NICHOLS RANCH ISR PROJECT

URANIUM SOLUTION MINE

Campbell and Johnson Counties, Wyoming

Volume I
(Technical Report)

U.S.N.R.C. Source Material License Application

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2.2 USES OF ADJACENT LANDS AND WATERS

2.2.1 General

The lands within the Nichols Ranch ISR Project **(including Nichols Ranch, Hank, and Jane Dough Units)** have historically been used for cattle grazing and wildlife habitat. Presently the lands are used for a variety of purposes. Livestock grazing, oil and gas extraction, coal bed methane extraction, and uranium recovery activities are all currently taking place on or near the project area. The immediate future land use for the project area and adjacent areas will be continued livestock grazing, in situ uranium recovery, coal bed methane extraction, and oil and gas extraction.

No residential sites are located within the **three** Unit permit areas. There are two ranches located **within 1.0 mile of the three units permit areas**. The Pfister Ranch is located approximately 0.6 mi north of the Hank Unit in Township 44 North Range 75 West, Southwest Quarter of Section 19. The Dry Fork Ranch lies approximately 0.9 mi to the west of the Nichols Ranch Unit and **Jane Dough Unit** in Township 42 North Range 76 West, Northeast Quarter of Section 24. Other residential sites that are located near the Nichols Ranch ISR Project are listed in Table 2-1. All of these residents are located outside the Nichols Ranch ISR Project area. Figure D1-2 (see map pocket) of the attached Appendix D1 – Land Use shows the location of the residents listed in Table 2-1 in relation to the Nichols Ranch ISR Project.

Three NRC licensed in situ uranium recovery facilities are located within 50 mi of the Nichols Ranch ISR Project. COGEMA's Christensen Ranch ISR facility is located approximately 6.0 mi north of the Nichols Ranch Unit and approximately 4.0 mi to the northwest of the Hank Unit. Power Resources Inc. (PRI) licensed North Butte amendment area lays approximately 2.0 mi to the north of the Hank Unit and 5.0 mi to the northeast of the Nichols Ranch Unit. PRI's Smith-Highlands Ranch (SR-HUP) ISR facility is located approximately 45 mi to the southeast of the Nichols Ranch ISR Project. Two of the licensed facilities, Christensen Ranch and SR-HUP, currently have existing yellowcake processing plants with the SR-HUP being in operation. The Christensen Ranch plant was idle, but is back in production. PRI's North Butte amendment area is currently active with a satellite facility and related wellfields.

Table 2-1 Nearest Residents.

Nearest Residences	Number of Inhabitants	Nearest Permit Area	Distance From Permit Area (mi)	Direction
T-Chair (Rolling Pin) Ranch*	5	Nichols Ranch, **Jane Dough,** Hank	1.9, 1.6, 2.9	E, SW
Pfister Ranch	3	Hank	0.6	N
Pumpkin Buttes Ranch	2	Hank	1.1	E
Van Buggenum Ranch	0	Hank	4	E
Ruby Ranch	2	Hank	6.1	E
Dry Fork Ranch	3	Nichols, **Jane Dough**	0.9, 0.9	W
Christensen Ranch	1	Hank	3.5	NW

* T-Chair Ranch sits between the Nichols Ranch and Hank Unit areas.

Figure 1-4 (see map pocket) of Chapter 1.0, Proposed Activities, shows the location of each facility in relation to Uranerz Energy Corporation's Nichols Ranch ISR Project.

After mining activities are completed, the land will be returned to the pre-mining land use of wildlife habitat and livestock grazing. Decommission and reclamation activities of the affected areas resulting from the uranium recovery activities are detailed in Chapter 6.0 of this application.

2.2.2 Agricultural

Livestock grazing is the main activity on the project area and adjacent lands. No known sources of mass food production for human consumption exist within 10 km of the project area. Hay was grown in the past on approximately 127.8 acres of the southern part of the Nichols Ranch Unit, but because of drought conditions over the last seven years, this crop has not been produced. The National Resources Conservation Service (NRCS) stocking rate for the Nichols Ranch ISR Project ranges from 1.0 to 3.0 animal units per acre, per month on range that varies from average to excellent as listed in the NRCS Technical Guides for the Northern Plains.

2.4 HISTORIC, SCENIC, AND CULTURAL RESOURCES

2.4.1 General

The following reports attached as Addendum 2B, Addendum 2B2, **Addendum 2C1** Addendum 2C, **Addendum 2C2**, Exhibit 2-1, and Exhibit **2-1A** contain information that is considered confidential information under 10 CFR 2.390. This information must be withheld from public disclosure.

2.4.2 Cultural Resources

2.4.2.1 Class I Literature Search for Uranerz Energy Corporation's Nichols Ranch and Hank Units

File searches were conducted from November 2007 through January 2010, through the Cultural Records Office of the Wyoming State Historic Preservation Office (SHPO) for Sections 7, 8, 17, 18, and 20, T43N, R76W; Sections 30 and 31, T44N, R75W; and Sections 5-8, T43N, R75W. Uranerz Energy Corporation's proposed Nichols Ranch ISR Project occurs within these legal descriptions.

Twelve projects have been conducted within the sections listed above for nine block and three block/linear surveys (Table 2-5). A few recent projects have not been accessioned into the SHPO database; therefore, they do not have accession numbers in Table 2-5. Fifty-four sites have been recorded in the 11 sections listed above. Of these, 46 sites are prehistoric, five sites are historic, and three site are multicomponent prehistoric/historic. The sites are summarized in Table 2-6. Of the prehistoric sites, 17 are eligible for listing on the National Register of Historic Places (NRHP), 20 are not eligible, eight are not eligible with SHPO concurrence, and one (Site 48CA6153) is unevaluated with SHPO concurrence. The five historic sites are not eligible, one (Site 48JO2951) with SHPO concurrence. Of the three multicomponent sites, one (Site 48CA268, Pumpkin Buttes Traditional Cultural Property [TCP]) is eligible for the NRHP with SHPO concurrence, and two are not eligible with SHPO concurrence.

remains because of the geology and poor exposures of fossil bearing sediments. One recommendation from the survey is to have a paleontological monitor present to oversee any major ground disturbing events when more than a few feet of surface are removed.

The complete paleontological survey for the Jane Dough Unit is attached as Addendum 2C2.

2.4.4 Cultural Resource Mitigation

Uranerz Energy Corporation will comply with the following cultural resource mitigation measures.

1. Uranerz will not conduct any ground disturbing work in areas that have not been previously inventoried and cleared for cultural resources.

2. Uranerz will protect all cultural properties that have been determined eligible to the National Register of Historic Places within the permit area from ground disturbing activities until appropriate cultural resource mitigation measures can be implemented as part of an approved mining and reclamation plan unless modified by mutual agreement in consultation with the SHPO and other regulatory agencies.

3. To protect a previously identified traditional cultural property, Uranerz will also not conduct any ground disturbing activities above the 5,500 foot elevation within the Hank Unit.

4. If cultural resources are discovered during operations, Uranerz will immediately stop ground disturbing activities in the area of the discovery and will immediately notify the NRC, WDEQ-LQD, the BLM (if the resources are located on BLM-administered lands), the SHPO, and any other appropriate regulatory agency.

2.4.5 Scenic Resources

2.4.5.1 Nichols Ranch and Hank Units

Because the Nichols Ranch ISR Project is located almost entirely on private land in a remote location, the operations aesthetic impact is limited to only the landowner and those that have

Approximately 6 mi east of **the Jane Dough** and Nichols Ranch Units and immediately adjacent to the Hank Unit is a series of buttes known as Pumpkin Buttes. These buttes rise approximately 1,200 feet above the proposed project area of the **Jane Dough Unit**. The proximity of the Pumpkin Buttes to the Nichols Ranch ISR Project cannot be ignored and likely creates a microclimate on the surrounding area. Considering that the prevailing winds in the area are from the east, the change in elevation is relatively minor, temperature and relative humidity in the region are quite low, topographically generated weather systems are expected to be nominal. However, it is possible that the buttes do produce some microclimatic effects on the local precipitation pattern but these effects would be variable and diverse especially given the variable nature of summer precipitation events.

The along-slope wind systems, while certainly present, are expected to be insignificant since the daytime adabatic or upslope wind has just a few hundred meters to gather strength before reaching the apex of the buttes. Returning katabatic or down slope winds in the evening should also be minimal as winds in the area tend to decrease with nightfall. The potential for mountain-gap wind between North Butte and North Middle Butte exists but is expected to be negligible. First, the narrow dimensions of the buttes do not allow for a buildup of wind speed as would be expected in a true valley situation. Secondly, in general when air stratification is stable, the air flow tends to be from high to low pressure and wind could emerge through a gap as a "jet" known as mountain-gap wind. However, joint frequency distribution data shows stability class F winds, the most stable, to be quite light in the region. Therefore, while the buttes themselves are a striking visual characteristic of the landscape topographically speaking they are of limited magnitude.

2.5.3.10 On-site Atmospheric Stability Class

A discussion on the method used to determine on-site atmospheric stability is presented in Appendix JD-D4 (Addendum JD-D4-A) (page 18a).

2.5.4 Air Quality

2.5.4.1 General

Uranerz submitted a permit application to WDEQ/AQD for the Nichols Ranch and Hank Units and permit CT-8644 was issued. **Uranerz will prepare and submit a modification to WDEQ/AQD for the Jane Dough Unit to its existing air quality construction permit (CT-8644). The application will include all required information for construction and operation of the Jane Dough Unit.**

2.5.4.2 Impacts due to the Nichols Ranch, **Jane Dough** and Hank Units

Impacts on air quality associated with the operations of the Nichols Ranch ISR Project **(including Nichols Ranch, Jane Dough and Hank Units)** will be very minimal. Access to the project area will be via 8.5 mi of Campbell County maintained gravel road, then 8.5 mi of gravel ranch roads if accessing the project area from Wyoming Highway 50, or approximately **17.7** mi of gravel ranch roads if accessing the property from U.S. Highway 387. Both the county and ranch roads are currently used by numerous oil/gas and coal bed methane companies that are active in the region. These roads have been developed and range from 18 to 24 ft wide crowned-and-ditch roads. The closest residence to the access route is the Pfister Ranch located approximately less than a 0.25 mi to the west of the route and approximately 0.6 mi to the North of the Hank Unit. With the prevailing wind direction out of the southwest, **dust produced by the mining operations and vehicular traffic will generally be blown to the northeast which should not affect ranching operations.**

Particulate emissions associated with the Nichols Ranch ISR Project will also be minimal. **Of the 7,050 acres within the project area, only approximately 401 acres or less of lands will be disturbed with stripping of topsoil occurring approximately on 135 acres or less.** In order to reduce particulate emissions in the wellfield by drilling equipment and wellfield maintenance vehicles, access roads will be maintained via motorized patrol. Natural vegetation will also be left undisturbed whenever possible to prevent wind erosion.

Vehicle traffic entering the Nichols Ranch ISR Project is estimated at eight passenger vehicles per day per week along with **two** tractor trailers per **day**. Fugitive dust emissions **(PM_{10})** from this traffic are estimated at **range from 14.3 to 28.6 tons per year, and average approximately 27.4 tons** per year using the longer of the two access routes as a basis for the fugitive dust calculations. Wellfield fugitive dust emissions were not considered in calculating the overall fugitive dust emissions since the wellfield is not considered a major source of emissions. Estimated fugitive dust emissions during construction of the facilities of the Nichols Ranch ISR Project were also not included in the fugitive dust emission calculation since the amount of vehicular activity that will be taking place during the construction will be similar to the traffic of the actual operation. Figure 2-11 outlines the methods used to calculate the fugitive dust emissions.

From Figure 2-11, PM_{10} emissions for the Nichols Ranch ISR Project will range from 0.1 tons/year to 9.8 tons/year with an average of 4.5 tons/year without ingress and egress traffic emissions. Including ingress and egress traffic emission, the range of total emissions is 14.4 tons/year to 38.4 tons per year (refer to Figure 2-11). It should also be noted that these emission calculations do not include implementation of dust control measures required under the WDEQ-AQD permit issued for this project. Dust control on access roads within the Nichols Ranch, Hank, and Jane Dough Units and between the Nichols Ranch and Hank Units are the responsibility of Uranerz (refer to Figure 2-1). Based on EPA control efficiencies, use of water and/or dust supressants would result in a 50% control factor for these road segments where the dust control measures are applied. As this is below the 250 tons per year threshold for PSD review, an analysis to determine air quality impact is considered unnecessary.

All other emissions from the Nichols Ranch ISR Project are minimal. Table 2-10 details the other potential operation emissions and their potential emission quantity.

Figure 2-11 Fugitive Dust Calculations.

SUMMARY OF PRODUCTION SCHEDULE — Number of Months Activity will Occur (include months for Production Areas 1 and 2)

Unit	Development Phase	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
All Units	Pickup and Semi Traffic	0	8	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	6
Nichols Ranch	Production	0	8	12	15	24	24	18	12	12	6											
Nichols Ranch	Groundwater Restoration							6	12	12	18	24	9									
Nichols Ranch	Wellfield & Site Reclamation												14	18	4							
Hank	Production													9	12	12	12	6				
Hank	Groundwater Restoration															6	12	18	24	16	3	
Hank	Wellfield & Site Reclamation																			9	21	6
Jane Dough	Production							9	12	12	21	24	24	15	12	9						
Jane Dough	Groundwater Restoration													9	12	17	15	7				
Jane Dough	Wellfield & Site Reclamation																6	11	12	7		

SUMMARY OF PM$_{10}$ EMISSIONS — Total PM$_{10}$ Emissions per year[1] (Tons/year); PM$_{10}$ Emissions

Unit	Development Phase	Monthly PM$_{10}$ Emissions (Tons)*	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	Tons of total Emissions	Tons of Total of Emissions per Unit	Years of Operations	Average Emissions per year (tons)
All Units	Pickup and Semi Traffic (in & out)	2.39		19.1	28.6	28.6	28.6	28.6	28.6	28.6	28.6	28.6	28.6	28.6	28.6	28.6	28.6	28.6	28.6	28.6	28.6	28.6	14.3	548.8		20	27.4
Nichols Ranch	Production	0.27		2.1	3.2	4.0	6.4	6.4	4.8	3.2	3.2	1.6												35.2			
Nichols Ranch	Groundwater Restoration	0.09							0.5	1.1	1.1	1.6	2.1	0.8										7.3			
Nichols Ranch	Wellfield & Site Reclamation	0.01												0.2	0.2	0.0								0.4	42.85	13	3.3
Hank	Production	0.64													5.7	7.6	7.6	7.6	3.8					32.4			
Hank	Groundwater Restoration	0.18															1.1	2.1	3.2	4.3	2.9	0.5		14.1			
Hank	Wellfield & Site Reclamation	0.02																			0.2	0.5	0.1	0.8	47.36	9	5.3
Nichols Ranch & Hank Unit Emissions (w/o traffic emissions)				2.1	3.2	4.0	6.4	6.4	5.4	4.3	4.3	3.2	2.1	1.0	5.9	7.7	8.7	9.8	7.0	4.3	3.1	1.0	0.1		90.21	20	4.5
Nichols Ranch & Hank Unit Emissions (w/ traffic emissions)				21.2	31.9	32.7	35.1	35.1	34.0	32.9	32.9	31.9	30.8	29.6	34.6	36.3	37.3	38.4	35.7	32.9	31.7	29.6	14.4				
Jane Dough	Production	1.07							9.7	12.9	12.9	22.6	25.8	25.8	16.1	12.9	9.7							148.3			
Jane Dough	Groundwater Restoration	0.36													3.2	4.3	6.1	5.4	2.5					21.5			
Jane Dough	Wellfield & Site Reclamation	0.04																0.3	0.5	0.5	0.3			1.6	171.40	13	13.2
	Total Tons Per Year for all Units		0.0	21.2	31.9	32.7	35.1	35.1	43.7	45.8	45.8	54.5	56.6	55.4	53.9	53.5	53.1	44.1	38.7	33.4	32.0	29.6	14.4	810.4		20	40.5

* Refer to following sheets for detailed explanation

[1] - Total annual emissions are based on monthly emission rate X the number of months (see table above).

Figure 2-11 Fugitive Dust Calculations (Continued)).

Fugitive Dust (PM_{10}) Emissions Generated During the Production and Wellfield Restoration Phases for Ingress and Egress of Site Personnel the Nichols Ranch ISR Project

Column Designation	a	b	c	d	e	f	g
Vehicle Type	**# of vehicles**	**distance of round trip (miles)***	**round trips per day**	**miles per day**	**vehicle miles travelled per month**	**average speed (mph)**	**e X f**
pickup access travel	8	35.4	1	283.2	8496	30	254880
semi's access travel (including all equipment, material, and resin delivery trucks)	2	35.4	1	70.8	2124	25	53100
Totals					10620		307980
* assumed to be worst case with longest distane for the entire project.							
Emission Factors for PM_{10} determination	**Value**						
S = mean vehicle speed (mph) based on miles travelled per month by vehicle = sum g/sum e =	29.0						
C = emission factor from AP-42 =	0.00047						
M = surface material moisture content (%) (from AP-42) =	0.5						
P = number of days per year with at least 0.01 inches of precipitation (from AP-42) =	100						
s = surface material silt content (%) from AP-42 =	4.2						
k = imperical constant from AP-42 =	1.8						
a = imperical constant from AP-42 =	1.0						
d = imperical constant from AP-42 =	0.50						
c = imperical constant from AP-42 =	0.20						
E = emissions of PM_{10} per month per VMT) (using Equation 1) =	0.449						
	lbs/month	Tons/month					
E (PM_{10}) = (total miles/month) (lbs per month/VMT) =	4772	2.39					

$$E = \left[\frac{\left[k \left(\frac{s}{12} \right)^{a} \left(\frac{S}{30} \right)^{b} \right]}{\left(\frac{M}{0.5} \right)^{c}} - C \right] \left[\frac{(365 - P)}{365} \right]$$

Source: Equation 1b in EPA AP-42 (Chapter 13.2.2 for travel on unpaved roads).

Figure 2-11 Fugitive Dust Calculations (Continued).

Fugitive Dust (PM_{10}) Emissions Generated During the Production Phase (including Construction) of the Nichols Ranch Unit							
Column Designation	a	b	c	d	e	f	g
vehicle type	**# of vehicles[1]**	**distance of round trip (miles)[2]**	**round trips per day**	**miles per day**	**vehicle miles travelled per month**	**average speed (mph)**	**e X f**
pickup infield travel	6	1.0	8	48.0	1440	20	28800
Totals					1440		28800
[1] - this includes all construction related equipment							
[2] refer to text for an explanation of the round trip mileage.							

Emission Factors for PM_{10} determination	**Value**
S = mean vehicle speed (mph) based on miles travelled per month by vehicle = sum g/sum e =	20.0
C = emission factor from AP-42 =	0.00047
M = surface material moisture content (%) (from AP-42) =	0.5
P = number of days per year with at least 0.01 inches of precipitation (from AP-42) =	100
s = surface material silt content (%) from AP-42 =	4.2
k = imperical constant from AP-42 =	1.8
a = imperical constant from AP-42 =	1.0
d = imperical constant from AP-42 =	0.50
c = imperical constant from AP-42 =	0.20

$$E = \left[\frac{\left[k\left(\frac{s}{12}\right)^{a}\left(\frac{S}{30}\right)^{b} \right]}{\left(\frac{M}{0.5}\right)^{c}} - C \right] \left[\frac{(365 - P)}{365} \right]$$

Source: Equation 1b in EPA AP-42 (Chapter 13.2.2 for travel on unpaved roads).

E = emissions of PM_{10} per month per VMT) (using Equation 1) =	0.373	
	lbs/month	Tons/month
E (PM_{10}) = (total miles/month) (lbs per month/VMT) =	537	0.27

Figure 2-11 Fugitive Dust Calculations (Continued).

Fugitive Dust (PM_{10}) Emissions Generated During the Groundwater Resoration Phase of the Nichols Ranch Unit							
Column Designation	a	b	c	d	e	f	g
vehicle type	**# of vehicles**	**distance of round trip (miles)***	**round trips per day**	**miles per day**	**vehicle miles travelled per month**	**average speed (mph)**	**e X f**
pickup infield travel	2	1.0	8	16.0	480	20	9600
Totals					480		9600
* refer to text for an explanation of the round trip mileage.							
Emission Factors for PM_{10} determination	**Value**						
S = mean vehicle speed (mph) based on miles travelled per month by vehicle = sum i/sum e =	20.0						
C = emission factor from AP-42 =	0.00047						
M = surface material moisture content (%) (from AP-42) =	0.5						
P = number of days per year with at least 0.01 inches of precipitation (from AP-42) =	100						
s = surface material silt content (%) from AP-42 =	4.2						
k = imperical constant from AP-42 =	1.8						
a = imperical constant from AP-42 =	1.0						
d = imperical constant from AP-42 =	0.50						
c = imperical constant from AP-42 =	0.20						
E = emissions of PM_{10} per month per VMT) (using Equation 1) =	0.373						
	lbs/month	Tons/month					
E (PM_{10}) = (total miles/month) (lbs per month/VMT) =	179	0.09					

Equation 1

$$E = \left[\frac{\left[k \left(\frac{s}{12} \right)^{a} \left(\frac{S}{30} \right)^{b} \right]}{\left(\frac{M}{0.5} \right)^{c}} - C \right] \left[\frac{(365 - P)}{365} \right]$$

Source: Equation 1b in EPA AP-42 (Chapter 13.2.2 for travel on unpaved roads).

Figure 2-11 Fugitive Dust Calculations (Continued).

Fugitive Dust (PM_{10}) Emissions Generated During the Wellfield & Site Reclamation Phase of the Nichols Ranch Unit							
Column Designation	a	b	c	d	e	f	g
Vehicle Type	**# of vehicles[1]**	**distance of round trip (miles)[2]**	**round trips per day**	**miles per day**	**vehicle miles travelled per month**	**average speed (mph)**	**e X f**
pickup infield travel	2	1.0	1	2.0	60	20	1200
Totals					60		1200
[1] - this includes all construction related equipment							
[2] refer to text for an explanation of the round trip mileage.							
Emission Factors for PM_{10} determination	**Value**						
S = mean vehicle speed (mph) based on miles travelled per month by vehicle = sum g/sum e =	20.0						
C = emission factor from AP-42 =	0.00047						
M = surface material moisture content (%) (from AP-42) =	0.5						
P = number of days per year with at least 0.01 inches of precipitation (from AP-42) =	100						
s = surface material silt content (%) from AP-42 =	4.2						
k = imperical constant from AP-42 =	1.8						
a = imperical constant from AP-42 =	1.0						
d = imperical constant from AP-42 =	0.50						
c = imperical constant from AP-42 =	0.20						
E = emissions of PM_{10} per month per VMT) (using Equation 1) =	0.373						
	lbs/month	Tons/month					
E (PM_{10}) = (total miles/month) (lbs per month/VMT) =	22	0.01					

$$E = \left[\frac{\left[k \left(\frac{s}{12} \right)^{a} \left(\frac{S}{30} \right)^{b} \right]}{\left(\frac{M}{0.5} \right)^{c}} - C \right] \left[\frac{(365 - P)}{365} \right]$$

Source: Equation 1b in EPA AP-42 (Chapter 13.2.2 for travel on unpaved roads).

Figure 2-11 Fugitive Dust Calculations (Continued).

Fugitive Dust (PM_{10}) Emissions Generated During the Production Phase (including Construction) of the Hank Unit							
Column Designation	a	b	c	d	e	f	g
vehicle type	**# of vehicles[1]**	**distance of round trip (miles)[2]**	**round trips per day**	**miles per day**	**vehicle miles travelled per month**	**average speed (mph)**	**e X f**
semi's travel between SPP and CPP	1	15.6	1	15.6	468	25	11700
pickup infield travel	6	2.0	8	96.0	2880	20	57600
Totals					3348		69300
[1] - this includes all construction related equipment							
[2] refer to text for an explanation of the round trip mileage.							

Emission Factors for PM_{10} determination	**Value**	
S = mean vehicle speed (mph) based on miles travelled per month by vehicle = sum g/sum e =	20.7	
C = emission factor from AP-42 =	0.00047	
M = surface material moisture content (%) (from AP-42) =	0.5	
P = number of days per year with at least 0.01 inches of precipitation (from AP-42) =	100	
s = surface material silt content (%) from AP-42 =	4.2	
k = imperical constant from AP-42 =	1.8	
a = imperical constant from AP-42 =	1.0	
d = imperical constant from AP-42 =	0.50	
c = imperical constant from AP-42 =	0.20	
* refer to text for an explanation of the round trip mileage.		
E = emissions of PM_{10} per month per VMT) (using Equation 1) =	0.380	
	lbs/month	Tons/month
E (PM_{10}) = (total miles/month) (lbs per month/VMT) =	1271	0.64

Equation 1

$$E = \left[\frac{\left[k\left(\frac{s}{12}\right)^{a} \left(\frac{S}{30}\right)^{b} \right]}{\left(\frac{M}{0.5}\right)^{c}} - C \right] \left[\frac{(365 - P)}{365} \right]$$

Source: Equation 1b in EPA AP-42 (Chapter 13.2.2 for travel on unpaved roads).

Figure 2-11 Fugitive Dust Calculations (Continued).

Fugitive Dust (PM_{10}) Emissions Generated During the Groundwater Restoration Phase of the Hank Unit							
Column Designation	a	b	c	d	e	f	g
vehicle type	**# of vehicles**	**distance of round trip (miles)***	**round trips per day**	**miles per day**	**vehicle miles travelled per month**	**average speed (mph)**	**e X f**
pickup infield travel	2	2.0	8	32.0	960	20	19200
Totals					960		19200

Emission Factors for PM_{10} determination	**Value**	
S = mean vehicle speed (mph) based on miles travelled per month by vehicle = sum g/sum e =	20.0	
C = emission factor from AP-42 =	0.00047	
M = surface material moisture content (%) (from AP-42) =	0.5	
P = number of days per year with at least 0.01 inches of precipitation (from AP-42) =	100	
s = surface material silt content (%) from AP-42 =	4.2	
k = imperical constant from AP-42 =	1.8	
a = imperical constant from AP-42 =	1.0	
d = imperical constant from AP-42 =	0.50	
c = imperical constant from AP-42 =	0.20	
* refer to text for an explanation of the round trip mileage.		
E = emissions of PM_{10} per month per VMT) (using Equation 1) =	0.373	
	lbs/month	Tons/month
E (PM_{10}) = (total miles/month) (lbs per month/VMT) =	358	0.18

Equation 1

$$E = \left[\frac{\left[k\left(\frac{s}{12}\right)^{a} \left(\frac{S}{30}\right)^{b} \right]}{\left(\frac{M}{0.5}\right)^{c}} - C \right] \left[\frac{(365 - P)}{365} \right]$$

Source: Equation 1b in EPA AP-42 (Chapter 13.2.2 for travel on unpaved roads).

Figure 2-11 Fugitive Dust Calculations (Continued).

Fugitive Dust (PM_{10}) Emissions Generated During the Wellfield & Site Reclamation Phase of the Hank Unit							
Column Designation	a	b	c	d	e	f	g
vehicle type	**# of vehicles[1]**	**distance of round trip (miles)[2]**	**round trips per day**	**miles per day**	**vehicle miles travelled per month**	**average speed (mph)**	**e X f**
pickup infield travel	2	2.0	1	4.0	120	20	2400
Totals					120		2400
[1] - this includes all construction related equipment							
[2] refer to text for an explanation of the round trip mileage.							

Emission Factors for PM_{10} determination	**Value**
S = mean vehicle speed (mph) based on miles travelled per month by vehicle = sum g/sum e =	20.0
C = emission factor from AP-42 =	0.00047
M = surface material moisture content (%) (from AP-42) =	0.5
P = number of days per year with at least 0.01 inches of precipitation (from AP-42) =	100
s = surface material silt content (%) from AP-42 =	4.2
k = imperical constant from AP-42 =	1.8
a = imperical constant from AP-42 =	1.0
d = imperical constant from AP-42 =	0.50
c = imperical constant from AP-42 =	0.20
E = emissions of PM_{10} per month per VMT) (using Equation 1) =	0.373

Equation 1

$$E = \left[\frac{\left[k\left(\frac{s}{12}\right)^{a} \left(\frac{S}{30}\right)^{b} \right]}{\left(\frac{M}{0.5}\right)^{c}} - C \right] \left[\frac{(365 - P)}{365} \right]$$

Source: Equation 1b in EPA AP-42 (Chapter 13.2.2 for travel on unpaved roads).

	lbs/month	Tons/month
E (PM_{10}) = (total miles/month) (lbs per month/VMT) =	45	0.02

Figure 2-11 Fugitive Dust Calculations (Continued).

Fugitive Dust (PM_{10}) Emissions Generated During the Production Phase (including Construction) of the Jane Dough Unit

Column Designation	a	b	c	d	e	f	g
vehicle type	**# of vehicles**	**distance of round trip (miles)***	**round trips per day**	**miles per day**	**vehicle miles travelled per month**	**average speed (mph)**	**e X f**
pickup infield travel	6	4.0	8	192.0	5760	20	115200
Totals					5760		115200
[1] - this includes all construction related equipment							
[2] refer to text for an explanation of the round trip mileage.							

Emission Factors for PM_{10} determination	**Value**
S = mean vehicle speed (mph) based on miles travelled per month by vehicle = sum g/sum e =	20.0
C = emission factor from AP-42 =	0.00047
M = surface material moisture content (%) (from AP-42) =	0.5
P = number of days per year with at least 0.01 inches of precipitation (from AP-42) =	100
s = surface material silt content (%) from AP-42 =	4.2
k = imperical constant from AP-42 =	1.8
a = imperical constant from AP-42 =	1.0
d = imperical constant from AP-42 =	0.50
c = imperical constant from AP-42 =	0.20
* refer to text for an explanation of the round trip mileage.	
E = emissions of PM_{10} per month per VMT) (using Equation 1) =	0.373

$$E = \left[\frac{\left[k\left(\frac{s}{12}\right)^{a} \left(\frac{S}{30}\right)^{b} \right]}{\left(\frac{M}{0.5}\right)^{c}} - C \right] \left[\frac{(365 - P)}{365} \right]$$

Source: Equation 1b in EPA AP-42 (Chapter 13.2.2 for travel on unpaved roads).

	lbs/month	Tons/month
E (PM_{10}) = (total miles/month) (lbs per month/VMT) =	2149	1.07

Figure 2-11 Fugitive Dust Calculations (Continued).

Fugitive Dust (PM_{10}) Emissions Generated During the Groundwater Resoration Phase of the Jane Dough Unit							
Column Designation	a	b	c	d	e	f	g
vehicle type	**# of vehicles**	**distance of round trip (miles)***	**round trips per day**	**miles per day**	**vehicle miles travelled per month**	**average speed (mph)**	**e X f**
pickup infield travel	2	4.0	8	64.0	1920	20	38400
Totals					1920		38400

Emission Factors for PM_{10} determination	**Value**
S = mean vehicle speed (mph) based on miles travelled per month by vehicle = sum g/sum e =	20.0
C = emission factor from AP-42 =	0.00047
M = surface material moisture content (%) (from AP-42) =	0.5
P = number of days per year with at least 0.01 inches of precipitation (from AP-42) =	100
s = surface material silt content (%) from AP-42 =	4.2
k = imperical constant from AP-42 =	1.8
a = imperical constant from AP-42 =	1.0
d = imperical constant from AP-42 =	0.50
c = imperical constant from AP-42 =	0.20
* refer to text for an explanation of the round trip mileage.	
E = emissions of PM_{10} per month per VMT) (using Equation 1) =	0.373

Equation 1

$$E = \left[\frac{\left[k\left(\frac{s}{12}\right)^{a} \left(\frac{S}{30}\right)^{b} \right]}{\left(\frac{M}{0.5}\right)^{c}} - C \right] \left[\frac{(365 - P)}{365} \right]$$

Source: Equation 1b in EPA AP-42 (Chapter 13.2.2 for travel on unpaved roads).

	lbs/month	Tons/month
E (PM_{10}) = (total miles/month) (lbs per month/VMT) =	716	0.36

Figure 2-11 Fugitive Dust Calculations (Continued).

Fugitive Dust (PM_{10}) Emissions Generated During the Wellfield & Site Reclamation Phase of the Jane Dough Unit							
Column Designation	a	b	c	d	e	f	g
Vehicle Type	**# of vehicles[1]**	**distance of round trip (miles)[2]**	**round trips per day**	**miles per day**	**vehicle miles travelled per month**	**average speed (mph)**	**e X f**
pickup infield travel	2	4.0	1	8.0	240	20	4800
Totals					240		4800
[1] - this includes all construction related equipment							
[2] refer to text for an explanation of the round trip mileage.							

Emission Factors for PM_{10} determination	**Value**	
S = mean vehicle speed (mph) based on miles travelled per month by vehicle = sum g/sum e =	20.0	
C = emission factor from AP-42 =	0.00047	
M = surface material moisture content (%) (from AP-42) =	0.5	
P = number of days per year with at least 0.01 inches of precipitation (from AP-42) =	100	
s = surface material silt content (%) from AP-42 =	4.2	
k = imperical constant from AP-42 =	1.8	
a = imperical constant from AP-42 =	1.0	
d = imperical constant from AP-42 =	0.50	
c = imperical constant from AP-42 =	0.20	
E = emissions of PM_{10} per month per VMT) (using Equation 1) =	0.373	
	lbs/month	Tons/month
E (PM_{10}) = (total miles/month) (lbs per month/VMT) =	90	0.04

Equation 1

$$E = \left[\frac{\left[k\left(\frac{s}{12}\right)^{a} \left(\frac{S}{30}\right)^{b} \right]}{\left(\frac{M}{0.5}\right)^{c}} - C \right] \left[\frac{(365 - P)}{365} \right]$$

Source: Equation 1b in EPA AP-42 (Chapter 13.2.2 for travel on unpaved roads).

Table 2-10 Emissions Inventory, Nichols Ranch, Hank and Jane Dough Units.

Emission	Estimated Emission (tons/yr)
CO_2	353.70
HCL	0.017
H_2O_2	0.003
NaOH	0.0003
Fugitive Dust (PM_{10})	40.5*

*Does not include ingress and egress traffic emissions.

The air quality impacts of the proposed project in the local and regional areas are minimal. The main impact to the air quality would be from fugitive dust that is generated from the construction of facilities, construction, and operation of the wellfields, and the increase in traffic from the operation of the proposed project. Fugitive dust releases are estimated to be the same during the construction of the Jane Dough Unit as they are during the operation of the proposed project since the amount of vehicle traffic is expected to be the same. Detailed calculations of the amount of estimated fugitive dust that would be released by the project are presented in Appendix JD-D4). The estimated release of fugitive dust from the proposed project is under the allowable 250 tons per year increment for prevention of significant deterioration of air quality.

The potential for fugitive dust emissions from wind erosion would be minimized by promptly reclaiming disturbed soil and establishing vegetative cover on soil stockpiles. Most of the work associated with wellfield installation would take place with stationary equipment hence any additional fugitive dust releases resulting from vehicular traffic in the wellfield would be small because of low traffic volume.

It is possible that radon gas could be released as result of operations in the wellfield. This gas can be present in the processing solutions and could escape into the atmosphere in several locations. In order to escape, the radon gas would first have to be vented in the wellfield from either individual well vents or from the header house.

The radiological effects of radon or any radiological emission upon the local and surrounding area was completed using the NRC MILDOS model for predicting radiological doses. The results of the MILDOS modeling are described in Chapter 7.0, Section 7.3 of the NRC Technical Report. The estimated releases from the Jane Dough Unit are small fractions of the allowable does limit for the general public.

Figure 2-11 outlines the methods used to calculate the fugitive dust emissions.

From these calculations, it is estimated that an annual emission rate of 13.2 tons per year without ingress and egress traffic emissions can be expected for the Jane Dough Unit. Over the life of the project (including the Nichols Ranch, Hank, and Jane Dough Units) total PM_{10} emissions are expected to range from 14.4 tons/year to 56.6 tons/year with an average of 40.5 tons/year including ingress and egress traffic emissions (refer to Figure 2-11). It should also be noted that these emission calculations do not include implementation of dust control measures required under the WDEQ-AQD permit used for this project. Dust control on access roads within the Nichols Ranch, Hank, and Jane Dough Units and between the Nichols Ranch and Hank Units are the responsibility of Uranerz (refer to Figure 2-1). Based on EPA control efficiencies, use of water and/or dust supressants would result in a 50% control factor for these road segments where the dust control measures are applied. As this is below the 250 tons per year threshold for PSD review, an analysis to determine air quality impact is considered unnecessary.

The Wasatch Formation consists of interbedded mudstones, carbonaceous shales, silty sandstones, and relatively clean sandstones. In the vicinity of the Pumpkin Buttes, the Wasatch Formation is known to be 1,575 ft thick (Sharp and Gibbons, 1964). The interbedded mudstones, siltstones, and relatively clean sandstones in the Wasatch vary in degree of lithification from uncemented to moderately well cemented sandstones, and from weakly compacted and cemented mudstones to fissile shales. The Wasatch contains significant uranium resources and hosts the ore bodies for which this application is subject to.

The Fort Union Formation in the PRB is lithologically similar to the Wasatch Formation. The Fort Union includes interbedded silty claystones, sandy siltstones, relatively clean sandstones, claystones, and coal. The degree of lithification is quite variable, ranging from virtually uncemented sands to moderately well cemented siltstones and sandstones. The total thickness of the Fort Union in this area is approximately 3,000 ft. The Fort Union contains significant uranium mineralization at various locations in the basin. The Fort Union is also the target formation for Coal Bed Methane (CBM) extraction activities. CBM target depths in the Nichols Ranch Unit are about 1,000 ft and 1,200 ft at the Hank **and Jane Dough** Units. A minimum of 300 ft of primarily mudstones and impermeable shales interspersed with fine-grained sands and siltstones separate the proposed uranium mining from CBM production horizons at both Nichols Ranch, **Jane Dough** and Hank. Since CBM wells have their casings cemented to the surface, no interference, water loss, or water invasion is anticipated.

Maps of the surface and sub-surface geology of the Powder River Basin are depicted in Exhibits 5a and 5b (see map pockets) of Appendix D5 in Volume V.

2.6.2 Site Geology

2.6.2.1 Nichols Ranch and Hank Units

The Nichols Ranch Unit site is located in the Eocene Wasatch Formation about eight miles west of the South Pumpkin Butte and straddles the Johnson and Campbell County lines. The mineralized sand horizons are in the lower part of the Wasatch, at an approximate average depth of 550 ft. The host sands are primarily arkosic in composition, friable, and contain trace amounts of carbonaceous material and organic debris. There are locally sandy mudstone/siltstone intervals within the sands and the sands may thicken or thin to the point of removal in some areas.

be taken to protect the well and wellhead. Barriers surrounding the well such as cement blocks, protective steel casing around the wellheads, or other measures to protect the wells from damage will be utilized. Additionally, if a new road or any access roads have to cross an ephemeral drainage, efforts will be made to cross the drainage at right angles to minimize erosion with the appropriate sized culverts installed. Rocked low water crossings or culverts in combination with a low water crossing will be designed to pass a 25-year peak runoff event. Culverts will be used in diverting drainage from roads or for crossing small drainages. In the event that drainage has to be crossed, but cannot be crossed at a right angle or along elevation contours, appropriate measures for erosion control will be examined and implemented. All measures will use the best management practices (rock, riprap, etc.) in accordance to WDEQ-LQD Rules and Regulations, Chapter 3 **and will suffice WDEQ-WQD WYPDES requirements,** or those stated in 10 CFR Part 40.

2.7.1.1.3 Surface-Water Quality

The surface water quality from the Cottonwood, Tex, Dry Willow and Willow Creek drainages is generally very good in the upper channel reaches of these areas. A typical TDS is 200 mg/l. Water quality generally deteriorates as the surface water flows further downstream and is in contact with the streambed for longer periods of time.

The U. S. Geological Survey has monitored the Dead Horse Creek drainage which is approximately 30 mi north of the confluence of the Dry Fork with the Powder River and roughly 20 mi north of the confluence of Willow Creek with the Powder River. Dead Horse Creek drainage area is 151 square mi, which is significantly greater than the local drainages of the mining area. Limited water quality data from this gauging station shows that ion concentrations are significant with conductivity of greater than 2,000 umhos/cm.

Table D6A.1-1 in Addendum D6A of Appendix D6 presents water quality data available from surface water samples within the drainages in the project. Figure 2-15 shows the location of surface water quality samples. These surface water results should be representative of conditions in 2007 because CBM discharges in this area have not started. Discharges to Tex Draw are expected to start in 2008 but a large portion of this area will not have CBM discharges because

over a very significant width of the flood plane. The velocity in Seventeen Mile Creek will be greater due to the steeper channel slope and smaller channel width and are near 10 ft/sec. The flow velocity over the 25-year peak discharge for the smaller sub basins is also presented in Table JD-D6-1. The velocities for the Jane Dough Unit vary from a low of 7.20 to a high of 14.66 ft/sec.

The 25-year peaks and conveyance from Table JD-D6-1 were used to define the flood inundated areas for the Jane Dough permit areas. Figure JD-D6-2 shows the Jane Dough Unit inundated areas. A pattern in shown over the Cottonwood Creek inundated area. This entire area should be flooded during the 25-year peak runoff event. The 25-year peak runoffs for the incised small tributaries within the Jane Dough Unit will be confined to these channels and are the approximate flooded area is shown by the narrow channel lines presented on Figure JD-D6-2.

2.7.1.2.3 Surface Water Quality

The surface water quality from the Dry Fork of the Powder River, Cottonwood, and Seventeen Mile Creek drainages is generally very good in the upper channel reaches of these areas. A typical TDS is 200 mg/l. Water quality generally deteriorates as the surface water flows further down stream and is in contact with the streambed for longer periods of time. The U. S. Geological Survey has monitored the Dead Horse Creek drainage which is approximately 30 miles north of the confluence of the Dry Fork with the Powder River and roughly 20 miles north of the confluence of Willow Creek with the Powder River. Dead Horse Creek drainage area is 151 square miles, which is significantly greater than the local drainages of the mining area. Limited water quality data from this gauging station shows that ion concentrations are significant with conductivity greater than 2,000 mhos/cm.

Table JD-D6A.1-1 in Addendum JD-D6A presents water quality data available from surface water samples within the drainages in the project. Figure JD-D6-1 shows the location of surface water quality samples. There are two self samplers, JD SS1 and JD SS2, which are shown on the map as well. This data shows that the surface water quality can naturally vary greatly. TDS values for the reservoirs sampled range from 382 to 2,930 mg/l. The surface sample location JD SS1 shows considerably lower TDS values than that of the reservoirs, ranging from 112 to 232 mg/l. No sample has been collected from JD SS2. Surface runoff water quality is generally dominated by bicarbonate concentrates but increase concentrations of calcium and sulfate are observed with increasing exposure time in channels.

The aquifer and aquitard sequence at the project area is shown in Figure JD-D6-3. This shows labeled sands from the 1, A, B, C, F, G, and H Sands. This figure also shows the aquitards that exist between the different sands and those aquitards are labeled as by the combination of labels for the two adjacent sands. The AB aquitard is absent in the eastern and northwest portions of the Jane Dough Unit as described in Appendix JD-D5. These sands are the same names that are used at Power Resources North Butte permit which exists just north of the Hank Unit site. The majority of the wells completed in the Jane Dough Unit are completed in the A Sand because this is the ore bearing sand in this area. Figure JD-D6-4 shows the locations of the Jane Dough Unit wells and Exhibit JD-D6-1 shows the locations of wells within three miles of the Jane Dough Unit. Table JD-D6-2 presents the tabulation of the well data for the Jane Dough Unit wells. Table JD-D6-2 shows that eight of the wells have been completed in the A Sand for definition of baseline water level and water quality with four wells completed in the B Sand, one well in the C Sand, three wells in the F Sand, two wells in the G Sand, three in the 1 Sand. Three wells were completed in the Cottonwood, Dry Fork, and Seventeen Mile alluviums. All of these wells with the exception of URZJG-17 and the alluvial wells, URZJQ-24-1, URZJQ-25, and URZJQ-26, are open hole completed. Additional ranch wells, Nichols #1, Pats #1, and Pug #1, are presented in the table but not used for baselining. Addendum JD-D6L gives the Uranium Data Submission Spreadsheets which contain additional information on the wells.

2.7.2.2.2 Summary of Aquifer and Aquitard Properties

Numerous single-well pump tests and multi-well pump tests were conducted at the Jane Dough Unit to define the aquifer properties. The detailed hydrologic analyses and supporting data are contained in Addendums JD-D6B and JD-D6C for the single-well and multi-well tests, respectively. Five multi-well pump tests were conducted at the Jane Dough Unit site and are referred to in this report as the URZJA-1, URZJA-7, URZJA-8, URZJA-13-1 and URZJA-14-1 tests. Table JD-D6-2 presents the basic well data for wells used to define the aquifer properties for the Jane Dough Unit. Addendum JD-D6J presents the aquifer test theory used to analyze the pump tests.

2.7.2.2.2.1 Aquifer Properties

In addition to determining the aquifer properties from the multi-well test, numerous single well tests were conducted to define the aquifer properties. Several pump tests were

previously conducted by Cleveland-Cliffs and Uranerz and the results of these tests were analyzed and included in the general hydrologic analysis.

The aquifer property tables and discussion present the ore sand first, then the overlying and underlying aquifers and finally shallowest to deeper aquifer for the remaining aquifers. Table JD-D6-3 presents a summary of the aquifer properties for the Jane Dough Unit. This table shows a summary of the aquifer properties for the AB, A, B, 1, F, and C Sands for the Jane Dough Unit. In the eastern half and northwest portion of the Jane Dough Unit, the aquitard between the A and B Sands is not continuous and thus the two sands show good connection and create the AB aquifer. Three multi-well and two single well tests were conducted in areas where that connection was evident. Transmissivities from these pump tests varied from 48 to 1,610 gal/day/ft. The vertical hydraulic conductivity near URZJA-1 is 3.1 E-4 ft/day. This value is likely due to a thin clay layer that significantly retards the vertical movement of water and isn't representative of the A sand. The average vertical hydraulic conductivity near URZJA-7 and URZJA-8 is 0.012 ft/day. The drawdown from the operation of the wellfield will cause the gradient between the A and B Sands to reverse in these areas. The gradient from the B Sand to the A Sand as well as the significantly dampened vertical hydraulic conductivity should act as an adequate confinement of the ore zone.

Two multi-well tests were conducted in the A Sand near URZJA-13-1 and URZJA-14-1. Transmissivities for these A Sand aquifer tests varied from a low of 30.8 to a high of 76.7 gal/day/ft. The hydraulic conductivity (horizontal permeability) varied from 0.10 to .16 ft/day (46.2 to 76.8 milliDarcy).

A transmissivity range of 270-350 gal/day/ft is typical of the ore-bearing A Sand. Typical horizontal and vertical hydraulic conductivity of 0.25 and 0.012 ft/day, respectively, are thought to best represent the A Sand. A storage coefficient of 1.3 E-4 is representative of the A Sand.

Two single-well pump tests at different locations were conducted in the B Sand and produced a range of transmissivities from 9.8 to 132 gal/day/ft. An average transmissivity of 86 gal/day/ft and a horizontal permeability of .07 ft/day are thought to best represent the

the aquifers in this area. Addendum JD-D6D presents the water-level plots and tabulation of ground-water levels. Addendum JD-D6L also presents a tabulation of the water levels in the Uranium Data Submission Spreadsheets.

The historical and current water-level elevation maps for the aquifers in this area are essentially the same. Water-level plots show that historically only small changes have occurred in these water levels since the late 1970s. Coal bed methane production in the immediate area had not started and by 2007, therefore the 2007 piezometric surface maps can be used as historical water-level elevations. CBM has started in this area and has caused large drawdown in the coal aquifer but these drawdowns have not been observed in the aquifers adjacent to the production zones. The drawdowns in the sands above the CBM production aquifers have generally been observed in some of the sands closer to the coal aquifer. These drawdowns should generally be relatively small and decrease in sands with greater distances from the coal aquifer.

The water-level elevation for the A Sand, which is the production sand at the Jane Dough Unit, is presented in Figure JD-D6-5. This water-level elevation map shows that the ground water in the A Sand is flowing to the northwest with an average gradient of 0.0064 ft/ft. This gradient, an effective porosity of 0.05 and an average hydraulic conductivity of 0.25 ft/day indicates that the ground water in the A Sand is flowing at an average rate of 0.032 ft/day (12 ft/yr).

The regional piezometric surface of the A Sand aquifer is developed from the Nichols Ranch Unit A Sand wells and from three additional A Sand wells in this region. Figure D6-5a in Appendix D6 of the Nichols Ranch permit presents the 1980 regional water-level elevation map for the A Sand. This map shows that the regional ground water flow direction is the same as that in the Jane Dough Unit area. The regional ground-water velocity would be expected to be similar to the local ground-water velocity in the Jane Dough Unit area. Three F Sand wells were added at the Jane Dough Unit to define the shallow ground water at this site. Figure JD-D6-8 shows the water-level elevation for F Sand wells URZJF-5, URZJC-16, and URZJC-22. The water-level elevation of this shallow sand is an average of 27 feet less than the water-level elevation than the A Sand at this location.

Additional shallow monitoring wells were installed in the Jane Dough Unit in the Cottonwood, Dry Fork, and Seventeen Mile alluviums. These monitoring wells are located on the downstream edge of the Jane Dough Unit area while the Cottonwood well is upgradient of Jane Dough (see Figure JD-D6-10 for location). Completion information for this well is presented in Table JD-D6-2. This water-level elevation is approximately 35 feet below the water-level elevation of the A Sand near URZJQ-24-1 and URZJQ-26, but closer to 45 feet below the A Sand at URZJQ-25.

Figure D6-6 in Appendix D6 of the Nichols Ranch permit shows the regional water-level elevation for the F Sand for the Nichols Ranch ISR Project area. This map includes wells in both the Nichols Ranch and Hank Units.The new Jane Dough Unit wells exist just south of the Nichols Ranch Unit. The ground-water elevation in Figure JD-D6-8 shows that the water in the F Sand is flowing northwest with an average gradient of 0.011 ft/ft. This gradient, along with an average hydraulic conductivity of 2.2 ft/day and an effective porosity of 0.14, indicates that the ground water velocity is moving at 0.17 ft/day (62.6 ft/yr). Ground water in the F Sand likely flows into the Cottonwood alluvium in the southern area of the Nichols Ranch Unit and in the northern portion of the Jane Dough Unit.

A regional water-level elevation for the 1 Sand, the underlying aquifer to the Jane Dough Unit A Sand production, is presented in Figure D6-6a in Appendix D6 of the Nichols Ranch permit. This water-level elevation map shows that the ground-water flow in the 1 Sand is mainly to the northwest. Figure JD-D6-6 presents the water-level elevation map for the 1 Sand in the Jane Dough Unit area. The gradient of the 1 Sand piezometric surface is 0.008 ft/ft and this gradient, and a hydraulic conductivity of 0.15 ft/day and an effective porosity of 0.05 indicates ground water in the 1 Sand is moving at 0.024 ft/day (8.8 ft/yr). Figure D6-6c in Appendix D6 of the Nichols Ranch permit presents the regional water-level elevations for wells that are completed in the B Sand. The water-level elevations in these sands indicate that the gradient is to the west-northwest in the Nichols Ranch ISR Project area. The water-level elevations for the B Sand aquifer in the Jane Dough Unit area are presented in Figure JD-D6-7. The piezometric gradient in the ground-water systems has a west-northwest gradient in the Jane Dough Unit. The gradient is 0.008 ft/ft in the B Sand

JD-D6D.1-5 in Addendum JD-D6D present the water-level elevations; versus time for the Jane Dough Unit wells. Water levels for the A Sand wells since 2010 have been fairly steady with a very gradual decrease observed in 2012 and 2013.

Water levels in the northeast cluster of the Jane Dough Unit all show a very slight decrease in water level over the last two years. B Sand well URZJB-3 has had very similar water levels to A Sand wells URZJA-1 and URZJA-2 up until the beginning of 2013. The underlying 1 Sand is roughly 18 feet above the A Sand in this cluster. The F Sand, as shown by the URZJF-5, water levels in this cluster is slightly over 15 feet lower than the A Sand.

The A and B Sand water levels in the southeast cluster have very similar water levels. The AB mudstone is not continuous on the eastern portion of the Jane Dough Unit; hence the similar heads in the adjacent aquifers. The 1 Sand water level is over 35 feet higher than that of the A Sand. The C Sand, as shown by well URZJC-10, water level is roughly four feet higher than the A Sand. The most surficial aquifer, the G Sand, shows a water level nearly 30 feet higher than the A Sand.

The A Sand wells in the southwestern cluster show a slight increase in water level in 2013. The overlying B and F Sands both have water levels over 20 feet lower than the A Sand in this area.

The A Sand wells in the northwestern cluster of the Jane Dough Unit have shown a slight decline from 2011. The B Sand is approximately four feet lower than the A Sand in this area. The underlying 1 Sand shows a highly variable water level that's on average 10 feet higher than the A Sand. The overlying F Sand shows a slight increase in water level from 2011 to 2013 and is roughly 18 feet higher than the A Sand. The G Sand has a fairly steady water level over that same time frame and has a water level that is on average forty feet lower than the A Sand. The three alluvial wells in the Jane Dough Unit have all shown a slight increase in depth to water from 2011 to 2013.

2.7.2.2.3.3 Coal Bed Project Effects on Water Levels

This section presents the potential effects of the coal bed water production on the ore sands. Coal bed methane (CBM) production has been underway for more than 15 years in the

that particular constituent. The maximum, mean and standard deviation are also given in the summary tabulations. The number of samples that have a concentration above the DEQ Class I standard is presented in the last row. The A Sand water typically has very low TDS, (less than 500 mg/l), with its major components being sodium, sulfate and bicarbonate. For the 33 samples, the TDS varies from a minimum of 299 to 715 mg/l with a standard deviation of 71.9 mg/l. The sulfate concentrations for the 33 samples vary from 88 to 141 mg/l while the chloride concentrations vary from 5 to 113 mg/l. Variations are 95 to 127 mg/l for sodium and 3 to 29 mg/l for calcium. The variation of uranium concentrations are over a small range from less than detection values to a maximum 0.0495 mg/l. Radium-226+228 concentrations from the A Sand vary from less than detection to 247.7 pCi/l. Eleven of the radium-226+228 values exceed the Class I standard.

The B Sand analysis includes wells URZJB-3, URZJB-9, URZJB-15, and URZJB-21. TDS concentrations for this aquifer are typically above 300 mg/l with the larger major constituent concentrations being those of sodium, bicarbonate, and sulfate. The TDS of this water ranges from 303 to 451 mg/l. Sodium is the major cation in this water with concentration variations of 96 to 119 mg/l. Sulfate is a major anion with concentrated variation from 111 to 156 mg/l. These sands do show low concentrations of uranium in some areas that is attributed to limited mineralization. The radium-226+228 concentrations in the B aquifer vary from less than detection to a maximum of 4.72 pCi/l.

The water quality for the C Sand is summarized on the second page of Table JD-D6-6. Well URZJC-10 was used to develop a summary of the C Sand water quality. TDS concentrations in the C Sand vary from a minimum of 251 to 303 mg/L. The major cation in this water is sodium and the major anions are sulfate and bicarbonate. Sulfate concentrations vary from a maximum of 89 to a minimum of 84 mg/L. None of the concentrations exceeded Class I standards aside from the 5 samples with a pH higher than 8.5.

The second page of Table JD-D6-6 also presents the summary of water quality for the 1 Sand. Wells URZJ1-6, URZJ1-12, and URZJ23-1 in the Jane Dough Unit were used. This data shows that the TDS average is 253 mg/l with sodium and bicarbonate being the major components of this water quality. Sodium concentrations vary from 77-107 mg/l.

ranch house towards Cottonwood Creek and was thought to be artesian in nature. The depth of the well was not known but it was likely hand dug and fed off the waters of Cottonwood Creek.

The water source for the Pumpkin Buttes Ranch, located approximately 1.1 mi east of the Hank Unit permit area, is currently being supplied by a new well that was drilled sometime in 2008/2009 according to the landowner. This well is approximately 500 ft deep and completed between 400 and 480 ft placing it in the G Sand. The landowner also stated that there is another well present at the ranch near the current well that can be used as a backup well. The landowner did not know the depth of the well, it is not listed in the SEO database, and the landowner did not remember when it was drilled, but did state that the well had been there for some time.

2.7.3.2 Jane Dough Unit

Surface and ground-water rights on, adjacent to, and within 3 miles of the Jane Dough Unit are listed in Table JD-D6F.1-1 in Addendum F. Table JD-D6G.1-1 lists the wells within the Jane Dough Unit and adjacent ½ mile. Table JD-D6G.1-2 in Addendum JD-D6G list wells within three miles (including those within ½ mile) of the Jane Dough Unit. Table JD-D6F.1-2 in Addendum JD-D6F lists the abbreviations used by the State Engineers Office for both the surface and groundwater rights. Figure JD-D6-14 present the locations of the Jane Dough Unit surface rights. Exhibit JD-D6-1 shows the locations of the permitted wells within three miles of the Jane Dough Unit. No adjudicated surface water rights are located in or adjacent to (within 1/2 mile of the project unit) the Jane Dough Unit. The surface water rights that do exist within the proposed mining project area are limited to tock/storage ponds and ephemeral creeks.

Groundwater rights in the Jane Dough Unit area are mainly associated with the old monitoring wells and stock wells. No other adjudicated water rights are in the project area and lands adjacent to the project area according to the Wyoming State Engineers Office. Uranerz Energy Corporation also does not hold any adjudicated water rights in the project area. Most wells that are located within the Jane Dough Unit area were previously installed

Taylor #21-3, Seventeen Mile #1, and Fetty Well #1 are thought to be completed in the 1 Sand and should not be affected by Jane Dough.

The Brown 20-9 well is within the Nichols Ranch Unit and flows at approximately one gpm. This well is thought to be completed in the A Sand and has a total depth of 740 feet with perforations from 495 to 695 feet. The Nichols #1 well, which is located in Section 19, is completed down to a depth of 310 feet. This well is likely completed in the C Sand and flows at approximately one gpm.

Based on a conversation with the current owner of the property where the Nichols Ranch once stood the source of water; was a well which was located approximately 200 yards from the old ranch house towards Cottonwood Creek and was thought to be artesian in nature. The depth of the well was not known but it was likely hand dug and fed off the waters of Cottonwood Creek.

