RAI-7

Description of Deficiency

The information in TR Section 2.6.2 does not meet the applicable requirements of 10 CFR 40.41(c), using the review procedures in Section 2.6.2 and acceptance criteria in Section 2.6.3 of the SRP.

Basis for Request

SRP Section 2.6.3 indicates that the characterization of the site geology will be acceptable in the application if it includes a description of the local stratigraphy with:

(1)(d)(ii) Cross sections through the ore deposit roughly perpendicular and parallel to the principal ore trend.

(2) All maps and cross sections are at sufficient scale and resolution to clearly show the intended geologic information.

(3) In the local stratigraphic section, all mineralized horizons, confining, and other important units such as drinking water aquifers are clearly shown with their depths from the surface clearly indicated.

Uranium One provided geological cross sections for the entire license area. A geological cross section index map was provided in Figure 2.6-2 of the TR. The cross section index map did not show the location of the North Platte Satellite wellfields or ore bodies. Based on staff's assessment, cross section, C-C', in Figure 2.6-5, which extends from the far western boundary of the license area to the eastern boundary, spanning approximately seven miles, appears to have four well logs that may pass through one North Platte ore body located in Sections 15 and 16. Another cross section, N-N' in Figure 2.6-16, passes north to south across the license area. Four well logs on this cross section are located in Section 15 and may pass through the proposed North Platte ore body location. Both cross sections C-C' and N-N' indicate the ore is located in the 70 sand which may be composed of three distinct layers. There appears to be little to no underlying confining layer separating the underlying 60 sand from the 70 sand on either cross section. In addition, the overlying 80 sand is discontinuous above the 70 sand where the ore lies. The distance between well logs on both cross sections ranged from 1000-3500 ft, which does not provide the resolution necessary for staff to assess confining layers or continuity of any formation of interest.

Cross section, I-I', in Figure 2.6-11 appeared to pass north to south through the North Platte satellite southern ore body located in Section 20. Three well logs in Section 20, located 800-1950 ft apart indicated the presence of ore in two separate 70 sands. Once again the overlying 80 sand appeared discontinuous and the underlying 60 sand did not appear to have a significant confining layer between it and the 70 sand ore zone.

Formulation of RAI
The staff is unable to evaluate the site geology of the North Platte Satellite based on the information provided in the application. Uranium One provided only a small portion of two large cross sections to describe the site geology at one ore body and a small portion of only one large cross section to describe the geology for the other ore body. Staff is aware that the North Platte site was previously assessed by Uranium Resources, Inc. as a potential uranium recovery site in the early 1980s. Therefore exploratory well logs should exist to create detailed local geological cross sections. Uranium One has also provided well boring maps that show numerous borings were made to assess resources in the North Platte Satellite. The staff therefore requests that Uranium One provide local geological cross sections based on several well logs through the principal axes of the North Platte Satellite's two ore body locations at the proposed wellfield locations. These cross sections should at a minimum show the subsurface geology from the ground surface through the mineralized horizons to be targeted for extraction to the first aquifer below the mineralized horizons. Confining layers and aquifers should be clearly defined and labeled. The potentiometric water levels of aquifers if available and any other information which can inform the local site geology of the North Platte Satellite should be included.

RAI-7 Response

See RAI-6 for response to this RAI.

RAI-8

Description of Deficiency

The information in TR Section 2.6.2 does not meet the applicable requirements of 10 CFR 40.41(c), using the review procedures in Section 2.6.2 and acceptance criteria in Section 2.6.3 of the SRP.

Basis for Request

In accordance with SRP Section 2.6.3, the characterization of the site geology will be acceptable in the application if it includes a description of the local stratigraphy with:

(1)(d)(ii) Cross sections through the ore deposit roughly perpendicular and parallel to the principal ore trend.

(2) All maps and cross sections are at sufficient scale and resolution to clearly show the intended geologic information.

(3) In the local stratigraphic section, all mineralized horizons, confining, and other important units such as drinking water aquifers are clearly shown with their depths from the surface clearly indicated.

Uranium One provided geological cross sections for the entire license area. A geological cross section index map was provided in Figure 2.6-2 of the TR. The cross section index map does not show the location of the Peterson Satellite wellfields or the ore bodies. Based on staff's assessment, a small portion of cross sections, E-E', in Figure 2.6-4, and cross section, J-J', in Figure 2.6-12, appear to pass through the ore body in Section 28. Two well bores, located 2700 ft apart on J-J' indicated the presence of ore in a sand identified as the 80 sand. On cross section E-E', three well borings located 1200-2500 ft apart indicated the presence of ore in the 80 sand.

For the ore body located in Sections 34, 35 and 36, four cross sections appeared to intersect the ore body; F-F' in Figure 2.6-8, L-L' in Figure 2.6-14, N-N' in Figure 2.6-16, and M-M' in Figure 2.6-17. Cross section F-F' runs west to east and contains five well logs spaced at distances of 1800 to 2500 ft, which indicate the presence of ore in the two separate sands identified as the 90 sand. The top of the 90 sand in the west is located approximately 100 ft below ground surface. In the east, the top of the 90 sand is near the surface and outcrops above the flood plain of Sage Creek. Ore is located very near to the outcrop. The underlying and overlying sands appear to be separated by very thin confining layers. The information provided in the north to-south cross sections agree with the interpretation in the F-F' cross section.

Formulation of RAI

The staff is unable to evaluate the site geology of the Peterson Satellite based on the cross sections provided in the application. Uranium One has provided well boring maps that show numerous borings were made to assess resources in the Peterson Satellite. The staff therefore requests that Uranium One provide local geological cross sections based on several well logs through the principal axes of the Peterson Satellite two ore body locations at the proposed wellfield locations. These cross sections *should, at a minimum, show the subsurface geology from the ground surface through the mineralized horizons to be targeted for extraction to the first aquifer below the mineralized horizons. Confining layers and aquifers should be clearly defined and labeled. The potentiometric water levels of aquifers if available, and any other information which can inform the local site geology of the Peterson Satellite, should be included.*

RAI-8 Response

See RAI-6 for response to this RAI.

RAI-14

Description of Deficiency

The information provided in TR Section 2.7.1 does not meet the applicable requirements of 10 CFR 40.41(c), using the review procedures in Section 2.7.2 and acceptance criteria in Section 2.7.3 of the SRP.

Basis for Request

Uranium One identified several surface water impoundments within the license area. Approximately 195 individual water bodies were identified ranging from 28 ft2 to 5.1 acres. The larger ponds were described as drainages which had been impounded for livestock. Some of these stock ponds were supplied by windmills. The two largest ponds were identified as Gilbert Lake in the eastern portion of the license area which was 16 acres and 6 inches deep when surveyed in 2008. Another depression pond was located in the northern portion of the license area and was 4.8 acres and 12 in deep.

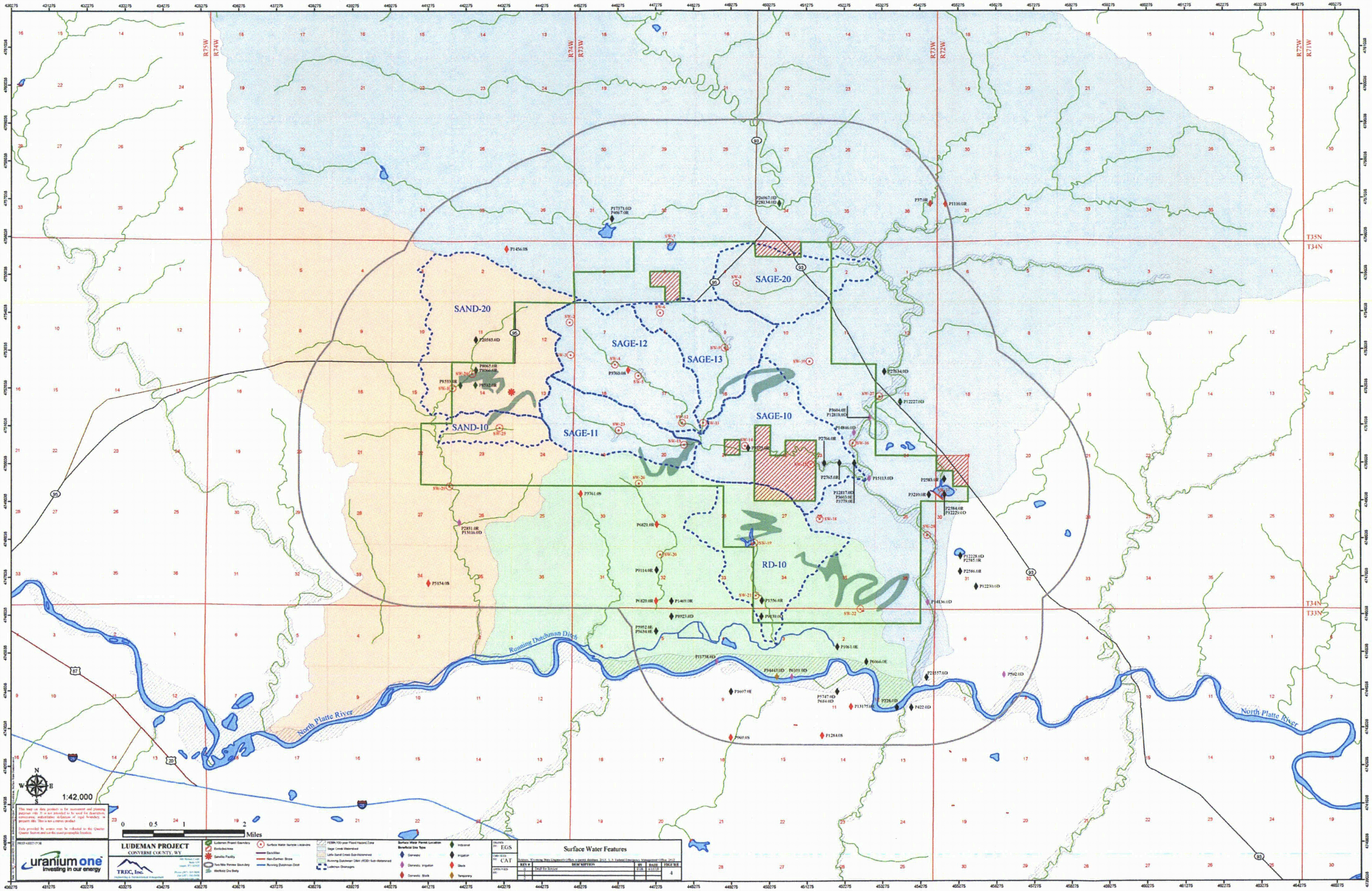
Uranium One did not appear to provide a listing of any surface water rights associated with drainages or impoundments within the license area. However, staff found this information in Addendum 2.7-A mingled with the groundwater rights. Uranium One did not provide a map showing the surface water rights in the license area.

Formulation of RAI

Uranium One should provide the surface water rights in a separate addendum from groundwater rights for a 2 mi buffer around the license area. In addition, NRC requests that Uranium One provide a map(s) identifying the surface water rights within 2 km of the proposed wellfields and surge ponds separately for the Leuenberger, North Platte and Peterson Satellites.

RAI-14 Response

The Ludeman Project operations now propose to employ a single satellite facility; thus, there is a single corresponding figure identifying surface water rights for the project area and 2-mile buffer. The figure referenced and presented in the response to RAI-12(attached below) identifies the updated surface water rights within the proposed project boundary and a 2-mile buffer. Uranium One makes the commitment to restructure tables located in the TR Addendum 2.7 to separate groundwater and surface rights and list these rights individually. Surface water impoundments not identified by a permit number on the below attached map do not appear to have surface water rights filed with the Wyoming State Engineers Office (SEO) and no information could not be found within the SEO database for these surface water impoundments. The reviewer is reminded that this project is located on private lands, and permits for surface impoundments may not have been filed by the land owners at the time the impoundment was constructed.



SAND-20
SAND-10
SAGE-12
SAGE-13
SAGE-11
SAGE-10
SAGE-20
RD-10
Running Dutchman Ditch
North Platte River
R75W
R74W
R74W
R73W
R73W
R72W
R72W
R71W
T35N
T34N
T34N
T33N
1:42,000
0
0.5
1
2
Miles
PREPARED FOR
uranium one
investing in our energy
LUDEMAN PROJECT
CONVERSE COUNTY, WY
TREC, Inc.
Surface Water Features
DRAWN BY: EGS
CHECKED BY: CAT
APPROVED BY:
REV #
DESCRIPTION
BY
DATE
FIGURE
4

RAI-16

Description of Deficiency

The information provided in TR Section 2.7.3.1 does not meet the applicable requirements of 10 CFR 40.41(c), using the review procedures in Section 2.7.2 and acceptance criteria in Section 2.7.3 of the SRP.

Basis for Request

Staff's review of the surface water sampling results identified two locations where measurements appeared to show anomalous values for cations, anions, and radionuclides. The two locations of concern are SW-1 and SW-29 located down-stream of the Leuenberger Satellite on Little Sand Creek. SW-1 is located just west of the Leuenberger Satellite and SW-29 is located further downstream from the satellite. As shown in the RAI 17 Surface Water Quality table SW-1 and SW-29 showed anomalously high average values for bicarbonate, chloride, conductivity, sulfate, calcium, sodium, magnesium, uranium and gross alpha. The values of these constituents at SW-24 on Little Sand Creek directly up-gradient of the Leuenberger Satellite were below the license area average.

Uranium One did not address the surface water quality anomalies at SW-1 and SW-29. Staff does not have reasonable assurance that Uranium One has characterized surface water quality at Little Sand Creek.

Formulation of RAI

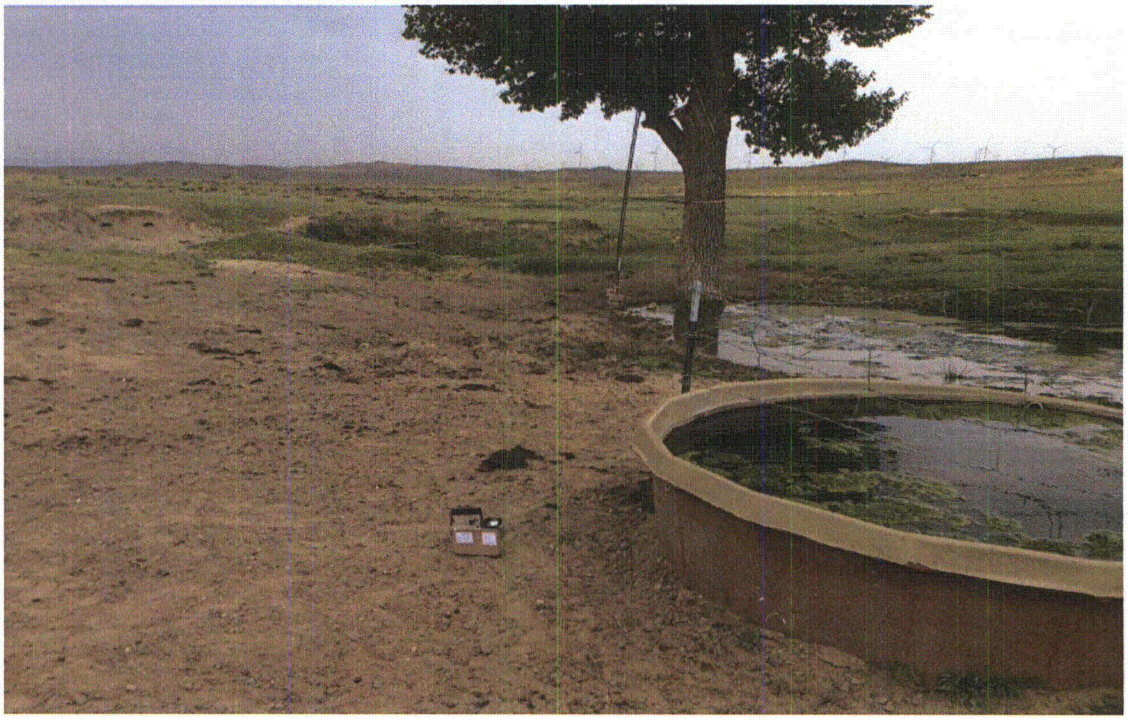
Uranium One should evaluate the source of anomalous surface water quality at SW-1 and SW-29 at Little Sand Creek.

RAI-16 Response

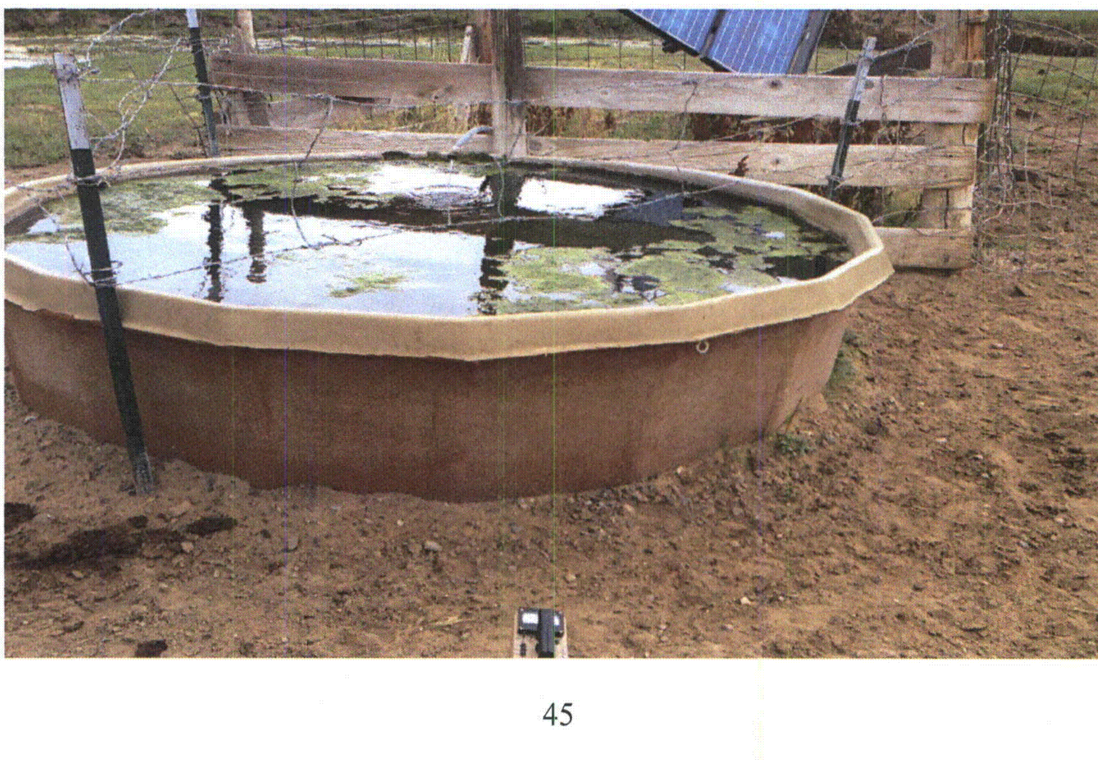
It is possible there are sources within the project area that may contribute to the anomalous cations and bicarbonate, chloride, conductivity, sulfate, calcium, magnesium uranium and gross alpha; although, Uranium One is currently unaware of any documented spills or other agricultural sources in these areas.

Uranium One has done some further investigation and from discussions with the land owner representative Stock Well 12 (STW12) may actually be within the Wyoming State Engineer Office (SEO) database as cancelled well P4988.OP or Smith Well #5. STW12 is a seep or spring that feeds into little sand creek approximately 100 yards above the baseline sampling point for SW-1. Baseline water sample results from STW12 collected in June 29, 2009 and December 7, 2009 indicate elevated values for cations, anions, bicarbonate, chloride, conductivity, sulfate, calcium, sodium magnesium, and radionuclides. Uranium One releases that NRC does not currently have the analytical results for the December 2009 sampling event as the results were not reported until after the permit application was submitted. A copy of the update water quality for STW12 has been included for reference in this response and will incorporated into Appendix 2.7-E as the document is updated. SW-1 and SW-29 are both downstream of where STW-12 waters feed into little sand creek and water quality would appear to be impacted from these waters. Regardless of these impacts water quality would be considered background water conditions. Photos of the location of SW-1 in relation to STW12 are included for reference purposes below:

STW12 Little Sand Creek



STW12 Stock Tank and Well Discharge



e

SW-1 Looking Upstream Toward STW12

Uranium recovery solutions associated with ISR operations have a distinctive geochemical fingerprints related to their elevated alkalinity, chloride, conductivity, and radionuclide content. The surface water sampling locations are ephemeral in nature and have diluted waters that appear to be mostly derived from rain or snow melt; thus, different compositions. These distinctive ISR solution water quality fingerprints will enable the rapid and verifiable determination of any potential contamination due to leaks or spills associated with satellite operations

Uranium One will make a commitment to collect additional surface water samples at the SW-1, SW-29 and STW-12 to further characterize surface water quality within Little Sand Creek. Although historical ISR operations have occurred in the proximity of these locations, the surface water quality presently observed at SW-1 and SW-29 constitute current background conditions.

