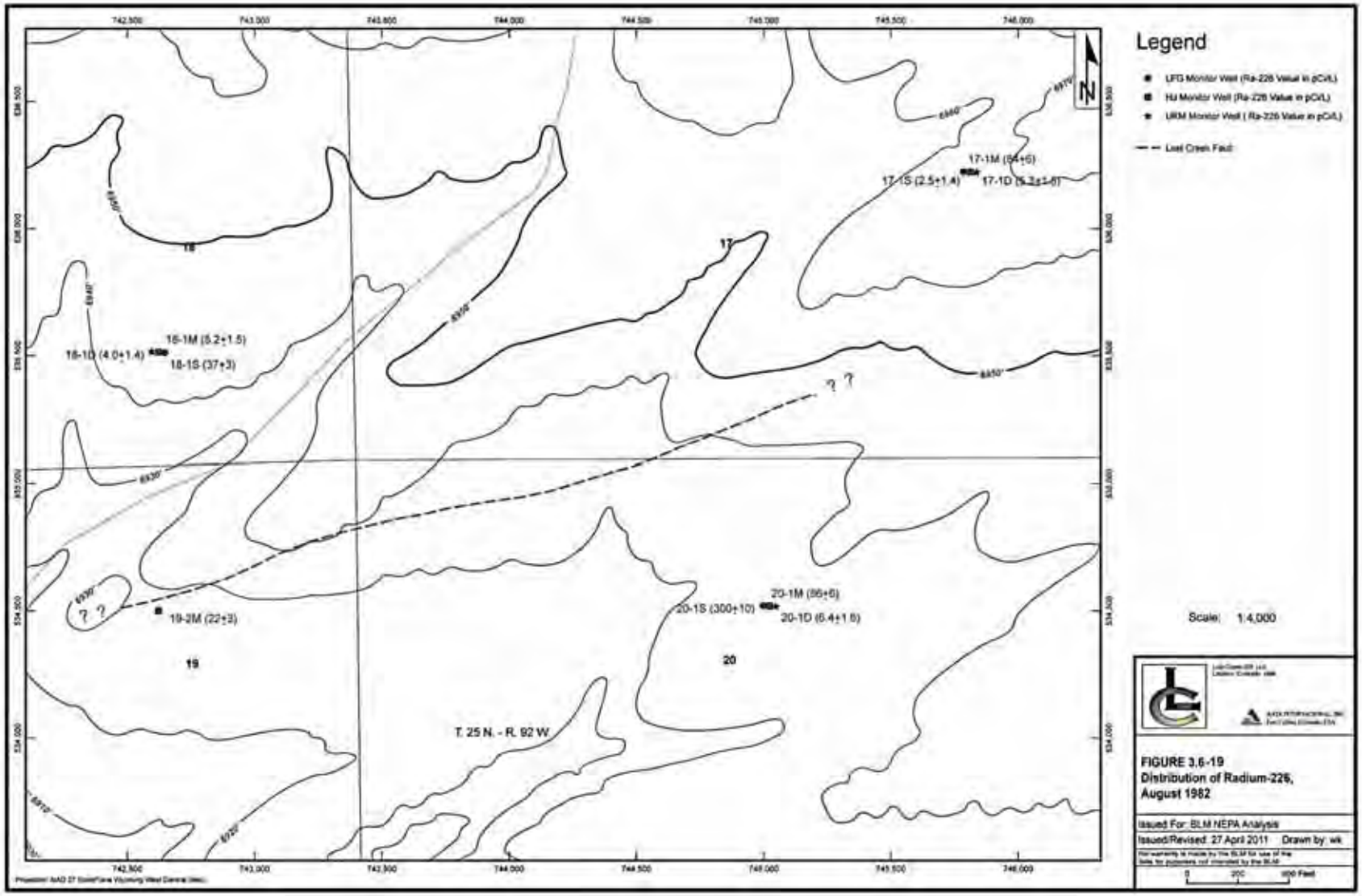
[2] USDI BLM = United States Department of Interior's Bureau of Land Management; WSBLC = Wyoming State Board of Land Commissioners

[3] INP = Information not provided by the online WSEO database.

[4] LCS = Part of the on-going Lost Creek Project study. Information will be provided when it becomes available.

[5] This well does not currently have an associated WSEO permit number.


BLM East Eagle Nest Draw Well
BLM Boundary Well No. 4775
BLM Battle Spring Draw Well No. 4451
BLM Battle Spring Well No. 4777
43, 44, 83
14, 15, 16, 57, 58, 59
18, 20, 21, 30, 45, 46, 49, 50
10, 11, 12, 13, 55, 56
47, 48, 60, 61, 62
78, 79, 80, 81, 7
24, 25, 26, 54
17, 19, 22, 23, 27, 28, 84
32, 33, 34, 41, 42
Legend
Potentially Active Permit
Abandoned Permit
Cancelled Permit
Abandoned and Cancelled Permit
BLM Wells
Lost Creek Permit Area
Lost Creek ISR Project
Sweetwater County, WY
AATA INTERNATIONAL, INC.
Fort Collins, Colorado, USA
FIGURE 3.6-15
Groundwater Permits Within 3 Miles of the Permit Area
Issued For: BLM NEPA Analysis
Issued/Revised: 26 April 2011
0 0.5 1 Miles
No warranty is made by the BLM for use of the data for purposes not intended by BLM


Legend
UFG Monitor Well (Ra-226 Value in pCi/L)
HJ Monitor Well (Ra-226 Value in pCi/L)
URM Monitor Well (Ra-226 Value in pCi/L)
Lost Creek Fault
Scale: 1:4,000
FIGURE 3.6-19
Distribution of Radium-226,
August 1982
Issued For: BLM NEPA Analysis
Issued/Revised: 27 April 2011 Drawn by: wk
17-1M (54±6)
17-1S (2.5±1.4)
17-1D (5.3±1.6)
16-1M (5.2±1.5)
16-1D (4.0±1.4)
16-1S (37±3)
19-2M (22±3)
20-1M (86±6)
20-1S (300±10)
20-1D (6.4±1.6)
T. 25 N. - R. 92 W.
16
17
19
20
N

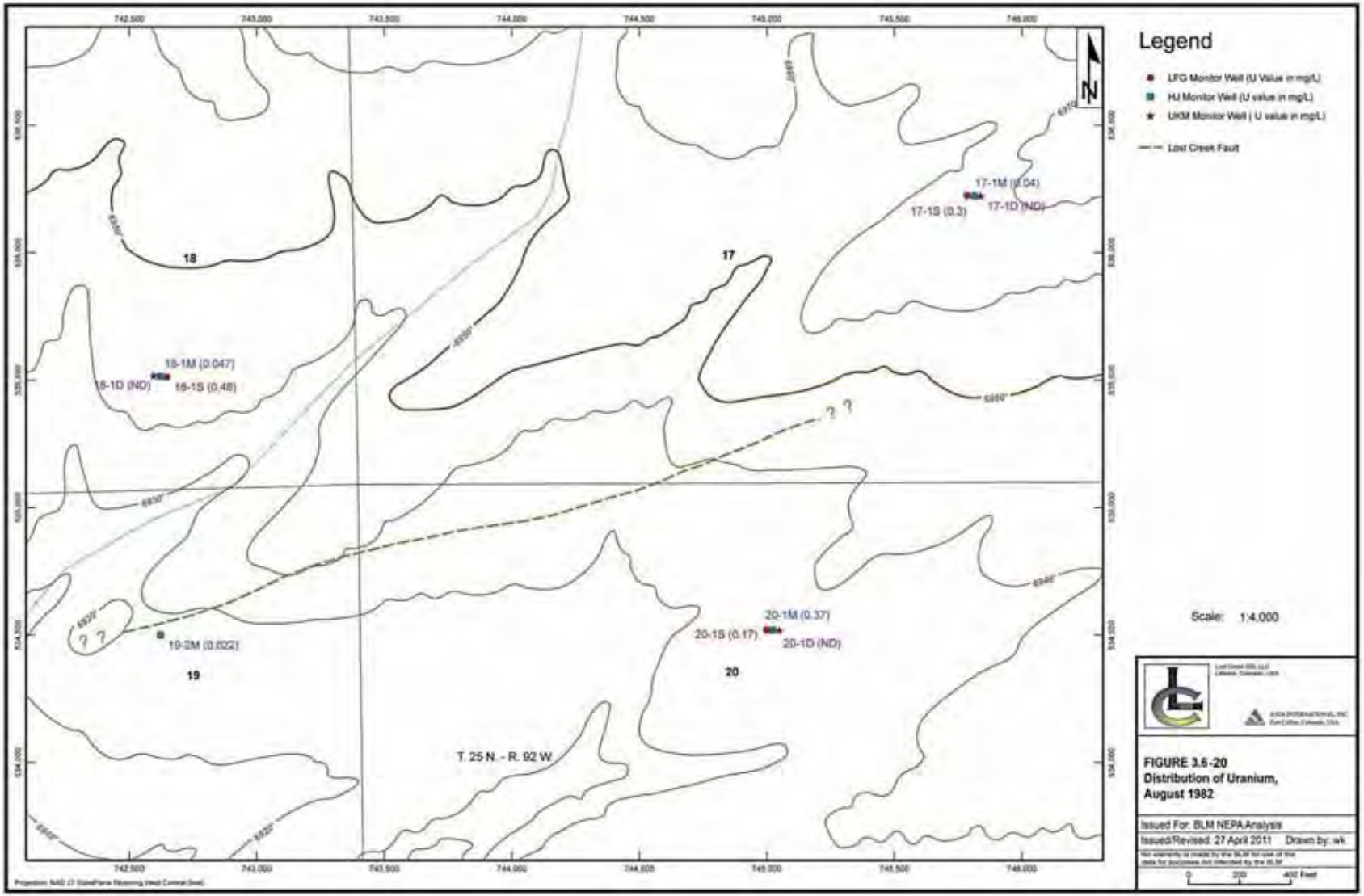

Legend
LFG Monitor Well (U Value in mg/L)
HJ Monitor Well (U value in mg/L)
UKM Monitor Well (U value in mg/L)
Lost Creek Fault
Scale: 1:4,000
FIGURE 3.6-20
Distribution of Uranium,
August 1982
Issued For: BLM NEPA Analysis
Issued/Revised: 27 April 2011 Drawn by: wk
17-1M (0.04)
17-1D (ND)
17-1S (0.3)
18-1M (0.047)
18-1D (ND)
18-1S (0.48)
19-2M (0.022)
20-1M (0.37)
20-1S (0.17)
20-1D (ND)
18
17
19
20
T. 25 N. - R. 92 W.
742,500
743,000
743,500
744,000
744,500
745,000
745,500
746,000
0
200
400 Feet

Table 3.6-8 Analytical Results of Baseline Monitoring (Page 1 of 17)

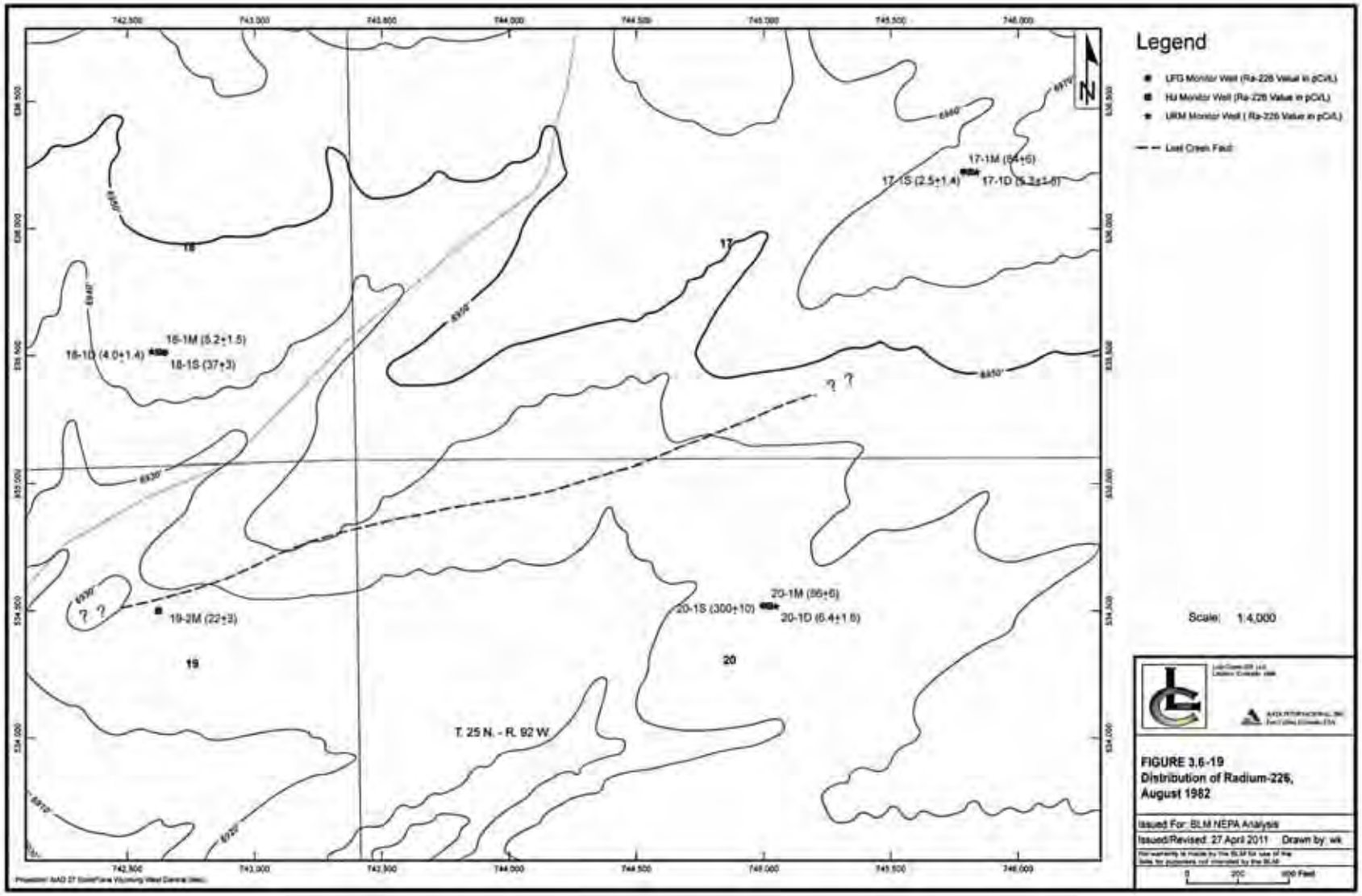
Major Cations and Anions												
Well ID	Completion Zone	Sample Date	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	Cl (mg/L)	HCO_3 (mg/L)	CO_3 (mg/L)	SO_4 (mg/L)	SiO_2 (mg/L)	NO_3+NO_2 (mg/L)
LC29M	DE	9/20/06	26.0	2.0	57.0	4.0	6.0	137.0	ND	108.0	12.0	ND
LC29M	DE	11/26/06	26.0	3.0	64.0	4.0	4.0	98.0	ND	131.0	17.2	ND
LC29M	DE	3/1/07	24.0	2.0	57.0	3.0	4.0	205.0	ND	54.0	18.1	ND
LC29M	DE	5/4/07	27.0	2.0	47.0	3.0	10.0	183.0	ND	21.0	15.3	0.90
LC30M	DE	9/20/06	29.0	2.0	33.0	2.0	6.0	122.0	ND	31.0	14.7	1.40
LC30M	DE	11/26/06	25.0	1.0	31.0	2.0	5.0	124.0	ND	26.0	13.7	1.20
LC30M	DE	3/1/07	51.0	2.0	33.0	2.0	6.0	156.0	ND	51.0	17.4	0.60
LC30M	DE	5/3/07	62.0	2.0	28.0	2.0	6.0	176.0	ND	55.0	17.7	ND
LC31M	DE	9/21/06	40.0	3.0	140.0	9.0	7.0	140.0	ND	***316.0***	15.0	0.80
LC31M	DE	11/26/06	39.0	3.0	120.0	8.0	7.0	145.0	ND	***280.0***	13.9	0.40
LC31M	DE	2/28/07	64.0	3.0	108.0	7.0	8.0	156.0	ND	***277.0***	17.0	0.30
LC31M	DE	5/3/07	71.0	3.0	99.0	6.0	6.0	159.0	ND	***279.0***	15.9	0.20
MB-1	DE	8/27/09	22.0	3.0	10.0	ND	12.0	ND	18.0	22.0	15.7	1.55
MB-1	DE	1/4/10	23.0	2.0	11.0	ND	8.0	59.0	ND	21.0	14.4	1.60
MB-1	DE	3/30/10	29.0	3.0	19.0	1.0	6.0	108.0	ND	21.0	14.2	1.80
MB-1	DE	6/29/10	28.0	3.0	20.0	1.0	6.0	112.0	ND	20.0	14.3	1.60
MB-7	DE	8/26/09	Insufficient water to sample.									
MB-10	DE	8/26/09	Insufficient water to sample.									

Table 3.6-8 Analytical Results of Baseline Monitoring (Page 2 of 17)

			General Water Quality				Radionuclides					
Well ID	Completion Zone	Sample Date	TDS (mg/L)	Specific Conductivity	Lab pH (SU)	Alkalinity (mg/L)	Gross Alpha (pCi/L)	Gross Beta (pCi/L)	Ra-226 (pCi/L)	Ra-228 (pCi/L)	Ra-226 + Ra-228 (pCi/L)	Uranium (mg/L)
LC29M	DE	9/20/06	283.0			112.0	***328.0***	142.0	1.9	ND	1.9	***0.499***
LC29M	DE	11/26/06	298.0	491.0	7.68	80.0	***158.0***	54.0	1.7	4.7	***6.4***	***0.246***
LC29M	DE	3/1/07	265.0	385.0	7.77		***265.0***	86.1	4.0	ND	4.0	***0.318***
LC29M	DE	5/4/07	219.0	356.0	7.75		***200.0***	84.6	3.0	ND	3.0	***0.251***
LC30M	DE	9/20/06	184.0			100.0	***129.0***	41.5	1.0	ND	1.0	***0.141***
LC30M	DE	11/26/06	170.0	288.0	7.33	102.0	***107.0***	32.3	0.9	1.6	2.5	***0.154***
LC30M	DE	3/1/07	241.0	393.0	8.02		***108.0***	31.9	5.7	ND	***5.7***	***0.162***
LC30M	DE	5/3/07	260.0	440.0	8.07		***109.0***	40.0	2.1	ND	2.1	***0.130***
LC31M	DE	9/21/06	***602.0***	800.0	7.85	114.0	***1120.0***	405.0	2.0	1.7	3.7	***1.890***
LC31M	DE	11/26/06	***528.0***	838.0	7.79	119.0	***1430.0***	395.0	2.6	3.2	***5.8***	***2.100***
LC31M	DE	2/28/07	***563.0***	817.0	7.94		***967.0***	262.0	7.2	1.0	***8.2***	***1.400***
LC31M	DE	5/3/07	***559.0***	860.0	7.79		***1030.0***	319.0	1.9	2.4	4.3	***1.610***
MB-1	DE	8/27/09	121.0	186.0	***10.10***		***21.4***	10.1	0.7	0.9	1.6	0.011
MB-1	DE	1/4/10	95.0	183.0	***9.27***	55.0	***74.7***	18.9	0.3	1.6	1.9	***0.063***
MB-1	DE	3/30/10	167.0	235.0	8.42	88.0	***158.0***	27.1	0.3	1.0	1.3	***0.135***
MB-1	DE	6/29/10	133.0	242.0	***8.61***	92.0	***173.0***	36.7	0.2	0.9	1.1	***0.126***
MB-7	DE	8/26/09	Insufficient water to sample.									
MB-10	DE	8/26/09	Insufficient water to sample.									