2.7.4 Coal Bed Methane Wells and Oil/Gas Wells

2.7.4.1 Nichols Ranch and Hank Units

Wells permitted for coal bed methane production is presented on Exhibits D6-3 and D6-4 in Appendix D6 for the Nichols Ranch and Hank Units respectively. The tabulation of the coal bed methane wells is presented in Addendum D6H of Appendix D6. Exhibit D6-5 in Appendix D6 shows the distance between the base of the ore sand for each of the two sites and the top of the coal bed methane coal.

The coal bed methane wells in the area of the Nichols Ranch are expected to start water production in 2008. Presently no coal bed methane water is being discharged to the stream channels, but it is expected to start in 2008 into Tex Draw. The majority of the coal bed methane wells in this area are planned to be pumped to a deep injection well.

Oil/Gas wells are shown on Exhibit D6-6 in Appendix D6 for the combined Nichols Ranch Project. Tabulation of the oil/gas wells is presented in Addendum D6H of Appendix D6.

2.9.3 Baseline Radon-222 and Direct Gamma Exposure Rates

2.9.3.1 Purpose and Procedure

As noted in the discussion on soil and sediment baseline sampling, ISR operations do not generate significant levels of particulates, but they do have Rn-222 emissions, which include radon daughter products with varying half-lives. For this reason, ambient baseline Rn-222 levels should be established. In establishing the baseline, the monitoring procedure outlined in Regulatory Guide 4.14 was followed, and it involved deploying Rn-222 detectors and gamma dosimeters at suggested locations.

2.9.3.2 Survey Methodology

The detectors that were used in the one-year monitoring program were Landauer Extra Sensitive Outdoor Rn-222 Detectors and X-9 Gamma Dosimeters. Prior to installing the detectors, the prevailing wind direction was obtained from the National Climatic Data Center for Gillette. The data covered a period from 1996 through 2005. Data from this period was compared to data from Casper and to a data collected between 1978 and 1979 by AeroVironment for Cleveland Cliffs Iron Company (CCI), who operated a meteorological station near North Butte (Pathfinder Mines Corporation, 1988). CCI's baseline data was used in support of their NRC license application for the North Butte ISL Project. A comparison of the databases showed that Casper has a stronger southwest/west-southwest/south-southwest component, while North Butte and Gillette have a component from the south/southwest/southeast. A third site, the Antelope Coal Company (ACC) meteorological station was also used in January 2009 to verify that the prevailing wind direction at the Nichols Ranch ISR Project site was from the south/southwest. **Based on tie down letters to the license, as described in License Condition 9.2, surveys for Jane Dough Unit will be performed as stated within those letters (dated: February 19, 2014, February 28, 2014, March 4-6, 2014 and March 11, 2014). In addition, two quarters of data will be collected prior to commencing operations at the Jane Dough Unit.**

The detectors were deployed and retrieved at the same time for each location. Exposure time was on a quarterly basis. Detector locations included: (1) the nearest residence or structure that could be occupied; (2) locations at or near the license boundary; and (3) a control point to reflect background (upwind of the site). Figures 2-25 and 2-26 (see map pockets) and Exhibits D11-3

and D11-4 (of the attached Appendix D11) show the locations of the Rn-222 and gamma dosimeters.

Given that the prevailing wind direction is from the south-southwest, two monitoring stations were placed in the northern parts of both sites see previously referenced Figures 2-25 and 2-26 and Exhibits D11-3 and D11-4 (of the attached Appendix D11). In contrast, control detectors were placed in the extreme southern parts of the license areas. During operations, the downwind monitors will reflect the maximum change from baseline while the control detectors will measure the minimum change. In addition to these placements, two monitors were placed near the license boundary on the east and west side of the Hank Unit and one was placed at a nearest residence (Dry Fork Ranch), which is approximately 1.3 mi to the southwest of the process facility location.

2.9.3.3 Nichols Ranch Unit Results

The one-year monitoring results are given in Table 2-28. A comparison of the values shows background levels to be within the expected range. When compared to historical radon levels measured over a one year period (1988-1989) at the nearby North Butte Project site, it can be seen that values at Nichols are not surprisingly different. North Butte's annualized average was 0.8 pCi/l compared to Nichols' 1.2 pCi/l average. Because radon levels are known to vary widely from place to place, the difference between 0.8 pCi/l and 1.2 pCi/l is not significant. It must also be remembered that some of difference between the two annual averages can be attributed to the detectors. Significant improvements have been made in this area over the past 10 years. As noted above, Extra Sensitive detectors were used in the monitoring program at the Nichols and Hank Units. Differences in the prevailing weather conditions at the two sites would also play a role in the background concentrations.

Both sites have ambient radon levels that are much above the U.S. average. According to EPA, the U.S. outdoor average radon concentration is 0.4 pCi/l. The higher-than-background levels are not surprising given that with the exception of two counties, Weston and Platte, the predicted average indoor screening radon levels in Wyoming are at or above the EPA Action Level of 4 pCi/l (epa.gov/radon/zonemap). The indoor average for the U.S. is 1.3 pCi/l, and this puts Wyoming at three times the average.

Table 2-28 Ambient Radon-222 Levels - Nichols Ranch Unit.

		Fourth Quarter (10/06 to 1/07) pCi/l	First Quarter (1/07 to 3/07) pCi/l	Second Quarter (4/07 to 7/07) pCi/l	Third Quarter (7/07 to 10/07) pCi/l
R-1	Nearest Residence	1.2	0.7	0.9	1.1
R-2	Upwind Control	0.9	0.8	1.1	1.7
R-3	Downwind Boundary	0.6	27.7*, 0.9**	2.3	1.4
R-4	Downwind Boundary	0.7	0.8	1.9	1.4
	Site Averages	0.9	0.8	1.6	1.4

1. *The adhesive that holds the detector within the protective housing failed and the detector was found on the ground. The anomalous value was not used in the average.
2. The annualized average for all sites combined is 1.2 pC/l.
3. The annualized average measured between 1988 and 1989 at the nearby North Butte; Project was 0.8 pCi/l.
4. The U.S. average outdoor Rn-222 level is 0.4 pCi/l (U.S. EPA).
5. **Additional reading was collected in the 4th Quarter of 2008, value was not used in average.
6. An additional monitoring site, NR-5, was added to the Nichols site in March 2009. Background levels for the past year are as follows: 3/4/009 to 6/26/09 = 1.2 pCi/l; 7/9/09 to 10/2/09=1.9 pCi/l; 102/09 to 1/4/10=0.9 pCi/l; and 1/4/10 to 4/5/10 = 0.9 pCi\l. The annualized average at NR-5 is 1.2 pCi\l, and this matches the annualized average of 1.2 pCi\l reported for sites R-1 through R-4.

Background gamma exposure rates from the one year monitoring program are summarized in Table 2-29. The averages range from 35 mrem to 48 mrem. When compared to the gamma survey results from the North Butte Project mentioned earlier, the values are similar. The North Butte quarterly averages ranged from 32.3 mrem to 39.7 mrem. To put these values into perspective, the following exposure rates are given.

- Average dose to the U.S. Public from natural sources: 300 mrem/year.
- Background radiation (total) in the Colorado Plateau: 75 to 140 mrem/year.
- Terrestrial background (Rocky Mountains): 40 mrem/year.
- Average dose to the public from all sources: 360 mrem/year.

Table 2-29 Background Gamma Exposure Rate - Nichols Ranch Unit.

		Fourth Quarter (10/06 to 1/07) Mrems/**qtr**	First Quarter (1/07 to 3/07) Mrems/**qtr**	Second Quarter (4/07 to 7/07) Mrems/**qtr**	Third Quarter (7/07 to 10/07) Mrems/**qtr**
R-1	Nearest Residence (Dry Fork Ranch)	34.7	41.1	49.3	37.4
R-2	Upwind Control (South)	36.4	41.9	48.2	38.0
R-3	Downwind Boundary (Northeast)	35.2	49.4	41.1	39.1
R-4	Downwind Boundary (Northwest)	33.6	57.6	52.8 (LP)	44.0
Site Averages		35.0	47.5	47.9	39.6

Notes: LP: Low energy photon.

Gamma exposure rate was also monitored at NR-5 for a one year period. The results are as follows: 4/1/09 to 7/10/09=51.7 mrem; 7/10/09 to 10/14/09=38.1 mrem; 10/14/09 to 1/19/10=38.0 mrem; and 1/19/10 to 4/20/10=40.9 mrem. The annualized average for NR-5 is 42.2 mrem, and this falls within the range of averages shown above for sites R-1 through R-4.

2.9.3.4 Hank Unit Results

Not unexpectedly, Rn-222 levels measured at the Hank Unit match up well with those just discussed for the Nichols Ranch Unit. The one high value (9.2 pCi/l) was caused by the detector being on the ground for some unknown period of time. This value was not used in calculating the average shown on Table 2-30. Background gamma exposure rates from the one year monitoring program are summarized in Table 2-31. The averages range from 34.4 mrem to 55 mrem. Once again these results are very similar to the Nichols Ranch Unit results and those of the historic North Butte results.

Table 2-30 Ambient Radon-222 Levels - Hank Unit.

		Fourth Quarter (10/06 to 1/07) pCi/l	First Quarter (1/07 to 3/07) pCi/l	Second Quarter (4/07 to 7/07) pCi/l	Third Quarter (7/07 to 10/07) pCi/l
R-1	Nearest Residence	1.2	1.2	1.4	2.2
R-2	Downwind Boundary	0.4	0.6	0.7	3.4
R-3	Boundary	0.5	0.3	0.9	1.4
R-4	Upwind Control	0.3	9.2*, 0.6**	1.0	1.0
R-5	Boundary	0.4	0.5	0.8	1.7
Site Averages		0.6	0.6	1.0	1.9

Notes:
1. *The adhesive that holds the detector within the protective housing failed and the detector was found on the ground. The anomalous value was not used in the average.
2. The annualized average for all sites combined is 1.0 pC/l.
3. The annualized average measured between 1988 and 1989 at the nearby North Butte; Project was 0.8 pCi/l.
4. The U.S. average outdoor Rn-222 level is 0.4 pCi/l (U.S. EPA).
5. **Additional reading was collected in the 4th Quarter of 2008, value was not used in average.

Table 2-31 Background Gamma Exposure Rate - Hank Unit.

		Fourth Quarter (10/06 to 1/07) mrems	First Quarter (1/07 to 3/07) mrems	Second Quarter (4/07 to 7/07) mrems	Third Quarter (7/07 to 10/07) mrems
R-1	Nearest Residence (Pfister Ranch)	33.5	39.0	45.1	H*, 30.9**
R-2	Downwind Boundary (North)	33.5	50.0 (LP)	49.9	H *, 32.9**
R-3	Boundary (Northwest)	33.5	40.5	53.9	44.0
R-4	Upwind Control (South)	34.1	114.5 (LP)	51.8	39.1
R-5	Boundary (Southeast)	37.5	31.3	52.0	41.4
Site Averages		34.4	55.0	50.5	41.5

Notes:
*H – Not Read (Fault with dosimeter)
** Additional readings were collected in the 4th Quarter of 2008 in order to obtain 4 quarters of data.
LP- Low Energy Photon

2.9.3.5 Jane Dough Unit Results

Monitoring covered a full year beginning in the third quarter of 2010 and ending in the second quarter of 2011. The results of the baseline year are summarized in Table 2-31a. A review of the table shows that the third quarter had the highest average (0.9 pCi/l) and the first quarter had the lowest average (0.3 pCi/l). It is also interesting to note that five of the seven sites had readings greater than 1.0 pCi/l during the third quarter while all of the sites had values well below 1.0 pCi/l throughout the remaining three quarters. A similar result was recorded at the Hank and Nichols Ranch Units when baseline surveys were conducted.

To illustrate, the first and third quarter averages for all five monitoring locations at the Hank and Nichols Ranch Units are summarized as follows.

Hank Unit	Nichols Ranch Unit
1st Quarter: 0.6 pCi/l	1st Quarter: 0.8 pCi/l
3rd Quarter: 1.9 pCi/l	3rd Quarter: 1.4 pCi/l

Although the second quarter average at the Nichols site was slightly higher than the third quarter (1.6 pCi/l vs.1.4 pCi/l), a sample location in the second quarter had a single high value of 2.3 pCi/l which raised the average. If the value had been closer to the values of 0.6 pCi/l and 1.4 pCi/l that were measured at that location during other quarters, the third quarter average would have been the highest as is was at Hank and Jane Dough. The apparent cycle of higher values occurring in the third quarter and the lower values in the first quarter could likely be the result of weather conditions. The first quarter is usually the months of colder weather with snow cover which adds another barrier; whereas the third quarter is generally the months of warmer and drier weather. The colder months tend to suppress radon exhalation rates, while the warmer months tend to increases the emanation rate. In addition, radon exhalation rates fluctuate with wet and dry soil conditions and with changes in vegetative cover. This explanation is further supported by the fact that highest and lowest values are not found at a single site; instead, the highest and lowest values vary with the time of year.

Table 2-31a also shows the annualized average for all locations combined as being 0.6 pCi/l. This average is lower than the averages of 1.0 pCi/l and 1.2 pCi/l recorded at the Hank and Nichols Ranch Units, respectively. The range of the averages at all three units are consistent with values found in the U.S. Background radon varies considerable in the U.S. due to factors such as soil and rock types and the presence of naturally occurring uranium. The 0.6 pCi/l average measured at the Jane Dough Unit is consistent with but slightly above the U.S. average outdoor Rn-222 level of 0.4 pCi/l (U.S. EPA).

Table 2-31a Baseline Radon-222 at the Jane Dough Unit.

	Third Quarter 2010 (pCi/l)	Fourth Quarter 2010 (pCi/l)	First Quarter 2011 (pCi/l)	Second Quarter 2011 (pCi/l)	Average by Site (pCi/l)
JD-1	1.0 +/- 0.09	0.6+/-0.05	0.3 +/-0.04	0.6 +/-0.05	0.6
JD-2	1.2 +/-0.10	0.5+/-0.05	0.3 +/-0.04	0.7 +/-0.06	0.7
JD-3	0.7 +/-0.07	0.6+/-0.06	0.3 +/-0.04	0.6 +/-0.05	0.6
JD-4	0.6 +/-0.07	0.7+/-0.06	0.5 +/-0.05	0.4 +/-0.04	0.6
JD-5	1.0 +/-0.09	0.6+/-0.05	0.4 +/-0.04	0.6 +/-0.05	0.7
JD-6/NR-2	1.1 +/-0.09	0.6+/-0.06	0.3 +/-0.04	0.7 +/-0.06	0.7
JD-7/NR-1*	1.1 +-/0.10	0.8+/-0.07	0.3 +/-0.04	0.5 +/-0.05	0.7
Average	1.0	0.6	0.3	0.6	

Notes: *Nearest residence
Minimum detectable dose equivalent: 0.10 mrem

Background gamma exposure rates from the one year monitoring in the Jane Dough Unit are summarized in Table 2-31b. The quarterly average for all seven sites ranged from 11.3 mrem (second quarter 2011) to 45.8 mrem (fourth quarter 2010). When compared to previous baseline surveys at the Hank and Nichols Ranch, the quarterly averages for all monitoring locations ranged from 35.0 mrem to 55.0 mrem (Hank) and 35.0 mrem to 47.9 mrem (Nichols Ranch). An additional comparison can be made to values from an even earlier baseline that was developed for the nearby North Butte project. The quarterly averages from North Butte ranged from 32.3 mrem to 39.7 mrem (Pathfinder Mines Corporation 1988).

Table 2-31b Baseline Gamma Exposure Rate at the Jane Dough Unit Air Monitoring Stations.

Sample Site	Third Quarter 2010 (mrems/qtr)	Fourth Quarter 2010 (mrems/qtr)	First Quarter 2011 (mrems/qtr)	Second Quarter 2011 (mrems/qtr)	Average by Site (mrems/qtr)
JD-1	34.7	45.0	36.2	44.5	40.1
JD-2	38.8	45.1	34.3	38.0	39.1
JD-3	33.9	46.9	35.6	34.0	37.6
JD-4	30.8	42.7	33.0	34.7	35.3
JD-5	35.0	45.9	30.2	33.0	36.0
JD-6/NR-2	37.4	49.4	38.8	38.4	41.0
JD-7/NR-1*	36.2	45.7	37.2	38.0	39.3
Average	35.3	45.8	35.0	37.2	38.3
Nichols Ranch	39.6	35.0	47.5	47.9	42.5
Hank	41.5	34.4	55.0	50.5	45.4

Notes: *Nearest residence
Minimum detectable dose equivalent: 0.10 mrem

Apart from the comparisons just noted, the average values (38.3, 42.5, and 45.4 mrem) recorded at the three project sites of approximately 40 to 45 mrem/year can be put into a better perspective when compared to the following:

- Average dose to the U.S. Public from natural sources: 300 mrem/year.
- Background radiation (total) in the Colorado Plateau: 75 to 140 mrem/year.
- Terrestrial background (Rock Mountains): 40 mrem/year.
- Average dose to the public from all sources: 360 mrem/year.

As the comparison shows, the average background at the project site is very similar to terrestrial background (Rocky Mountains) of 40 mrem/year.

The baseline sampling program was modified somewhat from the guidance given in Regulatory Guide 4.14. Departure from the guide is discussed in the Methods Section below. While developing the pre-operational baseline studies, it was understood through experience and through the evolution of ISR, that pathways to flora and fauna and hence to human populations are not significant. The reasons supporting this assertion were given above and are discussed in other sections of this application.

Even though potential impacts from ISR operations on flora, fauna and the food chain have been shown to be insignificant, good baseline characterizations continue to be an important part of a NRC license application. Measured baseline values can be compared to values during actual operations to validate the minimal to no-impact prediction of the MILDOS model. Additionally, having baseline data to compare with values recorded during operations, underscores the fact that modern ISR activities do not have a significant impact on human health and the environment. Following is a description of the baseline sampling program that was performed at the Nichols Ranch Unit, the Hank Unit, **and the Jane Dough Unit**.

2.9.4.2 Methods

Regulatory Guide 4.14 suggests that vegetation, crops, livestock and fish samples should be collected and analyzed for Ra-226 and Pb-210. According to the field reconnaissance, no permanent surface water exists at or immediately adjacent to the sites. Given the absence of water, fish too are absent. The sites were surveyed for the presence a crop-growing areas and none was found. Agricultural activities appear to be limited to cattle grazing. Although the guide suggests sacrificing livestock to obtain samples, it is Uranerz's opinion that this is not necessary for ISR operations. To reiterate, ISR operations do not cause significant build-up of radionuclides in soil or vegetation and therefore a significant pathway for exposure does not exist. In addition, since operational monitoring will include routine sampling of vegetation, food crops (if they are grown in the area) and grazing/forage foods, a mechanism will be in place to monitor this pathway to local fauna.

Given this setting, baseline sampling included samples from grazing areas and vegetation from the nearest residences and Rn-222/gamma monitoring locations (shown on Figures 2-25 and 2-26). The vegetation sampled consisted mainly of sagebrush shrubland and mix grassland communities. Grab samples were collected in mid-August. While collecting the samples, care was taken to clip the vegetation approximately one inch above the ground to avoid mixing with surface soil. Samples were placed in large plastic bags and transported to the laboratory within 24 hours of collection. All samples were analyzed for Ra-226, Pb-210, Po-210, Th-230, Uranium, Arsenic and Selenium.

2.9.4.3 Nichols Ranch Unit Results

Table 2-32 summarizes the radiological and nonradiological (arsenic and selenium) background concentrations found in the samples. Although there is the usual variation in concentrations for the radiometric parameters, the values are within normal background ranges. The same generalization can be made for the arsenic and selenium values.

2.9.4.4 Hank Unit Results

Background values for the Hank Unit are given in Table 2-33. A comparison of the concentrations with those reported for the Nichols Ranch Unit shows a great deal of consistency. In brief, the values are not unusual for baseline conditions.

2.9.4.5 Jane Dough Unit Results

Background values for the Jane Dough Unit are given in Table 2-33a. Although there is the usual variation, the values are within normal background ranges. To illustrate the consistency in the background values, a comparison was made with the baseline previously established for the Hank and Nichols Ranch Units. As can be seen from Table 2-33b, the averages for all three sites are in close agreement.

Table 2-32 Radiological and Non-radiological Background Levels in Vegetation Nichols Ranch Unit.

	Radiological Elements				
Sample Location	Ra-226 (µCi/kg)	Pb-210 (µCi/kg)	Po-210 (µCi/kg)	Th-230 (µCi/kg)	Uranium (µCi/kg)
R-1 Dry Fork Ranch	3.7E-04	4.2E-04	9.3E-05	3.7E-06	1.1E-04
+/-	5.1E-06	2.9E-05	2.7E-05	1.8E-06	4.6E-07*
R-2 Control Upwind	8.8E-05	4.5E-04	1.5E-04	2.8E-06	6.6E-05*
+/-	6.0E-06	2.3E-05	2.3E-05	4.2E-06	3.0E-07*
R-3 Downwind NE	1.4E-04	7.5E-04	1.1E-04	3.6E-05	9.5E-05*
+/-	8.0E-06	3.0E-05	2.3E-05	4.4E-04	3.3E-07*
R-4 Downwind NW	2.7E-04	6.6E-04	9.9E-05	1.4E-04	2.4E-04*
+/-	1.1E-05	2.6E-04	2.2E-05	9.9E-06	2.8E-07*
Grazing Area	6.7E-05	4.3E-04	7.2E-05	2.4E-05	8.3E-05*
+/-	4.2E-06	1.8E-05	1.7E-05	3.6E-05	2.1E-07*

	Non-radiological Elements			
Sample Location	Arsenic (mg/kg-dry)	RL*	Selenium (mg/kg-dry)	RL*
R-1 Dry Fork Ranch	ND	0.5	ND	0.5
R-2 Control Upwind	ND	0.5	ND	0.5
R-3 Downwind NE	1.0	0.5	0.7	0.5
R-4 Downwind NW	0.7	0.5	1.3	0.5
Grazing Area	ND	0.5	1.2	0.5

Table 2-33 Radiological and Non-radiological Background Levels in Vegetation Hank Unit.

	Radiological Elements				
Sample Location	Ra-226 (µCi/kg)	Pb-210 (µCi/kg)	Po-210 (µCi/kg)	Th-230 (µCi/kg)	Uranium (µCi/kg)
R-1 Pfister Ranch	7.5E-05	4.0E-04	4.1E-05	2.3E-06	4.5E-05
+/-	5.7E-06	2.1E-05	1.3E-05	3.6E-06	2.8E-07*
R-2 Downwind	4.6E-05	5.8E-04	2.9E-05	2.0E-05	4.9E-05*
+/-	2.0E-06	2.1E-05	8.5E-06	4.5E-06	2.1E-07*
R-3 West Boundary	6.3E-05	2.5E-04	1.5E-04	6.8E-06	1.5E-05*
+/-	6.1E-06	2.1E-05	2.9E-05	2.1E-06	3.9E-07*
R-4 Control South	7.3E-05	2.6E-04	4.9E-05	2.4E-05	4.5E-05*
+/-	5.4E-06	1.8E-05	1.3E-05	4.2E-06	2.8E-07*
R-5 East Boundary	9.6E-05	5.9E-04	1.1E-04	3.5E-05	7.1E-07*
+/-	6.9E-06	2.8E-05	2.8E-05	4.9E-06	3.4E-07
Grazing Area	6.7E-05	2.5E-04	5.9E-05	8.1E-06	4.0E-05*
+/-	7.0E-06	2.4E-05	2.3E-05	2.7E-06	4.5E-07*

	Non-radiological Elements			
Sample Location	Arsenic (mg/kg-dry)	RL*	Selenium (mg/kg-dry)	RL*
R-1 Pfister Ranch	ND	0.5	0.8	0.5
R-2 Downwind	ND	0.5	0.6	0.5
R-3 West Boundary	1.0	0.5	ND	0.5
R-4 Control South	ND	0.5	ND	0.5
R-5 East Boundary	ND	0.5	1.7	0.5
Grazing Area	ND	0.5	1.0	0.5

Notes: *RL is the reporting limit for U.
+/- is the counting error.

Table 2-33a Radiological Baseline Values in Vegetation: Jane Dough Unit.

Sample Site	Uranium (µCi/kg)	Pb-210 (µCi/kg)	Ra-226 (µCi/kg)	Th-230 (µCi/kg)
JD-1	2.7E-05+/- 3.7E-07*	2.1E-04+/- 4.7E-06	4.3E-06+/- 8.9E-07	2.1E-06+/- 3.0E-06
JD-2	5.5E-05+/- 2.0E-07*	5.8E-04+/- 8.7E-06	1.1E-05+/-1.6E-06	7.4E-06+/- 4.7E-06
JD-3	5.8E-05+/- 2.0E-07*	7.4E-04+/- 1.0E-05	2.4E-05+/-2.5E-06	2.5E-05+/- 8.9E-06
JD-4	5.9E-05+/- 2.0E-07*	4.1E-04+/- 8.4E-06	8.4E-06+/-1.6E-06	5.5E-06+/- 4.7E-06
JD-5	3.4E-05+/- 2.0E-07*	2.1E-04+/- 6.7E-06	1.0E-05+/-1.6E-06	6.6E-06+/- 4.5E-06
JD-6	1.2E-05+/- 2.0E-07*	2.4E-04+/- 7.4E-06	6.9E-06+/-1.4E-06	9.4E-06+/- 6.0E-06
JD-7	5.5E-05+/- 2.0E-07*	1.9E-04+/- 8.3E-06	5.5E-06+/-1.5E-06	9.1E-06+/- 6.8E-06
Random-1	8.2E-05+/- 2.0E-07*	9.5E-04+/- 1.3E-05	1.2E-05+/-2.0E-06	3.8E-05+/- 8.8E-06
Random-2	9.7E-05+/- 2.0E-07*	6.1E-04+/- 1.0E-05	1.9E-05+/-2.3E-06	2.4E-05+/- 6.6E-06

***Reporting limit.**

Table 2-33b Comparison of Average Baseline Values: Jane Dough, Nichols Ranch and Hank Unit.

Average Baseline Values				
Mine Unit	**Uranium (µCi/kg)**	**Pb-210 (µCi/kg)**	**Ra-226 (µCi/kg)**	**Th-230 (µCi/kg)**
Jane Dough Unit	5.3E-05	4.6E-04	1.1E-05	1.5E-05
Nichols Ranch	1.2E-04	5.4E-04	1.9E-04	4.1E-05
Hank Unit	3.2E-05	3.9E-04	7.0E-05	1.6E-05

2.9.5 Radon Flux

Regulatory Guide 4.14 indicates that radon flux measurements should be conducted at eight locations within 1.5 km of the site. Because there will be no tailings impoundments or evaporation ponds at the Nichols Ranch ISR Project radon flux is not an applicable radiological parameter for baseline characterization. Radon flux measurements have not been collected in support of this project and none are planned in association with future monitoring schedules.

2.9.6 Air Particulates

2.9.6.1 Purpose and Procedure

Baseline air particulate radionuclide concentration monitoring for the Nichols Ranch ISR Project was conducted from the 2nd Quarter 2009 through the 1st Quarter 2010 (June 2009-March 2010), **for the Nichols Ranch and Hank Units and 3rd Quarter 2010 through 2nd Quarter 2011 (July 2010-June 2011), for the Jane Dough Unit.** The continuous monitoring was conducted at 4 different locations at both the Nichols Ranch and Hank Units as depicted on Figures 2-25 and 2-26 (see map pockets) **and at seven different locations at the Jane Dough Unit, as depicted on Exhibit JD-D11-2 in Appendix JD-D11.**

All air particulate sampling was conducted based on Regulatory Guide 4.14. Sampling locations were selected based on prevailing wind direction, CPP/Satellite plant location, practical access to samplers, and nearest residents. Each sampler was powered by solar panels with battery back-up since line power was not available.

2.9.6.2 Methods

To collect the baseline radiological air particulate data, F&J Specialty Products, Inc. Model DF-40L-AC air samplers were used (Figure 2-27). These samplers were calibrated by the manufacturer and programmed to draw approximately 30 liters per minute of air through a 47 mm glass fiber air sampling filter. Each air sampler was housed in a protective metal enclosure with the air intake/sampler filter holder assembly positioned approximately 5.0 ft above the ground surface (Figure 2-28).

Air particulate filters were collected on a weekly basis to help prevent dust loading. Once collected, the samples were composited on a quarterly basis to provide respective estimates of average radionuclide concentration as stated in Regulatory Guide 4.14. After collection, the quarterly composited batch of filters from each of the eight samplers (4 Nichols Ranch, 4 Hank, **7 Jane Dough**) were submitted to Energy Laboratories in Casper, Wyoming for analysis of Uranium (natural), Thorium 230 (Th-230), Radium 226 (Ra-226), and Lead 210 (Pb-210).

2.9.6.3 Results for the Nichols Ranch and Hank Unit

A summary of the baseline radiological concentration air particulate results for both the Nichols Ranch and Hank Units is provided in Table 2-33**c**. Tables 2-33**c** through 2-33**g** provide additional details such as lower limits of detection from Reg. Guide 4.14; counting precision and reference to figures (maps) that depict monitoring site locations. Referring again to Table 2-33a, one can see the general consistency in the baseline values between the individual monitoring locations and between the two sites (Hank and Nichols). For the most part, concentrations are quite similar for all parameters at both sites and from season to season. For example, the combined average uranium values for Hank and Nichols are as follows: second quarter = 1.51E-16; third quarter = 1.21E-16; fourth quarter = 2.12E-16; and first quarter 2010 = 6.62E-16. Two values reported for sites NR-1 and NR-3 caused the first quarter 2010 average to be higher than the previous three quarters: the reported values for NR-1 and NR-3 are 1.30E-15 and 2.69E-15, respectively. The overall consistency of uranium concentrations throughout the one-year monitoring period for both sites can be seen from the summary below.

Monitoring Period	**Hank Unit**	**Nichols Ranch Unit**
Uranium (natural) Average		
2nd Quarter 2009	1.56E-16	1.46E-16
3rd Quarter 2009	1.14E-16	1.28E-16
4th Quarter 2009	1.83E-16	2.40E-16
1st Quarter 2010	2.51E-16	1.07E-15
Annual Average	**1.76E-16**	**3.96E-16**

Units: µCi/ml

Table 2-33c Summary Comparison of Radiological Concentrations for 1 Year (Second Quarter 2009 through First Quarter 2010).

	Second Quarter 2009 Hank				Second Quarter 2009 Hank			
	HPS	HR-1	HR-2	HR-4	NRPS	NR-1	NR-2	NR-3
µCi/ml								
U	1.43E-16	1.36E-16	1.07E-16	2.37E-16	1.44E-16	1.59E-16	1.50E-16	1.32E-16
Th-230	1.73E-16	9.15E-17	-6.76E-16	-5.71E-17	1.46E-16	-1.55E-17	-1.32E-16	9.88E-17
Ra-226	-6.10E-17	-1.21E-17	-9.03E-17	-1.46E-16	2.86E-17	3.56E-17	2.71E-16	2.29E-17
Pb-210	8.41E-15	-1.36E-15	8.69E-15	1.18E-14	5.46E-15	1.65E-15	1.10E-15	6.44E-15
	Third Quarter 2009 Hank				Third Quarter 2009 Nichols Ranch			
	HPS	HR-1	HR-2	HR-4	NRPS	NR-1	NR-2	NR-3
µCi/ml								
U	1.27E-16	1.44E-16	1.03E-16	8.28E-17	1.50E-16	9.72E-17	1.26E-16	1.39E-16
Th-230	5.50E-18	-2.27E-17	-4.71E-17	1.49E-18	-5.60E-17	-1.47E-17	-1.09E-16	6.53E-17
Ra-226	-2.96E-17	-4.91E-17	2.12E-18	-8.76E-17	1.39E-16	-6.86E-17	-1.43E-16	-6.22E-17
Pb-210	1.28E-14	1.35E-14	1.07E-14	1.32E-14	1.28E-14	1.25E-15	9.36E-15	6.67E-15
	Fourth Quarter 2009 Hank				Fourth Quarter 2009 Nichols Ranch			
	HPS	HR-1	HR-2	HR-4	NRPS	NR-1	NR-2	NR-3
µCi/ml								
U	2.65E-16	1.93E-16	1.93E-16	8.28E-17	1.63E-16	1.80E-16	3.61E-16	2.56E-16
Th-230	-3.94E-18	2.20E-16	2.72E-16	1.49E-18	1.23E-19	8.39E-17	4.91E-17	7.21E-18
Ra-226	-5.62E-18	3.65E-17	2.62E-17	-8.76E-17	-4.98E-17	1.27E-17	5.45E-17	1.50E-17
Pb-210	6.31E-15	7.21E-15	8.06E-15	1.32E-14	3.94E-15	1.40E-14	1.12E-14	5.12E-15
	First Quarter 2010 Hank				First Quarter 2010 Nichols Ranch			
	HPS	HR-1	HR-2	HR-4	NRPS	NR-1	NR-2	NR-3
µCi/ml								
U	3.84E-16	2.66E-16	1.68E-16	1.86E-16	1.49E-16	1.30E-15	1.51E-16	2.69E-15
Th-230	-5.98E-18	1.71E-17	-7.46E-17	-3.35E-17	-2.75E-17	9.30E-18	3.58E-18	2.42E-17
Ra-226	2.47E-17	5.57E-17	8.02E-17	5.98E-17	6.50E-17	1.06E-17	8.17E-17	1.77E-17
Pb-210	1.12E-14	8.85E-15	5.33E-15	8.04E-15	1.04E-14	1.71E-14	2.01E-14	9.14E-15

Table 2-33**d** Baseline Radionuclide Concentrations in Air (Second Quarter 2009).

	U	Th-230	Ra-226	Pb-210
Hank				
	μCi/ml	μCi/ml	μCi/ml	μCi/ml
Monitoring Site*				
HPS	1.43E-16	1.73E-16	-6.10E-17	8.41E-15
Counting Precision	N/A	2.17E-16	5.38E-17	9.83E-15
HR-1	1.36E-16	9.15E-17	-1.21E-17	-1.36E-15
Counting Precision	N/A	2.99E-16	6.07E-17	9.70E-15
HR-2	1.07E-16	-6.76E-16	-9.03E-17	8.69E-15
Counting Precision	N/A	4.73E-16	9.10E-17	1.67E-14
HR-4	2.37E-16	-5.71E-17	-1.46E-16	1.18E-14
Counting Precision	N/A	3.42E-16	7.78E-17	1.67E-14
Nichols Ranch				
	U	Th-230	Ra-226	Pb-210
	μCi/ml	μCi/ml	μCi/ml	μCi/ml
Monitoring Site*				
NRPS	1.44E-16	1.46E-16	2.86E-17	5.46E-15
Counting Precision	N/A	1.70E-16	3.62E-17	5.97E-15
NR-1	1.59E-16	-1.55E-17	3.56E-17	1.65E-15
Counting Precision	N/A	1.26E-16	3.66E-17	5.93E-15
NR-2	1.50E-16	-1.32E-16	2.71E-16	1.10E-15
Counting Precision	N/A	1.01E-16	5.67E-17	5.93E-15
NR-3	1.32E-16	9.88E-17	2.29E-17	6.44E-15
Counting Precision	N/A	1.67E-16	3.62E-17	6.01E-15
Effluent Concentration 10 CFR Part 20 Appendix B, Table 2	**9.00E-14**	**3.00E-14**	**9.00E-13**	**6.00E-13**

Notes: *See Figures 2-25 and 2-26 for Monitoring Site Locations
LLD (μCi/ml): U, Th-230 and Ra-226 = 1.00E-16; Pb-210 = 2.00E-15 (Reg. Guide 4.14).

Table 2-33**e** Baseline Radionuclide Concentrations in Air (Third Quarter 2009).

Hank				
	U µCi/ml	Th-230 µCi/ml	Ra-226 µCi/ml	Pb-210 µCi/ml
Monitoring Site*				
HPS	1.27E-16	5.50E-18	-2.96E-17	1.28E-14
Counting Precision	N/A	9.81E-17	7.33E-17	3.05E-15
HR-1	1.44E-16	-2.27E-17	-4.91E-17	1.35E-14
Counting Precision	N/A	8.22E-17	7.88E-17	3.07E-15
HR-2	1.03E-16	-4.71E-17	2.12E-18	1.07E-14
Counting Precision	N/A	7.52E-17	8.88E-17	3.05E-15
HR-4	8.28E-17	1.49E-18	-8.76E-17	1.32E-14
Counting Precision	N/A	7.69E-17	8.37E-17	3.07E-15
Nichols Ranch				
	U µCi/ml	Th-230 µCi/ml	Ra-226 µCi/ml	Pb-210 µCi/ml
Monitoring Site*				
NRPS	1.50E-16	-5.60E-17	1.39E-16	1.28E-14
Counting Precision	N/A	8.60E-17	9.46E-17	3.07E-15
NR-1	9.72E-17	-1.47E-17	-6.86E-17	1.25E-15
Counting Precision	N/A	1.10E-16	7.15E-17	3.07E-15
NR-2	1.26E-16	-1.09E-16	-1.43E-16	9.36E-15
Counting Precision	N/A	7.23E-17	5.30E-17	3.03E-15
NR-3	1.39E-16	6.53E-17	-6.22E-17	6.67E-15
Counting Precision	N/A	9.90E-17	7.12E-17	3.00E-15
Effluent Concentration 10 CFR Part 20 Appendix B, Table 2	**9.00E-14**	**3.00E-14**	**9.00E-13**	**6.00E-13**

Notes: *See Figures 2-25 and 2-26 for Monitoring Site Locations
LLD (µCi/ml): U, Th-230 and Ra-226 = 1.00E-16; Pb-210 = 2.00E-15 (Reg. Guide 4.14).

Table 2-33**f** Baseline Radionuclide Concentrations in Air (Fourth Quarter 2009).

		Hank		
	U µCi/ml	Th-230 µCi/ml	Ra-226 µCi/ml	Pb-210 µCi/ml
Monitoring Site*				
HPS	2.65E-16	-3.94E-18	-5.62E-18	6.31E-15
Counting Precision	N/A	5.82E-17	2.69E-17	1.39E-15
HR-1	1.93E-16	2.20E-16	3.65E-17	7.21E-15
Counting Precision	N/A	8.40E-17	3.06E-17	1.40E-15
HR-2	1.93E-16	2.72E-16	2.62E-17	8.06E-15
Counting Precision	N/A	1.06E-16	2.96E-17	1.40E-15
HR-4	8.28E-17	1.49E-18	-8.76E-17	1.32E-14
Counting Precision	N/A	7.69E-17	8.37E-17	3.07E-15
		Nichols Ranch		
	U µCi/ml	Th-230 µCi/ml	Ra-226 µCi/ml	Pb-210 µCi/ml
Monitoring Site*				
NRPS	1.63E-16	1.23E-19	-4.98E-17	3.94E-15
Counting Precision	N/A	6.04E-17	2.01E-17	1.36E-15
NR-1	1.80E-16	8.39E-17	1.27E-17	1.40E-14
Counting Precision	N/A	8.39E-17	2.72E-17	1.47E-15
NR-2	3.61E-16	4.91E-17	5.45E-17	1.12E-14
Counting Precision	N/A	7.64E-17	3.72E-17	1.67E-15
NR-3	2.56E-16	7.21E-18	1.50E-17	5.12E-15
Counting Precision	N/A	6.65E-17	2.63E-17	1.37E-15
Effluent Concentration 10 CFR Part 20 Appendix B, Table 2	**9.00E-14**	**3.00E-14**	**9.00E-13**	**6.00E-13**

Notes: *See Figures 2-25 and 2-26 for Monitoring Site Locations
LLD (µCi/ml): U, Th-230 and Ra-226 = 1.00E-16; Pb-210 = 2.00E-15 (Reg. Guide 4.14).

Table 2-33g Baseline Radionuclide Concentrations in Air (First Quarter 2010).

	U µCi/ml	Th-230 µCi/ml	Ra-226 µCi/ml	Pb-210 µCi/ml
Hank				
Monitoring Site*				
HPS	3.84E-16	-5.98E-18	2.47E-17	1.12E-14
Counting Precision	N/A	7.16E-17	3.79E-17	1.50E-15
HR-1	2.66E-16	1.71E-17	5.57E-17	8.85E-15
Counting Precision	N/A	6.64E-17	3.92E-17	1.47E-15
HR-2	1.68E-16	-7.46E-17	8.02E-17	5.33E-15
Counting Precision	N/A	6.16E-17	4.09E-17	1.43E-15
HR-4	1.86E-16	-3.35E-17	5.98E-17	8.04E-15
Counting Precision	N/A	6.25E-17	4.68E-17	1.69E-15
Nichols Ranch				
	U µCi/ml	Th-230 µCi/ml	Ra-226 µCi/ml	Pb-210 µCi/ml
Monitoring Site*				
NRPS	1.49E-16	-2.75E-17	6.50E-17	1.04E-14
Counting Precision	N/A	6.59E-17	4.04E-17	1.49E-15
NR-1	1.30E-15	9.30E-18	1.06E-17	1.71E-14
Counting Precision	N/A	7.30E-17	3.67E-17	1.56E-15
NR-2	1.51E-16	3.58E-18	8.17E-17	2.01E-14
Counting Precision	N/A	6.31E-17	3.92E-17	1.58E-15
NR-3	2.69E-15	2.42E-17	1.77E-17	9.14E-15
Counting Precision	N/A	7.51E-17	3.75E-17	1.47E-15
Effluent Concentration 10 CFR Part 20 Appendix B, Table 2	**9.00E-14**	**3.00E-14**	**9.00E-13**	**6.00E-13**

Notes: *See Figures 2-25 and 2-26 for Monitoring Site Locations
LLD (µCi/ml): U, Th-230 and Ra-226 = 1.00E-16; Pb-210 = 2.00E-15 (Reg. Guide 4.14).

2.9.6.4 Results for the Jane Dough Hank Unit

Although one full year of monitoring is required, Uranerz has included five quarters of baseline measurements. Because of the multiple sites, multiple quarters and multiple constituents, three sets of tables are provided: the first, Table 2-33h tabulates the quarterly values by site; the second, Table 2-33i, is arranged to conveniently show quarterly comparisons; and the third, Table 2-33j, shows average air concentrations by site for each constituent throughout the monitoring period. Because of the consistency of the values over time and at each site it can be concluded that the data are representative of baseline. Additionally, the data from Jane Dough compares favorably with previously-collected data from eight locations at the Hank and Nichols Ranch Units. Lastly, and as expected, the baseline data is orders of magnitude below the 10 CFR 20 Effluent Concentration Limits of Uranium (9E-14); Pb-210 (6E-13); Ra-226 (9E-13); and Th-230 (3E-14).

Table 2-33h Jane Dough Baseline Radionuclide Concentrations in Air.

	Third Quarter 2010			
Sample Site	**Uranium (µCi/ml)**	**Pb-210 (µCi/ml)**	**Ra-226 (µCi/ml)**	**Th-230 (µCi/ml)**
LLD*	1E-16	2E-15	1E-16	1E-16
JD-1	2E-16	1.1E-14	1E-17	-9E-17
Precision	N/A	1E-14	5E-17	7E-17
JD-2	2E-16	1.0E-14	3E-17	-3E-18
Precision	N/A	1E-15	3E-17	8E-17
JD-3	4E-16	1.3E-14	6E-17	-6E-17
Precision	N/A	1E-15	4E-17	8E-17
JD-4	2E-16	6.0E-15	2E-17	-1E-17
Precision	N/A	1E-15	3E-17	8E-17
JD-5	2E-16	1.4E-14	5E-17	1E-16
Precision	N/A	1E-15	4E-17	1E-16
JD-6	3E-16	9.9E-15	6E-16	7E-17
Precision	N/A	1E-15	8E-17	9E-17
JD-7	3E-16	5.0E-15	2E-16	2E-17
Precision	N/A	1E-15	6E-17	1E-15

***Lower Limit of Detection: Regulatory Guide 4.14.**

Table 2-33h Jane Dough Baseline Radionuclide Concentrations in Air Fourth Quarter 2010. (continued)

Sample Site	Uranium (µCi/ml)	Pb-210 (µCi/ml)	Ra-226 (µCi/ml)	Th-230 (µCi/ml)
		Fourth Quarter 2010		
LLD*	1E-16	2E-15	1E-16	1E-16
JD-1	1E-16	2.4E-14	1E-17	-9E-17
Precision	N/A	3E-15	6E-17	6E-17
JD-2	2E-16	2.1E-14	4E-17	-1E-16
Precision	N/A	2E-15	6E-17	7E-17
JD-3	2E-16	2.2E-14	5E-17	-1E-16
Precision	N/A	2E-15	6E-17	6E-17
JD-4	1E-16	2.3E-15	3E-17	-7E-17
Precision	N/A	3E-15	6E-17	6E-17
JD-5	2E-16	2.2E-14	5E-17	-2E-16
Precision	N/A	2E-15	6E-17	5E-16
JD-6	1E-16	2.0E-14	7E-18	-7E-17
Precision	N/A	2E-15	6E-17	7E-17
JD-7	2E-16	2.0E-15	4E-17	-3E-17
Precision	N/A	2E-15	6E-17	6E-17

***Lower Limit of Detection: Regulatory Guide 4.14.**

Table 2-33h Jane Dough Baseline Radionuclide Concentrations in Air First Quarter 2011. (continued)

Sample Site	Uranium (µCi/ml)	Pb-210 (µCi/ml)	Ra-226 (µCi/ml)	Th-230 (µCi/ml)
		First Quarter 2011		
LLD*	1E-16	2E-15	1E-16	1E-16
JD-1	1E-16	2.1E-14	-1E-17	2E-16
Precision	N/A	2E-15	6E-17	7E-17
JD-2	2E-16	1.2E-14	4E-17	1E-16
Precision	N/A	2E-15	7E-17	7E-17
JD-3	2E-16	1.3E-14	3E-17	2E-16
Precision	N/A	2E-15	6E-17	8E-17
JD-4	2E-16	1.2E-14	-4E-17	1E-16
Precision	N/A	2E-15	5E-17	7E-17
JD-5	2E-16	1.1E-14	7E-17	1E-16
Precision	N/A	2E-15	7E-17	6E-17
JD-6	2E-16	1.2E-14	2E-17	9E-17
Precision	N/A	2E-15	6E-17	6E-17
JD-7	2E-16	1.2E-14	5E-18	1E-16
Precision	N/A	2E-15	6E-17	6E-17

***Lower Limit of Detection: Regulatory Guide 4.14.**

Table 2-33h Jane Dough Baseline Radionuclide Concentrations in Air Second Quarter 2011. (continued)

	Second Quarter 2011			
Sample Site	**Uranium (µCi/ml)**	**Pb-210 (µCi/ml)**	**Ra-226 (µCi/ml)**	**Th-230 (µCi/ml)**
LLD*	1E-16	2E-15	1E-16	1E-16
JD-1	1E-16	8.7E-15	-3E-17	2E-16
Precision	N/A	1E-15	6E-17	7E-17
JD-2	2E-16	9.3E-15	2E-17	2E-16
Precision	N/A	2E-15	1E-16	9E-17
JD-3	2E-16	8.7E-15	-3E-17	2E-16
Precision	N/A	1E-15	6E-17	8E-17
JD-4	1E-16	8.9E-15	9E-17	2E-16
Precision	N/A	2E-15	5E-17	7E-17
JD-5	2E-16	9.0E-15	6E-17	2E-16
Precision	N/A	2E-15	1E-16	1E-16
JD-6	2E-16	9.0E-15	8E-17	2E-16
Precision	N/A	1E-15	1E-16	9E-17
JD-7	2E-16	8.3E-15	1E-16	2E-16
Precision	N/A	1E-15	9E-17	8E-17

***Lower Limit of Detection: Regulatory Guide 4.14.**

Table 2-33h Jane Dough Baseline Radionuclide Concentrations in Air Third Quarter 2011. (continued)

	Third Quarter 2011			
Sample Site	**Uranium (µCi/ml)**	**Pb-210 (µCi/ml)**	**Ra-226 (µCi/ml)**	**Th-230 (µCi/ml)**
LLD*	1E-16	2E-15	1E-16	1E-16
JD-1	4E-16	8.7E-15	9E-17	4E-16
Precision	N/A	4E-15	3E-16	2E-16
JD-2	4E-16	1.5E-14	5E-16	6E-16
Precision	N/A	4E-15	4E-16	2E-16
JD-3	4E-16	1.5E-14	2E-16	6E-16
Precision	N/A	4E-15	3E-16	2E-16
JD-4	4E-16	1.2E-14	3E-16	4E-16
Precision	N/A	4E-15	4E-16	2E-16
JD-5	4E-16	1.5E-14	5E-16	2E-16
Precision	N/A	4E-15	4E-16	2E-16
JD-6	8E-16	1.4E-14	8E-16	3E-16
Precision	N/A	4E-15	4E-16	2E-16
JD-7	4E-16	1.3E-15	4E-16	3E-16
Precision	N/A	4E-15	4E-16	2E-16

***Lower Limit of Detection: Regulatory Guide 4.14.**

Table 2-33i Radionuclide Air Concentrations: Quarterly Comparison.

JD-1

Sample Period	Uranium (µCi/ml)	Pb-210 (µCi/ml)	Ra-226 (µCi/ml)	Th-230 (µCi/ml)
3rd Q 2010	2E-16	1.1E-14	1E-17	-9E-17
4th Q 2010	1E-16	2.4E-14	1E-17	-9E-17
1st Q 2011	1E-16	1.2E-14	-1E-17	2E-16
2nd Q 2011	1E-16	8.7E-15	-3E-17	2E-16
3rd Q 2011	4E-16	8.7E-15	9E-17	4E-16

JD-2

Sample Period	Uranium (µCi/ml)	Pb-210 (µCi/ml)	Ra-226 (µCi/ml)	Th-230 (µCi/ml)
3rd Q 2010	2E-16	1.0E-14	3E-17	-3E-18
4th Q 2010	2E-16	2.1E-14	4E-17	-1E-16
1st Q 2011	2E-16	1.2E-14	4E-17	1E-16
2nd Q 2011	2E-16	9.3E-15	2E-17	2E-16
3rd Q 2011	4E-16	1.5E-14	5E-16	6E-16

JD-3

Sample Period	Uranium (µCi/ml)	Pb-210 (µCi/ml)	Ra-226 (µCi/ml)	Th-230 (µCi/ml)
3rd Q 2010	4E-16	1.3E-14	6E-17	-6E-17
4th Q 2010	2E-16	2.2E-14	5E-17	-1E-16
1st Q 2011	2E-16	1.3E-14	3E-17	2E-16
2nd Q 2011	2E-16	8.7E-15	-3E-17	2E-16
3rd Q 2011	4E-16	1.5E-14	2E-16	6E-16

JD-4

Sample Period	Uranium (µCi/ml)	Pb-210 (µCi/ml)	Ra-226 (µCi/ml)	Th-230 (µCi/ml)
3rd Q 2010	2E-16	6.0E-15	2E-17	-1E-17
4th Q 2010	1E-16	2.3E-14	3E-17	-7E-17
1st Q 2011	2E-16	1.2E-14	-4E-17	1E-16
2nd Q 2011	1E-16	8.9E-15	9E-17	2E-16
3rd Q 2011	4E-16	1.2E-14	3E-16	4E-16

Table 2-33i (continued)

Sample Period	Uranium (µCi/ml)	Pb-210 (µCi/ml)	Ra-226 (µCi/ml)	Th-230 (µCi/ml)
		JD-5		
3rd Q 2010	2E-16	1.4E-14	5E-16	1E-16
4th Q 2010	2E-16	2.2E-14	5E-17	-2E-17
1st Q 2011	2E-16	1.1E-14	7E-17	1E-16
2nd Q 2011	2E-16	9.0E-15	6E-17	2E-16
3rd Q 2011	4E-16	1.5E-14	5E-16	2E-16
		JD-6		
3rd Q 2010	3E-16	9.9E-15	6E-16	7E-17
4th Q 2010	1E-16	2.0E-14	7E-18	-7E-17
1st Q 2011	2E-16	1.2E-14	2E-17	9E-17
2nd Q 2011	2E-16	9.0E-15	8E-17	2E-16
3rd Q 2011	8E-16	1.4E-14	8E-16	3E-16
		JD-7		
3rd Q 2010	3E-16	9.9E-15	2E-16	2E-17
4th Q 2010	2E-16	2.0E-14	4E-17	-3E-17
1st Q 2011	2E-16	1.2E-14	5E-18	1E-16
2nd Q 2011	2E-16	8.3E-15	1E-16	2E-16
3rd Q 2011	4E-16	1.3E-14	4E-16	3E-16

Table 2-33j Average Air Concentrations Over Five Quarters of Monitoring: Jane Dough Unit.

	Uranium (µCi/ml)						Pb-210 (µCi/ml)					
Site	**Q3/2010**	**Q4/2010**	**Q1/2011**	**Q2/2011**	**Q3/2011**	**Ave.**	**Q3/2010**	**Q4/2010**	**Q1/2011**	**Q2/2011**	**Q3/2011**	**Ave.**
JD-1	2E-16	1E-16	1E-16	1E-16	4E-16	2E-16	1.1E-14	2.4E-14	1.2E-14	8.7E-15	8.7E-15	1.3E-14
JD-2	2E-16	2E-16	2E-16	2E-16	4E-16	2E-16	1.0E-14	2.1E-14	1.2E-14	9.3E-15	1.5E-14	1.4E-14
JD-3	4E-16	2E-16	2E-16	2E-16	4E-16	3E-16	1.3E-14	2.2E-14	1.3E-14	8.7E-15	1.5E-14	1.4E-14
JD-4	2E-16	1E-16	2E-16	1E-16	4E-16	2E-16	6.0E-15	2.3E-14	1.2E-14	8.9E-15	1.2E-14	1.2E-14
JD-5	2E-16	2E-16	2E-16	2E-16	4E-16	2E-16	1.4E-14	2.2E-14	1.1E-14	9.0E-15	1.5E-14	1.4E-14
JD-6	3E-16	1E-16	2E-16	2E-16	8E-16	3E-16	9.9E-15	2.0E-14	1.2E-14	9.0E-15	1.4E-14	1.3E-14
JD-7	3E-16	2E-16	2E-16	2E-16	2E-16	2E-16	9.9E-15	2.0E-14	1.2E-14	8.3E-15	1.3E-14	1.3E-14

	Ra-226 (µCi/ml)						Th-230 (µCi/ml)					
Site	**Q3/2010**	**Q4/2010**	**Q1/2011**	**Q2/2011**	**Q3/2011**	**Ave**	**Q3/2010**	**Q4/2010**	**Q1/2011**	**Q2/2011**	**Q3/2011**	**Ave.**
JD-1	1E-17	1E-17	-1E-17	-3E-17	9E-17	3E-17	-9E-17	-9E-17	2E-16	2E-16	4E-16	2E-16
JD-2	3E-17	4E-17	4E-17	2E-17	5E-16	3E-17	-3E-18	-1E-16	1E-16	2E-16	6E-16	2E-16
JD-3	6E-17	5E-17	3E-17	-3E-17	2E-16	7E-17	-6E-17	-1E-16	2E-16	2E-16	6E-16	2E-16
JD-4	2E-17	3E-17	-4E-17	9E-17	3E-16	1E-16	-1E-17	-7E-17	1E-16	2E-16	4E-16	2E-16
JD-5	5E-16	5E-17	7E-17	6E-17	5E-16	2E-16	1E-16	-2E-17	1E-16	2E-16	2E-16	1E-16
JD-6	6E-16	7E-18	2E-17	8E-17	8E-16	3E-16	7E-17	-7E-17	9E-17	2E-16	3E-16	2E-16
JD-7	2E-16	4E-17	5E-18	1E-16	4E-16	1E-16	2E-17	-3E-17	1E-16	2E-16	3E-16	1E-16

Regulatory Guide 14 Lower Limit of Detection: Uranium (1E-16); Pb-210 (2E-15); Ra-226 (1E-16); and Th-230 (1E-16). 10 CFR 20 Effluent Concentration Limits: U (9E-14); Pb-210(6E-13); Ra-226 (9E-13); and Th-230 (3E-14).
All values in the table are as reported in the laboratory reports. To allow the average to be approximated, negative values were revised to the lower limit of detection.

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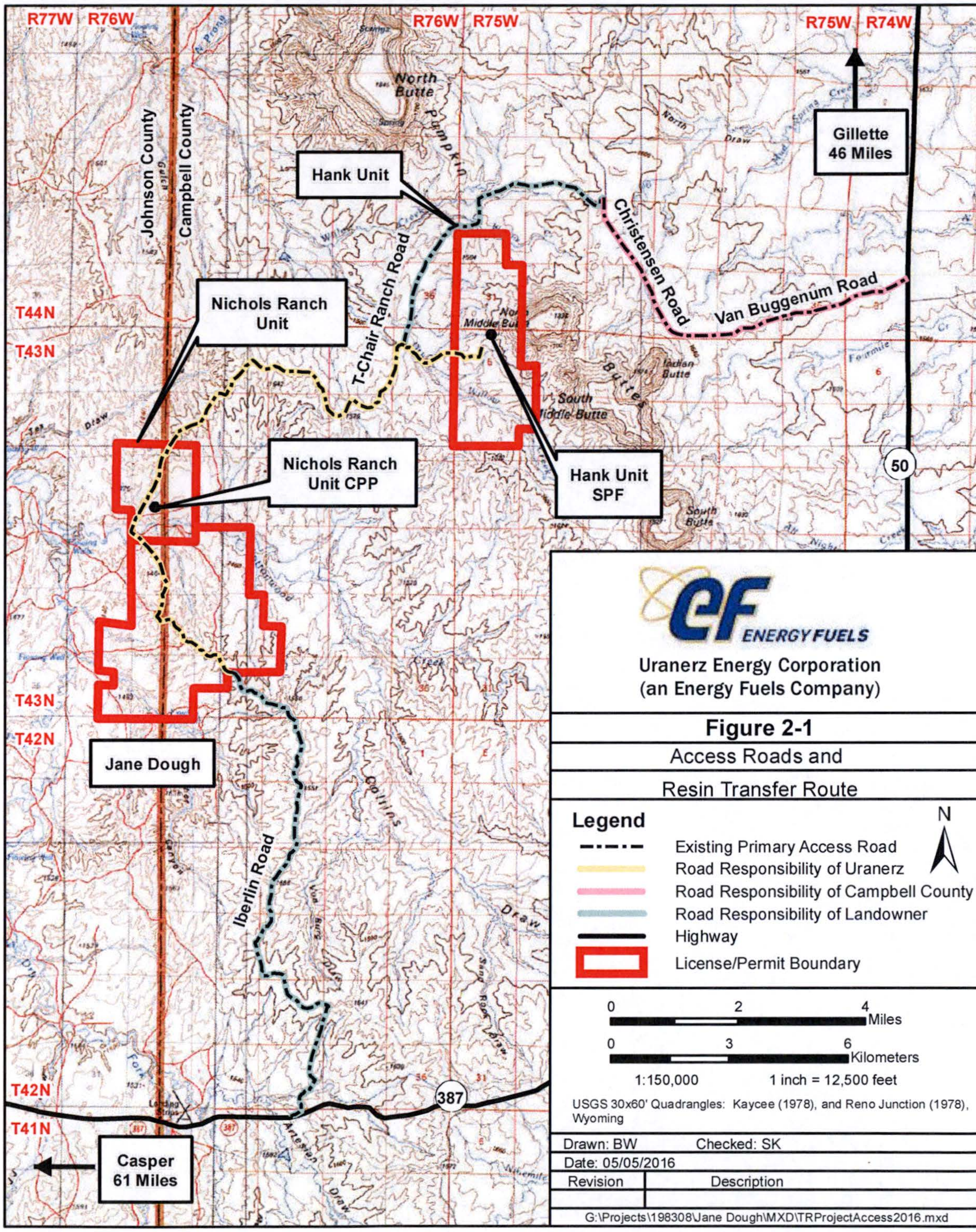
Sharp, W.N., MacKay, E.J., McKeown, F.A., White, A.M., 1964. Geology and Uranium Deposits of the Pumpkin Buttes Area of the Powder River Basin Wyoming. Geological Survey Bulletin 1107-H.