Uranium One has attached a copy of the SEO Permit for Smith #5 for reference purposes. Uranium One will verify in the field with the landowner representative that what we are calling STW12 is indeed what the landowner refers to as Smith #5.

PERMIT SUMMARY

General Info | Beneficial Uses |Appropriator(s) |Water Right POD | WR POU | Comments |Appropriation Amount |Remarks |Documents |Construction |Well Log/Water Quality |

Instrument: WELLS AND SPRINGS

Facility Name :	SMITH #5	Water Right Status :	CANCELLED
Application Number :		Date Accepted for Processing :	
Temporary File Number :		Priority Date :	12/31/1945
Permit Number :	P4988.0P	Division :	1 District : 15
Proof Number :		SC Original Expiration Date :	
Docket Number :		SC Extended Expiration Date :	
Order Number :		SC Actual Date :	12/31/1945
Certificate Record Number :		BU Original Expiration Date :	
Auto Cancellation Date :		BU Extended Expiration Date :	
Extended Auto Cancellation Date :		BU Actual Date :	12/31/1945
Last Modified By :		Last Modified Date :	01/01/1800
Created By :			

General Info

Type Of Diversion:	Not Applicable, Production Well
Supply Type:	Original Supply
Special Cases:	
Appropriation Amount :	10.000 GPM

Prefix	Water Right Number	Suffix

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Appropriator(s)

Appropriator	Last Name	First Name	Company	City	State
Agent	SMITH	WILLIAM J.		DOUGLAS	Wyoming
Applicant			SMITH SHEEP CO.	Douglas	Wyoming

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Beneficial Uses

Beneficial Uses:	Stock Watering()

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Water Right POD

Principal Meridian	Township	Range	Section	Quarter	Qtr-Qtr	SurveyType	Number	Primary POD
06	034N	074W	14	NW	SWNW			Y

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Water Right POU

Principal Meridian	Township	Range	Section	Quarter	Q-Q	WR Status	Acres	Use	Sub Use	Supply Type
06	034N	074W	14	NW	SWNW					ORIGINAL
1										

Supply Type	Acres
Original	0.000

Total acres Irrigated : 0.000

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Construction

Diversion Type	Contruction Type	Construction Description	Total Depth (feet)	Casing Height (feet)	static water level (feet)
			145.00		60.00

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Well Log/Water Quality

Total Depth (feet)	Well Diameter (inches)	WaterBearing Formation (feet)	WaterBearing Formation Top (feet)	WaterBearing Formation Bottom (feet)	Water Quality
		-1.00	-1.00	-1.00	

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Comments

Created Date	Comment Details	Created by
1/1/1800 12:00:00 AM	FOLLOWING DATE CHANGES MADE ON 07/22/90 FOR COMPUTER ACCEPTANCE. MONTH OF COMMENCEMENT DATE CHANGED FROM "00" TO "12". DAY OF COMMENCEMENT DATE CHANGED FROM "00" TO "31". MONTH OF COMPLETION DATE CHANGED FROM "00" TO "12". DAY OF COMPLETION DATE CHANGED FROM "00" TO "31". MONTH OF BENEFICIAL USE DATE CHANGED FROM "00" TO "12". DAY OF BENEFICIAL USE DATE CHANGED FROM "00" TO "31".	MIGRATED
1		

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Documents

Document Type	Document Name	Document Date	Document Created by	Document Uploaded by	Uploaded Date	View
Permit						

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Remarks

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Appropriation for Ground Water	
Appropriation Amount (GPM)	10.00

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Related Transactions

Instrument Type	Instrument Name	Instrument Code	WR Number Type	WR Number	Instrument

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Well		Collection Date	Analyte	A/C Balance (± 5) (%)	Anions (meq/L)	Bicarbonate as HCO3 (mq/L)	Carbonate as CO3 (mg/L)	Cations (meq/L)	Chloride (mg/L)	Conductivity (umhos/cm)	Fluoride (mg/L)	pH (s.u.)	Solids, Total Dissolved Calculated (mg/L)	Solids, Total Dissolved TDS @ 180 C (mg/L)	TDS Balance (0.80 - 1.20) (dec. %)	Sulfate (mg/L)	Nitrogen, Ammonia as N (mg/L)	Nitrogen, Nitrate+Nitrite as N (mg/L)	Aluminum (mg/L)
				DIS	DIS	DIS	DIS	DIS	DIS	DIS	DIS	DIS	DIS	DIS	DIS	DIS	DIS	DIS	DIS
Stock Well #1		11/6/2008		2.51	6.13	215	1	6.44	4	529	0.6	7.79	381	356		116	0.1	0.94	0.1
		9/22/2009		-5.42	6.15	226	5	5.52	4	536	0.5	7.92	353	383		108	0.05	0.9	0.1
		Average		**-1.46**	**6.14**	**220.50**	**3.00**	**5.98**	**4.00**	**532.50**	**0.55**	**7.86**	**367.00**	**369.50**	**#DIV/0!**	**112.00**	**0.08**	**0.92**	**0.10**
Stock Well #2		11/6/2008		2.72	7.09	200	1	7.49	5	630	0.5	8	441	416		175	0.1	0.05	0.1
		9/22/2009		-3.46	7.18	211	5	6.70	6	634	0.5	8.02	423	450		170	0.05	0.1	0.1
		Average		**-0.37**	**7.14**	**205.50**	**3.00**	**7.10**	**5.50**	**632.00**	**0.50**	**8.01**	**432.00**	**433.00**	**#DIV/0!**	**172.50**	**0.08**	**0.08**	**0.10**
Stock Well #3		11/10/2008		2.83	5.45	184	1	5.78	4	469	0.2	7.83	343	316		112	0.1	0.05	0.1
		6/30/2009		-0.934	5.28	187	1	5.18	3	519	0.2	8.07	319	357		102	0.05	0.01	0.1
		9/24/2009		-2.77	5.52	195	5	5.22	3	482	0.2	8.09	326	335		107	0.05	0.1	0.1
		Average		**-0.29**	**5.42**	**188.67**	**2.33**	**5.39**	**3.33**	**490.00**	**0.20**	**7.98**	**329.33**	**336.00**		**107.00**	**0.07**	**0.05**	**0.10**
Stock Well #4		9/24/2009		-5.25	5.31	202	5	4.78	3	456	0.2	8.23	304	330		90	0.05	0.1	0.1
		Average		**-5.25**	**5.31**	**202.00**	**5.00**	**4.78**	**3.00**	**456.00**	**0.20**	**8.23**	**304.00**	**330.00**	**#DIV/0!**	**90.00**	**0.05**	**0.10**	**0.10**
Stock Well #5		9/24/2009		-5.63	5.40	210	5	4.82	3	466	0.2	8.02	310	303		90	0.05	0.1	0.1
		Average		**-5.63**	**5.40**	**210.00**	**5.00**	**4.82**	**3.00**	**466.00**	**0.20**	**8.02**	**310.00**	**303.00**	**#DIV/0!**	**90.00**	**0.05**	**0.10**	**0.10**
Stock Well #6		9/24/2009		-5.23	5.40	199	5	4.86	3	469	0.2	8.20	313	321		97	0.05	0.1	0.1
		Average		**-5.23**	**5.40**	**199.00**	**5.00**	**4.86**	**3.00**	**469.00**	**0.20**	**8.20**	**313.00**	**321.00**	**#DIV/0!**	**97.00**	**0.05**	**0.10**	**0.10**
Stock Well #7		6/30/2009		0.34	20.7	362	1	20.9	23	1790	0.4	7.66	1310	1390		680	0.05	0.04	0.1
		9/24/2009		-2.32	21.2	379	5	20.2	25	1810	0.4	7.65	1310	1360		687	0.05	0.1	0.1
		Average		**-0.99**	**20.95**	**370.50**	**3.00**	**20.55**	**24.00**	**1800.00**	**0.40**	**7.66**	**1310.00**	**1375.00**	**#DIV/0!**	**683.50**	**0.05**	**0.07**	**0.10**
Stock Well #8		6/29/2009		-4.79	5.8	262	1	5.27	4	520	0.2	7.6	326	326		60	0.1	1.78	0.1
		9/22/2009		-7.80	5.88	274	5	5.03	4	473	0.2	7.66	319	314		56	0.05	1.5	0.1
		Average		**-6.30**	**5.84**	**268.00**	**3.00**	**5.15**	**4.00**	**496.50**	**0.20**	**7.63**	**322.50**	**320.00**	**#DIV/0!**	**58.00**	**0.08**	**1.64**	**0.10**
Stock Well #9		11/20/2008		2.27	7.65	273	1	8.01	5	679	0.6	8.15	456	435		142	0.05	0.72	0.1
		Average		**2.27**	**7.65**	**273**	**1.00**	**8.01**	**5.00**	**679.00**	**0.60**	**8.15**	**456.00**	**435.00**		**142.00**	**0.05**	**0.72**	**0.10**
Stock Well #10		6/30/2009		0.865	5.42	200	3	5.51	5	535	0.7	8.2	326	359		90	0.05	0.09	0.1
		Average		**0.87**	**5.42**	**200**	**3.00**	**5.51**	**5.00**	**535.00**	**0.70**	**8.20**	**326.00**	**359.00**		**90.00**	**0.05**	**0.09**	**0.10**
Stock Well #11		6/29/2009		-4.09	4.96	221	1	4.57	3	470	0.5	7.9	274	276		59	0.07	0.05	0.1
		Average		**-4.09**	**4.96**	**221**	**1.00**	**4.57**	**3.00**	**470.00**	**0.50**	**7.90**	**274.00**	**276.00**		**59.00**	**0.07**	**0.05**	**0.10**
Stock Well #12		6/29/2009		-4.22	20.3	404	1	18.7	29	1700	0.5	7.3	1230	1300		616	0.05	0.56	0.1
		12/7/2009		-5.52	19.2	417	5	17.2	28	1590	0.5	7.5	1150	1190		556	0.05	0.5	0.1
		Average		**-4.87**	**19.75**	**410.50**	**3.00**	**17.95**	**28.50**	**1645.00**	**0.50**	**7.40**	**1190.00**	**1245.00**	**#DIV/0!**	**586.00**	**0.05**	**0.53**	**0.10**
Stock Well #13		6/29/2009		-1.8	5.79	214	1	5.59	2	550	0.4	7.9	337	335		106	0.05	0.05	0.1
		9/24/2009		-4.71	6.05	226	5	5.51	3	525	0.4	7.99	344	339		108	0.05	0.1	0.1
		Average		**-3.26**	**5.92**	**220.00**	**3.00**	**5.55**	**2.50**	**537.50**	**0.40**	**7.95**	**340.50**	**337.00**	**#DIV/0!**	**107.00**	**0.05**	**0.08**	**0.10**
Stock Well #15		6/30/2009		-1.88	6.33	209	1	6.09	5	600	0.2	8.03	385	421		129	0.05	1.23	0.1
		9/22/2009		-3.84	6.30	227	5	5.83	4	554	0.2	7.80	372	389		113	0.05	1.4	0.1
		Average		**-2.86**	**6.32**	**218.00**	**3.00**	**5.96**	**4.50**	**577.00**	**0.20**	**7.92**	**378.50**	**405.00**		**121.00**	**0.05**	**1.32**	**0.10**

Well		Collection Date	Arsenic (mg/L)	Barium (mg/L)	Boron (mg/L)	Cadmium (mg/L)	Calcium (mg/L)	Chromium (mg/L)	Copper (mg/L)	Iron (mg/L)	Lead (mg/L)	Magnesium (mg/L)	Manganese (mg/L)	Mercury (mg/L)	Molybdenum (mg/L)	Nickel (mg/L)	Potassium (mg/L)	Selenium (mg/L)
			DIS	DIS	DIS	DIS	DIS	DIS	DIS	DIS	DIS	DIS	DIS	DIS	DIS	DIS	DIS	DIS
Stock Well #1		11/6/2008	0.002	0.1	0.1	0.005	80	0.05	0.01	0.03	0.001	14	0.02	0.001	0.1	0.05	8	0.013
		9/22/2009	0.001	0.1	0.1	0.005	66	0.05	0.01	0.03	0.001	12	0.06	0.001	0.1	0.05	8	0.012
		Average	**0.00**	**0.10**	**0.10**	**0.01**	**73.00**	**0.05**	**0.01**	**0.03**	**0.00**	**13.00**	**0.04**	**0.00**	**0.10**	**0.05**	**8.00**	**0.01**
Stock Well #2		11/6/2008	0.001	0.1	0.1	0.005	69	0.05	0.01	0.03	0.001	17	0.03	0.001	0.1	0.05	7	0.001
		9/22/2009	0.001	0.1	0.1	0.005	60	0.05	0.01	0.03	0.001	15	0.03	0.001	0.1	0.05	7	0.001
		Average	**0.00**	**0.10**	**0.10**	**0.01**	**64.50**	**0.05**	**0.01**	**0.03**	**0.00**	**16.00**	**0.03**	**0.00**	**0.10**	**0.05**	**7.00**	**0.00**
Stock Well #3		11/10/2008	0.001	0.1	0.1	0.005	45	0.05	0.01	0.03	0.001	12	0.02	0.001	0.1	0.05	6	0.001
		6/30/2009	0.001	0.1	0.1	0.005	38	0.05	0.01	0.03	0.001	10	0.02	0.001	0.1	0.05	6	0.001
		9/24/2009	0.001	0.1	0.1	0.005	39	0.05	0.01	0.03	0.001	10	0.02	0.001	0.1	0.05	6	0.001
		Average	**0.001**	**0.10**	**0.10**	**0.005**	**40.67**	**0.05**	**0.01**	**0.03**	**0.001**	**10.67**	**0.02**	**0.001**	**0.10**	**0.05**	**6.00**	**0.001**
Stock Well #4		9/24/2009	0.001	0.1	0.1	0.005	41	0.05	0.01	0.03	0.001	12	0.01	0.001	0.1	0.05	6	0.001
		Average	**0.001**	**0.10**	**0.10**	**0.005**	**41.00**	**0.05**	**0.01**	**0.03**	**0.001**	**12.00**	**0.01**	**0.001**	**0.10**	**0.05**	**6.00**	**0.001**
Stock Well #5		9/24/2009	0.001	0.1	0.1	0.005	42	0.05	0.01	0.03	0.001	12	0.01	0.001	0.1	0.05	6	0.001
		Average	**0.001**	**0.10**	**0.10**	**0.005**	**42.00**	**0.05**	**0.01**	**0.03**	**0.001**	**12.00**	**0.01**	**0.001**	**0.10**	**0.05**	**6.00**	**0.001**
Stock Well #6		9/24/2009	0.001	0.1	0.1	0.005	37	0.05	0.01	0.03	0.001	14	0.01	0.001	0.1	0.05	6	0.001
		Average	**0.001**	**0.10**	**0.10**	**0.005**	**37.00**	**0.05**	**0.01**	**0.03**	**0.001**	**14.00**	**0.01**	**0.001**	**0.10**	**0.05**	**6.00**	**0.001**
Stock Well #7		6/30/2009	0.001	0.1	0.1	0.005	126	0.05	0.01	0.03	0.001	61	0.01	0.001	0.1	0.05	5	0.001
		9/24/2009	0.001	0.1	0.1	0.005	123	0.05	0.01	0.03	0.001	58	0.01	0.001	0.1	0.05	5	0.001
		Average	**0.001**	**0.10**	**0.10**	**0.005**	**124.50**	**0.05**	**0.01**	**0.03**	**0.001**	**59.50**	**0.01**	**0.001**	**0.10**	**0.05**	**5.00**	**0.001**
Stock Well #8		6/29/2009	0.001	0.1	0.1	0.005	69	0.05	0.01	0.03	0.001	9	0.01	0.001	0.1	0.05	7	0.015
		9/22/2009	0.001	0.1	0.1	0.005	65	0.05	0.01	0.03	0.001	9	0.01	0.001	0.1	0.05	7	0.010
		Average	**0.001**	**0.10**	**0.10**	**0.005**	**67.00**	**0.05**	**0.01**	**0.03**	**0.001**	**9.00**	**0.01**	**0.001**	**0.10**	**0.05**	**7.00**	**0.013**
Stock Well #9		11/20/2008	0.002	0.1	0.1	0.005	73	0.05	0.01	0.03	0.001	20	0.01	0.001	0.1	0.05	7	0.010
		Average	**0.002**	**0.10**	**0.10**	**0.005**	**73.00**	**0.05**	**0.01**	**0.03**	**0.001**	**20.00**	**0.01**	**0.001**	**0.10**	**0.05**	**7.00**	**0.010**
Stock Well #10		6/30/2009	0.001	0.1	0.1	0.005	20	0.05	0.01	0.03	0.001	8	0.13	0.001	0.1	0.05	5	0.002
		Average	**0.001**	**0.10**	**0.10**	**0.005**	**20.00**	**0.05**	**0.01**	**0.03**	**0.001**	**8.00**	**0.13**	**0.001**	**0.10**	**0.05**	**5.00**	**0.002**
Stock Well #11		6/29/2009	0.001	0.1	0.1	0.005	40	0.05	0.01	0.03	0.001	12	0.05	0.001	0.1	0.05	6	0.001
		Average	**0.001**	**0.10**	**0.10**	**0.005**	**40.00**	**0.05**	**0.01**	**0.03**	**0.001**	**12.00**	**0.05**	**0.001**	**0.10**	**0.05**	**6.00**	**0.001**
Stock Well #12		6/29/2009	0.001	0.1	0.2	0.005	199	0.05	0.01	0.03	0.001	48	0.54	0.001	0.1	0.05	10	0.004
		12/7/2009	0.001	0.1	0.2	0.005	185	0.05	0.01	0.03	0.001	44	0.50	0.001	0.1	0.05	9	0.004
		Average	**0.001**	**0.10**	**0.20**	**0.005**	**192.00**	**0.05**	**0.01**	**0.03**	**0.001**	**46.00**	**0.52**	**0.001**	**0.10**	**0.05**	**9.50**	**0.004**
Stock Well #13		6/29/2009	0.004	0.1	0.1	0.005	43	0.05	0.01	0.03	0.001	14	0.02	0.001	0.1	0.05	7	0.001
		9/24/2009	0.003	0.1	0.1	0.005	43	0.05	0.01	0.03	0.001	13	0.02	0.001	0.1	0.05	6	0.001
		Average	**0.004**	**0.10**	**0.10**	**0.005**	**43.00**	**0.05**	**0.01**	**0.03**	**0.001**	**13.50**	**0.02**	**0.00**	**0.10**	**0.05**	**6.50**	**0.001**
Stock Well #15		6/30/2009	0.001	0.1	0.1	0.005	71	0.05	0.01	0.03	0.001	12	0.03	0.001	0.1	0.05	8	0.034
		9/22/2009	0.001	0.1	0.1	0.005	71	0.05	0.01	0.03	0.001	10	0.02	0.001	0.1	0.05	8	0.028
		Average	**0.001**	**0.10**	**0.10**	**0.005**	**71.00**	**0.05**	**0.01**	**0.03**	**0.001**	**11.00**	**0.03**	**0.001**	**0.10**	**0.05**	**8.00**	**0.031**