Table 3.6-8 Analytical Results of Baseline Monitoring (Page 3 of 17)

Trace Parameters (Dissolved unless otherwise noted.)											
Well ID	Completion Zone	Sample Date	Al (mg/L)	NH_3-N (mg/L)	As (mg/L)	Ba (mg/L)	B (mg/L)	Cd (mg/L)	Cr (mg/L)	Cu (mg/L)	F (mg/L)
LC29M	DE	9/20/06	ND	**1.07**	0.002	ND	ND	ND	ND	ND	0.30
LC29M	DE	11/26/06	ND	**0.57**	0.003	ND	ND	ND	ND	ND	0.30
LC29M	DE	3/1/07	ND	0.26	0.005	ND	ND	ND	ND	ND	0.20
LC29M	DE	5/4/07	ND	0.18	ND	ND	ND	ND	ND	ND	0.20
LC30M	DE	9/20/06	ND	0.11	0.002	ND	ND	ND	ND	ND	0.50
LC30M	DE	11/26/06	ND	0.08	0.002	ND	ND	ND	ND	ND	0.50
LC30M	DE	3/1/07	ND	0.07	0.004	ND	ND	ND	ND	ND	0.50
LC30M	DE	5/3/07	ND	0.06	0.007	ND	ND	ND	ND	ND	0.50
LC31M	DE	9/21/06	ND	ND	ND	ND	ND	ND	ND	ND	ND
LC31M	DE	11/26/06	ND	0.07	ND	ND	ND	ND	ND	ND	0.20
LC31M	DE	2/28/07	ND	ND	ND	ND	ND	ND	ND	ND	0.20
LC31M	DE	5/3/07	ND	ND	ND	ND	ND	ND	ND	ND	0.20
MB-1	DE	8/27/09	ND	ND	0.00	ND	ND	ND	ND	ND	ND
MB-1	DE	1/4/10	ND	ND	0.00	ND	ND	ND	ND	ND	0.30
MB-1	DE	3/30/10	ND	ND	0.00	ND	ND	ND	ND	ND	ND
MB-1	DE	6/29/10	ND	ND	0.00	ND	ND	ND	ND	ND	0.30
MB-7	DE	8/26/09	Insufficient water to sample.								
MB-10	DE	8/26/09	Insufficient water to sample.								


Legend
UFG Monitor Well (Ra-226 Value in pCi/L)
HJ Monitor Well (Ra-226 Value in pCi/L)
URM Monitor Well (Ra-226 Value in pCi/L)
Lost Creek Fault
Scale: 1:4,000
FIGURE 3.6-19
Distribution of Radium-226,
August 1982
Issued For: BLM NEPA Analysis
Issued/Revised: 27 April 2011 Drawn by: wk
17-1M (54±6)
17-1S (2.5±1.4)
17-1D (5.3±1.6)
16-1M (5.2±1.5)
16-1D (4.0±1.4)
16-1S (37±3)
19-2M (22±3)
20-1M (86±6)
20-1S (300±10)
20-1D (6.4±1.6)
T. 25 N. - R. 92 W.
16
17
19
20
N

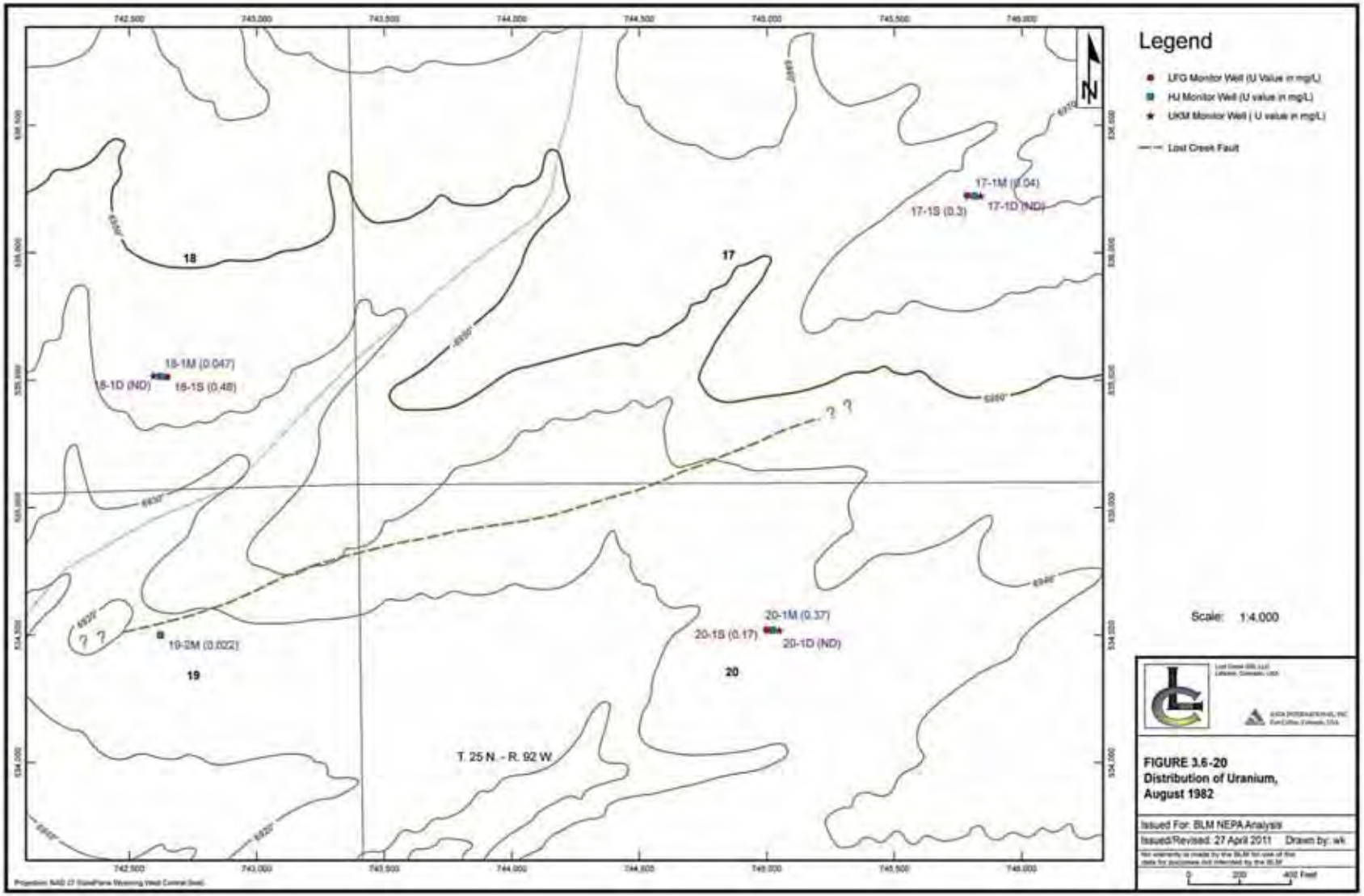

Legend
LFG Monitor Well (U Value in mg/L)
HJ Monitor Well (U value in mg/L)
UKM Monitor Well (U value in mg/L)
Lost Creek Fault
Scale: 1:4,000
FIGURE 3.6-20
Distribution of Uranium,
August 1982
Issued For: BLM NEPA Analysis
Issued/Revised: 27 April 2011 Drawn by: wk
17-1M (0.04)
17-1D (ND)
17-1S (0.3)
18-1M (0.047)
18-1D (ND)
18-1S (0.48)
19-2M (0.022)
20-1M (0.37)
20-1S (0.17)
20-1D (ND)
18
17
19
20
T. 25 N. - R. 92 W.
742,500
743,000
743,500
744,000
744,500
745,000
745,500
746,000
0
200
400 Feet

Table 3.6-8 Analytical Results of Baseline Monitoring (Page 1 of 17)

Major Cations and Anions												
Well ID	Completion Zone	Sample Date	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	Cl (mg/L)	HCO_3 (mg/L)	CO_3 (mg/L)	SO_4 (mg/L)	SiO_2 (mg/L)	NO_3+NO_2 (mg/L)
LC29M	DE	9/20/06	26.0	2.0	57.0	4.0	6.0	137.0	ND	108.0	12.0	ND
LC29M	DE	11/26/06	26.0	3.0	64.0	4.0	4.0	98.0	ND	131.0	17.2	ND
LC29M	DE	3/1/07	24.0	2.0	57.0	3.0	4.0	205.0	ND	54.0	18.1	ND
LC29M	DE	5/4/07	27.0	2.0	47.0	3.0	10.0	183.0	ND	21.0	15.3	0.90
LC30M	DE	9/20/06	29.0	2.0	33.0	2.0	6.0	122.0	ND	31.0	14.7	1.40
LC30M	DE	11/26/06	25.0	1.0	31.0	2.0	5.0	124.0	ND	26.0	13.7	1.20
LC30M	DE	3/1/07	51.0	2.0	33.0	2.0	6.0	156.0	ND	51.0	17.4	0.60
LC30M	DE	5/3/07	62.0	2.0	28.0	2.0	6.0	176.0	ND	55.0	17.7	ND
LC31M	DE	9/21/06	40.0	3.0	140.0	9.0	7.0	140.0	ND	***316.0***	15.0	0.80
LC31M	DE	11/26/06	39.0	3.0	120.0	8.0	7.0	145.0	ND	***280.0***	13.9	0.40
LC31M	DE	2/28/07	64.0	3.0	108.0	7.0	8.0	156.0	ND	***277.0***	17.0	0.30
LC31M	DE	5/3/07	71.0	3.0	99.0	6.0	6.0	159.0	ND	***279.0***	15.9	0.20
MB-1	DE	8/27/09	22.0	3.0	10.0	ND	12.0	ND	18.0	22.0	15.7	1.55
MB-1	DE	1/4/10	23.0	2.0	11.0	ND	8.0	59.0	ND	21.0	14.4	1.60
MB-1	DE	3/30/10	29.0	3.0	19.0	1.0	6.0	108.0	ND	21.0	14.2	1.80
MB-1	DE	6/29/10	28.0	3.0	20.0	1.0	6.0	112.0	ND	20.0	14.3	1.60
MB-7	DE	8/26/09	Insufficient water to sample.									
MB-10	DE	8/26/09	Insufficient water to sample.									

Table 3.6-8 Analytical Results of Baseline Monitoring (Page 2 of 17)

			General Water Quality				Radionuclides					
Well ID	Completion Zone	Sample Date	TDS (mg/L)	Specific Conductivity	Lab pH (SU)	Alkalinity (mg/L)	Gross Alpha (pCi/L)	Gross Beta (pCi/L)	Ra-226 (pCi/L)	Ra-228 (pCi/L)	Ra-226 + Ra-228 (pCi/L)	Uranium (mg/L)
LC29M	DE	9/20/06	283.0			112.0	***328.0***	142.0	1.9	ND	1.9	***0.499***
LC29M	DE	11/26/06	298.0	491.0	7.68	80.0	***158.0***	54.0	1.7	4.7	***6.4***	***0.246***
LC29M	DE	3/1/07	265.0	385.0	7.77		***265.0***	86.1	4.0	ND	4.0	***0.318***
LC29M	DE	5/4/07	219.0	356.0	7.75		***200.0***	84.6	3.0	ND	3.0	***0.251***
LC30M	DE	9/20/06	184.0			100.0	***129.0***	41.5	1.0	ND	1.0	***0.141***
LC30M	DE	11/26/06	170.0	288.0	7.33	102.0	***107.0***	32.3	0.9	1.6	2.5	***0.154***
LC30M	DE	3/1/07	241.0	393.0	8.02		***108.0***	31.9	5.7	ND	***5.7***	***0.162***
LC30M	DE	5/3/07	260.0	440.0	8.07		***109.0***	40.0	2.1	ND	2.1	***0.130***
LC31M	DE	9/21/06	***602.0***	800.0	7.85	114.0	***1120.0***	405.0	2.0	1.7	3.7	***1.890***
LC31M	DE	11/26/06	***528.0***	838.0	7.79	119.0	***1430.0***	395.0	2.6	3.2	***5.8***	***2.100***
LC31M	DE	2/28/07	***563.0***	817.0	7.94		***967.0***	262.0	7.2	1.0	***8.2***	***1.400***
LC31M	DE	5/3/07	***559.0***	860.0	7.79		***1030.0***	319.0	1.9	2.4	4.3	***1.610***
MB-1	DE	8/27/09	121.0	186.0	***10.10***		***21.4***	10.1	0.7	0.9	1.6	0.011
MB-1	DE	1/4/10	95.0	183.0	***9.27***	55.0	***74.7***	18.9	0.3	1.6	1.9	***0.063***
MB-1	DE	3/30/10	167.0	235.0	8.42	88.0	***158.0***	27.1	0.3	1.0	1.3	***0.135***
MB-1	DE	6/29/10	133.0	242.0	***8.61***	92.0	***173.0***	36.7	0.2	0.9	1.1	***0.126***
MB-7	DE	8/26/09	Insufficient water to sample.									
MB-10	DE	8/26/09	Insufficient water to sample.									

Table 3.6-8 Analytical Results of Baseline Monitoring (Page 4 of 17)

Trace Parameters (Dissolved unless otherwise noted.)													
Well ID	Completion Zone	Sample Date	Fe (mg/L)		Hg (mg/L)	Mn (mg/L)		Mo (mg/L)	Ni (mg/L)	Pb (mg/L)	Se (mg/L)	V (mg/L)	Zn (mg/L)
			Dissolved	Total		Dissolved	Total						
LC29M	DE	9/20/06	0.09	0.09	ND	***0.12***	***0.11***	ND	ND	ND	0.002	ND	ND
LC29M	DE	11/26/06	***0.67***	***0.46***	ND	***0.48***	***0.32***	ND	ND	ND	ND	ND	ND
LC29M	DE	3/1/07	***0.40***	***0.40***	ND	***0.24***	***0.24***	ND	ND	ND	ND	ND	ND
LC29M	DE	5/4/07	0.14	0.14	ND	0.04	0.04	ND	ND	ND	ND	ND	ND
LC30M	DE	9/20/06	ND	ND	ND	0.01	ND	ND	ND	ND	0.016	ND	ND
LC30M	DE	11/26/06	ND	ND	ND	0.01	0.01	ND	ND	ND	0.016	ND	ND
LC30M	DE	3/1/07	0.11	0.11	ND	***0.08***	***0.08***	ND	ND	ND	0.006	ND	ND
LC30M	DE	5/3/07	0.09	0.09	ND	***0.07***	***0.07***	ND	ND	ND	0.003	ND	ND
LC31M	DE	9/21/06	ND	ND	ND	0.01	ND	ND	ND	ND	***0.215***	ND	ND
LC31M	DE	11/26/06	ND	ND	ND	***0.06***	0.05	ND	ND	ND	***0.211***	ND	ND
LC31M	DE	2/28/07	0.10	0.10	ND	***0.10***	***0.10***	ND	ND	ND	***0.151***	ND	ND
LC31M	DE	5/3/07	0.07	0.07	ND	0.02	0.02	ND	ND	ND	***0.111***	ND	ND
MB-1	DE	8/27/09	***0.40***	***0.42***	ND	ND	ND	ND	ND	ND	0.003	ND	ND
MB-1	DE	1/4/10	0.03	0.10	ND	ND	ND	ND	ND	ND	0.004	ND	ND
MB-1	DE	3/30/10	ND	ND	ND	ND	ND	ND	ND	ND	0.004	ND	ND
MB-1	DE	6/29/10	ND	0.14	ND	ND	ND	ND	ND	ND	0.004	ND	ND
MB-7	DE	8/26/09	Insufficient water to sample										
MB-10	DE	8/26/09	Insufficient water to sample										

Table 3.6-8 Analytical Results of Baseline Monitoring (Page 5 of 17)

Major Cations and Anions												
Well ID	Completion Zone	Sample Date	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	Cl (mg/L)	HCO_3 (mg/L)	CO_3 (mg/L)	SO_4 (mg/L)	SiO_2 (mg/L)	NO_3+NO_2 (mg/L)
LC15M	LFG	9/12/06	31.0	4.0	86.0	4.0	8.0	127.0	ND	180.0	16.0	ND
LC15M	LFG	11/26/06	31.0	2.0	84.0	4.0	6.0	134.0	ND	157.0	14.3	ND
LC15M	LFG	3/1/07	33.0	3.0	89.0	5.0	1.0	130.0	ND	180.0	14.8	0.20
LC15M	LFG	5/4/07	34.0	9.0	46.0	3.0	6.0	85.0	ND	142.0	13.0	0.40
LC18M	LFG	9/20/06	35.0	3.0	61.0	3.0	5.0	122.0	ND	122.0	13.2	ND
LC18M	LFG	11/22/06	31.0	2.0	55.0	3.0	5.0	117.0	ND	117.0	12.4	ND
LC18M	LFG	3/1/07	33.0	2.0	60.0	3.0	5.0	120.0	ND	120.0	13.6	ND
LC18M	LFG	5/4/07	30.0	3.0	49.0	3.0	5.0	112.0	ND	119.0	12.6	ND
LC21M	LFG	9/20/06	33.0	2.0	46.0	3.0	6.0	121.0	5.0	62.0	15.8	1.00
LC21M	LFG	11/26/06	30.0	2.0	41.0	3.0	5.0	132.0	ND	59.0	13.9	0.80
LC21M	LFG	2/28/07	31.0	3.0	35.0	3.0	5.0	120.0	ND	60.0	15.2	1.00
LC21M	LFG	5/3/07	30.0	2.0	41.0	3.0	5.0	124.0	ND	58.0	13.7	1.00
LC25M	LFG	9/21/06	35.0	4.0	73.0	2.0	6.0	100.0	2.0	146.0	14.1	0.30
LC25M	LFG	11/17/06	34.0	2.0	70.0	4.0	6.0	120.0	ND	139.0	14.6	0.20
LC25M	LFG	3/1/07	32.0	2.0	72.0	4.0	6.0	126.0	ND	150.0	14.7	0.20
LC25M	LFG	5/3/07	34.0	4.0	34.0	3.0	4.0	36.0	ND	133.0	13.5	ND
MB-2	LFG	8/27/09	29.0	2.0	37.0	3.0	8.0	121.0	ND	53.0	16.1	1.2
MB-2	LFG	12/14/09	27.0	2.0	34.0	3.0	8.0	124.0	ND	58.0	14.7	1.1
MB-2	LFG	3/30/10	34.0	3.0	38.0	2.0	8.0	128.0	ND	58.0	16.5	1.2
MB-2	LFG	7/6/10	31.0	2.0	37.0	3.0	8.0	128.0	ND	59.0	15.1	1.1
MB-5	LFG	8/27/09	24.0	3.0	63.0	3.0	6.0	132.0	ND	105.0	17.2	ND
MB-5	LFG	12/14/09	24.0	2.0	61.0	3.0	7.0	134.0	ND	114.0	15.9	ND
MB-5	LFG	3/31/10	25.0	2.0	62.0	3.0	6.0	141.0	ND	108.0	12.8	ND
MB-5	LFG	7/6/10	26.0	2.0	61.0	3.0	6.0	139.0	ND	109.0	16.2	ND
MB-8	LFG	8/26/09	24.0	3.0	70.0	4.0	5.0	159.0	ND	121.0	16.9	0.0
MB-8	LFG	1/4/10	27.0	2.0	74.0	5.0	6.0	154.0	ND	129.0	17.5	ND
MB-8	LFG	3/30/10	26.0	2.0	73.0	5.0	6.0	163.0	ND	130.0	16.8	ND
MB-8	LFG	6/29/10	25.0	2.0	72.0	5.0	6.0	159.0	ND	131.0	16.1	ND

Table 3.6-8 Analytical Results of Baseline Monitoring (Page 6 of 17)