Uranerz Energy Corporation
(an Energy Fuels Company)

Figure 2-1
Access Roads and
Resin Transfer Route

Drawn: BW | Checked: SK
Date: 05/05/2016

Revision	Description

G:\Projects\198308\Jane Dough\MXD\TRProjectAccess2016.mxd

3.0 DESCRIPTION OF THE FACILITIES

The Nichols Ranch In-Situ Recovery (ISR) Project is divided into **three** units, the Nichols Ranch Unit, the Hank Unit, **and the Jane Dough Unit.** The Nichols Ranch Unit encompasses approximately 1,120 acres of land, the Hank Unit area encompasses approximately 2,250 acres of land, and the Jane Dough Unit encompasses approximately 3,680 acres. The project units will contain all of the proposed operations. The major surface facilities in the **Nichols Ranch and Hank Units** include the central processing plant, satellite plant, wellfields, and deep disposal wells. The injection and production proposed wellfield and disturbance area for Nichols Ranch Unit will contain approximately 113 acres, and Hank Unit will contain approximately 155 acres. The deep disposal wells will be designed such that there will be adequate disposal capacity for the various phases of operation (i.e. Production, Production and Restoration, and Restoration. For this application a disposal estimate of 100 gpm flow rate for each has been used and each disposal well will have a maximum injection pressure less than the fracture pressure of the formation. **The Jane Dough Unit only includes wellfields and the injection and production proposed wellfield and disturbance area for Jane Dough Unit will contain approximately 101 acres.**

3.1 IN SITU RECOVERY PROCESS AND EQUIPMENT

Uranerz plans to mine the Nichols Ranch Unit (Township 43N, Range 76 West, Sections 7, 8, 17, 18, and 20), Hank Unit (Township 44N, Range 75 West, Sections 30 and 31; Township 43N, Range 75 West, Sections 5, 6, 7 and 8) and the Jane Dough Unit (Township 43 North, Range 76 West, portions of Sections 20, 21, 27, 28, 29, 30, 31, 32, 33, and 34) ore zones using the in-situ recovery (ISR) extraction method. This is the same method that is used by Power Resources Inc. (PRI) at the Smith-Highland mine in the southern Powder River Basin and is the same method used by COGEMA (AREVA) at the nearby Christensen Ranch site.

The ore zones at the Nichols Ranch Unit, the Hank Unit, and **Jane Dough** Unit will be divided into individual production areas where injection and recovery wells will be installed. As typical with the above mentioned commercial operations, the wells will be arranged in 4-spot, 5-spot or 7-spot patterns. In some situations, a line-drive pattern or staggered line-drive pattern may be employed. Horizontal and vertical excursion monitor wells will be installed at each wellfield as dictated by geologic and hydro-geologic parameters, and as approved by the Wyoming Department of

Environmental Quality - Land Quality Division and the United States Nuclear Regulatory Commission. The facilities will be constructed according to acceptable engineering practices.

60 x 60 ft. By storing the drummed yellowcake within an enclosed area, employee safety will be improved (no snow or ice to work around) and the packaged product will be secured under locked conditions.

An office building, now planned to be approximately 150 x 60 ft, will be located adjacent to the process building. The office will be near the process building to allow use of a centralized lunch room and restroom facilities. In addition to office spaces for professional staff; a central security monitoring room, computer server room and the on-site laboratory will be located in the office building.

A second auxiliary building (maintenance building) will house the vehicle, electrical, and rotating equipment maintenance area, as well as provide an area for additional office spaces for field and operating personnel. The first aid area may be located in the maintenance building.

3.2.2 Hank Unit – Satellite Facility

The Hank Unit Satellite facility will consist of an ion exchange circuit and lixiviant make-up circuit, bleed treatment and disposal well. Most of the process equipment will be housed in an approximate 80 x 160 ft metal building with eave heights less than 40 ft. The process equipment layout is shown in Figure 3-4 (see map pocket) with some of the bulk chemical storage tanks located outside of the process building. **Figure 3-4a (see map pocket) illustrates plant flow details.** Carbon dioxide will be added to the lixiviant as the fluid exits the Hank Unit satellite facility and returns to the header houses where oxygen and/or sodium bicarbonate could be added prior to injection into the wellfield.

3.2.3 Process Description

3.2.3.1 Uranium Recovery

The proposed uranium in-situ recovery (ISR) process has been successfully tested at the Ruth R & D project and at a commercial scale at other uranium ISR extraction properties in Wyoming including the nearby Christensen Ranch Mine. This process, involving the dissolution of the

The recovery/extraction circuit includes the flow of lixiviant from the wellfield to the sand filters, or directly to the ion exchange columns and back to the wellfield. The uranium, that is liberated underground, is extracted in the ion exchange system of the process plant. The bleed from the circuit is permanently removed from the lixiviant flow to create a "cone of depression" in the wellfield's static water level and ensure that the lixiviant is contained by the inward movement of groundwater within the designated recovery area. The bleed is disposed of by means of injection into Class I – Non Hazardous approved deep disposal wells. The volume of the concentrated bleed is approximately 0.5% to 1.5% of the circulating lixiviant flow for the Nichols Ranch **and Jane Dough** Units and 2.5% to 3.5% for the Hank Unit.

The Nichols Ranch Unit elution circuit is designed to release the uranium from the loaded ion exchange resin by applying an aqueous solution of salt and sodium carbonate or sodium bicarbonate to the loaded ion exchange resin. The uranium concentration in the eluate will be built up at a controlled concentration range of between 20 to 40 grams per liter. This uranium rich eluate is ready for the de-carbonation process that occurs in the uranium precipitation circuit.

The yellowcake production circuit starts when the eluate is treated with acid to destroy the carbonate portion of the dissolved uranium complex. In addition to adding the acid slowly, a common defoamer may be used to reduce the foaming activity. The precipitation reagents, hydrogen peroxide and sodium hydroxide, or ammonia are added to the eluate to precipitate uranium yellowcake. The yellowcake slurry is then filtered, washed, dried, and drummed.

A bleed from the elution and the yellowcake precipitation circuits is used to control the concentration of undesirable ions such as sulfates. The chemical strength is refortified during each cycle.

Uranerz also conducted an analysis regarding shutting in the wellfield and not having a bleed during the time the deep disposal well is down. A cone of depression is in place, and Uranerz wanted to determine the amount of time the groundwater would migrate without a bleed.

A depression in the piezometric surface will exist during operation of the wellfields. If the wellfield operation had to be shut-in for a short period of time the water levels would gradually recover with flow inward to the wellfield on the down gradient side initially, then becoming a very flat gradient with very little flow and finally recovery to an outward gradient that is flatter than the natural gradient for the aquifer. The use of the natural gradient to estimate the movement of the ground water outward during a shut-in period is therefore very conservative. The use of the natural gradient in the ground-water movement rate should account for the variability in the ground-water velocity due to variability in aquifer properties.

The natural ground-water velocity for the A Sand aquifer at Nichols Ranch Unit is 12 ft/yr. This ground-water velocity was used to estimate the movement of ground-water at Nichols Ranch Unit for 45 days of non-operation which indicates that the ground-water would move less than two feet from its position prior to the shut-off period. This analysis demonstrates adequate containment of the ISR solution during a significant shut-in period of 45 days at the Nichols Ranch Unit. **The natural ground-water velocity for the A Sand aquifer at the Jane Dough Unit is also 12 ft/yr as presented in Section 2.7.2.2.3.1, and the travel distance during a 45 day shut-off would be less than two feet.**

The natural ground-water velocity for the F Sand aquifer at Hank Unit is 8 ft/yr. The use of this ground-water velocity to estimate the travel distance of the ISR solution during a 45 day shut-in period indicates that the solution would move roughly one foot during the non-operation period. This indicates that the Hank Unit solution should adequately be contained during a significant shut-in period of 45 days.

For the Nichols Ranch Unit there are three types of liquid effluent that will constitute the bleed that can be up to 35 GPM: 1) the wellfield bleed, 2) the elution circuit bleed, and 3) the general plant waste (resin wash, filter backwash, etc). A small quantity of water, about 1 to 2 GPM, may be introduced from a permitted water well for plant wash down and yellowcake wash.

Nichols Ranch/Jane Dough Units 1% Bleed

Production Only

Deep Disposal Well (DDW) Flow	+100	GPM	**(Capacity*)**
Production Flow to DDW	(-)40	GPM	
Other	(-)1-2	GPM	
Remaining Capacity Balance	+58	GPM	

Production and Restoration

Deep Disposal Well (DDW) Flow	+100	GPM	**(Capacity*)**
Production Flow to DDW	(-)40	GPM	
Restoration Flow to DDW	(-)57	GPM	
Other	(-)1-2	GPM	
Remaining Capacity Balance	+1	GPM	

Restoration Only

Deep Disposal Well (DDW) Flow	+100	GPM	**(Capacity*)**
Restoration Flow to DDW	(-)90	GPM	
Other	(-)1-2	GPM	
Remaining Capacity Balance	+8	GPM	

(*The 100 GPM is a conservative estimate)

Jane Dough Unit

Jane Dough production occurs after the Nichols Ranch Unit production is completed. Therefore production and restoration water balance usage will not increase with Jane Dough Unit but will only extend the same usage for a longer period of time.

Hank Unit 3% Bleed

Production Only

Deep Disposal Well (DDW) Flow	+100	GPM	**(Capacity*)**
Production Flow to DDW	(-)75	GPM	
Other	(-)1-2	GPM	
Remaining Capacity Balance	+23	GPM	

Production and Restoration

Deep Disposal Well (DDW) Flow	+100	GPM	**(Capacity*)**
Production Flow to DDW	(-)75	GPM	
Restoration Flow to DDW	(-)22	GPM	
Other	(-)1-2	GPM	
Remaining Capacity Balance	+1	GPM	

Restoration Only

Deep Disposal Well (DDW) Flow	+100	GPM	**(Capacity*)**
Restoration Flow to DDW	(-)90	GPM	
Other	(-)1-2	GPM	
Remaining Capacity Balance	**+8**	**GPM**	

Chemical	Name	Regulation	Minimum Reporting
NH_3	Ammonia	Threshold Quantity(TQ) from Clean Air Act for 40 CFR part 68 RMP	10,000 lb
		TQ for OHSA 29 CFR part 1910.119 Process Safety Management	10,000 lb
		TPQ (planning) for 40 CFR part 355 Emergency Response (ERP)	500 lb
		Reportable for CERCLA from 40 CFR 302.4	100 lb
H_2SO_4	Sulfuric Acid	TPQ for 40 CFR 355 ERP	1,000 lb
H_2O_2	Hydrogen Peroxide	TPQ for 40 CFR 355 ERP (conc > 52%)	1,000 lb
		TQ for OSHA 29 CFR 1910.119 PSM (conc > 52%)	7,500 lb
O_2	Oxygen	Not listed in any of the 4 regulations	NA
CO_2	Carbon Dioxide	Not listed in any of the 4 regulations	NA
Na_2CO_3	Sodium Carbonate	Not listed in any of the 4 regulations	NA
NaCl	Sodium Chloride	Not listed in any of the 4 regulations	NA
HCl	Hydrochloric Acid	TQ from CAA for 40 CFR Part 68 RMP (conc >37%)	15,000 lb
		TQ from OSHA for 29 CFR 1910.119 PSM (anhydrous HCl)	5,000 lb
		RQ for CERCLA from 40 CRF 302.4	5,000 lb
NaOH	Sodium Hydroxide	RQ for CERCLA from 40 CRF 302.4	1,000 lb

3.4 WELLFIELDS

3.4.1 Ore Zone

The ore zone for the Nichols Ranch Unit and Jane Dough Unit is 300-700 ft below the surface and is confined to the A Sand (100 Sand). The northwest extent of the ore zone is at Nichols Ranch Unit. The southwestern and southeastern portions of the mineralized zone make up the Jane Dough Unit. The depth is dependent on topography. The average grade at Nichols Ranch and Jane Dough is approximately 0.1% and averages above 7 ft thick. The combined areal distribution is approximately 4,041 acres.

The Hank Unit's ore zone is approximately 200-600 ft below the surface. The host is the F Sand (150 Sand). The depth is also dependent on the topography, the changes in the levels of the formation and the stratigraphic horizon. The average grade at Hank is 0.1% and averages above 7 ft thick. The area contained in Hank is approximately 2,250 acres.

bleed will be disposed of in a Class I deep disposal well. With the cone of depression being created, the natural groundwater movement from the surrounding areas is toward the wellfield providing an additional control of the leaching solution.

Wellfield bleed is defined as the difference between the amount of solution injected and produced. The bleed rate is anticipated to average 1% of the total production rate for the Nichols Ranch Unit and up to 3% for the Hank Unit. Over- production can be adjusted to guarantee the horizontal ore zone monitor wells are influenced by the cone of depression from the wellfield bleed.

Depending on the oxidation requirement of the formation, the injection wells may be equipped with oxygen spargers so that each well can be controlled as to the amount of oxygen concentration it receives, or a header house oxygen manifold distributor will be installed. Header houses are small buildings that contain the manifolds with valves, piping, and instrumentation for injection and recovery wells. Each header house will contain approximately 110 well accommodations, but may contain more or less. **The typical header house design is shown in Figure 3-9A Header House Details (see map pocket), and the details of the piping and instrumentation for the header house is shown in Figure 3-9B Header House Piping and Instrumentation (see map pocket).**

The header houses will be metal buildings. **The dimensions for the header houses will be approximately 40 feet by 20 feet, but may be more or less. The terrain and logistics in the wellfield will determine which engineered foundation (e.g. pad, pillar, or basement) the header house will be built on. The foundation will be constructed of durable materials that meet engineering requirements or other suitable materials with sealed penetrations (as needed) to provide containment.** The foundation will have grating which will allow access to the sub floor containing valves and hose runs. **The floor will curb and/or slope to a sump with an automatic level control pump. The sump will pipe to the recovery system and will include check valves. In header houses with basements the basement will contain the hose runs and injection and recovery lines. The header house may be designed to contain the electrical equipment in the same room with the piping or the electrical room may be attached to the main header house building and placed on concrete pillars that are buried underground for structural support.**

There are two separate solution trunk lines connecting the header houses. One of the trunk lines will take the recovery solutions from the header houses back to the processing plants, and the other trunk line will take injection fluid from the plants out to the header houses for injection into the wellfields. The actual number of header houses will depend on field placement of wells.

At each header house the individual injection and recovery flow and pressure readings can be monitored. Individual well flow readings will be recorded on a shift basis, and the overall wellfield flowrates will be balanced at least once per day. Alternately, flow and totallizer data will be transferred to the main or satellite plant and checked automatically. The recovery and injection trunk lines will have electronic pressure gauges and the information will be monitored from the Unit's control room. The control system will have high and low alarms for pressure and flow. If the pressure and/or flow is out of range the alarms will alert personnel to make adjustments, and certain ranges will signal automatic shutoffs or shutdowns.

The pipelines transport the wellfield solutions to and from the ion exchange columns. The flow rates and pressures are monitored to the individual lines. Automatic valves are installed for control of the flow. High density polyethylene (HDPE), Polyvinyl chloride (PVC), and/or stainless steel piping are used in the wellfield. The piping will be designed for operating pressure of 150 psig. However, the equipment will be operated at pressures less than or equal to the designed piping and other equipment ratings. If higher operating pressures are needed, the overall system will be evaluated and materials of construction with appropriate pressure ratings will be used.

Some of the lines from the ion exchanges facilities, header houses, and individual well lines may be buried to prevent freezing. Other ISR sites in Wyoming have successfully buried pipelines to protect them from freezing.

3.4.4 Wellfield Operations – Production Areas

To plan production, develop extraction schedules, establish baseline data, comply with monitoring requirements and complete restoration, the Nichols Ranch Unit will be divided into two production areas. The Nichols Ranch Unit contains the central processing plant with two production areas, NR Production Area #1 and NR Production Area #2. As the productivity or head grade of some patterns for the NR Production Area #1 decrease below the economic limit, replacement patterns for the NR Production Area #2 will be placed into operation in order to maintain the desired flow rate and head grade to the processing plant. Eventually, all the patterns in NR Production Area #1 will reach their economic limit and all production flow in that area will cease. At that time, all production flow will be coming from NR Production Area #2, and restoration activities will commence at NR Production Area #1. Figure 3-10 (see map pocket) shows the two Production Areas for Nichols Ranch. A characteristic flow rate for each of the two Nichols Ranch Unit Production Areas will range from 1,000-3,500 gallons per minute (GPM).

The Hank Unit is a remote satellite facility with two production areas, Hank Production Area #1 and Hank Production Area #2. The Hank Production Areas will follow a similar developmental, production, and restoration schedule as outlined in the above section for the Nichols Ranch Production Areas. The two Hank Production Areas are shown in Figure 3-11 (see map pocket). A characteristic flow rate for each of the Hank Unit Production Areas will range from 1,000-2,500 (GPM).

The Jane Dough Unit is divided into two production area, Jane Dough Production Area #1 and Jane Dough Production Area #2. The Jane Dough Production Areas will follow a similar developmental, production, and restoration schedule as outlined in the above section for the Nichols Ranch Production Areas. The two Jane Dough Production Areas are shown in Figure 3-11a (see map pocket). A characteristic flow rate for each of the two Jane Dough Unit Production Areas will range from 1,000 - 3,500 gpm.

A Gantt chart showing Nichols Ranch, Hank, **and Jane Dough** Production Areas is shown in Figure 3-12 (see map pocket). The chart shows the proposed plan for production, groundwater restoration, and decommissioning of each production area. However, the plan is subject to change due to extraction schedules, variations with production area recoveries, production plant issues, economic conditions, etc. The exact annual extraction schedules will be updated in the Annual report to the WDEQ. The proposed plan incorporates an adequate water balance calculations so that the deep disposal well can process the proposed production and restoration efforts at any given time.

The amount of time for restoration shown in Figure 3-12 is based on the current estimate of deep disposal well capacity and the restoration methods outlined in Chapter 6.0 of the Technical Report. As stated in Chapter 6.0, Section 6.1, Uranerz will adhere to 10 CFR 40.42. When decommissioning and/or restoration begin, the NRC will be notified and a plan submitted for review or approval. If, at that time, groundwater restoration is estimated to take longer than 24 months based on items such as deep disposal well capacity, Uranerz will request an alternate schedule as allowed under 10 CFR 40.42(i).

After each production area is completed, aquifer restoration will begin as soon as practical. If a completed production area is near a unit that is currently being mined, a portion of the first production area's restoration may be delayed to limit interference with the current extraction production area. The exact production area size and location may change based on the final delineation results of the ore zone and the actual production performance of the particular ore zone.

3.4.5 Well Completion

Pilot holes for monitor, production, and injection wells are drilled through the target completion interval with a small rotary drilling unit using native mud and a small amount of commercial drilling fluid additive for viscosity control. **In some instances, pilot holes may be drilled into the underlying aquitard if a completion interval is at the bottom of the production sandstone to allow for maneuverability during logging and well completion of the production zone. The hole is logged, reamed, casing set, and cemented to isolate the completion interval from all other aquifers and prevent fluid migration.** The cement will be placed by pumping it down the casing and forcing it out the bottom of the casing and back up the casing-drill hole annulus. The drill holes will be large enough in diameter for adequate sealing and, at any given depth, at least three inches greater in nominal diameter than the diameter of the outer casing at that depth.

Typical well completion schematics for production wells (recovery and injection wells), and monitor wells are shown on Figures 3-13 (see map pocket) and 3-14 (see map pocket), respectively. Production zone ring monitor wells, overlying monitor wells, and underlying monitor wells are completed with the entire aquifer sand exposed to open hole. Screens are

installed in these wells and open slots are adjacent to the sand for the entire thickness of the aquifer. Production zone monitor wells do not have screens installed in them. Some of these wells have the entire thickness of the production sand exposed. The remainder of this type of well is under reamed for better contact with the mineralization but collectively cover the full thickness of the production aquifer.

The well casing will be fiberglass, PVC, or HDPE. The fiberglass casing has a standard joint length of 30 ft and is rated for at least 950 pounds per square inch operating pressure. PVC well casing is typically 4 to 6 inches in diameter and SDR·17 to SDR·26 (or equivalent). The PVC casing joints normally have a length of approximately 20 ft each. When PVC casing is used, each joint is connected by a water tight o-ring seal. The casing for the well completions will be joined using an O-ring and spline locking system. Screw and glue joints will not be used for well completions. Products that typically are used include CERTA-LOK and SureFIT.

Casing centralizers, located approximately every 40 ft along the casing, are normally placed around the casing to ensure it is centered in the drill hole. Effective sealing materials shall consist of neat cement slurry and/or sand-cement grout meeting Wyoming State requirements described in Section 6, Chapter 11 of the LQD Non Coal Rules and Regulations unless a variance is obtained from the LQD Administrator. The purpose of the cement is to stabilize and strengthen the casing and plug the annulus of the hole to prevent vertical migration of solutions. If needed, the upper portion of the annulus will be cemented from the surface to stabilize the wellhead. This procedure is called "topping off." Tremie pipes can be used to top off a well.

After the well is cemented and the cement has set, the well is under reamed in the mineralized zone and completed either as an open hole or it is fitted with a screen assembly (slotted liner), which may have a sand filter pack installed between the screen and the under reamed formation. The well may then be air lifted for 30 minutes or more to remove any remaining drilling mud and/or cuttings. A submersible pump or small trailer mounted air compressor may be run in the well for final cleanup and/or sampling.

3.4.6 Well Casing Integrity

After an injection or recovery **or monitor** well has been completed, and before it is made operational, a Mechanical Integrity Test (MIT) of the well casing is conducted. For the integrity test, the bottom of the casing adjacent to or below the confining layer above the production zone is sealed with a plug, down hole packer, or other suitable device. The top of the casing is then sealed in a similar manner or with a sealed cap, and a pressure gauge is installed to monitor the pressure inside the casing. The pressure in the sealed casing is then increased to 125% of the maximum operating wellhead casing pressure or to an amount less than the formation fracture pressure (which is less). The well pressure is then monitored for a period of 10 minutes. A well is considered satisfactory with a pressure drop of no more than 10%.

If there are obvious leaks, or the pressure drops by more than 10% during the 10 minute period, the seals and fittings will be reset and/or checked and another test is conducted. If the pressure drops less than or equal to 10% the well casing is considered to have demonstrated acceptable mechanical integrity.

The results of the MITs conducted during a quarter are documented on a quarterly bases to include the well designation, date of the test, method by which the MIT was completed, verification of whether the MIT was or was not established, test duration, beginning and ending pressures, and the signature of the individual responsible for conducting the test. Results of the MITs are maintained on site and are available for inspection by NRC and WDEQ personnel. In accordance with regulatory requirements the results of MITs are reported to the WDEQ on a quarterly basis for those wells that were tested. In accordance with WDEQ and EPA requirements, MITs are repeated once every five (5) years for all wells used for injection of lixiviant, or injection of fluids for restoration operations. **MITs on production area monitor wells are also repeated every 5 years as required by NRC license.**

If a well casing does not meet the MIT criteria, the well will be placed out of service and the casing may be repaired and the well re-tested or abandoned. If a repaired well passes the MIT, it will be employed in its intended service. If an acceptable test cannot be obtained after repairs, the well will be plugged and abandoned. The WDEQ-LQD Administration will be notified in

the quarterly report of wells that fail the MIT. In the quarterly report the following is required: the identification of the failed well, a description of the method of plugging or repair, a status of the corrective actions on defective wells, the results of well plugging or repair, statements that the wells were plugged according to the approved permit and that the volume of material used for plugging equals the volume of material placed in the well.

The injection pressures for the Class III wells for the Nichols Ranch Unit, the Hank Unit, **and Jane Dough** will be calculated to assure the pressure in the production zones do not generate new fractures or spread existing fractures. Uranerz Energy Corporation will operate the Class III wells in a manner that the injection pressure will be lower than the calculated pressure that could fracture the confining zone, or cause the injection fluid to migrate to unauthorized zones. The injection pressure for the Nichols Ranch Unit, Hank Unit, **and Jane Dough Unit** will be no greater than 60% (range – 38% to 60%) of the formation fracture pressure and will not exceed the pressure rating of the casing.

Search of published fracture gradient information resulted in selecting a conservative fracture gradient of 0.80 psi/ foot of depth, for reservoir rock formations of 2,000 feet in depth or less. The following range for maximum injection pressures are: average depth for Nichols Ranch (600 ft X 0.80 psi/foot = 480 psi), **average depth for Jane Dough (500 ft X 0.80 psi/foot = 400psi)** and average depth for Hank (375 ft X 0.80 psi/foot = 300 psi). The range of 480 psi to 300 psi is greater than the maximum injection pressure ratings for PVC casing that Uranerz intends to use. The maximum operating pressure rating for SDR 17 casing is 180 psi and for SDR 21 casing (if used would only be at Hank) is 130 psi. MIT testing will be conducted at the maximum operating pressure of the installed casing. The casing pressure rating; therefore, will be the limiting factor and maximum injection pressure would be 180 psi. At Nichols Ranch 180 psi is 38% of the formation fracture pressure and for Hank it is 60% of the formation fracture pressure.

Injection wells will not be used for injection purposes if they do not demonstrate mechanical integrity. Additionally, a MIT will be conducted on any well to be used for injection purposes after any well repair where a down hole drill bit or under reaming tool is used. Any injection well with evidence of suspected subsurface damage will require a new MIT prior to the wellbeing returned to service.

3.4.7 Monitoring of Wellfield Flow and Pressure

Injection well and recovery well flow rates and pressures are monitored in order that injection and recovery can be balanced for each pattern and the entire production area. Recovery flow rates will always be greater than injection rates. This flow information is also needed for assessing operational conditions and mineral royalties. The volume of fluid for each recovery and injection well is determined by monitoring individual flow meters in each production areas header houses. Recovery well volumes are determined on a daily basis. More details on the instrumentation are given in a following Section 3.5.

3.4.8 Monitor Well Ring Gradient Reversal

3.4.8.1 Analytical Modeling

An analytical simulation of the gradient reversal was conducted with the use of the Theis well flow equation, and a program by Walton (1989), which is called "WELFLO". The program sums the drawdowns from numerous stresses over a grid. The critical location for the gradient reversal at the Nichols Ranch Unit is to the northwest in the down gradient direction. The wellfield orientation extends in this direction; therefore, the drawdowns for the northwestern portion of the wellfield were calculated to evaluate the gradient reversal. Figure 3-15 (see map pocket) shows the location of 73 recovery wells in the northwestern end of the number one wellfield. Additional stresses were lumped together and placed at 15 locations over the remainder with the wellfield, which extends an additional length of 4,800 ft to the southeast of these 73 stresses. This accounts for the entire stress from the wellfield with distribution of the stresses over the area. The bleed rate was applied to each of the recovery wells to simulate the net withdrawal of water from the A Sand aquifer.

An average transmissivity of 350 gal/day/ft and a storage coefficient of 1.8E-4 were used to simulate the drawdowns resulting from the bleed of the Nichols Ranch Unit Production Areas. A stress of 0.155 gpm was applied to each of the 73 recovery wells shown in the northern portion of the production area. The lumped bleed rates for the remaining 15 stresses varied from 0.93 to 2.48 gpm for a total bleed of 23.7 gpm from the additional stresses. The simulation period was one year to allow definition of the gradient reversals after a significant period of operation. The cumulative drawdown was calculated at each of the nodes. The differences

between the 100 ft node drawdowns to the northwest (ground water gradient direction) are shown on Figure 3-15 (see map pocket).

This simulated bleed rate was 1% of the overall flow and the distance between adjacent nodes on the diagonal is 141 ft. In the northwest direction, a simulated head difference between adjacent nodes that is greater than 0.47 ft indicates gradient reversal toward the wellfield. The northwest corner of the model grid is approximately 1,100 ft from the northwest edge of the wellfield, and the simulated head difference between adjacent nodes in the northwest corner of the model grid is much greater than 0.47 ft. Hence, the operation of the Nichols Ranch Unit Production Areas at a bleed of 1% will result in gradient reversal to the wellfield at a distance much greater than 1,100 ft from the northwest edge of the wellfield. A horizontal monitoring ring that is located 500 ft from the perimeter of the Nichols Ranch Unit Production Areas is within the zone of gradient reversal and will be adequate for detection of potential excursions from the Production Areas. These monitoring wells will also be spaced 500 ft from each other.

The magnitude of this simulated gradient reversal shows that the maintenance of a reversal zone in the confined aquifer at the Nichols Ranch Unit is readily achievable, and adjustments in local wellfield balance can be used to quickly induce reversal in the event of excursions.

The groundwater gradient at the Hank Unit site is 0.005 ft/ft to the west. Seventy one wells in the southern end of the Hank Unit Production Area #1 were used to simulate the composite drawdown response for the Hank Units at a rate of 0.426 gpm per well. Aquifer properties used in the simulation were a transmissivity of 400 gal/day/ft and a specific yield of 0.05. A simulation period of 365 days was also used for the Hank Unit Production Areas. The Hank Unit Production Areas are planned for a 2,500 gpm production rate and a 3% bleed was used in this simulation. This resulted in a stress at the seventy one recovery wells of 0.426 gpm. An additional nine stresses were used to simulate the remaining 105 wells in the northern portion of the wellfield with varying stresses from 3.41 to 7.24 gpm for a total additional stress of 44.74 gpm for the northern wells. The total stress rate was 75 gpm.

Figure 3-16 (see map pocket) shows the results of the gradient reversal for the Hank Unit. The head change between the 100 ft nodes is shown on this figure to the left of the 71 recovery stresses. An additional drawdown of 0.5 ft is needed to create gradient reversal toward the wellfield. Horizontal monitoring ring distance for this unconfined aquifer will be adequate at a distance of 500 ft from the wellfield perimeter with a 3% bleed rate for the Hank Unit. A spacing of 500 ft between the monitoring ring wells is also proposed for the Hank Unit.

An additional simulation was conducted on the gradient reversals for the Hank Unit. The second simulation was the same as presented above except that the net extraction from the nine southern recovery wells in the production area were increased by a total of 5 gpm, which increases the overall wellfield bleed from 3% to 3.2%. The individual bleed rate for these nine wells was 0.982 gpm instead of the 0.462 gpm used in the first Hank Unit simulation. This small localized increase in the bleed rate caused the reversal to increase by greater than 60% at a distance of 500 ft from the production area. The second simulation shows that small local adjustments in the bleed rate can be used to expand the local zone of reversal and prevent or retrieve an excursion in a particular area for the Hank Unit.

This analysis provides the impacts that in situ recovery operations might have on surrounding groundwater. The surface pathways that might transport extraction solutions offsite include the Cottonwood Drainage and Tex Draw for the Nichols Ranch Unit and the Dry Willow and Willow Creek Drainage for the Hank Unit. The expected post-extraction impacts on geochemical properties and water quality are discussed in the Restoration Chapter, Chapter 6.0. The flood and flood velocities are provided in Appendix D6-1.

The analytical model was not used to simulate the Jane Dough wellfield conditions because a numerical model was developed for the initial analysis of this unit. Average aquifer properties of 330 gal/day/ft and 1.3E-4 were used for the transmissivity and storage coefficient for the Jane Dough unit to simulate the drawdowns resulting from the bleed of the Jane Dough Unit Production Areas. The stress from the Nichols Ranch Unit was initially input to the Jane Dough Unit model to develop cumulative drawdowns from both the Nichols Ranch and Jane Dough Units in the A Sand aquifer. A total of 337 recovery and 591 injection wells were used to simulate the #1 Production Area. Production Area #2 has 195 recovery wells and 356 injection wells. A one percent (1%) wellfield bleed was used in the Jane Dough wellfield simulations.

3.4.8.2 Numerical Modeling

The MODFLOW numerical model was used to simulate the groundwater conditions at the Nichols Ranch Unit **and Jane Dough Unit for the A Sands** and the Hank Unit for the F Sands, respectively. Addendum 3 presents the results of the Nichols Ranch Unit numerical groundwater modeling while Addendum 3C presents the results of the numerical modeling for the Hank Unit. **Addendum 3D present the results of the numerical modeling for the Jane Dough Unit.**

The results for the horizontal flare evaluation for the Nichols Ranch Unit are presented in Addendum 3B in Figures 3B.1-14 and 3B.1-15. The horizontal flare evaluation for the Hank Unit is presented in Addendum 3C and Figures 3C.1-9 through 3C.1-11.

The partially penetrating unconfined groundwater equation was used to evaluate the vertical flare between two wells for the Hank Unit. The vertical flare evaluation for the F Sand is presented in Addendum 3C in Figure 3C.1-12.

The numerical model simulation results for evaluation of excursion retrieval are presented in Figures 3B.1-16 through 3B.1-18 in Addendum 3B for the Nichols Ranch Unit. The results for the retrieval simulation for the Hank Unit are presented in Addendum 3C and Figures 3C.1-13 through 3C.1-17.

The horizontal flare for the Jane Dough Unit should be very similar to the Nichols Ranch Unit flare because the aquifer is the same with similar aquifer properties and the two unit wellfields are similarly aligned with the ground-water flow in the A Sand aquifer. Three ore intervals are planned to be mined at both Nichols Ranch and Jane Dough and the middle ore zone is the primary production interval. In comparing middle ore zone well patterns at the two sites (see Figure MPG.1-4 of Addendum 3B and Figure MPI.1-4 of Addendum 3D), the ore bodies are long, narrow and sinuous. The typical middle ore body width at the Jane Dough Project is slightly greater than that at the Nichols Ranch Project and, in general, an increase in the ratio of width to length of narrow ore bodies will reduce the horizontal flare. Hence, although the ore body width differences are small, the Nichols Ranch horizontal flare estimates should be conservatively large when applied to the Jane Dough production areas.

The estimation of vertical flare is typically based on industry experience and some interpretation of the stratigraphic sequence and corresponding hydrologic properties that may limit vertical fluid movement. The composite flare factor of 1.45 used in the Nichols Ranch Project area included the horizontal flare factor of 1.19 and approximate vertical flare factor of 1.22. This vertical flare factor was estimated for the Hank Project area and is also generally consistent with industry estimates. The composite flare factor of 1.45 which includes vertical flare is considered appropriate for the Jane Dough Project area given the similarities to the Nichols Ranch Project.

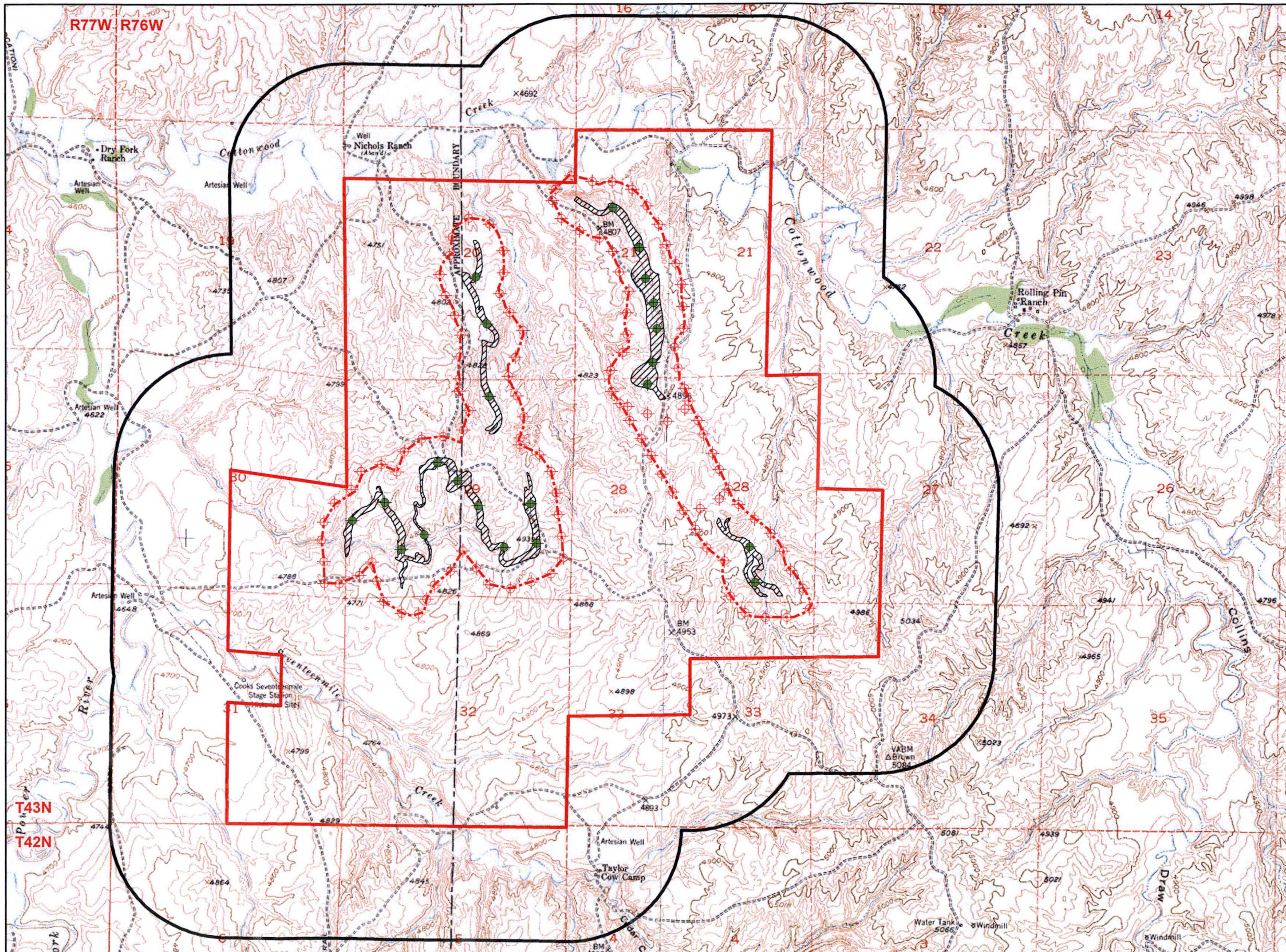
3.5 PLANT EQUIPMENT, INSTRUMENTATION, AND CONTROL

The plant equipment at the proposed facilities will consist of standard design, construction, and materials for uranium in-situ recovery extraction. Uranerz plans to install automated devices within the plant circuits to assist the operators with their coverage and reduce the number of operators required for successful coverage. Most of the automated devices will be pre-programmed to control operating parameters and the process information will be recorded. The automated systems will include alarms and shutoffs to prevent overflow and overpressure situations and provide centralized monitoring of the process variables.

The central processing plant, satellite plant, production circuits, wellfields, header houses, lines from the wellfield to the plant, and the deep disposal well will have instrumentation. The control system will have continuous monitoring, and alarms that are set when operating parameters are outside of the specified operating ranges. The alarms signal the operators to proceed with corrective actions until the parameter is back within specific ranges. Extreme tank levels or pressures will activate automatic shutdown of equipment for that area. The header houses, pipelines, and deep disposal wells are the sources of greatest risk for large spills and will have high and low pressure, and flow alarms for automatic shutdown of related equipment.

The total plant flow, total waste flow leaving the plant, and tank levels will be monitored. There will also be a low vacuum alarm for the dyer that will indicate either corrective action or automatic shut down. Manufacture's recommendations for the operating and maintenance of the dryer will be followed and recorded according to 10 CFR Part 40, Appendix A, Criterion 8. The critical systems will be equipped with back up systems that are automatically activated in a power failure or operating failure. The wellfield flows and pressures may be continually recorded, but at a minimum once a day recordings. The pressures will be kept under casing and formation rupture pressures.

The Uranerz Standard Operating Procedures (SOP) will address alarm responses, automatic shutdowns, and start up after automatic shutdowns. The SOP at both the Nichols Ranch **and Jane Dough Units** and



![Energy Fuels logo]

Uranerz Energy Corporation
(an Energy Fuels Company)

Figure 3-8C

Jane Dough Unit

Proposed Monitor Well Locations

Legend

- Proposed Horizontal Monitor Well
- Proposed Vertical Monitor Well (Overlying, Underlying Ore Zone)
- Proposed Horizontal Monitor Well Ring
- 0.5-mi Buffer Around Jane Dough Unit
- Jane Dough Unit
- Jane Dough Wellfield

N

0 0.25 0.5 1 Miles

0 0.25 0.5 1 Kilometers

1:30,000 1 inch = 2,500 feet

USGS 7.5' Quadrangles: Dry Fork Ranch (1953, Photoinspected 1973), and Rolling Pin Ranch (1953, Photoinspected 1973), Wyoming

Drawn: BW Checked: SK

Date: 04/29/2014

Revision	Description
03/21/16	Proposed vertical monitor wells added
05/05/16	Changed Logo and modify wellfield (RFB)

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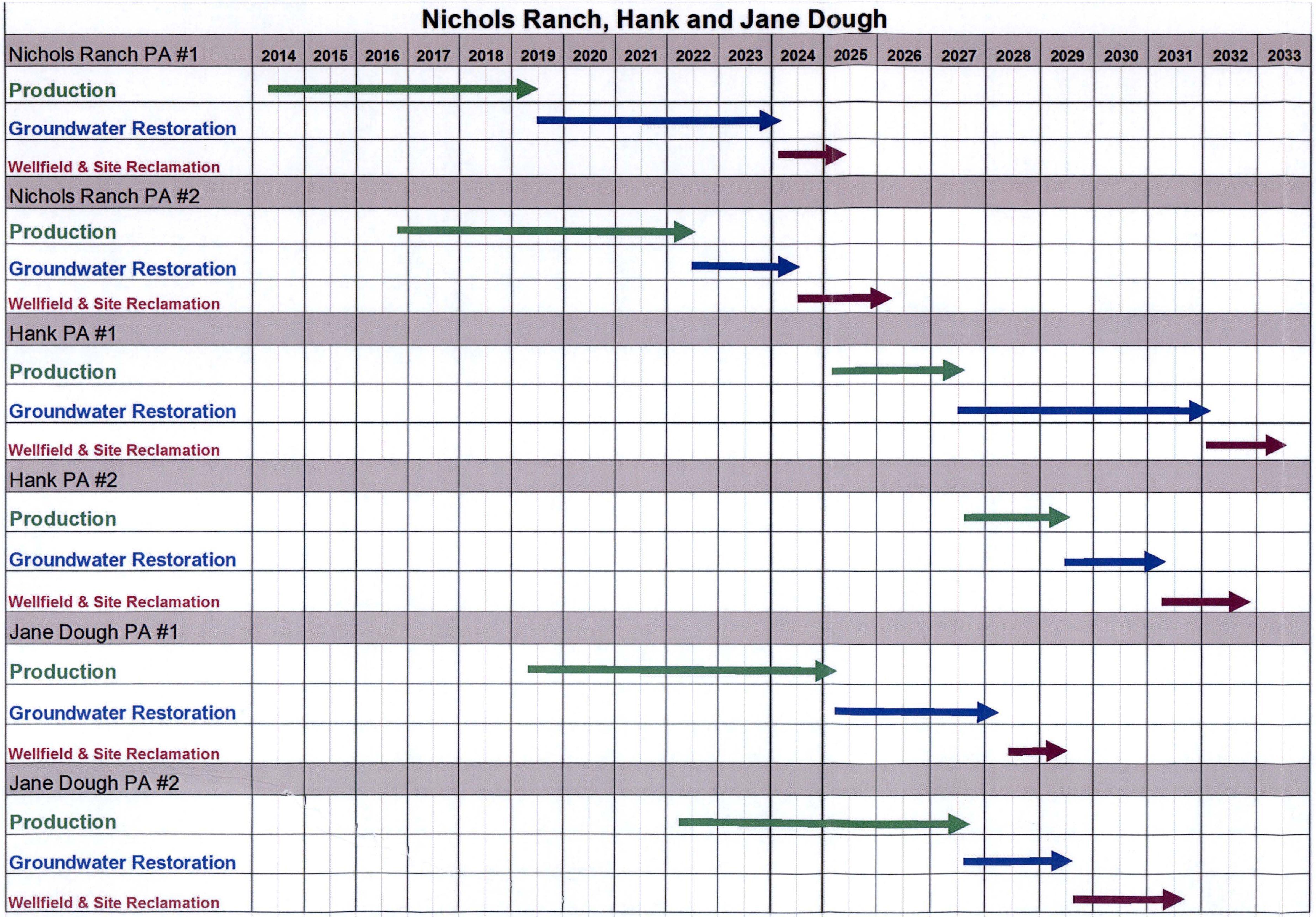

Note: Nichols Ranch Unit is divided into two production areas: Nichols Ranch Production Area #1 and Nichols Ranch Production Area #2. Hank Unit is divided into 2 production areas: Hank Production Area #1 and Hank Production Area #2.
This is a projected estimate for Production, Restoration and Reclamation. The actual schedule will depend on construction efficiency, actual production results and actual restoration of the groundwater.

ENERGY FUELS RESOURCES

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Figure 3-12

Nichols Ranch ISR Project

Production, Restoration & Reclamation Schedule

Drawn : A.A Checked: DK

Revision	Description
03/11/2014	Add Jane Dough
05/11/2015	Add Jane Dough
05/12/2016	

Document Path: T\IT\Drafting\JaneDough

5.3.2 Inspections

Inspections will be conducted periodically, as described below, of the wellfield and process areas. The purpose of the inspections will be to ensure that radiation protection, monitoring, and safety requirements are being followed and/or are properly functioning. The inspections will be performed and documented in accordance with a written procedure.

Daily

RSO's, RST's and qualified designees will conduct a daily walkthrough inspection of the process and storage areas. The inspection will provide for a visual survey of proper implementation of procedures, housekeeping, and contamination control.

Weekly

A RSO will complete a weekly inspection of the site. The scope of the inspection will include radiation safety practices, procedural compliance, environmental monitoring, and environmental conditions at the site.

Monthly

The ESH Manager will provide to site management a written summary of the conditions of radiation safety and environmental monitoring. The report will include summaries of personnel monitoring, radiation and contamination surveys, trends important to ALARA considerations, a general assessment of compliance, and a description of problems with recommendations for corrective action.

5.4 QUALIFICATIONS FOR PERSONNEL CONDUCTING THE RADIATION SAFETY PROGRAM

The qualifications are described below for personnel assigned responsibility for developing, conducting, and administering the radiation safety program. The qualifications will be consistent with NRC Regulatory Guide 8.31, "Information Relevant to Ensuring that Occupational Radiation Exposures at Uranium Mills Will Be As Low As Is Reasonably Achievable," Revision 1, 2002 at Section 2.4. Additional information regarding the qualifications and requirements for people conducting the daily inspection are contained in section 5.4.1.

Radiation Safety Officer

The RSO should have the following education, training, and experience:

Education: A bachelor's degree in the physical sciences, industrial hygiene, or engineering from an accredited college or university, or an equivalent combination of training and relevant experience in radiation safety. Two years of relevant experience may be considered equivalent to one year of academic study.

Radiation Safety Experience: At least one year of work experience relevant to uranium recovery operations in applied radiation safety, industrial hygiene, or similar work. This experience should involve actually working with radiation detection and measurement equipment, and administrative duties.

Specialized Training: At least four weeks of specialized classroom training in radiation safety applicable to uranium recovery. Refresher training on relevant radiation safety matters should be completed every two years.

Specialized Knowledge: Knowledge of the proper application and use of all radiation safety equipment used at the facility, the analytical procedures used for radiological sampling and monitoring, methodologies used to calculate personnel exposure to uranium and its daughters, an understanding of the processes and equipment used at the facility, and how the radiation hazards are generated and controlled.

Radiation Safety Technician

The radiation safety technician should have one of the following combinations of education, training, and experience:

Education: An associate degree or two or more years of study in the physical sciences, engineering, or a health-related field;

Training: At least four weeks of generalized training (up to two weeks may be on-the-job training) in radiation safety applicable to uranium recovery facilities;

Experience: One year of work experience using sampling and analytical laboratory procedures that involve radiation safety, industrial hygiene, or industrial safety measures to be applied at a uranium recovery facility;

Or

Education: A high school diploma;

Training: A total of three months of specialized training (up to one month may be on-the-job training) in radiation safety relevant to uranium recovery facilities;
Experience: Two years of relevant work experience in applied radiation safety.

The radiation safety technician should demonstrate a working knowledge of the proper operation of radiation safety instruments used in the facility, surveying and sampling techniques, and personnel dosimetry requirements.

5.4.1 Qualifications and Requirements for Conducting Daily Inspections

Qualified Designee

A qualified designee will only be responsible for performing the daily walkthrough visual inspections in accordance with section 5.3.2. Qualified designees will only perform the inspections on weekends or holidays when the RSO's or RST's are not present; for no more than 3 consecutive days per week except when a holiday falls on a Monday or Thanksgiving (4 days). Reports from designees will be reviewed by the RSO's or RST's by the close of business on the first day the RSO or RST returns to work. If the RSO or RST cannot review documents and perform the walk-through for more than 3 days (e.g. holidays or adverse weather events); the RSO or RST will call the designee and review previous un-reviewed reports and current operational conditions over the phone.

The RSO will determine who is qualified to be a candidate for training as a designee. Because of their knowledge of the plant area, the process, and associated equipment such as pumps, sumps, and the plant ventilation system, plant operators will primarily be chosen for training in completing daily radiation safety inspections. Other suitable personnel, such as environmental technicians, safety officers, wellfield operators, or other supervisors may also be trained as a qualified designee if they meet the education and experience requirements.

Qualified designees will be trained to perform daily inspections of operational areas as is required in Regulatory Guide 8.31. This includes the processing plant, satellite facilities, and other work and storage areas. Designees will also be trained to observe whether staff are performing work while wearing appropriate PPE, specifically PPE related to radiation hazards, such as rubber gloves or protective coveralls. Designees will look for leaks and spills and verify proper operations of ventilation systems. They will observe if radiological postings are in good working order and will correct minor deficiencies as trained. For example, if a radiation area sign has fallen off of a rope they will be trained to replace the posting or if a barrier has fallen down they will be trained to properly place the barrier upright. In an instance where they cannot fix the situation, such as a sign has blown away and they cannot find and replace the sign, they will be trained to notify the RSO's or RST's who will correct the discrepancy as soon as is practicable. Designees will not be trained to operate radiation detecting instruments (besides personnel scanning stations) and will not be trained to move or post new radiological areas. As operational areas expand additional items will be added to the inspection details through the SERP process.

In the case where a problem or question arises during the daily inspection, RSO's or RST's will be available by phone to direct any additional action that may be required. The RSO or RST would then direct the designee on appropriate actions or they may choose to go to the site to assist with the corrective action if they deem necessary. Additionally, all employees are trained as radiation workers and have a responsibility for identifying, reporting, and if possible correcting radiation hazards.

Personnel are also trained during new hire radiation and safety training on how to respond to emergency situations without RSO's or RST's present. Uranerz has created Emergency Response Manuals (ERM) that employees are trained to. The ERM addresses situations such as emergency conditions like uncontained leaks and spills that require RSO and/or RST notification.

Radiation safety officers or radiation safety technicians will be allowed to train designees. Designees will not be allowed to perform unsupervised daily inspections unless they have met the education and experience requirements and training is complete, reviewed, and approved by a RSO.

Education and experience requirements: Trainees will have education and experience commensurate with risks associated with the task being performed. Uranerz will therefore require the following qualifications from personnel who will be trained and perform daily radiation safety inspections.

a. High school diploma or equivalent;
b. At least three months of experience working in uranium recovery as a radiation worker or qualification as a plant operator.
c. Classroom training covering the sections regarding daily inspections in Uranerz procedures. Training will also cover ALARA principles related to an operational uranium recovery facility. A written test will be performed at the completion of the training where an 80% or better must be achieved to display appropriate knowledge base for performing inspections.
d. Upon successful completion of classroom training and subsequent test, trainees will perform at least 4 daily inspections while supervised by RSO's or RST's. RSO's or RST's will coach trainees on how to perform an inspection focusing on ALARA principles and appropriate radiation control techniques.
e. After completing items in part d above trainees will perform a final inspection while being evaluated by a RSO. The RSO will grade the trainee on the inspection as either pass or fail.
f. If the trainee passes the final inspection then the training documents will be completed and placed in the employees training file for review during inspection. The trainee is now a qualified designee approved to perform daily inspections in accordance with section 5.4.1.
g. Re-training of the employee will occur within six months of initial training and at least annually thereafter. Re-training will require successful completion of one inspection as described in part "d" above and one final inspection as described in point "e" above, along with a written test at the completion of the final inspection with a required passing grade of 80%.
h. If during the original training or re-training the trainee fails the final inspection the trainee will be required to complete training starting back at point "c" listed above.

5.5 RADIATION SAFETY TRAINING

All personnel will be provided training before entering controlled areas or beginning their jobs. The scope of the training will be based on access requirements to the facility and potential for exposure to radiation and radioactive materials. The scope of training will initially be determined with respect to whether the individual is a visitor, or an employee or contractor. Training of visitors will be applicable to newly hired employees and contractors, and visitors who will not or have not completed other site-specific training (e.g. as described below). All visitors to the facility will receive instruction on what they should do to avoid possible radiological, and nonradiological

hazards in the areas of the facility they will be visiting, escort requirement, and actions to take during an emergency.

All new employees and contractors will be instructed by means of an established course in the inherent risk of exposure to radiation and the fundamentals of protection against exposure to uranium and its daughters before beginning their jobs. The training will be commensurate with the risks and hazards associated with their requirements for access to the site. Those personnel who need unescorted access to the wellfield and process area will be provided a course of instruction covering those topics identified in NRC Regulatory Guide 8.31, "Information Relevant to Ensuring that Occupational Radiation Exposures at Uranium Recovery Facilities Will Be As Low As Is Reasonably Achievable," Revision 1, 2002 at Section 2.5. The instruction will be consistent with NRC Regulatory Guide 8.29, "Instruction Concerning Risks from Occupational Radiation Exposure," Revision 1, 1996 and NRC Regulatory Guide 8.13, "Instruction Concerning Prenatal Radiation Exposure," Revision 3, 1999.

Those employees and contractors who will work in the wellfield or process area (i.e. working around radiation and/or with radioactive materials) will be provided additional training. The additional training will include more depth on the previously identified topics, particular instruction on the health and radiation safety aspects and nonradiological hazards of tasks, and the requirements of procedures and instructions pertaining to radiation safety.

A written or oral test will be given to each individual. The test will cover radiation safety and health protection principles and requirements as applicable to the Nichols Ranch ISR Project site. The test will be reviewed with the individual(s), including discussion of wrong answers. Individuals who fail the test will be provided additional training and successfully retested if the intention remains to place them in the wellfield or process area.

Employees and contractors will be provided refresher training annually. The refresher training will be an abbreviated form of the original training. Refresher training will also include relevant information available since the previous training, review of safety issues since the previous training, applicable changes in regulations and license conditions, and personnel exposure trends.

Training will be documented to include individuals name and employer, topic, date, and identification of instructor. Records will be maintained of this documentation and test results.

(1 concentrations of radioactive materials in air (air sampling), or (2) quantities of radionuclides excreted form the body (bioassay), or (3) combinations of these measurements. The air sampling program is described in Section 5.7.3. The bioassay program is described in Section 5.7.5.

Internal dose will be determined for routine operations, non-routine operations, maintenance, and cleanup activities. Internal dose calculations will be equivalent to the methodologies provided in NRC Regulatory Guide 8.30, Health Physics Surveys in Uranium Recovery Facilities, 2002, Section 3; NRC Regulatory Guide 8.34, Monitoring Criteria and Methods to Calculate Occupational Radiation Doses, 1992, Section C; or a combination of these methodologies.

Intake will be determined for actual exposure time. Exposure time will be determined from interview, the radiation work permit, other record of work, or a combination. Intake calculations will be equivalent to NRC Regulatory Guide 8.30, Health Physics Surveys in Uranium Recovery Facilities, 2002, Equation A.1; NUREG/CR-4884 Interpretation of Bioassay Measurements; or a combination of these methodologies.

5.7.4.1 Uranium

The intake or concentration or radioactive material in air will be compared to the annual limit on Intake or the Derived Air Concentration value, respectively, of 10 CFR 20, Appendix B, Table 1, Column 3, Uranium-natural. A solubility classification "**W**" will be assigned to all uranium at the Nichols Ranch ISR Project sites.[1] Account will be made for use of respiratory protection according to 10 CFR 20 at paragraph 1703(i) and Appendix A.

The resulting intakes will also be compiled to allow comparison to the weekly intake limit for soluble uranium of 10 CFR 20.1201(e). Intake of soluble uranium will be limited to 10 mg per week per 10 CFR 20.1201(e). Accordingly, at an assumed specific activity of 0.67 µCi/gram for Unat (10 CFR 20, Appendix B, footnote 3), the weekly soluble intake limit is 6.7 E-3 µCi. Initially, solubility Class W will be used to establish the appropriate ALI of 0.8 µCi and DAC of3 E-10 µCi/ml for U natural (10 CFR 20, App B, Table 1).

[1] U.S. NRC Regulatory Guide 8.30 . Health Physics Surveys in Uranium Recovery Facilities. March 2002, Section 2.2.

Assuming a 40 hour work week and average breathing rate of 20 liters/min, the average concentration at the soluble weekly intake limit is approximately equal to 50% of the DAC. Compliance to this requirement will be documented by recording of worker airborne exposure in DAC – hrs, whenever long lived particulate concentrations in air are determined to be ≥ 10 % DAC and an action level of 25% DAC will be established requiring RSO investigation and potential corrective actions. Assignments of positive airborne exposure will be reviewed weekly. Accordingly, any exposures to soluble uranium > 20 % of the 10 mg/week limit will in fact be recorded (as DAC-hrs) and controlling exposure to 25% of DAC ensures both that the 10 mg / week limit is not exceeded and ALARA. Worker exposure to soluble uranium will be assessed via standard grab and breathing zone sampling particulate filtration techniques and subsequent analysis of radionuclide content of filter papers.