Well		Collection Date	Silica (mg/L)	Sodium (mg/L)	Uranium (mg/L)	Vanadium (mg/L)	Zinc (mg/L)	Iron (mg/L)	Manganese (mg/L)	Gross Alpha (pCi/L)	Gross Alpha MDC (pCi/L)	Gross Alpha precision (±) (pCi/L)	Gross Beta (pCi/L)	Gross Beta MDC (pCi/L)	Gross Beta precision (±) (pCi/L)	Lead 210 (pCi/L)	Lead 210 MDC (pCi/L)	Lead 210 precision (±) (pCi/L)
			DIS	DIS	DIS	DIS	DIS	TOT	TOT	DIS	DIS		DIS	DIS		DIS		
Stock Well #1		11/6/2008	18.7	25	0.0054	0.1	0.02	0.89	0.02	25.4	1.7	2.3	10.3	2.8	1.8	5.1	5.1	3.0
		9/22/2009	13.6	24	0.0060	0.1	0.02	0.03	0.06	18.6	2.3	2.3	9.5	2.8	1.9	8.4	2	1.2
		Average	**16.15**	**24.50**	**0.01**	**0.10**	**0.02**	**0.46**	**0.04**	**22.00**	**2.00**	**2.30**	**9.90**	**2.80**	**1.85**	**6.75**	**3.55**	**2.10**
Stock Well #2		11/6/2008	9.6	57	0.0013	0.1	0.58	0.26	0.03	6.5	1.8	1.5	3.3	2.8	1.7	10.2	10.2	6.1
		9/22/2009	6.9	52	0.0015	0.1	0.26	0.03	0.03	2.4	2.4	1.5	8.3	2.8	1.8	6.7	2.0	1.2
		Average	**8.25**	**54.50**	**0.0014**	**0.10**	**0.42**	**0.15**	**0.03**	**4.45**	**2.10**	**1.50**	**5.80**	**2.80**	**1.75**	**8.45**	**6.10**	**3.65**
Stock Well #3		11/10/2008	15.3	55	0.0064	0.1	0.01	0.12	0.03	25.3	1.8	2.5	12.6	2.9	1.9	4.7	4.7	2.8
		6/30/2009	13.4	53	0.0063	0.1	0.01	0.12	0.02	27.3	2.0	2.6	7.2	2.6	1.7	2.1	2.1	1.2
		9/24/2009	10.9	52	0.0064	0.1	0.01	0.03	0.01	19.2	2.0	2.2	8.8	2.8	1.8	7.9	5.0	3.0
		Average	**13.20**	**53.33**	**0.0064**	**0.10**	**0.01**	**0.09**	**0.02**	**23.93**	**1.93**	**2.43**	**9.53**	**2.77**	**1.80**	**4.90**	**3.93**	**2.33**
Stock Well #4		9/24/2009	13.2	36	0.0014	0.1	0.02	0.03	0.01	2.0	2.0	1.2	3.5	2.8	1.7	4.9	2.0	1.2
		Average	**13.20**	**36.00**	**0.0014**	**0.10**	**0.02**	**0.03**	**0.01**	**2.00**	**2.00**	**1.20**	**3.50**	**2.80**	**1.70**	**4.90**	**2.00**	**1.20**
Stock Well #5		9/24/2009	13.5	36	0.0010	0.1	0.01	0.03	0.01	2.1	2.1	1.2	2.8	2.8	1.9	8.4	2.0	1.2
		Average	**13.50**	**36.00**	**0.0010**	**0.10**	**0.01**	**0.03**	**0.01**	**2.10**	**2.10**	**1.20**	**2.80**	**2.80**	**1.90**	**8.40**	**2.00**	**1.20**
Stock Well #6		9/24/2009	13.5	40	0.0010	0.1	0.02	0.03	0.01	2.0	2.0	1.2	5.3	2.8	1.8	2.0	2.0	1.2
		Average	**13.50**	**40.00**	**0.0010**	**0.10**	**0.02**	**0.03**	**0.01**	**2.00**	**2.00**	**1.20**	**5.30**	**2.80**	**1.80**	**2.00**	**2.00**	**1.20**
												0						
Stock Well #7		6/30/2009	14	218	0.0129	0.1	0.16	0.03	0.01	8.2	7.1	4.8	8.8	8.8	5	2.1	2.1	1.2
		9/24/2009	11.5	211	0.0121	0.1	0.09	0.03	0.01	9.6	6.5	4.5	6.4	6.4	3.9	8.4	2.0	1.2
		Average	**12.75**	**214.50**	**0.0125**	**0.10**	**0.13**	**0.03**	**0.01**	**8.90**	**6.80**	**4.65**	**7.60**	**7.60**	**4.45**	**5.25**	**2.05**	**1.20**
Stock Well #8		6/29/2009	15.1	19	0.0183	0.1	0.01	0.03	0.01	52.9	2.4	3.9	13.4	2.7	1.8	2.1	2.1	1.2
		9/22/2009	13.5	20	0.0176	0.1	0.01	0.03	0.01	31.8	2.8	2.3	16.9	2.8	2	4.9	2	1.2
		Average	**14.30**	**19.50**	**0.0180**	**0.10**	**0.01**	**0.03**	**0.01**	**42.35**	**2.60**	**3.10**	**15.15**	**2.75**	**1.90**	**3.50**	**2.05**	**1.20**
Stock Well #9		11/20/2008	10.6	58	0.0365	0.1	0.01	0.03	0.01	49.5	2.0	3.8	13.3	3.1	2.1	4.7	4.7	2.8
		Average	**10.60**	**58.00**	**0.0365**	**0.10**	**0.01**	**0.03**	**0.01**	**49.50**	**2.00**	**3.80**	**13.30**	**3.10**	**2.10**	**4.70**	**4.70**	**2.80**
Stock Well #10		6/30/2009	8.9	86	0.0144	0.1	0.01	0.15	0.14	27.2	2.1	2.7	6.9	2.6	1.7	2.1	2.1	1.2
		Average	**8.90**	**86.00**	**0.0144**	**0.10**	**0.01**	**0.15**	**0.14**	**27.20**	**2.10**	**2.70**	**6.90**	**2.60**	**1.70**	**2.10**	**2.10**	**1.20**
Stock Well #11		6/29/2009	9.3	34	0.0003	0.1	0.02	0.15	0.05	2.2	2.1	1.4	5.3	2.6	1.7	2.1	2.1	1.2
		Average	**9.30**	**34.00**	**0.0003**	**0.10**	**0.02**	**0.15**	**0.05**	**2.20**	**2.10**	**1.40**	**5.30**	**2.60**	**1.70**	**2.10**	**2.10**	**1.20**
Stock Well #12		6/29/2009	16.1	103	0.2030	0.1	0.01	0.03	0.55	315	6.7	15.1	58.1	7.6	5.5	2.1	2.1	1.2
		12/7/2009	15.4	95	0.1460	0.1	0.01	0.03	0.52	216	5.6	10.6	52.7	5.8	4.3	2.0	2.0	1.2
		Average	**15.75**	**99.00**	**0.17**	**0.10**	**0.01**	**0.03**	**0.54**	**265.50**	**6.15**	**12.85**	**55.40**	**6.70**	**4.90**	**2.05**	**2.05**	**1.20**
Stock Well #13		6/29/2009	8.1	49	0.0104	0.1	0.01	0.4	0.02	21.4	2.1	2.5	10.6	2.7	1.8	2.1	2.1	1.2
		9/24/2009	7.0	49	0.0102	0.1	0.01	0.33	0.02	14.5	2.1	2.0	8.9	2.8	1.8	11.8	2.0	1.3
		Average	**7.55**	**49.00**	**0.0103**	**0.10**	**0.01**	**0.37**	**0.02**	**17.95**	**2.10**	**2.25**	**9.75**	**2.75**	**1.80**	**6.95**	**2.05**	**1.25**
Stock Well #15		6/30/2009	16.4	32	0.0133	0.1	0.09	0.22	0.03	41.6	2.4	3.5	11.7	2.7	1.8	2.1	2.1	1.2
		9/22/2009	13.3	29	0.0125	0.1	0.09	0.24	0.03	27.2	2.4	2.7	9.6	2.8	1.9	11.4	5.0	3.1
		Average	**14.85**	**30.50**	**0.0129**	**0.10**	**0.09**	**0.23**	**0.03**	**34.40**	**2.40**	**3.10**	**10.65**	**2.75**	**1.85**	**6.75**	**3.55**	**2.15**

	Collection Date	Polonium 210 (pCi/L)	Polonium 210 precision (±) (pCi/L)	Radium 226 (pCi/L)	Radium 226 MDC (pCi/L)	Radium 226 precision (±) (pCi/L)	Radium 228 (pCi/L)	Radium 228 MDC (pCi/L)	Radium 228 precision (±) (pCi/L)	Thorium 230 (pCi/L)	Thorium 230 precision (±) (pCi/L)	Lead 210 (pCi/L)	Lead 210 MDC (pCi/L)	Lead 210 precision (±) (pCi/L)	Polonium 210 (pCi/L)	Polonium 210 precision (±) (pCi/L)	Radium 226 (pCi/L)	Radium 226 MDC (pCi/L)	Radium 226 precision (±) (pCi/L)	Radium 228 (pCi/L)	Radium 228 MDC (pCi/L)	Radium 228 precision (±) (pCi/L)	Thorium 230 (pCi/L)	Thorium 230 precision (±) (pCi/L)	Uranium (mg/L)
		DIS		DIS	DIS		DIS	DIS		DIS		SUS			SUS		SUS	SUS					SUS		SUS
Stock Well #1	11/6/2008	1.0	0.3	0.56	0.33	0.29	2.5	2.5	1.6	0.2	0.3	8.5	8.5	5.0	1.0	0.3	0.3	0.3	0.2	NOT ANALYZED			0.2	0.03	0.0003
	9/22/2009	0.5	0.2	0.93	0.07	0.13	1.6	1.5	0.9	0.5	0.3	5.6	1.2	0.8	0.3	0.2	0.2	0.2	0.08				0.06	0.05	0.0003
	Average	**0.75**	**0.25**	**0.75**	**0.20**	**0.21**	**2.05**	**2.00**	**1.25**	**0.35**	**0.30**	**7.05**	**4.85**	**2.90**	**0.65**	**0.25**	**0.25**	**0.25**	**0.14**				**0.13**	**0.04**	**0.0003**
Stock Well #2	11/6/2008	1.0	0.5	0.69	0.33	0.32	2.5	2.5	1.5	0.2	0.4	8.3	8.3	4.9	1.0	0.4	0.3	0.3	0.20	NOT ANALYZED			0.2	0.05	0.0003
	9/22/2009	0.7	0.3	0.72	0.17	0.18	1.2	1.2	0.7	0.4	0.2	3.2	1.0	0.6	0.4	0.2	0.2	0.2	0.08				0.04	0.04	0.0003
	Average	**0.85**	**0.40**	**0.71**	**0.25**	**0.25**	**1.85**	**1.85**	**1.10**	**0.30**	**0.30**	**5.75**	**4.65**	**2.75**	**0.70**	**0.30**	**0.25**	**0.25**	**0.14**				**0.12**	**0.05**	**0.0003**
Stock Well #3	11/10/2008	1.0	0.2	3.6	0.2	0.37	1.1	1.1	0.7	0.2	0.05	8.2	8.2	4.9	1.0	0.3	0.3	0.3	0.20	NOT ANALYZED			0.2	0.05	0.0003
	6/30/2009	0.6	0.2	3.3	0.18	0.36	1.2	1.2	0.8	0.1	0.06	2.8	2.8	1.7	0.2	0.2	0.04	0.04	0.02				0.06	0.04	0.0003
	9/24/2009	0.6	0.3	3.4	0.17	0.35	1.2	1.2	0.7	0.4	0.2	3.2	1.0	0.6	0.3	0.2	0.2	0.2	0.09				0.07	0.04	0.0003
	Average	**0.80**	**0.23**	**3.43**	**0.18**	**0.36**	**1.17**	**1.17**	**0.73**	**0.23**	**0.10**	**4.73**	**4.00**	**2.40**	**0.60**	**0.23**	**0.18**	**0.18**	**0.10**				**0.11**	**0.04**	**0.0003**
Stock Well #4	9/24/2009	0.5	0.3	0.17	0.17	0.12	1.2	1.2	0.7	0.5	0.2	3.3	1.1	0.7	0.4	0.2	0.2	0.2	0.07	NOT ANALYZED			0.08	0.04	0.0003
	Average	**0.50**	**0.30**	**0.17**	**0.17**	**0.12**	**1.20**	**1.20**	**0.70**	**0.50**	**0.20**	**3.30**	**1.10**	**0.70**	**0.40**	**0.20**	**0.20**	**0.20**	**0.07**				**0.08**	**0.04**	**0.0003**
Stock Well #5	9/24/2009	0.4	0.2	0.31	0.17	0.14	1.2	1.2	0.8	0.3	0.2	3.3	1.1	0.7	0.4	0.2	0.2	0.2	0.09	NOT ANALYZED			0.3	0.1	0.0008
	Average	**0.40**	**0.20**	**0.31**	**0.17**	**0.14**	**1.20**	**1.20**	**0.80**	**0.30**	**0.20**	**3.30**	**1.10**	**0.70**	**0.40**	**0.20**	**0.20**	**0.20**	**0.09**				**0.30**	**0.10**	**0.0008**
Stock Well #6	9/24/2009	0.4	0.3	0.19	0.19	0.12	1.3	1.3	0.8	0.3	0.1	3.3	1.1	0.7	0.5	0.2	0.2	0.2	0.07	NOT ANALYZED			0.05	0.05	0.0003
	Average	**0.40**	**0.30**	**0.19**	**0.19**	**0.12**	**1.30**	**1.30**	**0.80**	**0.30**	**0.10**	**3.30**	**1.10**	**0.70**	**0.50**	**0.20**	**0.20**	**0.20**	**0.07**				**0.05**	**0.05**	**0.0003**
Stock Well #7	6/30/2009	0.5	0.3	0.35	0.17	0.15	1.2	1.2	0.7	0.2	0.1	2.9	2.9	1.7	0.3	0.1	0.04	0.04	0.02	NOT ANALYZED			0.5	0.2	0.0003
	9/24/2009	0.8	0.3	0.20	0.16	0.12	1.1	1.1	0.4	0.4	0.02	3.2	1.0	0.6	0.3	0.1	0.20	0.06	0.20				0.07	0.05	0.0003
	Average	**0.65**	**0.30**	**0.28**	**0.17**	**0.14**	**1.15**	**1.15**	**0.55**	**0.30**	**0.06**	**3.05**	**1.95**	**1.15**	**0.30**	**0.10**	**0.12**	**0.05**	**0.11**				**0.29**	**0.13**	**0.0003**
Stock Well #8	6/29/2009	0.6	0.3	0.33	0.2	0.16	2.3	1.0	0.7	0.2	0.07	2.8	2.8	1.7	0.2	0.2	0.04	0.04	0.02	NOT ANALYZED			0.2	0.2	0.0003
	9/22/2009	0.7	0.3	0.61	0.1	0.15	2.7	1.2	0.8	0.4	0.2	3.2	0.6	1.0	0.2	0.1	0.2	0.2	0.07				0.08	0.05	0.0003
	Average	**0.65**	**0.30**	**0.47**	**0.15**	**0.16**	**2.50**	**1.10**	**0.75**	**0.30**	**0.14**	**3.00**	**1.70**	**1.35**	**0.20**	**0.15**	**0.12**	**0.12**	**0.05**				**0.14**	**0.13**	**0.0003**
Stock Well #9	11/20/2008	0.2	0.2	0.31	0.31	0.19	1	1	0.6	0.2	0.1	8.2	8.2	4.9	1	1	0.4	0.4	0.2	NOT ANALYZED			0.2	0.2	0.0003
	Average	**0.20**	**0.20**	**0.31**	**0.31**	**0.19**	**1.00**	**1.00**	**0.60**	**0.20**	**0.10**	**8.20**	**8.20**	**4.90**	**1.00**	**1.00**	**0.40**	**0.40**	**0.20**				**0.20**	**0.20**	**0.0003**
Stock Well #10	6/30/2009	0.4	0.2	0.19	0.18	0.13	1.2	1.2	0.7	0.2	0.1	2.8	2.8	1.7	0.3	0.2	0.04	0.04	0.02	NOT ANALYZED			0.07	0.06	0.0003
	Average	**0.40**	**0.20**	**0.19**	**0.18**	**0.13**	**1.20**	**1.20**	**0.70**	**0.20**	**0.10**	**2.80**	**2.80**	**1.70**	**0.30**	**0.20**	**0.04**	**0.04**	**0.02**				**0.07**	**0.06**	**0.0003**
Stock Well #11	6/29/2009	0.7	0.2	0.94	0.17	0.21	1.2	1.2	0.8	0.2	0.1	2.8	2.8	1.7	0.4	0.4	0.04	0.04	0.2	NOT ANALYZED			0.07	0.05	0.0003
	Average	**0.70**	**0.20**	**0.94**	**0.17**	**0.21**	**1.20**	**1.20**	**0.80**	**0.20**	**0.10**	**2.80**	**2.80**	**1.70**	**0.40**	**0.40**	**0.04**	**0.04**	**0.20**				**0.07**	**0.05**	**0.0003**
Stock Well #12	6/29/2009	0.6	0.2	0.13	0.19	0.13	1.1	1.0	0.6	0.2	0.09	2.8	2.8	1.7	0.3	0.2	0.04	0.04	0.02	NOT ANALYZED			0.05	0.03	0.0003
	12/7/2009	0.5	0.2	0.61	0.09	0.14	1.3	1.0	0.7	0.3	0.1	3.2	1.0	0.6	0.4	0.2	0.1	0.1	0.08				0.06	0.04	0.0003
	Average	**0.55**	**0.20**	**0.37**	**0.14**	**0.14**	**1.20**	**1.00**	**0.65**	**0.25**	**0.10**	**3.00**	**1.90**	**1.15**	**0.35**	**0.20**	**0.07**	**0.07**	**0.05**				**0.06**	**0.04**	**0.0003**
Stock Well #13	6/29/2009	0.6	0.3	2.0	0.2	0.3	1.0	1.0	0.6	0.2	0.08	2.8	2.8	1.7	0.4	0.1	0.04	0.04	0.03	NOT ANALYZED			0.05	0.05	0.0003
	9/24/2009	0.7	0.3	2.4	0.1	0.27	1.6	1.1	0.7	0.4	0.2	3.2	1.0	0.6	0.3	0.1	0.20	0.20	0.08				0.06	0.03	0.0003
	Average	**0.65**	**0.30**	**2.20**	**0.15**	**0.29**	**1.30**	**1.05**	**0.65**	**0.30**	**0.14**	**3.00**	**1.90**	**1.15**	**0.35**	**0.10**	**0.12**	**0.12**	**0.06**				**0.06**	**0.04**	**0.0003**
Stock Well #15	6/30/2009	0.5	0.2	0.28	0.17	0.14	1.2	1.2	0.7	0.1	0.06	5.9	5.9	3.5	0.7	0.4	0.08	0.08	0.04	NOT ANALYZED			0.2	0.08	0.0003
	9/22/2009	0.7	0.2	0.56	0.1	0.13	2.4	1.1	0.7	0.6	0.3	3.2	1.0	0.6	0.3	0.1	0.2	0.2	0.07				0.06	0.04	0.0003
	Average	**0.60**	**0.20**	**0.42**	**0.14**	**0.14**	**1.80**	**1.15**	**0.70**	**0.35**	**0.18**	**4.55**	**3.45**	**2.05**	**0.50**	**0.25**	**0.14**	**0.14**	**0.06**				**0.13**	**0.06**	**0.0003**

RAI-24

Description of Deficiency

The information provided in TR Section 2.7.2 does not meet the applicable requirements of 10 CFR 40.41(c), using the review procedures in Section 2.7.2 and acceptance criteria in Section 2.7.3 of the SRP.

Basis for Request

Uranium One did not characterize the surficial (uppermost) aquifer at the proposed Leuenberger Satellite. Characterization is critical to assess if spills and leaks from proposed surface operations and subsurface piping will contaminate the uppermost aquifer which may be connected to surface water. Staff cannot evaluate or provide reasonable assurance of the safety of operations without characterization of the surficial (uppermost) aquifer.

Formulation of RAI

Uranium One should characterize the surficial (uppermost) aquifer(s) at the Leuenberger Satellite. Provide a map of the depth to the uppermost aquifer(s) at the Leuenberger Satellite within a 2 km buffer around Wellfields 1, 2 and 3 and the proposed surge ponds. Uranium One should discuss any hydraulic connection between the uppermost aquifer(s) with surface water features and the drainages, particularly Little Sand Creek, at the Leuenberger Satellite.

RAI-24 Response

Uranium One has provided additional information on the hydraulic connection with the uppermost aquifer and the Little Sand Creek Drainage in response to RAI 16 relating to baseline water quality conditions for surface water location SW-1 and SW-29. Water quality for the uppermost aquifer can vary considerably as is observed in wells located at the Negley area and the stock well locations which in most instances would be representative of the uppermost aquifer for that location.

Uranium One has committed to install a guard well system that will further characterize the surficial (uppermost) aquifer in the Leuenberger area see response to RAI 57.

Based on the drilling data and geology in the Leuenberger area Uranium One believes the uppermost aquifer is in the 120 and or 110 sands. Uranium One proposes to locate surficial aquifer wells for each specific wellfield to further characterize the surficial (uppermost) aquifer. Well locations are proposed between Little Sand Creek and Negely Subdivision for Wellfields 1 and 2 and within the mine units for the remainder of the wellfields. The below Table and Figure depict the proposed locations and anticipated target zone which is believed to be the surficial aquifer for each specific wellfield.