			General Water Quality				Radionuclides					
Well ID	Completion Zone	Sample Date	TDS (mg/L)	Specific Conductivity	Lab pH (SU)	Alkalinity (mg/L)	Gross Alpha (pCi/L)	Gross Beta (pCi/L)	Ra-226 (pCi/L)	Ra-228 (pCi/L)	Ra-226 + Ra-228 (pCi/L)	Uranium (mg/L)
LC15M	LFG	9/12/06	390.0				***263.0***	83.3	5.3	0.9	***6.2***	***0.489***
LC15M	LFG	11/26/06	370.0	605.0	7.84	110.0	***334.0***	116.0	3.8	4.8	***8.6***	***0.472***
LC15M	LFG	3/1/07	390.0	587.0	7.32		***374.0***	92.7	6.0	3.5	***9.5***	***0.467***
LC15M	LFG	5/4/07	296.0	492.0	8.27		***236.0***	92.1	3.6	ND	3.6	***0.358***
LC18M	LFG	9/20/06	303.0			100.0	***518.0***	192.0	43.0	2.8	***45.8***	***0.523***
LC18M	LFG	11/22/06	277.0	461.0	8.33	98.0	***490.0***	199.0	63.5	3.9	***67.4***	***0.546***
LC18M	LFG	3/1/07	296.0	460.0	7.86		***439.0***	148.0	ND	ND	0.0	***0.533***
LC18M	LFG	5/4/07	277.0	467.0	8.09		***385.0***	115.0	26.4	ND	***26.4***	***0.419***
LC21M	LFG	9/20/06	233.0			106.0	***219.0***	70.3	1.6	1.2	2.8	***0.251***
LC21M	LFG	11/26/06	219.0	373.0	8.17	108.0	***205.0***	49.2	1.2	12.0	***13.2***	***0.278***
LC21M	LFG	2/28/07	214.0	333.0	8.25		***815.0***	62.6	230.0	ND	***230.0***	***0.270***
LC21M	LFG	5/3/07	219.0	371.0	8.17		***202.0***	65.2	3.7	ND	3.7	***0.236***
LC25M	LFG	9/21/06	336.0	452.0	8.37	91.0	***353.0***	124.0	3.1	3.3	***6.4***	***0.465***
LC25M	LFG	11/17/06	330.0	516.0	8.28		***301.0***	138.0	3.1	ND	3.1	***0.460***
LC25M	LFG	3/1/07	344.0	519.0	7.97		***369.0***	107.0	2.3	2.3	4.6	***0.517***
LC25M	LFG	5/3/07	244.0	390.0	***8.57***		***194.0***	72.5	2.9	ND	2.9	***0.289***
MB-2	LFG	8/27/09	220.0	337.0	8.17		***223.0***	61.4	1.7	2.0	3.7	***0.164***
MB-2	LFG	12/14/09	195.0	345.0	8.07		***175.0***	61.9	1.5	1.3	2.8	***0.172***
MB-2	LFG	3/30/10	231.0	341.0	8.14	105.0	***196.0***	34.2	1.4	2.1	3.5	***0.191***
MB-2	LFG	7/6/10	236.0	344.0	7.78	105.0	***185.0***	56.7	1.0	1.5	2.5	***0.178***
MB-5	LFG	8/27/09	295.0	438.0	7.99		***80.9***	28.4	32.0	3.3	***35.3***	0.017
MB-5	LFG	12/14/09	298.0	449.0	7.92		***70.2***	30.9	29.0	2.8	***31.8***	0.018
MB-5	LFG	3/31/10	301.0	440.0	7.90	115.0	***67.9***	24.5	32.0	2.5	***34.5***	0.016
MB-5	LFG	7/6/10	311.0	439.0	7.57	114.0	***67.9***	23.6	34.0	2.2	***36.2***	0.016
MB-8	LFG	8/26/09	333.0	487.0	7.91		***204.0***	54.9	3.2	2.4	***5.6***	***0.152***
MB-8	LFG	1/4/10	306.0	501.0	7.94	126.0	***261.0***	60.6	1.8	3.0	4.8	***0.190***
MB-8	LFG	3/30/10	332.0	505.0	7.86	133.0	***195.0***	35.9	1.7	2.6	4.3	***0.204***
MB-8	LFG	6/29/10	325.0	509.0	7.78	130.0	***291.0***	52.0	2.1	2.5	4.6	***0.207***

Table 3.6-8 Analytical Results of Baseline Monitoring (Page 7 of 17)

Trace Parameters (Dissolved unless otherwise noted.)											
Well ID	Completion Zone	Sample Date	Al (mg/L)	NH_3-N (mg/L)	As (mg/L)	Ba (mg/L)	B (mg/L)	Cd (mg/L)	Cr (mg/L)	Cu (mg/L)	F (mg/L)
LC15M	LFG	9/12/06	ND	ND	ND	ND	ND	ND	ND	ND	0.20
LC15M	LFG	11/26/06	ND	ND	ND	ND	ND	ND	ND	ND	0.20
LC15M	LFG	3/1/07	ND	ND	ND	ND	ND	ND	ND	ND	0.20
LC15M	LFG	5/4/07	ND	ND	ND	ND	ND	ND	ND	ND	0.20
LC18M	LFG	9/20/06	ND	ND	0.004	ND	ND	ND	ND	ND	0.20
LC18M	LFG	11/22/06	ND	ND	0.002	ND	ND	ND	ND	ND	0.20
LC18M	LFG	3/1/07	ND	ND	0.002	ND	ND	ND	ND	ND	0.20
LC18M	LFG	5/4/07	ND	ND	ND	ND	ND	ND	ND	ND	0.20
LC21M	LFG	9/20/06	ND	0.08	ND	ND	ND	ND	ND	ND	0.30
LC21M	LFG	11/26/06	ND	ND	ND	ND	ND	ND	ND	ND	0.30
LC21M	LFG	2/28/07	ND	ND	ND	ND	ND	ND	ND	ND	0.20
LC21M	LFG	5/3/07	ND	ND	ND	ND	ND	ND	ND	ND	0.20
LC25M	LFG	9/21/06	ND	ND	0.004	ND	ND	ND	ND	ND	0.20
LC25M	LFG	11/17/06	ND	ND	ND	ND	ND	ND	ND	ND	0.20
LC25M	LFG	3/1/07	ND	ND	ND	ND	ND	ND	ND	ND	0.20
LC25M	LFG	5/3/07	ND	ND	ND	ND	ND	ND	ND	ND	0.20
MB-2	LFG	8/27/09	ND	0.14	0.00	ND	ND	ND	ND	ND	ND
MB-2	LFG	12/14/09	ND	ND	0.00	ND	ND	ND	ND	ND	0.20
MB-2	LFG	3/30/10	ND	ND	ND	ND	ND	ND	ND	ND	ND
MB-2	LFG	7/6/10	ND	ND	0.00	ND	ND	ND	ND	ND	ND
MB-5	LFG	8/27/09	ND	0.08	ND	ND	ND	ND	ND	ND	ND
MB-5	LFG	12/14/09	ND	ND	ND	ND	ND	ND	ND	ND	0.10
MB-5	LFG	3/31/10	ND	ND	ND	ND	ND	ND	ND	ND	ND
MB-5	LFG	7/6/10	ND	ND	ND	ND	ND	ND	ND	ND	ND
MB-8	LFG	8/26/09	ND	0.13	ND	ND	ND	ND	ND	ND	ND
MB-8	LFG	1/4/10	ND	ND	ND	ND	ND	ND	ND	ND	ND
MB-8	LFG	3/30/10	ND	ND	ND	ND	ND	ND	ND	ND	
MB-8	LFG	6/29/10	ND	ND	ND	ND	ND	ND	ND	ND	ND

Table 3.6-8 Analytical Results of Baseline Monitoring (Page 8 of 17)

Trace Parameters (Dissolved unless otherwise noted.)													
Well ID	Completion Zone	Sample Date	Fe (mg/L)		Hg (mg/L)	Mn (mg/L)		Mo (mg/L)	Ni (mg/L)	Pb (mg/L)	Se (mg/L)	V (mg/L)	Zn (mg/L)
			Dissolved	Total		Dissolved	Total						
LC15M	LFG	9/12/06	0.03	ND	ND	ND	ND	ND	ND	ND	0.019	ND	ND
LC15M	LFG	11/26/06	ND	ND	ND	ND	ND	ND	ND	ND	0.016	ND	ND
LC15M	LFG	3/1/07	ND	ND	ND	ND	ND	ND	ND	ND	0.017	ND	ND
LC15M	LFG	5/4/07	ND	ND	ND	ND	ND	ND	ND	ND	0.010	ND	ND
LC18M	LFG	9/20/06	***0.53***	***0.53***	ND	ND	ND	ND	ND	ND	0.024	ND	ND
LC18M	LFG	11/22/06	***0.51***	***0.51***	ND	ND	ND	ND	ND	ND	0.015	ND	ND
LC18M	LFG	3/1/07	***0.67***	***0.67***	ND	ND	ND	ND	ND	ND	0.016	ND	ND
LC18M	LFG	5/4/07	0.10	0.10	ND	ND	ND	ND	ND	ND	ND	ND	ND
LC21M	LFG	9/20/06	***0.40***	***0.40***	ND	0.02	0.02	ND	ND	ND	0.040	ND	ND
LC21M	LFG	11/26/06	ND	ND	ND	ND	ND	ND	ND	ND	0.039	ND	ND
LC21M	LFG	2/28/07	ND	ND	ND	ND	ND	ND	ND	ND	0.034	ND	ND
LC21M	LFG	5/3/07	ND	ND	ND	ND	ND	ND	ND	ND	0.032	ND	ND
LC25M	LFG	9/21/06	ND	ND	ND	ND	ND	ND	ND	ND	0.027	ND	ND
LC25M	LFG	11/17/06	ND	ND	ND	ND	ND	ND	ND	ND	0.027	ND	ND
LC25M	LFG	3/1/07	ND	ND	ND	ND	ND	ND	ND	ND	0.025	ND	ND
LC25M	LFG	5/3/07	ND	ND	ND	ND	ND	ND	ND	ND	0.015	ND	ND
MB-2	LFG	8/27/09	0.20	ND	ND	ND	ND	ND	ND	ND	0.013	ND	ND
MB-2	LFG	12/14/09	ND	ND	ND	ND	ND	ND	ND	ND	0.013	ND	ND
MB-2	LFG	3/30/10	ND	ND	ND	ND	ND	ND	ND	ND	0.015	ND	ND
MB-2	LFG	7/6/10	ND	ND	ND	ND	ND	ND	ND	ND	0.013	ND	ND
MB-5	LFG	8/27/09	0.10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MB-5	LFG	12/14/09	ND	ND	ND	ND	0.01	ND	ND	ND	ND	ND	ND
MB-5	LFG	3/31/10	ND	0.04	ND	0.01	0.01	ND	ND	ND	ND	ND	ND
MB-5	LFG	7/6/10	ND	0.04	ND	ND	ND	ND	ND	ND	ND	ND	ND
MB-8	LFG	8/26/09	0.10	***0.42***	ND	ND	ND	ND	ND	ND	0.003	ND	0.05
MB-8	LFG	1/4/10	ND	ND	ND	ND	ND	ND	ND	ND	0.003	ND	ND
MB-8	LFG	3/30/10	ND	ND	ND	ND	ND	ND	ND	ND	0.004	ND	ND
MB-8	LFG	6/29/10	ND	ND	ND	ND	ND	ND	ND	ND	0.004	ND	ND

Table 3.6-8 Analytical Results of Baseline Monitoring (Page 9 of 17)

Major Cations and Anions												
Well ID	Completion Zone	Sample Date	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	Cl (mg/L)	HCO_3 (mg/L)	CO_3 (mg/L)	SO_4 (mg/L)	SiO_2 (mg/L)	NO_3+NO_2 (mg/L)
LC16M	HJ	9/12/06	27.0	2.0	77.0	4.0	5.0	134.0	ND	144.0	16.0	ND
LC16M	HJ	11/10/06	29.3	8.0	80.1	3.9	7.0	128.0	ND	136.0		ND
LC16M	HJ	3/1/07	30.0	2.0	74.0	4.0	4.0	132.0	ND	138.0	15.0	ND
LC16M	HJ	5/4/07	29.0	2.0	74.0	4.0	5.0	137.0	ND	139.0	14.8	ND
LC19M	HJ	9/20/06	35.0	3.0	66.0	3.0	6.0	103.0	2.0	139.0		ND
LC19M	HJ	11/3/06	32.8	2.1	72.9	3.2	6.0	132.0	ND	146.0	15.0	ND
LC19M	HJ	3/5/07	40.0	13.0	41.0	3.0	6.0	73.0	ND	124.0	14.5	ND
LC19M	HJ	5/4/07	33.0	8.0	45.0	3.0	5.0	93.0	ND	137.0	14.8	ND
LC22M	HJ	9/21/06	40.0	2.0	74.0	3.0	5.0	113.0	ND	170.0	15.0	ND
LC22M	HJ	11/16/06	36.0	2.0	62.0	3.0	4.0	109.0	ND	154.0	12.8	ND
LC22M	HJ	3/1/07	37.0	4.0	60.0	3.0	6.0	110.0	ND	142.0	14.2	ND
LC22M	HJ	5/3/07	35.0	4.0	64.0	3.0	5.0	113.0	ND	137.0	13.0	ND
LC26M	HJ	9/21/06	35.0	4.0	133.0	6.0	6.0	168.0	ND	***269.0***	17.7	ND
LC26M	HJ	11/17/06	33.0	3.0	127.0	5.0	6.0	166.0	ND	***256.0***	17.0	ND
LC26M	HJ	3/1/07	33.0	3.0	125.0	5.0	5.0	159.0	ND	***253.0***	16.2	ND
LC26M	HJ	5/3/07	34.0	8.0	90.0	5.0	5.0	57.0	ND	***259.0***	17.5	ND
MB-3B	HJ	8/27/09	31.0	4.0	37.0	2.0	11.0	108.0	ND	66.0	17.2	0.9
MB-3B	HJ	12/14/09	30.0	3.0	37.0	2.0	10.0	112.0	ND	70.0	15.3	0.8
MB-3B	HJ	3/30/10	32.0	2.0	35.0	3.0	10.0	118.0	ND	71.0	15.1	0.8
MB-3B	HJ	7/6/10	32.0	3.0	38.0	2.0	9.0	120.0	ND	71.0	16.0	0.8
MB-6	HJ	8/27/09	38.0	3.0	38.0	1.0	4.0	77.0	ND	106.0	16.8	ND
MB-6	HJ	12/14/09	19.0	2.0	50.0	2.0	5.0	142.0	ND	71.0	16.7	ND
MB-6	HJ	3/31/10	21.0	2.0	52.0	2.0	6.0	149.0	ND	71.0	13.4	ND
MB-6	HJ	7/7/10	22.0	2.0	55.0	2.0	5.0	146.0	ND	73.0	16.9	ND
MB-9	HJ	8/27/09	24.0	3.0	70.0	4.0	5.0	159.0	ND	121.0	16.9	0.0
MB-9	HJ	12/15/09	21.0	6.0	47.0	2.0	5.0	117.0	ND	75.0	19.0	ND
MB-9	HJ	3/30/10	24.0	5.0	48.0	2.0	6.0	136.0	ND	75.0	18.5	ND
MB-9	HJ	7/6/10	23.0	4.0	48.0	2.0	5.0	136.0	ND	75.0	18.9	ND

Table 3.6-8 Analytical Results of Baseline Monitoring (Page 10 of 17)

			General Water Quality				Radionuclides					
Well ID	Completion Zone	Sample Date	TDS (mg/L)	Specific Conductivity	Lab pH (SU)	Alkalinity (mg/L)	Gross Alpha (pCi/L)	Gross Beta (pCi/L)	Ra-226 (pCi/L)	Ra-228 (pCi/L)	Ra-226 + Ra-228 (pCi/L)	Uranium (mg/L)
LC16M	HJ	9/12/06	330.0				***299.0***	109.0	166.0	4.3	***170.3***	***0.164***
LC16M	HJ	11/10/06	304.0	517.0			***274.0***	120.0	2.0	78.4	***80.4***	***0.133***
LC16M	HJ	3/1/07	333.0	509.0	7.92		***290.0***	79.7	65.1	3.8	***68.9***	***0.134***
LC16M	HJ	5/4/07	335.0	534.0	8.01		***188.0***	69.2	122.0	3.2	***125.2***	***0.122***
LC19M	HJ	9/20/06	319.0			87.0	***985.0***	540.0	366.0	4.8	***370.8***	***0.336***
LC19M	HJ	11/3/06	328.0	506.0	7.85	108.0	***863.0***	592.0	547.0	4.1	***551.1***	***0.051***
LC19M	HJ	3/5/07	278.0	432.0	8.02		***1220.0***	473.0	316.0	3.4	***319.4***	***0.844***
LC19M	HJ	5/4/07	266.0	482.0	8.11		***1470.0***	603.0	423.0	1.0	***424.0***	***0.762***
LC22M	HJ	9/21/06	366.0	511.0	8.14	93.0	***810.0***	358.0	261.0	3.2	***264.2***	***0.342***
LC22M	HJ	11/16/06	328.0	531.0	8.15		***597.0***	258.0	247.0	1.9	***248.9***	***0.185***
LC22M	HJ	3/1/07	319.0	483.0	7.87		***86.5***	97.9	1.7	3.6	***5.3***	***0.129***
LC22M	HJ	5/3/07	316.0	513.0	8.11		***576.0***	186.0	308.0	3.8	***311.8***	***0.097***
LC26M	HJ	9/21/06	***554.0***	741.0	8.16	138.0	***306.0***	111.0	87.7	4.6	***92.3***	***0.107***
LC26M	HJ	11/17/06	***528.0***	786.0	8.06		***300.0***	119.0	77.2	3.8	***81.0***	***0.072***
LC26M	HJ	3/1/07	***519.0***	745.0	7.85		***30.5***	46.1	ND	3.6	3.6	***0.045***
LC26M	HJ	5/3/07	449.0	653.0	8.44		***50.2***	23.4	12.4	ND	***12.4***	***0.037***
MB-3B	HJ	8/27/09	231.0	353.0	8.29		***255.0***	48.8	1.9	3.1	5.0	***0.179***
MB-3B	HJ	12/14/09	220.0	358.0	8.17		***215.0***	61.8	1.5	1.5	3.0	***0.186***
MB-3B	HJ	3/30/10	246.0	359.0	8.23	97.0	***204.0***	31.9	1.5	1.5	3.0	***0.174***
MB-3B	HJ	7/6/10	247.0	361.0	7.86	98.0	***235.0***	57.1	1.9	1.3	3.2	***0.194***
MB-6	HJ	8/27/09	256.0	374.0	***8.79***		10.2	8.9	3.4	3.8	***7.2***	0.000
MB-6	HJ	12/14/09	242.0	373.0	7.98		***21.0***	12.9	5.9	3.8	***9.7***	0.007
MB-6	HJ	3/31/10	265.0	370.0	7.90	122.0	***27.9***	12.9	5.5	3.1	***8.6***	0.006
MB-6	HJ	7/7/10	259.0	374.0	7.66	120.0	***24.3***	13.4	4.6	4.5	***9.1***	0.006
MB-9	HJ	8/27/09	333.0	487.0	7.91		***204.0***	54.9	3.2	2.4	***5.6***	***0.152***
MB-9	HJ	12/15/09	240.0	361.0	8.47		12.5	12.3	2.9	4.4	***7.3***	0.004
MB-9	HJ	3/30/10	231.0	369.0	8.05	111.0	***19.2***	13.0	2.2	4.4	***6.6***	0.004
MB-9	HJ	7/6/10	254.0	366.0	7.53	111.0	12.4	6.8	2.7	3.7	***6.4***	0.004

Table 3.6-8 Analytical Results of Baseline Monitoring (Page 11 of 17)