The resulting intakes and doses are recorded onto each worker's occupational exposure record.

5.7.6.7 Survey Record

The following information will be recorded for each contamination survey:

- Date of survey
- Identification of the person, area, or item surveyed. This identification will be unique for persons, respiratory protection equipment, and as reasonable for other areas and items.
- Identification of the person performing the survey.
- Unique identification of the instrument(s) used to complete the survey.
- The results of the survey.

5.7.7 Airborne Effluent and Environmental Monitoring

A program will be established for measuring concentrations and quantities of radioactive materials released to and in the environment surrounding the facility. This program will be implemented consistent with NRC Regulatory Guide 4.14 "Radiological Effluent and Environmental Monitoring at Uranium Mills," Revision 1, 1980.

The sampling and measurement locations of the program are shown in **Exhibit 5-1** (see map pocket).

Uranerz will manage the area between the process area and the site boundary as a controlled area pursuant to 10 CFR 20.1003. The types of controls used for this area are described in the Technical Report at Section 5.6. Uranerz will show compliance with the annual dose limit in 10 CFR 20.1301 by using results from routine monitoring supplemented by calculation pursuant to 10 CFR Part 20.1302(b)(1). The results of process area and environmental monitoring for direct radiation, air particulates, radon, and surface water will be extrapolated and or used to estimate a dose from licensed operations in the controlled area.

1. Discussion of the results and conclusions of the production area pump test including pumping data, drawdown match curves, potentiometric surface maps, water level graphs, drawdown map, and directional transmissivity data and graphs.
2. Data showing that the monitor well ring and the ore zone are in communication with the production patterns.
3. Any other information that is pertinent to the production area being tested.

5.7.8.5 Baseline Water Quality Determination

The importance of properly defining the baseline groundwater quality for individual production areas cannot be overemphasized as the data collected will be used to establish the Upper Control Limits (UCL's) and the restoration target values that will be used in groundwater restoration. Standard Operating Procedures (SOP) will be developed that will detail acceptable water quality sampling and handling procedures, as well as the statistical assessment of the groundwater data.

5.7.8.5.1 Data Collection

Water quality samples will be collected and analyzed from all monitor wells to establish baseline groundwater quality for the ore zone, ore zone aquifer, underlying aquifer, and the overlying aquifer. Table D6-6a in Volume VI of Appendix D6 details the parameters that will be analyzed during the sampling of baseline water quality. The sampling of the monitor wells will be in accordance to all sampling, preservation, and analysis procedures. Sampling procedures are based on WDEQ-LQD Guideline 4 guidance and are available onsite to all employees. The number of samples collected and the parameters that the samples will be tested for are as follows:

1. Ore Zone (Production Pattern) Wells (MP Wells) **and Ore Zone (Perimeter Monitor) Wells (MR-Wells) –Samples will be collected from ore zone monitoring production (MP) wells at a minimum density of one MP well per 4 acres of production area. Samples will also be collected from the ore zone monitor wells at the same frequency. These samples will be analyzed for the parameters found in WDEQ-LQD Guideline No. 8 including uranium parameters (see Table D6-6a in Volume VI of Appendix D6).**

2. Overlying Aquifer Wells (MO Wells) and Underlying Aquifer Wells (MU Wells) – The overlying and underlying aquifer monitoring wells **(one well per 4 acres of production area)** will be sampled four times with at least two weeks between sampling events. **These samples will be analyzed for the parameters found in WDEQ-LQD Guideline No. 8 including uranium parameters (see Table D6-6a of Appendix D6).**
3. **Surficial Aquifer- One surficial well will be located and samples in each production area. The samples will be analyzed for those parameters listed in Table D6-6a in Volume VI of Appendix D6.**
4. **Sampling and analysis. Four samples shall be collected from each well to establish background levels. Consecutive sampling events will be at least 14 days apart. The third and fourth sample events may be analyzed for a reduced list of parameters. The parameters that can be deleted form the third and fourth sampling events are those that are below the minimum analytical detection limits recorded during the first and second sampling events.**
5. **Ground water RTVs for the ore zone aquifer will be established on a parameter-by-parameter basis using either a production area or well-specific basis for all constituents.**

5.7.8.6 Statistical Assessment of Baseline Water Quality Data

Baseline water quality for the overlying, underlying, ore zone, and monitoring ring wells will be determined by averaging the data collected for each parameter analyzed. In addition to calculating the average of the data, the variability of the data will also be calculated. Outliers will be determined by using the methods outlined in WDEQ-LQD Guideline No. 4 or other accepted methods. Any value determined to be an outlier will not be used in baseline calculations.

Average data from wells that are not uniformly distributed will be calculated by weighting the data according to the fraction of area, or water volume, represented by the data. Baseline conditions will be calculated as follows:

1. Ore Zone Wells (MP Wells) – Baseline water quality will be calculated by using the average of each parameter that is analyzed. If the data collected shows that water from

the entire production area is that of waters of different under-groundwater classes, the data then will not be averaged together, but separated into sub-zones. Data within the sub-zones will then be averaged. The boundaries of the sub-zones, where required, will be delineated at halfway between the sets of sampled wells that define the sub-zones.

2. Monitoring Ring Wells (MR Wells) – Baseline water quality will be calculated by averaging each parameter that is analyzed. As with the ore zone wells, if sub-zones are present that have different classes of water, data in the sub-zones will be averaged separately.

3. Overlying and Underlying Aquifer Wells (MO and MU Wells) – The baseline water quality will be calculated by using the average of each parameter that is analyzed.

5.7.8.7 Restoration Target Values

The Restoration Target Values (RTV's) are calculated from the baseline water quality data collected from the ore zone monitoring wells. The RTV's are used in determining and assessing the effectiveness of groundwater restoration within a production area. Baseline water quality **mean plus two standard deviations** for the parameters sampled for the ore zone wells constitute the RTV's. If sub-zones exist in the ore zone, the RTV's will be determined for each sub-zone. The Restoration Target Value Parameters are listed in Table 5-1.

5.7.8.8 Upper Control Limits

Upper Control Limits (UCL's) are used to define excursions at monitoring wells. Through the installation of the monitoring ring wells, and the overlying and underlying aquifer monitoring wells, tracking of the lixiviant and processing fluids can be accomplished to ensure that the fluids are not leaving the defined ore zone. The process bleed or wellfield purge in combination with the production area pumping and injection rates assist in keeping all processing fluids within the ore zone.

All water quality samples from the monitor wells will be analyzed at the Nichols Ranch Unit laboratory for chlorides, total alkalinity, and conductivity within 48 hours of the sample being collected. All samples will be analyzed in accordance with accepted methods based on WDEQ-LQD Guideline 4 guidance. Standard Operating Procedures (SOP's) will be developed that will detail all water sampling and laboratory analysis procedures. The detailed SOP for water sampling and laboratory analysis is available onsite for employee's use.

5.7.8.10.3 Excursions

If any two of the three UCL excursion parameters (chloride, total alkalinity, or conductivity) are exceeded, an excursion is suspected to have occurred. Within 24 hours of the first analysis, a second verification sample will be taken and analyzed to determine that two of the three excursion parameters have been exceeded. The verification sample is then split and analyzed in duplicate to assess any analytical error. If two of the three UCL's are exceeded, an excursion is then verified. **If the second sample does not exceed the UCL's, then a third sample will be taken within 24 hours of the second sample (or 48 hours of the first sample). All re-samples need to be completed within 30 days or the excursion is confirmed.** During an excursion event, all monitoring wells that are placed on excursion status will be sampled at least every seven days for the UCL parameters.

If an excursion is verified **by the second or third sample, steps for notification and reporting will be followed in accordance with WDEQ-LQD Chapter 11 and the NRC license.** The WDEQ-LQD and NRC Project Manager will be verbally notified within 24 hours. The WDEQ-LQD and NRC Project Manager will also be notified in writing within **five** days of a verified excursion. Corrective actions such as changes in the injection and recovery flow rates in the affected area will be implemented as soon as practical. The corrective actions will continue until the excursion is mitigated. A written report describing the excursion event, corrective actions, and the corrective action results must also be submitted to the NRC Project Manager within 60 days of the excursion confirmation.

An excursion is controlled when it can be demonstrated that recovery fluid in unauthorized areas (i.e. monitoring well) is declining. In the event that the concentration of the UCL parameters that were detected in the monitor well(s) do not begin to decline within 60 days after

established. If a declining trend is not established in a reasonable time period, additional measures will be implemented. When a significant declining trend is established, normal operations will resume with injection and/or production rates monitored such that net water withdrawals for the excursion area will continue. The declining trend will be maintained until such time that the concentrations of excursion parameters in the affected monitor well(s) has returned to concentrations less than the established UCL's. Addendum 3B and 3C of Volume II include numerical modeling of how the retrieval of an excursion will be conducted in the event that an excursion does take place.

In the event that an excursion remains for more than 60 days, Uranerz will increase the posted surety amount to a level that is agreeable to the NRC. The increased amount will cover the full expected cost of correcting and cleaning up the excursion as stated in NUREG-1569 Section 5.7.8.5. (5). The surety increase will remain in force until the excursion is corrected.

5.7.8.11 Operational Surface Water Monitoring Program

Surface water samples will continue to be collected in the same locations that were used during the pre-mining baselining for the Nichols Ranch, **Jane Dough** and Hank Units. Additionally surface water samples will be collected whenever water is present in the locations outlined in Table D6A.1-1 of Appendix D6, Addendum D6A **for Nichols Ranch and Hank Units and Addendum JD-D6A for Jane Dough Unit. Refer to Section 5.7.7.3.1 for additional monitoring requirements.**

5.7.9 Quality Assurance

A quality assurance program **has been** established to provide a measure of the completeness and accuracy of sampling and measurement results. The results of the quality assurance program demonstrates effectiveness of implemented programs or allow for identification of deficiencies so that corrective action can be taken. The quality assurance program will be applied to all radiological, effluent, and environmental programs.

the wellfield drilling and pipeline installation are limited and reclaimed as soon as possible after completion of these items. Access roads to and from the wellfield are also limited with minimum surface disturbance.

6.2.3 Topsoil Handling and Replacement

Topsoil will be salvaged from any building sites, permanent storage areas, main access roads, and chemical storage areas prior to construction in accordance with Wyoming Department of Environmental Quality-Land Quality Division (WDEQ-LQD) requirements. To accomplish this, typical earth moving equipment such as rubber tired scrapers and front end loaders will be utilized. Topsoil salvage operations for the wellfield will be limited to the removal of topsoil at header house locations. Wellfield access roads topsoil removal will be in accordance with the landowner's road construction practices. These practices are outlined in the letter attached in Addendum 6A. Altogether, an estimated **135** acres of topsoil will be salvaged, stockpiled, and reapplied during the life of the Nichols Ranch ISR Project.

Topsoil that is salvaged during construction activities will be stored in designated topsoil stockpiles. These stockpiles will be located so as to minimize topsoil losses from wind erosion. Topsoil stockpiles will also not be located in any drainage channels or other locations that could lead to a loss of material. Berms will be constructed around the base of the stockpiles along with the seeding of the stockpiles with a mixture of Western Wheatgrass and Thickspike Wheatgrass at a seeding rate of seven pounds pure live seed per acre per wheatgrass species to reduce the risk of sediment runoff. Additionally, all topsoil stockpiles will be identified with highly visible signs labeled "Topsoil" in accordance with WDEQ-LQD requirements.

During excavations of mud pits associated with well construction, exploration drilling, and delineation drilling activities, topsoil is separated from the subsoil with a backhoe. The topsoil is first removed and then placed at a separate location. The subsoil is then removed and deposited next to the mud pit. When the use of the mud pit is complete (usually within 30 days of initial excavation), the subsoil is then redeposited in the mud pit followed by the replacing of the topsoil. Pipeline ditch construction will follow a similar path with the topsoil stored separately

from the subsoil with the topsoil deposited on the subsoil after the pipeline ditch has been backfilled. These methods of topsoil salvaging have proven to be adequate as demonstrated by the successful revegetation and reclamation at prior and existing ISR operations.

6.2.4 Vegetation Reclamation Practices

All revegetation practices will be conducted in accordance with the WDEQ-LQD regulations and the methods outlined in the mining permit. Topsoil stockpiles, along with as many as practical disturbed areas of the wellfield, will be seeded with vegetation throughout the mining operation to reduce wind and water erosion. Final revegetation of the mine area will consist of seeding the area with one final reclamation seed mix. Table 6-1 shows a typical seed mixture that will be used for reclamation. Seed mixtures are developed through discussions with the landowner **and the BLM (Hank Unit only) and** approved by the WDEQ-LQD. Changes to the seed mix requested by the landowner will be submitted to WDEQ-LQD for approval. A seeding rate of a minimum of 15 of pure live seed per acre will be used when using a rangeland drill. On areas where it is not practicable to use a drill, the seed will be broadcast at a rate of 30 pounds pure live seed per acre.

The success of the final revegetation will be determined by measuring the revegetation in meeting prior mining land use conditions and reclamation success standards as compared to the "Extended Reference Area" outlined in WDEQ-LQD Guideline No. 2. The Extended Reference Area allows for a statistical comparison of the reclaimed area with an adjacent undisturbed area of the same or nearly the same vegetation type. The area that the Extended Reference Area has to encompass needs to be at least one half the size of the reclaimed area that is being assessed or at least no smaller than 25 acres in size.

In choosing the Extended Reference Area, the WDEQ-LQD will be consulted. This will ensure that the Extended Reference Area adequately represents the reclaimed area being assessed. The success of the final revegetation and final bond release will be determined by the WDEQ-LQD.

Table 6-1 Uranerz Reclamation Seed Mixture.

Species	Percent of Mix	Pounds PLS/acre
Western Wheatgrass	28	4.2
Revenue Slender Wheatgrass	28	4.2
Bozoisky Russian Wildrye	19	2.85
Greenleaf Pubescent	9	1.35
Gulf Annual Ryegrass	6	0.9
Yellow Blossom Sweet Clover	5	0.75
Ladak 65 Alfalfa	5	0.75
Species that may be substituted for or added to the above mix		
Pubescent Wheatgrass	**19**	**2.85**
Intermediate Wheatgrass	**15**	**2.0**

Table 6-2 BLM Seed Mix Used for Surface Areas at the Hank Unit.

Species	Percent of Mix	Pounds PLS/acre
Western Wheatgrass	**37**	**5.5**
Thickspike Wheatgrass	**20**	**3.0**
Green Needlegrass	**10**	**1.5**
Slender Wheatgreat	**20**	**3**
Needle and Thread	**10**	**1.5**
Purple Prairie Clover	**3**	**0.5**

6.2.5 Road Reclamation

6.2.5.1 Access Roads

Two access roads will be built to connect both the Nichols Ranch central processing plant (CPP) and the Hank satellite plant with the existing ranch roads. The length of the Nichols Ranch CPP road is approximately 0.20 mi in length. The Hank satellite plant road will also be approximately 0.20 mi in length. If the landowner desires, the roads will be left in place when operations are complete. If not, the roads will be reclaimed. Even if the roads are left in place, third party reclamation costs will be included in the reclamation bond estimate.

If the access roads are to be reclaimed, the first step will be to pick up and remove the scoria/gravel on the road surface. Once the scoria/gravel has been removed the roadbed will be disced or ripped. Next, the topsoil stored in the ditch will be re-applied on the road surface. Finally, the road surface will be mulched and seeded with the permanent seed mixture.

those areas. The surety estimates are revised annually, via the Annual Report, to provide an update of the surety calculations and to assess the adequacy of the current bond.

Groundwater restoration costs for the Nichols Ranch Unit are based on the treatment of one pore volume of groundwater sweep and 6 pore volumes of treatment using reverse osmosis. The calculation for pore volume is as follows:

> Pore Volume = (Affected Ore Zone Area) x (Average Well Completed Thickness) x (Flare Factor) x (Porosity).

The number of pore volumes needed to restore a production area can vary from operation to operation or from wellfield to wellfield. As seen by COGEMA, who is located just a few miles to the north-northwest of the Nichols Ranch ISR Project and who has operated in very similar formations and conditions as the Nichols Ranch ISR Project; the number of pore volumes needed to restore Wellfieds 1-9, that were fully operational on a commercial scale, has varied from 9.5 to 18.4 with an average of 14.6. Other Wyoming ISR operations such as the commercial Bison Basin ISR uranium project needed just six pore volumes to achieve restoration; while the Reno Creek R&D uranium project successfully restored the groundwater without RO by using ten pore volumes in both confined and unconfined settings. Based on these operations and the restoration techniques that will be used by Uranerz Energy Corporation, the number of pore volumes that Uranerz estimates that will be needed to restore the partial operating Production Area 1 in the first year of operation at the Nichols Ranch Unit has been modified to seven pore volumes, one pore volume groundwater sweep and six pore volumes circulated through an RO unit. **The Jane Dough Unit being similar in nature to Nichols Ranch Unit, with regard to production, flare factor, porosity, and average well completed thickness; it is estimated to require the same pore volumes as Nichols Ranch for restoration.**

Along with researching the number of pore volumes used at other commercial and R&D operations, the flare factor for a typical ISR operation can be anywhere from 1.3 as seen and approved for the HRI Churchrock ISR operations in New Mexico; to 1.5 to 1.7 as modeled using MODFLOW and MODPATH by PRI's Smith Ranch wellfields. COGEMA's Irigaray/Christensen Ranch sites have used an overall flare factor of 1.44. Knowing that flare factor can be influenced by such things as well completion, but also taking into account the flare

factors that have been used at operating commercial ISR operations that are adjacent to the Nichols Ranch ISR Project and operate in very similar sandstone formations and deposits along with conduction Numerical Modeling for both units (found in Addendums 3B and 3C), Uranerz will be using a flare factor of 1.45 for the Nichols Ranch Unit for the surety estimates attached in Addendum 6B. For the Hank Unit a flare factor of 1.89 will be used.

Porosity values used in the surety estimate are based on total porosity of the Nichols Ranch, Hank, **and Jane Dough** Units. Although, in places, a porosity of 0.05 is used in the application, this porosity is used in only discussion about effective porosity. The effective porosity values for the A and F Sands of 0.05 was used for calculation of groundwater velocity. A total porosity is more appropriate for the restoration pore volumes than for the effective porosity. The effective porosity for groundwater velocity estimates was conservatively estimated from the lithologic materials at the two sites. A smaller effective porosity results in a conservatively higher groundwater velocity. The porosity value in the surety estimate has been revised to 0.3 for consistency.

use, and ecological systems are minor and temporary as seen by the past and current in situ recovery operations that are located in the areas near the proposed project and in currently operating facilities in Wyoming, Nebraska, and Texas.

7.2.1 Surface Water Impacts

Surface water impacts that result from the Nichols Ranch ISR Project are considered to be nonexistent to minimal. Any impacts that might arise to surface water from the Nichols Ranch ISR Project will be temporary.

Surface water for the Nichols Ranch ISR Project is limited to four identified jurisdictional wetlands located on the Nichols Ranch Unit. These wetlands are in such locations that they will not be disturbed by the mining activities. In the event that any disturbance would occur in a jurisdictional wetland, consultation with the Corp of Engineers would be initiated to establish mitigation and control plans. The attached Appendix D10 **and JD-D10** provides more information regarding the wetlands.

The potential for erosion and potential movement of sediments into drainages may occur during construction and reclamation activities associated with processing facilities and wellfield. Berms and contouring when and where possible will be utilized to minimize potential erosion and sediment movement. Re-seeding with native seed mixture or cover crops will also occur upon completion and reclamation of the project area. Re-seeding of an area will take place during the appropriate growing seasons, either spring or fall, whichever comes first.

Surface water runoff should not be affected by the presence of any surface facilities including the wellfields and associated structures, access roads, office and maintenance buildings, pipelines, and processing facilities (both main and satellite facilities). In the event that surface runoff flows are impeded by any facilities, culverts and diversion ditches will be implemented to control the runoff and prevent excessive erosion. If the surface runoff is concentrated in an area, measures such as energy dissipaters will be used to slow the flow of the runoff so that erosion and sediment transportare minimized. Figure 2-15 of Chapter 2.0 provides a map of the surface drainage areas for the Nichols Ranch ISR Project.

The topography shown in Figure JD-D6-1 controls the surface pathways that could possibly result in transport of solution spills, with the delineated drainage areas representing general boundaries for this surface flow. Surface flow inside the drainage divide for local drainages JDA3 through JDA6 would flow down to the drainage channel within each of the areas and eventually flow to Cottonwood Creek if the flow is large enough to exceed the infiltration rate along the wetted pathway. The surface pathway for drainage JDA2 would be similar, but would eventually flow to the Dry Fork of the Powder River while the local drainage from JDA1 would enter Seventeen Mile Creek which is also a tributary to the Dry Fork.

7.3.1.1 Exposures from Water Pathways

The extraction solutions in the ore zone will be monitored and controlled to detect and prevent migration from the production zone. The monitoring and controls are described in Section 5.7.8 of this report.

The method of liquid waste disposal at the facility will be by deep disposal well. The deep disposal well(s) will be completed at depths significantly deeper than zones planned for mining and current CBM operations and will be isolated geologically from underground sources of drinking water. The deep disposal well(s) are described in Sections 3.2.6 of this report.

The uranium ion exchange, precipitation, drying and packaging facilities will be located on curbed, re-inforced concrete pads to prevent liquids from entering the environment. Solutions collected on these pads including water; used to wash down equipment, and accidental spills drain to a sump collection network and are either pumped back into the process circuit or to the disposal well.

No liquid effluents will be discharged to surface water. There are no surface waters on either site. Thus no definable water related pathways exist for routine operations.

7.3.1.2 Exposures from Air Pathways

Release rates of airborne radioactivity were estimated for the Nichols Ranch ISR Project. Dose commitments received by individuals and the general population within an 80 km radius of the site were estimated from atmospheric dispersal of such radioactivity with respect to **site-specific** meteorological data. Only airborne releases of radon are considered. Particulate emissions are not considered since such releases are not expected under normal operating conditions for vacuum dryers.

Table 7-3 Nearest Residents to Nichols Ranch Central Processing Plant.

Nearest Residence	Number of Inhabitants	Distance from mill center km		Elevation from mill center z m
		x(E)	y(N)	
T-Chair (Rolling Pin) Ranch	5	3.7	-2.2	-7
Dry Fork Ranch	3	-2.7	-1.1	-58
Christensen Ranch	1	1.8	7.8	-1
Pfister Ranch	3	7.8	7.4	78
Pumpkin Butte Ranch	2	11.1	3.6	218
Van Buggenum Ranch	0	15.4	5.3	130
Ruby Ranch	2	19.0	2.9	101
Hank Satellite Plant	0	7.9	3.5	121

Table 7-4 Center of Site Boundary from Nichols Ranch Central Processing Plant.

Location		**Distance from mill center** (km)		**Elevation from mill center** z (m)
		x(E)	**y(N)**	
Nichols Ranch	- north central	-0.4	1.3	57
	- east central	0.6	0.2	-2
	- south central	-0.3	-1.1	-18
	- west central	-1.4	0.5	12
Hank	- north central	7.9	6.6	86
	- east central	8.8	3.3	160
	- south central	7.9	1.3	139
	- west central	7.1	4.2	102
Jane Dough	- north central	0.4	-1.1	-15
	- east central	2.2	-3.2	35
	- south central	0.4	-5.6	18
	- west central	-1.0	-3.2	35

7.3.1.2.4 Time Parameters

The dose commitments were completed for development, production, and restoration of wellfields for the operating years 2014 through 2023. The respective schedule is provided in **Figure 3-12.**

The time parameters were input as:

- Beginning Year: **2014.**
- Number of Time Steps: 9.
- Time Increment: 1 year.
- Population Adjustment: 1.2 (see "Population Distribution")
- Source Adjustment: varied per source to reflect development, production, and restoration schedule of **Figure 3-12.**

7.3.1.2.5 Food Pathway Parameters

The MILDOS code requires four inputs to describe the feeding habits of livestock near the sites. The inputs used to describe the fraction of total annual livestock feed requirements are:

- Pasture Grass/Individual: 0.5 (default)
- Pasture Grass/Population: 0.5 (default)
- Hay/Individual: 0.5 (default)
- Hay/Population: 0.5 (default)

The MILDOS code also requires input of the areal food-production rate per unit area around the facility. The inputs used are:

- Vegetables: 3120 $kg/y\text{-}m^2$
- Meat: 345 $kg/y\text{-}m^2$
- Milk: 134 $kg/y\text{-}m^2$

7.3.1.2.6 Meteorological Parameters

The meteorological parameters for the MILDOS code were input as:

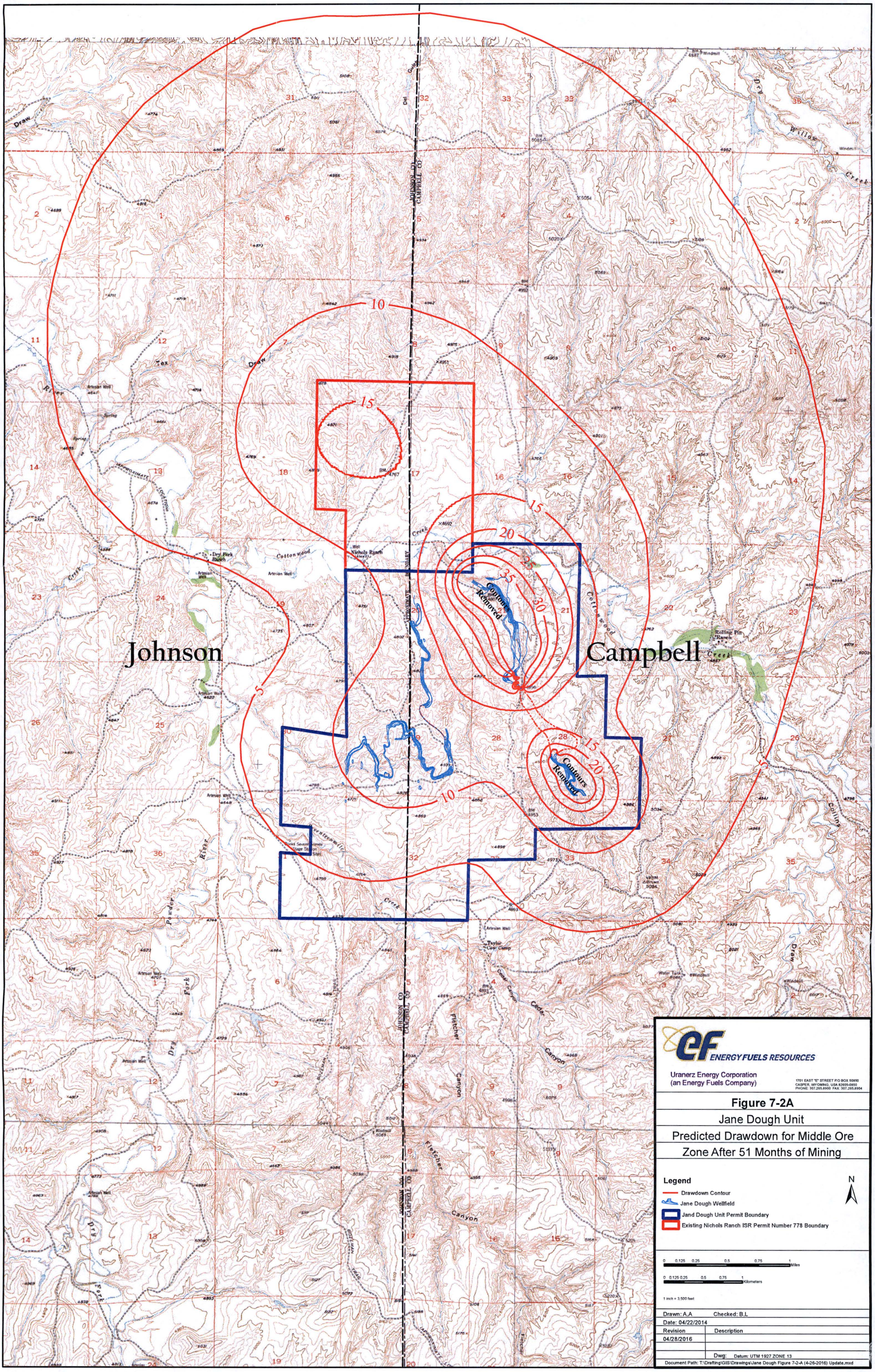
- The annual average morning and afternoon mixing heights each as the code default of 100 m
- The Briggs height cutoff vertical dispersion coefficient as the code default of 50 m
- **The fractional joint frequency distribution of wind speed, direction, and stability for an on-site meteorological station. This information is presented in Appendix JD-D4 (Addendum JD-D4-A).**

7.3.1.2.7 Source Terms

The parameters and values used to develop the source terms and the resulting annual releases are listed in Tables 7-6, 7-7, and **7-7a** for Nichols Ranch, Hank Units, **and Jane Dough Unit**, respectively. The respective source terms determined by MILDOS are included in these tables.

The fraction of radon attributable to the site was input as one for Casper, Wyoming.

A source term for release of particulates from drying and packaging activities was not developed since no particulate emissions are expected under normal operating conditions for vacuum dryers.



Johnson
Campbell
Contours Removed
Contours Removed
10
15
20
25
30
35
5
Nichols Ranch
Cottonwood
Creek
Powder
River
Rolling Pin Ranch
Dry Fork Ranch
Fletcher
Canyon
JOHNSON CO. CAMPBELL CO.
ENERGY FUELS RESOURCES
Uranerz Energy Corporation
(an Energy Fuels Company)
1701 EAST "E" STREET P.O BOX 50850
CASPER, WYOMING, USA 82605-0850
PHONE: 307.265.8900 FAX: 307.265.8904
Figure 7-2A
Jane Dough Unit
Predicted Drawdown for Middle Ore
Zone After 51 Months of Mining
Legend
Drawdown Contour
Jane Dough Wellfield
Jand Dough Unit Permit Boundary
Existing Nichols Ranch ISR Permit Number 778 Boundary
N
0 0.125 0.25 0.5 0.75 1 Miles
0 0.125 0.25 0.5 0.75 1 Kilometers
1 inch = 3,500 feet
Drawn: A.A
Checked: B.L
Date: 04/22/2014
Revision
Description
04/28/2016
Dwg: Datum: UTM 1927 ZONE 13
Document Path: T:\Drafting\GIS\Drawings\Jane Dough Figure 7-2-A (4-26-2016) Update.mxd

Table 10-1**a** Permit and Licenses for the **Jane Dough Unit.**

Permit, License, or Approval Name	**Agency**	**Status**
Permit to Appropriate Groundwater	SEO	Existing wells are approved, new well permits will be filed prior to drilling
DEQ Drilling Permit	WDEQ-LQD	In Possession, No. **378**DN
WYPDES	WDEQ-WQD	In Possession
Permit to Construct Septic Leach Field	County	In Possession
Air Quality Permit	WDEQ-AQD	In Possession, CT-8644

Notes:

WDEQ-LQD - Wyoming Department of Environmental Quality - Land Quality Division
WDEQ-WQD - Wyoming Department of Environmental Quality - Water Quality Division
WDEQ-AQD - Wyoming Department of Environmental Quality - Air Quality Division
SEO - State Engineer's Office

Method Used to Determine Atmospheric Stability Classes

IML used the σ_θ method was used to determine the Pasquill-Gifford stability class, where σ_θ refers to the standard deviation of the horizontal wind azimuth angle in degrees. This method is also referred to as the σ_A method in EPA's Meteorological Monitoring Guidance for Regulatory Modeling Applications (February 2000). It is a lateral turbulence based method which uses the standard deviation of the wind direction in combination with the scalar mean horizontal wind speed. Wind speed and direction data are recorded hourly at a height of 10 meters. To minimize the effects of wind meander, the 1-hour σ_θ is defined using 15-minute σ_θ values which are in turn based on more frequent sampling of wind direction (e.g. every five seconds). According to this method, initial stability classes are assigned based solely on standard deviation of wind direction, or σ_θ. The initial assignments are then adjusted for horizontal wind speed. The magnitude of this adjustment depends on whether the measurement is taken during daylight or nighttime hours, a diurnal dependency that varies with the time of year.

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1.3 THE PROPOSED ACTION

The Jane Dough Unit is located in the Pumpkin Buttes Mining District of the Powder River Basin in the state of Wyoming in the counties of Johnson and Campbell. The recovered uranium would be transported via pipelines to the central processing plant in the Nichols Ranch Unit where the uranium would be processed. **Additional discussion of pipelines (e.g. materials used, decommissioning/decontamination practices, financial assurance) is provided in the Technical Report.**

The Jane Dough Unit contains approximately 3,680 acres. The project site is approximately 46 air mi south/southwest of Gillette, Wyoming and approximately 61 air mi to the north/northeast of Casper, Wyoming. The general location of the project is shown in Figures 1-1 and 1-3 (see map pocket) of the Technical Report.

Extraction of the uranium ore contained in the Wasatch formation of the Powder River Basin would be through the in situ recovery method of mining. A sodium carbonate/sodium bicarbonate solution and an oxidizing agent such as oxygen would be injected and recovered through a complex of well patterns. 4-spot, 5-spot, and 7-spot well patterns would be used in the ore recovery process. The wellfield at the Jane Dough Unit is divided into production areas. Construction for each production area is estimated to take approximately one year and each area would require approximately six months to ramp up to full production. It will take an estimated 3-4.25 years to extract the uranium from the Jane Dough Unit.

The NRC has approved the licenses for the Uranerz central processing plant and the plant is on-line except for final processing and drying. The central processing plant has a nameplate capacity to produce 2,000,000 pounds per year of U_3O_8 (yellowcake). Once the uranium has been "loaded" onto resin beads, the uranium could be processed to yellowcake at the central processing plan or it could be transported via trucks to Cameco Resources Inc.'s Smith Ranch-Highland central processing plant for the processing of yellowcake. Cameco Resource Inc.'s Smith Ranch-Highland central processing plant is located about 17 miles north of Glenrock Wyoming in east-central Wyoming. Uranerz and Cameco Resources Inc. entered into an agreement in 2013 in which Uranerz could transport uranium-loaded resin beads to Cameco Resource Inc.'s Smith Ranch-Highland CPP, if needed. Uranerz is also approved by NRC for its own dryer and will also

use its own dryer in the Nichols Ranch CPP should this equipment be installed. Initially, Uranerz will transport uranium-loaded resin beads from the Nichols Ranch CPP to Cameco Resource Inc.'s Smith Ranch Highland CPP but at some point this activity would not be necessary or conducted.

Once mining is completed in a production area, reclamation of that production area would begin. Figures 3-11(see map pockets) of the NRC Technical Report show the production areas for the Jane Dough Unit. Groundwater would be restored to its pre-mining conditions (as is reasonably achievable) or to its class of use by utilizing groundwater restoration methods such as groundwater sweep, groundwater transfer, and reverse osmosis. Groundwater reclamation is anticipated to take approximately three years from start to finish. Solid material such as pipelines, buildings, etc. would either be reused in different production areas or decommissioned and removed for disposal at a NRC licensed disposal facility or nearby landfill.

1.4 APPLICABLE REGULATORY REQUIREMENTS, PERMITS, AND REQUIRED CONSULTATIONS

Various state and federal permits and licenses that are needed or are in-hand for the Nichols Ranch ISR Project are listed in Chapter 10.0, Table 10-**1** of the Uranerz, Nichols Ranch ISR Project NRC Source Material License Application Technical Report. Prior to the start of mining (the injection of lixiviant into the ore zone aquifer), Uranerz would obtain all permits, licenses, and approvals required by the WDEQ and the NRC. The list of additional state and federal permits and licenses required for the Jane Dough Unit is listed in Table 10-**1a** in the Nichols Ranch ISR Project NRC Source Material License Application Technical Report.

The general area of the Jane Dough Unit has also been subject to numerous federal environmental reviews over the past few years. The Nichols Ranch ISR project area (without the Jane Dough Unit) was subject to an environmental impact statement (EIS) completed by the NRC in 2011. In addition, the Bureau of Land Management (BLM) is currently preparing an environmental assessment (EA) for the Hank Unit due to separate jurisdictional requirements associated with BLM-administered lands in the Hank Unit. With the presence of coalbed methane (CBM) extraction on the land in and adjacent to the permit boundary of the Jane Dough Unit, the area has

system. In addition to engineering controls, employees who are in the wellfields on a daily basis are trained to observe routinely the condition pipelines and wellheads. Leaks or breaks would be reported immediately. In the event of a break, the wetted area would be surveyed, sampled, and recorded on a spill map. Soils with significantly elevated levels of uranium and radium-226 would be removed and disposed at a licensed site.

Knowing that potential impacts are attributed to pipeline ruptures and leaks, the pre-operational sampling program was designed to thoroughly characterize radiological baseline conditions in the areas most likely to experience potential impacts. A review of Exhibit **JD-D11-2, Radiological Sample Location** Map in the attached Appendix JD-D11 clearly shows that the focus of the baseline characterization was on the wellfield areas and the intermittent/ephemeral streams passing through the license area. A close examination of the map shows that sediment samples were collected from upstream and downstream locations in all of the streambeds. In addition to thoroughly sampling the wellfields and water courses, the radiological baseline was supplemented by including samples from areas within the license area (see sample sites labeled LAS on the map), the process facility location and the Rn-222/Gamma monitoring stations. Again, using Regulatory Guide 4.14 for general guidance, all soils and sediments were analyzed for Ra-226 and a large percentage of the total number of samples included analyses for U, Pb-210 and Th-230. In brief, the extensive coverage of the sampling effort provides a representative radiological baseline against which operational activities can be measured.

6.1.1.2 Sampling Methodology

The sample site map and coordinates described above, guided field personnel to the sample site locations. Surface and subsurface soils were collected with a 3-inch diameter bucket auger. Surface soils were collected from surface to a depth of 6-inches, and subsurface soils were collected in 12-inch increments to a total depth of 36 inches. The depth increments generally follow Regulatory Guide 4.14.

To avoid cross-contamination, the sampler and other tools were cleaned after each use using paper towels and de-ionized water. Samples were placed in 1-gallon plastic freezer bags and stored in

Table ER6-8 Gamma Survey Results: Jane Dough Unit.

Sample Site	Gamma (μR/hr)	Sample Site	Gamma (μR/hr)	Sample Site	Gamma (μR/hr)
Random 1*	14	SS-1	14	SD-1	15
Random 2*	16	SS-2	14	SD-2	14
JD-1	14	SS-3	15	SD-3	15
JD-2	14	SS-4	15	SD-4	17
JD-3	16	SS-5	15	SD-5	15
JD-4	13	SS-6	16	SD-6	16
JD-5	13	SS-7	15	SD-7	18
JD-6**	15	SS-8	14	SD-8	15
JD-7**	15	SS-9	14	SD-9	17
LAS-1	15	SS-10	16	SD-10	17
LAS-2	16	SS-11	15	SD-11	16
LAS-3	16	SS-12	16	SD-12	15
LAS-4	14	SS-13	14	SD-13	17
LAS-5	15	SS-14	15	SD-14	16
LAS-6	14	SS-15	15	SD-15	14
LAS-7	14	SS-16	16	SD-16	14
LAS-8	15	SS-17	14	SD-17	18
LAS-9	15	SS-18	14	SD-18	15
LAS-10	13	SS-19	14	SD-19	16
LAS-11	16	SS-20	13	--	--
LAS-12	14	SS-21	14	--	--
LAS-13	17	SS-22	15	--	--
LAS-14	14	SS-23	14	--	--
SB-1	15	SS-24	15	--	--
SB-2	15	SS-25	15	--	--
SB-3	15	SS-26	15	--	--
SB-4	15	SS-27	16	--	--
SB-5	15	SS-28	14	--	--
SB-6	15	SS-29	13	--	--
SB-7	14	SS-30	15	--	--
SB-8	15	SS-31	13	--	--
SB-9	16	SS-32	14	--	--
SB-10	14	SS-33	15	--	--
SB-11	15	SS-34	15	--	--
SB-12	16	SS-35	16	--	--
SB-13	16	SS-36	16	--	--
--	--	SS-37	14	--	--
--	--	SS-38	15	--	--
--	--	SS-39	16	--	--
--	--	SS-40	15	--	--
--	--	SS-41	15	--	--
Sample Site	**JD**	**LAS**	**SB**	**SS**	**SD**
Average	**14.3**	**14.9**	**15.1**	**14.7**	**15.8**
Minimum	**13**	**13**	**14**	**13**	**14**
Maximum	**16**	**17**	**16**	**16**	**18**

Notes: *Random 1 and 2 are additional vegetation sample sites.
**Nearest residences.
JD-1 through 7: gamma exposure rate/air/vegetation sample sites.
SS: Surface Soil Site
SB: Subsurface Soil Site
SD: Sediment Sample Site
LAS: License Area Sample Site
See Exhibit JD-D11-2 for sample site locations.

Based on the existing land use, samples were collected from wildlife browsing/grazing areas (Random-1 and Random-2 sites); the nearest residences (JD-6 and JD-7); and at the Rn-222/gamma/air monitoring sites (JD-1 through JD-5). Exhibit JD-D11-2 shows the sample site locations. Samples were collected on September 29, 2011 and delivered to the laboratory on September 30, 2011. While collecting the samples, care was taken to clip the vegetation approximately one inch above the ground to avoid mixing with surface soil. All samples were analyzed for Uranium, Ra-226, Pb-210 and Th-230.

6.1.4.3 Results for the Jane Dough Unit

Table ER6-11 provides a summary of the laboratory analyses. Although there is the usual variation, the values are within normal background ranges. To illustrate the consistency in the background values, a comparison was made with the baseline previously established for the Nichols Ranch and Hank Units. As can be seen from the Table ER6-12, the averages for all three sites are in close agreement. A single, somewhat higher Ra-226 value of 3.7E-04 µCi/kg, which was collected at sample site R-1 Dry Fork Ranch while developing the Nichols Ranch Unit baseline explains the higher average Ra-226 level in the table.

Table ER6-11 Radiological Baseline Values in Vegetation: Jane Dough Unit.

Sample Site	Ra-226 (µCi/kg)	Pb-210 (µCi/kg)	Th-230 (µCi/kg)	Uranium (µCi/kg)
JD-1	4.3E-06 +/- 8.9E-07	2.1E-04 +/- 4.7E-06	2.1E-06 +/- 3.0E-06	2.7E-05 +/- 3.7E-07*
JD-2	1.1E-05 +/- 1.6E-06	5.8E-04 +/- 8.7E-06	7.4E-06 +/- 4.7E-06	5.5E-05 +/- 2.0E-07*
JD-3	2.4E-05 +/- 2.5E-06	7.4E-04 +/- 1.0E-05	2.5E-05 +/- 8.9E-06	5.8E-05 +/- 2.0E-07*
JD-4	8.4E-06 +/- 1.6E-06	4.1E-04 +/- 8.4E-06	5.5E-06** +/- 4.7E-06	5.9E-05 +/- 2.0E-07*
JD-5	1.0E-05 +/- 1.6E-06	2.1E-04 +/- 6.7E-06	6.6E-06 +/- 4.5E-06	3.4E-05 +/- 2.0E-07*
JD-6	6.9E-06 +/- 1.4E-06	2.4E-04 +/- 7.4E-06	9.4E-06 +/- 6.0E-06	1.2E-05 +/- 2.0E-07*
JD-7	5.5E-06 +/- 1.5E-06	1.9E-04 +/- 8.3E-06	9.1E-06 +/- 6.8E-06	5.5E-05 +/- 2.0E-07*
Random-1	1.2E-05 +/- 2.0E-06	9.5E-04 +/- 1.3E-05	3.8E-05 +/- 8.8E-06	8.2E-05 +/- 2.0E-07*-
Random-2	1.9E-05 +/- 2.3E-06	6.1E-04 +/- 1.0E-05	2.4E-05 +/- 6.6E-06	9.7E-05 +/- 2.0E-07*
Average	**1.1E-05**	**4.6E-04**	**1.5E-05**	**5.3E-05**

*Reporting limit.
See Exhibit JD-D11-2 for sample site locations.

in Table ER6-13. These parameters are those that are required by the Wyoming Department of Environmental Quality in determining baseline groundwater quality. The results of the regional baseline water quality sampling are detailed in Addendum D6E of the attached Appendix D6. Additionally, Section 2.7 of the NRC Technical Report summarizes the groundwater quality information obtained during baseline groundwater sampling.

6.2.1.2 Pre-Operational Wellfield Assessment

The groundwater monitoring program for the Jane Dough Unit would begin with pre-operation wellfield testing. These tests are conducted utilizing the baseline geologic and hydrologic information that was collected and assembled for Jane Dough Unit. Appendix D5 and D6 this application contains the baseline geologic and hydrologic information.

By using the detailed geologic and hydrologic information, monitoring zones can be defined, geologic and hydrologic parameters quantified, wellfields planned, hydrologic monitoring programs developed, and baseline water quality sufficiently determined. This information would then be utilized for prevention and/or detecting excursions of lixiviant outside of the wellfield or into the underlying or overlying aquifers.

6.2.1.3 Monitor Well Spacing

The density and spacing of monitor wells for the Nichols Ranch Unit and the Hank Unit is determined during the geologic and hydrologic assessment of a proposed wellfield. Monitor wells would be installed in the ore zone at a density of one monitoring well per four acres in the proposed wellfield. These wells would be used to obtain baseline water quality data for the proposed wellfield to determine groundwater Restoration Target Values (RTV's).

Horizontal monitor wells would also be installed on the edge of the wellfield in the same zone as the ore zone. This "ring" of wells would be used to obtain baseline water quality data in the area were determined using a groundwater flow model and estimated hydrologic properties for the proposed wellfield. This distance also takes into consideration that if an excursion were to occur, processing fluids could be controlled within 60 days as required by the WDEQ.

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time that uranium was emplaced, as is true today, the groundwater in the Powder River Basin generally flowed to the north and northwest. As the original uranium charged groundwater flowed in the host sands, the chemical reductant was consumed and the roll fronts migrated down the hydrologic gradient leaving in their wake, a characteristic yellow to red to brown stain on the sandstone grains (see Figure JD-D5-a in map pocket). As many as 11 separate roll front systems have been identified in different horizons of the Wasatch Formation in the Powder River Basin area. A diagram of stacked roll fronts is depicted in Figure JD-D5-b (map pocket).

JD-D5.2 REGIONAL GEOLOGY

The Jane Dough Unit is located in the Powder River Basin (PRB) which is a large structural and topographic depression parallel to the Rocky Mountain trend. The basin is bounded on the south by the Hartville Uplift and the Laramie Range, on the east by the Black Hills, and the Big Horn Mountains and the Casper Arch on the west. The Miles City Arch in southeastern Montana forms the northern boundary of the basin.

The PRB is an asymmetrical syncline with its axis closely paralleling the western basin margin. During sedimentary deposition, the structural axis (the line of greatest material accumulation) shifted westward resulting in the basin's asymmetrical shape. On the eastern flank of the PRB, sedimentary rock strata dip gently to the west at approximately 0.5 to 3.0 degrees. On the western flank, the strata dip more steeply, 0.5 to 15 degrees to the east with the dip increasing as distance increases westward from the axis. The Jane Dough Unit location in the PRB is shown in Figure JD-D5-1 (see map pocket).

The PRB hosts a sedimentary rock sequence that has a maximum thickness of about 15,000 ft along the synclinal axis. The sediments range in age from Recent (Holocene) to early Paleozoic (Cambrian - 500 million to 600 million years ago) and overlie a basement complex of Precambrian-age (more than a billion years old) igneous and metamorphic rocks. Geologically, the PRB is a closed depression in what was, for a long geologic time period, a large basin extending from the Arctic to the Gulf of Mexico. During Paleozoic and Mesozoic time, the configuration of this expansive basin changed as the result of uplift on its margins.

By late Tertiary - Paleocene time, marked uplift of inland masses surrounding the Powder River Basin resulted in accelerated subsidence in the southern portion of the basin with thick sequences of arkosic (containing feldspar) sediments being deposited. Arkosic sediments were derived from the granitic cores of the Laramie and Granite Mountains exposed to weathering and erosion by the Laramide uplift. Near the end of Eocene time, northward tilting and deep weathering with minor erosion took place in the basin. Subsidence resumed in the late Oligocene and continued through the Miocene and into the Pliocene. A great thickness of tuffaceous sediments were deposited in the basin during at least a part of this period of subsidence. By the late Pliocene, regional uplift was taking place, leading to a general rise in elevation of several thousand feet. The massive erosional pattern that characterizes much of the PRB began with the Pliocene uplift and continues to the present. Of particular interest in the project area are the Tertiary-age formations:

FormationAge (Million Years)
White River (Oligocene)25-40
Wasatch (Eocene)40-60
Fort Union (Paleocene)60-70

The White River Formation is the youngest Tertiary unit that still exists in the PRB. Locally, it's only known remnants are found on top of the Pumpkin Buttes. Elsewhere the unit consists of thick sequences of buff colored tuffaceous sediments interspersed with lenses of fine sand and siltstone. A basal conglomerate forms the resistant cap rock on top of the buttes. This formation is not known to contain significant uranium resources in this area.

The Wasatch Formation is the next unit down and consists of interbedded mudstones, carbonaceous shales, silty sandstones, and relatively clean sandstones. In the vicinity of the Pumpkin Buttes, the Wasatch Formation is known to be 1,575 ft thick (Sharp and Gibbons, 1964). The interbedded mudstones, siltstones, and relatively clean sandstones in the Wasatch vary in degree of lithification from uncemented to moderately well-cemented sandstones, and from weakly compacted and cemented mudstones to fissile shales. The Wasatch contains

significant uranium resources and hosts the ore bodies for which this permit application is subject to.

The next unit is the Fort Union Formation. In the PRB this unit is lithologically similar to the Wasatch Formation. The Fort Union includes interbedded silty claystones, sandy siltstones, relatively clean sandstones, claystones, and coal. The degree of lithification is quite variable, ranging from virtually uncemented sands to moderately well-cemented siltstones and sandstones. The total thickness of the Fort Union in this area is approximately 3,000 ft. The Fort Union contains significant uranium mineralization at various locations in the basin. The Fort Union is also the target formation for Coal Bed Methane (CBM) extraction activities. CBM target depths in the Jane Dough Unit are about 1,000 and 1,200 ft. Since CBM wells have their casings cemented to the surface, no or little interference, water loss, or water invasion is anticipated other than for localized areas. Addendum JD-D6H further discusses CBM.

Maps of the surface and sub-surface geology of the Powder River Basin are depicted in Exhibits JD-D5a and JD-D5b (see map pockets).

JD-D5.3 SITE GEOLOGY

<u>Depositional Environment: Jane Dough</u>

In the Pumpkin Buttes Mining District, the Eocene Wasatch Formation hosts the geologic setting for uranium mining at the Jane Dough Unit. The Wasatch Formation in this area was deposited in a multi-channel fluvial and flood plain environment. The climate at the time of deposition was wet tropical to subtropical with medium stream and river sediment load depositing a majority of medium grained materials. The source of the sediments, as evidenced by abundant feldspar grains in the sandstones, was the near-by Laramie and Granite Mountains (see Figure JD-D5-1a).

At the Jane Dough Unit location, there are eight identified fluvial sandstone horizons or units. Beginning with the deepest unit they are the 1, A, B, C, F, G and H Sand units which are

stratigraphically the same as at Nichols Ranch ISR (see Figure JD-D5-2). Separating the sand units are horizons composed of siltstones, mudstones, carbonaceous shales and poorly developed thin coals. These fine-grained materials were deposited in flood plain, shallow lake (lacustrine) and swamp environments. Ultimately, deposition of the Wasatch Formation was a function of stream bed load entering the basin and subsidence from within the basin. However, in the central part of the Powder River Basin, long periods of balanced stability occurred. During these periods the stream gradients were relatively low and allowed for development of broad (0.5 to 6.0 mi wide) meander belt systems, associated overbank deposits, and finer grained materials in flood plains, swamps and shallow bodies of water. Evidence for depositional stability exists as a number of coal bed markers with little or no channel scouring are in contact with the major sand horizons (Davis, 1970). The A Sand at Jane Dough is in close proximity to basal lignite and carbonaceous shales.

In a fluvial meandering stream process, the flow channel is sinuous in plan view with the highest flow energy concentrated on the outside edge of the channel as it turns through a meander. This results in cutting into the outside channel wall and caving material into the channel especially during flooding. In cross section view, the outside edge of a meander is the steepest and the inside of the meander is sloped more gently. The inside edge of a meander is where deposition takes place. Finer materials are deposited in the shallower (upper) slow flow region of the inside slope and coarser materials are deposited in the lower region. The major fraction of sand in the Wasatch Formation in the Pumpkin Buttes area is medium-grained with lesser fractions of coarse and fine grains. This is accompanied with mostly medium scale festoon cross bedding and current lamented cross bedding. These features can only be seen in cores. In a typical point bar sedimentation process, grain size and sediment structure fine upwards within a single point bar accumulation (see Figure JD-D5-2a).

The meandering stream environment is a process of cut and fill. Each time a cut occurs, the inside slope fills with sand and sediment. A single increment of this process results in a structure called a point bar and an accumulation of point bars is sometimes referred to as a meander belt. As the meander process progresses, meander loops eventually migrate down gradient in the direction of flow and can laterally spread out in almost any direction. The size of the complete

meander belt system is a function of the size of the valley or basin and stream flow rate, load and gradient. If the subsidence rate and stream load are in the proper proportion, successive layers of meander belts, or meander belt systems, may form as the stream channel wanders back and forth during subsidence.

Meander belts in the Wasatch formation are generally 5 to 30 ft thick. The A Sand at Jane Dough is made up of three to four stacked meander belts. Individual meander belt layers will rarely terminate at the same location twice. Meanders have been noted to frequently terminate in the interior of a belt system but are more likely to terminate somewhere closer to the edge of the meander stream valley. The net effect for fluvial sands is to generally thin away from the main axis of the meander belt system. The A Sand meander belt system at Jane Dough is four miles wide as at Nichols Ranch.

On an electric log resistivity curve, the grading is apparent where the curve sharply deflects from low to higher resistance and then gradually returns to lower resistance in an upward direction. Other meander belt system sand features such as overbank and crevasse deposits are present as fingers of sand that taper out from a meander termination. These are thin sands without a lot of grain size sorting. Inter –meander channel sands occur between meanders that are migrating in different directions. These sands have more uniform grain size and show on the electric log as a semi-flat curve with only small variations. Tributary and meander cut-off channel sand features form where pre-existing sediments are scoured by a river or stream and subsequently fill with medium and coarse sediments. These channels may cut randomly into meander belts, flood plain or swamp sediments (see Figure JD-D5-2b). On the electric resistivity log, channel fills have a massive semi-rounded signature.

Jane Dough Uranium Deposition

The A Sand at Jane Dough is the same stratigraphic unit as the A Sand at Nichols Ranch. The mineralization on the east and west sides of Jane Dough are a continuation of the same chemical cell which is to be mined at Nichols Ranch.

The Jane Dough Unit and Nichols Ranch Unit ISR Project are located in the Eocene Wasatch Formation about eight miles west of the South Pumpkin Butte and straddles the Johnson and Campbell County lines. The mineralized sand horizons are in the lower part of the Wasatch, at an approximate average depth of 550 ft. The host sands are primarily arkosic in composition, friable, fine- to coarse-grained and contain trace amounts of carbonaceous material and organic debris.

The ore body at the Jane Dough Unit is a typical Powder River Basin type roll front deposit. Uranium ore, where present, is found at the interface of a naturally occurring chemical boundary between reduced sandstone facies and oxidized sandstone facies. The ore body at the Jane Dough Unit forms roughly two lateral sides, an east side and west side, and are continuations of the Nichols Ranch uranium deposit. The interior area formed by the sides and nose is the chemically oxidized sandstone facies and the exterior of the area is the reduced sandstone facies. The east side of the mineralization appears to be curvilinear in form while the west side is irregular, having two sub-noses (penetrations) as shown in Figure JD-D5-3.

The uranium ore bearing sandstone unit on the east side of the Jane Dough Unit is composed of at least two vertically stacked subsidiary roll fronts. The roll fronts have been designated the middle and lower fronts. Stacked roll fronts develop due to small differences in sandstone permeability or from the vertical contact between successive meander loop sand accumulations. The lateral surface distance between stacked rolls ranges from 0 to over 200 ft and results in some overlapping patterns. The presence or absence of one or more of the sand channels creates the thin and thick areas on the A Sand Isopach Map (Exhibit JD-D5-18). The mineralization on the west side appears to be principally one roll front which occasionally splits into three sub-rolls, having only minor lateral separation between the sub-rolls. **All sub-rolls are contained in the same aquifer and are in near proximity to each other. Water quality will be the same for all mineralized zones.**

The Jane Dough Unit ore body has uranium mineralization composed of amorphous uranium oxide, sooty pitchblende, and coffinite. The uranium is deposited in void spaces between detrital sand grains and within minor authigenic clays. The host sandstone is composed of quartz, feldspar, accessory biotite and muscovite mica, and locally occurring carbon fragments. Grain size ranges from very fine- to very coarse sand but is medium-grained over all. The sandstone

are weakly to moderately cemented and friable. Pyrite and calcite are associated with the sands in the reduced facies. Hematite or limonite stain from pyrite, are common oxidation products in the oxidized facies. Montmorillonite and kaolinite clays from oxidized feldspars are also present in the oxidized facies.

There are five notable Wasatch Formation sand units in the Jane Dough Unit mining area. The sand members have been identified as G, F, B, A, and the 1 (one) Sand units. The G Sand unit is the shallowest and the 1 Sand unit is the deepest. The principle uranium ore bearing sand unit is the A Sand. The B Sand has been designated the overlaying aquifer in the southwest portion of the Jane Dough Unit and the 1 Sand the underlying aquifer. In the east and northwest portion of the Jane Dough Unit the B Sand rests directly on the A Sand. In these areas the C, F, or G Sands may be considered the overlying aquifer. The B Sand is wide spread over the nearly all of the unit area the 1 Sand is confined to deep cut channels cut into the 1A Mudstone. Both of the A and B Sand units thin to zero in the southwest.