Table Location of Proposed surficial wells and Leuenberger MU 2 wells

ID	Hole	Mine Unit	Location	Deep/Shallow	Target Sand	Approximate Sand Interval	Well Depth
#1	3474-13-L19	MU-2	Inside WF	Deep(underlying)	50 Sand	760'-768'	800
#2	3474-13-M-9	MU-2	Inside WF	Shallow(overlying)	70 Sand	490'-515'	600
#3	3474-13-M-7	MU-2	Northeast (N of M-7)	Surficial Aquifer	110 Sand	235'-280'	300
#4	3474-13-M-9	MU-2	Inside WF	Surficial Aquifer	100 Sand	190'-204'	300
#5	3474-14-L13	MU1	North	Surficial Aquifer	100 Sand	100'-126'	150
#6	3474-14-1067	MU1	West	Surficial Aquifer	100 Sand	45'-67'	100
#7	3473-15-M-11	MU3	Inside WF	Surficial Aquifer	100 Sand	177'-184'	200
#8	3473-20-1018	MU4	Inside WF	Surficial Aquifer	100 Sand	158'-166'	200
#9	3473-27-1016	MU5	Inside WF	Surficial Aquifer	100 Sand	109'-120'	150
#10	3473-35-2006	MU6	Inside WF	Surficial Aquifer	90 Sand	126'-166'	200

Uranium One would propose to utilize the proposed surficial wells to establish baseline conditions that would then be utilized to determine if impacts have occurred from operations to these waters.

Based on the recommendations of a hydrologist solicited to review NRC concerns as stated in RAI 24 Uranium One is in agreement to proceed forward with the following proposed actions to resolve NRC concerns in regards to superficial aquifer concerns.

Uranium One proposes to install additional monitor wells in the wellfield and satellite areas to identify the uppermost aquifer and establish baseline water quality for those aquifers, additional information and discussion may be helpful in satisfying the NRCs request.

Detailed isopachs maps are already provided in the TR for each of the sands identified within the project area, with the shallowest being the 120 Sand. Several geologic cross sections were also presented in the TR. Based on those isopachs and cross sections it appears that the 120 Sand is the shallowest sand in the vicinity of the Luenberger Satellite. The 120 Sand is eroded away to the southeast and is not present in the vicinity of the Peterson Satellite and may be only marginally present in the area of the North Platte Satellite. The 120 and 110 Sands represent the most likely occurrence of shallow groundwater at the site, particularly where topographic lows intercept those Sand units. In fact, several of the wells in the Negley Subdivision are indicated as being completed within the 120 Sand

Uranium One will prepare a structure map for the top and bottom of the 110 and 120 Sands. Isopach maps of the net depth to the top of the 120 and 110 Sands should also be developed. The structure maps and net depth isopachs should provide an indication of the low points within each of the Sands and likely target areas for monitor well sites.

Uranium One has already completed a well survey in the areas of concern. The NRC License Application Technical Report for the Ludeman Project (TR) indicates that there are 49 stock wells with depths of 14 to 72 feet within 2 kilometers of the project area. These wells are likely to be completed in shallow units such as the 120 and 110 Sands. The depths of the wells identified in the survey should be posted on the net depth isopachs to provide an indication of which sands may be water-bearing.

The structure maps and net depth isopachs and the location of the shallow existing wells should be used to select monitor points for the uppermost aquifer. If possible, Uranium One should attempt to measure water levels in any wells that appear to be completed in uppermost aquifer.

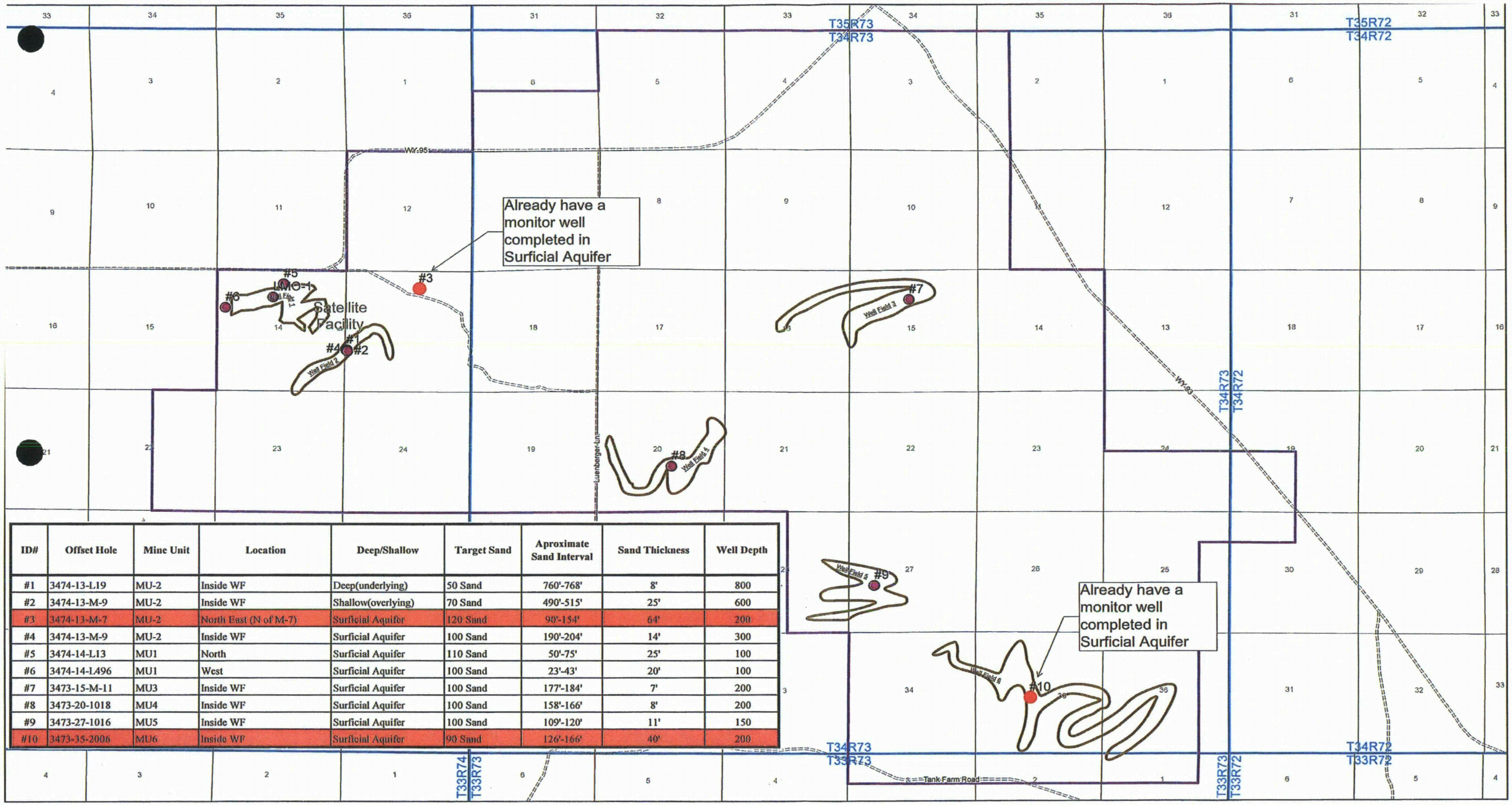
This data may provide a preliminary indication of the direction of groundwater flow in the uppermost aquifer in the vicinity of the 3 satellite areas.

Uranium One proposes monitor wells be installed in the 120 Sand (if that unit is water-bearing) in the vicinity of the Luenberger Satellite. Additionally monitor wells should be installed in the 110 Sand (if that unit is water-bearing) in areas where the 120 Sand is not present. Having these points of control for water level measurements will provide for assessment of the orientation of the potentiometric surface and direction of groundwater flow within the uppermost aquifers.

Single well pump tests should be conducted on each of the 120 and 110 Sand monitor wells that are installed. Data collected from those tests should be analyzed to estimate aquifer properties of the uppermost aquifer(s). The aquifer property data, coupled with the potentiometric surface data, will be used to identify the direction and rate of flow of the uppermost aquifer.

Baseline water quality sampling should be conducted at each of the 120 and 110 Sand monitor wells for the parameters indicated in the TR.

This additional data collection and evaluation should be adequate for characterization of the uppermost aquifer in meeting the applicable requirements of 10 CFR 40.41(c).



ID#	Offset Hole	Mine Unit	Location	Deep/Shallow	Target Sand	Aproximate Sand Interval	Sand Thickness	Well Depth
#1	3474-13-L19	MU-2	Inside WF	Deep(underlying)	50 Sand	760'-768'	8'	800
#2	3474-13-M-9	MU-2	Inside WF	Shallow(overlying)	70 Sand	490'-515'	25'	600
#3	3474-13-M-7	MU-2	North East (N of M-7)	Surficial Aquifer	120 Sand	90'-154'	64'	200
#4	3474-13-M-9	MU-2	Inside WF	Surficial Aquifer	100 Sand	190'-204'	14'	300
#5	3474-14-L13	MU1	North	Surficial Aquifer	110 Sand	50'-75'	25'	100
#6	3474-14-L496	MU1	West	Surficial Aquifer	100 Sand	23'-43'	20'	100
#7	3473-15-M-11	MU3	Inside WF	Surficial Aquifer	100 Sand	177'-184'	7'	200
#8	3473-20-1018	MU4	Inside WF	Surficial Aquifer	100 Sand	158'-166'	8'	200
#9	3473-27-1016	MU5	Inside WF	Surficial Aquifer	100 Sand	109'-120'	11'	150
#10	3473-35-2006	MU6	Inside WF	Surficial Aquifer	90 Sand	126'-166'	40'	200

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0 3,100 6,200 Feet
1 inch = 3,800 feet

Legend
MonitorWells
Roads
Estimated Well Fields

Uranium One USA, Inc.
Wyoming Production Geology Group
907 North Poplar St. Suite 260
Casper, WY 82601
(307) 234-8235

RAI-28

Description of Deficiency

The information provided in TR Addendum 2-7A does not meet the applicable requirements of 10 CFR 40.41(c), using the review procedures in Section 2.7.2 and acceptance criteria in Section 2.7.3 of the SRP.

Basis for Request

Staff reviewed the Addendum 2-7A table for private wells (other than Negley Subdivision) within 2 km of the Leuenberger wellfields which included wells in Sections 9, 10, 11, 12, 13,14,15, 16, 22, 23, 24, 25, and 26. Within the table, staff identified 4 private wells in Section 9, one private well in Section 10, one private well in Section 12, one private well in Section 13, one private well in Section 14, 2 private wells in Section 15, and no private wells in Sections 22, 23 and 24. These wells are listed in the following table. Staff has no information on which aquifer(s) these wells are completed in and their current use. Staff cannot evaluate the safety of their use within 2 km of the proposed wellfields.

The staff also searched the WSEO water rights database to verify the completeness of wells provided in the Addendum 2-7 A table and identify any additional wells completed within 2 km of the Leuenberger proposed wellfields. The area reviewed within the 2 km included all of Sections 10, 11, 12,13,14,15, 22, 23, and 24. This search uncovered four new wells which had been permitted or installed within the 2 km buffer but were not listed by Uranium One and one well which had a different location description which placed it one mile closer to the wellfields. These wells are listed in the following table. One well, identified as Hart 1 had been installed and 2 wells, Brody 1 and Wesston 1 received permits in the Negley Subdivision. Staff is concerned about the Brody 1 and Wesston 1 wells as their approved depth may be in the 90 or 80 sands. Additionally a miscellaneous/drilling water well, South Hylton, had been permitted for Section 24. This well may be located in the 80 sand and its approved rate could be sufficient to impact hydraulic control of any 80 sand ore zone extraction. Staff has no information on the current status of these wells. Therefore, staff cannot evaluate the safety of their use within 2 km of the proposed wellfields.

Formulation of RAI

(A.) Uranium One should provide the status, target aquifer(s), current use and predicted use of the wells which are listed in the above tables and indicate if any of these wells are completed in the 80 or 90 sand or any targeted ore zone aquifers and overlying/underlying aquifers at the North Platte Sattelite. (B.) Uranium One should discuss if operation of those wells could incur any safety issue for well owners or impact hydraulic control of the wellfields during operations. (C.) Uranium One should also provide a commitment to annually update information on private well use and describe any new private wells installed within 2 km of the Leuenberger Satellite proposed wellfields including their coordinates, completion, type of use and rate until the license is terminated.

RAI-28(A) Response

Based on the regional cross sections the wells listed in the Table as provided by NRC appear to be located within the 110 to 100 sands aquifers with the exception of WOECK #2 which appears to be in the bottom of the 100 sand aquifer or top of the 90 sand aquifer, and State Deep Water Well#7 which would appear to be in the lower part of the 50 sand aquifer or top of the 40 sand aquifer. Woeck # 2 is approximately 1 mile northwest of proposed Leuenberger wellfield #1 and upgradient of the water flow indicated during the regional pump test. The potential for this well to impact Leuenberger wellfield 1 operations is minimal and will be evaluated as part of the wellfield specific data package. Current use approved for Woeck #2 with the SEO is for irrigation purposes. State Deep Water Well #7 is located over a mile west of Leuenberger wellfield #1. The proposed mining sands for Leuenberger wellfield #1 is the 80 and 90 sand aquifer, which has multiple confining units with at least 50 feet of shale between the 50 sand and the 80 sand production unit. Additionally groundwater flow in the area of Mine Unit #1 is in a northeasterly direction which would indicate State Deep Water Well #& is up gradient. Given the location and indicated well aquifer completion operation of Leuenberger Wellfield #1 would have minimal impacts on the operations of this well. The above estimates are based on discussions with our geologist and are estimated sand projections based on the regional cross section data. Where new data was available this information was added to the table and will be incorporated into the Addendum 2.7-A of the TR. Well P8171OP appears to be outside the 2 kilometer boundary of the proposed wellfields.

: Leuenberger Satellite Private Wells (excluding Negley Subdivision)

Permit Number	Location	Name/Date	Owner	Specified use	Screen/ Depth	Permit Rate
P174491.0W	T34NR74W S9 SE1/4 SE 1/4	Woeck 2 2/24/2006	Peter Woeck	Irrigation	300	40 gpm
P8171.0P	T34NR74W S9 NW1/4 SW 1/4	Henry Keenan 1 3/31/1940	Peter and Kathy Woeck	Domestic, Stock	100 ft	5 gpm
P8172.0P	T34NR74W S9 NE1/4 SE 1/4	Henry 2 4/30/1953	Henry Keenan	Domestic, Stock	60 ft	5 gpm
P8173.0P	T34NR74W S9 NE1/4 SE1/4	Henry Keenan 3 4/30/1920	Henry Keenan	Domestic, Stock	41 ft	3 gpm
P70764W	T34NR74W S10 NW1/4 SW1/4	Keenan 4 7/31/1985	Joe R. Keenan	Domestic	92-114ft	25 gpm
P4987P	T34NR74W S12 SE1/4 NE1/4	Smith 4	Smith Sheep Company	Stock	?/150 ft	10 gpm
P9823W	T34NR74W S13 SW1/4 SE1/4	Smith 45 deepened October 2009	Smith Sheep Company	Stock	160-180 ft	7 gpm
P78113W	T34NR74W S14 NW1/4 NE1/4	PN5 L314 9/26/1988	William J. Smith	Stock, Misc	535-604 ft	20 gpm
P4988	T34NR74W S14 SW1/4 NW1/4	Smith #5 12/31/45	Smith Sheep Company	Stock	145 ft	10 gpm
41/2/72W	T34NR74W S15 SE1/4 NW1/4	Benevides 1 5/5/2008	Peter Benevides	Domestic, Stock	Does not appear to have been constructed? ?	

P27740P	T34NR74W S15 SE1/4 NW1/4	Hildebrand 1 8/22/74	Hildebrand , Inc**	Domestic, Stock	20 ft	7.5 gpm
P27741P	T34NR74W S15 SE1/4 NW1/4	Hidelbrand 2 8/22/74	Hildebrand , Inc**	Stock	20 ft	17.5 gpm
P182754W	T34NR74W S16 SE1/4 NW1/4	State Deep Water Well 7-16	North Finn, LLC, WY Board of Land Com.	Industrial	545 ft	40 gpm

Uranium One is only able to state with any confidence that the predicted use of any well is that which is listed within the SEO database. This information is already included in the Table provided in Addendum 2.7-A of the TR.

The potential well depths/screen depths listed by the reviewer for those remaining two wells (Brody 1 and Wesston 1) are simply estimated depths contained within the permit application. For example, the final depth for Hart 1 is only 108 feet; yet, the estimated depth was 700 feet on the permit application. Here is the current disposition of each well as stated by WSEO (June 1, 2013).

1. **Brody 1: Permit No. U.W. 197937** - The U.W. 5 Form, or Application for Permit to Appropriate Ground Water, lists the estimated depth of the well at 300 feet, and the estimated production interval at 280 - 300 feet. A U.W. 6 Form, or Statement of Completion and Description of Well or Spring has not yet been filed with the State Engineer's Office. Therefore, SEO does not yet know how the actual well was constructed. The appropriator has until December 31, 2013 to file either a U.W. 6 Form or request an extension of time for completion of construction and completion of the beneficial use of water for the purposes specified on the approved permit. As of September 2013 this well had not been installed.
2. **Wesston 1: Permit No. U.W. 197938** – This is the correct permit number. The RAI incorrectly lists the number at P197937.0W. The U.W. 5 Form, or Application for Permit to Appropriate Ground Water, lists the estimated depth of the well at 300 feet, and the estimated production interval at 280 - 300 feet. A U.W. 6 Form, or Statement of Completion and Description of Well or Spring has not yet been filed with the State Engineer's Office. Therefore, SEO does not yet know how the actual well was constructed. The appropriator has until December 31, 2013 to file either a U.W. 6 Form or request an extension of time for completion of construction and completion of the beneficial use of water for the purposes specified on the approved permit. As of September 2013 this well had not been installed.
3. **Hart 1: Permit No. U.W. 191727** - The U.W. 5 Form, or Application for Permit to Appropriate Ground Water, lists the estimated depth of the well at 700 feet. An estimated production interval was not provided. A U.W. 6 Form, or Statement of Completion and Description of Well or Spring was received on December 8, 2009 and notes the total depth at 108 feet. The actual production interval was not provided.
4. **South Hylton Ranch: Permit No. U.W. 195273** – This is the correct permit number. The RAI incorrectly lists the number at P195723.0W. This permit has been cancelled per request of the applicant. It is SEO's understanding the well authorized under this permit was never constructed.

RAI-28 (B) (C) Response

As previously discussed in RAI-27, an updated figure depicting all groundwater wells has been developed utilizing the latest 2013 WSEO data. Operation of these wells will not incur a safety risk or impact hydraulic control of the wellfields during operations. All targeted, overlying, and underlying aquifers will have a monitoring program designed to detect potential excursions of lixiviant for a wellfield during uranium recovery operations and restoration. As noted in SUA-1341 (LC 11.8), Uranium One will include in its annual report to NRC the identification of any new ground water wells or new use of existing wells, where the information is publicly available and/or known to Uranium One. This includes the proposed project area and the area within 2 km.

The proposed project will have an extensive program of wellfield and pipeline flow and pressure monitoring. Injection and recovery flow rates will be monitored at each header house to balance injection and recovery throughout the wellfield. The recovery and injection flow rate in each well will be continuously individually monitored by electronic flow meters in each wellfield header house. The pressure of each recovery and injection trunk line also will be monitored at the header house with electronic pressure gauges. Both flow meter and pressure gauges will tie into the header house control panel that will ultimately tie into the satellite control room. High and low, pressure and/or flow alarms will alert wellfield and plant operators if specified ranges are exceeded. Automatic shutoff valves will stop the flow in the event of significant changes in volume or pressure. This monitoring will alert the operators to detect malfunctions that could lead to either wellfield infrastructure or pipeline failures.

RAI-30

Description of Deficiency

The information provided in TR Section 2.7.2 does not meet the applicable requirements of 10 CFR 40.41(c), using the review procedures in Section 2.7.2 and acceptance criteria in Section 2.7.3 of the SRP.

Basis for Request

Uranium One did not characterize the surficial (uppermost) aquifer at the proposed North Platte Satellite. Characterization is critical to assess if spills and leaks from surface operations and subsurface piping will contaminate the uppermost aquifer which may be connected to surface water. Staff cannot evaluate or provide reasonable assurance of the safety of operations without characterization of the surficial (uppermost) aquifer.

Formulation of RAI

Uranium One should identify the surficial (uppermost) aquifer(s) under the North Platte Satellite. Provide a map of the depth to the uppermost aquifer(s) at the North Platte Satellite within a 2 km buffer around Wellfields 1 and 2 and the proposed surge ponds. In addition, the TR should discuss any hydraulic connection between the uppermost aquifer(s) with surface water features and the drainages, at the North Platte Satellite.

RAI-30 Response

See RAI-24 for response to this RAI.

RAI-34

Description of Deficiency

The information provided in TR Addendum 2-7A does not meet the applicable requirements of 10 CFR 40.41(c), using the review procedures in Section 2.7.2 and acceptance criteria in Section 2.7.3 of the SRP.

Basis for Request

The staff reviewed the Addendum 2-7A for private wells within 2 km of the North Platte wellfields. For Wellfield 1, this includes wells in Sections 8, 9, 10, 11,13,14,15, 16, 17, 21, 22 and 23. For Wellfield 2, this includes wells in Sections 16, 17, 18, 19, 20, 21, 28, 29, and 30. From the table, staff identified two private wells in Section 9, two in Section 15, and one each in Sections 17, 19, 30 and 35. These wells are listed in the following table. The TR provides no information on which aquifer(s) these wells are completed in and their current use. Therefore staff cannot evaluate the safety of their use within 2 km of the proposed wellfields.