Trace Parameters (Dissolved unless otherwise noted.)											
Well ID	Completion Zone	Sample Date	Al (mg/L)	NH_3-N (mg/L)	As (mg/L)	Ba (mg/L)	B (mg/L)	Cd (mg/L)	Cr (mg/L)	Cu (mg/L)	F (mg/L)
LC16M	HJ	9/12/06	ND	ND	0.002	ND	ND	ND	ND	ND	0.10
LC16M	HJ	11/10/06	ND	ND	ND	ND	ND	ND	ND	ND	0.10
LC16M	HJ	3/1/07	ND	ND	ND	ND	ND	ND	ND	ND	0.20
LC16M	HJ	5/4/07	ND	ND	ND	ND	ND	ND	ND	ND	0.20
LC19M	HJ	9/20/06	ND	ND	***0.014***	ND	ND	ND	ND	ND	ND
LC19M	HJ	11/3/06	ND	ND	0.002	ND	ND	ND	ND	ND	ND
LC19M	HJ	3/5/07	ND	0.06	0.008	ND	ND	ND	ND	ND	0.20
LC19M	HJ	5/4/07	ND	ND	0.007	ND	ND	ND	ND	ND	ND
LC22M	HJ	9/21/06	ND	ND	0.005	ND	ND	ND	ND	ND	ND
LC22M	HJ	11/16/06	ND	ND	ND	ND	ND	ND	ND	ND	0.20
LC22M	HJ	3/1/07	ND	ND	0.002	ND	ND	ND	ND	ND	0.20
LC22M	HJ	5/3/07	ND	ND	0.002	ND	ND	ND	ND	ND	0.20
LC26M	HJ	9/21/06	ND	ND	0.003	ND	ND	ND	ND	ND	ND
LC26M	HJ	11/17/06	ND	ND	ND	ND	ND	ND	ND	ND	ND
LC26M	HJ	3/1/07	ND	0.07	ND	ND	ND	ND	ND	ND	ND
LC26M	HJ	5/3/07	ND	ND	ND	ND	ND	ND	ND	ND	0.20
MB-3B	HJ	8/27/09	ND	0.25	0.00	ND	ND	ND	ND	ND	ND
MB-3B	HJ	12/14/09	ND	ND	ND	ND	ND	ND	ND	ND	0.20
MB-3B	HJ	3/30/10	ND	ND	ND	ND	ND	ND	ND	ND	ND
MB-3B	HJ	7/6/10	ND	ND	ND	ND	ND	ND	ND	ND	ND
MB-6	HJ	8/27/09	ND	ND	0.00	ND	ND	ND	ND	ND	ND
MB-6	HJ	12/14/09	ND	ND	ND	ND	ND	ND	ND	ND	0.20
MB-6	HJ	3/31/10	ND	ND	ND	ND	ND	ND	ND	ND	ND
MB-6	HJ	7/7/10	ND	ND	ND	ND	ND	ND	ND	ND	ND
MB-9	HJ	8/27/09	ND	0.13	ND	ND	ND	ND	ND	ND	ND
MB-9	HJ	12/15/09	ND	ND	0.01	ND	ND	ND	ND	ND	0.20
MB-9	HJ	3/30/10	ND	ND	0.00	ND	ND	ND	ND	ND	ND
MB-9	HJ	7/6/10	ND	ND	0.00	ND	ND	ND	ND	ND	ND

Table 3.6-8 Analytical Results of Baseline Monitoring (Page 12 of 17)

Trace Parameters (Dissolved unless otherwise noted.)													
Well ID	Completion Zone	Sample Date	Fe (mg/L)		Hg (mg/L)	Mn (mg/L)		Mo (mg/L)	Ni (mg/L)	Pb (mg/L)	Se (mg/L)	V (mg/L)	Zn (mg/L)
			Dissolved	Total		Dissolved	Total						
LC16M	HJ	9/12/06	0.03	ND	ND	ND	0.01	ND	ND	ND	ND	ND	ND
LC16M	HJ	11/10/06	0.06	0.06	ND	ND	0.01	ND	ND	ND	ND	ND	ND
LC16M	HJ	3/1/07	ND	ND	ND	ND	0.01	ND	ND	ND	ND	ND	ND
LC16M	HJ	5/4/07	ND	ND	ND	ND	0.01	ND	ND	ND	ND	ND	ND
LC19M	HJ	9/20/06	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
LC19M	HJ	11/3/06	ND	ND	ND	ND	0.01	ND	ND	ND	ND	ND	ND
LC19M	HJ	3/5/07	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
LC19M	HJ	5/4/07	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
LC22M	HJ	9/21/06	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
LC22M	HJ	11/16/06	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
LC22M	HJ	3/1/07	ND	ND	ND	0.02	0.01	ND	ND	ND	ND	ND	ND
LC22M	HJ	5/3/07	ND	0.03	ND	ND	0.01	ND	ND	ND	ND	ND	ND
LC26M	HJ	9/21/06	ND	ND	ND	0.02	0.02	ND	ND	ND	ND	ND	ND
LC26M	HJ	11/17/06	0.23	0.23	ND	0.03	0.03	ND	ND	ND	ND	ND	ND
LC26M	HJ	3/1/07	ND	ND	ND	0.02	0.02	ND	ND	ND	ND	ND	ND
LC26M	HJ	5/3/07	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MB-3B	HJ	8/27/09	0.20	ND	ND	ND	ND	ND	ND	ND	0.02	ND	0.01
MB-3B	HJ	12/14/09	ND	ND	ND	ND	ND	ND	ND	ND	0.02	ND	ND
MB-3B	HJ	3/30/10	ND	ND	ND	ND	ND	ND	ND	ND	0.01	ND	ND
MB-3B	HJ	7/6/10	ND	0.10	ND	ND	ND	ND	ND	ND	0.02	ND	ND
MB-6	HJ	8/27/09	0.10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MB-6	HJ	12/14/09	ND	0.04	ND	ND	0.01	ND	ND	ND	ND	ND	ND
MB-6	HJ	3/31/10	ND	0.04	ND	0.01	0.01	ND	ND	ND	ND	ND	ND
MB-6	HJ	7/7/10	ND	0.14	ND	ND	0.01	ND	ND	ND	ND	ND	ND
MB-9	HJ	8/27/09	0.10	***0.42***	ND	ND	ND	ND	ND	ND	0.00	ND	0.05
MB-9	HJ	12/15/09	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MB-9	HJ	3/30/10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MB-9	HJ	7/6/10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Table 3.6-8 Analytical Results of Baseline Monitoring (Page 13 of 17)

Major Cations and Anions												
Well ID	Completion Zone	Sample Date	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	Cl (mg/L)	HCO_3 (mg/L)	CO_3 (mg/L)	SO_4 (mg/L)	SiO_2 (mg/L)	NO_3+NO_2 (mg/L)
LC17M	UKM	9/12/06	27.0	4.0	55.0	2.0	4.0	107.0	4.0	107.0	15.2	ND
LC17M	UKM	11/26/06	27.0	2.0	55.0	2.0	5.0	120.0	ND	94.0	15.1	ND
LC17M	UKM	3/1/07	29.0	2.0	62.0	3.0	5.0	124.0	ND	105.0	16.8	ND
LC17M	UKM	5/4/07	27.0	2.0	61.0	3.0	4.0	142.0	ND	108.0	15.9	ND
LC20M	UKM	9/21/06	32.0	3.0	56.0	2.0	6.0	113.0	2.0	102.0	17.2	ND
LC20M	UKM	11/22/06	32.0	5.0	38.0	ND	6.0	63.0	3.0	80.0	12.7	ND
LC20M	UKM	3/1/07	36.0	11.0	15.0	ND	5.0	39.0	ND	95.0	14.6	ND
LC20M	UKM	5/4/07	35.0	11.0	12.0	ND	6.0	34.0	2.0	91.0	14.1	ND
LC23M	UKM	9/21/06	44.0	8.0	58.0	ND	5.0	83.0	6.0	165.0	13.9	ND
LC23M	UKM	11/26/06	41.0	7.0	50.0	2.0	3.0	85.0	ND	150.0	14.1	ND
LC23M	UKM	3/1/07	64.0	48.0	52.0	ND	15.0	7.0	137.0	146.0	10.7	ND
LC23M	UKM	5/3/07	63.0	52.0	86.0	ND	5.0	4.0	66.0	126.0	9.4	ND
LC24M	UKM	9/21/06	32.0	3.0	68.0	4.0	5.0	109.0	ND	138.0	16.1	ND
LC24M	UKM	11/26/06	29.0	2.0	66.0	3.0	4.0	126.0	2.0	121.0	14.7	ND
LC24M	UKM	3/1/07	31.0	7.0	43.0	3.0	5.0	73.0	ND	126.0	14.8	ND
LC24M	UKM	5/4/07	31.0	7.0	48.0	3.0	5.0	85.0	ND	126.0	14.6	ND
LC27M	UKM	9/26/06	19.5	4.1	29.5	0.6	4.0	93.0	1.0	29.0	15.3	ND
LC27M	UKM	11/16/06	21.0	4.0	27.0	ND	6.0	82.0	2.0	29.0	15.5	ND
LC27M	UKM	3/1/07	21.0	5.0	11.0	ND	4.0	38.0	ND	39.0	16.4	ND
LC27M	UKM	5/3/07	22.0	5.0	7.0	ND	4.0	33.0	5.0	32.0	17.8	ND
LC28M	UKM	9/21/06	27.0	3.0	60.0	3.0	6.0	125.0	ND	101.0	16.1	ND
LC28M	UKM	11/26/06	24.0	2.0	58.0	3.0	4.0	127.0	ND	88.0	15.7	ND
LC28M	UKM	2/28/07	25.0	2.0	59.0	3.0	6.0	127.0	ND	95.0	16.9	ND
LC28M	UKM	5/3/07	25.0	2.0	62.0	3.0	6.0	130.0	ND	96.0	15.0	ND
MB-4	UKM	8/31/09	32.0	8.0	32.0	ND	10.0	ND	23.0	61.0	19.5	0.5
MB-4	UKM	12/14/09	33.0	8.0	19.0	ND	32.0	15.0	10.0	66.0	14.0	0.7
MB-4	UKM	3/30/10	32.0	5.0	21.0	ND	7.0	23.0	16.0	73.0	17.4	0.9
MB-4	UKM	7/7/10	29.0	3.0	19.0	ND	6.0	35.0	10.0	72.0	16.0	ND

Table 3.6-8 Analytical Results of Baseline Monitoring (Page 14 of 17)

			General Water Quality				Radionuclides					
Well ID	Completion Zone	Sample Date	TDS (mg/L)	Specific Conductivity	Lab pH (SU)	Alkalinity (mg/L)	Gross Alpha (pCi/L)	Gross Beta (pCi/L)	Ra-226 (pCi/L)	Ra-228 (pCi/L)	Ra-226 + Ra-228 (pCi/L)	Uranium (mg/L)
LC17M	UKM	9/12/06	262.0				***28.4***	13.7	10.6	1.1	***11.7***	0.0135
LC17M	UKM	11/26/06	262.0	436.0	8.02	98.0	***29.0***	15.5	8.8	12.9	***21.7***	0.010
LC17M	UKM	3/1/07	284.0	433.0	7.88		***26.8***	11.5	5.5	ND	***5.5***	0.011
LC17M	UKM	5/4/07	291.0	467.0	8.11		***17.3***	9.1	7.2	1.5	***8.7***	0.009
LC20M	UKM	9/21/06	274.0	388.0	***8.56***	96.0	***44.4***	24.0	9.6	3.9	***13.5***	***0.036***
LC20M	UKM	11/22/06	216.0	362.0	***8.91***	56.0	***38.7***	19.5	9.3	3.4	***12.7***	0.025
LC20M	UKM	3/1/07	197.0	305.0	7.66		***65.3***	23.9	47.8	ND	***47.8***	0.024
LC20M	UKM	5/4/07	188.0	322.0	***9.04***		***31.9***	23.6	9.2	2.6	***11.8***	0.025
LC23M	UKM	9/21/06	341.0	451.0	***8.87***	76.0	***32.8***	17.5	3.3	ND	3.3	0.023
LC23M	UKM	11/26/06	303.0	498.0	7.97	70.0	***35.0***	14.9	4.7	6.7	***11.4***	0.019
LC23M	UKM	3/1/07	452.0	1180.0	***11.60***		5.3	34.8	1.9	1.0	2.9	0.002
LC23M	UKM	5/3/07	***526.0***	1720.0	***11.60***		***15.1***	44.7	4.7	1.5	***6.2***	0.002
LC24M	UKM	9/21/06	321.0	455.0	8.30	91.0	***107.0***	43.2	6.5	1.5	***8.0***	***0.134***
LC24M	UKM	11/26/06	302.0	500.0	8.33	105.0	***86.8***	27.6	5.9	5.8	***11.7***	***0.100***
LC24M	UKM	3/1/07	266.0	410.0	7.99		***48.6***	22.6	1.8	2.0	3.8	***0.062***
LC24M	UKM	5/4/07	277.0	452.0	8.08		***49.1***	23.8	8.9	1.5	***10.4***	***0.052***
LC27M	UKM	9/26/06	136.0				10.7	9.7	1.1	0.4	1.5	0.0026
LC27M	UKM	11/16/06	145.0	243.0	***8.66***		6.8	9.4	1.1	3.6	4.7	0.002
LC27M	UKM	3/1/07	117.0	171.0	***8.74***		***77.7***	4.1	26.6	ND	***26.6***	0.001
LC27M	UKM	5/3/07	111.0	178.0	***9.51***		2.9	3.9	0.4	ND	0.4	0.002
LC28M	UKM	9/21/06	276.0	394.0	8.14	103.0	***30.7***	19.4	8.1	3.4	***11.5***	0.017
LC28M	UKM	11/26/06	259.0	435.0	8.00	104.0	***18.1***	14.4	8.4	4.2	***12.6***	0.006
LC28M	UKM	2/28/07	269.0	400.0	8.15		***27.0***	13.0	7.7	2.1	***9.8***	0.007
LC28M	UKM	5/3/07	273.0	440.0	8.01		***19.4***	11.2	7.1	3.7	***10.8***	0.023
MB-4	UKM	8/31/09	209.0	474.0	***11.10***		***49.8***	22.4	0.5	1.7	2.2	0.017
MB-4	UKM	12/14/09	183.0	329.0	***9.65***		***59.2***	23.0	0.9	1.2	2.1	***0.065***
MB-4	UKM	3/30/10	198.0	285.0	***9.91***	45.0	***58.6***	13.2	ND	ND	ND	***0.037***
MB-4	UKM	7/7/10	182.0	259.0	***9.36***	45.0	***70.5***	20.5	0.2	0.3	0.5	***0.044***

Table 3.6-8 Analytical Results of Baseline Monitoring (Page 15 of 17)

Trace Parameters (Dissolved unless otherwise noted.)											
Well ID	Completion Zone	Sample Date	Al (mg/L)	NH_3-N (mg/L)	As (mg/L)	Ba (mg/L)	B (mg/L)	Cd (mg/L)	Cr (mg/L)	Cu (mg/L)	F (mg/L)
LC17M	UKM	9/12/06	ND	ND	0.006	ND	ND	ND	ND	ND	0.20
LC17M	UKM	11/26/06	ND	ND	0.003	ND	ND	ND	ND	ND	0.20
LC17M	UKM	3/1/07	ND	0.06	0.002	ND	ND	ND	ND	ND	0.20
LC17M	UKM	5/4/07	ND	ND	0.002	ND	ND	ND	ND	ND	0.20
LC20M	UKM	9/21/06	ND	ND	***0.012***	ND	ND	ND	ND	ND	ND
LC20M	UKM	11/22/06	ND	ND	***0.012***	ND	ND	ND	ND	ND	0.20
LC20M	UKM	3/1/07	ND	ND	***0.012***	ND	ND	ND	ND	ND	0.20
LC20M	UKM	5/4/07	ND	ND	***0.011***	ND	ND	ND	ND	ND	0.20
LC23M	UKM	9/21/06	ND	ND	0.009	ND	ND	ND	ND	ND	ND
LC23M	UKM	11/26/06	ND	ND	0.004	ND	ND	ND	ND	ND	0.20
LC23M	UKM	3/1/07	ND	**0.86**	0.003	0.30	ND	ND	ND	ND	0.40
LC23M	UKM	5/3/07	***0.20***	**0.75**	0.002	0.30	ND	ND	ND	ND	0.20
LC24M	UKM	9/21/06	ND	0.13	0.003	ND	ND	ND	ND	ND	ND
LC24M	UKM	11/26/06	ND	0.08	ND	ND	ND	ND	ND	ND	0.20
LC24M	UKM	3/1/07	ND	0.08	ND	ND	ND	ND	ND	ND	ND
LC24M	UKM	5/4/07	ND	ND	ND	ND	ND	ND	ND	ND	0.20
LC27M	UKM	9/26/06	ND	ND	0.009	ND	ND	ND	ND	ND	0.20
LC27M	UKM	11/16/06	ND	ND	0.006	ND	ND	ND	ND	ND	0.30
LC27M	UKM	3/1/07	ND	ND	0.007	ND	ND	ND	ND	ND	0.30
LC27M	UKM	5/3/07	ND	ND	0.005	ND	ND	ND	ND	ND	0.30
LC28M	UKM	9/21/06	ND	ND	0.005	ND	ND	ND	ND	ND	ND
LC28M	UKM	11/26/06	ND	ND	ND	ND	ND	ND	ND	ND	0.20
LC28M	UKM	2/28/07	ND	ND	ND	ND	ND	ND	ND	ND	0.20
LC28M	UKM	5/3/07	ND	ND	ND	ND	ND	ND	ND	ND	0.20
MB-4	UKM	8/31/09	***0.30***	0.07	0.00	ND	ND	ND	ND	ND	ND
MB-4	UKM	12/14/09	ND	ND	0.01	ND	ND	ND	ND	ND	0.30
MB-4	UKM	3/30/10	ND	ND	0.01	ND	ND	ND	ND	ND	ND
MB-4	UKM	7/7/10	ND	ND	0.01	ND	ND	ND	ND	ND	ND

Table 3.6-8 Analytical Results of Baseline Monitoring (Page 16 of 17)

Trace Parameters (Dissolved unless otherwise noted.)													
Well ID	Completion Zone	Sample Date	Fe (mg/L)		Hg (mg/L)	Mn (mg/L)		Mo (mg/L)	Ni (mg/L)	Pb (mg/L)	Se (mg/L)	V (mg/L)	Zn (mg/L)
			Dissolved	Total		Dissolved	Total						
LC17M	UKM	9/12/06	0.03	0.03	ND	ND	ND	ND	ND	ND	ND	ND	ND
LC17M	UKM	11/26/06	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
LC17M	UKM	3/1/07	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
LC17M	UKM	5/4/07	0.05	0.05	ND	ND	0.01	ND	ND	ND	ND	ND	ND
LC20M	UKM	9/21/06	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
LC20M	UKM	11/22/06	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
LC20M	UKM	3/1/07	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
LC20M	UKM	5/4/07	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
LC23M	UKM	9/21/06	ND	ND	ND	ND	ND	ND	ND	ND	0.002	ND	ND
LC23M	UKM	11/26/06	ND	ND	ND	ND	ND	ND	ND	ND	0.002	ND	ND
LC23M	UKM	3/1/07	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
LC23M	UKM	5/3/07	ND	ND	ND	ND	ND	ND	ND	0.002	0.005	ND	ND
LC24M	UKM	9/21/06	***0.32***	***0.32***	ND	ND	ND	ND	ND	ND	0.002	ND	ND
LC24M	UKM	11/26/06	0.16	0.16	ND	ND	ND	ND	ND	ND	0.002	ND	ND
LC24M	UKM	3/1/07	0.06	0.06	ND	ND	ND	ND	ND	ND	ND	ND	ND
LC24M	UKM	5/4/07	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
LC27M	UKM	9/26/06	0.15	0.15	ND	ND	ND	ND	ND	ND	ND	ND	ND
LC27M	UKM	11/16/06	0.08	0.08	ND	ND	ND	ND	ND	ND	ND	ND	ND
LC27M	UKM	3/1/07	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
LC27M	UKM	5/3/07	0.04	0.04	ND	ND	ND	ND	ND	ND	ND	ND	ND

Table 3.6-8 Analytical Results of Baseline Monitoring (Page 17 of 17)

Trace Parameters (Dissolved unless otherwise noted.)													
Well ID	Completion Zone	Sample Date	Fe (mg/L)		Hg (mg/L)	Mn (mg/L)		Mo (mg/L)	Ni (mg/L)	Pb (mg/L)	Se (mg/L)	V (mg/L)	Zn (mg/L)
			Dissolved	Total		Dissolved	Total						
LC28M	UKM	9/21/06	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
LC28M	UKM	11/26/06	0.04	0.04	ND	ND	ND	ND	ND	ND	ND	ND	ND
LC28M	UKM	2/28/07	ND	ND	ND	ND	0.01	ND	ND	ND	ND	ND	ND
LC28M	UKM	5/3/07	0.05	0.05	ND	ND	0.01	ND	ND	ND	0.002	ND	ND
MB-4	UKM	8/31/09	0.30	ND	ND	ND	ND	ND	ND	ND	0.016	ND	ND
MB-4	UKM	12/14/09	ND	ND	ND	ND	ND	ND	ND	ND	0.014	ND	ND
MB-4	UKM	3/30/10	ND	0.12	ND	ND	ND	ND	ND	ND	0.015	ND	ND
MB-4	UKM	7/7/10	ND	ND	ND	ND	ND	ND	ND	ND	0.02	ND	ND

ND - Concentration was below the laboratory detection limit.