The Jane Dough Unit A Sand ore body is bounded above and below by aquitards. In the southwest portion of the Unit area the AB Mudstone is the upper aquitard and the 1A Mudstone is the lower aquitard. The B Sand rests directly on the A Sand in the northwest and east portions of the Unit area. In these areas the B Sand will be combined with the A Sand and the next mudstone and sand above the top of the B Sand will be considered the upper aquitard and upper aquifer, respectively. The 1A Mudstone is the lower aquitard for the entire Unit area. The upper and lower aquitards are composed of shales or mudstones, silty shales and shaley lignitic horizons. Measured permeability of the mudstones and shales has been found to be less than 0.1 millidarcies whereas the permeability of the ore sands average between 250 and 2000 millidarcies **(Gentzler, E, Spoonemore, C. et al, 1980).**

Site geology and stratigraphy are summarized in cross section Exhibits JD-D5-1 through JD-D5-15 (see map pockets) for the Jane Dough Unit. These cross sections run north/south and east/west through the permit boundaries and ore bodies. The cross sections provide for correlation of the sand units, aquitards, and the nomenclatures utilized for the project areas. Figure JD-D5-2 details a typical stratigraphic column for the Jane Dough Unit.

Description of the Jane Dough Unit aquifers and aquitards are as follows:

Beginning with the lower monitor aquifer sand at the Jane Dough Unit, this unit has been designated the 1 (one) Sand. This sand is variable ranging from 0 to 75 ft in thickness and occurs at depths of 430 to 630 ft below the ground surface. The sand is very fine to coarse-grained and is gray in color in the Jane Dough Unit area. The 1 Sand is confined to incised valleys that cut into the 1A Mudstone. Two significant 1 Sand trends are mapped in the Jane Dough Unit area as shown on Exhibit JD-D5-**20**. This sand is defined by being over 10 ft thick and showing some continuity between test holes. The eastern channel runs to the north into the Nichols Ranch Unit (Nichols Ranch PA #1, Figure 2-12). The data from Jane Dough drilling suggests that it is on the order of one quarter to one half of a mile wide. The complete 1 Sand section can be seen in test hole U07D-01 (Exhibits JD-D5-7 and JD-D5-2) where the 1 Sand is 66 ft thick. No other holes were drilled completely through this interval but a few holes appear to have penetrated the top on this side of the property. On the west side the 1 Sand is observed in the test hole A36-31-016 log (Section CC; Exhibit JD-D5-3) where it is approximately 75 ft thick. This sand channel appears to also trend north-south on the west side of the mine unit. It is present in holes to the north but is not present to the east as seen in Exhibits JD-D5-12 and JD-D5-13.

Exhibits JD-D5-1 through JD-D5-15 are composed of electric logs that have penetrated deepest horizons in the local area. It is clear that the 1 Sand as described is not present in the central portion of the Jane Dough Unit even though a number of holes have been drilled well below the A Sand. There are sand stringers which are generally less than ten ft thick contained within the 1A Mudstone. These sands are difficult to see in the samples and are only observed on electric logs. On Exhibit JD-D5-16 are number marked with + signs which indicate the combined measured thickness of the sand stringers as measured on the electric log. They appear to be generally discontinuous lenses with little to no recharge. Monitor Test well URZ J1-6 (Exhibit JD-D5-5) pumped 0.5 gpm for 1000 minutes with 75 ft of drawdown. This indicates that this 1 Sand stringer might produce 0.5 gpm at this location. Monitor Test well URZ-J1-12 (Exhibit JD-D5-12) sustained a flow rate of 1.0 gpm for a few days. Monitor Test well URZ-J1-23-1 pumped 1.5 gpm for a short time. The sand intervals that were tested as aquifers

are greater than 60 ft below the base of the A Sand. **As interior monitor well clusters are installed, a hole will be drilled at least 50 ft. below the base of the A Sand to check for the presence of the 1 Sand. If the 1 Sand (> 10 feet thick less than fifty feet from the base of the A Sand) is encountered, the hole will be cased and completed as a monitor well. Where the 1 Sand is not present and the aquiclude is 50 feet or greater, no monitoring is required as per the WDEQ. The hole will then be plugged back to the A Sand and will be completed as a monitor/production well for the A Sand.**

The next unit up section is the aquitard, 1A Mudstone. It consists of dark and medium gray mudstones and carbonaceous shale with occasional thin lenses of poorly developed coal. The 1A Mudstone Isopach (Exhibit JD-D5-19) shows that this unit ranges in thickness from 29 to more than 120 ft thick. The top of the 1A Mudstone is bounded by the A Sand base and by the top of the 1 Sand, where the 1 Sand is present. The holes labeled with + signs indicate the thickness between the base of the A Sand and total depth of the hole. The red numbers with + indicate this thickness of 1A Mudstone drilled is 50 ft or greater without encountering any significant 1 Sand. Where the 1 Sand channels area not present the next significant lower marker is the Badger Coal which is located approximately 120 ft below the base of the A Sand. Several holes have been drill across the mine area to the Badger Coal or reached total depths just above it. Cross sections AA and BB (Exhibits JD-D5-1 and JD-D5-2) show these relationships. The thin areas of 1A Mudstone reflects the presence of the 1 Sand channels. The isopach of the 1A Mudstone shows that many holes have been drilled to 50 beyond the base of the A Sand and have not encountered a 1 Sand channel.

The A Sand is the next unit up section. This is the mining zone sand at the Jane Dough Unit. Within the Jane Dough Unit boundary the unit has a thickness between 0 and 115 ft. The A Sand is thickest to the east and thins to the west (Exhibit JD-D5-18). The A Sand is fine- to coarse grained and is gray or red in color depending on location relative to the ore body as discussed above. The A Sand is occasionally separated by lenses of mudstone and siltstone which rarely exceed 15 ft in thickness. The mudstone lenses are generally 50 to 100 ft wide and may extend for a few hundred feet in a north/south direction. The lenses are not expected to present any

problem to mining or restoration. The A Sand is extensive and has been correlated across the area between the Jane Dough and Nichols Ranch Units.

The next up section unit is Jane Dough Unit AB **Mudstone** aquitard (Exhibit JD-D5-**17**). It varies from 0 to 160 ft thick, thickening to the west and thinning to zero the east and northwest. This unit consists of gray mudstones and thin discontinuous light gray siltstones. Where the AB **Mudstone** aquitard is not present the B Sand sits directly upon the A Sand.

The next higher unit at the Jane Dough Unit is the B Sand upper monitor aquifer in the southwest portion of Unit area (Exhibit JD-D5-**16**). The B Sand ranges in thickness from 0 to 234 ft. The B Sand is fine- to coarse grained and red or oxidized within the permit boundary. Elsewhere in the Pumpkin Buttes area the B Sand is host to some large known ore bodies including those at Christensen Ranch and North Butte. The body of the B Sand is occasionally split by lenses of mudstone, siltstone, and carbonaceous shale. Some of these mudstone splits exceed 25 ft in thickness and may extend for thousands of feet. Most are more localized. The mudstones will be further delineated as drilling progresses.

Above the B Sand is the CB Mudstone aquitard (Exhibit JD-D5-26). This unit is defined as the mudstone between the top of the B Sand and the base of the C Sand (where the C Sand is present and exceeds ten feet in thickness) with the maximum thickness being defined as the top of the B Sand to the base of the first marker above the B sand. The CB Mudstone unit consists of gray mudstones and thin discontinuous light gray siltstones. It is 40 to 80 ft over most of the Jane Dough area.

The C Sand (Exhibit JD-D5-**25**) is defined as the sand bodies which are greater than 10 ft thick and located above the B Sand and below the first marker. This marker is a thin lignite to coal bed which is generally less that two feet thick. The C sands are up to 55 ft thick appear to be discontinuous over the unit area. They are composed of silt to medium grained sand and are gray in color. No evidence of oxidation or mineralization has been observed in this sand indicating no significant water flows have gone through this unit. The C Sand appears to be a poor aquifer as discussed in JD-D6.2 Hydrology.

The FB Mudstone is the interval from the top of the B Sand to the base of the F sand, where the F Sand is present. Where the F Sand is not present the top of the interval is defined as being from the top of the first marker to approximately 100 ft above the top of the first marker. In some portions of the Jane Dough Unit there is often a second marker (thin lignite bed) at approximately that level but it is not always present. The FB Mudstone unit consists of gray mudstones and thin discontinuous light gray siltstones. The FB Mudstone (Exhibit DJ-D5-24) ranges from **70 to 180** ft thick across the Jane Dough area.

The F Sand is the next unit up section and includes any sand that is situated between the first marker and up to 100 ft above the 1st marker. At the Nichols Ranch Unit this unit is the shallow monitor zone sand and this would be true for some areas of Jane Dough where the C Sand is not present. This sand is medium and fine-grained, red or gray and is over 70 ft thick as mapped in Exhibit JD-D5-23. The F Sand is generally not present over the east portion of the Jane Dough Unit.

The GB Mudstone is defined as being the interval between the top of the B Sand and the base of the G Sand. This unit consists of gray mudstones, thin carbonaceous shales, poorly developed lignitic coal beds, and thin discontinuous light gray siltstones. Exhibit JD-D5-22 shows this unit's thickness ranges from 140 to 300 ft. Where the F Sand does not exist this would be the upper aquitard.

The uppermost relatively continuous aquifer in the Jane Dough Unit is the G Sand. Where the F Sand does not exist this would be the overlying aquifer. This sand is medium and fine-grained, red or gray and is over 60 ft thick as mapped in Exhibit JD-D5-21. This unit appears to be the present over most of the Jane Dough Area. It outcrops to the surface on the northern and southwest portion of the area where steep gullies have been incised into present land surface.

Peizometric surfaces for the 1, A, B, F, and G Sands can be seen on the cross sections, Exhibits JD-D5-1 through JD-D5-15. A detailed discussion of the remaining upper aquifers and aquitards can be found in the Nichols Ranch ISR Project, Appendix D5, Section D5.3, Site Geology.

Isopach maps depicting the G Sand, GB Mudstone, F Sand, FB Mudstone, C Sand, CB Mudstone B Sand, AB Shale, A Sand, 1A Shale, and 1 Sand for Jane Dough are found as Exhibits JD-D5-16 through D5-26 (see map pockets).

JD-D5.4 ABANDONED DRILL HOLES

Addendum JD-D6I of Appendix JD-D6.5-Hydrology discusses all known abandoned exploration drill holes located in the area of the Jane Dough Unit.

JD-D5.5 SEISMOLOGY

The area of central Wyoming where the Jane Dough Unit site is located lies in a relatively minor seismic region of the United States. Although distant earthquakes (such as the western Wyoming area) may produce shocks strong enough to be felt in the Powder River Basin, the region is ranked as a one (1) seismic risk as shown in Figure JD-D5-4 (see map pocket). Few earthquakes capable of producing damage have originated in this region.

The seismically active region closest to the site is the Intermountain Seismic Belt of the Western United States, which extends in a northerly direction between Arizona and British Columbia. It is characterized by shallow earthquake foci between 10 and 25 mi in depth, and normal faulting. Part of this seismic belt extends along the Wyoming-Idaho border, more than 350 km (approximately 200 mi) west of the project area. More detailed information can be found in the report "Basic Seismological Characterization for Campbell County and Basic Seismological Characterization for Johnson County, Wyoming" by the Wyoming State Geological Survey.

Table JD-D5-1 lists the largest recorded earthquakes (greater than 4.0 magnitude on the Richter Scale) that have occurred within 200 km (120 mi) of the Jane Dough Unit site and gives the maximum ground acceleration that could be realized at the site as a result of these disturbances from the period 1873 through 2006 (Sources–Wyoming State Geological Survey, 2002 and USGS, 2007). The earthquake of highest intensity recorded during that time interval was the Casper, Wyoming earthquake of 1897. This earthquake has been assigned a probable maximum

Mercalli shaking intensity of VI -VII (5.7 on the Richter scale) based on accounts of damage incurred.

No surface faulting or fault traces in the project area has been reported, nor is any faulting evident from geophysical log interpretations. Based on historic data, the ground accelerations reported in Table JD-D5-1 (.01g to .04g) are not considered to be of a magnitude that would disturb the operations or facilities in the event that an earthquake occurred.

Table JD-D5-1

MAXIMUM EXPECTED EARTHQUAKES INTENSITIES AND GROUND ACCELERATIONS AT THE JANE DOUGH UNIT SITE

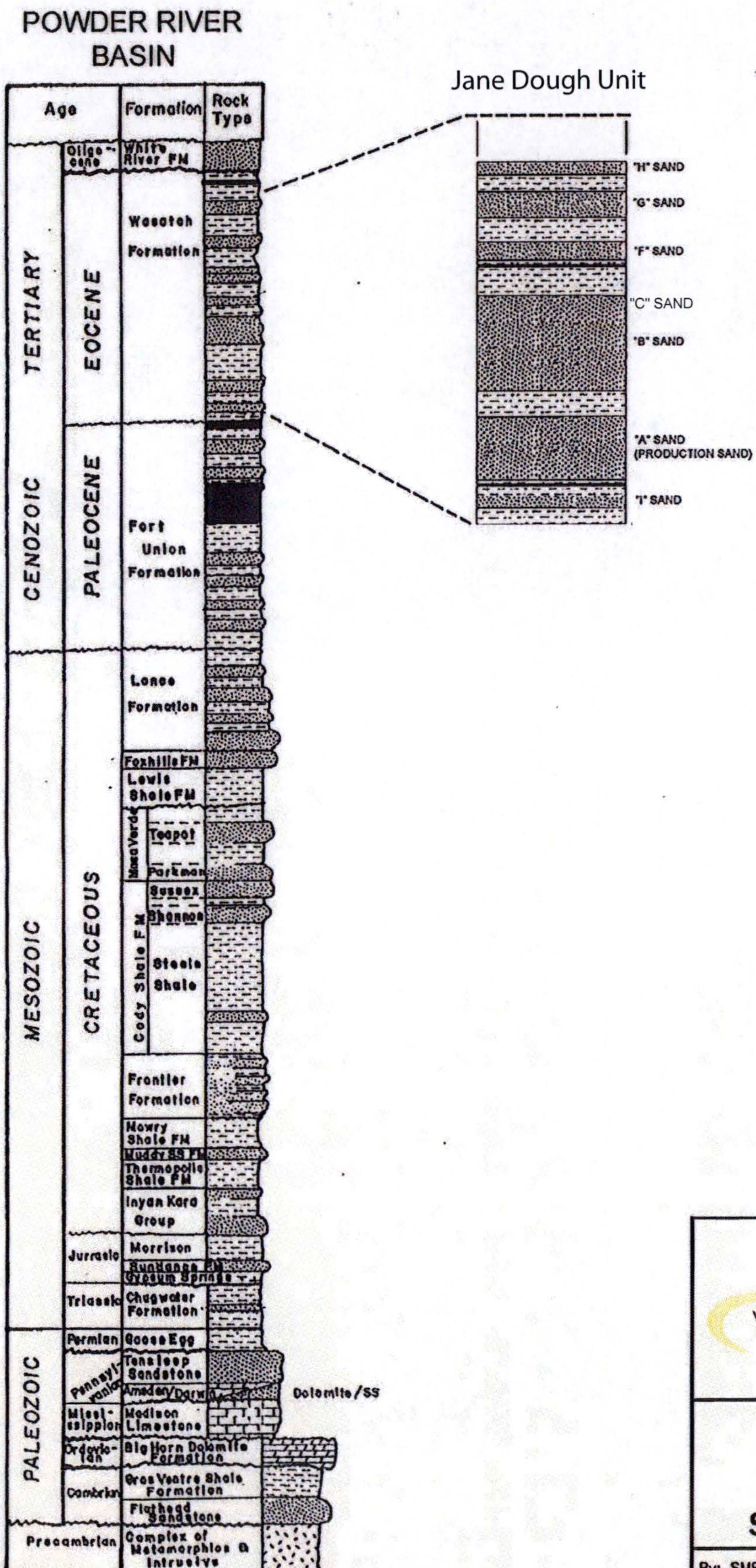
Earthquake Location and Year	Epicenter Intensity (Mercalli)	Magnitude (Richter)	Distance From Jane Dough Unit	Ground Acceleration at Jane Dough Unit
Casper (1894)	V	4.5	65	0.01g
Casper (1897)	VI-VII	5.7	64	0.04g
Kaycee (1965)	V	4.7	30	0.02g
Pine Tree Jct. (1967)	V	4.8	10	0.04g
West of Gillette (1976)	IV-V	4.3	38	0.02g
SW of Gillette (1976)	V	4.8	18	0.03g
Bar Nunn (1978)	V	4.6	56	0.01g
West of Kaycee (1983)	V	4.8	65	0.01g
West of Gillette (1984)	V	5.1	30	0.03g
West of Gillette (1984)	V	5	28	0.03g
Laramie Mtns (1984)	VI	5.5	95	0.01g
Mayoworth (1992)	V-VI	5.2	52	0.02g
W Converse Co. (1996)	IV-V	4.2	54	0.01g

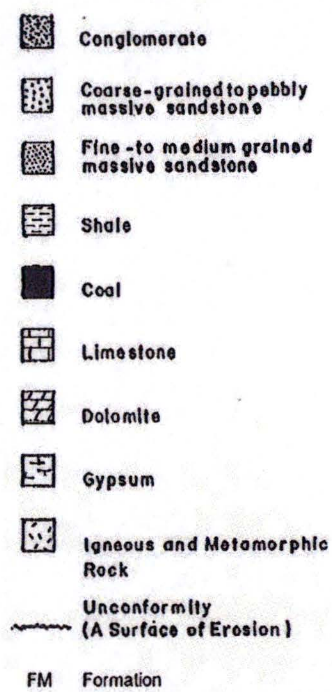
JD-D5.6 REFERENCES

Davis, James H, 1970. Uranium Deposits of the Powder River Basin, Wyoming: Symposium on Wyoming Sandstones: Their Economic Importance- Past, Present, and Future: Pages 21-29.

Gentzler, E., Spoonemore, C. et al, 1980. Rocky Mountain Energy Company (RMEC),Disequilibrium Study, Core Analysis Reports, Reno Creek ISL Project (27 7020C)

Sharp, W.N., MacKay, E.J., McKeown, F.A., White, A.M., 1964. Geology and Uranium Deposits of the Pumpkin Buttes Area of the Powder River Basin Wyoming. Geological Survey Bulletin 1107-H.





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JANE DOUGH UNIT
FIGURE JD-D5-2

STRATIGRAPHIC COLUMN

By: SMF	Date: 7-7-09
Datum: NAD27 UTM13	Revision Date: 04/28/2016
Scale: N/A	Contour Interval:

The estimated peak flows for various recurrence intervals for Cottonwood and Seventeen Mile Creek drainages are presented in Table JD-D6-1. The technique that was used to estimate the peak flows is presented in Lowham (1976).

The predicted peak flows in Table JD-D6-1 vary from 454 cubic feet per second (csf) for a two-year recurrence interval to 7,500 csf for a hundred year recurrence interval for the Cottonwood Creek drainage.

The smaller drainages at the Jane Dough Unit were divided in drainages JDA1-JDA6. The Craig-Rankl method (1978) for small drainage basins in Wyoming was used to estimate the peak discharges for the small sub-basins. JDA1 drains into the Seventeen Mile Creek. JDA2 drains directly to the Dry Fork of the Powder River. JDA3-JDA6 all flow to the south side of Cottonwood Creek. Table JD-D6-1 presents the peak flows for these sub basins with a ten-year flood varying from 177 to 475 cfs using the Craig-Rankl method (1978).

The flow velocities for the 25-year peak discharges are calculated to present an estimate of the channel velocities during a significant runoff event. The bottom half of Table JD-D6-1 presents the calculation of the flow velocities based on typical channel slope and the 25-year peak discharge. The 25-year peak discharge was selected as representing a reasonable design period for the life of this operation. These 25-year peaks are calculated for the confluence of the drainages and therefore are a very conservative representation of the peak at the project location. The peak velocities for Cottonwood Creek are smaller due to the wide flood plane and the milder channel slope. Cottonwood Creek does have an incised pilot channel which has been dammed and, therefore, runoff flow during any significant event will be spread over a very significant width of the flood plane. The velocity in Seventeen Mile Creek will be greater due to the steeper channel slope and smaller channel width and are near 10 ft/sec.

The flow velocity over the 25-year peak discharge for the smaller sub basins is also presented in Table JD-D6-1. The velocities for the Jane Dough Unit vary from a low of **7.20** to a high of **14.66** ft/sec.

The 25-year peaks and conveyance from Table JD-D6-1 were used to define the flood inundated areas for the Jane Dough permit areas. Figure JD-D6-2 shows the Jane Dough Unit inundated areas. A pattern in shown over the Cottonwood Creek inundated area. This entire area should be flooded during the 25-year peak runoff event. The 25-year peak runoffs for the incised small tributaries within the Jane Dough Unit will be confined to these channels and are the approximate flooded area is shown by the narrow channel lines presented on Figure JD-D6-2.

JD-D6.1.3 SURFACE-WATER QUALITY

The surface water quality from the Dry Fork of the Powder River, Cottonwood, and Seventeen Mile Creek drainages is generally very good in the upper channel reaches of these areas. A typical TDS is 200 mg/l. Water quality generally deteriorates as the surface water flows further down stream and is in contact with the streambed for longer periods of time.

The U. S. Geological Survey has monitored the Dead Horse Creek drainage which is approximately 30 miles north of the confluence of the Dry Fork with the Powder River and

outcrop area to the southwest. TDS concentrations near the outcrops have been reported to be <1,000 mg/l.

The Foxhills Sandstone exists below the base of the Lance Formation. Foxhills is mainly a fine to medium grain sandstone. The ground-water flow direction in the Foxhills would be expected to be to the north in this area based on a map presented in Whitehead, 1996. The TDS values varied from 2,230 to 4,800 mg/l from the drill stem test for the deep disposal well in the Nichols Ranch Unit. The TDS in the outcrop area to the southwest has been measured to be from 1,000 to >2,000 mg/l.

The Lewis Shale underlies the Foxhill aquifer and is mainly an aquitard. This shale contains some lenses of fine grained sandstone but is generally not a very significant producer of water. The water quality in the Lewis Shale would be expected to be very poor. TDS in the Lewis Shale is likely to exceed 5,000 mg/l in this area.

JD-D6.2.1 HYDROLOGIC SETTING AND WELL CONSTRUCTION

The Jane Dough Unit is located in the outcrop of the Wasatch Formation. The stratigraphy of the Wasatch at this site consists of alternating layers of sand and shale with lignite marker beds. The mineable ore exists in one sand member, designated as the A Sand at the Jane Dough Unit.

The aquifer and aquitard sequence at the project area is shown in Figure **JD-D6-3**. This shows labeled sands from the 1, A, B, C, F, G, and H Sands. This figure also shows the aquitards that exist between the different sands and those aquitards are labeled as by the combination of labels for the two adjacent sands. These sands are the same names that are used at Power Resources North Butte permit which exists just north of the Hank Unit site.

The majority of the wells completed in the Jane Dough Unit are completed in the A Sand because this is the ore bearing sand in this area. Figure JD-D6-4 shows the locations of the Jane Dough Unit wells and Exhibit JD-D6-1 shows the locations of wells within three miles of the Jane Dough Unit. Table JD-D6-2 presents the tabulation of the well data for the Jane Dough Unit wells. Table JD-D6-2 shows that eight of the wells have been completed in the A Sand for definition of baseline water level and water quality with four wells completed in the B Sand, one well in the C Sand, three wells in the F Sand, two wells in the G Sand, three in the 1 Sand. Three wells were completed in the Cottonwood, Dry Fork, and Seventeen Mile alluviums. All of these wells with the exception of URZJF-17 and the alluvial wells, URZJQ-24-1, URZJQ-25, and URZJQ-26, are open hole completed. Additional ranch wells, N1, Pats #1, and Pug #1, are presented in the table but not used for baselining. Addendum JD-D6L gives the Uranium Data Submission Spreadsheets which contain additional information on the wells.

JD-D6.2.2 SUMMARY OF AQUIFER AND AQUITARD PROPERTIES

Numerous single-well pump tests and multi-well pump tests were conducted at the Jane Dough Unit to define the aquifer properties. The detailed hydrologic analyses and supporting data are contained in Addendums JD-D6B and JD-D6C for the single-well and multi-well

tests, respectively. Five multi-well pump tests were conducted at the Jane Dough Unit site and are referred to in this report as the URZJA-1, URZJA-7, URZJA-8, URZJA-13-1 and URZJA-14-1 tests. Table JD-D6-2 presents the basic well data for wells used to define the aquifer properties for the Jane Dough Unit. Addendum JD-D6J presents the aquifer test theory used to analyze the pump tests.

JD-D6.2.2.1 AQUIFER PROPERTIES

In addition to determining the aquifer properties from the multi-well test, numerous single-well tests were conducted to define the aquifer properties. Several pump tests were previously conducted by Cleveland-Cliffs and Uranerz and the results of these tests were analyzed and included in the general hydrologic analysis.

The aquifer property tables and discussion present the ore sand first, then the overlying and underlying aquifers and finally shallowest to deeper aquifer for the remaining aquifers.

Table JD-D6-3 presents a summary of the aquifer properties for the Jane Dough Unit. This table shows a summary of the aquifer properties for the AB, A, B, 1, F, and C Sands for the Jane Dough Unit. In the eastern half of the Jane Dough Unit, the aquitard between the A and B Sands is not continuous and thus the two sands show good connection and create the AB aquifer. Three multi-well and two single well tests were conducted in areas where that connection was evident. Transmissivities from these pump tests varied from 48 to 1,610 gal/day/ft. The vertical hydraulic conductivity near URZJA-1 is 3.1 E-4 ft/day. This value is likely due to a thin clay layer that significantly retards the vertical movement of water and isn't representative of the A sand. The average vertical hydraulic conductivity near URZJA-7 and URZJA-8 is 0.012 ft/day. The drawdown from the operation of the wellfield will cause the gradient between the A and B Sands to reverse in these areas. The gradient from the B Sand to the A Sand as well as the significantly dampened vertical hydraulic conductivity should act as an adequate confinement of the ore zone.

Two multi-well tests were conducted in the A Sand near URZJA-13-1 and URZJA-14-1. Transmissivities for these A Sand aquifer tests varied from a low of 30.8 to a high of 76.7 gal/day/ft. The hydraulic conductivity (horizontal permeability) varied from 0.10 to **0.**16 ft/day (46.2 to 76.8 milliDarcy).

A transmissivity range of 270-350 gal/day/ft is typical of the ore-bearing A sand. Typical horizontal and vertical hydraulic conductivity of **0.25** and 0.012 ft/day, respectively, are thought to best represent the A Sand. A storage coefficient of **5.4**E-4 is representative of the A Sand.

Two single-well pump tests at different locations were conducted in the B Sand and produced a range of transmissivities from 9.8 to 132 gal/day/ft. An average transmissivity of 86 gal/day/ft and a horizontal permeability of .07 ft/day are thought to best represent the B Sand.

The two single-well pump tests for the 1 Sand produced transmissivity values between 1.6 and 19.4 gal/day/ft. A value of 17.7 gal/day/ft is thought to be most representative of the 1 Sand in the Jane Dough Unit.

Three single-well pump tests were conducted in the F Sand and yielded a large range of transmissivity values. Transmissivities ranged from 7.6 to 4,440 gal/day/ft. A small transmissivity of 2.1 gal/day/ft and hydraulic conductivity of 0.01 ft/day were determined for the C Sand from the URZJC-10 single-well pump test.

JD-D6.2.2.2 AQUITARD PROPERTIES

The multi-well pump tests were used to define the confinement of the aquitards between the ore aquifer and the overlying and underlying aquifers. The URZJA-1, URZJA-7, and URZJA-8 multi-well pump test had no indication of connection between the A Sand and the underlying 1 Sand during this multi-well pump test. The URZJA-13-1 and URZJA-14-1 multi-well pump tests showed that no indication of connection between the A Sand and the overlying B Sand.

The most important parameter for confinement of the ore sand from the adjacent aquifers is the thickness of the aquitard. Experience has shown that the continuity of only a few feet of Powder River shale is needed to form an adequate confinement between the ore sand and adjacent aquifers. Exhibit **JD-D5-17** presents the aquitard thickness for the AB Mudstone. This isopach map shows that the thinnest location observed is in the eastern portion of the Jane Dough Unit. Exhibit **JD-D5-19** presents the aquitard thickness between the 1 and A Sands in the Jane Dough Unit area.

The vertical hydraulic conductivities of the aquitard in the Powder River Basin have been defined at numerous locations. These hydraulic conductivities have been measured in multi-well pump tests with the Neuman-Witherspoon (1972) method, determined from the results from the leaky aquifer pump test analysis with the modified Hantush (1960) method, and from laboratory measurements. This data has shown that the vertical hydraulic conductivity of these aquitards is low enough that site specific measurements of the aquitard hydraulic conductivity are not necessary. Aquitard hydraulic conductivity was measured in the area northeast of the Jane Dough Unit in Power Resources North Butte permit. This permit presents aquitards evaluated with the Neuman-Witherspoon field test for the CF aquitard between the F and C Sands. Table JD-D6-4 presents the North Butte aquitard properties. The vertical hydraulic conductivity of this material was 3.4E-8 cm/sec (3.5E-2 ft/yr). A second multi-well test at the North Butte site defined the 1A aquitard hydraulic conductivity between the A Sand and the 1 Sand. The results of this test were 4.1E-8 cm/sec (4.2E-2 ft/yr). Additional field tests were evaluated using the modified Hantush method to define the vertical hydraulic conductivity of the aquitard. These calculated hydraulic conductivities varied from a low of 6.7E-9 to a high of 6.9E-8 cm/sec (6.9E-3 to 7.1E-2 ft/yr). Laboratory hydraulic conductivities were also measured on two samples of the aquitards at the North Butte permit

and these hydraulic conductivities varied from 6.4E-9 to 1.3E-8 cm/sec (6.6E-3 to 1.3E-2 ft/yr).

Additional test of aquitard properties have been made in this area at the Ruth and Ruby projects. The Ruth project located approximately 5 miles southwest of the Jane Dough project while the Ruby project is approximately 11 miles to the east. Table JD-D6-4 presents additional field and laboratory aquitard properties for the Ruby and Ruth projects. The aquitards between the AB Sands and 1A Sands were measured at the Ruth project. The aquitards between the BC Sands and AB Sands were measured at the Ruby project. These aquitard properties show that the aquitards at both the Ruth and Ruby sites are similar to those that were measured at the North Butte site. This data shows that the aquitards in this area have sufficiently small vertical hydraulic conductivities to restrict the movement of ground water from one aquifer to the next. Aquifer confinement will be further defined for each of the wellfields during the wellfield multi-well pump test.

JD-D6.2.3 GROUND-WATER FLOW

Water levels have been measured in the wells in the Jane Dough ISR Project area to define the direction and gradient of the ground water movement and define water-level changes in the aquifers in this area. Addendum JD-D6D presents the water-level plots and tabulation of ground-water levels. Addendum JD-D6L also presents a tabulation of the water levels in the Uranium Data Submission Spreadsheets.

The historical and current water-level elevation maps for the aquifers in this area are essentially the same. Water-level plots show that historically only small changes have occurred in these water levels since the late 1970s. Coal bed methane production in the immediate area had not started and by 2007, therefore the 2007 piezometric surface maps can be used as historical water-level elevations. CBM has started in this area and has caused large drawdown in the coal aquifer but these drawdowns have not been observed in the aquifers adjacent to the production zones. The drawdowns in the sands above the CBM production aquifers have generally been observed in some of the sands closer to the coal aquifer. These drawdowns should generally be relatively small and decrease in sands with greater distances from the coal aquifer.

The water-level elevation for the A Sand, which is the production sand at the Jane Dough Unit, is presented in Figure JD-D6-5. This water-level elevation map shows that the ground water in the A Sand is flowing to the northwest with an average gradient of 0.0064 ft/ft. This gradient, an effective porosity of 0.05 and an average hydraulic conductivity of **0.25** ft/day indicates that the ground water in the A Sand is flowing at an average rate of **0.032** ft/day (**12-** ft/yr).

The regional piezometric surface of the A Sand aquifer is developed from the Nichols Ranch Unit A Sand wells and from three additional A Sand wells in this region. Figure D6-5a in Appendix D6 of the Nichols Ranch permit presents the 1980 regional water-level elevation map for the A Sand. This map shows that the regional ground water flow direction is the same as that in the Jane Dough Unit area. The regional ground-water velocity would be expected to be similar to the local ground-water velocity in the Jane Dough Unit area.

Unit wellfields. Depths to water in the G Sand are 50 ft in the northern portion of the wellfields. The alluvial aquifers are important surficial aquifers outside of the wellfield areas.

Jane Dough Unit Aquitard Flow

Table JD-D6-5 presents the gradient calculations through the aquitards based on the heads in the adjacent aquifers and the thickness of the aquitard. The head in the A Sand is 3 ft higher than the head in the B Sand at the Jane Dough Unit at well URZJA-20. These head differences indicate a gradient of 0.15 ft/ft across the 20 ft of aquitard at this location. The actual gradient in the aquitard is expected to be mainly controlled by the higher head in the A Sand and therefore, based on observation of head measurements in aquitards in the Powder River Basin the actual gradient in the overlying aquitard at the Jane Dough Unit is likely to be roughly 0.1 ft/ft. The head in the underlying aquifer 1 Sand in this location is approximately 15 feet higher than the head in the A Sand, therefore, an upward gradient exists between the A Sand and the underlying 1 Sand. This indicates a gradient across the aquitard of approximately -0.24 ft/ft. The higher head in the 1 Sand is expected to mainly control the head in the aquitard until within a very few feet adjacent to the A Sand.

JD-D6.2.3.1 JANE DOUGH UNIT WATER LEVEL CHANGES

The water-level elevations have been measured on the Jane Dough Unit wells and are presented in Addendum JD-D6D. Table JD-D6D.1-1 in Addendum JD-D6D presents the water-level data tabulation for the Jane Dough Unit. Figures JD-D6D.1-1 through JD-D6D.1-5 in Addendum JD-D6D present the water-level elevations; versus time for the Jane Dough Unit wells. Water-levels for the A Sand wells since 2010 have been fairly steady with a very gradual decrease observed in 2012 and 2013.

Water levels in the **northeast** cluster of the Jane Dough Unit all show a very slight decrease in water level over the last two years. B Sand well URZJB-3 has had very similar water levels to A Sand wells URZJA-1 and URZJA-2 up until the beginning of 2013. **Water-level in** the underlying 1 Sand is roughly 18 ft above the A Sand in this cluster. The F Sand, as shown by the URZJF-5, water levels in this cluster is slightly over 15 ft lower than the A Sand.

The A and B Sand water levels in the southeast cluster have very similar water levels. The AB mudstone is not continuous on the eastern portion of the Jane Dough Unit; hence, the similar heads in the adjacent aquifers. The 1 Sand water level is over 35 ft higher than that of the A Sand. The C Sand, as shown by well URZJC-10, water-level is roughly four feet higher than the A Sand. The most surficial aquifer, the G Sand, shows a water level nearly 30 ft higher than the A Sand.

The A Sand wells in the southwestern cluster show a slight increase in water level in 2013. The overlying B and F Sands both have water levels over 20 ft lower than the A Sand in this area.

JD-D6.3 WATER RIGHTS

Surface and ground-water rights on, adjacent to, and within 3 miles of the Jane Dough Unit are listed in Table JD-D6F.1-1 in Addendum F for the surface water and Tables JD-D6G.1-1 and JD-D6G.1-2 permitted water wells. Table JD-D6G.1-1 lists the wells within the Jane Dough Unit while Table JD-D6G.1-2 in Addendum JD-D6G list wells in and within three miles of the Jane Dough Unit. Table JD-D6F.1-2 in Addendum JD-D6F lists the abbreviations used by the State Engineers Office for both the surface and ground-water rights. Figures JD-D6-4 and JD-D6-14 present the locations of the Jane Dough Unit surface rights. Exhibit JD-D6-1 shows the locations of the permitted wells within three miles of the Jane Dough Unit. No adjudicated surface water rights are located in or adjacent to (within ½ mile of the project unit) the Jane Dough Unit. The surface water rights that do exist within the proposed mining project area are limited to stock/storage ponds and ephemeral creeks. Ground-water rights in the Jane Dough Unit area are mainly associated with the old monitoring wells and stock wells. No other adjudicated water rights are in the project area and lands adjacent to the project area according to the Wyoming State Engineers Office. Uranerz Energy Corporation also does not hold any adjudicated water rights in the project area. Most wells that are located within the Jane Dough Unit area were previously installed by uranium exploration companies, the T-Chair Livestock Company, or coal bed methane companies. Several additional wells have been completed in the project areas by Uranerz Energy Corporation for use in collecting base line ground water quality data.

The current regional ground water use in this area is mainly wells for wildlife and livestock. A few domestic wells exist at the ranch houses. The production of water from coal bed methane has been occurring in the region for approximately 15 years.

Wells in the area of the proposed project area are uniformly distributed over the area excluding monitoring/sampling wells that are permitted by Uranerz Energy Corporation. Most of the wells are used for livestock watering through the use of windmills or electric well pumps. Non-mining or oil company well depths vary from 135 ft to 1,593 ft in depth, and most wells are completed in sands other than the ore bearing sands. Those wells that are completed in the ore bearing sand will be abandoned using acceptable WDEQ methods or will be used as monitoring wells if not completed in multiple sands. No wells in or adjacent to the project area are used for domestic water consumption. The extensive ground-water monitoring program utilized during the mining project will detect any problems prior to this well being adversely affected by mining activity.

Seventeen permitted wells that are not related to the mining operations also exist within ½ mile of Jane Dough Unit. **No domestic wells exist within ½ mile of the Jane Dough Unit permit. The nearest domestic well is the Nichols Ranch facility well just north of the Jane Dough permit boundary. Two domestic wells, Garden Well and Doughstick #3 exists approximately one mile to the east of the permit boundary and are thought to be completed in the A Sand. Domestic well Dry Fork #1 exists slightly more than a mile to the northwest of the permit boundary and its completion interval is unknown. All of the wells that exists within ½ mile of the permit boundary are stock wells.** The Pat #1 well is thought to be completed in the A or B Sands based on its well depth. Water levels in this well could be affected by the Jane Dough Unit operation. Wells East Dry Fork #1, Dry Fork Flowing #3, and Pug well #1 are thought to be completed in the B Sand. Small drawdowns in

these wells could be caused by the Jane Dough ISR wellfield. The Taylor #22-1 is thought to be completed in the C Sand and should not have drawdowns from the Jane Dough operations.

Six of the ranch wells within or within one half mile of the Jane Dough permit boundary are completed below the 1 Sand. These wells are Taylor Unit #9, Doughstick #2, Pug Well #2, T-Chair 12-22, Car Body Well #1, and Brown 21-6. Also Dry Fork Samson #1 is completed in the 1 Sand and below. The Jane Dough wellfield should not have any effects on this well. Taylor #21-3, Seventeen Mile #1, and Fetty Well #1 are thought to be completed in the 1 Sand and should not be affected by Jane Dough.

The Brown 20-9 well is within the Nichols Ranch Unit and flows at approximately one gpm. This well is thought to be completed in the A Sand and has a total depth of 740 ft with perforations from 495 to 695 ft. The Nichols #1 well, which is located in Section 19, is completed down to a depth of 310 ft. This well is likely completed in the C Sand and flows at approximately one gpm.

Based on a conversation with the current owner of the property where the Nichols Ranch once stood, the source of water was a well which was located approximately 200 yards from the old ranch house towards Cottonwood Creek and was thought to be artesian in nature. The depth of the well was not known but it was likely hand dug and fed off the waters of Cottonwood Creek.

JD-D6.4 COAL BED METHANE WELLS AND OIL/GAS WELLS

Wells permitted for coal bed methane production are presented on Exhibits JD-D6-2 for the Jane Dough Unit. The tabulation of the coal bed methane wells is presented in Addendum JD-D6H. The coal bed methane wells in the area of the Jane Dough Unit have been in production for the last few years.

Oil/Gas wells are shown on Exhibit JD-D6-3 for the combined Jane Dough Unit. Tabulation of the oil/gas wells is presented in Addendum JD-D6H.

JD-D6.5 EXPLORATION DRILL HOLES

The areas surrounding the Nichols Ranch ISR Project have been historically drilled by several different companies over the past 50 years. Companies such as Cleveland-Cliff Iron Company, American Nuclear Company, Texas Eastern Nuclear, Everest Minerals Corporation, Rio Algom Mining, and Silver King Mines have historically drilled in the Pumpkin Buttes Mining District. A search of the drill hole database maintained by Uranerz Energy Corporation and drill holes provided by the WDEQ-LQD resulted in a total of 2,165 abandoned exploration drill holes located within the Nichols Ranch ISR Project boundaries that were drilled by Cleveland Cliff Iron Company (CCI), Rio Algom (RAM), Texas Eastern Nuclear (TE), and Uranerz Energy Corporation (U). Holes drilled from 2006 through year to date 2013 have been plugged in accordance with current State of Wyoming regulations.

TABLE JD-D6-1. SURFACE DRAINAGE PROPERTIES, ESTIMATED PEAK FLOWS AND VELOCITIES

SITE	DRAINAGE AREA (sq. mi)	ESTIMATED PEAK FLOWS (CFS) RECURRENCE INTERVAL (YRS) 2-YR	5-YR	10-YR	25-YR	50-YR	100-YR
Cottonwood Creek	80.2	454	1220	2150	3760	5420	7500
Seventeen Mile Creek	11.5	226	607	1049	1832	2641	3654
JDA1	2.15	150	319	475	731	968	1248
JDA2	1.39	117	244	361	548	720	920
JDA3	0.44	60	121	174	257	330	412
JDA4	1.26	110	230	339	514	673	859
JDA5	0.45	60	122	177	260	335	418
JDA6	1.72	132	278	413	631	832	1068

25-YEAR VELOCITIES

Channel Station (ft)	Base Width (ft)	Side Slope (?H:1V)	Bottom Slope (ft/ft)	Discharge (cfs)	Normal Flow Depth (ft)	Flow Area (ft^2)
Cottonwood Creek	100	2	0.0030	3760	4.768	522.3
Seventeen Mile Creek	20	2	0.0090	1832	5.301	162.2
JDA1	5	2	0.0300	731	3.898	49.9
JDA2	5	2	0.0200	548	3.747	46.8
JDA3	5	2	0.0300	257	2.366	23.0
JDA4	5	2	0.0150	514	3.888	49.7
JDA5	5	2	0.0450	260	2.152	20.0
JDA6	5	2	0.0200	631	3.999	52.0

Station (ft)	Wetted Perimeter (ft)	Hydraulic Radius (ft)	Flow Velocity (fps)	Top Width (ft)	Froude Number	AVG Unit Discharge (cfs/ft)
Cottonwood Creek	121.32	4.30	7.20	119.07	0.61	34.33
Seventeen Mile Creek	43.70	3.71	11.29	41.20	1.00	59.87
JDA1	22.43	2.22	14.66	20.59	1.66	57.13
JDA2	21.76	2.15	11.71	19.99	1.35	43.86
JDA3	15.58	1.48	11.16	14.46	1.56	26.41
JDA4	22.39	2.22	10.35	20.55	1.17	40.23
JDA5	14.62	1.37	12.99	13.61	1.89	27.95
JDA6	22.89	2.27	12.14	21.00	1.36	48.54

TABLE JD-D6-2. BASIC WELL DATA FOR JANE DOUGH UNIT WELLS.

WELL NAME	NORTH. COORD.	EAST. COORD.	MP ELEV. (ft-msl)	CASING DIA. (in)	STICK-UP ABOVE LSD	WELL DEPTH (ft-mp)	WATER LEVEL				SCREEN INTERVAL (ft-lsd)	AQUIFER
							DATE	DEPTH (ft-mp)	ELEVATION (ft-msl)			
N1	1102532	269925	4622.33	2.0	0.0	310	---	--	---		191 - 310	F
NQ-4	1103219	272397	4638.44	4.0	1.5	35	2/3/2010	5.40	4633.04		15 - 35	ALL
Pats #1	1102872	279812	4690.00		---	405	---	--	---		375 - 405	A
Pug #1	1102383	275338	4685.00		---	370	---	--	---		340 - 370	B
URZJ1-12	15862733	1377933	4876.07	5.0	1.4	720	11/1/2013	99.63	4776.44	#	710 - 720	1
URZJ1-23-1	15869114	1371572	4762.66	5.0	2.3	623	11/1/2013	57.80	4704.86	#	602 - 623	1
URZJ1-6	15870338	1375279	4744.85	5.0	1.8	606	10/31/2013	31.45	4713.40	#	593 - 606	1
URZJA-1	15870308	1375108	4738.62	5.0	1.5	508	10/31/2013	43.07	4695.55	#	501 - 508	A
URZJA-13-1	15864216	1369452	4826.10	5.0	2.3	561	10/30/2013	116.77	4709.33	#	550 - 561	A
URZJA-14-1	15864321	1369495	4832.70	5.0	2.3	551	10/30/2013	124.66	4708.04	#	541 - 551	A
URZJA-19	15869262	1371440	4752.89	5.0	1.5	475	11/1/2013	70.71	4682.18	#	465 - 475	A
URZJA-2	15870345	1375230	4739.95	5.0	1.6	474	10/31/2013	42.68	4697.27	#	467 - 474	A
URZJA-20	15869337	1371529	4750.24	5.0	1.6	505	11/1/2013	67.88	4682.36	#	495 - 505	A
URZJA-7	15862638	1377772	4884.16	5.0	1.5	560	11/1/2013	143.00	4741.16	#	550 - 560	A
URZJA-8	15862654	1377884	4879.17	5.0	1.7	592	11/1/2013	138.03	4741.14	#	580 - 592	A
URZJB-15	15864245	1369393	4824.41	5.0	1.5	465	10/30/2013	149.00	4675.41	#	415 - 465	B
URZJB-21	15869222	137519	4754.74	5.0	1.4	448	11/1/2013	75.00	4679.74	#	410 - 448	B
URZJB-3	15870348	1375167	4737.90	5.0	1.5	415	10/31/2013	44.81	4693.09	#	379 - 415	B
URZJB-9	15862730	1377851	4881.18	5.0	1.5	525	11/1/2013	141.10	4740.08	#	470 - 525	B
URZJC-10	15862602	1377700	4888.54	5.0	1.4	280	11/1/2013	142.02	4746.52	#	250 - 280	C
URZJC-16	15864147	1369432	4821.46	5.0	1.3	220	10/30/2013	141.85	4679.61	#	193 - 220	F
URZJC-22	15869190	1371535	4758.98	5.0	1.8	165	11/1/2013	112.50	4646.48	#	120 - 165	F
URZJF-11	15862684	1377684	4893.69	5.0	1.5	130	11/1/2013	125.34	4768.35	#	113 - 130	G
URZJF-17	15869196	1371614	4757.85	4.0	0.9	63	10/30/2013	58.20	4699.65		40 - 63	G
URZJF-5	15870220	1375069	4744.90	5.0	1.7	133	10/31/2013	62.18	4682.72	#	110 - 133	F
URZJQ-24-1	15870915	1377046	4691.00	4.0	1.9	26	12/5/2013	16.21	4674.79		9 - 26	ALL
URZJQ-25	15859780	1368392	4695.00	4.0	1.4	30	12/5/2013	11.84	4683.16		9 - 30	ALL
URZJQ-26	15865161	1363353	4631.00	4.0	2.2	27	12/5/2013	12.44	4618.56		9 - 27	ALL

NOTE: * = Abandoned
# = Open Hole Completion
ALL = Alluvial

TABLE JD-D6-3. SUMMARY OF AQUIFER PROPERTIES FOR JANE DOUGH UNIT

	TRANSMISSIVITY (GAL/DAY/FT)				HOR. PERMEABILITY		AQUIFER	STORAGE COEFFICIENT		
	RECOVERY	JACOB	WTAQ	BEST VALUE	(FT/DAY)	(MILLIDARCY)	THICKNESS (FT)	JACOB	WTAQ	BEST VALUE
MULTI WELL TESTS						**AB SAND**				
URZJA-1 TEST	590	765		678	0.28	135	320			
URZJA-2 OBS	604	723	1610	663	0.27	128	330	2.70E-05	2.60E-04	2.60E-04
URZJB-3 OBS	807	795	1150	901	0.37	177	325	**1.0E-02**	**8.5E-05**	**8.5E-05**
URZJA-7 TEST	248	285		267	0.20	95	180			
URZJA-8 OBS	447	247	300	274	0.20	97	180	**8.10E-05**	**8.30E-06**	**4.47E-05**
URZJB-9 OBS	359	352	259	259	0.19	91.8	180	**6.3E-04**	**6.4E-07**	**6.3E-04**
URZJA-8 TEST	230	380		305	0.23	108	180			
URZJA-7 OBS	293	276	329	299	0.22	106	180	**8.0E-05**	**9.6E-06**	**4.48E-05**
URZJB-9 OBS	305	358	290	290	0.22	103	180	**2.90E-03**	**4.80E-06**	**2.90E-03**
SINGLE WELL TESTS										
URZJB-3		361		361	0.15	71	325			
URZJB-9	76	48		62	0.05	22.0	180			
MULTI WELL TESTS						**A SAND**				
URZJA-13-1 TEST	33.9	67.3		50.6	0.16	76.8	42			
URZJA-14-1 OBS	33.7	43	2870	38.4	0.10	46.2	53	**1.5E-05**	**2.3E-06**	**1.5E-05**
URZJA-14-1 TEST	30.8	76.7		53.8	0.14	64.7	53			
URZJA-13-1 OBS	33.1	48.7	5330	40.9	0.13	62.1	42	**7.8E-06**	**2.3E-07**	**7.8E-06**
SINGLE WELL TESTS						**B SAND**				
URZJB-15	58	9.8		58	0.05	25.5	145			
URZJB-21	132	98		115	0.09	41.9	175			
SINGLE WELL TESTS						**1 SAND**				
URZJ1-12	16	1.6		16	0.13	63.8	16			
URZJ1-12 (2nd test)		19.4		19.4	0.16	77.3	16			
SINGLE WELL TESTS						**F SAND**				
URZJF-5	31	7.6		31	0.17	79.1	25			
URZJF-5 (2nd test)	25	17.6		21.3	0.11	54.3	25			
URZJC-22	2110	4440		2110	6.27	2990	45			
SINGLE WELL TESTS						**C SAND**				
URZJC-10		2.1		2.1	0.01	6.70	20			

TABLE JD-D6-5. VERTICAL HYDRAULIC GRADIENTS THROUGH THE ADJACENT AQUITARDS.

AQUITARD	CALCULATED GRADIENT (ft/ft)	ESTIMATED GRADIENT (ft/ft)
Jane Dough Unit		
A-B	-0.15	-0.1
1-A	-0.24	-0.1

TABLE JD-D6-6. SUMMARY OF THE GROUND-WATER QUALITY

A SAND WELLS: URZJA-1, URZJA-2, URZJA-7, URZJA-8, URZJA-13-1, URZJA-14-1, URZJA-19, AND URZJA-20

	Ca	Cl	CO3	HCO3	K	Mg	Na	SO4	Fe	Temp	TDS	Cond	Cond(f)	pH
	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	deg C	mg/l	micromhos/ cm	micromhos/ cm	std. units
No. of Samples	33	33	33	33	33	33	33	33	33	31	33	31	31	33
Average	10	9	9	147	5	1	108	114	0.03	14.6	350	551	555	8.90
Maximum	29	113	41	177	13	4	127	141	0.03	35.0	715	789	771	9.94
Minimum	3	5	5	97	2	1	95	88	0.03	7.8	299	500	489	8.30
Standard Deviation	4.51	18.62	7.31	19.61	2.87	0.55	7.45	16.68	0.00	4.80	71.93	51.82	57.58	0.36
No. of Samples Above Class I	--	0	--	--	--	--	--	0	0	--	1	--	--	28

	pH(f)	Mn	NH3	NO3+NO2	F	Al	As	Ba	Cr	Cu	B	Cd	Hg	Mo
	std. units	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
No. of Samples	31	33	33	33	33	33	33	33	33	33	33	33	33	33
Average	8.78	0.011	0.05	0.1	0.3	0.10	0.002	0.10	0.049	0.01	0.10	0.005	0.001	0.097
Maximum	10.52	0.040	0.07	0.1	0.4	0.10	0.004	0.10	0.050	0.01	0.10	0.005	0.001	0.100
Minimum	7.39	0.008	0.05	0.1	0.1	0.04	0.001	0.05	0.005	0.01	0.05	0.001	0.000	0.002
Standard Deviation	0.83	0.01	0.00	0.00	0.09	0.01	0.00	0.01	0.01	0.00	0.01	0.00	0.00	0.02
No. of Samples Above Class I	15	0	0	0	0	--	0	0	0	0	0	0	0	--

	Ni	Pb	Se	Unat	V	Zn	Ra226	Ra228	Ra226 +Ra228	Alpha	Beta
	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	pCi/l	pCi/l	pCi/l	pCi/l	pCi/l
No. of Samples	33	33	33	33	33	33	33	33	31	33	33
Average	0.049	0.001	0.001	0.024	0.10	0.01	25.5	0.8	27.9	153.2	75.7
Maximum	0.050	0.001	0.002	0.050	0.10	0.04	243.0	4.7	247.7	1070.0	611.0
Minimum	0.005	0.001	0.001	0.001	0.01	0.01	-0.1	-0.6	-0.4	-0.7	0.3
Standard Deviation	0.01	0.00	0.00	0.01	0.02	0.01	59.62	1.16	61.99	292.56	159.15
No. of Samples Above Class I	--	0	0	--	--	0	--	--	11	29	--

B SAND WELLS: URZB-3, URZJB-9, URZJB-15, AND URZJB-21

	Ca	Cl	CO3	HCO3	K	Mg	Na	SO4	Fe	Temp	TDS	Cond	Cond(f)	pH
	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	deg C	mg/l	micromhos/ cm	micromhos/ cm	std. units
No. of Samples	22	22	22	22	22	22	22	22	21	21	22	22	21	22
Average	11	6	6	146	4	1	108	131	0.03	13.4	350	551	559	8.65
Maximum	16	7	16	168	7	2	119	156	0.03	18.0	451	600	644	9.44
Minimum	7	6	5	132	2	1	96	111	0.03	8.2	303	507	459	8.14
Standard Deviation	3.74	0.48	2.86	8.97	1.21	0.21	6.86	16.39	0.00	2.76	34.74	31.03	51.62	0.30
No. of Samples Above Class I	--	0	--	--	--	--	--	0	0	--	0	--	--	6

	pH(f)	Mn	NH3	NO3+NO2	F	Al	As	Ba	Cr	Cu	B	Cd	Hg	Mo
	std. units	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
No. of Samples	21	22	22	22	22	22	22	22	22	22	22	22	22	22
Average	8.54	0.010	0.05	0.1	0.2	0.10	0.003	0.10	0.048	0.01	0.10	0.005	0.001	0.096
Maximum	9.53	0.010	0.05	0.1	0.4	0.10	0.006	0.10	0.050	0.01	0.10	0.005	0.001	0.100
Minimum	7.34	0.008	0.05	0.1	0.1	0.03	0.002	0.05	0.005	0.01	0.05	0.001	0.000	0.001
Standard Deviation	0.50	0.00	0.00	0.00	0.09	0.01	0.00	0.01	0.01	0.00	0.01	0.00	0.00	0.02
No. of Samples Above Class I	10	0	0	0	0	--	0	0	0	0	0	0	0	--

	Ni	Pb	Se	Unat	V	Zn	Ra226	Ra228	Ra226 +Ra228	Alpha	Beta
	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	pCi/l	pCi/l	pCi/l	pCi/l	pCi/l
No. of Samples	22	22	22	22	22	22	22	22	18	22	22
Average	0.048	0.001	0.001	0.040	0.10	0.01	0.1	0.8	0.9	45.6	11.8
Maximum	0.050	0.001	0.003	0.049	0.10	0.05	0.4	4.6	4.7	63.6	21.7
Minimum	0.005	0.001	0.001	0.021	0.01	0.01	-0.1	-0.4	-0.3	28.6	5.7
Standard Deviation	0.01	0.00	0.00	0.01	0.02	0.01	0.10	1.02	1.11	10.16	4.11
No. of Samples Above Class I	--	0	0	--	--	0	--	--	0	27	--

TABLE JD-D6-6. SUMMARY OF THE GROUND-WATER QUALITY (cont.)

C SAND WELL: URZJC-10

	Ca	Cl	CO3	HCO3	K	Mg	Na	SO4	Fe	Temp	TDS	Cond	Cond(f)	pH
	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	deg C	mg/l	micromhos/ cm	micromhos/ cm	std. units
No. of Samples	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Average	7	8	7	143	5	1	89	86	0.04	15.2	278	464	463	8.92
Maximum	11	8	12	171	6	1	96	89	0.07	20.1	303	487	491	9.31
Minimum	3	7	5	97	4	1	76	84	0.03	8.0	251	419	430	8.51
Standard Deviation	3.63	0.45	3.36	32.84	0.84	0.00	8.00	2.07	0.02	5.06	23.70	28.27	25.43	0.35
No. of Samples Above Class I	--	0	--	--	--	--	--	0	0	--	0	--	--	5

	pH(f)	Mn	NH3	NO3+NO2	F	Al	As	Ba	Cr	Cu	B	Cd	Hg	Mo
	std. units	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
No. of Samples	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Average	9.08	0.010	0.05	0.6	0.4	0.10	0.001	0.10	0.050	0.01	0.10	0.005	0.001	0.100
Maximum	10.25	0.010	0.05	2.4	0.6	0.10	0.001	0.10	0.050	0.01	0.10	0.005	0.001	0.100
Minimum	8.42	0.010	0.05	0.1	0.4	0.10	0.001	0.10	0.050	0.01	0.10	0.005	0.001	0.100
Standard Deviation	0.79	0.00	0.00	1.03	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
No. of Samples Above Class I	3	0	0	0	0	--	0	0	0	0	0	0	0	--

	Ni	Pb	Se	Unat	V	Zn	Ra226	Ra228	Ra226 +Ra228	Alpha	Beta
	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	pCi/l	pCi/l	pCi/l	pCi/l	pCi/l
No. of Samples	5	5	5	5	5	5	5	5	5	5	5
Average	0.050	0.001	0.001	0.000	0.10	0.02	0.0	0.5	0.5	-1.1	3.1
Maximum	0.050	0.001	0.003	0.001	0.10	0.02	0.1	1.0	1.0	-0.8	4.5
Minimum	0.050	0.001	0.001	0.000	0.10	0.01	-0.1	0.1	0.1	-2.0	0.6
Standard Deviation	0.00	0.00	0.00	0.00	0.00	0.01	0.07	0.34	0.35	0.51	1.60
No. of Samples Above Class I	--	0	0	--	--	0	--	--	0	0	--

1 SAND WELLS: URZJ1-6, URZJ1-12, AND URZJ1-23-1

	Ca	Cl	CO3	HCO3	K	Mg	Na	SO4	Fe	Temp	TDS	Cond	Cond(f)	pH
	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	deg C	mg/l	micromhos/ cm	micromhos/ cm	std. units
No. of Samples	7	7	7	7	7	7	7	7	7	7	7	7	7	7
Average	5	4	16	234	3	1	96	2	0.16	14.2	253	411	429	8.95
Maximum	5	5	36	273	4	1	107	4	0.44	18.1	281	430	475	9.62
Minimum	4	3	7	160	3	1	77	1	0.03	7.4	218	391	388	8.66
Standard Deviation	0.53	0.98	10.49	38.75	0.49	0.00	10.09	1.13	0.19	3.60	22.23	13.69	35.26	0.31
No. of Samples Above Class I	--	0	--	--	--	--	--	0	2	--	0	--	--	7

	pH(f)	Mn	NH3	NO3+NO2	F	Al	As	Ba	Cr	Cu	B	Cd	Hg	Mo
	std. units	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
No. of Samples	7	7	7	7	7	7	7	7	7	7	7	7	7	7
Average	9.13	0.010	0.06	0.1	0.6	0.10	0.001	0.10	0.050	0.01	0.10	0.005	0.001	0.100
Maximum	10.74	0.010	0.08	0.1	0.7	0.10	0.001	0.10	0.050	0.01	0.10	0.005	0.001	0.100
Minimum	8.61	0.010	0.05	0.1	0.6	0.10	0.001	0.10	0.050	0.01	0.10	0.005	0.001	0.100
Standard Deviation	0.75	0.00	0.01	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
No. of Samples Above Class I	7	0	0	0	0	--	0	0	0	0	0	0	0	--

	Ni	Pb	Se	Unat	V	Zn	Ra226	Ra228	Ra226 +Ra228	Alpha	Beta
	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	pCi/l	pCi/l	pCi/l	pCi/l	pCi/l
No. of Samples	7	7	7	7	7	7	7	7	6	7	7
Average	0.050	0.001	0.002	0.000	0.10	0.01	0.1	0.2	0.4	-1.2	1.9
Maximum	0.050	0.001	0.003	0.000	0.10	0.01	0.3	1.0	1.1	1.8	4.8
Minimum	0.050	0.001	0.001	0.000	0.10	0.01	0.0	-0.4	-0.2	-3.0	-0.9
Standard Deviation	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.47	0.54	1.58	2.13
No. of Samples Above Class I	--	0	0	--	--	0	--	--	0	0	--

TABLE JD-D6-6. SUMMARY OF THE GROUND-WATER QUALITY (cont.)