The staff also searched the WSEO water rights database to verify the wells provided in the Addendum 2-7 A table and identify any additional wells completed within 2 km of the North Platte proposed wellfields. This search uncovered one new well which had been permitted or installed within the 2 km buffer but was not listed in Addendum 2-7 A. This well was a miscellaneous/drilling water well, Gilbert Ditch Unit 34-73 16-1H WW that had been permitted in Section 16. This well may be located in the 70 sand or another targeted ore zone sand and its approved rate could be sufficient to impact hydraulic control of the wellfields. The staff has no information on the current status of these wells. Therefore, the staff cannot evaluate the safety of their use within 2 km of the proposed wellfields.

Formulation of RAI

Uranium One should provide the status, target aquifer(s), current use and predicted use of the wells which are listed in the above tables, and indicate if any of these wells are completed in the 70 sand or any targeted ore zone aquifers and overlying/underlying aquifers at the North Platte Satellite. Uranium One should discuss if operation of these wells could incur any safety issue for well owners or impact hydraulic control of the wellfields during operations. Uranium One should also provide a commitment to annually update information on private well use and describe any new private wells installed within 2 km of the North Platte Satellite proposed wellfields including their coordinates, completion, type of use and rate until the license is terminated.

RAI-34 Response

Based on the regional cross sections the wells listed in the below Table as provided by NRC, indicate that wells P179808W, P22299P, P60274W, and P1429W appear to be located within the 100 sands aquifers. Wells P180989W and P14294W appear to be located within the 90 sand and wells P69576W and P4567W appear to be located in the 70 sand. The production ore body for wellfields located within the North Platte area of the Ludeman permit area is the 70 sand. Review of the data indicates that of the wells listed in the below Table, only P69576 would be located within an underlying, overlying or production sand which would have any potential impacts from wellfield operations. The potential for this well to impact North Platte wellfield 3 operations will be evaluated as part of the wellfield specific data package. Current uses approved for wells as listed in the below North Platte Table are permitted for stock watering or miscellaneous water use.

Table: North Platte Private Wells

Permit Number	Location	Name/Date	Owner	Specified use	Screen/ Depth	Permit Rate
P179808W	T34NR73W S9 NE1/4 SE 1/4	WW-347309-1 2/21/2007	Energy Metals	Misc.	260	25 gpm
P180989W	T34NR73W 35 SE1/4 SE 1/4	2081 WW 1/31/2007	Energy Metals	Misc.	273/290	25 gpm
P22299P	T34NR73W S9 NE1/4 SE 1/4	Moore 9-34-73 12/31/1947	Eddie Moore	Stock	?/ 260 ft	5 gpm
P60274W	T34NR73W S15 NE1/4 NW1/4	Water well 1 4/7/82	Uranium Resources	Misc.	200-250 ft/?	5 gpm
P69576W	T34NR73W S15 NW1/4 NE 1/4	URI North Platte Pilot Well#1 10/1/84	Uranium Resources	Misc.	520-570 ft/?	20 gpm
P14294W	T34NR73W S17 NW1/4 SE1/4	Spring Pasture Well 1 6/15/72	Edward D. Moore	Stock	216-246, 251-288 ft/?	4 gpm
P4567W	T34NR73W S30 SW1/4 SE1/4	Smith 39 2/13/70	Smith Sheep Company	Stock	240-265 ft/?	10 gpm
P8612.0W	T34NR73W S19 NW1/4 NW1/4	Smith 43 4/9/71	Smith Sheep Company	Stock	?	10 gpm

Energy Metals permitted wells P179808W and P180989W are listed as miscellaneous wells that provided water for exploratory drilling activities conducted at Ludeman. Miscellaneous use category wells are uses that do not meet classification as domestic, stock watering, irrigation, municipal, industrial, coalbed methane, or monitor/observation well designations.

The Chesapeake well Gilbert Ditch Unit 34-73-18-1H WW, Permit P197937.0W was canceled at the request of Chesapeake Energy by letter to the SEO on May 2, 2012. The request to cancel this well would lead Uranium One to believe the above mentioned well was never constructed or abandonment records would be present.

Uranium One is only able to state with any confidence that the predicted use of any well is the permitted use as listed within the SEO database. Although we cannot predict future use, it is anticipated the use of these wells will continue to be for stock watering or miscellaneous purposes. Uranium has committed to provide NRC with an annual land use report which will include new wells or new use of existing wells where this information is publicly available. This commitment is found in SUA-1341 License Condition 11.8 of which the Ludeman project would be listed as an amendment to this license.

Uranium One would like to remind NRC that for each proposed wellfield within the Ludeman Permit area that a specific Wellfield Hydrologic Data Package will need to be prepared and approved before any mining activities can begin. The Wellfield Hydrologic Data Package will contain the following information:

1. A description of the proposed mine unit (location, extent, etc.).
2. A map(s) showing the proposed production patterns and locations of all monitor wells.
3. Geologic cross-sections and cross-section location maps.
4. Detailed isopach maps (see Appendix D6 for maps) of the Production Zone sand, overlying confining unit and underlying confining unit. Isopach of the underlying and overlying aquifers will be provided if regional isopach maps were not included as part of the mine permit application.
5. Discussion of how the hydrologic test was performed, including well completion reports.
6. Discussion of the results and conclusions of the hydrologic test including pump test raw data, drawdown match curves, potentiometric surface maps, water level graphs, drawdown maps and when appropriate, directional transmissivity data and graphs.
7. Sufficient information to show that wells in the monitor well ring are in adequate communication with the production patterns.
8. Baseline water quality information including proposed UCLs for monitor wells and average production zone/restoration target values.
9. Any other information pertinent to the area tested will be included and discussed.
10. Evaluation of restoration target values will be conducted on a "parameter by parameter basis" and will be part of the Wellfield Hydrologic Data Package.
11. MIT information will be included as part of the Wellfied Hydrologic Data Package.
12. Location and completion depth of any wells located within 500 feet of a monitor well ring. provided cross sections are

Wellfield specific pump test data provided during this assessment would give a more detailed evaluation on if operations of any of the above listed wells in the above Table could incur any safety issue for well owners or impact hydraulic control of the wellfields during operations. Any identified safety issues with well owners would be mitigated before mining operations would be permitted in that specific wellfield.

RAI-36

Description of Deficiency

The information provided in TR Section 2.7.2 does not meet the applicable requirements of 10 CFR 40.41(c), using the review procedures in Section 2.7.2 and acceptance criteria in Section 2.7.3 of the SRP.

Basis for Request

Uranium One did not characterize the surficial (uppermost) aquifer at the proposed Peterson Satellite. Characterization is critical to assess if spills and leaks from surface operations and subsurface piping will contaminate the uppermost aquifer which may be connected to surface water. The staff cannot evaluate or provide reasonable assurance of the safety of operations without characterization of the surficial (uppermost) aquifer.

Formulation of RAI

Uranium One should identify the surficial (uppermost) aquifer(s) at the Peterson Satellite, and provide a map of the depth to the uppermost aquifer(s) within a 2 km buffer around Wellfields 1 and 2 and the proposed surge ponds. The TR should discuss any hydraulic connection between the uppermost aquifer(s) with surface water features and the drainages at the Peterson Satellite.

RAI-36 Response

Responses and commitments provided for NRC RAI's 24 and 30 that were related to NRC concerns on the surficial aquifers at the Leuenberger and North Platte wellfields would be applicable for the Peterson wellfields as well. Based on the drilling data and geology in the Peterson area Uranium One believes the uppermost aquifer is in the 100 and or 90 sands. Uranium One has proposed to locate surficial aquifer wells for each specific wellfield to further characterize the surficial (uppermost) aquifer around or within proposed wellfields. The proposed wells and target sands are shown in the Figure provided in RAI response 24. Uranium One would propose to utilize the proposed surficial wells to establish baseline conditions that would then be utilized to determine if impacts have occurred from operations to these waters. A map showing the uppermost aquifer for a regional basis is provided in the potentiometric maps contained in Section 2.7 of the TR.

Uranium One makes the commitment to provide a more detailed potentiometric map for each wellfield as part of the Wellfield Hydrologic Data Package for the Peterson Wellfields 1 and 2 which is submitted for WDEQ approval before mining activities can begin. The isopack maps provided in this response package provide the reviewer an indication of what sands are present within a proposed wellfield and what the potential uppermost sand with water bearing potential could be.

Prior to operations of any wellfields in the Ludeman Project area a specific Wellfield Hydrologic Data Package for the Peterson wellfields would have to be submitted and approved by WDEQ/LQD before any mining operations could begin.

RAI-39

Description of Deficiency

The information provided in TR Section 2.7.2 does not meet the applicable requirements of 10 CFR 40.41(c), using the review procedures in Section 2.7.2 and acceptance criteria in Section 2.7.3 of the SRP.

Basis for Request

The TR provides pumping test data and results from a 2008 pumping test conducted in the 90 sand in the Peterson Satellite. The pumping well, LPW-4 and observation wells, LMP-6 and LMP-7 for the 90 sand were located in proposed Wellfield 2 as shown on application Figure 2.7-22. Only one observation well was located in the underlying 80 sand next to the pumping well. The TR indicates there was no overlying monitoring well as there is no overlying aquifer in the location. Two ore zone aquifer observation wells, LMP-6 and LMP-7 were located in the 90 sand at 334 and 228 ft, respectively, from the pumping well. For the 90 sand aquifer test at LPW-4, the TR provides the water level vs time curves for the pumping wells and all of the observation wells for the pumping and recovery periods in Figures 6-22 through 6-25 of Appendix A-2. These plots are useful for a quick check of the well response to pumping and atmospheric conditions; however, the plots are insufficient for staff to evaluate the aquifer response as the time scale was oddly set as a log scale of the Julian date which repeated for several points instead of the usual log scale in minutes.

The TR provides a Cooper Jacob analysis of the recovery data of one observation well, LMP-7, in Appendix A-4. The value is substantially lower than the transmissivity reported in the 90 sand at the Leuenberger Satellite, 94.85 vs 18.11 ft2/day. The staff is concerned with the analysis and results of this aquifer test for several reasons. The recovery plot analysis of LMP-7 in Appendix A-4 shows a large t/t' at zero drawdown and an S/S' =1.34. Both of these values are outside the range considered acceptable for the assumptions inherent to this analysis. These values are indicative of an aquifer with a varying storage coefficient which may indicate the aquifer is unconfined (Driscoll, 1986). The staff evaluated the recovery water level data provided by Uranium One for both the pumping well and the LMP-7 monitoring well. Staff's analysis indicates that the curves show evidence of the delayed yield expected in an unconfined aquifer in the recovery. Finally, the test was conducted at rate of 8.9 gpm, which is half the aquifer test rate at the other satellites. The staff is concerned that Uranium One used this lower rate to avoid drawdown which would dewater the 90 sand aquifer. The Staff finds the information provided is not sufficient to review the 90 sand aquifer test at LPW-4 at the Peterson Satellite. Staff cannot evaluate or provide reasonable assurance for the safety of operations at this satellite without an evaluation of unconfined aquifer behavior in the 90 sand at the Peterson Satellite.

Formulation of RAI

Uranium One should:

- *Provide traditional time drawdown curves on semi-log time scale for all observation wells;*
- *Provide recovery curves on semi-log time scale for the pumping well and the observation wells;*

- *Analyze all curves for unconfined aquifer behavior;*
- *Provide transmissivity, specific yield and storage coefficient values from the analysis for all wells; and*
- *Describe and reassess the hydrogeologic characteristics of the 90 sand at the Peterson Satellite, if unconfined behavior is demonstrated.*

RAI-39 Response

See Appendix A for response to this RAI. Uranium is confused on what information in regards to our response to RAI 39 was not included as part of the Appendix A response. Please provide Uranium One specifically what information was considered not to be included in Appendix A of this response.

RAI-41

Description of Deficiency

The information provided in TR Addendum 2-7A does not meet the applicable requirements of 10 CFR 40.41(c), using the review procedures in Section 2.7.2 and acceptance criteria in Section 2.7.3 of the SRP.

Basis for Request

Addendum 2-7A identifies wells within 2 km of the Peterson Wellfields. For Wellfield 1 this includes wells in Sections 20, 21, 22, 23, 26, 27, 28, 29, 32, 33, and 34 of T34R73W. For Wellfield 2 this includes wells in Section 25 of T34R73W, Sections 30, and 31 of T34R72W, Sections 1, 2, 3, 4, 10, 11, and 12 of T33 R73, and Section 6 of T33R72. Staff identified numerous private wells within 2 km of the wellfields. These wells are listed in the following table. Addendum 2-7A provides no information on which aquifer(s) these wells are completed in and their current use. Therefore, staff cannot evaluate the safety of their use within 2 km of the proposed wellfields.

Formulation of RAI

Uranium One should; provide the status, target aquifer(s), current use and predicted use of the wells which are listed in the above tables, and determine if any of these wells are completed in the 90 sand or any targeted ore zone aquifers or underlying/overlying aquifers at Peterson Satellite. If yes, Uranium One should determine if operation of those wells could incur any safety issue for well owners or impact hydraulic control of the wellfields during operations.

Uranium One should provide a commitment to annually update information on private well use and describe any new private wells installed within 2 km of the Peterson Satellite proposed wellfields including their coordinates, completion, type of use and rate until the license is terminated.

RAI-41 Response

Based on the regional cross sections the wells listed in the below Table as provided by NRC, indicate that wells P77601.0W and P77521.0W appear to be located within the 90 sand aquifer. Wells P77522.0W and P14294W, P19404P, P150212W appear to be located within the 80 or 70 sands and wells P98857.0 appears to be located in the 60 sand. The remainder of the wells listed in the below Table appear to be river alluvium completed wells. The production ore body for wellfields located within the Peterson area of the Ludeman permit area is the 80/70 and 90 sand. Review of the data indicates that only the wells listed in the above would have the potential to be located within an underlying, overlying or production sand which would have any potential impacts from wellfield operations. The potential for these wells to impact North Platte wellfield 3 operations will be evaluated as part of the wellfield specific data package. Current uses approved for wells as listed in the below North Platte Table are permitted for stock watering or miscellaneous water use.

See RAI-28 for additional response to this RAI.

Peterson Satellite Private Wells

Permit Number	Location	Name/Date	Owner	Specified Use	Screen/ Depth	Permit Rate
P180989W	T34NR73W S35 SE1/4 SE1/4	2081 WW 1/31/2007	Energy Metals	Misc	273/298	25 gpm
P71052.0W	T34NR73W S32 NW1/4 SE1/4	Vollman Stock 9/6/85	Vollman Ranches	Stock	180	25 gpm
P77601.0W	T34NR73W S34 SW1/4 NE1/4	Lisco #3 7/22/88	Carroll Lisco	Stock	129/166 ft	15 gpm
P77521.0W	T34NR73W S35 SW1/4 SE1/4	OW1 7/7/88	Richard Lisco	Stock	127-167 ft/175 ft	15 gpm
P77522.0W	T34NR73W S35 NE1/4 NW1/4	OW9 7/7/88	Richard Lisco	Stock	283-325 ft/340 ft	15 gpm
P75291.0W	T33NR73W S2 SE1/4 SE1/4	Lisco 2 8/11/87	Carroll Lisco	Domestic , Stock	15- 18 ft/ 20 ft	10 gpm
P126595W	T33NR73W S2 SW1/4 SE1/4	Lisco 5 6/27/2000	Carroll Lisco	Domestic , Stock	10-18 ft/ 30 ft	9 gpm
P22297P	T33NR73W S2 SW1/4 SE1/4	Moore 2-33-73 12/31/68	Eddie Moore	Domestic	20/45 ft	6 gpm
P19404P	T33NR73W S3 NE1/4 SW1/4	Moore 10/31/46	Pacific Power and Light Co.	Domestic , Stock	?/80 ft	25 gpm
P150212W	T33NR73W S11 NW1/4 SE1/4	Thiel 1 4/22/03	Loren Thiel	Domestic , Stock	60-150 ft/ 160 ft	9 gpm
P25898W	T33NR73W S11 NE1/4 NW1/4	J Whiting 1 2/21/74	Jimmie D. Whiting	Domestic , Stock	10-20 ft/ 22 ft	6 gpm
P8238.0P	T33NR73W S11 SE1/4 NW1/4	Whiting 1 2/28/46	Adolf O. Whiting	Domestic , Stock	/18 ft	6 gpm
P8600.0P	T33NR73W S11 SE1/4 NW1/4	Whiting 2 12/31/39	Adolf O. Whiting	Stock	/14 ft	6 gpm
P22298.0P	T33NR73W S12 NE1/4 SW1/4	Moore 12-33-7 12/31/68	Eddie Moore	Stock	/50 ft	4 gpm
P98857.0W	T33NR73W S12 NW1/4 SW1/4	Thompson 1 4/24/95	David and Lea Thompson	Domestic	337-350 ft/360 ft	15 gpm
P184773W	T34NR72W S31 SW1/4 SE1/4	West Reed 1/16/2008	Smith Sheep Company	Stock	100-120 ft/140	10

RAI-42

Description of Deficiency

The information provided in TR Section 2.7.2 does not meet the applicable requirements of 10 CFR 40.41(c), using the review procedures in Section 2.7.2 and acceptance criteria in Section 2.7.3 of the SRP.

Basis for Request

On November 13, 2001, the Supreme Court of the United States issued the Modified North Platte River Decree which addressed water use from the North Platte River. In this decree, portions of the North Platte watershed are identified as hydrologically connected to the North Platte River. Within these regions surface water and ground water use for irrigation and other purposes is strictly controlled by a court order. Staff's review of the regional map (https://sites.google.com/a/wyo.gov/seo/documents-data/maps-and-spatial-data) for hydrologically connected areas near the North Platte River showed that the Peterson Satellite is located within the hydrologically connected region. Therefore all water use at this satellite, whether surface or ground water, must be approved by WSEO to meet the requirements of the decree. Any evaporation or surge ponds must also meet the terms of the decree. The TR does not include a discussion of the decree in its characterization of ground water or surface water or the implications for the safety of operations at the Peterson Satellite if water use is limited or restricted. Staff cannot provide reasonable assurance of the safety of operations without this information.

Formulation of RAI

Uranium One should provide:

A. A description of the Modified North Platte River Decree and implications for water use at Peterson Satellite;

B. Assurance that the water use required for production and restoration at the Peterson Satellite will be evaluated and approved as required under these orders. This water use includes wells and all surge /evaporation ponds; and

C. A commitment that if any changes to the wellfield design, ponds, or water use are incurred by the WSEO under this order before operations begin or during operations, Uranium One must inform NRC, so that a safety evaluation of these modifications may be made.

RAI-42 (A) and (B) Response

Uranium One performed an evaluation of the Wyoming State Engineer's Office (SEO) stream flow depletion from groundwater withdrawals based upon provisions of the Modified North Platte Decree and the Platte River Recovery Implementation Program (PRRIP), i.e. the "28:40" connection criteria (see Attachment 1 SEO Hydrological Connection – 28:40 criteria). This criterion established methods designed to assess for the potential of a "hydrological connection" related to groundwater usage on stream flow depletion. Therefore, several criteria's were utilized to initially screen for potential groundwater to surface water impacts related to the operation of proposed In-Situ Recovery (ISR) of Uranium via extraction wells located in the North Platte River Basin.

The recommended process for evaluation of hydrological connection under the 28:40 criteria was performed as follows, including results for each of the following initial screening criteria:

1. Screen for previous determinations of hydrological connection, e.g. the North Platte Decree and PRRIP "green area" maps. These have been endorsed by the relevant parties for specific application under those compliance programs. Similarly, there is a small number of individual well studies of hydrological connection conducted for various development and permitting purposes which may be relevant to a new investigation. If an area/aquifer has been previously determined to qualify as "not hydrologically connected", there may be no need for further evaluation. Contact the WSEO North Platte River Coordinator for details.

   Response/Results

   A portion of Well Field No. 5 and the entirety of Well Field No. 6 are located outside of the North Platte Decree and PRRIP "green area" map zones (see Attachment 2 Figures). Previous hydrologic connection for the 70, 80 and 90 sand aquifer systems in this region has not been determined. Therefore, information derived from a pumping test performed in the area of these two well fields was utilized to establish compliance under the 28:40 programs.

2. Assess the hydrogeologic setting as discussed above to determine if "hydrological connection" status is obvious. For example, a near-stream well drawing from a shallow aquifer is almost certainly "connected" under the 28:40 criteria. A far-from-stream well drawing from a deep, confined aquifer is likely to be "not connected".