Blank - Sample not analyzed for this parameter.

WQD and EPA criteria listed in Table D6-15b.

Bold Concentration exceeds WQD Domestic Class-of-Use (Class I).

Bold Concentration exceeds WQD Agricuture Class-of-Use (Class II).

Bold Concentration exceeds WQD Livestock Class-of-Use (Class III).

Bold Concentration exceeds EPA criteria.

Highlight for concentration exceeding WQD criteria is based on the lowest criteria exceeded. If EPA concentration also exceeded, both highlight and pattern are shown. Pattern for concentration exceeding EPA criteria is based on lowest criteria exceeded. For pH, narrowest range is used.

Table 3.6-9 State and Federal Groundwater Quality Criteria for Specified Parameters

Parameter	WQD Class-of-Use Criteria				EPA Drinking Water Criteria		
	Domestic (Class I)	Agriculture (Class II)	Livestock (Class III)		MCL	Treatment Action Level	Secondary Standard
Aluminum	--	5.0	5.0		--	--	0.05 to 0.2
Ammonia	0.5	--	--		--	--	--
Arsenic	0.05	0.1	0.2		0.010	--	--
Barium	2.0	--	--		2.0	--	--
Boron	0.75	0.75	5.0		--	--	--
Cadmium	0.005	0.01	0.05		0.005	--	--
Chloride	250.0	100.0	2000.0		--	--	250.0
Chromium	0.1	0.1	0.05		0.005	--	--
Copper	1.0	0.2	0.5		--	1.0	--
Fluoride	4.0	--	--		4.0	--	2.0
Gross Alpha (pCi/L, including Ra-226, excluding Radon and Uranium)	15.0	15.0	15.0		15.0	--	--
Lead	0.015	5.0	0.1		--	0.015	--
Manganese	0.05	0.2	--		0.05	--	--
Mercury	0.002	--	0.00005		0.002	--	--
Nickel	--	0.2	--		--	--	--
Nitrate	10.0	--	--		10.0	--	--
pH (SU)	6.5 - 8.5	4.5 - 9.0	6.5 - 8.5		--	--	6.5 - 8.5
Ra-226+Ra-228 (pCi/L)	5.0	5.0	5.0		5.0	--	--
Selenium	0.05	0.02	0.05		0.05	--	--
Sulfate	250.0	200.0	3000.0		--	--	250.0
TDS	500.0	2000.0	5000.0		--	--	500.0
Uranium	--	--	--		0.03	--	--
Vanadium	--	0.1	0.1		--	--	--
Zinc	5.0	2.0	25.0		--	--	5.0

All concentrations are in mg/L unless otherwise noted. Dashes indicate no criteria have been established.

WQD Class-of-Use criteria are from Table I in Chapter 8 (Quality Standards for Wyoming Groundwater) of the WQD Rules and Regulations, available at http://deq.state.wy.us/wqd/WQDrules/Chapter_08.pdf, accessed on November 3, 2008.

EPA Drinking Water Criteria are from http://www.epa.gov/safewater/consumer/pdf/mcl.pdf, accessed on November 3, 2008.

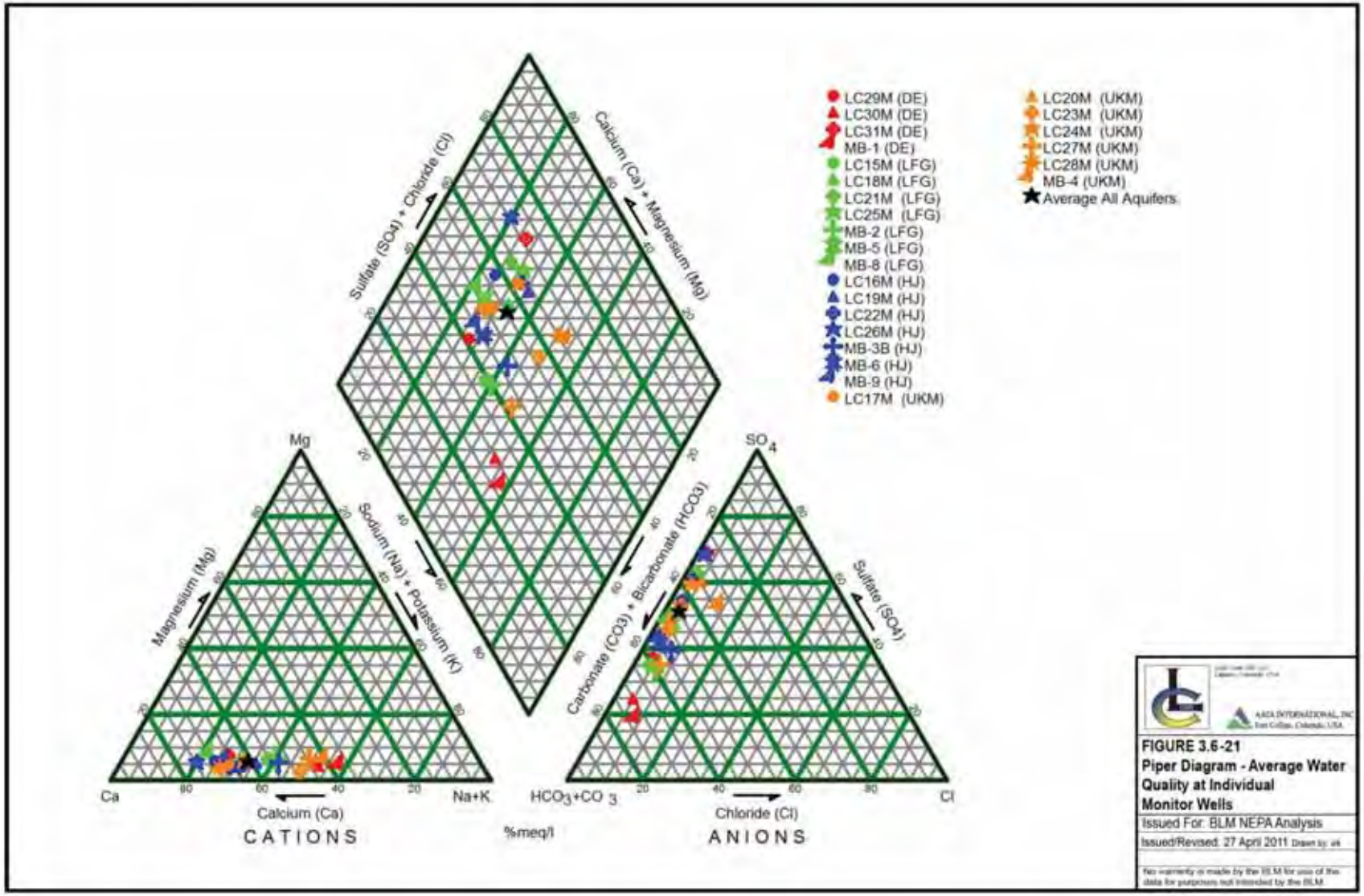
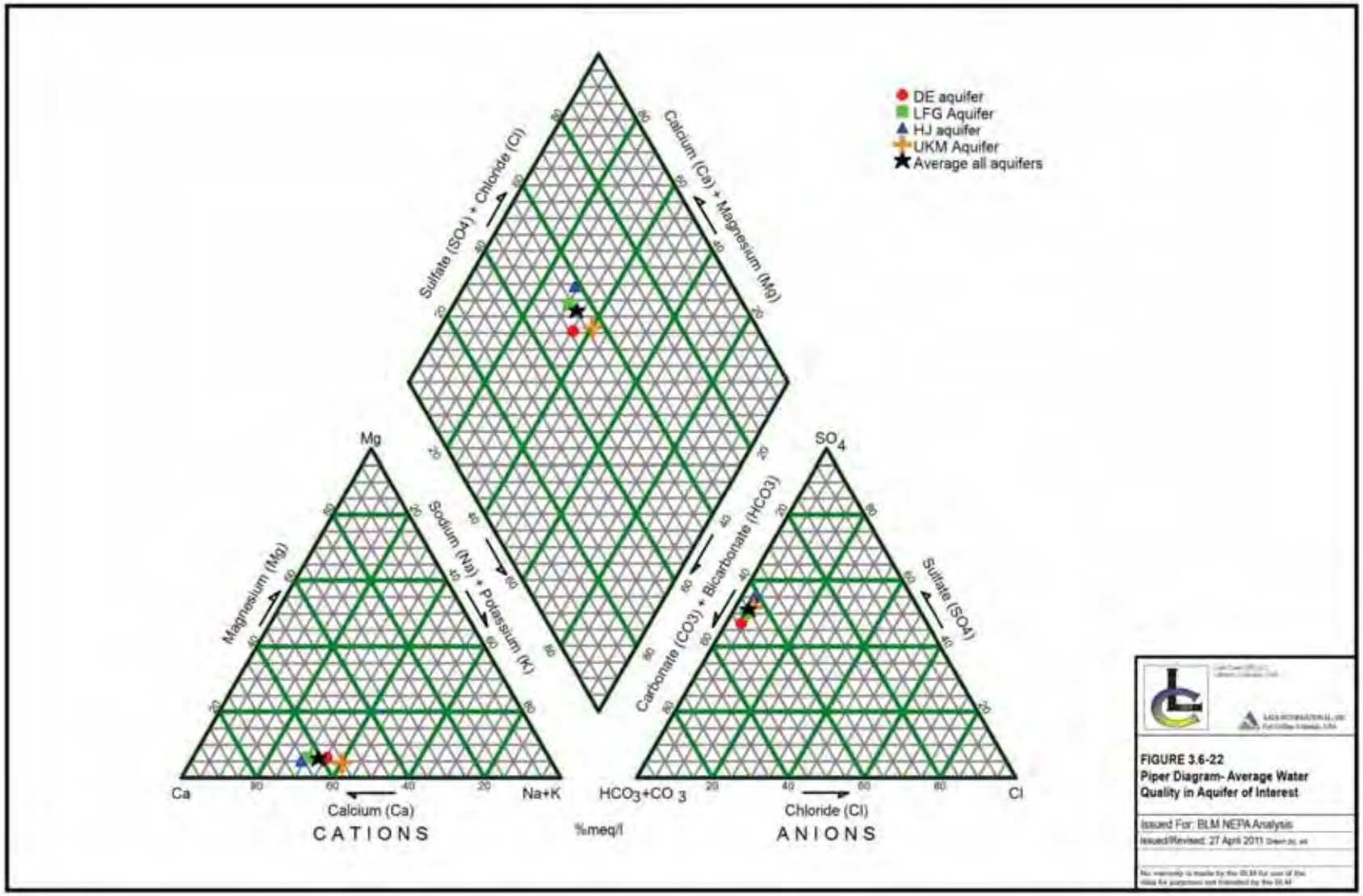
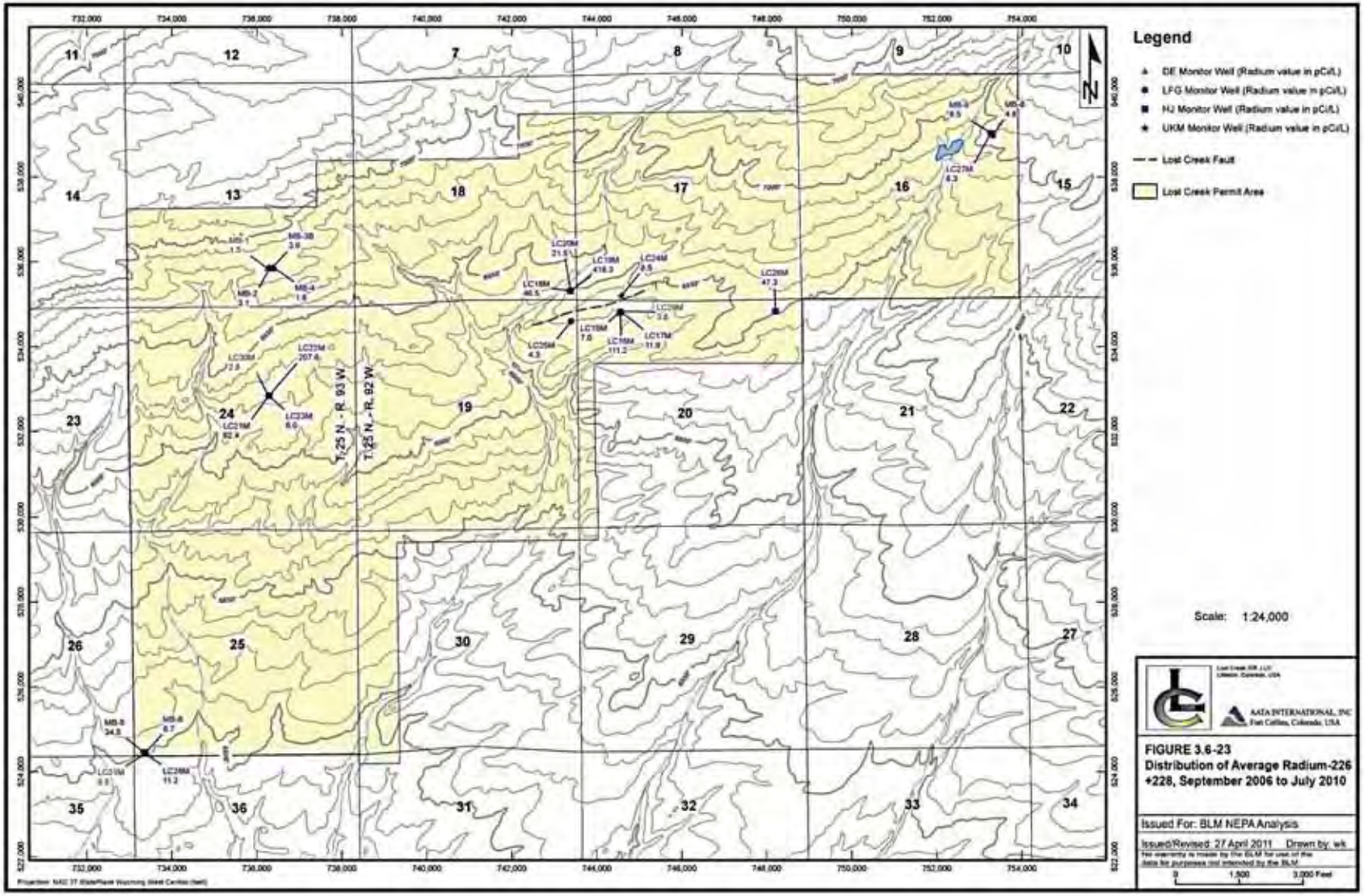
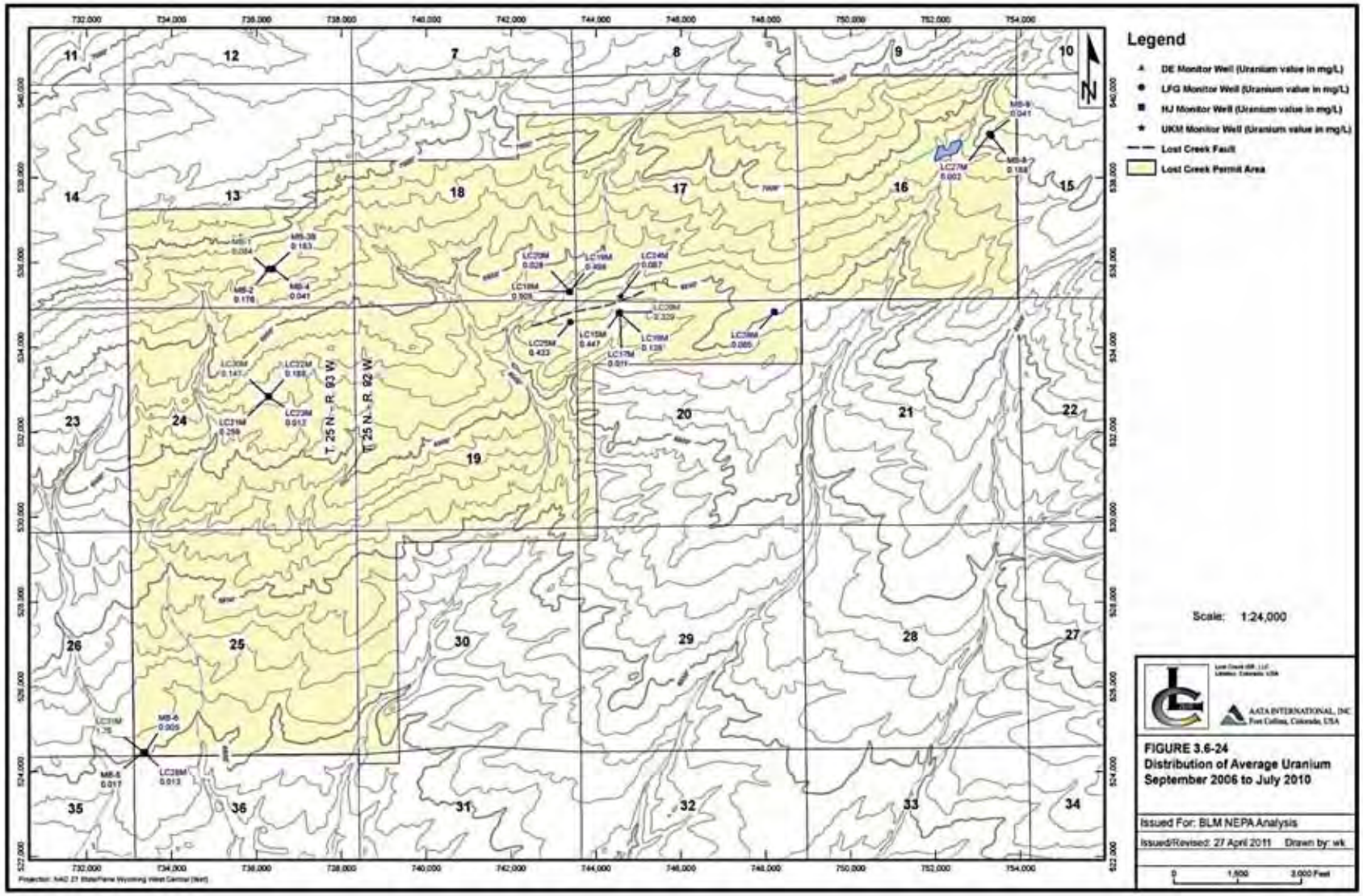


FIGURE 3.6-21
Piper Diagram - Average Water Quality at Individual Monitor Wells
Issued For: BLM NEPA Analysis
Issued/Revised: 27 April 2011 Drawn by: ak


DE aquifer
LFG Aquifer
HJ aquifer
UKM Aquifer
Average all aquifers
Sulfate (SO4) + Chloride (Cl)
Calcium (Ca) + Magnesium (Mg)
Sodium (Na) + Potassium (K)
Carbonate (CO3) + Bicarbonate (HCO3)
Mg
Magnesium (Mg)
Ca
Calcium (Ca)
Na+K
CATIONS
SO4
Sulfate (SO4)
Cl
Chloride (Cl)
HCO3+CO 3
ANIONS
%meq/l
FIGURE 3.6-22
Piper Diagram- Average Water Quality in Aquifer of Interest
Issued For: BLM NEPA Analysis
Issued/Revised: 27 April 2011


Legend
DE Monitor Well (Radium value in pCi/L)
LFG Monitor Well (Radium value in pCi/L)
HJ Monitor Well (Radium value in pCi/L)
UKM Monitor Well (Radium value in pCi/L)
Lost Creek Fault
Lost Creek Permit Area
Scale: 1:24,000
T.25 N. - R. 93 W.
T.25 N. - R. 92 W.
AATA INTERNATIONAL, INC
Fort Collins, Colorado, USA
FIGURE 3.6-23
Distribution of Average Radium-226 +228, September 2006 to July 2010
Issued For: BLM NEPA Analysis
Issued/Revised: 27 April 2011 Drawn by: wk


Legend
DE Monitor Well (Uranium value in mg/L)
LFG Monitor Well (Uranium value in mg/L)
HJ Monitor Well (Uranium value in mg/L)
UKM Monitor Well (Uranium value in mg/L)
Lost Creek Fault
Lost Creek Permit Area
Scale: 1:24,000
T. 25 N. – R. 93 W.
T. 25 N. – R. 92 W.
AATA INTERNATIONAL, INC
Fort Collins, Colorado, USA
FIGURE 3.6-24
Distribution of Average Uranium
September 2006 to July 2010
Issued For: BLM NEPA Analysis
Issued/Revised: 27 April 2011 Drawn by: wk

A summary of the water quality for each of the four hydrostratigraphic units of interest (DE, LFG, HJ and UKM) is presented below. All metal concentrations are reported as dissolved.