F SAND WELLS: URZJF-5, URZJC-16, AND URZJC-22

	Ca	Cl	CO3	HCO3	K	Mg	Na	SO4	Fe	Temp	TDS	Cond	Cond(f)	pH
	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	deg C	mg/l	micromhos/ cm	micromhos/ cm	std. units
No. of Samples	14	14	14	14	14	14	14	14	14	14	14	14	14	14
Average	163	7	7	149	14	30	209	832	0.20	15.1	1381	1753	1773	8.32
Maximum	279	8	23	229	32	59	269	1080	0.84	25.2	1810	2160	2260	11.00
Minimum	19	5	5	5	10	1	151	415	0.03	6.3	686	1070	1098	7.45
Standard Deviation	100.92	1.28	5.32	79.54	6.85	21.33	42.66	286.06	0.29	5.45	485.82	476.21	486.33	1.16
No. of Samples Above Class I	--	0	--	--	--	--	--	14	4	--	14	--	--	4

	pH(f)	Mn	NH3	NO3+NO2	F	Al	As	Ba	Cr	Cu	B	Cd	Hg	Mo
	std. units	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
No. of Samples	14	14	14	14	14	14	14	14	14	14	14	14	14	14
Average	8.10	0.097	0.08	0.7	0.2	0.10	0.001	0.10	0.050	0.01	0.11	0.005	0.001	0.100
Maximum	12.96	0.220	0.19	2.4	0.5	0.10	0.001	0.10	0.050	0.01	0.20	0.005	0.001	0.100
Minimum	7.05	0.010	0.05	0.1	0.1	0.10	0.001	0.10	0.050	0.01	0.10	0.005	0.001	0.100
Standard Deviation	1.55	0.08	0.05	0.82	0.16	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00
No. of Samples Above Class I	3	9	0	0	0	--	0	0	0	0	0	0	0	--

	Ni	Pb	Se	Unat	V	Zn	Ra226	Ra228	Ra226 +Ra228	Alpha	Beta
	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	pCi/l	pCi/l	pCi/l	pCi/l	pCi/l
No. of Samples	14	14	14	14	14	14	14	14	14	14	14
Average	0.050	0.001	0.011	0.073	0.10	0.02	53.6	1.7	55.3	290.9	79.7
Maximum	0.050	0.001	0.040	0.199	0.10	0.04	208.0	2.7	209.7	1000.0	373.0
Minimum	0.050	0.001	0.001	0.000	0.10	0.01	0.3	0.2	0.8	-2.0	10.5
Standard Deviation	0.00	0.00	0.01	0.09	0.00	0.01	87.08	0.74	87.27	331.06	109.67
No. of Samples Above Class I	--	0	0	--	--	0	--	--	4	9	--

G SAND WELLS: URZJF-11, AND URZJF-17

	Ca	Cl	CO3	HCO3	K	Mg	Na	SO4	Fe	Temp	TDS	Cond	Cond(f)	pH
	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	deg C	mg/l	micromhos/ cm	micromhos/ cm	std. units
No. of Samples	8	8	8	8	8	8	8	8	8	8	8	8	8	8
Average	204	8	12	105	23	47	176	961	13.44	8.6	1563	1736	1988	8.99
Maximum	328	9	35	172	46	78	236	1260	92.80	15.4	2000	2350	2870	11.10
Minimum	14	6	5	5	11	1	143	399	0.03	3.7	678	528	225	7.60
Standard Deviation	128.95	0.93	11.27	82.77	15.55	38.08	32.71	363.92	32.47	4.04	560.25	655.05	996.03	1.69
No. of Samples Above Class I	--	0	--	--	--	--	--	8	2	--	8	--	--	3

	pH(f)	Mn	NH3	NO3+NO2	F	Al	As	Ba	Cr	Cu	B	Cd	Hg	Mo
	std. units	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
No. of Samples	8	8	8	8	8	8	8	8	8	8	8	8	8	8
Average	8.57	0.110	0.09	0.4	0.2	0.24	0.001	0.10	0.050	0.01	0.10	0.005	0.001	0.100
Maximum	12.83	0.240	0.16	0.8	0.4	1.20	0.002	0.10	0.050	0.01	0.10	0.005	0.001	0.100
Minimum	6.21	0.010	0.05	0.1	0.1	0.10	0.001	0.10	0.050	0.01	0.10	0.005	0.001	0.100
Standard Deviation	2.75	0.08	0.04	0.30	0.11	0.39	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
No. of Samples Above Class I	3	6	0	0	0	--	0	0	0	0	0	0	0	--

	Ni	Pb	Se	Unat	V	Zn	Ra226	Ra228	Ra226 +Ra228	Alpha	Beta
	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	pCi/l	pCi/l	pCi/l	pCi/l	pCi/l
No. of Samples	8	8	8	8	8	8	8	8	8	8	8
Average	0.050	0.001	0.019	0.036	0.10	0.01	3.3	2.2	5.5	90.7	75.1
Maximum	0.050	0.001	0.034	0.063	0.10	0.02	11.0	5.2	13.4	232.0	173.0
Minimum	0.050	0.001	0.001	0.000	0.10	0.01	0.2	0.2	0.4	-0.2	28.5
Standard Deviation	0.00	0.00	0.02	0.03	0.00	0.01	3.45	1.64	4.18	85.22	60.02
No. of Samples Above Class I	--	0	0	--	--	0	--	--	3	5	--

TABLE JD-D6-6. SUMMARY OF THE GROUND-WATER QUALITY (cont.)

ALLUVIAL WELLS: URZJQ-24-1, URZJQ-25, AND URZJQ-26

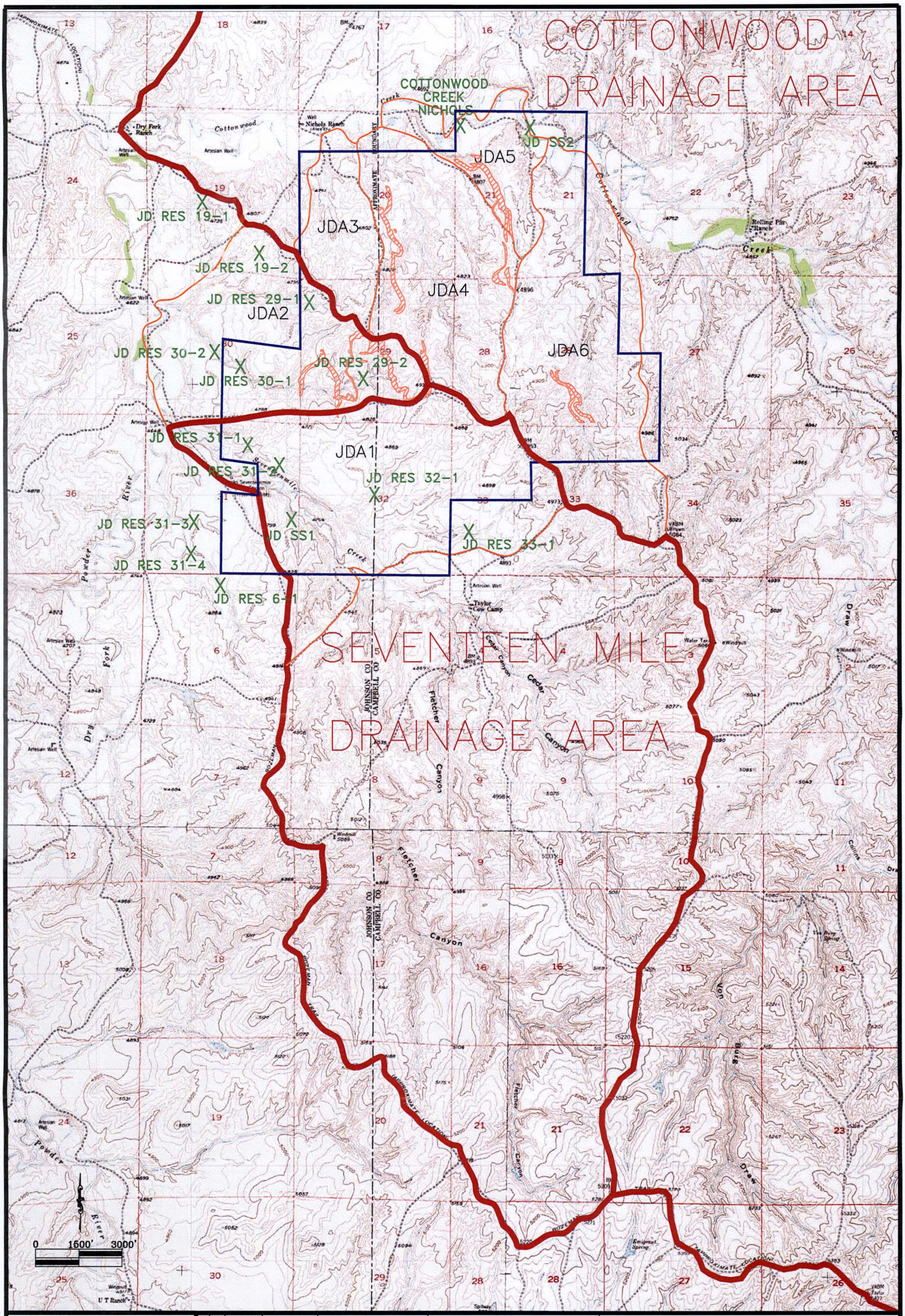
	Ca	Cl	CO3	HCO3	K	Mg	Na	SO4	Fe	Temp	TDS	Cond	Cond(f)	pH
	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	deg C	mg/l	micromhos/ cm	micromhos/ cm	std. units
No. of Samples	15	15	15	15	15	15	15	15	15	15	15	15	15	15
Average	462	29	5	397	9	141	439	2295	0.16	8.4	3713	3980	4500	7.35
Maximum	533	59	5	460	12	168	680	2900	0.67	13.0	4740	4860	5920	7.85
Minimum	370	12	5	296	7	102	246	1620	0.03	4.7	2640	2930	3110	7.16
Standard Deviation	56.97	17.61	0.00	59.27	1.91	27.33	163.39	464.54	0.22	2.62	762.68	740.67	935.26	0.23
No. of Samples Above Class I	--	0	--	--	--	--	--	15	2	--	15	--	--	0

	pH(f)	Mn	NH3	NO3+NO2	F	Al	As	Ba	Cr	Cu	B	Cd	Hg	Mo
	std. units	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
No. of Samples	15	15	15	15	15	15	15	15	15	15	15	15	15	15
Average	6.65	0.241	0.07	0.1	0.3	0.10	0.001	0.10	0.050	0.01	0.11	0.005	0.001	0.100
Maximum	7.17	0.410	0.25	0.1	0.5	0.10	0.001	0.10	0.050	0.01	0.20	0.005	0.001	0.100
Minimum	5.70	0.040	0.05	0.1	0.2	0.10	0.001	0.10	0.050	0.01	0.10	0.005	0.001	0.100
Standard Deviation	0.36	0.13	0.06	0.00	0.10	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00
No. of Samples Above Class I	5	13	0	0	0	--	0	0	0	0	0	0	0	--

	Ni	Pb	Se	Unat	V	Zn	Ra226	Ra228	Ra226 +Ra228	Alpha	Beta
	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	pCi/l	pCi/l	pCi/l	pCi/l	pCi/l
No. of Samples	15	15	15	15	15	15	15	15	14	15	15
Average	0.050	0.001	0.001	0.091	0.10	0.02	0.6	0.9	1.5	87.1	17.8
Maximum	0.050	0.002	0.003	0.120	0.10	0.05	1.3	1.8	2.6	132.0	29.4
Minimum	0.050	0.001	0.001	0.073	0.10	0.01	0.1	0.0	0.4	31.2	1.9
Standard Deviation	0.00	0.00	0.00	0.02	0.00	0.01	0.29	0.58	0.68	31.63	7.39
No. of Samples Above Class I	--	0	0	--	--	0	--	--	0	15	--

Mehtods Used for Constituent Analysis

EPA 200.7 or EPA 200.8: Ca, Cl, K, Mg, Na, Fe, Mn, Al, As, Ba, Cr, Cu, B, Cd, Mo, Ni, Pb, Se, Unat, V, and Zn
2320B: CO3 and HCO3
EPA 300.1: SO4
EPA 170.1: Temp
2540C: TDS
EPA 150.2: Cond
4500 NH3 H: NH3
4500-F C: F
EPA 200.8 or 3114B: As
EPA 200.8: Hg
EPA 903.0: Ra226
RA-05: Ra228
EPA 900.0: Alpha and Beta



LEGEND
WELLFIELD
PERMIT BOUNDARY
DRAINAGE AREA
MINOR DRAINAGE AREA
X SURFACE WATER SAMPLING SITE

REVISIONS

No.	DATE	MADE BY	DESCRIPTION
1	4/2016	ADA	
2			
3			
4			

DATE	DRAWN BY	CHECKED	APPROVED
1/2014	ADA		

HYDRO-ENGINEERING L.L.C.

HYDRO-ENGINEERING L.L.C.
4685 EAST MAGNOLIA
CASPER, WYOMING, 82604

FILE: C:\PROJECTS\2016-14\JDPIEZO

Uranerz ENERGY CORPORATION
Uranerz Energy Corporation (an Energy Fuels Company)
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FIGURE JD-D6-1. SURFACE DRAINAGE AREAS

TABLE JD-D6A.1-1. SURFACE WATER QUALITY

SITE	DATE	TEMP °C	pH(f)	Cond(f)	TDS	Alkalinity	U	Ra226	Ra226(e)	NH3	CO3	HCO3	SO4	F	Cl	N	Ca
Cottonwood U Nichols	6/9/2008	-	-	-	1800	-	0.137	0	-	0.7	<1	245	1030	0.2	18	0.1	141
Cottonwood D Nichols	6/10/2008	-	-	-	197	-	0.0009	-0.1	-	<0.1	<1	148	12	<0.1	<1	<0.05	22
JD RES 19-1	6/24/2010	20.70	8.95	1607	1100	--	0.0006	0.15	0.22	0.32	107	846	131	1.0	6	0.4	12
	7/16/2010	18.20	9.67	1699	1130	--	0.0008	0.25	0.16	0.13	116	868	121	1.1	7	0.2	11
	10/5/2010	11.80	9.81	1930	1340	--	0.0004	2.4	0.32	0.54	170	964	162	1.2	8	0.2	14
	3/24/2011	0.40	8.70	1608	961	--	0.0004	0.17	0.11	0.14	47	827	124	0.9	7	1.1	31
	7/26/2012	25.00	9.14	1702	1140	893	0.0009	0.33	0.19	<0.05	146	794	117	1.2	8	<0.1	10
JD RES 19-2	6/24/2010	20.20	8.84	1631	1080	--	0.0005	0.30	0.21	0.56	112	877	100	1.0	7	0.5	13
	7/16/2010	18.70	9.65	1709	1120	--	0.0006	0.21	0.14	<0.05	135	859	104	1.1	7	0.3	10
	10/6/2010	9.40	10.03	2480	1400	--	0.0030	0.99	0.26	<0.05	246	920	134	1.3	8	<0.1	8
	3/24/2011	0.30	8.79	1765	1020	--	0.0009	0.22	0.11	1.20	63	917	115	1.0	7	0.5	21
	7/26/2012	24.40	8.80	1762	1160	909	0.0007	0.26	0.15	0.49	95	916	132	1.2	9	0.3	12
	2/13/2013	10.50	7.84	1634	1020	911	<0.0003	1.0	0.21	3.02	27	1060	52	1.2	6	0.3	61
JD RES 29-1	6/24/2010	21.50	9.17	3160	2090	--	0.0011	0.46	0.28	<0.05	326	1590	115	1.3	11	<0.1	7
	7/16/2010	19.20	10.08	3700	2220	--	0.0013	0.02	0.13	<0.05	384	1610	123	1.4	12	<0.1	6
	10/6/2010	9.50	10.30	4860	2780	--	0.0035	7.3	0.58	<0.05	628	1820	149	1.7	14	<0.1	9
	3/24/2011	-0.40	9.07	1314	1530	--	0.0009	-0.07	0.07	<0.05	179	1230	111	1.1	10	1.1	13
	7/26/2012	24.10	9.47	4370	2930	2350	0.0047	0.25	0.14	0.17	583	1680	217	2.0	24	<0.1	7
JD RES 29-2	6/24/2010	21.80	8.26	2190	1400	--	<0.0003	0.44	0.22	0.22	72	1350	90	1.1	7	1.2	29
	7/16/2010	18.80	8.76	2410	1400	--	0.0004	0.24	0.14	0.22	83	1380	61	1.2	7	1.0	26
	10/6/2010	10.80	8.75	1994	1420	--	0.0008	0.70	0.21	0.10	95	1390	33	1.2	7	1.6	29
	3/24/2011	1.00	8.79	2690	1280	--	0.0006	0.02	0.09	0.31	68	1260	85	1.1	7	1.3	23
	7/24/2012	26.90	8.62	1810	1180	--	0.0004	0.35	0.16	<0.05	72	1110	39	1.2	7	0.7	19
JD RES 30-1	6/25/2010	22.40	8.79	1852	1270	--	0.0034	0.23	0.15	0.15	106	1080	113	1.2	7	0.3	14
	7/16/2010	18.70	9.40	2790	1710	--	0.0126	0.12	0.14	0.05	120	949	483	1.0	13	0.2	18
	4/26/2011	4.80	9.05	1923	1210	--	0.0070	0.35	0.20	0.07	83	933	172	1.1	8	0.4	20
	7/24/2012	26.30	8.96	2160	1400	--	0.0040	0.64	0.18	<0.05	146	1060	116	1.3	9	<0.1	12
JD RES 30-2	6/25/2010	22.00	8.58	1717	1190	--	0.0027	0.54	0.15	0.58	53	1080	106	1.2	7	0.3	21
	7/16/2010	20.00	9.31	2060	1210	--	0.0020	0.59	0.21	0.19	106	1050	89	1.2	7	0.3	13
	4/26/2011	5.10	9.25	1892	1200	--	0.0038	1.6	0.27	0.18	86	952	150	1.1	7	0.5	21
	6/19/2012	20.50	8.96	2100	1390	902	0.0077	0.29	0.25	<0.05	92	913	257	1.1	8	0.5	16
	7/24/2012	25.00	8.88	1844	1250	--	0.0037	0.50	0.20	<0.05	116	978	113	1.2	8	0.1	15
JD RES 31-1	6/25/2010	24.10	8.82	1868	1300	--	0.0071	0.31	0.13	<0.05	162	746	252	1.0	7	<0.1	9
	10/8/2010	9.30	9.36	1885	1260	--	0.0045	0.34	0.16	0.17	138	1080	95	1.2	7	0.4	13
	3/23/2011	2.00	8.80	384	202	--	0.0014	0.25	0.10	<0.05	11	157	46	0.5	2	<0.1	17
	6/18/2012	20.30	9.12	1245	821	596	0.0019	0.09	0.14	<0.05	94	535	114	1.6	6	0.2	13

*All concentrations are in mg/l, except conductivity in mmhos/cm and radium in pCi/l.
(e) Signifies Sample Value Error (+/-)

TABLE JD-D6A.1-1. SURFACE WATER QUALITY

SITE	DATE	TEMP °C	pH(f)	Cond(f)	TDS	Alkalinity	U	Ra226	Ra226(e)	NH3	CO3	HCO3	SO4	F	Cl	N	Ca
JD RES 31-2	6/25/2010	23.40	8.68	1810	1240	--	0.0052	0.39	0.16	<0.05	97	841	239	0.9	7	<0.1	16
	7/16/2010	20.00	9.64	2410	1460	--	0.0078	0.06	0.13	<0.05	146	904	284	1.0	8	<0.1	10
	10/8/2010	8.90	9.28	1666	1130	--	0.0035	0.21	0.13	0.21	116	973	84	1.2	6	0.5	15
	3/23/2011	2.00	9.46	647	382	--	0.0014	0.31	0.12	<0.05	22	254	80	0.4	4	<0.1	16
	3/29/2011	2.60	7.68	1892	1160	--	0.0048	0.66	0.17	0.42	52	1040	145	1.0	7	0.7	30
	7/25/2012	24.60	9.16	1250	814	623	0.0012	0.47	0.19	<0.05	102	551	105	1.7	7	0.1	11
JD RES 31-3	6/25/2010	23.60	8.89	1298	910	--	0.0041	0.37	0.15	0.05	51	458	269	0.7	6	<0.1	18
	7/19/2010	19.50	10.07	1397	927	--	0.0044	0.45	0.13	<0.05	89	409	283	0.8	7	<0.1	11
	10/8/2010	8.20	9.81	2520	1470	--	0.0100	0.30	0.10	0.23	143	683	443	1.2	11	<0.1	15
	3/29/2011	2.70	9.56	1523	988	--	0.0034	0.28	0.11	<0.05	75	547	250	1.0	8	<0.1	27
	6/19/2012	20.80	9.98	1721	1230	202	0.0054	-0.06	0.14	<0.05	78	88	635	0.8	9	0.1	19
	7/24/2012	24.50	10.31	1962	1350	--	0.0061	0.31	0.14	<0.05	93	50	734	0.8	10	0.3	22
JD RES 31-4	6/25/2010	22.80	9.12	1563	1070	--	0.0040	0.55	0.17	<0.05	125	625	206	1.1	8	<0.1	12
	7/19/2010	18.50	10.18	1693	1140	--	0.0043	0.22	0.10	<0.05	184	576	215	1.2	8	<0.1	10
	10/8/2010	8.40	10.33	2620	1420	--	0.0244	0.18	0.10	0.11	277	657	275	1.6	10	<0.1	11
	3/29/2011	3.60	10.04	1410	917	--	0.0038	0.38	0.11	<0.05	91	503	189	1.1	8	<0.1	8
	6/19/2012	21.60	9.67	1227	814	567	0.0009	-0.2	0.15	<0.05	173	339	132	1.3	6	0.4	11
	7/24/2012	25.10	10.05	1398	888	--	0.0012	0.20	0.13	<0.05	257	217	150	1.4	7	<0.1	6
JD RES 32-1	6/28/2010	23.60	8.83	1880	1270	--	0.0025	0.29	0.15	<0.05	144	1150	25	1.3	7	0.3	11
	7/19/2010	19.40	9.74	1969	1310	--	0.0022	0.39	0.12	<0.05	191	1110	19	1.3	7	0.1	8
	3/23/2011	1.00	5.34	1781	1040	--	0.0021	0.32	0.11	<0.05	109	1000	7	1.2	8	0.4	13
	4/26/2011	4.90	9.44	1773	1140	--	0.0011	0.06	0.21	0.06	124	1000	6	1.3	8	0.2	13
	6/22/2012	21.50	9.04	1807	1210	1090	0.0007	0.38	0.14	<0.05	143	1040	6	1.3	7	<0.1	11
	7/25/2012	25.40	9.14	1970	1280	1190	0.0006	0.30	0.14	<0.05	207	1030	5	1.3	8	0.5	8
JD RES 33-1	6/24/2010	22.90	8.84	1563	1040	--	0.0018	0.22	0.23	0.09	106	942	26	1.1	7	0.3	14
	7/19/2010	19.70	9.74	1676	1130	--	0.0020	0.38	0.12	<0.05	168	915	27	1.2	7	<0.1	8
	10/6/2010	11.50	9.94	1871	1310	--	0.0027	0.18	0.15	<0.05	223	1030	30	1.4	8	<0.1	7
	3/24/2011	-0.60	9.22	1195	692	--	0.0020	0.40	0.14	0.49	51	655	33	0.8	6	0.6	15
	6/18/2012	21.00	9.01	1500	976	850	0.0021	0.43	0.26	<0.05	109	816	41	1.1	7	0.1	13
	7/25/2012	24.20	9.10	1680	1090	962	0.0027	0.22	0.12	<0.05	157	855	45	1.2	8	<0.1	10
JD RES 6-1	6/28/2010	24.40	8.28	1399	897	--	0.0004	0.28	0.15	1.17	46	914	24	1.0	14	<0.1	27
	7/16/2010	19.90	8.84	1443	923	--	0.0004	0.05	0.11	1.03	60	900	20	1.0	28	0.1	23
	3/25/2011	0.40	8.83	1350	774	--	<0.0003	0.31	0.11	0.85	45	806	13	0.9	10	0.2	35
	6/22/2012	21.00	8.66	1158	741	678	0.0005	0.93	0.20	0.21	57	712	15	1.1	8	0.3	19
	7/25/2012	23.30	8.99	1241	803	708	0.0005	0.21	0.13	<0.05	87	686	18	1.1	10	<0.1	12
JD SS 1	3/23/2011	-2.50	5.74	155.4	112	--	0.0017	0.38	0.12	<0.05	<5	85	26	<0.1	1	<0.1	21
	4/19/2012	8.90	6.90	310	204	72	0.0018	0.23	0.15	0.32	<5	88	70	<0.1	2	<0.1	37
	6/6/2013				232	113	0.0004	0.14	0.17	1.19	<5	137	20	0.1	4	<0.1	38

*All concentrations are in mg/l, except conductivity in mmhos/cm and radium in pCi/l.
(e) Signifies Sample Value Error (+/-)

TABLE JD-D6A.1-1. SURFACE WATER QUALITY

SITE	DATE	Mg	K	Na	Fe	Mn	Cu	Zn	Pb	Ni	Cr	Ba	V	Mo	Al	B	Se
Cottonwood U Nichols	6/9/2008	77	27	288	0.19	0.36	<0.01	0.01	<0.001	<0.05	<0.05	<0.1	<0.1	<0.1	<0.1	0.1	0.001
Cottonwood D Nichols	6/10/2008	5	13	18	0.57	0.05	<0.01	<0.01	0.001	<0.05	<0.05	<0.1	<0.1	<0.1	0.2	<0.1	0.002
JD RES 19-1	6/24/2010	34	48	327	<0.03	<0.01	<0.01	0.07	<0.001	<0.05	<0.05	0.2	<0.1	<0.1	<0.1	0.2	<0.001
	7/16/2010	35	49	348	<0.03	<0.01	<0.01	<0.01	<0.001	<0.05	<0.05	0.3	<0.1	<0.1	<0.1	0.2	<0.001
	10/5/2010	41	59	413	<0.03	<0.01	<0.01	<0.01	<0.001	<0.05	<0.05	0.3	<0.1	<0.1	<0.1	<0.1	<0.001
	3/24/2011	31	44	296	<0.03	<0.01	<0.01	<0.01	<0.001	<0.05	<0.05	0.4	<0.1	<0.1	<0.1	0.2	<0.001
	7/26/2012	38	60	323	<0.03	<0.01	<0.01	0.01	<0.001	<0.05	<0.05	0.3	<0.1	<0.1	<0.1	0.2	0.001
JD RES 19-2	6/24/2010	36	52	354	<0.03	<0.01	<0.01	0.01	<0.001	<0.05	<0.05	0.3	<0.1	<0.1	<0.1	0.2	<0.001
	7/16/2010	38	53	372	<0.03	<0.01	<0.01	<0.01	<0.001	<0.05	<0.05	0.3	<0.1	<0.1	<0.1	0.3	<0.001
	10/6/2010	46	63	459	<0.03	<0.01	<0.01	<0.01	<0.001	<0.05	<0.05	0.2	<0.1	<0.1	<0.1	0.3	0.002
	3/24/2011	36	49	342	<0.03	<0.01	<0.01	<0.01	<0.001	<0.05	<0.05	0.3	<0.1	<0.1	<0.1	0.3	<0.001
	7/26/2012	37	64	340	0.05	<0.01	<0.01	<0.01	<0.001	<0.05	<0.05	0.3	<0.1	<0.1	<0.1	0.3	<0.001
	2/13/2013	32	51	272	<0.03	0.02	<0.01	<0.01	<0.001	<0.05	<0.05	1.7	<0.1	<0.1	<0.1	0.2	<0.001
JD RES 29-1	6/24/2010	33	34	820	0.08	<0.01	<0.01	0.02	0.003	<0.05	<0.05	0.4	<0.1	<0.1	<0.1	0.2	<0.001
	7/16/2010	35	36	872	<0.03	<0.01	<0.01	<0.01	<0.001	<0.05	<0.05	0.4	<0.1	0.7	<0.1	0.2	<0.001
	10/6/2010	42	45	1080	0.04	0.03	<0.01	<0.01	<0.001	<0.05	<0.05	0.5	<0.1	<0.1	<0.1	0.2	0.001
	3/24/2011	22	27	616	<0.03	0.02	<0.01	<0.01	<0.001	<0.05	<0.05	0.3	<0.1	<0.1	<0.1	0.1	<0.001
	7/26/2012	38	43	1100	0.04	<0.01	<0.01	<0.01	<0.001	<0.05	<0.05	0.2	<0.1	<0.1	<0.1	0.2	0.002
JD RES 29-2	6/24/2010	34	32	500	<0.03	<0.01	<0.01	0.02	0.001	<0.05	<0.05	0.7	<0.1	<0.1	<0.1	0.2	<0.001
	7/16/2010	34	31	486	<0.03	<0.01	<0.01	<0.01	<0.001	<0.05	<0.05	1.0	<0.1	0.1	<0.1	0.2	<0.001
	10/6/2010	34	32	482	0.09	0.01	<0.01	<0.01	<0.001	<0.05	<0.05	1.0	<0.1	<0.1	<0.1	0.2	<0.001
	3/24/2011	31	31	462	0.15	<0.01	<0.01	<0.01	<0.001	<0.05	<0.05	0.4	<0.1	<0.1	<0.1	0.2	<0.001
	7/24/2012	28	29	428	<0.03	<0.01	<0.01	0.01	<0.001	<0.05	<0.05	0.6	<0.1	<0.1	<0.1	0.2	<0.001
JD RES 30-1	6/25/2010	37	32	435	<0.03	<0.01	<0.01	<0.01	<0.001	<0.05	<0.05	0.6	<0.1	<0.1	<0.1	0.2	<0.001
	7/16/2010	56	29	515	<0.03	<0.01	<0.01	0.01	<0.001	<0.05	<0.05	0.4	<0.1	<0.1	<0.1	0.1	<0.001
	4/26/2011	39	30	378	<0.03	0.01	<0.01	<0.01	<0.001	<0.05	<0.05	0.2	<0.1	<0.1	<0.1	0.2	<0.001
	7/24/2012	35	35	524	0.03	<0.01	<0.01	0.01	<0.001	<0.05	<0.05	0.3	<0.1	<0.1	<0.1	0.2	<0.001
JD RES 30-2	6/25/2010	36	33	387	<0.03	<0.01	<0.01	<0.01	<0.001	<0.05	<0.05	0.7	<0.1	<0.1	<0.1	0.2	<0.001
	7/16/2010	35	34	397	<0.03	<0.01	<0.01	<0.01	<0.001	<0.05	<0.05	0.8	<0.1	<0.1	<0.1	0.2	<0.001
	4/26/2011	37	30	380	<0.03	<0.01	<0.01	<0.01	<0.001	<0.05	<0.05	0.3	<0.1	<0.1	<0.1	0.2	<0.001
	6/19/2012	42	33	426	<0.03	<0.01	<0.01	0.01	<0.001	<0.05	<0.05	0.2	<0.1	<0.1	<0.1	0.3	<0.001
	7/24/2012	31	29	402	0.04	<0.01	<0.01	0.02	<0.001	<0.05	<0.05	0.3	<0.1	<0.1	<0.1	0.2	<0.001
JD RES 31-1	6/25/2010	37	31	421	0.04	<0.01	<0.01	<0.01	<0.001	<0.05	<0.05	0.2	<0.1	<0.1	<0.1	0.1	<0.001
	10/8/2010	38	35	463	0.07	<0.01	<0.01	<0.01	<0.001	<0.05	<0.05	0.5	<0.1	<0.1	0.1	0.2	0.001
	3/23/2011	10	12	45	0.18	<0.01	<0.01	0.01	<0.001	<0.05	<0.05	<0.1	<0.1	<0.1	0.2	<0.1	<0.001
	6/18/2012	36	29	265	<0.03	<0.01	<0.01	0.04	<0.001	<0.05	<0.05	0.2	<0.1	<0.1	<0.1	0.1	0.011

*All concentrations are in mg/l, except conductivity in mmhos/cm and radium in pCi/l.

TABLE JD-D6A.1-1. SURFACE WATER QUALITY

SITE	DATE	Mg	K	Na	Fe	Mn	Cu	Zn	Pb	Ni	Cr	Ba	V	Mo	Al	B	Se
JD RES 31-2	6/25/2010	37	31	416	0.06	<0.01	<0.01	<0.01	<0.001	<0.05	<0.05	0.2	<0.1	<0.1	0.1	0.1	<0.001
	7/16/2010	39	31	484	<0.03	<0.01	<0.01	<0.01	<0.001	<0.05	<0.05	0.2	<0.1	<0.1	<0.1	0.2	<0.001
	10/8/2010	37	33	391	<0.03	<0.01	<0.01	0.01	<0.001	<0.05	<0.05	0.7	<0.1	<0.1	<0.1	0.2	0.001
	3/23/2011	11	15	110	0.19	<0.01	<0.01	0.02	<0.001	<0.05	<0.05	0.1	<0.1	<0.1	0.2	<0.1	<0.001
	3/29/2011	36	29	399	<0.03	0.01	<0.01	<0.01	<0.001	<0.05	<0.05	0.4	<0.1	<0.1	<0.1	0.2	<0.001
	7/25/2012	38	33	247	<0.03	<0.01	<0.01	0.02	<0.001	<0.05	<0.05	0.4	<0.1	<0.1	<0.1	0.1	<0.001
JD RES 31-3	6/25/2010	27	21	266	0.06	<0.01	<0.01	<0.01	<0.001	<0.05	<0.05	<0.1	<0.1	<0.1	<0.1	0.1	<0.001
	7/19/2010	27	22	284	0.04	<0.01	<0.01	0.01	<0.001	<0.05	<0.05	<0.1	<0.1	<0.1	<0.1	0.1	<0.001
	10/8/2010	36	31	495	0.13	<0.01	<0.01	<0.01	<0.001	<0.05	<0.05	<0.1	<0.1	<0.1	0.1	0.2	0.002
	3/29/2011	31	24	284	<0.03	<0.01	<0.01	<0.01	<0.001	<0.05	<0.05	0.2	<0.1	<0.1	<0.1	<0.1	<0.001
	6/19/2012	32	25	324	<0.03	<0.01	<0.01	<0.01	<0.001	<0.05	<0.05	<0.1	<0.1	<0.1	<0.1	0.1	0.001
	7/24/2012	33	29	364	<0.03	<0.01	<0.01	<0.01	<0.001	<0.05	<0.05	<0.1	<0.1	<0.1	<0.1	<0.1	0.001
JD RES 31-4	6/25/2010	36	30	345	0.04	<0.01	<0.01	<0.01	<0.001	<0.05	<0.05	<0.1	<0.1	<0.1	<0.1	0.2	<0.001
	7/19/2010	38	32	363	<0.03	<0.01	<0.01	<0.01	<0.001	<0.05	<0.05	<0.1	<0.1	<0.1	<0.1	0.2	<0.001
	10/8/2010	39	38	507	0.26	0.03	0.02	<0.01	0.021	<0.05	<0.05	<0.1	<0.1	<0.1	0.1	0.3	0.002
	3/29/2011	26	26	282	0.42	<0.01	<0.01	<0.01	<0.001	<0.05	<0.05	0.1	<0.1	<0.1	0.7	<0.1	<0.001
	6/19/2012	37	28	260	<0.03	<0.01	<0.01	0.01	<0.001	<0.05	<0.05	<0.1	<0.1	<0.1	<0.1	0.2	<0.001
	7/24/2012	34	29	255	<0.03	<0.01	<0.01	0.01	<0.001	<0.05	<0.05	<0.1	<0.1	<0.1	<0.1	0.1	<0.001
JD RES 32-1	6/28/2010	32	22	492	<0.03	<0.01	<0.01	<0.01	<0.001	<0.05	<0.05	0.6	<0.1	<0.1	<0.1	0.2	0.002
	7/19/2010	32	23	467	0.03	<0.01	<0.01	<0.01	<0.001	<0.05	<0.05	0.6	<0.1	<0.1	<0.1	0.1	0.002
	3/23/2011	24	19	399	0.04	<0.01	<0.01	0.02	<0.001	<0.05	<0.05	0.6	<0.1	<0.1	<0.1	0.1	<0.001
	4/26/2011	27	20	402	0.06	<0.01	<0.01	<0.01	<0.001	<0.05	<0.05	0.5	<0.1	<0.1	<0.1	0.1	<0.001
	6/22/2012	26	20	437	0.11	<0.01	<0.01	0.02	<0.001	<0.05	<0.05	0.3	<0.1	<0.1	0.1	0.2	<0.001
	7/25/2012	28	21	468	0.06	<0.01	<0.01	0.01	<0.001	<0.05	<0.05	0.3	<0.1	<0.1	<0.1	0.1	<0.001
JD RES 33-1	6/24/2010	33	21	359	0.05	<0.01	<0.01	<0.01	0.001	<0.05	<0.05	0.4	<0.1	<0.1	<0.1	0.2	<0.001
	7/19/2010	34	23	375	<0.03	<0.01	<0.01	<0.01	<0.001	<0.05	<0.05	0.4	<0.1	<0.1	<0.1	0.1	<0.001
	10/6/2010	41	26	450	<0.03	0.01	<0.01	<0.01	<0.001	<0.05	<0.05	0.5	<0.1	<0.1	<0.1	0.2	<0.001
	3/24/2011	24	18	231	0.11	<0.01	<0.01	<0.01	<0.001	<0.05	<0.05	0.3	<0.1	<0.1	0.2	0.1	<0.001
	6/18/2012	33	21	367	<0.03	<0.01	<0.01	0.03	<0.001	<0.05	<0.05	0.2	<0.1	<0.1	<0.1	0.1	0.009
	7/25/2012	35	24	381	0.06	<0.01	<0.01	0.01	<0.001	<0.05	<0.05	0.2	<0.1	<0.1	0.1	0.2	<0.001
JD RES 6-1	6/28/2010	35	25	284	<0.03	<0.01	<0.01	<0.01	<0.001	<0.05	<0.05	0.9	<0.1	<0.1	<0.1	0.2	<0.001
	7/16/2010	37	25	275	<0.03	<0.01	<0.01	<0.01	<0.001	<0.05	<0.05	0.9	<0.1	<0.1	<0.1	0.1	<0.001
	3/25/2011	30	21	239	<0.03	<0.01	<0.01	0.01	<0.001	<0.05	<0.05	1.0	<0.1	<0.1	<0.1	0.1	<0.001
	6/22/2012	36	26	249	<0.03	<0.01	<0.01	0.05	<0.001	<0.05	<0.05	0.6	<0.1	<0.1	<0.1	0.2	<0.001
	7/25/2012	36	30	256	<0.03	<0.01	<0.01	0.02	<0.001	<0.05	<0.05	0.4	<0.1	<0.1	<0.1	0.2	<0.001
JD SS 1	3/23/2011	4	6	7	0.18	0.02	<0.01	0.02	<0.001	<0.05	<0.05	<0.1	<0.1	<0.1	<0.1	<0.1	<0.001
	4/19/2012	8	8	8	0.53	<0.01	<0.01	<0.01	<0.001	<0.05	<0.05	<0.1	<0.1	<0.1	<0.1	<0.1	<0.001
	6/6/2013	6	13	4	0.53	0.27	<0.01	<0.01	<0.001	<0.05	<0.05	<0.1	<0.1	<0.1	<0.1	<0.1	0.001

*All concentrations are in mg/l, except conductivity in mmhos/cm and radium in pCi/l.

TABLE JD-D6A.1-1. SURFACE WATER QUALITY

SITE	DATE	As	Hg	Cd
Cottonwood U Nichols	6/9/2008	0.003	<0.001	<0.005
Cottonwood D Nichols	6/10/2008	0.004	<0.001	<0.005
JD RES 19-1	6/24/2010	0.001	<0.001	<0.005
	7/16/2010	0.002	<0.001	<0.005
	10/5/2010	0.002	<0.001	<0.005
	3/24/2011	<0.001	<0.001	<0.005
	7/26/2012	0.003	<0.001	<0.005
JD RES 19-2	6/24/2010	<0.001	<0.001	<0.005
	7/16/2010	0.001	<0.001	<0.005
	10/6/2010	0.003	<0.001	<0.005
	3/24/2011	0.001	<0.001	<0.005
	7/26/2012	0.003	<0.001	<0.005
	2/13/2013	<0.001	<0.001	<0.005
JD RES 29-1	6/24/2010	0.004	<0.001	<0.005
	7/16/2010	0.007	<0.001	<0.005
	10/6/2010	0.005	<0.001	<0.005
	3/24/2011	0.002	<0.001	<0.005
	7/26/2012	0.010	<0.001	<0.005
JD RES 29-2	6/24/2010	0.002	<0.001	<0.005
	7/16/2010	0.003	<0.001	<0.005
	10/6/2010	0.002	<0.001	<0.005
	3/24/2011	0.001	<0.001	<0.005
	7/24/2012	0.003	<0.001	<0.005
JD RES 30-1	6/25/2010	0.002	<0.001	<0.005
	7/16/2010	0.005	<0.001	<0.005
	4/26/2011	0.001	<0.001	<0.005
	7/24/2012	0.006	<0.001	<0.005
JD RES 30-2	6/25/2010	0.003	<0.001	<0.005
	7/16/2010	0.003	<0.001	<0.005
	4/26/2011	0.001	<0.001	<0.005
	6/19/2012	0.005	<0.001	<0.005
	7/24/2012	0.005	<0.001	<0.005
JD RES 31-1	6/25/2010	0.003	<0.001	<0.005
	10/8/2010	0.002	<0.001	<0.005
	3/23/2011	0.001	<0.001	<0.005
	6/18/2012	0.002	<0.001	<0.005

*All concentrations are in mg/l, except conductivity in mmhos/cm and radium in pCi/l.

TABLE JD-D6A.1-1. SURFACE WATER QUALITY

SITE	DATE	As	Hg	Cd
JD RES 31-2	6/25/2010	0.002	<0.001	<0.005
	7/16/2010	0.004	<0.001	<0.005
	10/8/2010	0.002	<0.001	<0.005
	3/23/2011	0.002	<0.001	<0.005
	3/29/2011	0.001	<0.001	<0.005
	7/25/2012	0.002	<0.001	<0.005
JD RES 31-3	6/25/2010	0.004	<0.001	<0.005
	7/19/2010	0.005	<0.001	<0.005
	10/8/2010	0.009	<0.001	<0.005
	3/29/2011	0.003	<0.001	<0.005
	6/19/2012	0.005	<0.001	<0.005
	7/24/2012	0.008	<0.001	<0.005
JD RES 31-4	6/25/2010	0.004	<0.001	<0.005
	7/19/2010	0.006	<0.001	<0.005
	10/8/2010	0.012	<0.001	<0.005
	3/29/2011	0.007	<0.001	<0.005
	6/19/2012	0.005	<0.001	<0.005
	7/24/2012	0.007	<0.001	<0.005
JD RES 32-1	6/28/2010	0.003	<0.001	<0.005
	7/19/2010	0.003	<0.001	<0.005
	3/23/2011	0.002	<0.001	<0.005
	4/26/2011	<0.001	<0.001	<0.005
	6/22/2012	0.004	<0.001	<0.005
	7/25/2012	0.005	<0.001	<0.005
JD RES 33-1	6/24/2010	0.003	<0.001	<0.005
	7/19/2010	0.003	<0.001	<0.005
	10/6/2010	0.004	<0.001	<0.005
	3/24/2011	0.002	<0.001	<0.005
	6/18/2012	0.004	<0.001	<0.005
	7/25/2012	0.006	<0.001	<0.005
JD RES 6-1	6/28/2010	<0.001	<0.001	<0.005
	7/16/2010	0.001	<0.001	<0.005
	3/25/2011	<0.001	<0.001	<0.005
	6/22/2012	0.002	<0.001	<0.005
	7/25/2012	0.003	<0.001	<0.005
JD SS 1	3/23/2011	0.001	<0.001	<0.005
	4/19/2012	0.002	<0.001	<0.005
	6/6/2013	0.005	<0.001	<0.005

*All concentrations are in mg/l, except conductivity in mmhos/cm and radium in pCi/l.

NOTES: *LOCATION

JD RES 19-1	T43N R76W	S19 SW
JD RES 19-2	T43N R76W	S19 SE
JD RES 29-1	T43N R76W	S29 NW
JD RES 29-2	T43N R76W	S29 SW
JD RES 30-1	T43N R76W	S30 SW
JD RES 30-2	T43N R76W	S30 SE
JD RES 31-1	T43N R76W	S31 NE
JD RES 31-2	T43N R76W	S31 NE
JD RES 31-3	T43N R76W	S31 SW
JD RES 31-4	T43N R76W	S31 SW
JD RES 32-1	T43N R76W	S32 NW
JD RES 33-1	T43N R76W	S33 SW
JD RES 6-1	T42N R76W	S6 NW
JD SS 1	T43N R76W	S31 SE
JD SS 2	T43N R76W	S21 NW

JANE DOUGH SINGLE-WELL PUMP TESTS ADDENUM JD-D6B

JD-D6B.0 INTRODUCTION AND SUMMARY

Numerous single well pump tests were conducted in the Jane Dough Unit area to define the local transmissivity of the aquifers adjacent to the ore sand. Two pump tests done at a single well site were used to define the 1 Sand aquifer properties at that point. The tests yielded a low of 1.6 gal/day/ft and a high of 19.4 gal/day/ft. Four single well tests were done on the B Sand aquifer. The results yielded transmissivity values from 9.8 to 361 gal/day/ft. One single well pump test was done in the C Sand and yielded a transmissivity value of 2.1 gal/day/ft. Three single well pump tests were done at two different locations in the F Sand. The results yielded values ranging from 7.6 to 4,440 gal/day/ft.

JD-D6B.1 SINGLE WELL TESTS

Single well pump tests have been conducted on eight of the wells at the Jane Dough Unit. These single well pump tests are useful in defining the local transmissivity and hydraulic conductivity (permeability) of the aquifers in this area. The Jane Dough Unit aquifer properties are summarized in Table **JD-D6-3** and Section JD-D6.2.2.

JD-D6B.1.1 URZJ1-12 TESTS

A single well pump test was performed on well URZJ1-12 on June 14, 2012 by pumping this well at an average rate of 0.5 gpm for approximately 24 hours. The manual and transducer data is presented in Tables JD-D6B.1-1 and JD-D6B.1-2, respectively. The drawdown data is presented in Figure JD-D6B.1-1 and yielded a transmissivity of 1.6 gal/day/ft. Figure JD-D6B.1-2 presents the recovery data of the test and gives a transmissivity value of 16 gal/day/ft.

A second single well pump test was performed on September 6, 2012. The well was pumped for approximately 24 hours at an average rate of 1 gpm. The data collected manually, and by a transducer is presented in Tables JD-D6B.1-3 and JD-D6B.1-4, respectively. The drawdown data is presented in Figure JD-D6B.1-3 and yields a transmissivity of 19.4 gal/day/ft. No recovery data was taken during this pump test.

An average of the recovery data from the first pump test and the drawdown of the second, 17.7 gal/day/ft, is thought to be most representative of the 1 Sand aquifer at this location.

JD-D6B.1.2 URZJB-3 TEST

On September 7, 2012, a pump test was conducted on well URZJB-3. The well was pumped at an average rate of 8 gpm for a period of approximately five hours. The manual and transducer data collected is presented in Tables JD-D6B.1-5 and JD-D6B.1-6, respectively. The drawdown data presented in Figure JD-D6B.1-4 and yields a transmissivity value of 361 gal/day/ft. During the last portion of the pump test the pump was valved back. This data was not used in the analysis but is presented. No recovery data was collected or analyzed for this pump test.

JANE DOUGH UNIT MULTI-WELL PUMP TESTS ADDENDUM JD-D6C

JD-D6C.0 INTRODUCTION AND SUMMARY

Five multi-well pump tests were conducted in the Jane Dough Unit area to define the local transmissivities of the A and B Sand aquifers. **Three of these multi-well** tests **evaluated the AB Sand aquifer and two tested the A Sand aquifer** while monitoring nearby A, B, C, **F**, G, and 1 Sand wells. The tests yielded a low of **38** gal/day/ft **for the A Sand** and a high of **901** gal/day/ft for the **AB** Sand aquifer. Storage coefficients obtained for the A Sand varied from **7.8**E-6 to **2.9E-3.** Transmissivity values for the B Sand varied from **58** gal/day/ft to **115** gal/day/ft.

JD-D6C.1 MULTI-WELL TESTS

The **first** three multi-well pump tests presented in this addendum are useful in defining the local transmissivity and hydraulic conductivity (permeability) of the **AB** Sand and determining whether connection exists between overlying and underlying aquifers. **The last two multi-well pump tests define aquifer properties for the A Sand.** The Jane Dough Unit aquifer properties are summarized in Table JD-D6-4 and Section JD-D6.2.2.

JD-D6C.1.1 URZJA-1 MULTI-WELL TEST

A multi-well pump test was conducted by pumping A Sand well URZJA-1 at 10 gpm for 2 days while observation wells URZJA-2, URZJB-3, URZJF-5, and URZJ1-6 were monitored for drawdown. Figure JD-D6C.1.1-1 presents the barometric pressure data and the water level change in wells URZJA-1, URZJA-2, and URZJB-3 during this multi-well pump test. The barometric pressure changed a maximum of approximately 0.35 inches of mercury during the monitoring of this multi-well pump test. The thickness of the **AB** Sand at pumping well URZJA-1 is **320** feet.

JD-D6C.1.1.1 PUMPING WELL URZJA-1

Partially penetrating well URZJA-1 was pumped from July 16 through July 18 at an average rate of 10 gallons per minute (gpm). Table JD-D6C.1.1-1 presents the pumping and manual data for this well. Table JD-D6C.1.1-2 presents the transducer data collected from the pumping well. Figure JD-D6C.1.1-1 presents a linear plot of the water-level change data collected during this pump test. This figure shows when the pump was turned on and turned off during this multi-well pump test. Figure JD-D6C.1.1-2 presents the semi-log plot of the corrected drawdown for pumping well URZJA-1. The straight-line fit to this data yields a transmissivity of 765 gal/day/ft. The late time data was used in this fit. Therefore no adjustments were needed for the partial penetration conditions.

A plot of the recovery data is presented on Figure JD-D6C.1.1-3 and a straight-line fit of this recovery data yields a transmissivity of 590 gal/day/ft. An average of the two values obtained, 678 gal/day/ft, is thought to be most representative of the A Sand near URZJA-1.

JD-D6C.1.1.2 OBSERVATION WELL URZJA-2

The manual water-level measurements made for observation well URZJA-2 are presented in Table JD-D6C.1.1-3 while the transducer water levels are presented in Table JD-D6C.1.1-4. Observation well URZJA-2 is located 127 feet from the pumping well, URZJA-1. Figure JD-D6C.1.1-1 presents the barometric pressure and water-level data collected in observation well URZJA-2. The figure shows that approximately 10 feet of drawdown was observed during the pump test.

Figure JD-D6C.1.1-4 presents the drawdown data for observation well URZJA-2 on a semi-log plot. The straight line fit yields a transmissivity of 723 gal/day/ft and a storage coefficient of 2.7 E-5. A log-log plot of the same data is presented in Figure JD-D6C.1.1-5 and yields a transmissivity value of 1610 gal/day/ft and a storage coefficient of 2.6 E-4. The higher transmissivity obtained through the WTAQ analysis is likely due to the low vertical permeability in the **AB** Sand dampening the drawdown.

The recovery plot from observation well URZJA-2 is presented in Figure JD-D6C.1.1-6 and a straight-line fit of this recovery data yields a transmissivity of 604 gal/day/ft. A transmissivity of 663 gal/day/ft(average from the two straight line fits) and a storage coefficient of 2.6 E-4 (from the WTAQ analysis) are thought to best represent the **AB** Sand at well URZJA-2.

JD-D6C.1.1.3 OBSERVATION WELL URZJB-3

Figure JD-D6C.1.1-1 presents the barometric pressure and water level change in the B Sand observation well URZJB-3. This figure shows drawdown after roughly an hour and a half of pumping of well URZJA-1. Well URZJB-3 is located **82** feet from the pumping well with 90 feet of sand vertically from the base of its perforations to the top of perforations in well URZJA-1. Tables JD-D6C.1.1-5 and JD-D6C.1.1-6 present the manual and transducer data, respectively.

The drawdown data is presented in Figure JD-D6C.1.1-7 and the straight line fit of the drawdown yields a transmissivity of 795 gal/day/ft with a storage coefficient of **1.0 E-2**. A log-log plot of the drawdown data is presented in Figure JD-D6C.1.1-8 and yields a transmissivity value of 1150 gal/day/ft and a storage coefficient of 8.5 E-5.

The recovery data for well URZJB-3 is presented in Figure JD-D6C.1.1-9. The straight line fit of the data results in a transmissivity value of 807 gal/day/ft. The average of the three transmissivity values, 901 gal/day/ft, is thought to be best representative of the B Sand near URZJB-3. A storage coefficient of **8.5 E-5** is thought to be representative of the B Sand aquifer near URZJB-3.

JD-D6C.1.1.4 UNDERLYING OBSERVATION WELL URZJ1-6

1 Sand well URZJ1-6 was monitored with manual and transducer measurements throughout the pumping of URZJA-1. Table JD-D6C.1.1-7 presents the manual data while Table JD-D6C.1.1-8

presents the transducer data. The barometric data and change in water level is graphed on Figure D6C.1.1-10 for this well. There were small variances in the transducer data through the monitoring period but these are thought to be due to the changes in barometric pressure as opposed to responses to the pump test.

JD-D6C.1.1.5 OVERLYING OBSERVATION WELL URZJF-5

Well URZJF-5 is located **97** feet from URZJA-1 and was monitored during the pump test. Tables JD-D6C.1.1-9 and JD-D6C.1.1-10 present the manual and transducer data, respectively. The water level change in well URZJF-5 is presented in Figure JD-D6C.1.1-10. The water level changes shown appear to correlate with the changes in barometric pressure and not a function of the pumping of URZJA-1.

JD-D6C.1.2 URZJA-7 MULTI-WELL TEST

A multi-well pump test was conducted by pumping A Sand well URZJA-7 for 1 day at a rate of 5.5 gpm while observation wells URZJA-8, URZJB-9, URZJC-10, and URZJ1-12 were monitored for drawdown. Figure JD-D6C.1.2-1 presents the barometric pressure data and the water level change in wells URZJA-7, URZJA-8, and URZJB-9 during this multi-well pump test. The barometric pressure changed a maximum of approximately 0.35 inches of mercury during the monitoring of this multi-well pump test.

JD-D6C.1.2.1 PUMPING WELL URZJA-7

Partially penetrating well URZJA-7 was pumped from July 25 through July 26 at a rate of 5.5 gpm. The pump notes and manual measurements taken during the pumping test are presented in Table JD-D6C.1.2-1. The transducer data is presented in Table JD-D6C.1.2-2. The drawdown data is presented on a semi-log plot in Figure JD-D6C.1.2-2. During the pump test, the water level dropped below the initial setting of the transducer and is noted on the figure. The straight line fit of the drawdown data yielded a transmissivity of 285 gal/day/ft.

The recovery data taken after the pump test is presented in Figure JD-D6C.1.2-3. The transmissivity calculated from the straight line fit is 248 gal/day/ft. An average of the drawdown and recovery data, 267 gal/day/ft, is thought to be best representative of the **AB** Sand aquifer at URZJA-7.

JD-D6C.1.2.2 OBSERVATION WELL URZJA-8

A Sand observation well URZJA-8 is located **113** feet from pumping well URZJA-7. Tables JD-D6C.1.2-3 and JD-D6C.1.2-4 present the manual and transducer data, respectively. Figure JD-D6.1.2-4 presents the semi-log drawdown plot for URZJA-8. A transmissivity of 247 gal/day/ft and a storage coefficient of **8.1 E-5** was obtained from the straight line fit of the data. Due to the partial penetrating nature of the wells, an analysis using WTAQ was done. A log-log plot of the drawdown data and the curve fit is presented is Figure JD-D6C.1.2-5.

The WTAQ analysis yielded a transmissivity value of 300 gal/day/ft and a storage coefficient of **8.3 E-6.**

The recovery data taken after the pump test is presented in Figure JD-D6C.1.2-6. The straight line fit of the data gave a transmissivity value of 447 gal/day/ft. An average of the two drawdown analyses is thought to be most representative.