   Response/Results

   An assessment of the hydrogeologic setting was conducted for proposed Well Field No. 5. This proposed well field is located at an approximate distance of 10,400 feet from the North Platte River. The proposed ISR wells will be completed at an average depth exceeding 300 feet bgs. From pumping tests conducted near the proposed Well Field No. 5, the aquifer systems are considered to be confined, since there was no drawdown response detected in monitoring wells completed in the overlying and underlying aquifer systems. Consequently, it could be assumed that these aquifer systems, due to their depth and confined nature, would not be connected to or contribute any meaningful volumes groundwater recharge to the North Platte River.

   Likewise, an assessment of the hydrogeologic setting was conducted for proposed Well Field No. 6. This proposed well field is located at an approximate distance of 5,000 feet from the North Platte River. The proposed ISR wells will be completed at an average depth exceeding 300 feet bgs. From pumping tests conducted in the proposed Well Field No. 6, the aquifer systems are considered to be confined, since there was no drawdown response detected in monitoring wells completed in the overlying and underlying aquifer systems. Consequently, it could be assumed that these aquifer systems, due to their depth and confined nature, would not be connected to or contribute any meaningful volumes groundwater recharge to the North Platte River.

However, due to the short duration of the pumping test (72 hours), drawdown produced from a single well may not be sufficient to detect all potential boundary and/or recharge conditions, to include the effects of groundwater flow through fracture networks in this region. Therefore, Uranium One opted to perform additional analyses to determine the likelihood of hydraulic connectivity of the proposed well fields to the North Platte River.

3. If additional analysis is indicated, compile available aquifer parameter data and apply a simple stream depletion model for general direction and screening-level analysis. The Jenkins (1968) implementation, with an "sdf" calculated directly as sdf = a^2S/T, is appropriate for this step.

Response/Results

Uranium One developed a simple stream depletion model based upon data derived from an aquifer pumping test conducted in the area of proposed Well Field No. 5 and No. 6. A Stream Depletion Factor (sdf) was calculated for both proposed well fields. An sdf for Well Field No. 5 was calculated, resulting in an sdf of 65,400 days (179.2 years) for 28% depletion. An sdf for Well Field No. 6 was calculated, resulting in an sdf of 15,117 days (41.4 years) for 28% depletion. These well fields are estimated to be in operation for approximately 10 to 12 years, to include an additional 5 years for recovery and restoration of the aquifer systems from post ISR activities. Due to the short duration of ISR activities (37% of the calculated sdf for Well Field No. 6), it is highly unlikely that the proposed ISR operations will have any significant effect on stream flow depletion of the North Platte River from the diversion groundwater recharge in the vicinity of the Ludeman Project Site.

Stream Depletion Factor
Ludeman Well Field No. 5
LPW-4 Pump Test

	Distance (ft)		Distance^2 (ft)	S		T (ft^2/day)
	10400		1.08E+08	0.021		34.73
	sdf					
	65400.52	days		179.1795	years	

Stream Depletion Factor Ludeman Well Field No. 6 LPW-4 Pump Test						
	Distance (ft)		**Distance^2 (ft)**	**S**		**T (ft^2/day)**
	5000		25000000	0.021		34.73
	sdf					
	15116.61388	days		41.41538	years	

Conclusion

Based upon the distance of proposed Well Field No. 5 and No. 6 from the North Platte River, the depth and confined nature of the aquifer systems targeted for proposed ISR activities, and the proposed time frame for ISR activities (approximately 37% of calculated sdf for Well Field No. 6), including calculated sdf factors in excess of 40 years, it is therefore concluded that such use of the deep, confined aquifer systems for proposed ISR recovery activities will have little to no effect on stream flow depletion of the North Platte River in the vicinity of the Ludeman Project Site. The Petersen Wellfields 5 and 6 based on the Wyoming SEO 28:40 criteria would not be considered a hydrologically connected and therefore water from wellfield 5 and 6 would not be subject to Modified North Platte Decree. A copy of this evaluation will be sent to the Wyoming State Engineers Office for concurrence that the proposed Peterson Wellfields 5 and 6 are not hydrologically connected to the Platte River and therefore waters from these wellfields are not subject to the Modified North Platte Decree.

Uranium One is not proposing to utilize any evaporation or surge ponds within the Petersen wellfield area (see Attachment 2 Figures).

RAI-42 (C) Response

Uranium One commits that if any changes to the wellfield design, ponds, or water use are required by the WSEO under the North Platte Decree prior to operations or during operations, Uranium One will inform NRC, so that a safety evaluation of these modifications may be made.

Attachment 1

Wyoming State Engineers Office
Hydrological Connection – the 28:40 criteria
February 22, 2011

State Engineer's Office

HERSCHLER BUILDING, 4-E CHEYENNE, WYOMING 82002
(307) 777-7354 FAX (307) 777-5451
seoleg@seo.wyo.gov

MATTHEW H. MEAD
GOVERNOR

PATRICK T. TYRRELL
STATE ENGINEER

MEMORANDUM

DATE: February 22, 2011

TO: State Engineer's Office

FROM: Patrick T. Tyrrell, State Engineer

SUBJECT: Hydrological Connection – the 28:40 criteria

This memo was prepared at the request of the Wyoming State Engineer's Office (SEO) to provide background and screening criteria for assessment of "hydrological connection" of groundwater wells in the North Platte River Basin under the provisions of the Modified North Platte Decree and the Platte River Recovery Implementation Program (PRRIP), i.e. the "28:40" connection criteria. Following discussion of the origin and associated principles, a step-by-step approach to application is suggested. The final section provides references and calculation tools.

BACKGROUND / HISTORY

MBSA, 1982. For a series of reports published in 1982, the Missouri Basin States Association developed an analysis of the impact of groundwater development on streamflow, i.e. "stream depletion", for the Platte and Kansas Rivers and their major tributaries, including the North Platte River (MBSA, 1982). This work developed a series of maps which included lines of equal hydrological connection for groundwater wells along the studied rivers, i.e. all wells along a given line would have the same depletive effect on the stream, as a proportion (percentage) of their groundwater pumping.

These maps were based on the concept of a "stream depletion factor" (sdf), as developed by Jenkins (1968). In an ideal aquifer/stream system (Figure 1), using mathematical relationships published by Glover and Balmer (1954), the rate of stream depletion can be estimated as a function of:

- a = distance from the well to the stream (ft.);
- S = specific yield of the intervening aquifer (dimensionless); and
- T = the transmissivity of the intervening aquifer (ft^2/day).

Jenkins combined these factors into a single term, "sdf", and provided tables and graphs relating sdf with stream depletion rates and volumes to simplify the calculations and to facilitate calculations for complex pumping patterns (like seasonal irrigation).

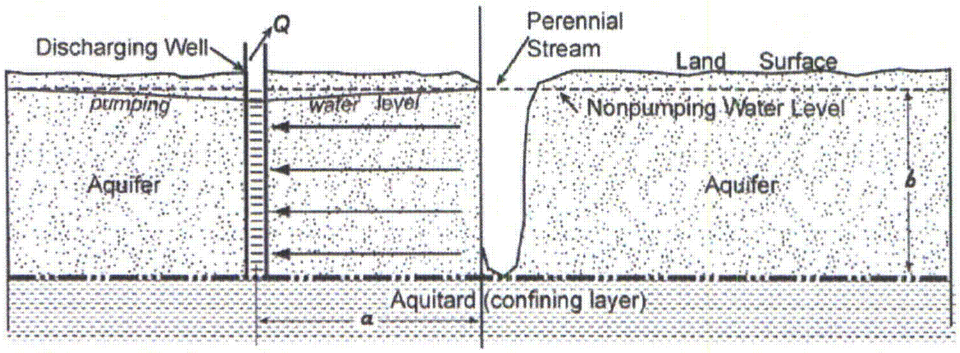

Figure 1 - Idealized "Glover" Model

In the idealized system of Figure 1:

$$sdf = a^2S/T$$

For non-ideal systems, Jenkins proposed an "effective value" of sdf be determined which incorporates, for example, "irregular impermeable boundaries, stream meanders, aquifer properties and their areal variation, distance from the stream, and imperfect hydraulic connection between the stream and aquifer." (Jenkins, 1968; p. 2). For the MBSA (1982) study, which was primarily concerned with stream depletion through groundwater development of the limited-width alluvial aquifers along major streams, sdf values were determined through numerical groundwater modeling of representative stream reaches.

The units of sdf are days. "When the well is pumped continuously and when the volume of depletion reaches 28 percent of the total volume pumped, the pumping time would be approximately equal to one sdf at the well." (MBSA, 1982; p. 9). For example, at a point in the aquifer where the combination of local transmissivity, specific yield, and distance create an sdf value of 500 days, the cumulative stream depletion after 500 days of pumping will be 28%. The cumulative depletion will be less than 28% at 400 days and more than 28% at 600 days. 28% is simply the cumulative depletion at the point in time where the pumping time is numerically equal to the sdf value.

Available data on specific yield and transmissivity were compiled for the aquifers along the streams of interest and the points at which the cumulative stream depletion equaled 28% of the volume pumped at specified times were calculated. These points defined a series of "sdf lines", which were extended loosely parallel to the studied streams -- greater sdf values at greater distance from the stream, smaller sdf values at smaller distances from the stream. Five sdf bands were developed and plotted on these maps, for sdf = 50, 500, 1500, 5,000, and 15,000 days. 15,000 days is approximately 40 years, which was the planning horizon adopted for the overall study program (1944 - 1983). Thus, the cumulative depletion from a point on the outermost mapped line (sdf = 15,000 days), after 40 years of continuous pumping, would be 28%.

The MBSA (1982) study then estimated pumping volumes from irrigations wells within each sdf band (between two sdf lines) and used the sdf bands to calculate the resulting streamflow depletions. Rather than extending explicit calculations to irrigation wells beyond the 15,000-day (40-year) band, all wells outside this line were simply assumed to have an aggregate instantaneous depletive impact of 2% of the amount pumped[1].

Modified North Platte Decree. As streamflow depletion by groundwater irrigation developed as an issue in the 1986 - 2001 Nebraska v. Wyoming lawsuit over the flows of the North Platte River (U.S. Supreme Court No. 108, Orig.), the parties' experts sought to quantify the impact on streamflows of irrigation well development over the period since the original (1945) North Platte Decree. Eventually, the settlement negotiations that resolved the lawsuit, resulting in the 2001 Modified North Platte Decree, boiled the groundwater-irrigation issue down to an assessment of which tracts of groundwater irrigation would be accounted under the agreed-upon limitations on total irrigated acreage and total consumptive use of irrigation water in various sub-basins of the North Platte River in Wyoming. For the North Platte River basin above Guernsey Dam both irrigated acreage and consumptive use limits were established; for the lower Laramie River basin (east of the Laramie Mountains) exclusive of the Wheatland Irrigation District, only an irrigated acreage limitation was established. As a negotiated criteria for identification of which irrigated areas would "count" and which would not, the parties adopted a concept of "hydrological connection" based on the location of the groundwater irrigation supply well:

> "A hydrologically connected groundwater well is one that is so located and constructed that if water were intentionally withdrawn by the well continuously for 40 years, the cumulative stream depletion would be greater than or equal to 28% of the total groundwater withdrawn from the well." (North Platte Decree Committee Charter - Exhibit 4, Sec. III, D, 2, b.)

For an initial definition of irrigation wells for which the associated irrigated acreage would be accounted under the Modified Decree, maps were developed by Wyoming and approved by the North Platte Decree Committee (NPDC) based on the best available hydrogeologic information. (No new aquifer data were developed for that analysis.) In some cases, e.g. the lower Laramie River basin, the delineation of "hydrological connection" under the 28:40 criteria was based on existing numerical modeling (i.e. MODFLOW). In most cases, the simpler, stream-depletion factor approach (Jenkins, 1968), with $sdf = a^2S/T$, was used[2]. The areas on these maps outside

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[1]No details are provided on the origin of the 2% estimate; the authors "recommend that criteria for areas outside the study limits of the SDF technique be developed and used in the next study."

[2]In the absence of a more complicated determination of an effective sdf value, Jenkins (1968) is

the 28:40 areas, shown in green, i.e. those areas judged not to be "hydrologically connected" under the 28:40 criteria, have come to be known as the "green areas", in the sense of a "green light" with respect to Decree restrictions on groundwater use.

Because the streamflows of interest were those entering Nebraska from Wyoming's North Platte River Basin, the stream impacts of concern are those contributing to (or subtracting from) flows at the stateline. Depletions to certain streams, which do not directly contribute to flows at the stateline, do not fall under the Modified Decree "hydrological connection" criteria. As per the procedures adopted by the NPDC, qualifying depletions are those to "perennial streams" which flow through to the mainstem of the North Platte River, as defined by the standard 1:100,000-scale topographic maps produced by the U.S. Geological Survey.

In Wyoming, there are many ephemeral streams which, when they flow at all, are essentially perched above the local groundwater table. These streams lose streamflow to groundwater, but the rate of loss is not affected by the elevation of the underlying groundwater table. A lowering of the groundwater table through pumping does not affect the rate of streamflow loss. No "depletion" occurs as a result of groundwater pumping under these circumstances.

Streams in the mountains of Wyoming are commonly perennial, gain water through groundwater inflow, and can be depleted through groundwater pumping. However, many of these streams become ephemeral once they exit the mountains, losing all perennial flow to the underlying aquifers (e.g. an alluvial fan at the mouth of a stream canyon). Because a depletion to such a stream is not directly translated through to the mainstem of the North Platte River and thus to the stateline, no "depletion" is considered to occur under the Modified Decree. (A more complex analysis is needed in areas where a depleted perennial stream becomes ephemeral close enough to a mainstem tributary that a 28% depletion may occur via the remaining, groundwater connection in less than 40 years.)

Included with adoption of the criteria defined for hydrological connection and the initial hydrological connection maps, was recognition that the maps approved by the NPDC were deliberately conservative, intended to err on the side of smaller rather than larger "green" areas. Because many areas which had not been identified as "green" might still have depletions of less than 28% in 40 years, the NPDC procedures allow case-by-case application of the criteria based on local data and more detailed studies. For example, the hydrological connection between a stream and a nearby well developing groundwater from a deep, confined aquifer might be quite small despite the fact that, in map view, the well is relatively close to the stream.
As of this writing, Modified Decree compliance with respect to annual irrigated acreage and consumptive use accounting associated with hydrologically-connected groundwater is based on the NPDC "green area" maps and a small number of individual site studies that have applied the 28:40 criteria outside the previously defined areas.

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essentially reduced to the configuration of Figure 1 and the equations of Glover and Balmer (1954). Narrow, high-transmissivity alluvial aquifers are largely ignored as being clearly within the bounds of "hydrological connection". (See individual map descriptions for details.)

Platte River Recovery Implementation Program (PRRIP). Similar issues regarding the impact of groundwater development on streamflow were subsequently resolved in the development of the Platte River Recovery Implementation Program (PRRIP). Recognizing that beyond a certain degree of hydrological connection, the estimation and accounting of groundwater impacts fell below an appropriate level of concern, the parties to that program negotiated adoption of the 28:40 hydrological connection criteria from the Modified North Platte Decree. With the same provisions for future individual studies, hydrological-connection maps as described above were developed for the remaining portions of the North Platte River basin in Wyoming (North Platte River below Guernsey Dam and upper Laramie River basin) and it was agreed that groundwater development outside the 28:40 bounds would be exempt from the recovery program.

As of this writing, PRRIP compliance with respect to 1997 "baselines" and calculation of "new" depletions are based on the "green area" maps in the Wyoming Depletion Plan and a small number of individual site studies that have applied the 28:40 criteria outside the previously defined areas.

The SEO website (http://seo.state.wy.us/) provides electronic versions of the "green area" maps for the various North Platte River sub-basins, and related policy documents.

PRINCIPLES

In principle, nearly all sources of groundwater are connected to surface water resources to some degree. Exceptions include connate water (e.g. sea water remaining since the original deposition of a formation) and, sometimes, water associated with hydrocarbon deposits. For the most part, groundwater of sufficiently high quality to be of value for irrigation, domestic, municipal, and stock use is likely to be part of an active groundwater flow system that, however slowly, begins and ends at the earth's surface.

The basic, physical constraint of "mass balance" requires that any increase in groundwater consumption at one point must be balanced by an equal decrease in storage or consumption somewhere else. For groundwater systems in which the hydrological connection with surface water is small, most of the extracted groundwater comes from storage within the aquifer. This is reflected in a decrease in aquifer water level or pressure (head). For groundwater systems in which the hydrological connection with surface water is large, most of the groundwater comes from surface depletions, and there may be little change in aquifer water levels. A third possible "source" of groundwater is a decrease in withdrawals elsewhere. For example, the term "ET salvage" is applied where the consumption of water by non-beneficial vegetation or natural evaporation is reduced as groundwater is withdrawn for crop consumption, with no decrease in streamflow or in aquifer storage (beyond the initial water-level drop that dries up the impacted evapotranspiration).

Thus, "hydrological connection" is rarely a binary, "connected" vs. "not connected" assessment. Instead, the reasonable working hypothesis is that aquifer and stream are connected, and one seeks to estimate or measure the degree of connection, commonly with reference to some regulatory, negotiated, or policy standard criteria. The 28:40 criteria presented in the Modified North Platte Decree for accounting and compliance with limitations on irrigated acreage and the consumptive use of irrigation water is an example of such a standard. That same standard was adopted by the parties to the PRRIP for their accounting and replacement water calculation procedures.

Other programs and jurisdictions have adopted different standards, for different purposes. In Colorado, for example, groundwater development that is calculated to have a 0.1% depletive effect in 100 years is considered "tributary" to surface water. The 2004 Platte River Conjunctive Management Study in Nebraska stated, "Hydrologic connection exists where pumping will cause a streamflow depletion within 50 years greater than 10% of the pumping rate." The latter example also differs from the 28:40 criteria in that it specifies a rate of depletion, rather than being based on the cumulative volume of depletion. (Under steady pumping, the rate of depletion, e.g. in gpm, will always be higher as a percentage of the pumping than the cumulative volume of depletion will be, because small depletion rates early in the pumping period will average out the higher depletion rates of later in the pumping period.)

The hydrological connection criteria cited above, including the 28:40, are all based on proportions rather than absolute volumes. For example, a stream depletion of 50 ac-ft would not be considered "connected" under the 28:40 criteria if the cumulative volume pumped over 40 years were more than 200 ac-ft (i.e. a 25% depletion), whereas a stream depletion of 5 ac-ft would be considered "connected" if the cumulative volume pumped were less than 17 ac-ft (i.e. a 29% depletion). High-yield wells are neither more nor less likely to be meet the criteria for hydrological connection than low-yield wells; nor is there any production threshold below which depletion is automatically considered inconsequential.

Beyond the consideration of groundwater impact with respect to whether a stream is perennial or not (discussed above), a proportion-based criteria for hydrological connection like the 28:40 is inherently insensitive to the flow rate of the stream. This creates an algebraic breakdown for particularly small streams, in that a 1000 gpm well cannot possibly exceed a depletion rate of 10% if the impacted stream only flows 100 gpm in the first place, regardless of distance, transmissivity, time, etc. To date, this issue has not been addressed with respect to application of the Modified Decree and PRRIP "hydrological connection" criteria.

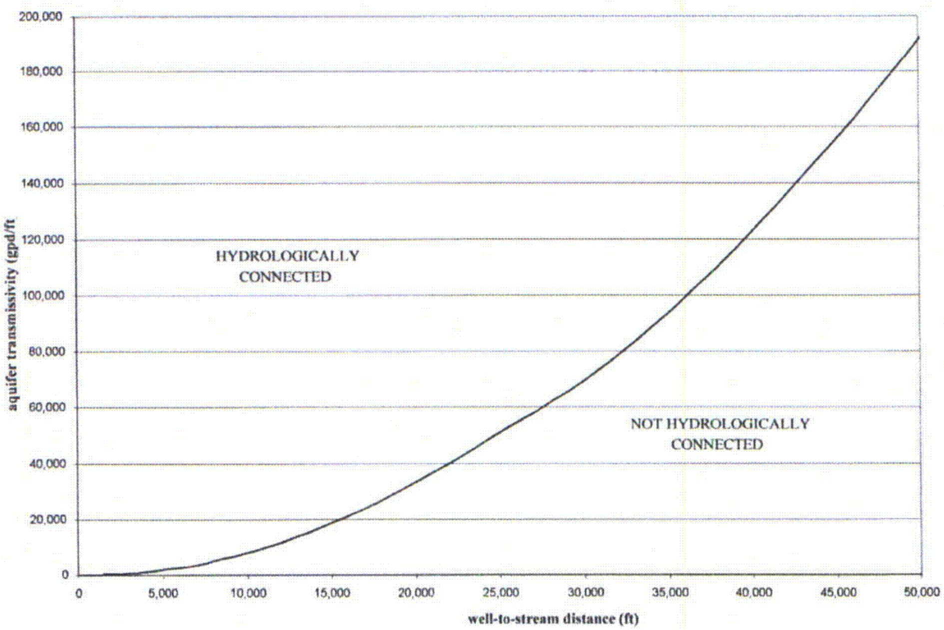
Hydrological connection is calculated under the 28:40 criteria without regard to the flow direction of groundwater. Stream depletion resulting from water physically leaving the stream to enter the aquifer being pumped is treated the same as stream depletion resulting from pumping groundwater that would otherwise flow on into the stream. This reflects the hydrologic principle of "superposition" which recognizes that the impact of a pumping well is simply added to whatever other stresses, gradients, impacts, etc. are otherwise present.