DE Sand

Six wells completed in the DE Sand were included in the baseline sampling program (LC29M, LC30M, LC31M, MB-1, MB-7, and MB-10). Both MB-7 and MB-10 had insufficient water to sample and therefore were not included in the analyses. Sample results from the existing baseline monitor wells are included in **Table 3.6-9**.

Results of the baseline sampling indicate that three of the DE monitor wells (LC29M, LC30M, and MB-1) are calcium bicarbonate water, whereas well LC31M is a calcium sulfate type. Both sulfate and TDS levels in LC31M exceed the WDEQ Class I Standards (250 mg/L and 500 mg/L, respectively). Chloride levels in all four wells are low (12 mg/L or less).

Manganese exceeded the WDEQ Class I Standard (0.05 mg/L) in seven of the 16 samples collected from DE monitor wells. The average detectable manganese value was 0.10 mg/L for the DE monitor wells. The average selenium concentration at well LC31M was 0.172 mg/L, exceeding the WDEQ Class I Standard of 0.05 mg/L.

Iron exceeded the WDEQ Class I Standard (0.3 mg/L) in two of the four samples from LC29M and one of the four samples from MB-1. The average values for the four samples from LC29M and MB-1 were below the standard. Similarly, the average ammonia concentration was below the WDEQ Class I Standard (0.5 mg/L) at well LC29M, although two of the four samples exceeded the standard.

Uranium levels exceeded the EPA MCL in every sample collected from the DE monitor wells except one MB-1 sample collected in August 2009. The average uranium concentration for the 16 samples collected was 0.577 mg/L. Ra-226 exceeded the EPA Radium 226+228 MCL of 5.0 pCi/L in two samples. Combined radium 226+228 exceeded the standard in four of the samples. However, the average radium 226+228 activity for each of the DE monitor wells was below the WDEQ Class I Standard.

LFG Sand

Seven wells completed in the LFG Sand were included in the baseline sampling program (LC15M, LC18M, LC21M, LC25M, MB-2, MB-5, and MB-8). Sample results from the existing baseline monitor wells are included in **Table 3.6-9**.

Results of the baseline sampling indicate that the LFG monitor wells are calcium-bicarbonate to calcium-sulfate water. TDS and sulfate levels are below the

WDEQ Class I Standards (500 mg/L and 250 mg/L, respectively) and chloride levels in all seven wells are low (10 mg/L or less).

Manganese and selenium were below the respective WDEQ Class I Standards in all the LFG samples. Iron exceeded the WDEQ Class I Standard in three out of four samples at LC18M, one out of four samples at LC25M, and in one sample at MB-8 for total iron.

Uranium levels exceeded the EPA MCL in every sample collected from the LFG monitor wells except for samples taken at MB-5. The average uranium concentration for the LFG samples was 0.289 mg/L. Radium levels were widely distributed. At least one sample from all LFG wells exceeded the WDEQ Class I Standard for radium 226+228 except for MB-2.

HJ Horizon

Seven wells completed in the HJ Horizon were included in the baseline sampling program (LC16M, LC19M, LC22M, LC26M, MB-3B, MB-6, and MB-9). Sample results from the existing baseline monitor wells are included in **Table 3.6-9**.

Results of the baseline sampling indicate that the HJ monitor wells are calcium-bicarbonate to calcium-sulfate water. Both sulfate and TDS levels in LC26M exceed the WDEQ Class I Standards (250 mg/L and 500 mg/L, respectively). Chloride levels in all four wells are low (11 mg/L or less).

Manganese and selenium were below the respective WDEQ Class I Standards in all the HJ samples.

Uranium levels exceeded the EPA MCL in every sample collected from the LC16M, LC19M, LC22M, LC26M, and MB-3B monitor wells. Only one sample from MB-9 and no samples from MB-6 exceeded the EPA MCL. The average uranium concentration for the HJ samples was 0.160 mg/L.

UKM Sand

Seven wells completed in the UKM Sand were included in the baseline sampling program (LC17M, LC20M, LC23M, LC24M, LC27M, LC28M, and MB-4). Two of the wells were originally thought to be completed in the HJ Horizon (LC27M and LC28M) but were later reinterpreted as UKM completions. Sample results from the existing baseline monitor wells are included in **Table 3.6-9**.

Results of the baseline sampling indicate that the UKM monitor wells are calcium-bicarbonate to calcium-sulfate water. TDS and sulfate levels are below the WDEQ Class I Standards (500 mg/L and 250 mg/L, respectively) in all but one sample and chloride levels in all seven wells are low (32 mg/L or less).

Manganese and selenium were below the respective WDEQ Class I Standards in all the UKM samples.

Uranium levels exceeded the EPA MCL in some samples collected at LC20M, LC24M, and MB-4. LC17M, LC23M, LC27M, and LC28M did not have any samples that exceeded the uranium EPA MCL. The average uranium concentration for the UKM samples was 0.028 mg/L.

Average radium 226+228 levels exceeded the WDEQ Class I Standard in at least one sample for each of the UKM monitor wells except MB-4.

3.6.4.3 MU1 Groundwater Quality, Ore-Bearing and Associated Aquifers

LCI conducted pre-operational sampling in MU1 in 2009 and 2010. The monitor well locations include the monitor well ring and locations within the pattern area (**Section 2.1.3**). During Mine Unit Production, these wells are used to monitor for excursions, i.e., conditions that indicate the production and injection is out of balance, and during Mine Unit Restoration, these wells are used to monitor restoration success. The monitor ring wells are completed in the same sand as the ore zone, and the wells within the pattern area are completed in overlying and underlying aquifers. The locations of the monitor wells are shown on **Figure 3.6-5**.

Per WDEQ-LQD requirements, at least four samples were collected, with at least two weeks between each sampling. The sampling results and associated calculation of Upper Control Limits are included in Attachments MU1 4-1 and 4-2 of the WDEQ-LQD MU1 documents (LCI, 2011b), and the results are analyzed in detail in Section 4.2.2 of the WDEQ-LQD MU1 documents (LCI, 2011b). None of the results indicate that conditions in MU1 are different than what would be anticipated from the site-wide baseline sampling.

3.6.4.4 Site Groundwater Quality, Deeper Formations Evaluated for UIC Class I Wells

Information on the water quality in the deeper formations that were evaluated for UIC Class I wells was obtained by a variety of methods, including sampling and evaluation of geophysical logs. In addition, the Wyoming Oil and Gas Conservation Commission website and USGS Produced Waters Database were reviewed for pertinent information. The results are summarized below and are described in more detail in the WDEQ-WQD application for the UIC Class I wells, which is included as Attachment ADJ-2 to the WDEQ-LQD Permit to Mine (LCI, 2011b).

In the target formation, the Fort Union Formation, samples were collected at multiple intervals in the test well, which is the deep well in the southwest corner

of the Permit Area (**Figure 1.2-3**). The samples were collected by cased-hole formation sampling at discrete intervals within the Fort Union Formation, and after casing perforation, samples of water produced from the well were collected, which are representative of the composite fluid from the perforated intervals. The sample results indicated an average TDS concentration just under 14,000 mg/L; concentrations of several inorganic parameters (mercury, manganese, barium, lead, arsenic, and iron) exceeded groundwater quality standards; and gross alpha and radium-226+228 concentrations exceeded groundwater quality standards. Volatile organic compounds were also detected, which was not unexpected as there is hydrocarbon production from this formation elsewhere in the Basin.

Information from the databases was limited in the vicinity of the Permit Area. Most of the data were from distant parts of the Basin, e.g., from areas proximate to oil and gas production or from the Basin margins, representing a wide range of formation depths and hydrogeologic conditions. Therefore, the water quality in the deeper formations was estimated using data from geophysical logs from two wells within about four miles of the Permit Area. These estimates are included in **Table 3.6-10**.

Table 3.6-10 Summary of Stratigraphy and Water Quality

Summary of Stratigraphy and Water Quality – Lost Creek Permit Area (Based on Lost Creek Test Well No. 1, Stratton 1-21 Well, and Federal 32-22 Well)		
Formation	***Depth (feet)***	***Estimated Water Quality***
Wasatch / Battle Spring Formation[1]	GS – 6,158	300 mg/L (shallow) – 4,000 mg/L TDS
Fort Union Formation[1]	6,158 – 11,000 (estimated)	13,945 mg/L TDS (average from testing at TW1)
Lance Formation[2]	9,150 – 11,960	6,700 – 60,000 ppm NaCl[3]
Fox Hills Sandstone[2]	11,960 – 12,635	12,100 – 12,800 ppm NaCl
Lewis Shale[2]	12,635 – 14,010	10,000 – 36,000 ppm NaCl
Mesaverde Formation[2]	14,010 – 16,000 (estimated)	15,500 – 42,000 ppm NaCl

Notes:
[1] – Formation depths from logging data at TW1; water quality from cased-hole formation testing conducted at TW1.
[2] – Formation depths from Stratton 1-21 well, located 4 miles southwest of Lost Creek, where stratigraphic section is approximately 2,000 feet shallower. Water quality data represents range of water quality calculations (as ppm NaCl) from resistivity and porosity data in sand intervals from Stratton 1-21 Well and Federal 32-22 Well.
[3] – Presence of gas observed in sand intervals in the Lance which results in lower calculated NaCl concentrations.

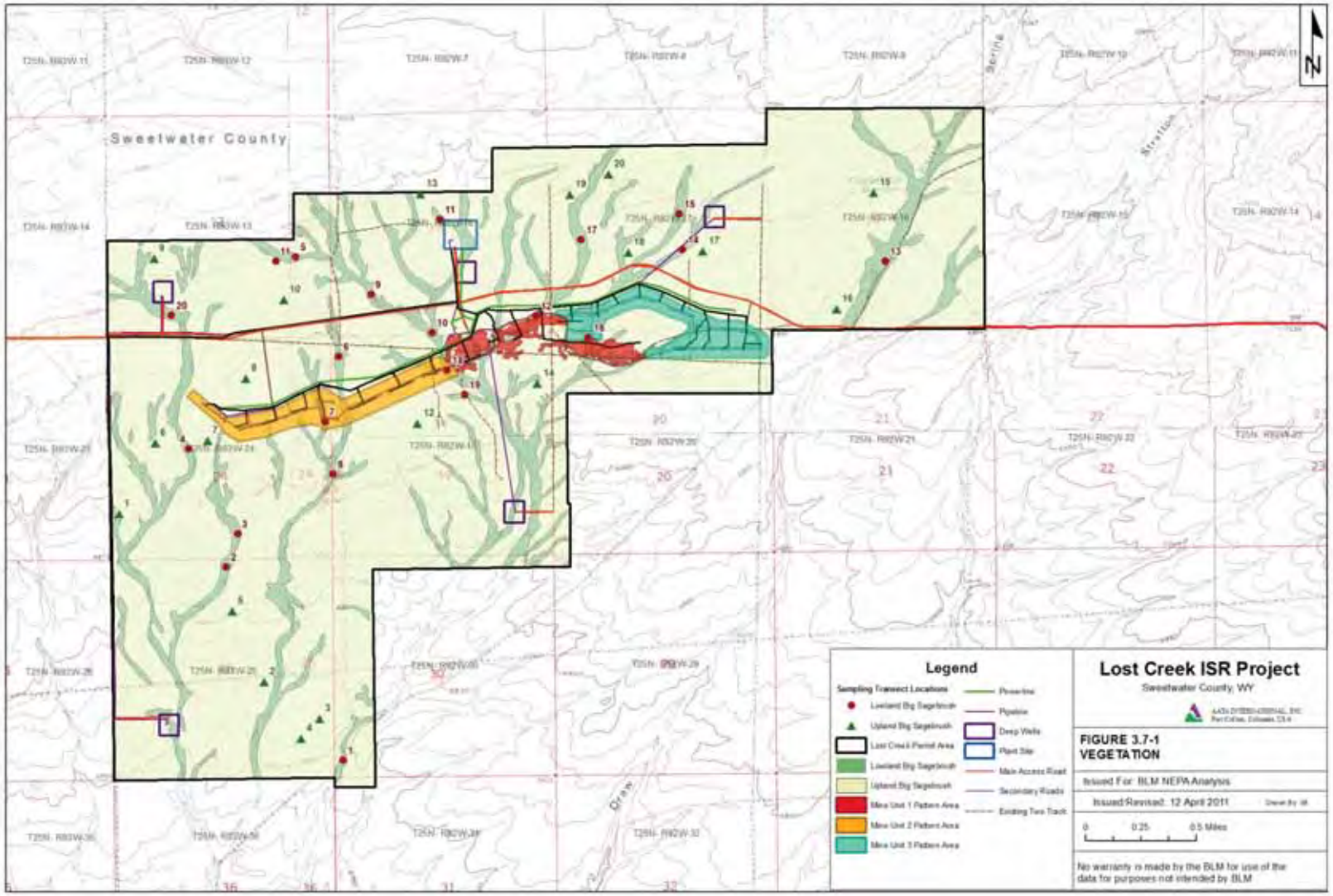
3.7 Vegetation

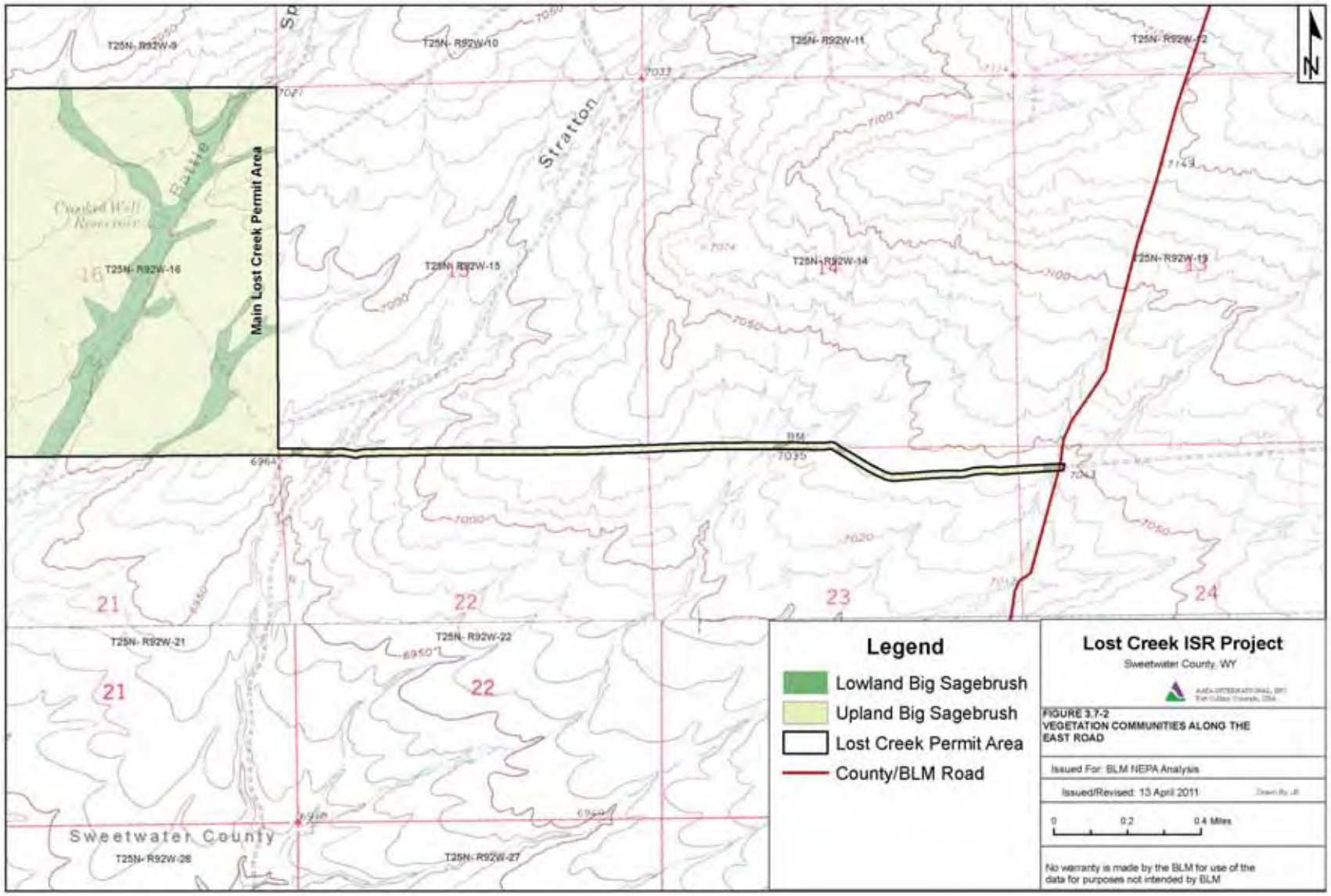
3.7.1 Vegetation Studies Performed

A vegetation survey was conducted within the area originally planned for the Permit Area during the 2006 growing season. Two vegetation types were identified and delineated: Upland Big Sagebrush Shrubland and Lowland Big Sagebrush Shrubland. The southern and southeastern Permit Area boundaries were changed in early 2007, resulting in the addition of about 160 acres to the planned Permit Area. In 2009, the East and West Access Roads were added to the Permit Area at the request of WDEQ-LQD. When the changes were made, a vegetation map was prepared based on aerial photos, and then checked in the field. The vegetation types in the added areas were the same as those in the original Permit Area. No additional cover sampling was conducted in these areas, but information on species present and rare plant habitat was collected. The distribution of the two vegetation types, Upland Big Sagebrush Shrubland and Lowland Big Sagebrush Shrubland, is shown on **Figure 3.7-1** for the main Permit Area and on **Figures 3.7-2** and **3.7-3** for the East and West Access Roads, respectively.

Each of the two vegetation types was sampled with 20 transects (a total of 40 transects) using a point-intercept approach to obtain vegetation cover and species diversity data. Vegetation cover observations were made on a species basis. Observations were also made for cover by litter and bare soil. The sampling locations are shown on **Figure 3.7-1**. Specific information about each of the sampling locations at the Permit Area is presented in **Table 3.7-1**.

Shrub and semi-shrub density data were obtained by counting all of the individual plants that occurred within one meter on either side of the transect line that was used for collecting cover data. This approach consisted of establishing a belt transect that was two meters wide and 25 meters long (a total of 50 square meters). The data from the transects were used to compute the mean number of shrubs and semi-shrubs per square meter and the number per acre. In addition to shrubs and semi-shrubs, density counts were also made for prickly pear cactus. No trees occurred on the Permit Area.