JD-D6C.1.2.3 OBSERVATION WELL URZJB-9

B Sand observation well URZJB-9 is located **121** feet from the pumping well. The manual and transducer data is presented in Tables JD-D6C.1.2-5 and JD-D6C.1.2-6, respectively. A semi-log plot of the drawdown data is presented in Figure JD-D6C.1.2-7 and yielded a transmissivity value of 352 gal/day/ft and a storage coefficient of **6.3 E-4.**

The log-log plot of the drawdown data and curve fit presented in Figure JD-D6C.1.2-8 gave a transmissivity value of 259 gal/day/ft and a storage coefficient of **6.4 E-7**. The storage is too small for the AB Sand thickness, which indicates that some separation in the sand exists, causing the drawdown in URZJB-9 to be delayed.

A semi-log plot of the recovery data is presented in Figure JD-D6C.1.2-9. The straight line fit of the data yielded a transmissivity value of 359 gal/day/ft. A transmissivity value of 259 gal/day/ft and a storage coefficient of **6.3 E-4** are thought to be best representative of the aquifer near URZJB-9.

JD-D6C.1.2.4 UNDERLYING OBSERVATION WELL URZJ1-12

Underlying 1 Sand well URZJ1-12 was monitored with a transducer and by manual measurements during the pump test. Figure JD-D6C.1.2-10 presents the barometric data and the water level changes in well URZJ1-12. Minor variations were observed in the water level, however they appear to be more indicative of changes in barometric pressure as opposed to responses to the pumping.

JD-D6C.1.2.5 OVERLYING OBSERVATION WELL URZJC-10

Figure JD-D6C.1.2-10 presents the barometric pressure and water level change in C Sand well URZJC-10. Variations in the water level of this overlying observation well, but they appear to have no correlation to the pumping of well URZJA-7.

JD-D6C.1.3 URZJA-8 MULTI-WELL TEST

A multi-well pump test was conducted by pumping A Sand well URZJA-8 for 2 days at a rate of 4.3 gpm while observation wells URZJA-7, URZJB-9, URZJC-10, URZJF-11 and URZJ1-12 were monitored for drawdown. Figure JD-D6C.1.3-1 presents the barometric pressure data and the water level change in wells URZJA-7, URZJA-8, and URZJB-9 during this multi-well pump

test. The barometric pressure changed a maximum of approximately 0.8 inches of mercury during the monitoring of this multi-well pump test.

JD-D6C.1.3.1 PUMPING WELL URZJA-8

Partially penetrating A Sand well URZJA-8 was pumped from June 19 through June 21. The manual and pumping data is presented in Table JD-D6C.1.3-1. The transducer data is presented in Table JD-D6C.1.3-2. The drawdown data is presented in a semi-log plot in Figure JD-D6C.1.3-2. The straight line fit of the data yields a transmissivity value of 380 gal/day/ft.

The recovery data is presented in Figure JD-D6C.1.3-3. A transmissivity value of 230 gal/day/ft was obtained from the straight line fit of the data. An average of these two values is thought to be most representative of the **AB** Sand near URZJA-8.

JD-D6C.1.3.2 OBSERVATION WELL URZJA-7

Observation well URZJA-7 is located **113** feet from pumping well URZJA-8. Manual and transducer data taken are presented in Tables JD-D6C.1.3-3 and JD-D6C.1.3-4. A semi-log plot of the drawdown data is presented in Figure JD-D6C.1.3-4 and yields a transmissivity value of 276 gal/day/ft and a storage coefficient of **8.0E-5**. A log-log plot of the drawdown data and curve fit are presented in Figure JD-D6C.1.3-5. A transmissivity value of 329 gal/da/ft and a storage coefficient of **9.6 E-6** were obtained through the WTAQ analysis.

Figure **JD-D6C.1.3-6** presents the recovery data from URZJA-7. The transmissivity value obtained from the straight line fit is 293 gal/day/ft. An average of the three transmissivity values and of the two storage coefficients are thought to be most representative of the aquifer around URZJA-7.

JD-D6C.1.3.3 OBSERVATION WELL URZJB-9

B Sand observation well URZJB-9 is located **82** feet from pumping well URZJA-8. Tables JD-D6C.1.3-5 and JD-D6C.1.3-6 present the manual and transducer data, respectively. A semi-log plot of the drawdown is presented in Figure JD-D6C.1.3-7. A transmissivity value of 358 galday/ft and a storage coefficient of **2.9** E-3 were obtained from the straight line fit. The log-log plot of the data is presented in Figure JD-D6C.1.3-8 and yields values of 290 gal/day/ft and **4.8 E-6** for transmissivity and storage coefficient.

The recovery data is presented in Figure JD-D6C.1.3-9 and yields a transmissivity value of 305 gal/day/ft. A transmissivity value of 290 gal/day/ft and a storage coefficient of **2.9 E-3** is thought to be most representative of the aquifer near URZJB-9.

JD-D6C.1.3.4 UNDERLYING OBSERVATION WELL URZJ1-12

Figure JD-D6C.1.3-10 presents the barometric pressure and water level change data for 1 Sand well URZJ1-12. The variation shown in water level change appears to be directly caused by the barometric pressure changes and not response to the pump test.

JD-D6C.1.3.5 OVERLYING OBSERVATION WELL URZJC-10

The water level change in overlying C Sand well URZJC-10 is also presented in Figure JD-D6C.1.3-10. The sharp drop in water level a day into the pump test is thought to be caused by the drastic barometric pressure change.

JD-D6C.1.3.6 OVERLYING OBSERVATION WELL URZJF-11

Overlying G Sand well URZJF-11 was monitored during the URZJA-8 pump test. Figure JD-D6C.1.3-10 presents the water level change for this well. This well shows a larger response to the barometric changes than URZJ1-12 or URZJC-10. There's no apparent sign of response from the pumping well URZJA-8.

JD-D6C.1.4 URZJA-13-1 MULTI-WELL TEST

A multi-well pump test was conducted by pumping A Sand well URZJA-13-1 for 2 days at a rate of 3.75 gpm while observation wells URZJA-14-1, URZJB-15, and URZJC-16 were monitored for drawdown. Figure JD-D6C.1.4-1 presents the barometric pressure data and the water level change in wells URZJA-13-1 and URZJA-14-1 during this multi-well pump test. The barometric pressure changed a maximum of approximately 0.6 inches of mercury during the monitoring of this multi-well pump test.

JD-D6C.1.4.1 PUMPING WELL URZJA-13-1

Partially penetrating A Sand well URZJA-13-1 was pumped from October 30 through November 1. The manual and pumping data is presented in Table JD-D6C.1.4-1. The transducer data is presented in Table JD-D6C.1.4-2. The drawdown data is presented in a semi-log plot in Figure JD-D6C.1.4-2. The straight line fit of the data yields a transmissivity value of 67.3 gal/day/ft.

The recovery data is presented in Figure JD-D6C.1.4-3. A transmissivity value of 33.9 gal/day/ft was obtained from the straight line fit of the data. An average of these two values is thought to be most representative of the A Sand near **URZJA-13-1**.

JD-D6C.1.4.2 OBSERVATION WELL URZJA-14-1

Observation well URZJA-14-1 is located **113** feet from pumping well URZJA-13-1. Manual and transducer data taken are presented in Tables JD-D6C.1.4-3 and JD-D6C.1.4-4, respectively. A semi-log plot of the drawdown data is presented in Figure JD-D6C.1.4-4 and yields a

transmissivity value of 43 gal/day/ft and a storage coefficient of **1.5** E-5. A log-log plot of the drawdown data and curve fit are presented in Figure JD-D6C.1.4-5. A transmissivity value of 2870 gal/day/ft and a storage coefficient of **2.3** E-5 were obtained through the WTAQ analysis.

Figure JD-D6C.1.4-6 presents the recovery data from URZJA-14-1. The transmissivity value obtained from the straight line fit is 33.7 gal/day/ft. An average of the two straight line analyses are thought to be most representative of the transmissivity. The storage coefficient from the semi-log plot is thought to be representative of the aquifer.

JD-D6C.1.4.3 OVERLYING OBSERVATION WELL URZJB-15

Figure JD-D6C.1.4-7 presents the barometric pressure and water level change data in overlying observation well URZJB-15. The manual data for well URZJB-15, shown in orange shows very little change throughout the monitoring period. The fluctuations shown in the transducer data is likely caused by the variations in barometric pressure.

JD-D6C.1.4.4 OVERLYING OBSERVATION WELL URZJC-16

Figure JD-D6C.1.4-7 also presents the water level change data for F Sand well URZJC-16. The green circles show the manual water level data. The manual data shows no response from the pumping of URZJA-13-1. The transducer data is shown in red and shows a fair amount of variation, most likely due to the barometric pressure changes.

JD-D6C.1.5 URZJA-14-1 MULTI-WELL TEST

Partially penetrating A Sand well URZJA-14-1 was pumped for 2 days at an average rate of 3.95 gpm while observation wells URZJA-13-1, URZJB-15, and URZJC-16 were monitored. The barometric pressure data and the water level change in wells URZJA-13-1 and URZJA-14-1 are presented in Figure JD-D6C.1.5-1. The barometric pressure changed a maximum of approximately 0.25 inches of mercury during the monitoring of this multi-well pump test.

JD-D6C.1.5.1 PUMPING WELL URZJA-14-1

Well URZJA-14-1 was pumped from November 4th through November 6th. Table JD-D6C.1.5-1 presents the manual and pumping data. Table JD-D6C.1.5-2 presents the transducer data. A semi log plot of the drawdown is presented in Figure JD-D6C.1.5-2 and yields a transmissivity value of 76.7 gal/day/ft.

The recovery data for the pumping well is presented in Figure JD-D6C.1.5-3 and yields a transmissivity value of 30.8 gal/day/ft. An average of the two transmissivities is thought to be most representative of the A Sand aquifer near well URZJA-14-1.

JD-D6C.1.5.2 OBSERVATION WELL URZJA-13-1

A Sand well URZJA-13-1 is located **113** feet from the pumping well. The manual and transducer data are presented in Tables JD-D6C.1.5-3 and JD-D6C.1.5-4. Figure JD-D6C.1.5-4 presents a semi log plot of drawdown. The straight line fit of these data yields a transmissivity of 48.7 gal/day/ft and a storage coefficient of 3.1 E-5. The WTAQ analysis is presented on a log-log scale in Figure JD-D6C.1.5-5. A transmissivity value of 5,330 gal/day/ft and a storage coefficient of **7.8** E-7 are obtained from the analysis.

The recovery data is presented in Figure JD-D6C.1.5-6 and yields a transmissivity value of 33.1 gal/day/ft. The results from the WTAQ analysis of the drawdown are not indicative of the aquifer properties. An average of the semi-log plot analyses are thought to be more representative of the aquifer near URZJA-13-1.

JD-D6C.1.5.3 OVERLYING OBSERVATION WELL URZJB-15

Figure JD-D6C.1.5-7 presents the barometric pressure and water level change data in overlying observation well URZJB-15. The manual data, shown in orange, shows very little change in the water level. The transducer data, shown in blue, shows the changes due to barometric pressure and a slight increase in water level across the entire monitoring period. The changes in water level do not appear to be a result of pumping URZJA-14-1.

JD-D6C.1.5.4 OVERLYING OBSERVATION WELL URZJC-16

The manual and transducer water level change data for F Sand well URZJC-16 is presented in Figure JD-D6C.1.5-7. The manual measurements, shown in green, show little change in the water level throughout the test, while the transducer data in red shows a slight rise across the entire monitoring period. These slight changes appear to have no correlation with the pumping of URZJA-14-1.

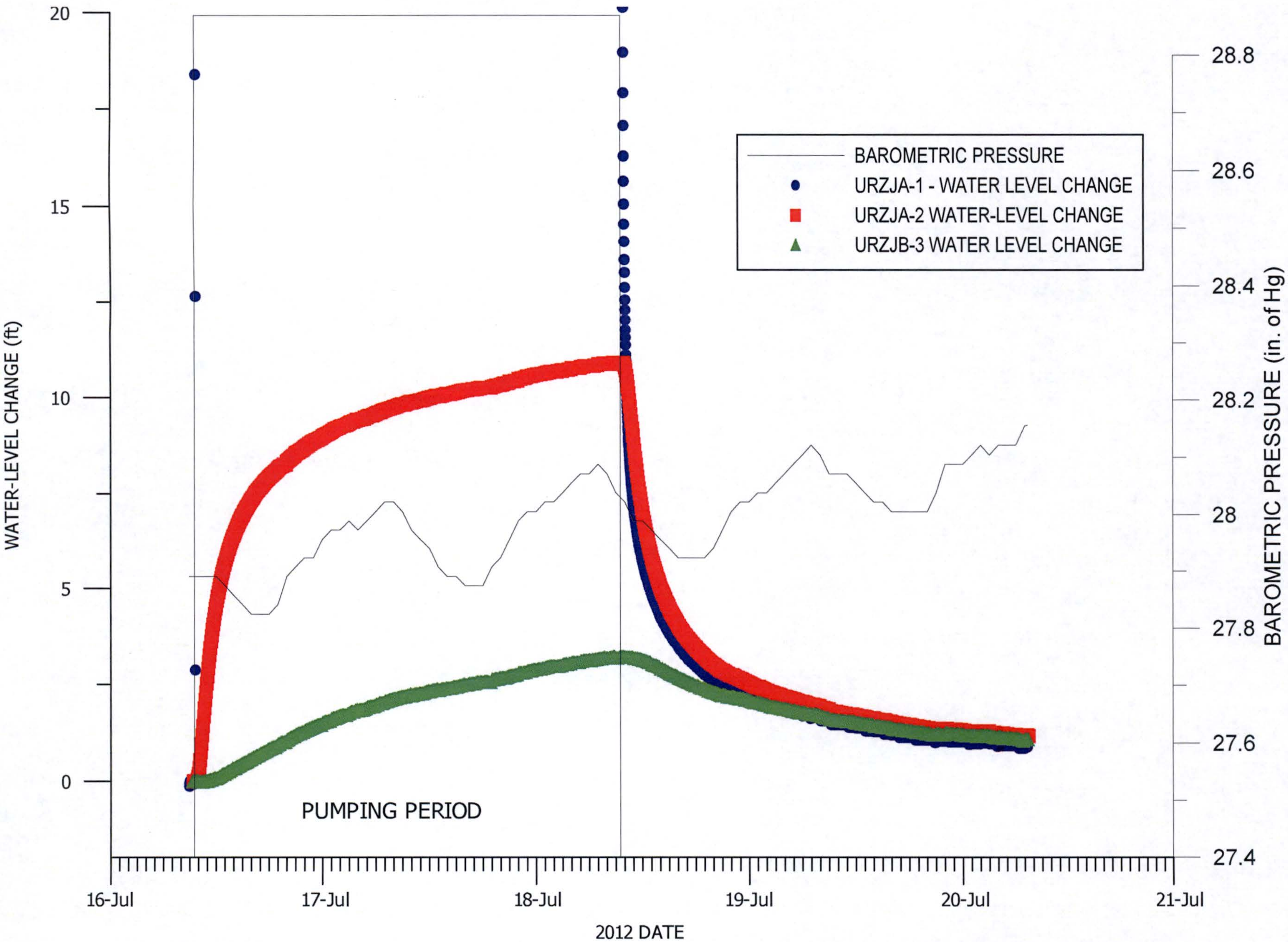

FIGURE JD-D6C.1.1-1. BAROMETRIC PRESSURE AND WATER-LEVEL CHANGE IN WELLS URZJA-1, URZJA-2, AND URZJB-3

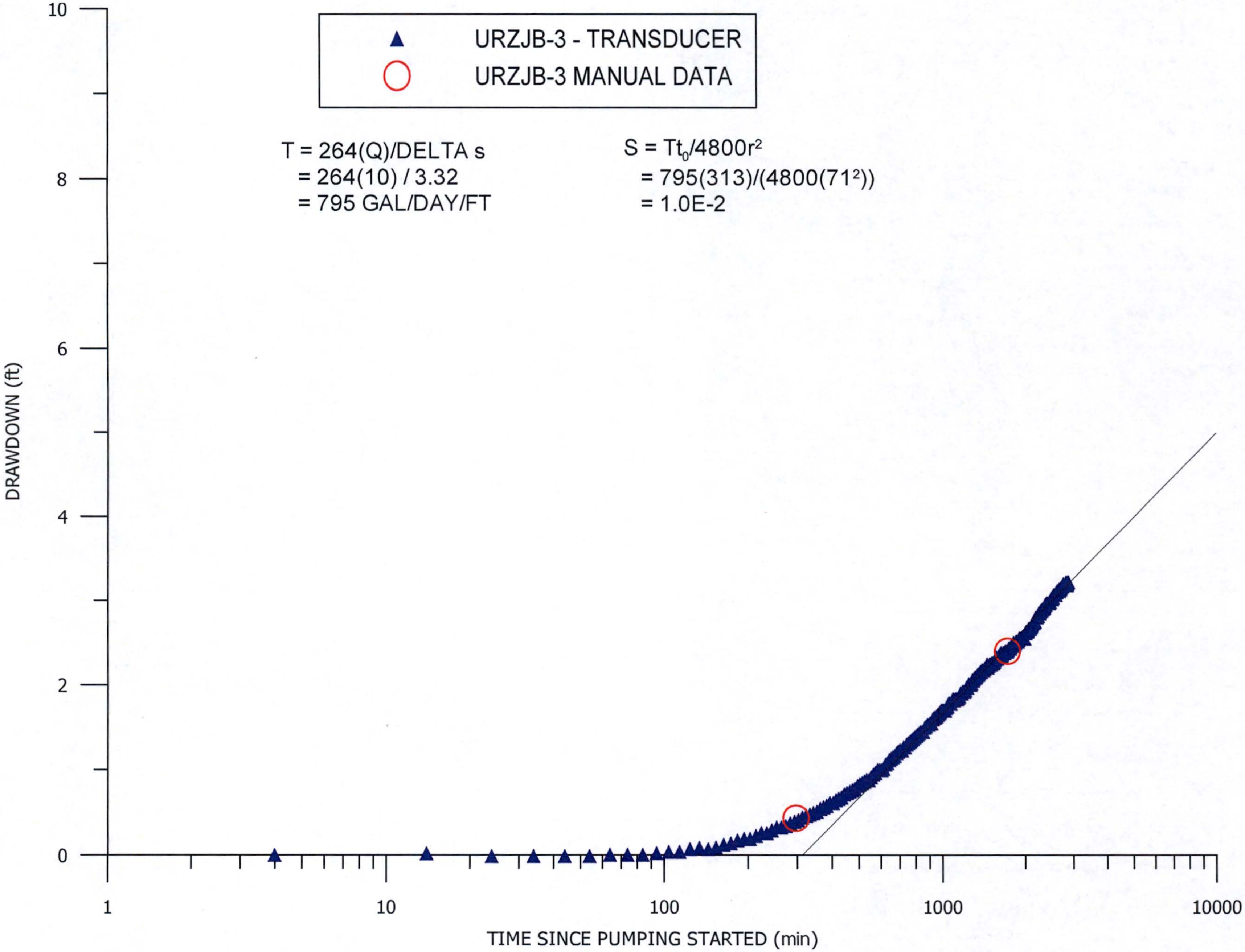

FIGURE JD-D6C.1.1-7. DRAWDOWN IN OBSERVATION WELL URZJB-3

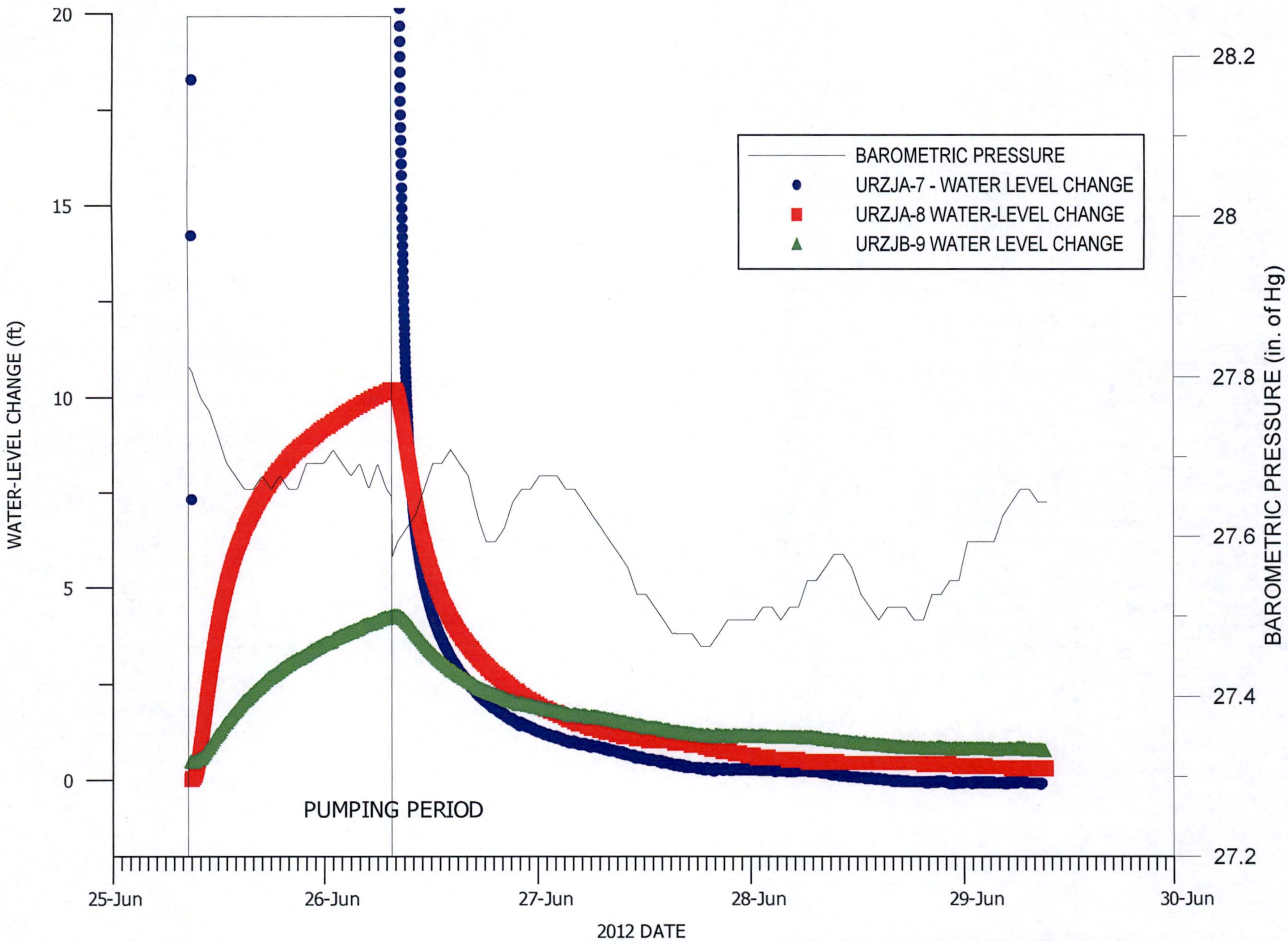

FIGURE JD-D6C.1.2-1. BAROMETRIC PRESSURE AND WATER-LEVEL CHANGE IN WELLS URZJA-7, URZJA-8, AND URZJB-9

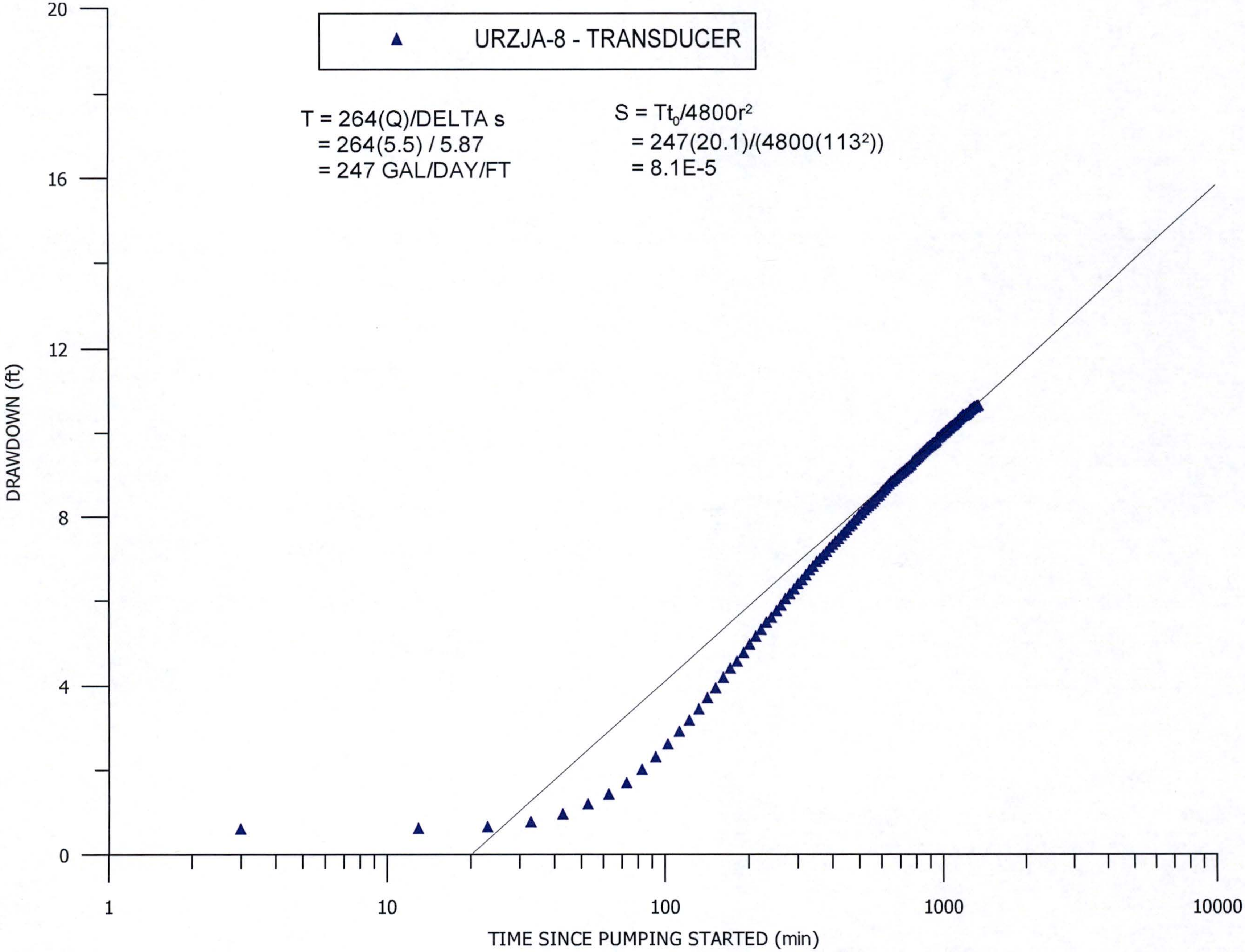

FIGURE JD-D6C.1.2-4. DRAWDOWN IN OBSERVATION WELL URZJA-8

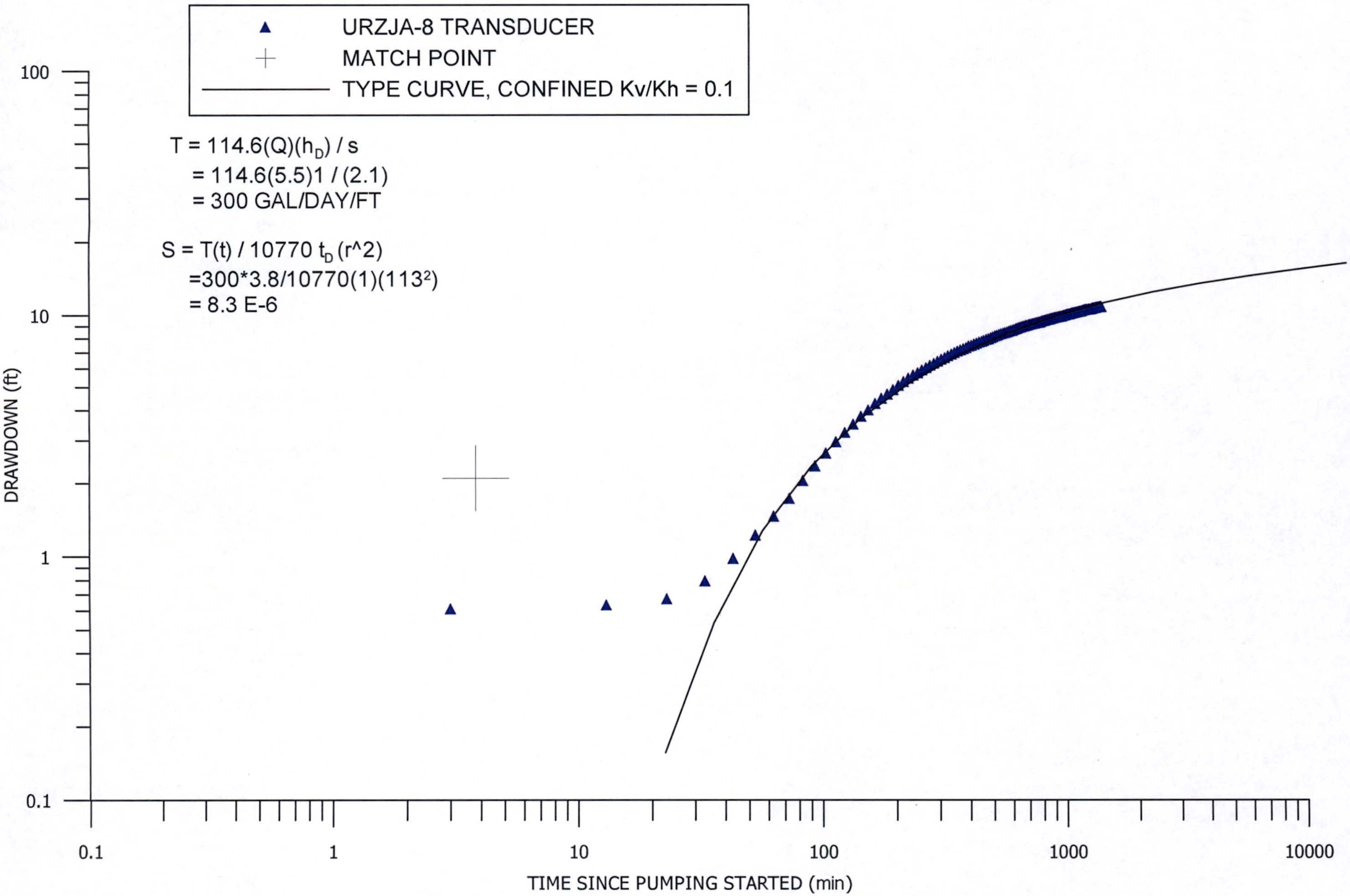

FIGURE JD-D6C.1.2-5. DRAWDOWN IN OBSERVATION WELL URZJA-8, LOG-LOG

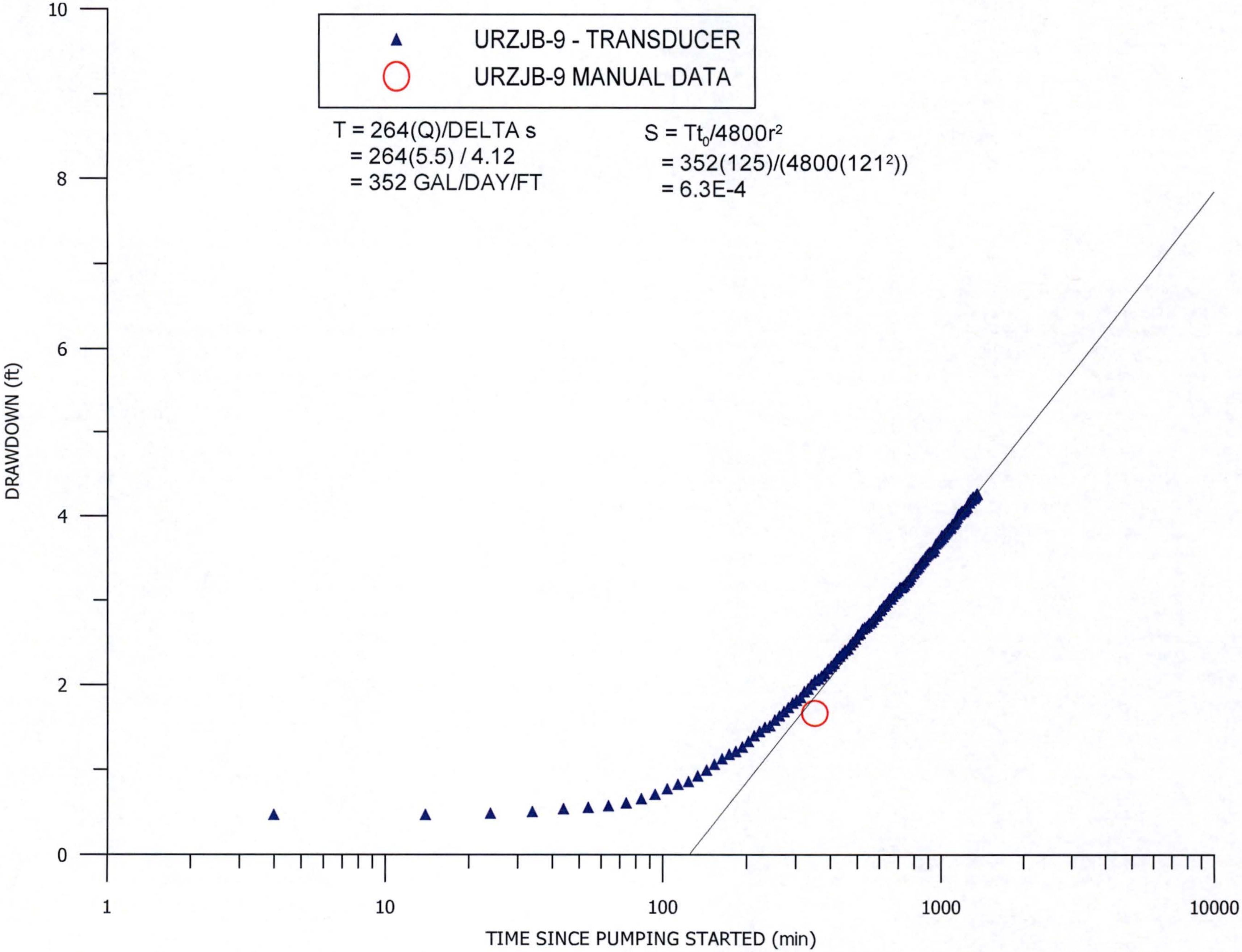

FIGURE JD-D6C.1.2-7. DRAWDOWN IN OBSERVATION WELL URZJB-9

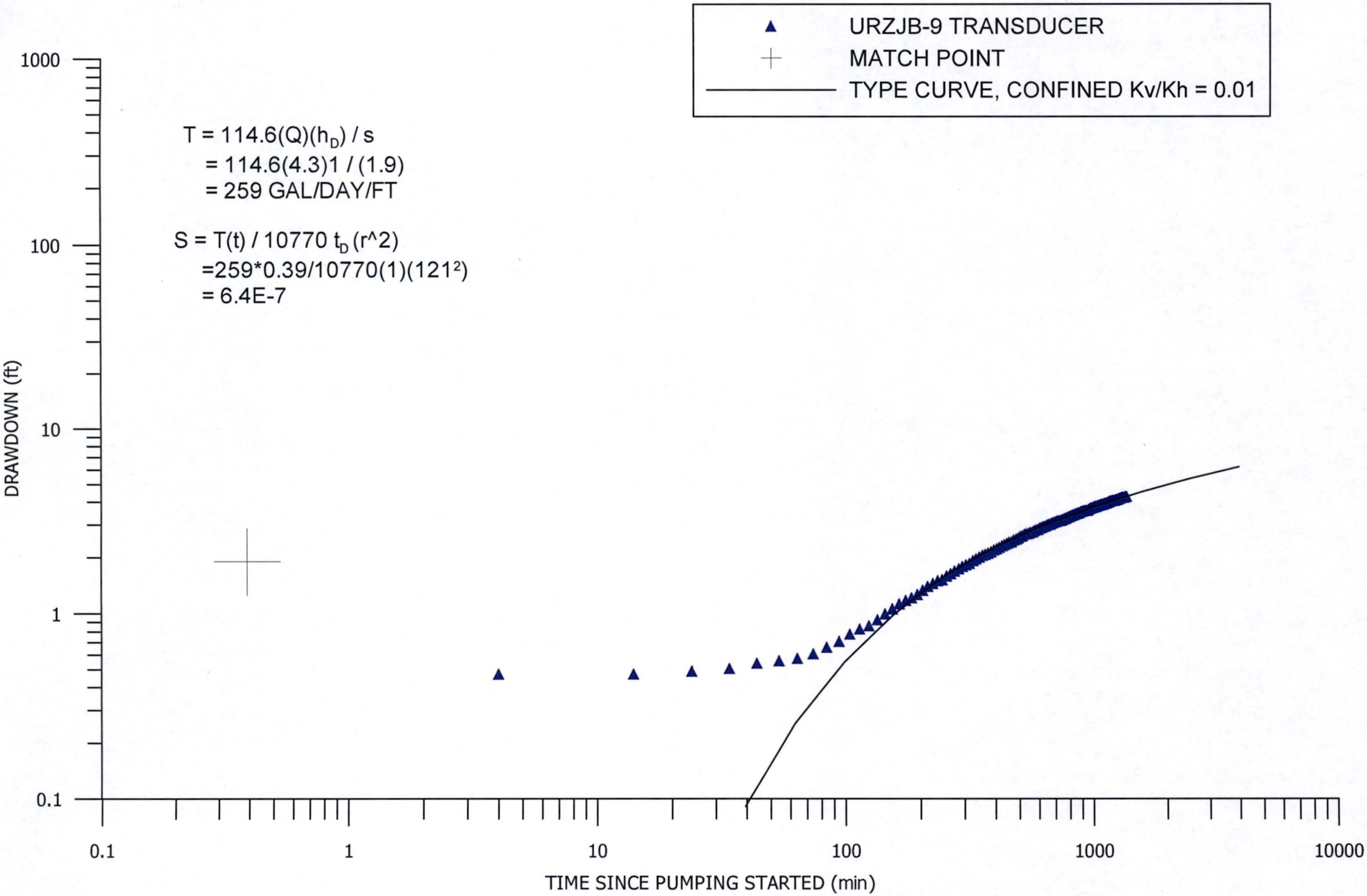

FIGURE D6C.1.2-8. DRAWDOWN IN OBSERVATION WELL URZJB-9, LOG-LOG

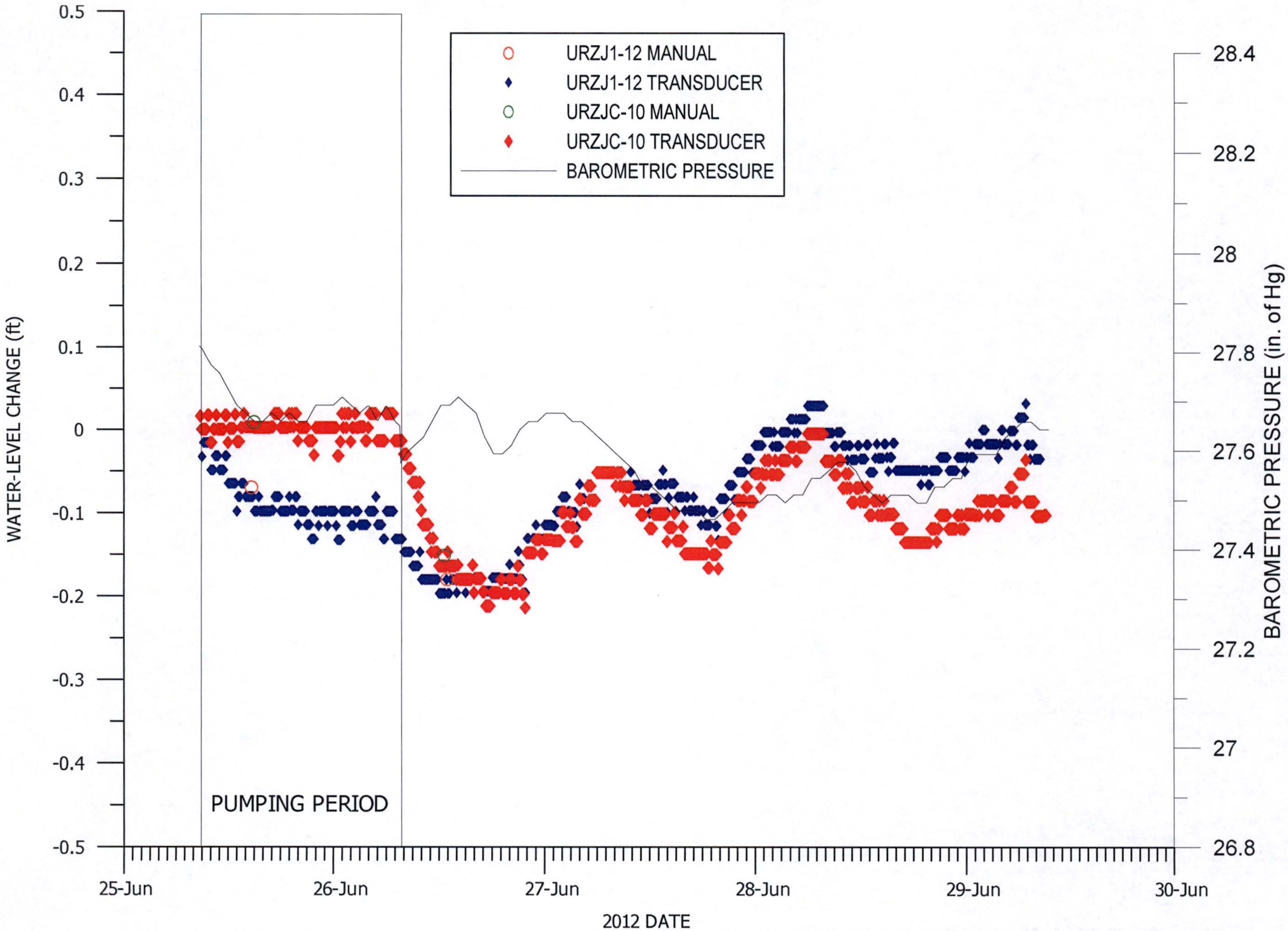

FIGURE JD-D6C.1.2-10. BAROMETRIC PRESSURE AND WATER-LEVEL CHANGE IN OVERLYING OBSERVATION WELL URZJC-10 AND UNDERLYING OBSERVATION WELL URZJ1-12

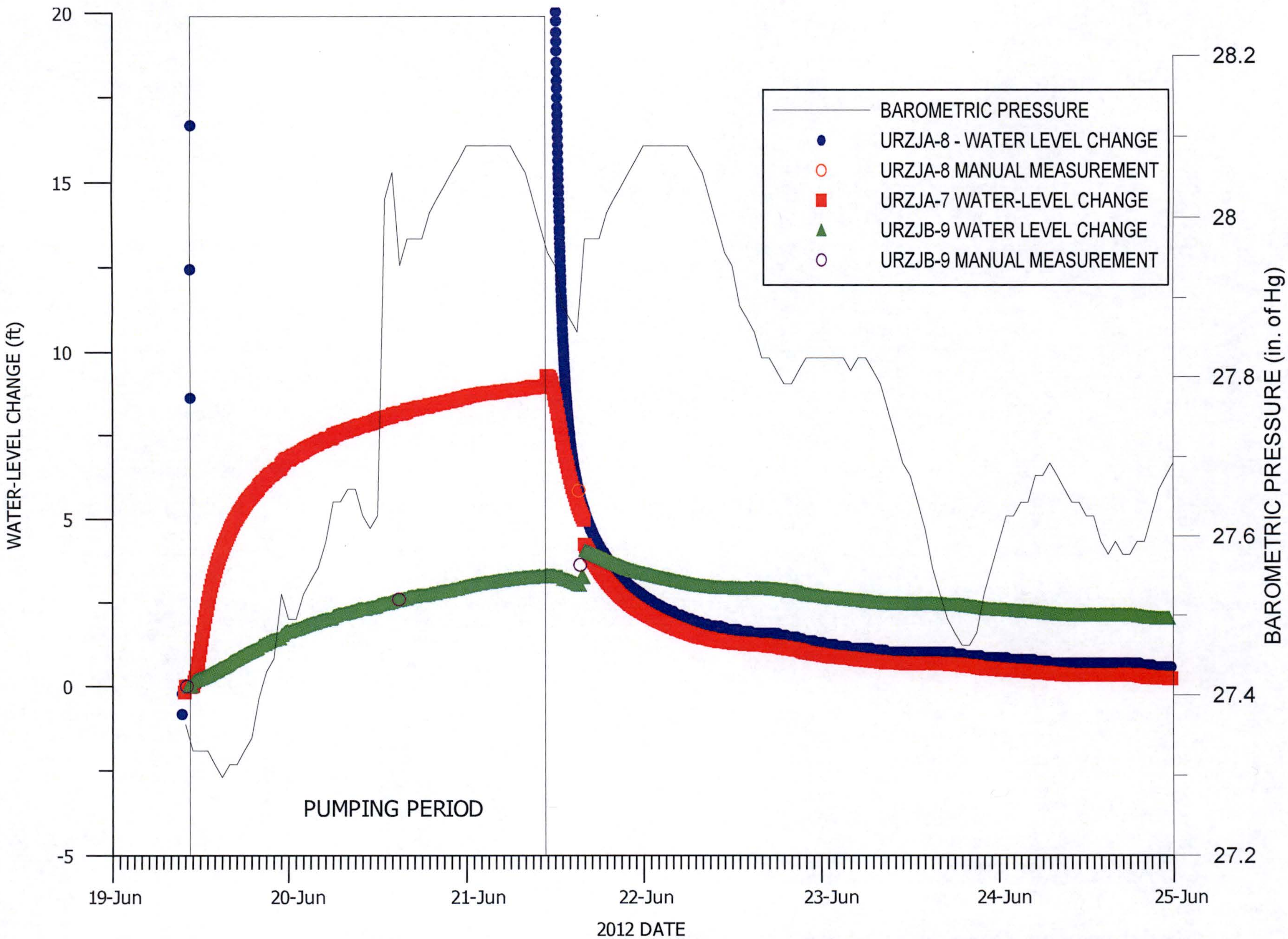

FIGURE JD-D6C.1.3-1. BAROMETRIC PRESSURE AND WATER-LEVEL CHANGE IN WELLS URZJA-8, URZJA-7, AND URZJB-9

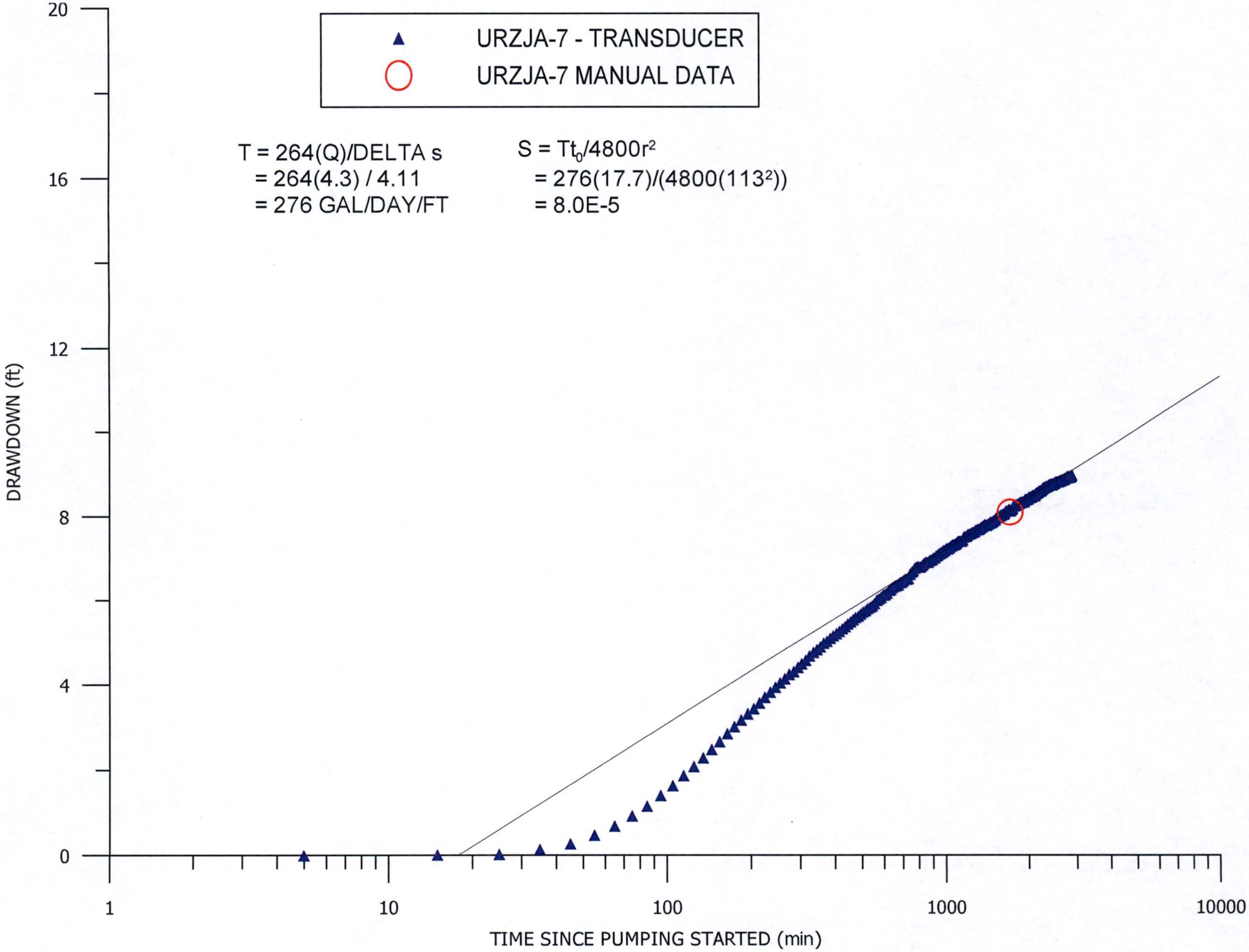

FIGURE JD-D6C.1.3-4. DRAWDOWN IN OBSERVATION WELL URZJA-7

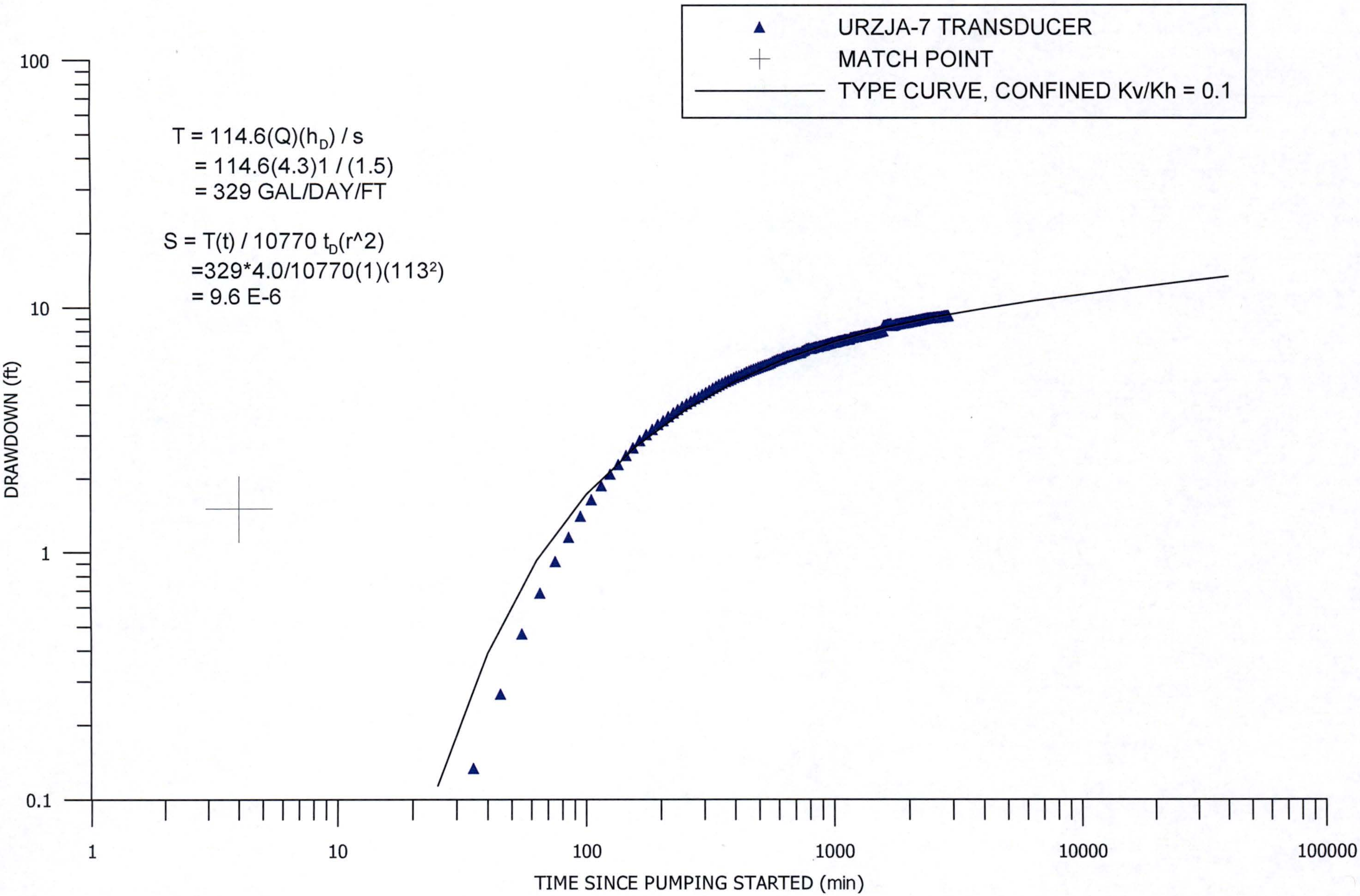

FIGURE JD-D6C.1.3-5. DRAWDOWN IN OBSERVATION WELL URZJA-7, LOG-LOG

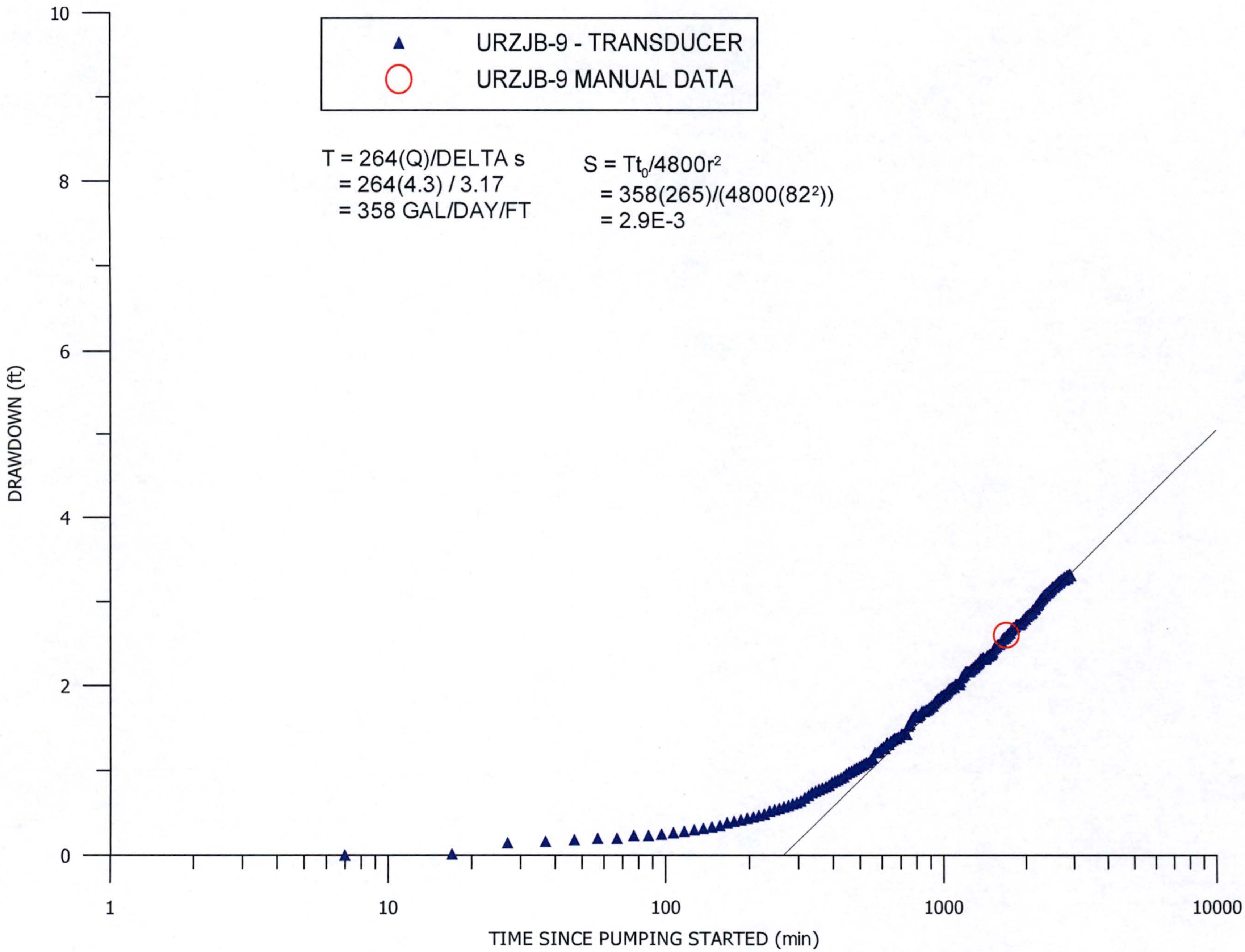

FIGURE JD-D6C.1.3-7. DRAWDOWN IN OBSERVATION WELL URZJB-9

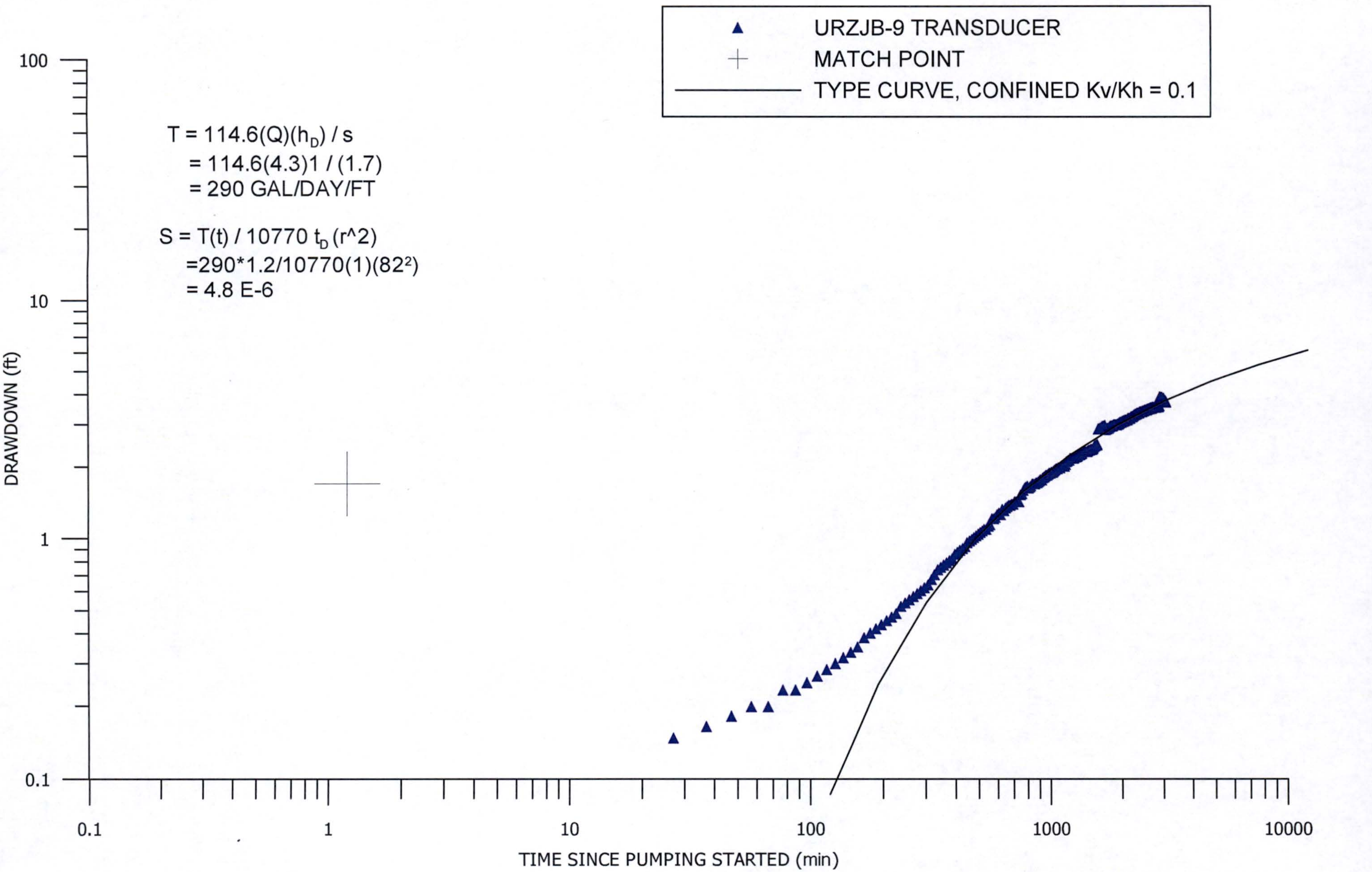

FIGURE JD-D6C.1.3-8. DRAWDOWN IN OBSERVATION WELL URZJB-9, LOG-LOG

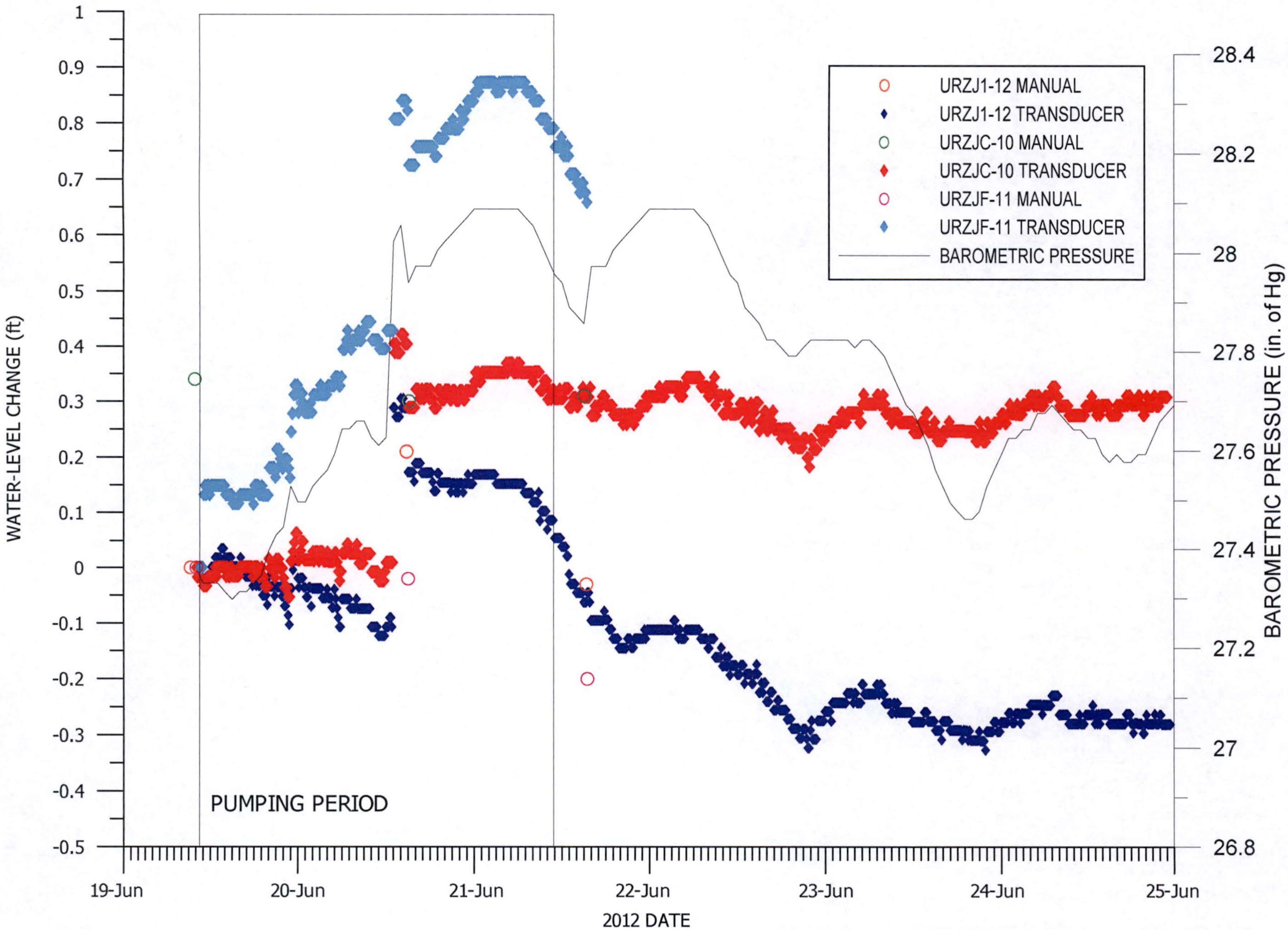

FIGURE JD-D6C.1.3-10. BAROMETRIC PRESSURE AND WATER-LEVEL CHANGE IN OVERLYING OBSERVATION WELLS URZJC-10 AND URZJF-11 AND UNDERLYING OBSERVATION WELL URZJ1-12