APPLICATION

Figure 2 presents the 28:40 criteria for hydrological connection as calculated for an ideal (i.e. thick, homogeneous, isotropic, "sandbox") aquifer. The figure assumes a generic, unconfined-aquifer specific yield of 0.15, then plots the line along which the transmissivity and distance parameters produce a 28% cumulative depletion in 40 years. The area above and to the left of the line represents wells for which either the distance to the stream is small enough and/or the transmissivity is high enough that the depletion is greater than 28%. Only where the distance is large enough or the transmissivity is small enough (the right-hand side of the graph), will wells in this idealized scenario be classified as "not hydrologically connected".

Consider an 8-inch diameter municipal-supply well for which the desired yield is 300 gpm. Under the idealized conditions of Figure 2, for drawdown to remain within reasonable magnitude, say 300 ft., a transmissivity in excess of 1,500 gpd/ft is required[3]. Such a well would have to be at least 4,400 ft from the stream to be considered not hydrologically connected under the 28:40 criteria. Absent contrary indications (discussed below), productive wells closer to the stream are likely be classified as "hydrologically connected" under the 28:40 criteria.

Figure 2 -- 28% Depletion in 40 Years (S = .15)
idealized aquifer



[3]The conversion between transmissivity units is: 1 ft^2/day = 7.48 gpd/ft

Given enough time, one might address the question of hydrological connection through direct observation, i.e. pump a well, measure flow in the potentially impacted stream, and see what happens. In practice, the 28:40 threshold for "connection" is likely too low to be directly assessed. Typical pump tests are run from a few hours to a few days. Where a critical factor in an important project cannot be adequately investigated without a longer test (e.g. delayed yield or where aquifer boundaries are expected), multi-week pump tests are occasionally justified. However, for a well in an ideal aquifer to fall outside the 28:40 criteria, the depletion rate over even a 60-day test would be less than 0.01% - almost certainly too small to be detected by direct streamflow measurements. If <u>any</u> discernable depletion were measured in a direct test, it would be clear that the well would be classified as "connected" under the 28:40 criteria, but the absence of discernable depletion could <u>not</u> be interpreted to mean the well would be classified as "not connected".

Thus, assessment of hydrological connection under a 28:40 criteria is almost inevitably based on groundwater theory (modeling), where aquifer hydrogeologic parameters are quantified and used to mathematically predict impacts over extended time periods, rather than relying on direct observation. Suitable models of aquifer behavior for predicting stream depletion impacts vary from such simple, 3-parameter equations as the "sdf" method described above (and used to develop Figure 1), to complex, multi-layer numerical models such as those built within the MODFLOW[4] structure.

<u>Hydrogeologic Parameters</u>

<u>Specific yield (storage coefficient; storativity)</u>. This parameter is necessary for even the simplest models, as it reflects the volume of water available for each increment of drawdown. The higher the specific yield, the more of the pumping demand that is met by release of aquifer storage and the less that is met by stream depletion. Specific yield values for the unconfined aquifers associated with surface interaction commonly fall in the range of 0.10 - 0.20. Storage coefficients derived from short-term pump tests should be evaluated with care, in that initially low, confined-aquifer values may approach unconfined-aquifer values over the extended time periods of interest here, i.e. a 40-year view that includes "delayed yield" reactions, the spread of drawdown into unconfined portions of a locally confined aquifer, etc.

<u>Transmissivity</u>. This parameter is also necessary for even the simplest models, as it reflects the ease with which water moves through the aquifer, between stream and well. Higher transmissivities produce higher stream depletion, all else being equal. Typically, wells are sited to maximize transmissivity, e.g. targeting coarse-textured zones or fracture zones, whereas the wider-area of the aquifer between well and stream may have a lower effective transmissivity. Use of a transmissivity value from a singularly productive well may thus be conservative in the sense of tending to overestimate stream depletion. Similarly, because transmissivity is the

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[4]MODFLOW is a standard, finite-difference groundwater flow model developed by the U.S. Geological Survey. There are many commercial versions of this model, for which graphical pre- and post-processors have been added to facilitate use.

product of permeability and aquifer saturated thickness, transmissivity will decrease as drawdown develops in an unconfined aquifer. Simple models of stream depletion assume an effectively constant transmissivity (i.e. that the saturated thickness does not significantly decrease with pumping), which may not be the case in relatively thin aquifers.

Hydraulic parameters for "confining" units. Based on lithologic considerations or pump-test drawdown measurements in various geologic layers, it may be possible to develop quantitative estimates of the permeability of significant low-permeability zones between the well and stream. The common mistake of a "not hydrologically connected" conclusion based simply on measurement of a head difference between two hydrogeologic units should be avoided. Head differences, whether vertical or horizontal, identify groundwater gradients and the resulting groundwater flow directions. Only combined with credible permeability information can hydrological connection interpretations be supported.

Boundaries. Pump tests of sufficient duration and/or geologic interpretation may provide aquifer boundary information. "Negative" boundaries in a pump test, e.g. when the cone of depression generated by well pumping encounters the termination of a water-bearing unit, suggest greater isolation of the aquifer from its surroundings, decreasing the opportunity for hydrological connection with the surface. "Positive" boundaries, particularly the occurrence of a point in time in a pump test beyond which no additional drawdown takes place, suggest a "recharge" source, the most likely candidate for which is commonly a surface-water feature.

In the development of parameters with which to project hydrological connection, pump-test drawdown data from observation wells can be particularly important in assessment of hydrogeologic conditions through the wider aquifer (away from the pumped wellbore) However, variation in groundwater levels near an impacted stream are strongly limited by the presence of the stream. The stream is depleted as it "works" to maintain adjacent groundwater levels. The perhaps subtle change in groundwater gradients accompanying stream depletion are necessarily less apparent close to the stream. The absence of readily discernable near-stream drawdown in the aquifer cannot be taken as demonstration that a pumped well is having little impact on streamflow.

Hydrogeologic Setting

Most of the initial "green area" maps developed for compliance and application of the Modified Decree and the PRRIP were produced by applying conservative parameters (e.g. using the highest of reasonable transmissivity values) and conservative assumptions (e.g. a continuous, homogeneous aquifer; a fully-penetrating stream) to a simple, idealized model of aquifer behavior, across large areas of the North Platte River basin. This broad approach was deemed inappropriate for geologically complex areas, e.g. much of the area south of the North Platte River between Casper and Douglas, and was recognized as ignoring many factors that, at a local scale, may serve to reduce or enhance hydrological connection. These are factors best addressed on a case-by-case basis, where detailed data collection and interpretation are available, and where site-specific groundwater modeling that takes more information into account can be developed.

In all cases, the general hydrogeologic setting of a well should be considered as part of the assessment of hydrological connection. Where the simple geometry of an aquifer makes the low magnitude of potential connection obvious, e.g. an aquifer with no outcrop within tens of miles, confined beneath several thousand feet of low-permeability shale, limited or no quantitative modeling may be necessary. In any case, the following hydrogeologic factors should be considered in assessment of the appropriate level of analysis:

Stratigraphy. Streams rarely fully penetrate the aquifer, as assumed by the simple, Glover-type models (Fig. 1). Where a well is completed in the deep zones of an aquifer while the stream penetrates only the uppermost zones, the thickness of the aquifer itself may become a significant factor in stream depletion. For this reason, even in a homogeneous aquifer, a shallow well is somewhat more likely to qualify as "connected" than a deep well.

Low-permeability formations/layers between the aquifer and the stream serve to reduce the degree of hydrological connection. Thickness is a key component, of course, in that the thicker the low-permeability layers are, the less the hydrological connection. The lateral continuity of a restricting or confining layer is also important, in that groundwater flow may "short-circuit" a low-permeability unit where the unit is thin or absent.

Geologic Structure. Most of the above discussion assumes horizontal orientations, e.g. an aquifer beneath a low-permeability layer remains separated from the surface at all locations. This conceptualization is incorrect where strata are dipping or are broken by faults or fractures.

Although the aquifer may be separated from the stream by low-permeability intervening strata at the closest point, the aquifer may be exposed to the surface and stream at an up-dip location close enough to meet hydrological connection criteria.

If an inter-formation fault juxtaposes the aquifer against a low-permeability unit between the well of interest and the potentially impacted stream, hydrological connection may be severed or greatly inhibited. On the other hand, intra-formational faults are generally considered to greatly enhance permeability. If such faulting/fracturing provides a groundwater pathway between aquifer and stream, hydrological connection will be greatly enhanced.

In many bedrock aquifers, fracturing (e.g. associated with faulting) is the predominant source of permeability. As with the faults themselves, fracture zones may provide a high-permeability pathways between well and stream, along which hydrological connection is enhanced.

Stream/Aquifer Continuity. The setting of a "perched" stream, where a stream is hydraulically decoupled from the underlying aquifer by an intervening unsaturated zone, was discussed above. Examination of the distribution of groundwater elevations (heads), e.g. potentiometric surface mapping, particularly with respect to the stream location and water-surface elevation, may assist in the interpretation of hydrological disconnection. A related issue is the hydraulic conductance of the streambed. Due to an accumulation of fine-grained material and organic debris at the streambed, a zone of permeability lower than that of the underlying aquifer may develop, which reduces hydrological connection.

Stream and Aquifer Geometry. The simplified stream depletion calculations assume a linear stream, extending to infinity in both directions past the well. If much of the stream is further from (or closer to) the well than this assumption, e.g. a regional stream curve, depletion will be less (or more). If a well is located so as to impact more than one stream, the total depletion will be more than is calculated for a single stream. If the aquifer comes to an end within a distance influenced by the well, e.g. an alluvial aquifer pinching out at the valley side, there will be less aquifer storage available to the well than is represented by Figure 1 and stream depletion will be enhanced accordingly.

RECOMMENDED APPROACH

The recommended process for evaluation of hydrological connection under the 28:40 criteria follows:

1. Screen for previous determinations of hydrological connection, e.g. the North Platte Decree and PRRIP "green area" maps. These have been endorsed by the relevant parties for specific application under those compliance programs. Similarly, there is a small number of individual well studies of hydrological connection conducted for various development and permitting purposes which may be relevant to a new investigation. If an area/aquifer has been previously determined to qualify as "not hydrologically connected", there may be no need for further evaluation. Contact the WSEO North Platte River Coordinator for details.

2. Assess the hydrogeologic setting as discussed above to determine if "hydrological connection" status is obvious. For example, a near-stream well drawing from a shallow aquifer is almost certainly "connected" under the 28:40 criteria. A far-from-stream well drawing from a deep, confined aquifer is likely to be "not connected".

3. If additional analysis is indicated, compile available aquifer parameter data and apply a simple stream depletion model for general direction and screening-level analysis. The Jenkins (1968) implementation, with an "sdf" calculated directly as sdf = a^2S/T, is appropriate for this step. (The Jenkins reference provides a hand-calculator suitable implementation; an electronic spreadsheet formula is provided in the "Tools" section of this memo; AWAS (2011) provides a computerized implementation with input screens and graphical output.)

4. Consider the potential impact of additional hydrogeologic detail on the screening-level analysis. For example, if the "sdf" parameter is simply being calculated from single values of aquifer transmissivity and storativity, it assumes an extensive, homogeneous aquifer. If the well is in an alluvial aquifer that terminates at the valley wall, stream depletion will be greater than calculated by the screening method. If the simplified method suggests "connected", it is unlikely that more detailed analysis will change that. If the simplified analysis suggests "connected" and there are fracture systems present that would serve to enhance rather than inhibit connection, there may be little point in

proceeding (if the hydrological connection issue is just "yes" or "no", rather than the degree of connection). Similarly, if the simplified analysis suggests "not connected" and qualitative consideration of the hydrogeologic setting demonstrates that conclusion would only be bolstered by more detailed analysis, the "yes/no" question may be considered resolved.

5. If ambiguity remains in the "hydrological connected" evaluation (e.g. the simplified calculation indicates a 35% depletion in 40 years, but there is a low-permeability layer between the well's completion interval and the stream), identify the critical hydrogeologic parameters necessary for development of a more accurate conceptual model of the stream / aquifer system and design an investigation program focused on elucidating the key components or parameters affecting the conclusion (e.g. the nature of faulting, groundwater vs. surface water elevations beneath a stream, the permeability of overlying strata, etc.)

6. Develop additional aquifer/stream data, e.g. through research, field mapping, water-level measurement, pump testing, etc. as per the previous step.

7. Apply/construct an appropriate groundwater model to quantitatively assess depletion relationships.

Successive steps in the above outline represent greater commitment of resources. If the desired answer is just a "yes" vs. "no" on "connected?" under the 28:40 criteria, the initial screening steps may be sufficient, depending on how close to the 28% value one falls. If the degree of hydrological connection is required, the analysis required will be proportional to the desired level of accuracy. It is more difficult to predict the difference between 22% and 18% depletion with confidence than the difference between 30% and 10%. However, even with the most complete and expensive analysis possible, the results will be based on projection of impacts in an idealized aquifer system and will include some level of error. Ultimately, the decision to proceed with more elaborate analysis should be based on a realistic assessment of the chances of usefully refining the conclusions, the resources necessary to conduct a credible investigation, and the potential value of the improved understanding potentially available.

TOOLS

This section provides the references cited above, with annotations, a sampling of the scientific literature related to stream depletion, and spreadsheet equations for calculating stream depletion for the idealized aquifer/stream system of Figure 1.

1. The most common, simplified modeling approach to stream depletion is that based on the work of Glover and Balmer (1954). Jenkins (1968) consolidated basic aquifer parameters into a "stream depletion factor" (sdf) to allow application of Glover's equations to more complex aquifer/stream configurations and to provide simple tables and graphs in lieu of complex mathematical calculations. This same basic formulation is known as "Glover" or "Jenkins" or "sdf" or, in Colorado, the "Schroeder" (Schroeder, 1987) program and its later, modern computer implementation, "AWAS" (2011).

Glover, Robert J. And Glenn G. Balmer; 1954; River Depletion Resulting From Pumping a Well Near a River; American Geophysical Union, Transactions, Vol. 35, No. 3. This is the seminal paper, of interest as an historical foundation, but long-since supplanted by more tractable publications.

Jenkins, C.T.; 1968; Computation of Rate and Volume of Stream Depletion by Wells; U.S. Geological Survey Techniques of Water-Resources Investigations, Chapter D1, Book 4 - Hydrologic Analysis and Interpretation; basically the same paper as:

Jenkins, C.T.; 1968; Techniques for Computing Rate and Volume of Stream Depletion Near Wells; Groundwater, 6, no. 2, pp. 37-46. Jenkins provides a readily usable explanation and non-computer implementation of basic stream depletion, including accommodation of multiple pumping and recovery periods, and including useful examples.

Missouri Basin States Association; 1982; Technical Paper - Ground Water Depletion (and accompanying maps). This work applied the "sdf" method to the major tributaries of the Missouri River, including the North Platte River below Guernsey Dam.

Schroeder, Dewayne R.; 1987; Analytical Stream Depletion Model; Colorado Division of Water Resources, Office of the State Engineer, Ground Water Software Publication No. 1. This user-interactive BASIC program applied the "Glover" equations (or the "Jenkins" approach if an sdf is independently available) to aquifers with boundaries parallel or perpendicular to the stream. Its DOS shell and primitive graphics have been replaced in the AWAS implementation described below.

AWAS - Alluvial Water Accounting System Ver.1.5.75; 2011. This program was developed by the Integrated Decision Support Group at Colorado State University. The AWAS "Original" mode duplicates Schroeder (1987). The latest version of the program, users manual, a quick tutorial, and the above-referenced Jenkins and Schroeder papers can be downloaded from website: http://www.ids.colostate.edu/projects/idsawas/

With the advent of electronic spreadsheets implementing advanced mathematical functions, the tabled, graphed, or programmed values in these references that relate depletion to sdf can be readily duplicated as single-cell spreadsheet formulas. In an EXCEL™ spreadsheet, for example:

v/Qt = ((sdf/(2*t))+1)*ERFC((sdf/(4*t))^0.5)-((sdf/(4*t))^0.5)*(2/(PI()^0.5)*EXP((sdf)/(4*t)))
= the cumulative volume of stream depletion over time t

and,

q/Q = 1-ERF(0,(sdf/(4*t))^0.5) = the instantaneous rate of stream depletion at time t

where,
sdf = a^2S/T = stream depletion factor (days)
and,
a = distance from the well to the stream (ft);
S = specific yield of the intervening aquifer (dimensionless);
T = the transmissivity of the intervening aquifer (ft^2/day);
t = pumping time (days);
q = the rate of stream depletion (ft^3/day);
Q = the rate of well pumping (ft^3/day);
v = cumulative volume of stream depletion (ft^3).

2. Analysis, critique, and refinement of this basic approach is provided in the following journal articles (among many others):

   Sophocleous, M., A. Kousis, J.L. Martin, and S.P. Perkins; 1995; Evaluation of Simplified Stream Aquifer Depletion Models for Water Rights Administration; Groundwater, Vol. 33, No. 4 uses a numerical model to evaluate some of the simplifying assumptions of the "sdf" approach. The general conclusion is that the "sdf" methods tend to somewhat overstate stream depletion by near-stream wells.
   Hunt, Bruce; 1999; Unsteady Stream Depletion from Ground Water Pumping; Groundwater, Vol. 37, No. 1 addresses depletion of a stream that does not fully penetrate the aquifer and which has an inhibiting streambed layer.

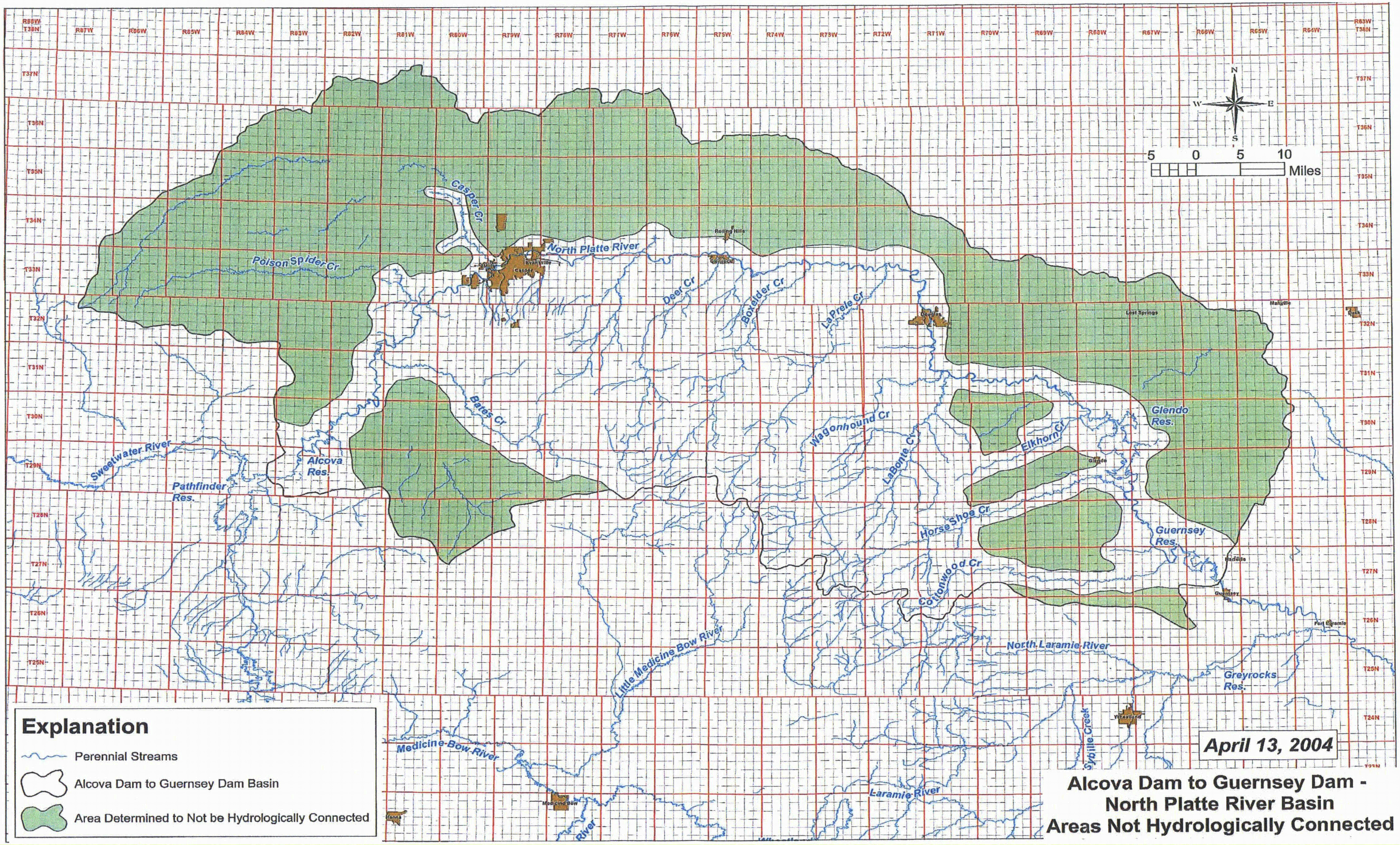
   Pattle Delamore Partners Ltd & Environment Canterbury; June, 2000; Guidelines for the Assessment of Groundwater Abstraction Effects on Stream Flow; Environment Canterbury (ROO/11)(ISBN 1-86937-387-1) presents extensions of the "sdf" equations to accommodate additional factors like streambed conductance, more than one stream, and springs.