Sweetwater County
Legend
Sampling Transect Locations
Lowland Big Sagebrush
Upland Big Sagebrush
Lost Creek Permit Area
Lowland Big Sagebrush
Upland Big Sagebrush
Mine Unit 1 Pattern Area
Mine Unit 2 Pattern Area
Mine Unit 3 Pattern Area
Powerline
Pipeline
Deep Wells
Plant Site
Main Access Road
Secondary Roads
Existing Two Track
Lost Creek ISR Project
Sweetwater County, WY
FIGURE 3.7-1
VEGETATION
Issued For: BLM NEPA Analysis
Issued/Revised: 12 April 2011
0 0.25 0.5 Miles
No warranty is made by the BLM for use of the data for purposes not intended by BLM


Legend
Lowland Big Sagebrush
Upland Big Sagebrush
Lost Creek Permit Area
County/BLM Road
Lost Creek ISR Project
Sweetwater County, WY
FIGURE 3.7-2
VEGETATION COMMUNITIES ALONG THE EAST ROAD
Issued For: BLM NEPA Analysis
Issued/Revised: 13 April 2011
0 0.2 0.4 Miles
No warranty is made by the BLM for use of the data for purposes not intended by BLM
Main Lost Creek Permit Area
Stratton
Battle
Sweetwater County
T25N- R92W-9
T25N- R92W-10
T25N- R92W-11
T25N- R92W-12
T25N- R92W-13
T25N- R92W-14
T25N- R92W-15
T25N- R92W-16
T25N- R92W-21
T25N- R92W-22
T25N- R92W-26
T25N- R92W-27
21
22
23
24
N

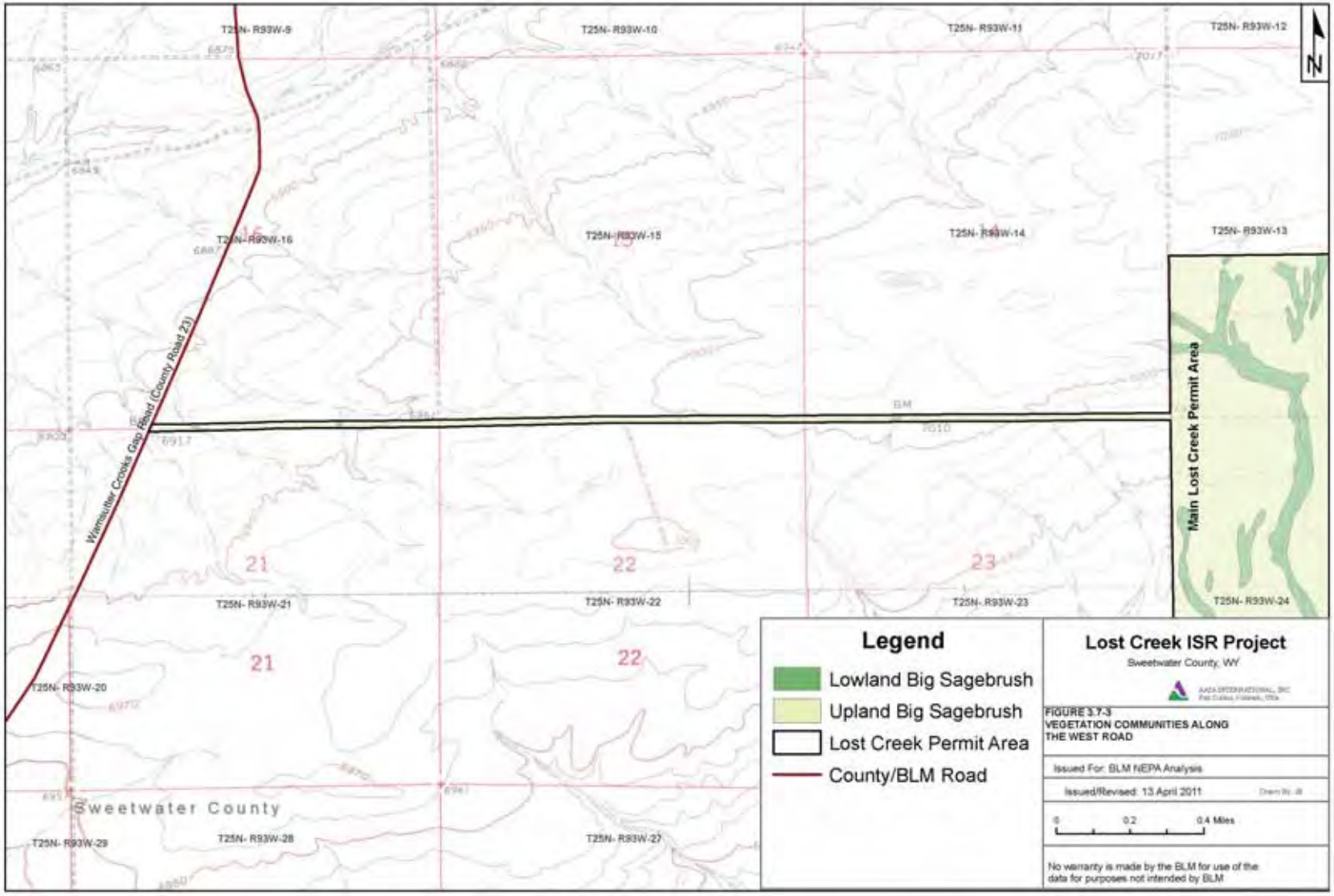

T25N- R93W-9
T25N- R93W-10
T25N- R93W-11
T25N- R93W-12
T25N- R93W-13
T25N- R93W-14
T25N- R93W-15
T25N- R93W-16
T25N- R93W-21
T25N- R93W-22
T25N- R93W-23
T25N- R93W-24
T25N- R93W-20
T25N- R93W-29
T25N- R93W-28
T25N- R93W-27
Warmsutter Crooks Gap Road (County Road 23)
Sweetwater County
Main Lost Creek Permit Area
N
Legend
Lowland Big Sagebrush
Upland Big Sagebrush
Lost Creek Permit Area
County/BLM Road
Lost Creek ISR Project
Sweetwater County, WY
FIGURE 3.7-3
VEGETATION COMMUNITIES ALONG
THE WEST ROAD
Issued For: BLM NEPA Analysis
Issued/Revised: 13 April 2011
0 0.2 0.4 Miles
No warranty is made by the BLM for use of the data for purposes not intended by BLM

Table 3.7-1 Vegetation Sampling Locations and Site Information (Page 1 of 2)

Transect Number	Location	Transect Bearing	Slope (percent)	Aspect	Sampling Date
Upland Big Sagebrush					
1	N42° 07’ 11.0”; W107° 53’ 27.5”	300°	2	South	June 10, 2006
2	N42° 06’ 31.8”; W107° 52’ 40.1”	187°	0	Flat	June 10, 2006
3	N42° 06’ 22.1”; W107° 52’ 19.7”	278°	0	Flat	June 10, 2006
4	N42° 06’ 19.0”; W107° 52’ 23.6”	95°	3	East	June 10, 2006
5	N42° 06’ 48.2”; W107° 53’ 00.7”	280°	2	Northeast	June 10, 2006
6	N42° 07’ 26.7”; W107° 53’ 16.2”	48°	4	Southwest	June 10, 2006
7	N42° 07’ 24.1”; W107° 52’ 57.8”	12°	2	South	June 10, 2006
8	N42° 07’ 43.2”; W107° 52’ 46.0”	280°	3	Southeast	June 10, 2006
9	N42° 08’ 09.4”; W107° 53’ 16.7”	290°	4	Southwest	June 11, 2006
10	N42° 08’ 00.7”; W107° 52’ 36.2”	355°	0	Flat	June 11, 2006
11	N42° 08’ 11.3”; W107° 52’ 39.7”	170°	6	South	June 11, 2006
12	N42° 07’ 31.6”; W107° 51’ 51.1”	225°	3	South	June 11, 2006
13	N42° 08’ 12.6”; W107° 52’ 01.1”	274°	0	Flat	June 11, 2006
14	N42° 07’ 41.9”; W107° 51’ 11.8”	325°	3	Northwest	June 11, 2006
15	N42° 08’ 25.8”; W107° 49’ 24.9”	229°	1	South	June 12, 2006
16	N42° 07’ 56.8”; W107° 49’ 37.6”	97°	1	South	June 12, 2006
17	N42° 08’ 11.5”; W107° 50’ 22.9”	358°	0	Flat	June 12, 2006
18	N42° 08’ 10.9”; W107° 50’ 47.2”	86°	2	Southwest	June 12, 2006
19	N42° 08’ 27.3”; W107° 51’ 03.9”	206°	5	South	June 12, 2006
20	N42° 08’ 32.3”; W107° 50’ 52.1”	171°	5	West	June 12, 2006

Table 3.7-1 Vegetation Sampling Locations and Site Information (Page 2 of 2)

Transect Number	Location	Transect Bearing	Slope (percent)	Aspect	Sampling Date
Lowland Big Sagebrush					
1	N42° 06’ 12.8”; W107° 52’ 18.2”	30°	0	Flat	June 10, 2006
2	N42° 06’ 55.4”; W107° 52’ 55.3”	5°	0	Flat	June 10, 2006
3	N42° 07’ 06.4”; W107° 52’ 50.0”	355°	1	South	June 10, 2006
4	N42° 07’ 24.4”; W107° 53’ 03.7”	170°	1	South	June 10, 2006
5	N42° 08’ 13.4”; W107° 52’ 38.2”	319°	3	Southeast	June 11, 2006
6	N42° 07’ 48.3”; W107° 52’ 17.3”	158°	2	Southeast	June 11, 2006
7	N42° 07’ 33.1”; W107° 52’ 22.2”	351°	2	South	June 11, 2006
8	N42° 07’ 19.4”; W107° 52’ 20.1”	18°	1	South	June 11, 2006
9	N42° 08’ 01.9”; W107° 52’ 05.6”	360°	0	Flat	June 11, 2006
10	N42° 07’ 52.9”; W107° 51’ 46.8”	109°	0	Flat	June 11, 2006
11	N42° 08’ 07.6”; W107° 51’ 54.4”	135°	2	Southeast	June 11, 2006
12	N42° 07’ 59.0”; W107° 51’ 12.9”	232°	1	Southwest	June 11, 2006
13	N42° 08’ 10.5”; W107° 49’ 25.6”	72°	1	South	June 12, 2006
14	N42° 08’ 11.3”; W107° 50’ 30.4”	251°	2	Southwest	June 12, 2006
15	N42° 08’ 20.3”; W107° 50’ 29.4”	191°	1	South	June 12, 2006
16	N42° 07’ 50.5”; W107° 50’ 57.6”	195°	0	Flat	June 12, 2006
17	N42° 08’ 17.1”; W107° 51’ 02.0”	355°	1	South	June 12, 2006
18	N42° 07’ 43.4”; W107° 51’ 39.7”	285°	1	Southeast	June 12, 2006
19	N42° 07’ 37.8”; W107° 51’ 33.1”	95°	3	East	June 12, 2006
20	N42° 07’ 58.5”; W107° 53’ 09.4”	89°	2	Southeast	June 12, 2006

Prior to conducting field work on the Permit Area, a literature review was conducted to determine what species of special concern might occur within the Permit Area. The review identified several species of special concern that occur within the general region (**Table 3.7-2**). As part of the field work, observations were made on the overall species composition of the area and special attention was paid to examining any unusual micro-environments where rare plant species might occur. Also, WDEQ-LQD Guideline No. 2 (1997) provides lists of prohibited and restricted noxious weeds, selenium indicators and plant species of special concern. These lists were reviewed and compared with the observed species composition at the Permit Area.

3.7.2 Results of Vegetation Studies Performed

As part of all field work, observations were made regarding the species composition in each of the vegetation types (**Table 3.7-3**). In all, 58 species were observed on the Permit Area. In the Upland Big Sagebrush Shrubland vegetation type, 36 species were noted; and in the Lowland Big Sagebrush Shrubland vegetation type, 43 species were noted, indicating a large overlap of species diversity in the two vegetation types. The relatively low number of species is a reflection of the overall homogeneity of the environmental conditions on the site. The Permit Area has limited topographic variability and no wetland environments (**Section 3.5**).

In the sections that follow, each of the vegetation types is described based on data collected and on general observations made during the site visits.

3.7.2.1 Upland Big Sagebrush Shrubland Type

The Upland Big Sagebrush Shrubland type covers most of the Permit Area (**Figure 3.7-1**). **Figure 3.7-4** is a photograph of an area typical of this vegetation type. Overall, this type covers approximately 85 percent of the main Permit Area and 96 percent of the area along the East and West Access Roads. It covers flat areas and the gently sloping south-facing slopes. The slope at the sampled transects in this type ranged between zero to six percent (**Table 3.7-1**). Soils throughout the upland areas are mostly shallow and coarse textured. The only environmental settings on the Permit Area that do not support the Upland Big Sagebrush Shrubland type are the areas along the drainages where the Lowland Big Sagebrush Shrubland type grows.

Table 3.7-2 Rare Plant Species in Sweetwater County

Scientific Name	Common Name	Distribution in Sweetwater County	Heritage Rank	Federal Status
Artemisia biennis var diffusa	Mystery Wormwood	Central	G5T1Q/S1	C2
Asclepias uncialis	Dwarf Milkweed	Northwestern	G3/SH	C2, S-R2
Astragalus jejunus var. jejunus	Starveling Milkvetch	Eastern & Western Edges	G3T1/S1	C2
Astragalus proimanthus	Precocious Milkvetch	Extreme Southwestern	G1/S1	C2
Cirsium ownbeyi	Ownbey's Thistle	South-Central	G3/S1	C2
Descurainia torulosa	Wyoming Tansy Mustard	South-Central	G1/S1	C2, S-R2, S-R4
Lesquerella macrocarpa	Large-fruited Bladderpod	North-Central	G2/S2	C2
Oryzopsis contracta	Contracted Indian Ricegrass	Northeast, Northwest & Southwest	G3/S3	C2
Penstemon acaulis var acaulis	Stemless Beardtongue	Extreme Southwestern	G3/S1	C2, S-R4
Penstemon gibbensii	Gibben's Beardtongue	Extreme Southeastern	G1/S1	C2
Phlox opalensis	Opal Phlox	West-Central	G1/S1	C2
Thelesperma caespitosum	Green River Greenthread	Southwestern	G1/S1	C2, S-R4

Heritage Rank Codes:

G1: Critically imperiled globally because of extreme rarity (5 or fewer occurrences, or very few remaining individuals), or because of some factor of its biology making it especially vulnerable to extinction (Critically endangered throughout its range).

G2: Imperiled globally because of rarity (6 to 20 occurrences) or because of other factors demonstrably making it very vulnerable to extinction throughout its range. (Endangered throughout its range).

G3: Very rare or local throughout its range or found locally in a restricted range (21 to 100 occurrences. (Threatened throughout its range).

G4: Apparently secure globally, though it might be quite rare in parts of range, especially at periphery.

G5: Demonstrably secure globally, though it may be quite rare in parts of range, especially at periphery.

T1: The variety is critically imperiled globally because of extreme rarity (5 or fewer occurrences, or very few remaining individuals), or because of some factor of its biology making it especially vulnerable to extinction (Critically endangered throughout its range).

Q: Indicates uncertainty about taxonomic status.

State Rank Codes:

S1: Critically imperiled in state because of extreme rarity (5 or fewer occurrences, or very few remaining individuals), or because of some factor of its biology making it especially vulnerable to extirpation from the state. (Critically endangered in state).

S2: Imperiled in state because of rarity (6 to 20 occurrences) or because of other factors demonstrably making it very vulnerable to extirpation from the state (Endangered or threatened in state).

S3: Rare in state (21 to 100 occurrences)

SH: Of historical occurrence, not documented in Wyoming since 1920.

Federal Status Codes:

C2: Notice of Review, Category 2: taxa for which current information indicates that proposing to list as endangered or threatened is possible, but appropriate or substantial biological information is not on file to support an immediate rulemaking.

S: Sensitive: those plant and animal species identified by the Regional Forester for which population viability is a concern as evidenced by:

a) Significant current or predicted downward trends in population numbers or density.

b) Significant current or predicted downward trends in habitat capability that would reduce a species' existing distribution.

R: Forest Region

Table 3.7-3 List of Vegetation Species Observed (Page 1 of 2)

Scientific Name	Common Name	Upland Big Sagebrush Shrubland	Lowland Big Sagebrush Shrubland
COOL SEASON PERENNIAL GRASSES AND GRASSLIKE PLANTS			
Agropyron dasystachyum	Thickspike Wheatgrass	x	x
Agropyron smithii	Western Wheatgrass		x
Agropyron spicatum	Bluebunch Wheatgrass	x	x
Carex douglasii	Douglas Sedge		x
Carex eleocharis	Spikerush Sedge		x
Elymus cinereus	Great Basin Wildrye		x
Hordeum jubatum	Foxtail Barley		x
Koeleria macrantha	Prairie Junegrass	x	x
Muhlenbergia richardsonis	Mat Muhly		x
Oryzopsis hymenoides	Indian Ricegrass	x	x
Poa secunda	Sandberg Bluegrass	x	x
Sitanion longifolium	Squirreltail Grass	x	x
Stipa comata	Needle-and-thread Grass	x	x
Stipa lettermannii	Lettermann Needlegrass		x
PERENNIAL FORBS			
Allium textile	Prairie Onion	x	x
Antennaria rosea	Pussytoes		x
Arabis sp.	Rockcress	x	x
Astragalus mollissimus	Woolly Milkvetch	x	
Astragalus sericoleucus	Silky Milkvetch	x	
Crepis occidentalis	Hawksbeard		x
Cryptantha thrysiflora	Cryptantha	x	
Erigeron pumilus	Fleabane	x	
Hymenoxis acaulis	Stemless Actinea	x	
Lomatium orientale	Bisquitroot	x	
Machaeranthera canescens	Machaeranthera	x	
Sedum lanceolatum	Stonecrop	x	
Senecio integerrimus	Groundsel		x
Trifolium gymnocarpon	Hollyleaf Clover	x	x
CUSHION PLANTS			
Arenaria hookeri	Hooker's Sandwort	x	x
Astragalus spatulatus	Spatulate Leaf Milkvetch	x	
Eriogonum acaule	Stemless Buckwheat	x	x
Eriogonum ovalifolium	Oval Leaved Buckwheat	x	x
Haplopappus acaulis	Stemless Goldenweed	x	
Paronychia sessiliflora	Nailwort	x	
Phlox hoodii	Hood's Phlox	x	x

Table 3.7-3 List of Vegetation Species Observed (Page 2 of 2)

Scientific Name	Common Name	Upland Big Sagebrush Shrubland	Lowland Big Sagebrush Shrubland
ANNUAL FORBS			
Alyssum desertorum	Desert Alyssum		x
Chenopodium album	Goosefoot		x
Chenopodium leptophyllum	Narrowleaf Goosefoot		x
Cordylanthus ramosus	Cordylanthus		x
Cryptantha minima	Small Cryptantha		x
Descurainia pinnata	Tansy Mustard		x
Gayophytum ramossissimum	Gaywings		x
Lupinus kingii	Annual Lupine	x	
Microsteris micrantha	Microsteris		x
Navarettia breweri	Navarettia		x
Polygonum aviculare	Devil's Shoestrings		x
Polygonum sawatchense	Sawatch Knotweed		x
Sisymbrium altissimum	Tumbling Hedge Mustard		x
SEMI-SHRUBS			
Artemisia frigida	Fringed Sagewort	x	
Artemisia spinescens	Bud Sage	x	
Ceratoides lanata	Winterfat	x	x
Gutierrezia sarothrae	Broom Snakeweed	x	
Leptodactylon pungens	Leptodactylon	x	x
CACTI			
Opuntia polyacantha	Plains Prickly Pear Cactus	x	x
SHRUBS			
Artemisia tridentata	Big Sagebrush	x	x
Chrysothamnus nauseosus	Rubber Rabbitbrush	x	x
Chrysothamnus viscidiflorus	Rabbitbrush	x	x
LICHENS			
Parmelia chlorochroa (lichen)	Parmelia	x	x
Total Species in Each Vegetation Type		36	43
Total Number of Species = 58			

Figure 3.7-4 Photo of the Upland Big Sagebrush Shrubland

* Photo taken at N42° 07’ 04.2”; W107° 53’ 10.7”, looking south, September 2006

The major species in the Upland Big Sagebrush Shrubland type is big sagebrush, which occurs at a mean absolute cover of 14 percent, and accounts for 54 percent of the cover by all species. Sandberg bluegrass (*Poa secunda*), needle-and-thread grass (*Stipa comata*), Indian ricegrass (*Oryzopsis hymenoides*), and thickspike wheatgrass (*Agropyron dasystachyum*) occur as the most prevalent perennial grass species. Together, these four species had a mean cover of eight percent and accounted for 31 percent of the cover by all species. Cushion plants are common in this vegetation type, but collectively accounted for only six percent of the cover by all species (**Table 3.7-4**). Even though the mean cover values for these species are low, they were commonly encountered along all the sample transects. The mean total vegetation cover in this type was 26 percent, the cover by litter and rock combined was 22 percent, the bare soil category was 52 percent, and the total ground cover (vegetation plus litter and rock) was 48 percent. The percent cover by bare soil is a reflection of the sparseness of the vegetation in the Upland Big Sagebrush Shrubland type. Even though there is a considerable amount of bare soil, the vegetation development is very homogeneous across the upland parts of the Permit Area. In general, vegetation development in the region is restricted because of the limited amount of annual precipitation.