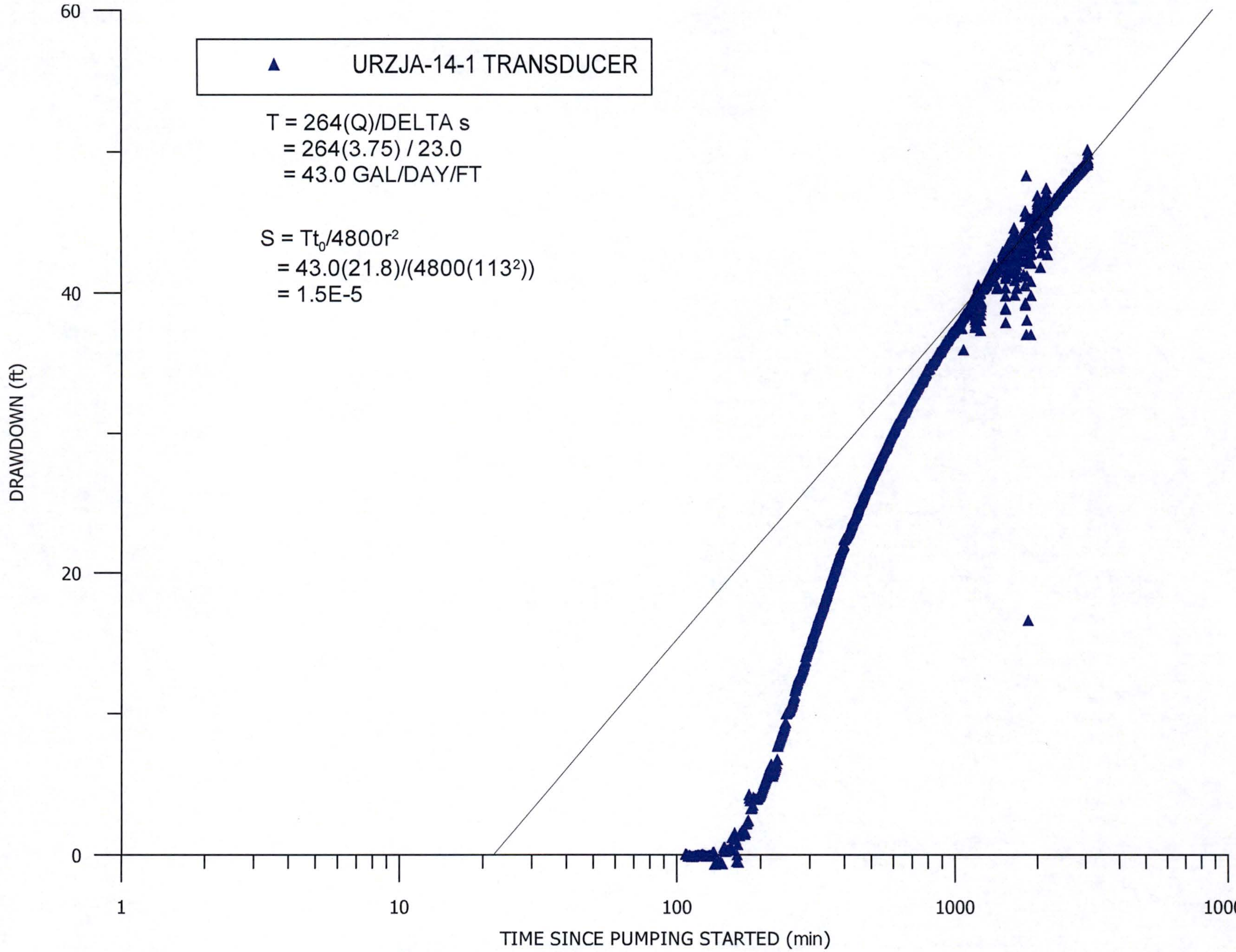

FIGURE JD-D6C.1.4-4. DRAWDOWN IN OBSERVATION WELL URZJA-14-1

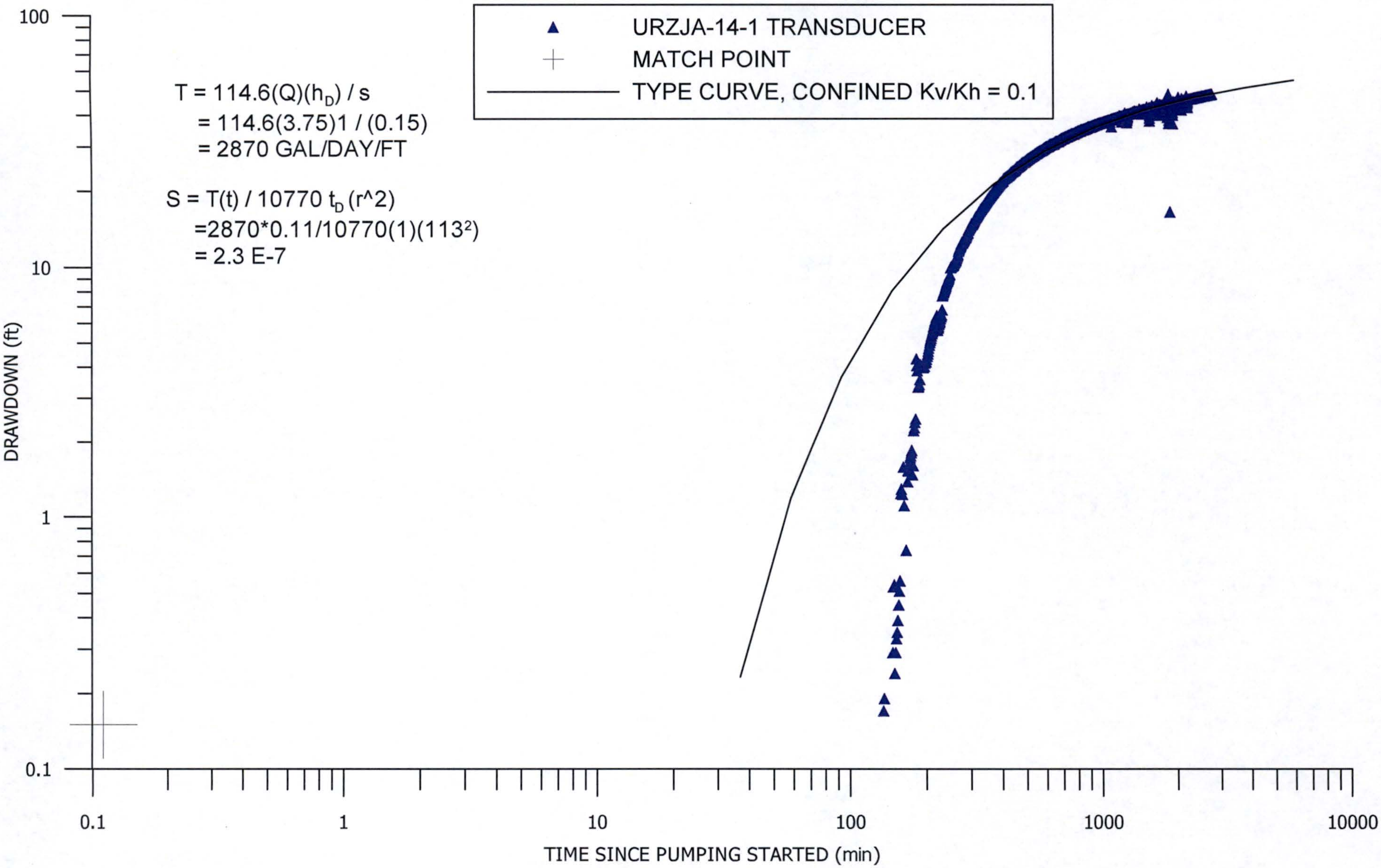

FIGURE JD-D6C.1.4-5. DRAWDOWN IN OBSERVATION WELL URZJA-14-1, LOG-LOG

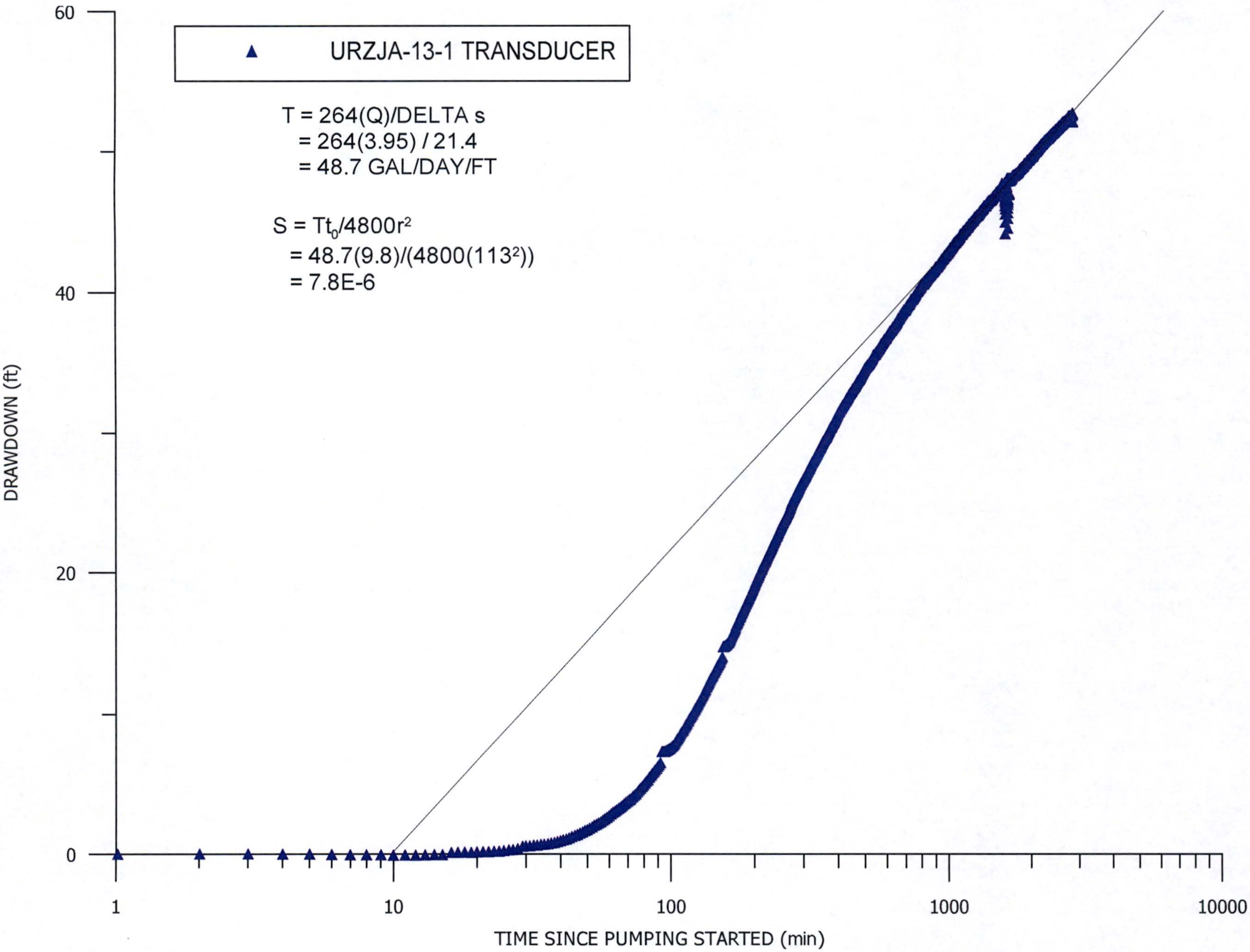

FIGURE JD-D6C.1.5-4. DRAWDOWN IN OBSERVATION WELL URZJA-13-1

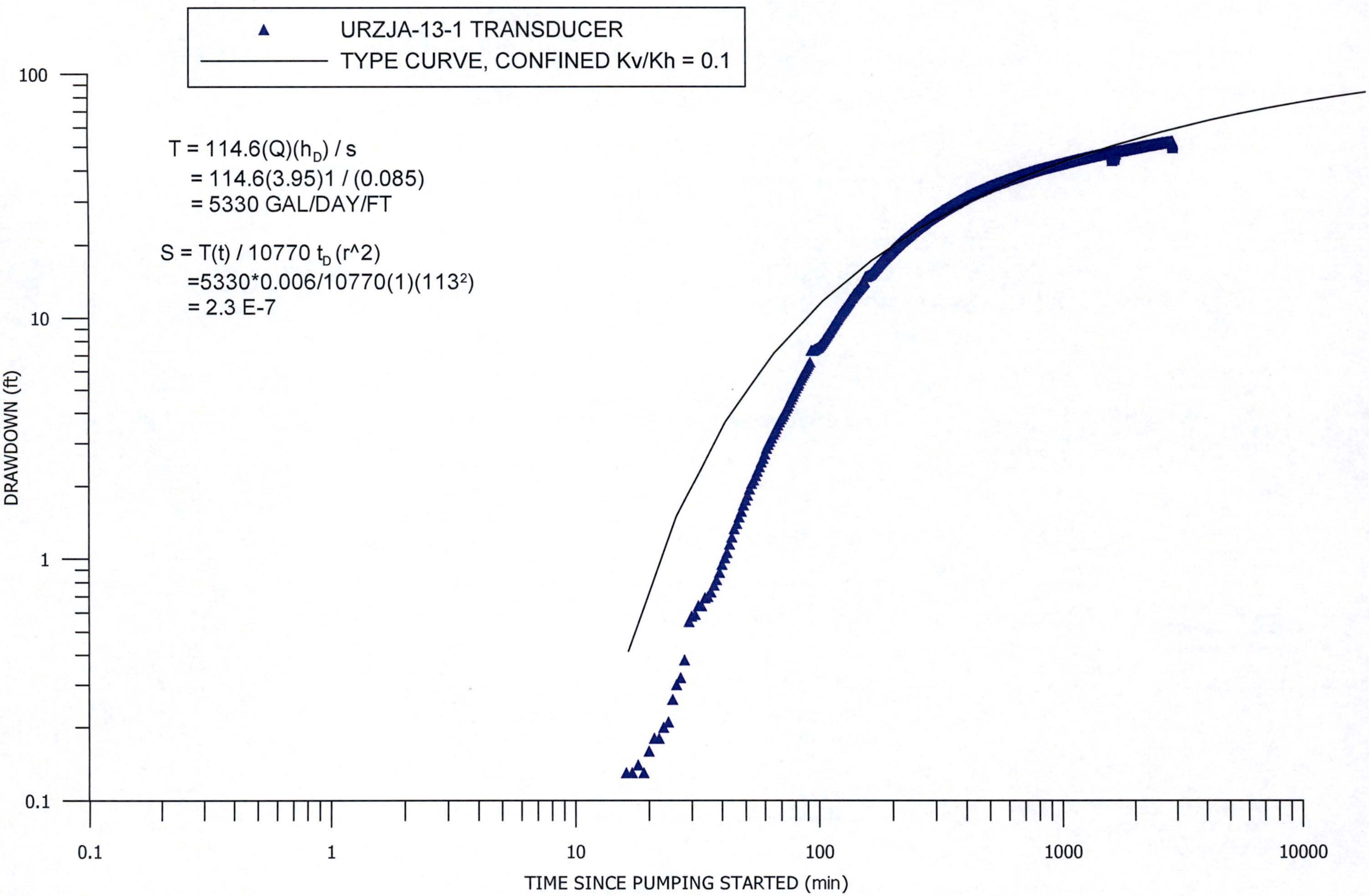

FIGURE JD-D6C.1.5-5. DRAWDOWN IN OBSERVATION WELL URZJA-13-1, LOG-LOG

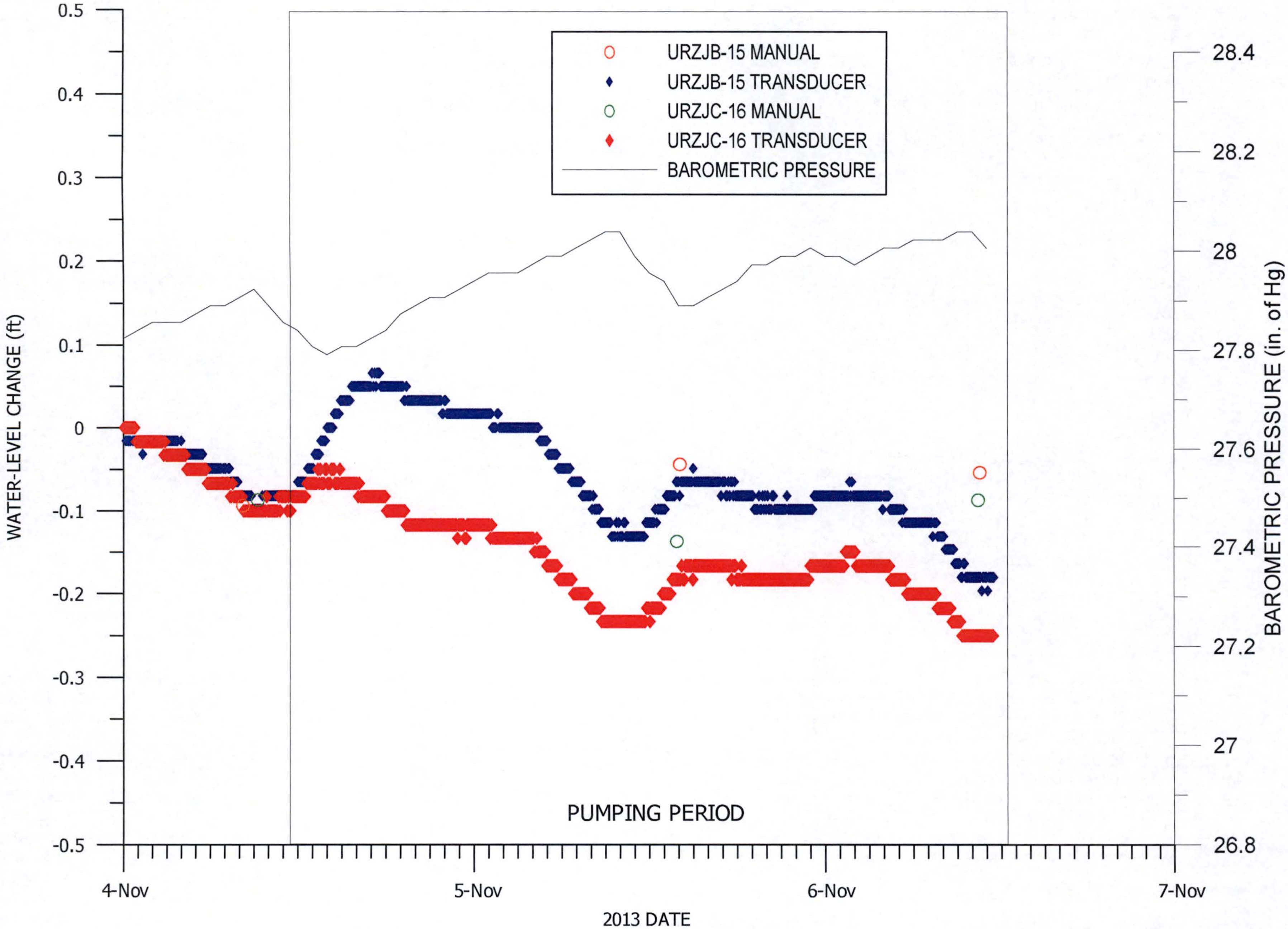

FIGURE JD-D6C.1.5-7. BAROMETRIC PRESSURE AND WATER-LEVEL CHANGE IN OVERLYING OBSERVATION WELLS URZJB-15 AND URZJC-16

TABLE D6E.1-1. JANE DOUGH UNIT GROUND-WATER QUALITY (cont.)

Well Name	Date	Ra226 (pCi/l)	Ra226(e) (pCi/l)	Ra228 (pCi/l)	Ra228(e) (pCi/l)	Alpha (pCi/l)	Beta (pCi/l)
y Fork Flowing	6/28/2010	0.1	0.1	0.3	1.0	5.7	2.0
	7/19/2010	0.2	0.1	0.2	0.7	4.0	1.9
	10/4/2010	-0.1	0.1	---	---	---	2.4
	1/6/2011	0.0	0.1	0.7	0.7	5.6	2.3
	8/15/2011	-0.1	0.1	0.4	0.7	2.3	2.8
	1/20/2012	0.2	0.1	0.6	0.8	4.4	1.3
	7/17/2012	0.4	0.2	0.3	0.7	3.5	-0.5
	11/7/2012	0.1	0.1	2.1	0.8	3.4	0.5
	1/7/2013	0.3	0.1	1.2	0.7	5.2	0.6
N1	12/15/2011	0.2	0.1	2.2	0.9	35.3	8.5
	1/20/2012	0.2	0.1	0.2	0.9	35.4	7.1
	7/17/2012	0.0	0.1	---	---	---	---
	7/23/2012	0.2	0.1	---	---	---	---
	1/9/2013	0.5	0.2	---	---	---	---
	1/9/2013	0.3	0.2	---	---	---	---
	7/22/2013	0.0	0.1	---	---	---	---
NQ-4	12/17/2007	0.7	± 0.3	< 1.0	---	72.6	25.8
	6/24/2008	0.6	± 0.1	0.3	± 0.7	113.0	27.8
	9/9/2008	0.4	± 0.2	1.4	± 0.8	114.0	19.6
	11/21/2008	0.9	± 0.2	1.3	± 0.8	164.0	61.9
	6/4/2012	0.9	0.2	0.6	0.6	91.8	27.0
Pats #1	1/24/2011	0.2	0.1	0.6	0.7	37.0	12.3
	8/10/2011	-0.1	0.1	0.9	0.9	46.6	11.6
	1/20/2012	0.3	0.1	0.2	0.7	51.1	9.1
	7/17/2012	0.2	0.1	---	---	---	---
	7/23/2012	0.3	0.1	---	---	---	---
	11/2/2012	0.3	0.2	---	---	---	---
	1/30/2013	0.2	0.1	---	---	---	---
	7/23/2013	0.2	0.2	---	---	---	---
Pug #1	1/24/2011	---	---	---	---	-3.0	1.3
	1/24/2011	0.0	0.1	0.4	0.7	---	---
	8/12/2011	0.1	0.1	0.4	0.9	-4.0	0.9
	1/23/2012	0.3	0.1	0.6	0.9	-1.0	-0.1
Pug #2	12/29/2010	0.2	0.2	0.3	0.5	-0.2	-0.3
	7/17/2012	0.3	0.1	---	---	---	---
	7/23/2012	0.3	0.1	---	---	---	---
	11/2/2012	0.2	0.1	---	---	---	---
	1/9/2013	0.0	0.1	---	---	---	---
	7/23/2013	0.3	0.2	---	---	---	---

TABLE D6E.1-1. JANE DOUGH UNIT GROUND-WATER QUALITY (cont.)

Well Name	Date	Ra226 (pCi/l)	Ra226(e) (pCi/l)	Ra228 (pCi/l)	Ra228(e) (pCi/l)	Alpha (pCi/l)	Beta (pCi/l)
eventeen Mile ↑	6/28/2010	0.0	0.1	1.4	1.0	8.6	5.3
	7/19/2010	0.8	0.2	-0.1	0.7	8.4	2.2
	10/4/2010	-0.1	0.1	0.2	0.7	6.1	0.7
	1/6/2011	-0.1	0.1	1.0	0.7	5.9	-0.9
	8/15/2011	0.0	0.1	0.9	0.9	1.6	-4.0
	1/20/2012	0.3	0.1	-0.1	0.7	4.2	0.3
	7/17/2012	0.2	0.1	0.1	0.7	4.3	0.1
	11/7/2012	0.1	0.1	1.3	0.8	7.7	1.2
	1/7/2013	0.2	0.1	1.2	0.7	5.8	-0.2
URZJ1-12	9/1/2011	0.0	0.1	0.3	0.7	-3.0	4.3
	12/2/2011	0.3	0.2	0.2	1.1	-2.0	2.3
	2/1/2012	0.1	0.1	0.2	0.7	-1.0	-0.9
	3/28/2012	0.2	0.1	0.5	0.8	1.8	4.8
	6/15/2012	0.1	0.1	-0.3	0.9	-2.0	0.7
	9/7/2012	0.1	0.1	1.0	0.6	-2.0	0.0
URZJ1-23-1	6/5/2013	0.2	0.1	-0.4	0.8	-0.3	2.3
URZJA-1	9/14/2011	0.3	0.1	0.2	0.7	38.1	12.0
	3/7/2012	0.3	0.1	-0.1	0.7	46.8	10.6
	6/19/2012	0.5	0.2	0.0	0.7	47.4	6.4
	7/18/2012	0.6	0.2	0.0	0.7	37.2	3.6
URZJA-2	9/21/2011	165.0	2.4	0.8	0.8	968.0	611.0
	2/6/2012	168.0	2.6	3.0	0.9	1070.0	564.0
	12/12/2012	135.0	2.6	2.0	1.0	1030.0	484.0
	1/30/2013	243.0	3.2	4.7	1.3	505.0	175.0
URZJA-7	9/1/2011	0.1	0.2	0.4	0.7	60.8	21.0
	11/7/2011	0.2	0.1	0.0	0.6	62.6	20.4
	2/1/2012	0.2	0.1	0.9	0.6	64.9	19.3
	12/6/2012	0.1	0.2	0.0	0.9	55.8	13.7
URZJA-8	9/12/2011	5.9	0.5	1.2	0.7	58.5	30.7
	11/7/2011	5.7	0.5	0.3	0.7	95.7	43.9
	1/31/2012	4.4	0.4	0.3	0.7	56.3	32.4
	6/21/2012	9.6	0.7	-0.5	1.3	70.3	20.5
URZJA-13-1	1/10/2013	28.0	1.0	1.6	0.6	178.0	171.0
	6/10/2013	18.0	0.9	-0.6	0.9	119.0	43.9
	9/18/2013	33.0	1.2	1.0	0.8	90.4	17.0
	11/1/2013	2.6	0.3	1.6	1.2	48.1	57.9
URZJA-14-1	1/10/2013	1.6	0.3	0.9	0.6	55.0	29.2
	6/6/2013	2.4	0.3	0.6	0.9	41.3	9.7

TABLE D6E.1-1. JANE DOUGH UNIT GROUND-WATER QUALITY (cont.)

Well Name	Date	Ra226 (pCi/l)	Ra226(e) (pCi/l)	Ra228 (pCi/l)	Ra228(e) (pCi/l)	Alpha (pCi/l)	Beta (pCi/l)
URZJA-14-1	9/19/2013	5.8	0.5	0.4	0.8	64.4	8.1
	11/6/2013	3.6	0.4	0.9	1.0	63.5	20.4
URZJA-19	3/14/2012	0.2	0.1	0.3	0.8	-0.5	8.9
	6/29/2012	0.1	0.1	-0.5	0.8	-0.7	1.1
	7/17/2012	0.1	0.1	-0.3	0.7	0.2	1.7
	11/13/2012	-0.1	0.1	1.6	0.9	1.7	0.3
URZJA-20	11/13/2012	1.3	0.3	3.5	1.1	26.0	22.9
	1/17/2013	1.0	0.2	1.2	0.8	24.3	12.0
	1/17/2013	# 1.2	# 0.2	# 0.7	# 0.8	# 21.8	# 9.4
	6/17/2013	1.4	0.3	0.2	1.0	26.6	6.5
	9/5/2013	1.6	0.3	1.2	0.8	28.6	8.9
URZJB-3	9/20/2011	0.1	0.1	0.1	0.8	48.7	19.2
	2/6/2012	0.0	0.1	0.7	0.8	43.4	14.0
	7/3/2012	0.2	0.1	-0.1	0.6	39.7	6.8
	9/7/2012	0.2	0.1	0.3	0.6	28.6	7.8
	11/30/2012	0.2	0.1	1.4	0.8	39.0	11.4
	11/30/2012	# 0.4	# 0.2	# 1.0	# 0.8	# 47.5	# 11.2
URZJB-9	8/31/2011	0.2	0.1	0.4	0.6	48.4	14.1
	11/8/2011	0.3	0.1	0.8	0.6	63.6	21.7
	11/8/2011	# 0.1	# 0.1	# 0.6	# 0.7	# 63.0	# 16.1
	1/31/2012	0.2	0.1	1.5	0.7	59.8	14.1
	4/5/2012	0.2	0.1	1.9	0.8	59.4	7.9
URZJB-15	3/14/2012	0.2	0.1	1.1	0.7	45.3	10.9
	6/27/2012	0.2	0.2	0.1	0.9	45.4	15.8
	10/2/2012	0.1	0.1	-0.4	0.9	54.2	6.9
	11/7/2012	0.1	0.1	4.6	1.0	48.8	12.5
	1/16/2013	0.2	0.1	0.5	0.8	52.0	13.5
URZJB-21	9/28/2011	0.0	0.1	1.3	0.6	33.2	10.5
	9/28/2011	0.1	0.1	0.3	0.5	33.2	11.6
	2/15/2012	0.0	0.1	0.4	0.6	42.6	5.7
	4/20/2012	-0.1	0.1	0.1	0.9	34.9	8.0
	11/13/2012	0.0	0.1	0.8	1.0	39.0	8.1
URZJC-10	8/31/2011	0.1	0.1	0.6	0.6	-2.0	4.0
	2/13/2012	-0.1	0.1	0.3	0.6	-0.8	3.9
	7/3/2012	0.0	0.1	0.6	0.9	-1.0	2.3
	9/6/2012	0.0	0.1	0.1	0.9	-0.8	4.5
	11/14/2012	0.0	0.1	1.0	1.2	-0.9	0.6
URZJC-16	6/14/2012	2.1	0.3	0.2	0.7	185.0	30.8

The drawings specifically in this package have been processed into ADAMS.

These drawings can be accessed within the ADAMS package or by performing a search on the Document/Report Number.

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TABLE D6E.1-1. JANE DOUGH UNIT GROUND-WATER QUALITY (cont.)

Well Name	Date	Ra226 (pCi/l)	Ra226(e) (pCi/l)	Ra228 (pCi/l)	Ra228(e) (pCi/l)	Alpha (pCi/l)	Beta (pCi/l)
URZJC-16	10/2/2012	1.0	0.2	1.3	1.1	175.0	30.8
	1/10/2013	0.7	0.2	1.7	0.6	251.0	24.7
	1/10/2013	# 0.8	# 0.2	# 2.1	# 0.6	# 283.0	# 26.2
	6/17/2013	0.8	0.2	2.6	0.9	217.0	17.1
URZJC-22	9/29/2011	208.0	3.0	1.7	0.8	898.0	239.0
	3/14/2012	178.0	2.3	2.7	0.8	493.0	170.0
	4/19/2012	186.0	2.7	1.7	1.0	1000.0	373.0
	12/17/2012	171.0	2.3	1.8	0.8	552.0	123.0
URZJF-5	9/23/2011	0.3	0.1	0.5	0.7	4.2	25.9
	3/7/2012	0.3	0.1	0.9	0.8	-2.0	19.7
	11/30/2012	0.5	0.2	2.3	1.0	7.5	10.7
	11/30/2012	# 0.4	# 0.2	# 2.3	# 0.8	# 5.8	# 14.1
	2/1/2013	0.6	0.2	1.6	1.4	2.7	10.5
URZJF-11	8/31/2011	1.1	0.2	1.7	0.7	11.3	74.9
	9/23/2011	11.0	1.2	2.4	3.0	232.0	173.0
	11/2/2012	0.2	0.1	0.2	0.7	-0.2	39.0
	1/7/2013	0.5	0.2	3.1	0.7	1.8	37.4
URZJF-17	12/9/2011	4.1	0.8	5.2	3.1	176.0	166.0
	1/23/2012	2.4	0.3	0.6	0.7	124.0	48.7
	6/25/2012	3.4	0.5	3.4	1.4	87.3	28.5
	9/28/2012	3.4	0.4	1.2	0.9	93.4	33.0
URZJQ-24-1	7/20/2012	1.3	0.3	0.0	1.0	105.0	8.3
	11/2/2012	0.4	0.1	1.7	0.9	102.0	17.7
	1/7/2013	0.8	0.2	1.8	0.7	126.0	11.9
	1/7/2013	# 0.8	# 0.2	# 1.6	# 0.7	# 132.0	# 15.4
	6/12/2013	0.7	0.2	1.4	0.8	117.0	14.8
URZJQ-25	12/28/2010	0.6	0.2	0.4	0.5	78.0	26.3
	1/26/2011	0.7	0.1	0.9	0.6	69.2	21.6
	5/6/2011	0.4	0.2	0.8	0.6	111.0	24.6
	8/11/2011	0.4	0.1	0.3	0.7	78.8	16.4
	2/1/2012	0.1	0.1	0.3	0.5	119.0	1.9
URZJQ-26	12/28/2010	0.5	0.2	1.6	0.6	45.4	14.2
	1/26/2011	0.6	0.1	1.0	0.6	31.2	21.1
	5/6/2011	0.4	0.2	0.9	0.8	48.4	29.4
	8/11/2011	0.3	0.1	0.5	0.6	63.3	26.6
	3/14/2012	0.6	0.2	0.6	0.7	79.9	16.8

routinely the condition **of** pipelines and wellheads. The Mine Plan has been revised through the SERP to incorporate the Benchmark approach. In this regard, spills that occur will be evaluated to determine prudence of reclamation at the time of the spill or at the time of decommissioning. Spills will be assessed using the radium benchmark dose and the unit rule at the time of decommissioning. Spills that result in a total effective dose in excess of 100 mrem per year analyzed through sampling and RESRAD modeling software will be cleaned up prior to decommissioning.

Knowing that potential impacts are attributed to pipeline ruptures and leaks, the pre-operational sampling program was designed to characterize radiological baseline conditions in the areas most likely to experience potential impacts. Exhibit JD-D11-2, Jane Dough Radiological Sample Location, shows that the focus of the baseline radiological characterization that was conducted on the wellfield areas and the intermittent/ephemeral streams passing through the proposed Jane Dough license expansion area. A close examination of the map shows that sediment samples were collected from upstream and downstream locations in all of the streambeds. In addition to thoroughly sampling the wellfields and intermittent water courses, the radiological baseline was supplemented by including samples from areas within the general license area (see sample sites labeled License Area Sample (or LAS) on Exhibit JD-D11-2), and at the air monitoring sites (see Air Sample Location JD-1 through JD-7 on Exhibit JD-D11-2). Again, using Regulatory Guide 4.14 for general guidance, all soils and sediments were analyzed for Ra-226 and a large percentage of the total number of samples included analyses for Uranium, Pb-210 and Th-230. The extensive coverage of the sampling effort provides a representative radiological baseline against which potential impacts can be measured.

JD-D11.1.2 Sampling Methodology

Using the GIS coordinates for the sample site locations on the map described above, field personnel were guided to the sampling sites. Surface and subsurface soils were collected with a 3-inch diameter bucket auger. Surface soils were collected from surface to a depth of 6-inches, and subsurface soils were collected intervals of 6-12 inches; 12-24; inches and 24-36 inches.

pocket). Gamma measurements were recorded by holding the meter at waist level and slowly passing it over each sample point and over the area proximate to the sample location.

JD-D11.2.2 Jane Dough Unit Gamma Survey Results

Table JD-D11-5 provides a summary of the gamma measurements **taken during the survey performed September 2011**. A review of the table shows a range of 4 μR/hr (13 to 17 μR/hr) for the surface soil locations and the same 4 μR/hr range (14 to 18 μR/hr) for the sediment sample sites. The high end range for the surface soil locations is represented by a single reading of 17 μR/hr at LAS-13. Similarly, only two sediment sample locations support the 18 μR/hr top range value. Most of the values are within 14 to 16 μR/hr, and the averages for the surface soil sites and the sediment locations are 15 and 16 μR/hr, respectively. The averages at the Jane Dough Unit are a little higher but similar to the 13 μR/hr average measured at the Hank and Nichols Ranch Units.

In summary, the density of the survey and its consistent values provide reasonable assurance that a representative baseline was established.

Table JD-D11-5 Gamma Survey Results: Jane Dough Unit.

Sample Site	Gamma (μR/hr)	Sample Site	Gamma (μR/hr)	Sample Site	Gamma (μR/hr)	Sample Site	Gamma (μR/hr)
Random 1*	14	LAS-8	15	SS-10	16	SS-26	15
Random 2*	16	LAS-9	15	SS-11	15	SS-27	16
JD-1	14	LAS-10	13	SS-12	16	SS-28	14
JD-2	14	LAS-11	16	SS-13	14	SS-29	13
JD-3	16	LAS-12	14	SS-14	15	SS-30	15
JD-4	13	LAS-13	17	SS-15	15	SS-31	13
JD-5	13	LAS-14	14	SS-16	16	SS-32	14
JD-6**	15	SS-1	14	SS-17	14	SS-33	15
JD-7**	15	SS-2	14	SS-18	14	SS-34	15
LAS-1	15	SS-3	15	SS-19	14	SS-35	16
LAS-2	16	SS-4	15	SS-20	13	SS-36	16
LAS-3	16	SS-5	15	SS-21	14	SS-37	14
LAS-4	14	SS-6	16	SS-22	15	SS-38	15
LAS-5	15	SS-7	15	SS-23	14	SS-39	16
LAS-6	14	SS-8	14	SS-24	15	SS-40	15
LAS-7	14	SS-9	14	SS-25	15	SS-41	15
SB-1	15	SD-1	15	SD-14	16	--	--
SB-2	15	SD-2	14	SD-15	14	--	--

months tend to increases the emanation rate. In addition, radon exhalation rates fluctuate with wet and dry soil conditions and with changes in vegetative cover. This explanation is further supported by the fact that highest and lowest values are not found at a single site; instead, the highest and lowest values vary with the time of year.Table JD-D11-6 also shows the annualized average for all locations combined as being 0.6 pCi/l. This average is lower than the averages of 1.0 pCi/l and 1.2 pCi/l recorded at the Hank and Nichols Ranch Units, respectively. The range of the averages at all three units are consistent with values found in the U.S. Background radon varies considerable in the U.S. due to factors such as soil and rock types and the presence of naturally occurring uranium. The 0.6 pCi/l average measured at the Jane Dough Unit is consistent with but slightly above the U.S. average outdoor Rn-222 level of 0.4 pCi/l (U.S. EPA).

JD-D11.3.3 Background Gamma Exposure Rate

Background gamma exposure rates from the one year monitoring in the Jane Dough Unit are summarized in Table JD-D11-7. The quarterly average for all seven sites ranged from 11.3 mrem (second quarter 2011) to 45.8 mrem (fourth quarter 2010). When compared to previous baseline surveys at the Hank and Ranch Nichols Ranch, the quarterly averages for all monitoring locations ranged from 34.4 mrem to 55.0 mrem (Hank) and 35.0 mrem to 47.9 mrem (Nichols Ranch). An additional comparison can be made to values from an even earlier baseline that was developed for the nearby North Butte project. The quarterly averages from North Butte ranged from 32.3 mrem to 39.7 mrem (Pathfinder Mines Corporation 1988).

Table JD-D11-7 Baseline Gamma Exposure Rate at the Jane Dough Unit Air Monitoring Stations.

Sample Site	Third Quarter 2010 (mrems/qtr)	Fourth Quarter 2010 (mrems/qtr)	First Quarter 2011 (mrems/qtr)	Second Quarter 2011 (mrems/qtr)	Average by Site (mrems/qtr)
JD-1	34.7	45.0	36.2	44.5	40.1
JD-2	38.8	45.1	34.3	38.0	39.1
JD-3	33.9	46.9	35.6	34.0	37.6
JD-4	30.8	42.7	33.0	34.7	35.3
JD-5	35.0	45.9	30.2	33.0	36.0
JD-6/NR-2	37.4	49.4	38.8	38.4	41.0
JD-7/NR-1*	36.2	45.7	37.2	38.0	39.3
Average	**35.3**	**45.8**	**35.0**	**37.2**	**38.3**
Nichols Ranch	**39.6**	**35.0**	**47.5**	**47.9**	**42.5**
Hank	**41.5**	**34.4**	**55.0**	**50.5**	**45.4**

Notes: *Nearest residence
Minimum detectable dose equivalent: 0.10 mrem

Apart from the comparisons just noted, the average values **(38.3, 42.5, and 45.4 mrem)** recorded **at** the three project sites can be put into a better perspective when compared to the following:

- Average dose to the U.S. Public from natural sources: 300 mrem/year.
- Background radiation (total) in the Colorado Plateau: 75 to 140 mrem/year.
- Terrestrial background (Rock Mountains): 40 mrem/year.
- Average dose to the public from all sources: 360 mrem/year

As the comparison shows, the average background at the project site is very similar to terrestrial background (Rocky Mountains) of 40 mrem/year.

JD-D11.6.2 Monitoring Results

Although one full year of monitoring is required, Uranerz has included five quarters of baseline measurements. Because of the multiple sites, multiple quarters and multiple constituents, three sets of tables are provided: the first, Table JD-D11-10 through JD-D11-14 tabulates the quarterly values by site; the second, Table JD-D11-5, is arranged to conveniently show quarterly comparisons; and the third, Table JD-D11-6, shows average air concentrations by site for each constituent throughout the monitoring period. Because of the consistency of the values over time and at each site it can be concluded that the data are representative of baseline. Additionally, the data from Jane Dough compares favorably with previously-collected data from eight locations at the Hank and Nichols Ranch Units. Lastly, and as expected, the baseline data is orders of magnitude below the 10 CFR 20 Effluent Concentration Limits of U (9E-14); Pb-210 (**6E-13**); Ra-226 (9E-13); and Th-230 (3E-14).

Table JD-D11-10 Jane Dough Baseline Radionuclide Concentrations in Air Third Quarter 2010.

	Third Quarter 2010			
Sample Site	**Uranium (µCi/ml)**	**Pb-210 (µCi/ml)**	**Ra-226 (µCi/ml)**	**Th-230 (µCi/ml)**
LLD*	1E-16	2E-15	1E-16	1E-16
JD-1	2E-16	1.1E-14	1E-17	-9E-17
Precision	N/A	1E-14	5E-17	7E-17
JD-2	2E-16	1.0E-14	3E-17	-3E-18
Precision	N/A	1E-15	3E-17	8E-17
JD-3	4E-16	1.3E-14	6E-17	-6E-17
Precision	N/A	1E-15	4E-17	8E-17
JD-4	2E-16	6.0E-15	2E-17	-1E-17
Precision	N/A	1E-15	3E-17	8E-17
JD-5	2E-16	1.4E-14	5E-17	1E-16
Precision	N/A	1E-15	4E-17	1E-16
JD-6	3E-16	9.9E-15	6E-16	7E-17
Precision	N/A	1E-15	8E-17	9E-17
JD-7	3E-16	5.0E-15	2E-16	2E-17
Precision	N/A	1E-15	6E-17	1E-15

*Lower Limit of Detection: Regulatory Guide 4.14

Table JD-D11-15 Radionuclide Air Concentrations: Quarterly Comparison.

JD-1

Sample Period	**Uranium** (µCi/ml)	**Pb-210** (µCi/ml)	**Ra-226** (µCi/ml)	**Th-230** (µCi/ml)
3rd Q 2010	2E-16	1.1E-14	1E-17	-9E-17
4th Q 2010	1E-16	2.4E-14	1E-17	-9E-17
1st Q 2011	1E-16	1.2E-14	-1E-17	2E-16
2nd Q 2011	1E-16	8.7E-15	-3E-17	2E-16
3rd Q 2011	4E-16	8.7E-15	9E-17	4E-16

JD-2

Sample Period	**Uranium** (µCi/ml)	**Pb-210** (µCi/ml)	**Ra-226** (µCi/ml)	**Th-230** (µCi/ml)
3rd Q 2010	2E-16	1.0E-14	3E-17	-3E-18
4th Q 2010	2E-16	2.1E-14	4E-17	-1E-16
1st Q 2011	2E-16	1.2E-14	4E-17	1E-16
2nd Q 2011	2E-16	9.3E-15	2E-17	2E-16
3rd Q 2011	4E-16	1.5E-14	5E-16	6E-16

JD-3

Sample Period	**Uranium** (µCi/ml)	**Pb-210** (µCi/ml)	**Ra-226** (µCi/ml)	**Th-230** (µCi/ml)
3rd Q 2010	4E-16	1.3E-14	6E-17	-6E-17
4th Q 2010	2E-16	2.2E-14	5E-17	-1E-16
1st Q 2011	2E-16	1.3E-14	3E-17	2E-16
2nd Q 2011	2E-16	8.7E-15	-3E-17	2E-16
3rd Q 2011	4E-16	1.5E-14	2E-16	6E-16

JD-4

Sample Period	**Uranium** (µCi/ml)	**Pb-210** (µCi/ml)	**Ra-226** (µCi/ml)	**Th-230** (µCi/ml)
3rd Q 2010	2E-16	6.0E-15	2E-17	-1E-17
4th Q 2010	1E-16	2.3E-14	3E-17	-7E-17
1st Q 2011	2E-16	1.2E-14	-4E-17	1E-16
2nd Q 2011	1E-16	8.9E-15	9E-17	2E-16
3rd Q 2011	4E-16	1.2E-14	3E-16	4E-16

Table JD-D11-15 (continued)

Sample Period	**Uranium** (µCi/ml)	**Pb-210** (µCi/ml)	**Ra-226** (µCi/ml)	**Th-230** (µCi/ml)
		JD-5		
3rd Q 2010	2E-16	1.4E-14	5E-16	1E-16
4th Q 2010	2E-16	2.2E-14	5E-17	-2E-17
1st Q 2011	2E-16	1.1E-14	7E-17	1E-16
2nd Q 2011	2E-16	9.0E-15	6E-17	2E-16
3rd Q 2011	4E-16	1.5E-14	5E-16	2E-16
		JD-6		
3rd Q 2010	3E-16	9.9E-15	6E-16	7E-17
4th Q 2010	1E-16	2.0E-14	7E-18	-7E-17
1st Q 2011	2E-16	1.2E-14	2E-17	9E-17
2nd Q 2011	2E-16	9.0E-15	8E-17	2E-16
3rd Q 2011	8E-16	1.4E-14	8E-16	3E-16
		JD-7		
3rd Q 2010	3E-16	9.9E-15	2E-16	2E-17
4th Q 2010	2E-16	2.0E-14	4E-17	-3E-17
1st Q 2011	2E-16	1.2E-14	5E-18	1E-16
2nd Q 2011	2E-16	8.3E-15	1E-16	2E-16
3rd Q 2011	4E-16	1.3E-14	4E-16	3E-16

Table JD-D11-16 Average Air Concentrations Over Five Quarters of Monitoring: Jane Dough Unit.

	Uranium (µCi/ml)						**Pb-210 (µCi/ml)**					
Site	**Q3/2010**	**Q4/2010**	**Q1/2011**	**Q2/2011**	**Q3/2011**	**Ave.**	**Q3/2010**	**Q4/2010**	**Q1/2011**	**Q2/2011**	**Q3/2011**	**Ave.**
JD-1	2E-16	1E-16	1E-16	1E-16	4E-16	**2E-16**	1.1E-14	2.4E-14	1.2E-14	8.7E-15	8.7E-15	**1.3E-14**
JD-2	2E-16	2E-16	2E-16	2E-16	4E-16	**2E-16**	1.0E-14	2.1E-14	1.2E-14	9.3E-15	1.5E-14	**1.4E-14**
JD-3	4E-16	2E-16	2E-16	2E-16	4E-16	**3E-16**	1.3E-14	2.2E-14	1.3E-14	8.7E-15	1.5E-14	**1.4E-14**
JD-4	2E-16	1E-16	2E-16	1E-16	4E-16	**2E-16**	6.0E-15	2.3E-14	1.2E-14	8.9E-15	1.2E-14	**1.2E-14**
JD-5	2E-16	2E-16	2E-16	2E-16	4E-16	**2E-16**	1.4E-14	2.2E-14	1.1E-14	9.0E-15	1.5E-14	**1.4E-14**
JD-6	3E-16	1E-16	2E-16	2E-16	8E-16	**3E-16**	9.9E-15	2.0E-14	1.2E-14	9.0E-15	1.4E-14	**1.3E-14**
JD-7	3E-16	2E-16	2E-16	2E-16	2E-16	**2E-16**	9.9E-15	2.0E-14	1.2E-14	8.3E-15	1.3E-14	**1.3E-14**

	Ra-226 (µCi/ml)						**Th-230 (µCi/ml)**					
Site	**Q3/2010**	**Q4/2010**	**Q1/2011**	**Q2/2011**	**Q3/2011**	**Ave**	**Q3/2010**	**Q4/2010**	**Q1/2011**	**Q2/2011**	**Q3/2011**	**Ave.**
JD-1	1E-17	1E-17	-1E-17	-3E-17	9E-17	**3E-17**	-9E-17	-9E-17	2E-16	2E-16	4E-16	**2E-16**
JD-2	3E-17	4E-17	4E-17	2E-17	5E-16	**3E-17**	-3E-18	-1E-16	1E-16	2E-16	6E-16	**2E-16**
JD-3	6E-17	5E-17	3E-17	-3E-17	2E-16	**7E-17**	-6E-17	-1E-16	2E-16	2E-16	6E-16	**2E-16**
JD-4	2E-17	3E-17	-4E-17	9E-17	3E-16	**1E-16**	-1E-17	-7E-17	1E-16	2E-16	4E-16	**2E-16**
JD-5	5E-16	5E-17	7E-17	6E-17	5E-16	**2E-16**	1E-16	-2E-17	1E-16	2E-16	2E-16	**1E-16**
JD-6	6E-16	7E-18	2E-17	8E-17	8E-16	**3E-16**	7E-17	-7E-17	9E-17	2E-16	3E-16	**2E-16**
JD-7	2E-16	4E-17	5E-18	1E-16	4E-16	**1E-16**	2E-17	-3E-17	1E-16	2E-16	3E-16	**1E-16**

Regulatory Guide 14 Lower Limit of Detection: Uranium (1E-16); Pb-210 (2E-15); Ra-226 (1E-16); and Th-230 (1E-16). 10 CFR 20 Effluent Concentration Limits: U (9E-14); Pb-210(6E-13); Ra-226 (9E-13); and Th-230 (3E-14).

All values in the table are as reported in the laboratory reports. To allow the Average to be approximated, negative values were revised to the lower limit of detection.

Table JD-D11-19 Center of Site Boundary from Nichols Ranch Central Processing Plant.

Location		Distance from mill center (km) x(E)	y(N)	Elevation from mill center z (m)
Nichols Ranch	- north central	-0.4	1.3	57
	- east central	0.6	0.2	-2
	- south central	-0.3	-1.1	-18
	- west central	-1.4	0.5	12
Hank	- north central	7.9	6.6	86
	- east central	8.8	3.3	160
	- south central	7.9	1.3	139
	- west central	7.1	4.2	102
Jane Dough	- north central	0.4	-1.1	-15
	- east central	2.2	-3.2	35
	- south central	0.4	-5.6	18
	- west central	-1.0	-3.2	35

JD-D11.7.3 Time Parameters

The dose commitments were completed for development, production, and restoration of wellfields for the operating years 2014 through 2024. The respective schedule is provided in Figure 3-**12** in the Mine Plan.

The time parameters were input as:

- Beginning Year: 2014.
- Number of Time Steps: 10.
- Time Increment: 1 year.
- Population Adjustment: 1.2 (see above "Population Distribution")
- Source Adjustment: varied per source to reflect development, production, and restoration schedule of Figure 3-**12** in the Mine Plan.