   Miller, Calvin D., Deanna Durnford, Mary R. Halstead, Jon Altenhofen, and Val Flory; 2007; Stream Depletion in Alluvial Valleys Using the SDF Semi-analytical Model; Groundwater, Vol. 45, No. 4, pp: 506-514 provides a lucid discussion of the use of the "sdf" parameter to incorporate limited aquifer deviations from ideal conditions, and offers a refinement to better reflect aquifer boundaries.

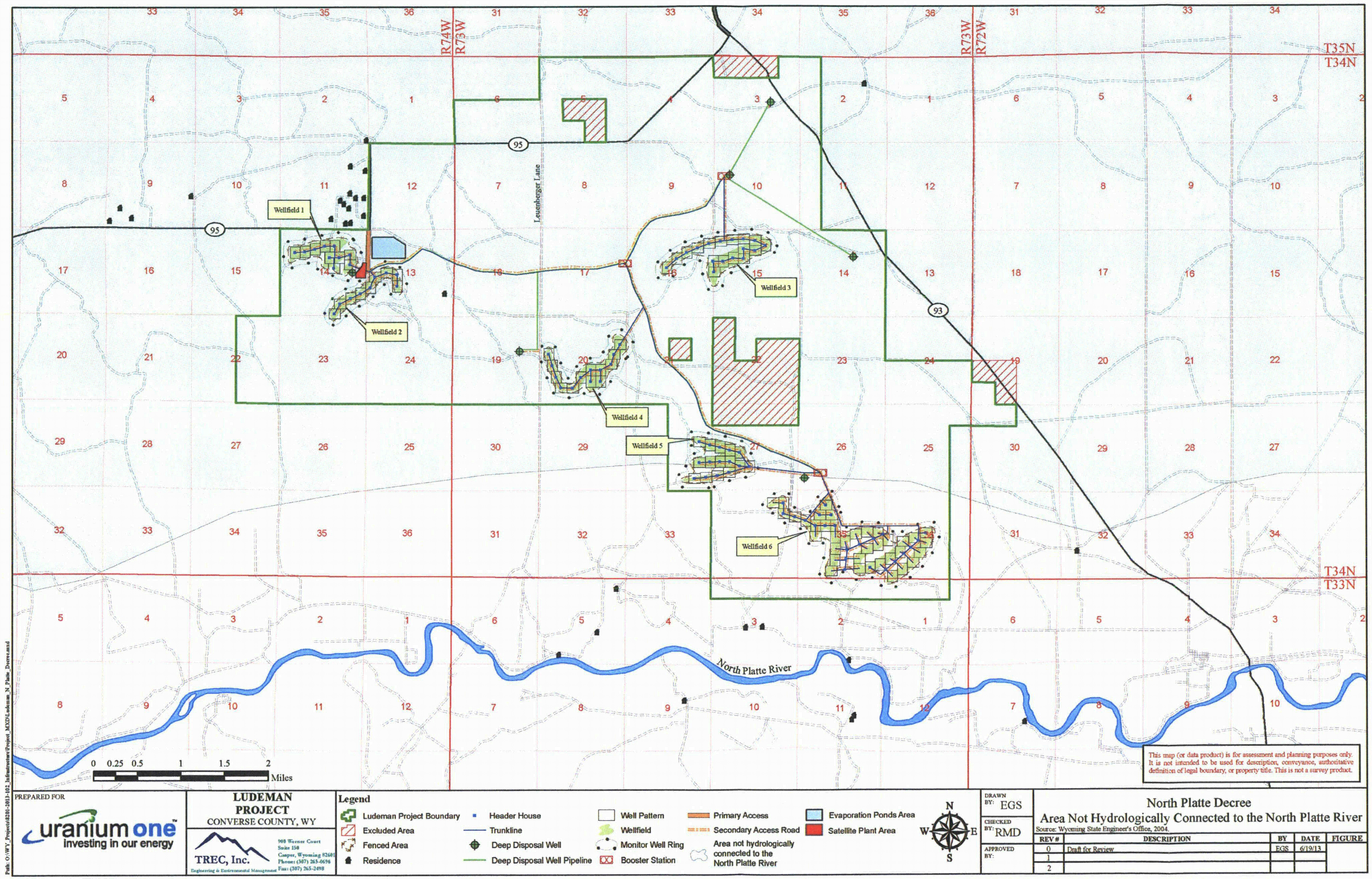
Reeves, Howard W.; 2008; STRMDEPL08 - An Extended Version of STRMDEPL with Additional Analytical Solutions to Calculate Streamflow Depletion by Nearby Pumping Wells; U.S. Geological Survey Open-File Report 2008-1166 incorporates analytical equations to accommodate partial penetration, streambed conductance, and leaky aquifer parameters.

3. The references cited above provide approaches that are idealized with respect to the nature of the aquifer – typically homogeneous, isotropic, and unconfined – and the overall aquifer/stream system geometry - e.g. fully-penetrating wells and streams, linear streams and aquifer boundaries, single-layer aquifers. Accommodation of more complex conceptualizations of the stream:aquifer system is generally provided through site-specific numerical modeling. Review of the professional literature will find many site-specific examples.

Attachment 2
North Platte Decree Figures
Areas Not Hydrologically Connected
April 13, 2004



Alcova Dam to Guernsey Dam - North Platte River Basin Areas Not Hydrologically Connected


T35N
T34N
T33N
R74W
R73W
R72W
95
93
Leuenberger Lane
Wellfield 1
Wellfield 2
Wellfield 3
Wellfield 4
Wellfield 5
Wellfield 6
North Platte River
0 0.25 0.5 1 1.5 2 Miles
This map (or data product) is for assessment and planning purposes only. It is not intended to be used for description, conveyance, authoritative definition of legal boundary, or property title. This is not a survey product.
PREPARED FOR
uranium one
investing in our energy
LUDEMAN PROJECT
CONVERSE COUNTY, WY
TREC, Inc.
Engineering & Environmental Management
900 Werner Court
Suite 150
Casper, Wyoming 82601
Phone: (307) 265-0696
Fax: (307) 265-2498
Legend
Ludeman Project Boundary
Excluded Area
Fenced Area
Residence
Header House
Trunkline
Deep Disposal Well
Deep Disposal Well Pipeline
Well Pattern
Wellfield
Monitor Well Ring
Booster Station
Primary Access
Secondary Access Road
Area not hydrologically connected to the North Platte River
Evaporation Ponds Area
Satellite Plant Area
N
E
S
W
DRAWN BY: EGS
CHECKED BY: RMD
APPROVED BY:
North Platte Decree
Area Not Hydrologically Connected to the North Platte River
Source: Wyoming State Engineer's Office, 2004.
REV # | DESCRIPTION | BY | DATE | FIGURE
0 | Draft for Review | EGS | 6/19/13
1
2

RAI-44

Description of Deficiency

The information provided in TR Section 2.7.3.2 does not meet the applicable requirements of 10 CFR 40.41(c), using the review procedures in Section 2.7.2 and acceptance criteria in Section 2.7.3 of the SRP.

Basis for Request

The water quality from stock well SW-12 shows anomalous values for cations, anions, and radionuclides compared to the averages for these wells. SW-12 is located in the Leuenberger Satellite as shown in Figure 2.7-26. Staff does not know the depth of SW-12. Another RAI addressed anomalous values in the surface water quality near this location in Little Sand Creek which may be hydraulically connected to the uppermost aquifer. Based on this information, staff cannot conclude that the water quality in the uppermost aquifer has been characterized.

Formulation of RAI

Uranium one should provide additional information on the water quality in the surficial (uppermost) aquifer at the Leuenberger Satellite.

RAI-44 Response

As has been observed in the wells within the Negley subdivision the water quality varies between well locations. While the depth of SW-12 was not able to be determined by a search of the SEO database, it is believed this well is completed in the 100 sands based on review of drilling logs and the geologist estimate that the surficial (uppermost) aquifer in the area of Wellfield 1 is the 100 sands.

Uranium One has had some further discussions with the land owner representative and the possibility exists that SW-12 may be cancelled well P4988.OP or Smith #5 identified in the Wyoming State Engineer Office database. A copy of the SEO permit summary for Smith #5 is included in the response to RAI-16. The landowner representative indicates that SW12 is a seep that feeds the well and the static water depth is approximately 15 feet. The well was constructed in the 1800's and permitted in 1945 and is brick lined and runs off a solar panel. Baseline water samples were collected from this well on June 29, 2009 and December 7, 2009 and this information has been included in the response to NRC RAI-16.

Anomalies identified in water quality at surface water locations SW-1 and SW-29 appear to be directly impacted by the discharge from stock well SW-12 which discharges approximately 100 yards upstream from the SW-1 sampling location. From further investigation stock well SW-12 would appear to be in the uppermost aquifer in this area of the Leuenberger Satellite area and characterization of the water quality although anomalous represents background conditions.

Uranium One will make a commitment to evaluate stock well and surface water conditions and collect additional water samples at the surface water locations SW-1 and SW-29 and stock well SW-12 to further characterize surface water quality within Little Sand Creek. Although historical ISR operations have occurred in the proximity of these locations, the surface water quality presently observed at SW-1 SW-29 and Stock Well SW-12 may constitute current background conditions.

See RAI-16 for additional information regarding stock well SW-12 (STW-12) which will address concerns in regards to this RAI. Uranium One has committed to provide additional information and proposed additional wells to characterize the surficial aquifer as part of the response to RAI 24.

RAI-57

Description of Deficiency

The information provided in the TR does not meet the applicable requirements of 10 CFR Part 40 using review procedures in Section 3.1.2 and acceptance criteria outlined in Section 3.1.3 of the SRP.

Basis for Request

In Addendum 2.7-F, Uranium One states that the Negley Subdivision has numerous domestic and stock wells located in the 120, 110 and 100 sands but none in the 90 or 80 ore zone sands. The closest of these private wells are within 1000 ft of the Leuenberger Wellfields. The 120, 110 and 100 sands are the overlying and uppermost aquifers at the Leuenberger Satellite Wellfields. These sands may experience contamination from spills, leaks or excursions from ISR operations which may go undetected. The TR reports the combined pumping rates for Negley domestic wells in the 100 and 110 sands was 5.61 gpm, and 2.1 gpm in the 120 sand. However, the TR did not include the rates for the stock wells in these sands which make the combined rates be substantially higher. The staff is concerned that the combined pumping rates of all domestic and stock wells may be sufficient to move any contamination in the 100, 110 and 120 sands from the Leuenberger Wellfields toward the Negley wells during the proposed operations. Uranium One did not assess the potential for such contamination to move toward the Negley wells in response to the ground water flow field created by the use of all domestic and stock wells in the Negley Subdivision. Staff cannot provide reasonable assurance of the safe operation of the Negley wells without an assessment of the potential for groundwater contamination to be drawn to the wells by the groundwater flow field created by the operations of all Negley wells. Additionally, staff cannot provide reasonable assurance that the Negley Subdivision wells will be protected from undetected contamination from the Leuenberger Satellite operations without a guard well monitoring strategy.

Formulation of RAI

Uranium One should evaluate and provide: (A) the ground water flow direction and magnitude in the 120, 110 and 100 sands created by all of the Negley wells combined while operating at (1) their permitted rates, and (2) their reported rates over the life of the Leuenberger Satellite operations (2014-2023); (B) an estimate of the time of travel of any contamination from spills, leaks or excursions into these sands at the Leuenberger facility to reach any well at the Negley Subdivision using these two separate ground water flow field scenarios. Uranium One is encouraged to determine the time of travel using a worst case scenario for a spill, leak or excursion into the 120, 110 or 100 sands near the northern edge of Leuenberger Wellfield 1; (C) based on these groundwater flow field scenarios, provide a monitoring guard well strategy to detect the movement of any contamination from leaks, spills or excursions in the 120, 110 or 100 sands at the Leuenberger Satellite toward the Negley Subdivision wells. This guard well strategy *is to be proposed in addition to the typical excursion monitoring of the overlying aquifers in the 100 and 110 sands.*

RAI-57 (A) (B) (C) Response

In addition to the typical excursion monitoring, Uranium One commits to developing a monitor network to detect the potential movement of any contamination from leaks, spills, or excursions that could impact Negley Subdivision wells. Uranium One requests to have further discussions with the NRC to implement a strategy on the development of the monitoring network.

Responses provided to RAI 24 are closely tied to the concerns addressed in RAI 57 and commitments made in RAI 24 to collect additional data on the uppermost aquifer with respect to groundwater flow direction and aquifer properties that would then be used to make predictions regarding the scenarios that the NRC suggests should address NRC concerns.

With respect to RAI(57) Uranium One is a little confused by what the NRC is requesting. They state *Uranium One should evaluate and provide: (A) the ground water flow direction and magnitude in the 120, 110 and 100 sands created by all of the Negley wells combined while operating at (1) their permitted rates, and (2) their reported rates over the life of the Leuenberger Satellite operations.* Uranium One would like clarification on what the 2nd bullet "reported rates" over the life of the Leuenberger Satellite operations is specifically requesting.

Uranium One proposes to do some analytical calculations (once we've determined aquifer properties) to indicate how much drawdown we would expect based on the permitted rates and what type of gradient that would induce out at the distance of the Luenberger Satellite.

RAI-58

Description of Deficiency

The information provided in TR Section 3.1.1 does not meet the applicable requirements of 10 CFR Part 40 using review procedures in Section 3.1.2 and acceptance criteria outlined in Section 3.1.3 of the SRP.

Basis for Request

TR Section 3.1.1 states that all production aquifers in the 90, 80 and 70 sands within the proposed license area are confined. However, staff has evaluated the characterization data presented for the 90 sand aquifer at Peterson Wellfield 2, and finds evidence that this aquifer is unconfined based on water levels and the aquifer pumping test at LPW-4.

Formulation of RAI

Please address the following topics with respect to operations at Peterson Wellfield 2 and any other production zone aquifer in the proposed license area which may be unconfined or is likely to become unconfined during operations:

A. *The limiting extraction rate for the unconfined aquifer for all operations (including excursion capture) to prevent excessive dewatering.*
B. *A revised production schedule if this limiting extraction rate for the unconfined aquifer is determined to be less than the proposed bleed of 15-45 gpm required for production and restoration operations.*
C. *Assurance that dissolved oxygen will be maintained at levels in the lixiviant to prevent "gas lock" when injected into the unconfined aquifer production zone.*
D. *A strategy to detect and correct for "gas lock" in the unconfined aquifer production zone.*
E. *A strategy to detect and correct for free gas in produced waters to prevent damage to piping, pumps and other wellfield infrastructure from the two phase flow of gas and water.*
F. *An evaluation of the maximum drawdown and mounding expected during operations anywhere the unconfined aquifer.*
G. *An evaluation which shows that an inward gradient in the wellfield will be maintained at all times with either five-spot, alternating line drive, or line drive patterns that may be used within the unconfined aquifer. If necessary, please provide the updated bleed rate to maintain this inward gradient.*
H. *A strategy for excursion capture in the unconfined aquifer given the limiting extraction rate.*
I. *A strategy for assuring complete sweep of the unconfined aquifer during restoration of given the mounding and dewatering patterns which will develop.*

J. *An updated flare value which takes into account the vertical flow from mounding and dewatering patterns in the unconfined aquifer.*

RAI-58 (A) (B) (F) (G) (H) (I) (J) Response

See Appendix A for response to this RAI. Uranium One is confused on specifically what information was not provided as part of our response to NRC concerns in Appendix A of the submittal.

RAI-58 (C) (D) (E) Response

See RAI-53 for response to this RAI. Uranium One provided responses in regards to NRC concerns on these issues and would like clarification on what information NRC deems was not provided in regards to the response to this RAI.

RAI-59

Description of Deficiency

The information provided in the TR does not meet the applicable requirements of 10 CFR Part 40 using review procedures in Section 3.1.2 and acceptance criteria outlined in Section 3.1.3 of the SRP.

Basis for Request

On November 13, 2001, The Supreme Court of the United States issued the Modified North Platte River Decree which addressed water use from the North Platte River. In this decree, portions of the North Platte watershed are identified as hydrologically connected to the North Platte River. Within these regions surface water and ground water use for irrigation and other purposes are strictly controlled by a court order. Staff's review of the regional map (https://sites.google.com/a/wyo.gov/seo/documents-data/maps-and-spatial-data) for hydrologically connected areas near the North Platte River showed that the Peterson Satellite is located within the hydrologically connected region. Therefore all water use at this satellite, whether surface or ground water must be approved by WSEO to meet the requirements of the decree. Any evaporation or surge ponds must also meet the terms of the decree. Uranium One did not discuss the decree in its analysis of operations at the Peterson Satellite. The TR does not address implications for the safety of operations at the Peterson Satellite if water use is limited or restricted by WSEO under the decree. Staff cannot provide reasonable assurance of the safety of operations without an analysis of the impact of this decree on proposed operations.

Formulation of RAI

Uranium One should provide a discussion of the operation of the Peterson Satellite with respect to the water use restrictions for all wells and surface impoundments under the Modified North Platte River Decree. This discussion should:

- *provide reasonable assurance that Uranium One will receive the necessary WSEO well permits to operate the wellfields and surface impoundments at the Peterson Satellite wellfields which are affected by the decree;*
- *provide assurance that wells will be permitted at required bleed and restoration rates (15-45 gpm) to ensure that the operations may be conducted safely;*
- *describe if this decree has the potential to reduce or revoke water well permits/rates or surface impoundments permits/rates at any time before restoration of the Peterson Wellfields is completed if water use is found to be in violation of the decree after operations start; and*
- *provide a commitment that if any changes to the wellfield design, ponds or water use are incurred by the WSEO under this decree before operations begin or during operations, Uranium One will inform NRC, so that a safety evaluation of these modifications may be made.*

RAI-59 Responses

See RAI-42 for response to this RAI.

Water Resources

RAI WR-1

Please provide additional information on the isopach maps of the sand and shale units under the Ludeman Project area.

A. Please extend the isopach maps to include the area between the southern Project boundary and the North Platte River.

B. Please add outlines of all ore bodies on the isopach maps and identify the production sand unit for each ore body.

Uranium recovery operations at the Leuenberger Satellite could potentially affect the wells in the Negley Subdivision and operations at the Peterson Satellite could potentially affect the North Platte River. The requested revisions to the isopach maps will allow the NRC to evaluate the potential impacts of uranium recovery operations at the Leuenberger and Peterson Satellites on adjacent areas (i.e., the Negley Subdivision and the North Platte River).

RAI WR-1 (A)(B)Response

Uranium One is evaluating the geologic setting based on additional data that was not available during the development of the initial application. The isopach maps will be updated accordingly based on the new data and submitted to the NRC as soon as reasonable possible. The sand unit within the production zone for each wellfield is provided in RAI WR-2.

The updated isopach maps requested are included in Attachment 3 in the Uranium One response to TR RAI 6.

RAI WR-2

Please identify the sand unit within which the production zone would be located for each wellfield at every Satellite.

The ER refers frequently to the "70, 80, and 90 sand" production zones, but it does not identify the respective sand units that would be developed in each of the individual wellfields in each Satellite area. This information will assist in the NRC's evaluation of the potential impacts of uranium recovery operations at each Project Satellite on adjacent areas.

RAI WR-2 Response

To allow for the NRC's evaluation of potential recovery operations impacts, the respective sand units that will be developed for each of the individual wellfields is provided in the table below. In addition, the overlying unit, underlying unit and estimated unit depths for each wellfield have been incorporated into the following table:

Uranium One has provided the requested Table as part of our response to RAI-22 of the TR. The referenced Table will provide the reviewer the production sand, overlying sand and underlying sand for each proposed wellfield at the Ludeman Project.