Table 3.7-4 Cover Parameters of the Upland Big Sagebrush Shrubland (Page 1 of 3)

Species	Mean Cover (percent)	Relative Cover (percent)	Lowest Cover Value (percent)	Highest Cover Value (percent)	Frequency (percent)	Relative Frequency (percent)	Importance Value	Rank
COOL SEASON PERENNIAL GRASSES AND GRASSLIKE PLANTS								
Agropyron dasystachyum	0.9	3.45	0	6	95	6.69	10.14	5
Agropyron spicatum	0.6	2.30	0	4	50	3.52	5.82	10
Koeleria macrantha	<0.1	<0.1	0	<1	5	0.35	0.35	23
Oryzopsis hymenoides	1.5	5.75	<1	10	100	7.04	12.79	4
Poa secunda	3.5	13.41	<1	10	100	7.04	20.45	2
Sitanion longifolium	<0.1	<0.1	0	<1	45	3.17	3.17	15
Stipa comata	2.3	8.81	0	16	80	5.63	14.45	3
Sub-Total	8.8							
PERENNIAL FORBS								
Allium textile	<0.1	<0.1	0	<1	5	0.35	0.35	23
Arabis sp.	<0.1	<0.1	0	<1	5	0.35	0.35	23
Astragalus mollissimus	<0.1	<0.1	0	<1	30	2.11	2.11	18
Cryptantha thrysiflora	<0.1	<0.1	0	<1	5	0.35	0.35	23
Erigeron pumilus	<0.1	<0.1	0	<1	90	6.34	6.34	9
Hymenoxis acaulis	<0.1	<0.1	0	<1	5	0.35	0.35	23
Machaeranthera canescens	<0.1	<0.1	0	<1	15	1.06	1.06	20
Trifolium gymnocarpon	<0.1	<0.1	0	<1	5	0.35	0.35	23
Sub-Total	<0.1							

Table 3.7-4 Cover Parameters of the Upland Big Sagebrush Shrubland (Page 2 of 3)

Species	Mean Cover (percent)	Relative Cover (percent)	Lowest Cover Value (percent)	Highest Cover Value (percent)	Frequency (percent)	Relative Frequency (percent)	Importance Value	Rank
CUSHION PLANTS								
Arenaria hookeri	0.2	0.77	0	<1	75	5.28	5.28	11
Astragalus spatulatus	0.1	0.38	0	2	15	1.06	1.06	20
Eriogonum acaule	<0.1	<0.1	0	<1	10	0.70	0.70	22
Eriogonum ovalifolium	<0.1	<0.1	0	<1	55	3.87	3.87	13
Haplopappus acaulis	<0.1	<0.1	0	<1	65	4.58	4.58	12
Paronychia sessiliflora	0.2	0.77	0	2	45	3.17	3.17	15
Phlox hoodii	1.6	6.13	0	6	100	7.04	7.04	8
Sub-Total	2.1							
SEMI-SHRUBS								
Artemisia frigida	0.1	0.38	0	2	30	2.11	2.11	18
Artemisia spinescens	<0.1	<0.1	0	<1	5	0.35	0.35	23
Ceratoides lanata	0.5	1.92	0	<1	55	3.87	3.87	13
Leptodactylon pungens	<0.1	<0.1	0	<1	40	2.82	2.82	17
Sub-Total	0.6							
CACTI								
Opuntia polyacantha	0.2	0.77	0	2	95	6.69	7.46	7

Table 3.7-4 Cover Parameters of the Upland Big Sagebrush Shrubland (Page 3 of 3)

Species	Mean Cover (percent)	Relative Cover (percent)	Lowest Cover Value (percent)	Highest Cover Value (percent)	Frequency (percent)	Relative Frequency (percent)	Importance Value	Rank
SHRUBS								
Artemisia tridentata	14.1	54.02	6	26	100	7.04	61.07	1
Chrysothamnus viscidiflorus	0.3	1.15	0	2	95	6.69	7.84	6
Sub-Total	14.4							
LICHENS								
Parmelia chlorochroa (lichen)	1.0		0	8	90			
Number of Species per 100 m^2	15.1							
		SD [1]						
Total Vegetation Cover	26.1	4.962						
Total Cover by Perennial Species	24.0	5.272						
Litter and Rock Combined	22	5.657						
Litter (and lichens)	22	5.657						
Rock								
Bare Soil	51.9	6.973						
Total Ground Cover	48.1	6.973						

Shrubs are abundant in this vegetation type. Big sagebrush occurred at a density of 12,332 individuals per acre (about three individuals per square meter) and rabbitbrush (*Chrysothamnus viscidiflorus*) occurred at a density of 1,490 individuals per acre (0.4 individuals per square meter). While these shrub species occur at high densities, none of the plants are tall. In general, most of the plants are less than 0.5 meters in height and many are less than 0.25 meters in height. Semi-shrubs are also common in these upland areas. The total density for semi-shrub species was 2,583 individuals per acre (0.64 individuals per square meter), with winterfat (*Ceratoides lanata*) and prickly gilia (*Leptodactylon pungens*) occurring as the most prevalent of the semi-shrub species (**Table 3.7-5**).

In all, 36 species were observed in the Upland Big Sagebrush Shrubland type (**Table 3.7-2**), with a mean density of about 15 species per 50 square meters.

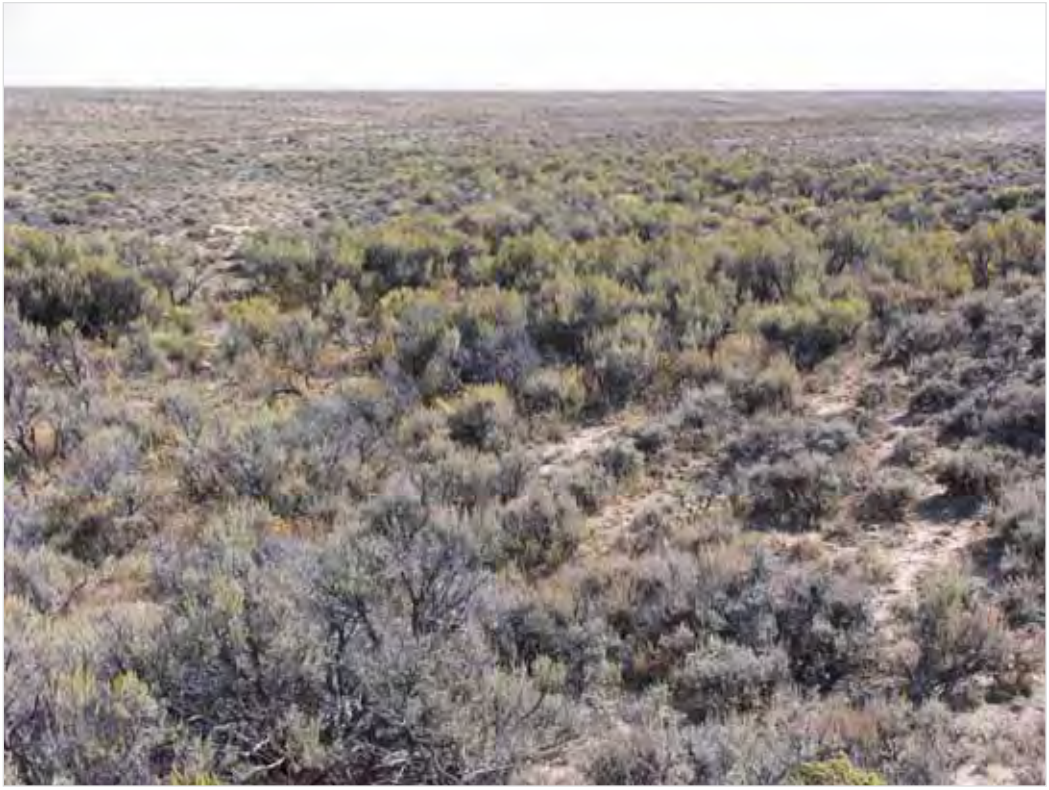
Table 3.7-5 Shrub, Semi-Shrub, and Cactus Densities of the Upland Big Sagebrush Shrubland

Species	Upland Big Sagebrush Shrubland			Lowland Big Sagebrush Shrubland		
	Frequency (percent)	Mean # per square meter	Mean # per acre	Frequency (percent)	Mean # per square meter	Mean # per acre
SHRUBS						
Artemisia tridentata	100	3.046	12,332	100	3.561	14,417
Chrysothamnus nauseosus	0	0	0	35	0.027	109
Chrysothamnus viscidiflorus	95	0.368	1490	95	0.64	2,591
Total Shrubs		3.414	13,822		4.228	17,117
SEMI-SHRUBS						
Artemisia frigida	30	0.048	194	0	0	0
Artemisia spinescens	5	0.003	12	0	0	0
Ceratoides lanata	55	0.467	1,891	15	0.003	12
Leptodactylon pungens	40	0.120	486	35	0.055	223
Total Semi-Shrubs		0.638	2,583		0.058	235
CACTI						
Opuntia polyacantha	95	0.09	364	50	0.069	279

3.7.2.2 Lowland Big Sagebrush Shrubland Type

The Lowland Big Sagebrush Shrubland type on the Permit Area occurs along and immediately adjacent to the ephemeral drainages that cross the Permit Area from north to south (**Figure 3.7-1**). **Figure 3.7-5** is a photograph of an area typical of this vegetation type. Overall this type covers approximately 15 percent of the main Permit Area and four percent of the area along the East and West Access Roads. The soils along the drainages have the potential for holding more moisture than the upland areas. The increased potential soil moisture allows for more growth by big sagebrush so that the individual shrubs growing along the drainages tend to be much larger than the shrubs growing on the upland areas. Along some of the drainages, there are individual big sagebrush plants that are more than two meters tall that have stem diameters greater than 20 centimeters. Slope measurements along the sampled transects in this type ranged between zero and three percent; and all of the transects were either flat or had a southerly aspect component (**Table 3.7-1**).

Figure 3.7-5 Photo of the Lowland Big Sagebrush Shrubland



* Photo taken at N42° 08’ 27.2”; W107° 49’ 13.7”, looking south, September, 2006

The major species in the Lowland Big Sagebrush Shrubland type is big sagebrush, which occurred at a mean cover of 31 percent and accounted for 72 percent of the cover by all species. Rabbitbrush had a mean cover of three percent and accounted for eight percent of the total vegetation cover. These two dominant

shrub species tend to overwhelm the vegetation to the degree that herbaceous species account for only limited amounts of cover in this type. All native perennial grasses combined had a mean cover of seven percent (16 percent of the total vegetation cover), with Sandberg bluegrass (*Poa secunda*), thickspike wheatgrass (*Agropyron dasystachyum*), and squirreltail grass (*Sitanion longifolium*) occurring as the most prevalent perennial grass species. Forb species occur throughout this type, but all occurred at mean cover values that were less than one percent. As a group, all forbs and cushion plants accounted for approximately three percent of the total vegetation cover. The mean total vegetation cover in this type was 43 percent, the cover by litter and rock combined was 34 percent, the bare soil category was 23 percent, and the total ground cover (vegetation plus litter and rock) was 77 percent (**Table 3.7-6**). Overall, the vegetation cover in the Lowland Big Sagebrush Shrubland type was 17 percent greater than the cover in the Upland Big Sagebrush Shrubland type.

Shrubs are abundant in this vegetation type. Big sagebrush occurred at a density of 14,417 individuals per acre (3.6 individuals per square meter), and rabbitbrush (*Chrysothamnus viscidiflorus*) occurred at a density of 2,591 individuals per acre (0.6 individuals per square meter). Semi-shrubs occur in this type, but the overall densities are lower than the densities for semi-shrubs in the upland areas. The total density for semi-shrub species was 235 individuals per acre (0.1 individuals per square meter), with prickly gilia (*Leptodactylon pungens*) occurring as the most common of the semi-shrub species (**Table 3.7-5**).

In all, 43 species were observed in this type (**Table 3.7-2**) with a mean density of about 13 species per 50 square meters. All of the raw data for vegetation cover and shrub density in this vegetation type are presented in Appendix D8 of the WDEQ-LQD Permit to Mine (LCI, 2011b).

3.7.2.3 Endangered or Threatened Species

Threatened and endangered species known to the region include the blowout penstemon (Penstemon haydenii) and the desert yellowhead (Yermo xanthocephalus). An additional 12 rare plant species are known to occur in Sweetwater County (**Table 3.7-2**). No threatened, endangered, or plant species of special concern were observed on the Permit Area; and no rare plants or appropriate habitat for them were found along the roadways.

Table 3.7-6 Cover Parameters of the Lowland Big Sagebrush Shrubland (Page 1 of 3)

Species	Mean Cover (percent)	Relative Cover (percent)	Lowest Cover Value (percent)	Highest Cover Value (percent)	Frequency (percent)	Relative Frequency (percent)	Importance Value	Rank
COOL SEASON PERENNIAL GRASSES AND GRASSLIKE PLANTS								
Agropyron dasystachyum	1.2	2.78	0	8	90	7.09	9.87	4
Agropyron spicatum	0.3	0.70	0	2	25	1.97	2.66	16
Carex douglasii	0.2	0.46	0	2	20	1.57	2.04	20
Carex eleocharis	<0.1	<0.1	0	<1	5	0.39	0.39	32
Elymus cinereus	0.2	0.46	0	2	15	1.18	1.65	22
Koeleria macrantha	0.1	0.23	0	2	10	0.79	1.02	26
Muhlenbergia richardsonis	<0.1	<0.1	0	<1	5	0.39	0.39	32
Oryzopsis hymenoides	0.7	1.62	0	4	65	5.12	6.74	7
Poa secunda	2.3	5.34	0	8	90	7.09	12.42	3
Sitanion longifolium	0.4	0.93	0	4	95	7.48	8.41	5
Stipa comata	0.8	1.86	0	4	55	4.33	6.19	8
Stipa lettermannii	0.7	1.62	0	4	45	3.54	5.17	9
Sub-Total	6.9							
PERENNIAL FORBS								
Allium textile	<0.1	<0.1	0	<1	20	1.57	1.57	23
Antennaria rosea	<0.1	<0.1	0	<1	10	0.79	0.79	27
Arabis sp.	<0.1	<0.1	0	<1	35	2.76	2.76	13
Crepis occidentalis	<0.1	<0.1	0	<1	5	0.39	0.39	32
Senecio integerrimus	<0.1	<0.1	0	<1	5	0.39	0.39	32
Trifolium gymnocarpon	0.1	0.23	0	2	30	2.36	2.59	17
Sub-Total	0.1							

Table 3.7-6 Cover Parameters of the Lowland Big Sagebrush Shrubland (Page 2 of 3)

Species	Mean Cover (percent)	Relative Cover (percent)	Lowest Cover Value (percent)	Highest Cover Value (percent)	Frequency (percent)	Relative Frequency (percent)	Importance Value	Rank
CUSHION PLANTS								
Arenaria hookeri	<0.1	<0.1	0	<1	5	0.39	0.39	32
Eriogonum acaule	0.1	0.23	0	2	25	1.97	2.20	18
Eriogonum ovalifolium	<0.1	<0.1	0	<1	5	0.39	0.39	32
Phlox hoodii	<0.1	<0.1	0	<1	35	2.76	2.76	13
Sub-Total	0.1							
ANNUAL FORBS								
Alyssum desertorum	0.2	0.46	0	2	20	1.57	2.04	19
Chenopodium album	<0.1	<0.1	0	<1	10	0.79	0.79	27
Chenopodium leptophyllum	<0.1	<0.1	0	<1	10	0.79	0.79	27
Cordylanthus ramosus	0.7	1.62	0	4	85	6.69	8.32	6
Cryptantha minima	<0.1	<0.1	0	<1	20	1.57	1.57	23
Descurainia pinnata	<0.1	<0.1	0	<1	25	1.97	1.97	21
Gayophytum ramossissimum	0.2	0.46	0	2	50	3.94	4.40	10
Microsteris micrantha	<0.1	<0.1	0	<1	5	0.39	0.39	32
Navarettia breweri	<0.1	<0.1	0	<1	10	0.79	0.79	27
Polygonum sawatchense	<0.1	<0.1	0	<1	10	0.79	0.79	27
Sub-Total	1.1							
SEMI-SHRUBS								
Ceratoides lanata	<0.1	<0.1	0	<1	15	1.18	1.18	25
Leptodactylon pungens	<0.1	<0.1	0	<1	35	2.76	2.76	13
Sub-Total	<0.1							

Table 3.7-6 Cover Parameters of the Lowland Big Sagebrush Shrubland (Page 3 of 3)

Species	Mean Cover (percent)	Relative Cover (percent)	Lowest Cover Value (percent)	Highest Cover Value (percent)	Frequency (percent)	Relative Frequency (percent)	Importance Value	Rank
CACTI								
Opuntia polyacantha	0.1	0.23	0	2	50	3.94	4.17	11
SHRUBS								
Artemisia tridentata	30.9	71.69	10	48	100	7.87	79.57	1
Chrysothamnus nauseosus	0.5	1.16	0	6	35	2.76	3.92	12
Chrysothamnus viscidiflorus	3.4	7.89	0	18	95	7.48	15.37	2
Sub-Total	34.8							
LICHENS								
Parmelia chlorochroa (lichen)	0.1							
Number of Species per 100 m^2	12.8							
		SD [1]						
Total Vegetation Cover	43.1	8.813						
Total Cover by Perenial Species	42.0	8.360						
Litter and Rock Combined	33.8	11.678						
Litter (and lichens)	33.8	11.678						
Rock								
Bare Soil	23.1	15.874						
Total Ground Cover	76.9	15.874						

† Based on data from twenty 25-meter point intercept transects sampled June 10 to 12, 2006

[1] SD = standard deviation

3.7.2.4 Weeds and Vegetation Communities with Limited Reclamation Potential

Overall, the Permit Area has very few weeds. In reference to the List of Prohibited and Restricted Noxious (Designated) Weeds in WDEQ-LQD Guideline No. 2 (1997), only one noxious weed species, tansy mustard (*Descurainia pinnata*), was noted on the Permit Area (**Table 3.7-3**). Tansy mustard is designated as a restricted noxious weed and was observed as scattered individuals in the Lowland Big Sagebrush Shrubland. Tansy mustard was not actually encountered as part of the cover sampling; however, it did occur within one meter of either side of five of the 20 Lowland Big Sagebrush Shrubland transects and has a relative frequency of 1.97 percent. No areas dominated by weedy species were observed on the Permit Area.

No vegetation communities with limited reclamation potential (LRP) or plant species indicative of soils with LPR were found on the Permit Area. Halophytes and salt-tolerant herbaceous species were among the vegetation species observed (e.g., Narrowleaf Goosefoot [*Chenopodium leptophyllum*] and Western Wheatgrass [*Agrophyron smithii*]), but the vegetation communities are dominated by Big Sagebrush (*Artemisia tridentata*) rather than Greasewood (*Sarcobatus* spp.) or Saltbush (*Atriplex* spp.). No selenium indicator species, such as Prince's Plume (*Stanleya pinnata*), were observed on the site, and none of the soils on the Permit Area are considered to be seleniferous (**Section 3.4.6**). As noted in the discussion of the soil data, there was surface disturbance prior to LCI exploration within the Permit Area. Most of this disturbance was due to historical exploration activities for oil and gas, as well as for uranium, and to livestock and wildlife grazing. In general, there were no reclamation requirements historically, so the areas of prior disturbance may be bare or some vegetation has naturally established. However, the extent of the historic disturbance in areas to be redisturbed and then reclaimed as part of the proposed action is limited and is not anticipated to interfere with the future reclamation.